Chapter 4
Affected Environment

TABLE OF CONTENTS

CHAPTER 4

List of Tables

List of Figures

CHAPTER 4:

AFFECTED ENVIRONMENT

This chapter describes the existing natural, cultural, manmade, and socioeconomic environments occurring within the Arkansas River Navigation study area. The existing environment results from all past and present actions in the study area. These descriptions serve to establish baseline conditions against which to evaluate anticipated impacts that could result from the proposed action. After the potential impacts of the proposed action are evaluated, a determination will be made whether mitigation is appropriate. Mitigation measures would be planned and developed to protect the baseline conditions that are identified in this chapter. The affected environment is described by resource categories either in general and/or by subcategory where appropriate. The following resource categories were determined to be appropriate to the study and are consistent with the guidelines in the Rivers and Harbors Act of 1970:

- Air Quality;
- Noise;
- Geology and Soils;
- Surface Water;
- Land Use;
- Infrastructure;
- Biological Resources;
- Recreation and Aesthetic Values;
- Cultural Resources;
- Sociological Environment; and
- Economic Environment.

4.1 Introduction

The affected environment of the Arkansas River Navigation Study includes the McClellan-Kerr Arkansas River Navigation System (MKARNS) from the Port of Catoosa near Tulsa, Oklahoma downstream to the confluence of the Mississippi River in southeastern Arkansas as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS.

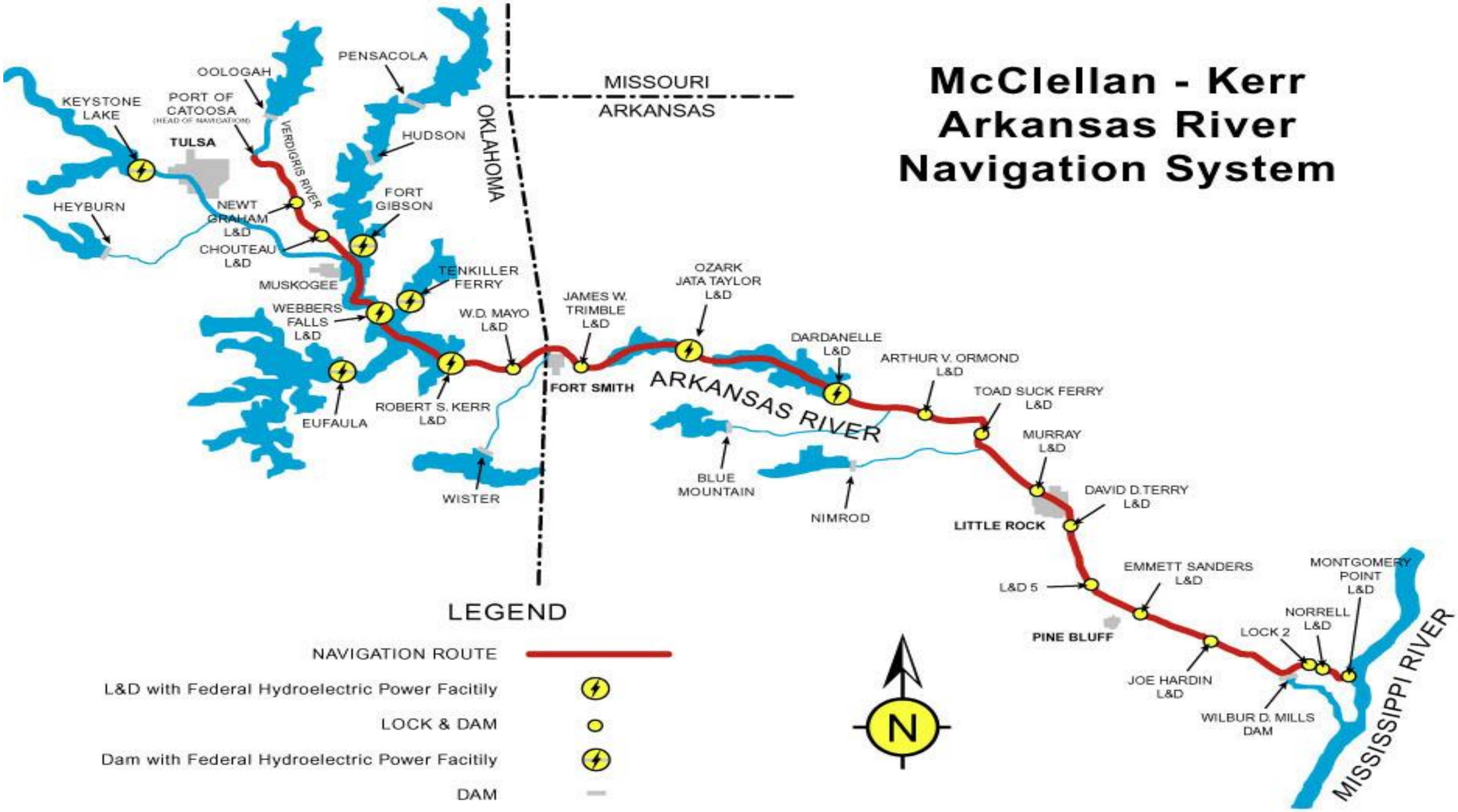
The MKARNS (Figure 4-1) is approximately 445 miles in length and consists of a series of 18 locks and dams. The principal components of the MKARNS waterways include:

- A 50 mile portion of the Verdigris River (navigation miles 445-394);
- Lower Arkansas River, which comprises 375 miles of the MKARNS (navigation miles 394 to 19);
- The Arkansas Post Canal, a nine 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); and
- The Lower Arkansas River downstream of Dam 2 (not formally part of the MKARNS). This portion of the Arkansas River is included in the Arkansas River Navigation Study project area because MKARNS river flows may also influence this segment of the river.

River flows on the MKARNS are primarily influenced by flows on the upper Arkansas River upstream of the confluence with the Verdigris River (river mile 394); as well as water storage and release from 11 reservoirs in Oklahoma. These reservoirs provide flood control, water supply, hydroelectric power, fish & wildlife, recreation, and other benefits.

In general, the affected environment portion of the Arkansas River Navigation Study Environmental Impact Statement (EIS) focuses on the river and associated floodplain of the MKARNS and also discusses the 11 reservoirs in Oklahoma, which defines the study area (Figure 4-2). However, the areas of consideration for environmental impacts associated with each resource category correspond to the geographic scope of the anticipated potential impacts. For example, the analysis area for changes to the MKARNS channel structure affects the MKARNS main channel and its floodplain areas up to the 100-year flood level. However, if the required changes include controlling water levels in the upstream reservoirs, then the areas of potential impact include the flood control pools and the lands that might be inundated more frequently by retaining flood waters for longer periods of time.

Figure 4-1. McClellen–Kerr Arkansas River Navigation System (MKARNS).



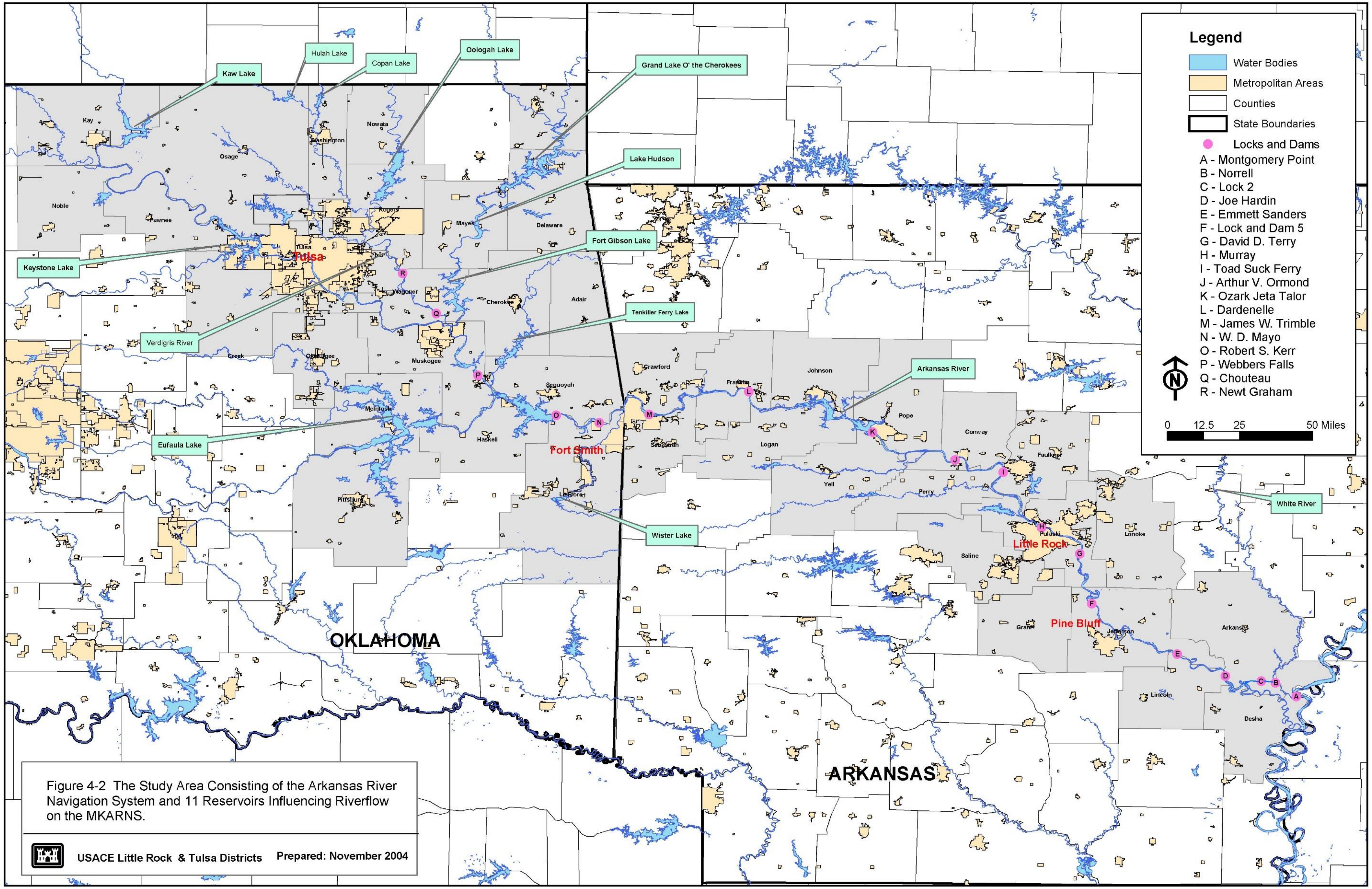


Figure 4-2 The Study Area Consisting of the Arkansas River Navigation System and 11 Reservoirs Influencing Riverflow on the MKARNS.

4.2 Air Quality

The air quality within a given area can be affected by climate conditions. Climate conditions vary from the northwestern portion of the study area in northeastern Oklahoma to the confluence of the MKARNS and the Mississippi River in southeastern Arkansas. Generally, the northeastern portion of Oklahoma receives significantly more precipitation than the western portion of the state. Low precipitation months include November through February. Spring and early or late summer typically account for the larger rainfall events. In the State of Arkansas, rainfall is generally greater in January and May. Rainfall events in southeastern Arkansas are influenced more by the Gulf Stream than those in the northwest portion of the study area.

The States of Oklahoma and Arkansas are responsible for administering their air pollution control programs developed by the respective Departments of Environmental Quality. In addition to State rules and regulations, the U.S. Environmental Protection Agency (EPA) has promulgated various Federal regulations, in the Code of Federal Regulations (CFR) that apply to areas with air constituents in excess of Federal statutes. The Air Quality Control Act of 1967 as amended by the Clean Air Act (CAA) of 1970, established Air Quality Control Regions (AQCRs) based on various criteria including jurisdictional boundaries as well as atmospheric areas of urban industrial concentrations of air contaminants.

The MKARNS study area encompasses several AQCRs in the States of Arkansas and Oklahoma including those shown in Table 4-1.

Table 4-1. MKARNS Study Area AQCRs and (National Ambient Air Quality Standards) NAAQSs Attainment Status.

Region	Contaminant Attainment - Yes (Y) or No (N)				
	Ozone	TSP	NO_2	CO	SO_2
016 - Central Arkansas Intrastate	Y	Y	Y	Y	Y
017 - Metropolitan Fort Smith Intrastate	Y	Y	Y	Y	Y
021 - Northwest Arkansas Intrastate	Y	Y	Y	Y	Y
185 - North Central Oklahoma Intrastate	Y	Y	Y	Y	Y
186 - Northeastern Oklahoma Intrastate	Y	Y	Y	Y	Y
188 - Southeastern Oklahoma Intrastate	Y	Y	Y	Y	Y

Source: 40 CFR 81

All six AQCRs in the study area are in attainment of applicable air quality standards. Both states have developed Air Divisions that are responsible for facilitating the departments' responsibilities for NAAQSs attainment issues, air emissions permitting, and development and enforcement of air regulations and initiatives. Because of the overall attainment with current NAAQSs, neither state has developed a State Action Plan, which is a plan developed by each state which details out measures needed to reduce greenhouse gases and bring all areas within the state into NAAQSs attainment.

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.

4.2.1 Stationary Emission Sources

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

4.2.2 Mobile Emission Sources

The primary pollutants produced through mobile emission sources are carbon monoxide, nitrous oxides, hydrocarbons, and particulate matter. Emissions produced in utilizing barges for transportation are generally much lower when compared to truck or rail transportation. The EPA Emissions Control Lab has evaluated the emissions produced by three modes of transportation moving one ton of cargo one mile. As shown below the impact on air quality from the use of barges is significantly less than other modes of transportation, resulting in the utilization of less fossil fuels and production and release of fewer air pollutants.

Emissions per Ton-Mile (pollutants in pounds)

	Hydrocarbon	Carbon monoxide	Nitrous oxide
Towboat	0.09	0.20	0.53
Rail	0.46	0.64	1.83
Truck	0.63	1.90	10.17

The Federal Highway Administration estimates that for each 1 million tons of coal diverted from barge to truck, 45,600 additional trucks would be needed to move the coal at a cost of $1.14 million in surface repairs. Not factored is the increased congestion caused by more traffic on the roadways. As shown below, the number of miles one ton of cargo can be carried per gallon of fuel is also more than double that of train and almost nine times that of truck.

Number of Miles One Ton of Cargo Can Be Carried Per Gallon of Fuel.

By Truck	59 miles
By Train	202 miles
By Inland Barge	514 miles

There are five public ports and over 50 private ports along the MKARNS on which both foreign and domestic trade is conducted. The public ports of Little Rock, Fort Smith, Pine Bluff, Muskogee and Catoosa handle the majority of the in-bound and out-bound tonnage of goods shipped. The Ports of Little Rock, Catoosa and Muskogee are also designated as Foreign Trade Zones. The Tulsa Port of Catoosa is the largest port on the MKARNS with over 2,000 acres of contiguous land area and nearly 50 companies employing 2,600 people located in the port's industrial complex. Traffic in 2001 on the MKARNS along with comparable sized navigation systems is shown in Table 4-2.

Table 4-2. Domestic Traffic for Selected U.S. Inland Waterways in 2001 (Millions of Short Tons, Billions of Ton-Miles[1], and % Change From 2000 for Each).

	Length	Tons		Ton-miles		Trip[2] ton-miles	
Waterway	**(miles)**	**2001**	**%**	**2001**	**%**	**2001**	**%**
Atlantic Coast							
Intracoastal Wtwy, Jacksonville to Miami, FL	349	1.0	18.5	**	-59.3	**	-42.6
Gulf Coast							
Black Warrior and Tombigbee Rivers, AL	449	18.9	-19.4	3.2	-36.0	6.6	-21.5
Tennessee-Tombigbee Waterway, AL and MS	234	6.8	-3.6	1.3	0.1	4.1	-0.6
Mississippi River System							
Cumberland River, KY and TN	381	23.2	2.2	2.4	3.7	10.5	2.0
Illinois Waterway, IL	357	43.5	-1.7	8.7	-3.0	43.8	-3.0
MKARNS, AR and OK	462	11.2	4.4	2.4	6.6	6.6	1.1
Ouachita and Black Rivers, AR and LA	332	1.6	6.7	0.2	4.3	0.7	-4.0
Pacific Coast							
Columbia River System, OR, WA, and ID	596	20.2	-12.2	0.7	-17.3	6.9	-12.7

[1]** denotes ton-miles of less than 50 million.
[2]Internal and intraport tons times total distance from origin to destination.
Includes deep draft waterways.

Source: Waterborne Commerce Statistics Center, 2003.

Tables 4-3 and 4-4 present information on freight shipments that have either an origin or a destination in Arkansas or Oklahoma. As shown in the table, trucks moved a large percentage of the tonnage and value of shipments, followed by rail. Truck traffic is expected to grow throughout the two states over the next 20 years. Much of the growth will occur in urban areas and on the Interstate highway system increasing the level of highway vehicle emissions in the two states.

Table 4-3. Freight Shipments To, From, and Within Arkansas.

Arkansas	**Tons (millions)**			**Value (billions $)**		
	1998	**2010**	**2020**	**1998**	**2010**	**2020**
By Mode						
Air	<1	<1	<1	6	17	34
Highway	163	253	331	133	268	445
Other	<1	<1	<1	<1	<1	<1
Rail	48	62	72	10	18	28
Water	14	20	24	2	4	6
Grand Total	224	335	428	151	307	512

Source: Office of Freight Management and Operations, http://www.ops.fhwa.dot.gov/freight, 2002.

Table 4-4. Freight Shipments To, From, and Within Oklahoma.

Oklahoma	**Tons (millions)**			**Value (billions $)**		
	1998	**2010**	**2020**	**1998**	**2010**	**2020**
By Mode						
Air	<1	<1	<1	7	17	30
Highway	171	241	296	122	228	366
Other	<1	<1	<1	<1	<1	<1
Rail	44	56	64	11	18	26
Water	4	6	7	<1	1	2
Grand Total	219	304	367	140	263	424

Source: Office of Freight Management and Operations, http://www.ops.fhwa.dot.gov/freight, 2002.

4.3 Noise

Sources of noise along the MKARNS include stationary sources and mobile sources on the waterway as well as in adjoining recreational areas. Transportation noise levels are not only generated by the source engines, but also by frictional contact with the ground and air. High-speed, heavy vehicles that travel by land or rail that incur both surface and air friction noise will generally cause more noise effects than waterway transportation. Horns and whistles associated with transportation vehicles create the highest readings.

Noise generation from stationary sources on the MKARNS is generally small and localized and includes fossil fuel and hydroelectric power plants located along the system as well as other stationary sources such as ports and their associated businesses.

Mobile sources would include towboat engines, dredging operation, recreational powerboat engines and personal watercraft. The Waterborne Commerce Statistics Center (Table 4-2) indicates that 11,200,000 tons were shipped on the MKARNS in 2001, which is equivalent to 7,467 barges (a larger barge can transport approximately 1,500 tons). The number of recreational vessels locking through the 12 Arkansas and 5 Oklahoma locks from 1993 to 2002 are shown in Table 4-5.

Table 4-5. Trends in Recreational Vessel Usage of the MKARNS, 1991 to 2003.

Year	Arkansas	Oklahoma
2003	8,132	Na
2002	6,243	2,341
2001	7,420	1,846
2000	6,849	2,325
1999	9,018	1,978
1998	9,750	2,577
1997	12,248	2,319
1996	15,470	2,941
1995	9,895	2,066
1994	10,426	2,688
1993	9,978	2,629
1992	12,111	3,155
1991	13,595	3,012

Source: U.S. Army Corps of Engineers (USACE), Little Rock and Tulsa Districts.

Mobile sources of noise on waterways are higher for smaller vehicles such as powerboats and personal watercraft than for larger vessels such as barge tows:

- Small pleasure craft noise at high rates of speed can exceed 120 decibels (Db) to passengers, whereas an individual on shore may only receive the sound at 90 Db; and

- At a distance of 50 feet, a tugboat's noise level registers approximately 82 (Db), less than a small pleasure craft (DA 2003). Therefore to a person standing on the shore of the river, a tugboat's passage would be quieter than that of a pleasure craft.

Several factors influence noise generation by barge tows when compared to smaller watercraft as well as land transportation including:

- Slower and steady rates of speed. Unlike smaller watercraft and land transportation, barges do not employ rapid acceleration or deceleration;
- There are no brakes for wheels, and barges have infrequent use of horns while in operation due to lack of crossings with roadway traffic. High decibel horn noise is more prevalent in road traffic;
- Noise levels generated through frictional contact with air are lower for barges than for smaller watercraft and land transportation. The slower speeds of tows compared to smaller powerboats, personal watercraft, rail and truck as well as partial submergence of the vessels reduce air friction; and
- Water dampens the tugboat engine noise. Smaller craft generally travel higher in the water at higher speeds, resulting in higher engine noise levels.

Other sources of mobile noise associated with the MKARNS include noise generated from human activity at ports and recreation areas, traffic noise, and noise from rail, truck yard, and water port operations. Rail and truck yard noise is typically higher than noise generated from water ports because much of the higher levels of sound generation results from vehicle brake, horn and whistle noise (USACE, 2005a). However, water ports are frequently tied in to other transportation modes such as rail and trucks so the noise generation level can be similar depending on the activities conducted at the water port.

The natural environment can also add to overall noise levels along the MKARNS including wildlife such as local and migratory bird populations. Also, minimal noise associated with flowing/rushing waters that would vary based on the flow regime of individual areas. Generally, waters leaving hydroelectric power turbines or through spillway gates at the dams generate more noise than areas of normal flow regime.

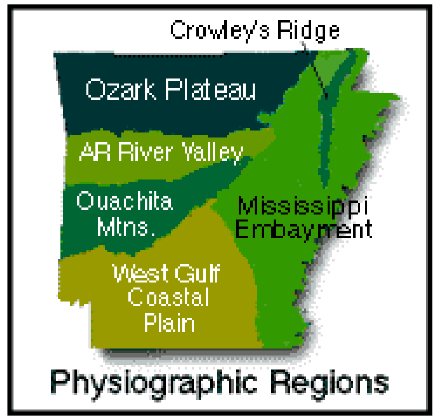
Sensitive receptors would be limited to residences or community receptors in lands immediately adjoining the MKARNS. Other receptors include recreational area users along the waterway and in adjoining areas.

4.4 Geology and Soils

4.4.1 Topography

The difference in elevation from the beginning of the MKARNS at the Port of Catoosa to the confluence with the Mississippi River is 420 feet. Because the elevation of the Arkansas River through Tulsa is 100 feet higher than the Verdigris at Catoosa the U.S. Army Corps of Engineers (USACE) channeled up the Verdigris River from Muskogee to Catoosa rather than the Arkansas. The MKARNS study area traverses many physiographic regions in Arkansas and Oklahoma.

The major physiographic provinces include the Ouachita Province, the Ozark Plateau Province and the Mississippi Alluvial Plain.



Source: Smith,, 1989

The Ouachita Province is divided into the Ouachita Mountains Section in the southern portion of the province and the Arkansas Valley Section in the northern portion. The Ouachita Mountains Section is distinguished by ridge and valley topography rising in some areas to more than 2,000 feet above sea level. The Arkansas Valley Section includes lower elevation plains (300-600 feet above sea level) with smaller east-west ridges generally no more than 1,000 feet above sea level. Normal MKARNS navigation pool elevation in Arkansas Valley Section varies from over 500 feet above sea level in eastern Oklahoma to approximately 250 feet above sea level near Little Rock, Arkansas.

The Ozark Plateau Province is north of the Ouachita Province and is separated into the Boston Mountains Section to the south of the Province and the Salem and Springfield Plateaus to the north. The Boston Mountains Section occurs along the northern portion of the Arkansas River Valley in northwestern Arkansas and northeastern Oklahoma. This 35-mile wide section is a deeply dissected plateau region characterized by flat-crested ridges that generally ranges from 1,900 to 2,500 feet above sea level. The valleys are generally V-shaped and are cut 300 to 1,000 feet below the ridges.

Downstream of Little Rock, Arkansas, the topography transitions to the Mississippi Alluvial Plain that generally consists of low floodplains, and floodplain terraces. Crowley's Ridge in Arkansas is the most prominent topographic feature of the Mississippi Alluvial Plain. It is thought that this ridge is in part a north-south outlier of older, underlying Coastal Plain rocks (Smith, 1989).

4.4.2 Geology

The rocks that underlie 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.

The Ouachita Province rock is mostly a thick sequence of shale and sandstone, deposited during the Cambrian to early Pennsylvanian time, within an elongating subsiding Ouachita trough. The trough was formed by rifting along a late Precambrian-early Paleozoic continental margin. The Ouachita trough contains depositional deep-water sediments. The trough was closed during the late Pennsylvanian time by compress ional tectonic forces. These forces created an intensely folded structure with north and south directed thrust faults. The thrust faults occur in folded structures and result in the rocks above the fracture depositing over the rocks below. Normal faults are common in the areas north of the Arkansas River, and thrust faults are present south of the river in the Ouachita Mountains.

The Ozark Plateau Province consists of rocks of Ordovician to Pennsylvanian age that are underlain by dolomite and sandstone beds of Cambrian Age that formed at the basal part of the Paleozoic sequence. The Ozark uplift, centered in southern Missouri affects the structural attitude of Paleozoic rocks in northern Arkansas. In general, outcrop rocks in northern Arkansas result from annular bands around the Ozark uplift. Rocks of Ordovician to Mississippian age in the Ozark Plateau Province that dip gently southward from northern Arkansas are dominated by shallow-water carbonate-shale sequences with some deltaic sandstones. These were deposited on a cretonic shelf in the Precambrian. The Boston Mountains Section of this province consists mostly of Pennsylvanian sedimentary rocks of sandstone and shale deposited in deltaic, open marine, coastal, and swamp environments.

The Mississippi Alluvial Plain contains alluvial deposition over the Coastal Plain sedimentary rock, which is of Cretaceous to early Tertiary in age, except where covered by Holocene deposition from the ancestral Mississippi River. About 12,000 years ago, a braided ancestral Mississippi River resulted from glacial melt waters carrying large volumes of course-grained sand and gravel detritus. As the sediment load lessened the Mississippi River became a meandering river system, depositing sand, silt, and clay (AGC, 2005).

4.4.3 <u>Soils</u>

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 may only be 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 alluvium and alluvial terraces of the main stem of the Arkansas River average more than 5 miles in width and 45 feet in depth between the confluence with the Cimarron River and where the Arkansas passes Tulsa. The deposits are predominantly sand and gravel and the water table is generally less than 20 feet below the soils.

In 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 National Resources Conservation Service (NRCS 1975) has indicated the following soil associations for the area:

- 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. The *Wrightsville* association is similar but predominantly level on old stream terraces; and
- 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.

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. Soils types range from loamy soils along bayou ridgetops to predominantly clay in lower elevations. The primary soil associations of the study area through this portion of the state include:

- 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; and
- 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.

4.4.4 <u>Alluvial Sediment</u>

During periods of high river flows, water velocities are reached that 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. These shoals, when they occur in the navigation channel, 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 most likely to be free of contaminants if the material is composed primarily of sand, gravel, or similar materials and is found in areas of high current or wave action. Maintenance dredged material from the Arkansas River is primarily composed of sand and relatively free of pollutants (USACE 2003). Sediment quality data can be found in Appendix E.

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 (CWA) 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. The Inland Testing Manual contains technical guidance for determining the potential for contaminant-related impacts associated with the discharge of dredged material into waters regulated under Section 404 of the CWA through chemical, physical, and biological evaluations. The manual utilizes a tiered process for analysis of a dredged material site. Subpart G of the Section 404 (b) (1) guideline, known as the "reason to believe principle" requires the use of available information to make a preliminary determination concerning the need for testing of the material proposed for dredging. The reason to believe that no testing is required is based on the type of material to be dredged and/or its potential to be contaminated. This general evaluation describes the procedures found in Tier I of the Inland Testing Manual's tiered-testing process. If the available information is sufficient to make a positive factual determination, no further testing is required. Evaluation at successive tiers is based on more extensive and specific information about the potential impact of the dredged material. It is necessary to proceed through the tiers only until information sufficient to make factual determinations been obtained.

A Long Term Dredge Material Disposal Plan (DMDP) for the Oklahoma portion of the MKARNS navigation system has been prepared by the USACE (2003). This plan, which is part of the Navigation Channel Depth Maintenance Feature of the Proposed Action, identifies 26 maintenance dredged material disposal sites that occur or are planned for the Tulsa District portion of the MKARNS (Pools 13 to 18). The USACE has performed a "screening" level analysis of MKARNS sediment quality in support of both future O&M dredging needs (maintenance of 9-ft channel) as well as impact assessment for channel deepening proposals. Similar methodology was used for sampling site selection for both Oklahoma and Arkansas portions of the MKARNS. Sampling sites in Oklahoma and Arkansas were selected by Tulsa and Little Rock District personnel, respectively. Detailed results from the USACE sediment sampling and testing can be found in Appendix E and represents the most recent sediment quality data available.

From 20th - 24th September, 2004, representatives of the USACE, Tulsa District collected sediment samples along the Oklahoma portion of the MKARNS. A total of 24 surface sediment and 12 subsurface sediment samples were collected. Samples were analyzed in accordance with current guidelines referenced in USEPA SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (3rd Edition).

In general, constituents were reported at low detection frequencies and concentrations throughout the sampled Oklahoma portion of the MKARNS:

- bis(2-ethylhexyl)phthalate, a phthalate ester, was detected in low concentrations in several samples. This compound is recognized by the USEPA as a common laboratory contaminant and may be introduced into a sample through laboratory cross-contamination (USEPA 1989);
- The only other detected semivolatile compounds included several detected at low concentrations in the depth-composited sample at river mile 421.0. For those with established Threshold Effects Concentration (TEC) values, "below which adverse effects are not expected to occur," detected concentrations were well-below TEC criteria;
- For chlorinated pesticides, detected constituents occurred in only three samples (7SBC B, 421.0 B, and 422.0 B). In all cases, concentrations were low and below TECs for specific pesticides;
- Detected concentrations of Polychlorinated Biphenyls (PCBs) were reported for only one sample (a surface sample at 9 San Bois Creek). Total PCBs at this location were 26.2 parts-per-billion or ppb, below the total PCB TEC of 59.8 ppb;
- With the one exception noted below, concentrations of all metals were below TEC values in all samples at all locations; and
- In the surface sample from river mile 421.0 (near Newt Graham Lock and Dam), cadmium was detected at 3.45 ppm. This concentration exceeds the cadmium TEC of 0.99 but is less than the Probable Effects Concentration (PEC), values "above which adverse effects are expected to occur more often than not," of 4.98 ppb. A much lower concentration was reported in the depth-composited sample at this location.

Along the Arkansas portion of the MKARNS, there are 138 pre-approved dredged material disposal sites encompassing 12,709 acres. Of those sites, 42 sites encompassing 6,207 acres are open-water dredged material disposal sites.

From 16th-20th February, 2005 representatives of the USACE, Little Rock District collected sediment samples along the Arkansas portion of the MKARNS. In particular, surface sediment and, subsurface sediment samples were collected. Samples were analyzed in accordance with current guidelines referenced in USEPA SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (3rd Edition).

Two facilities, under the regulatory jurisdiction of the U.S. Nuclear Regulatory Commission (NRC), are currently undergoing decommissioning and have the potential to contain onsite contamination. These facilities are FMRI, Inc. (formerly Fansteel), located directly on the western bank of the Arkansas River (Webbers Falls Pool) near Muskogee, Oklahoma and the Sequoyah Fuels Corporation, a uranium conversion facility, located in Gore, Oklahoma (Robert S. Kerr Pool).

The Fansteel facility was a rare metal extraction operation, producing tantalum and columbium metals from ores and tin slag feedstock. The raw materials used for tantalum and columbium production contained uranium and thorium as naturally occurring trace constituents in such concentrations that the facility was required to obtain an NRC license. As a result of operations and various accidents and releases, this facility, including its soils, groundwater, and surface waters, have been and continue to be contaminated by uranium, thorium, ammonia, arsenic, chromium, metals, cadmium, ammonia, methyl isobutyl ketone (MIBK), and fluoride (Earth Sciences Consultants, Inc. 1993).

At the Sequoyah Fuels Corporation site (located along the Illinois River near the confluence with the Arkansas River, Robert S. Kerr Pool), uranium and thorium contamination of the soils and subsoils has been identified. In addition, the groundwater is contaminated with uranium, thorium and metals. A remedial action program has been implemented to address the groundwater contamination at this site. A hearing has been granted to the State of Oklahoma and the Cherokee Nation on issues related to the reclamation plan proposed at the site. Additionally, the State of Oklahoma appealed the Commission's decision regarding classification of some wastes as 11e.(2) byproduct material to the Tenth Circuit Court of Appeals. Oklahoma has also petitioned for a hearing on a proposed plan to dewater raffinate sludges that are currently in settlement ponds (NRC 2005).

Negotiations are being conducted by the ODEQ, the NRC, and the facilities to resolve the contamination and decommissioning issues. To date, no contamination from these sites has been found in the MKARNS (Sequoyah Fuels Corporation 2002, USACE 1988).

4.4.5 Hydrogeology

The hydrogeology of the MKARNS study area is strongly influenced by the alluvial aquifers of the surface waters of the system such as the Arkansas River, as well as the physiographic confining units for the various regions. In the Oklahoma portion of the study area, alluvial aquifers are the main source of ground water. In Arkansas, there are several other aquifers that contribute along the system.

In Oklahoma, wells near the Arkansas River near Tulsa supply irrigation water that yield as much as 600 gallons per minute. The water storage in this `region occurs in deep alluvial sand and gravel deposits that can be as much as 150 feet thick and 5 miles wide. A small portion of the study area in Oklahoma crosses the narrow Ada-Vamoosa Aquifer, which runs north / south from the Kansas border to the middle of the state as a narrow band of the Central Lowland Physiographic Province. This aquifer produces very little groundwater compared to the more shallow alluvial system.

In Arkansas, available groundwater along the MKARNS study area also comes largely from alluvial aquifers of the Arkansas and the Mississippi River. These high yielding aquifers consist of sand, gravel, silt and clay. Highest water storage is found in the Mississippi River Alluvial Plain Section physiographic region from Little Rock to the confluence of the MKARNS with the Mississippi River. The Ozark Plateau Province and the Ouachita Mountain Province Aquifer systems in northwestern Arkansas, also provide groundwater resources along the study area.

The Ozark Plateau affects the study area from Muskogee, Oklahoma to Little Rock Arkansas and consists of limestone dolomite and sandstone. The Ouachita Aquifer is located along the southern portion of the MKARNS from Fort Smith Arkansas to Little Rock and consists of sandstone, shale, and chert-novaculite.

Overlapping aquifers in northwestern Arkansas and to a lesser extent northeastern Oklahoma, have minor connections to the Western Interior Plains Aquifer system, which is a large aquifer system that encompasses much of the Arkansas River watershed area in the plains states. This larger system acts more as a confining unit between the Ozark Plateau Aquifer and the Ouachita Aquifer, and consists of shale, siltstone, sandstone and minor limestone, producing only minimal amounts of groundwater at local levels (AGC, 2005).

4.5 Surface Waters

4.5.1 MKARNS

The source of the Arkansas River is near the town of Leadville, Colorado on the eastern slope of the Rocky Mountains. Along the journey to the mouth of the river at the Arkansas / Mississippi border into the Mississippi River near Rosedale, Mississippi, the Arkansas River flows southeasterly through Colorado, Kansas, Oklahoma and Arkansas. The river is the fourth longest river in the United States and the sixteenth longest in the world.

Many major tributaries flow into the Arkansas River including the Cimarron, Canadian, Neosho, Grand (formed by the confluence of the Neosho and the Spring Rivers) Verdigris, and White Rivers. Minor tributaries include the Currant and Big Sandy Rivers in Colorado, the Pawnee, Walnut, Rattlesnake and Little Arkansas Rivers in Kansas, the Salt Fork (Arkansas), and the Illinois and the Poteau Rivers in Oklahoma.

The Arkansas River has a rapid current as it flows through mountain valleys and canyons in the upper Arkansas River to rolling plains and lush forests of the lower Arkansas River. Numerous water storage, flood control, and hydroelectric projects are found throughout the river's length. Waters from several states encompassing approximately 160,500 square miles (415,690 kilometers) drain into the Arkansas River including waters from New Mexico, Colorado, Kansas, Texas, Oklahoma, Missouri and Arkansas.

The beginning of the MKARNS is located at the confluence of the White River and the Mississippi River. The Arkansas River comprises most of the MKARNS and is entered via the White River to the Arkansas Post Canal, then up the Arkansas River to Muskogee to the Port of Catoosa via the Verdigris near Tulsa. The total length of the MKARNS is 445 miles, of which 375 miles is the lower Arkansas River (navigation miles 394 to19). Other MKARNS components include approximately 50 miles of the Verdigris River (navigation miles 445 to 394), the Arkansas Post Canal, a nine-mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10), and the lower 10 miles of the White River (navigation miles 10 to 0).

4.5.1.1 Locks and Dams

Navigation on the lower Arkansas and the other components of the MKARNS is controlled by a series of 18 locks and dams. The USACE maintains a minimum 9-foot channel depth on the system. Passage through MKARNS lock chambers was configured for 8 barges, but can accommodate 15 barge tows using double lockage.

Each lock chamber is 110 feet wide and 600 feet in length. There are currently 18 completed locks. Five of the lock and dams are located in Oklahoma beginning on the Verdigris River. The remaining are located on the Arkansas portion of the MKARNS.

The lock and dam structures are constructed along the waterway in a stair step pattern that gradually follows the natural elevation changes of the topography while still maintaining a navigation pool. Table 4-6 includes the length, location and elevation for each navigation pool.

Table 4-6. Navigation Pools of the MKARNS.

Navigation Pool (NP)	Length (miles)	Navigation Mile[1]	Elevation[2]
Oklahoma Pools			
Newt Graham NP*	23.2	421.6	532 to 511
Chouteau NP*	20.2	401.4	511 to 490
Webbers Falls Lake	32.5	368.9	490 to 460
Robert S. Kerr Lake	32.7	336.2	460 to 412
W.D. Mayo NP	16.6	319.6	412 to 392
Arkansas Pools			
Hammerschmidt Lake (J.W. Trimble)	26.8	292.8	392 to 372
Ozark Lake (Ozark-Jeta Taylor)	36.0	256.8	372 to 338
Dardanelle Lake	51.3	205.5	338 to 284
Rockefeller Lake (Arthur V. Ormond)	28.6	176.9	284 to 265
Toad Suck Ferry NP	21.0	155.9	265 to 249
Murray NP	30.5	125.4	249 to 231
David D. Terry NP	17.3	108.1	231 to 213
Lock & Dam No. 5 NP	21.8	86.3	213 to 196
Emmett Sanders NP	20.3	66.0	196 to 182
Joe Hardin NP	15.8	50.2	182 to 162
Lock No. 2 (Canal)**	36.9	13.3	162 to 142
Norrell (Canal)**	3.1	10.2	142 to WR

[1] Navigation miles upstream from the mouth of the White River.

[2] Elevation in feet above mean sea level (msl) from upper pool to lower pool.

* Verdigris River; ** Arkansas Post Canal

Source: USACE, 2000.

4.5.1.2 River Elevations

The Arkansas River was once a meandering and unpredictable river, which had a wide floodplain in many areas. Large sections of the Arkansas River were often not navigable to boat travel because of the water level, and the economic benefit of the river was not completely realized. During certain times of the year people could practically walk across some parts of the river on sandbars. At other times, the river flooded and caused millions of dollars in lost farm crops and property damage.

In 1946, after many years of study and debate, Congress authorized the USACE to begin constructing a planned series of locks and dams on the Arkansas River from the mouth of the river well into Oklahoma (The McClellan-Kerr Project continues for 50 miles up the Verdigris River in Oklahoma to the Port of Catoosa in Tulsa). Two U.S. Senators, John L. McClellan of Arkansas and Robert S. Kerr of Oklahoma, worked to get Congress to appropriate the necessary billions of dollars needed for the huge project. After twenty years of study and work, the system was finished in 1970. The USACE constructed the locks and dams and continues to maintain them.

The MKARNS has also been channelized and stabilized with dikes and revetments to improve navigation on the system. This channelization has reduced the historic breadth of the floodplain in these areas. The placement of levees along the system to retain floodwaters and control normal flood events has also impacted the systems' historic floodplain.

The accumulation of alluvial deposits in the floodplain and floodplain terraces has created fertile soils for cultivation. The study area, which includes the navigation pools created above lock and dam structures along the MKARNS as well as the upstream reservoirs, covers much of the historic floodplain of the Arkansas River and its tributaries. Lands once cultivated by both Native Americans and settlers have now been inundated by pool and reservoir waters.

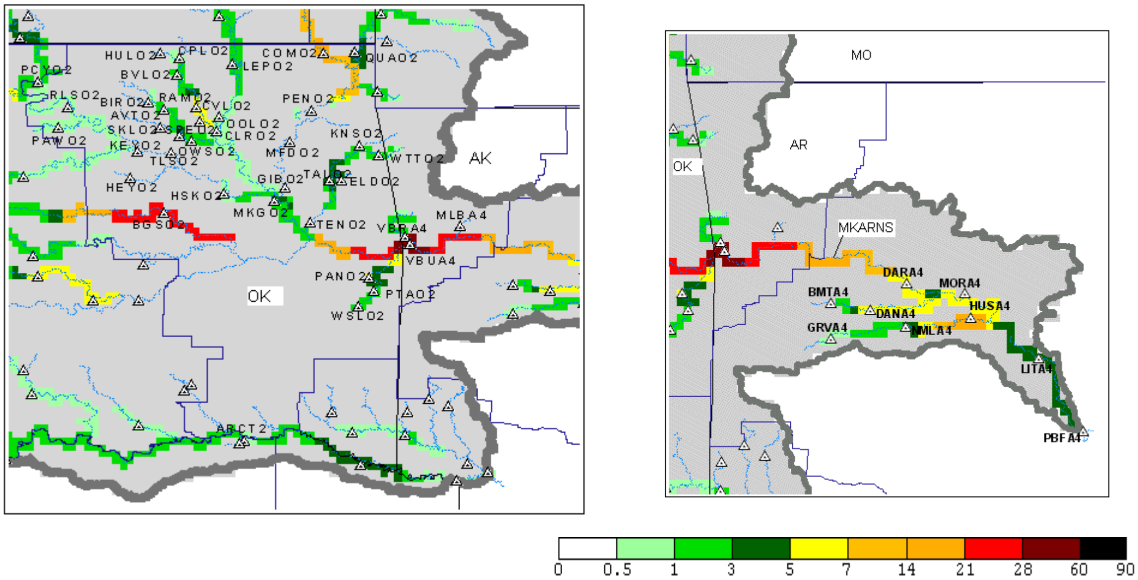
The Van Buren gauging station is used as the control point for river stages on the MKARNS. River flows are defined as follows:

- Optimum Flows. Optimum river flows are defined as less than 61,000 cubic feet per second (cfs). This definition correlates to optimum conditions for commercial navigation on the MKARNS;
- Moderate Flows. Moderate river flows are defined as those between 61,000 cfs and 100,000 cfs. Flooding of some fields along the main stem of the Arkansas River in western Arkansas begins at flows greater than 61,000 cfs;
- High Flows. High river flows are defined as those between 100,000 cfs and 175,000 cfs. The 100,000 cfs level is considered critical because any flow above 100,000 cfs renders the navigation system non-navigable for commercial barge traffic. A flow of 137,000 cfs represents bank full at Van Buren; and
- Very High Flows. Very high river flows are defined as those greater than 175,000 cfs. A flow of 175,000 cfs is notable because that is the point in the modeled condition data above which no appreciable difference is shown from the baseline or between alternatives.

Figure 4-3 shows the annual average number of flood days on rivers within the Red/Arkansas River Basin. The highest numbers of annual flood days on the MKARNS are located along the border of Oklahoma and Arkansas near Van Buren.

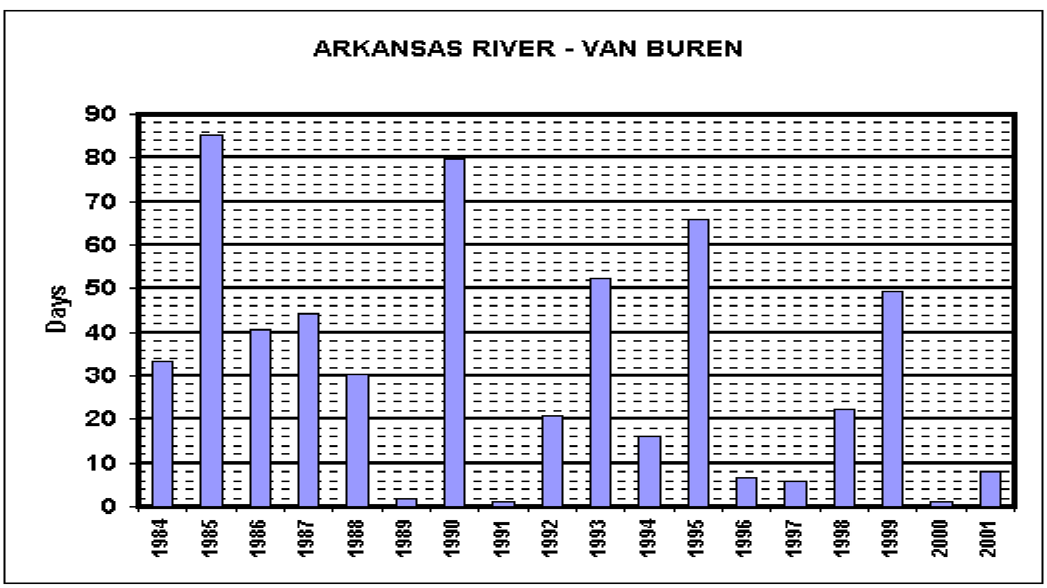
High river levels around the Van Buren, Arkansas area are also reflected in the yearly flood data collected between 1984 and 2001 as shown in Figure 4-4.

Figure 4-3. Average Number of Flood Days Per Year Along the MKARNS in Oklahoma and Arkansas



Source: National Oceanic and Atmospheric Administration (NOAA), 2003.

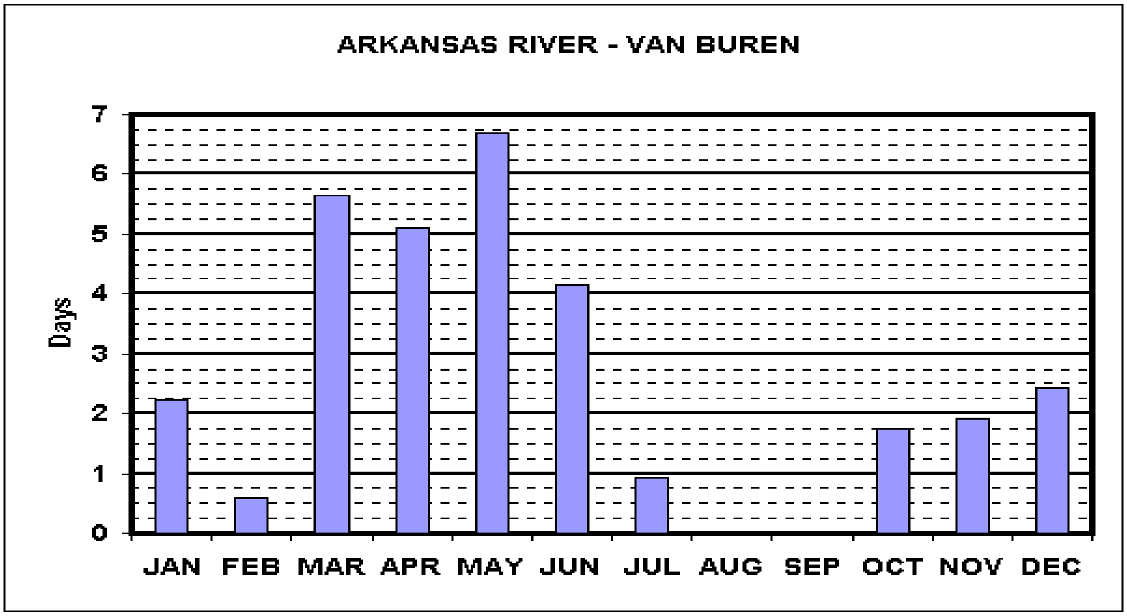
Figure 4-4. Number of Flood Days Per Year Between 1984 and 2001 at the Van Buren Recording Station.



Source: National Weather Service, Arkansas-Red Basin River Forecast Center, 2003.

The highest average number of flood days per month at Van Buren tend to fall between April and June as shown in Figure 4-5. This flooding trend is reflected throughout the MKARNS.

Figure 4-5. Average Number of Flood Days Per Month as Recorded on the MKARNS in Van Buren.



Source: National Weather Service, Arkansas-Red Basin River Forecast Center, 2003.

Until recently, Tulsa, Oklahoma had a long history of flooding. The city is subject to high intensity rainstorms that can strike with little warning and dump as much as fifteen inches of rain in eight hours. Much of the city was built within the floodplain of the Arkansas River or one of its tributaries. Over 25,000 homes and businesses were built in flood-prone areas. Between 1970 and the mid-1980s, Tulsa County led the nation in flood disasters and was declared a Federal disaster area ten times.

The following is a flooding time line of Oklahoma between 1900-2000:

- **1900 September 9-10:** Floods in eastern Indian Territory from heavy rains associated with remnants of the Galveston Hurricane;
- **1908 Wettest June of century:** Statewide-averaged precipitation of 8.73 inches. Widespread flooding reported;
- **1916 January:** Fort Gibson records 13.08 inches of precipitation. Neosho, Verdigris, and Arkansas rivers all flood. Widespread sleet and snow occurred late in the month;
- **1923 June 11-13:** Severe flooding along Arkansas and Chikaskia rivers, especially in Ponca City, Blackwell, and Tulsa. There were proposals to create reservoirs on the Arkansas and Red Rivers to help prevent future flooding. The Tulsa Chamber of Commerce leads an effort to form a seven state commission to investigate flood control methods in the Arkansas and Red River basins;

- **1927 April 6,7:** Heavy rains added to already high stream flow produce greatest flooding along the Arkansas River (below the mouth of the Neosho River) since 1833. The flood extended through the 19th inundating 165,000 acres with losses totaling $4 million (in 1927 dollars);
- **1943 May 18-22:** Record flood on the Arkansas near Muskogee;
- **1945 April 13-14:** 14.6 inches of rain at Seminole. Wewoka Dam fails;
- **1957 May 16-21:** Heavy rains throughout. Major flooding on Cimarron, Arkansas, Canadian. $20 million losses to agriculture alone. Lake Texoma emergency spillway opened for first time. Floods marked the end of persistent drought that began in 1952;
- **1959 October 2-5:** Severe flooding on Cimarron and Arkansas;
- **1984 May 26-27:** Tulsa Memorial Day flood — more than 12 inches of rain overnight, subsequent flooding left 14 dead, destroyed or damaged 5,500 homes and over 7,000 vehicles. In reaction to this disaster, Tulsa launched a massive flood prevention and warning system that remains among the most effective public safety programs in the nation;
- **1986 September 30-October 4:** Remnants of Hurricane Paine produce rains of around 10 inches in western and central Oklahoma and as much as 20 inches in north central Oklahoma. Major flooding on Arkansas River and its tributaries. Flooding was reported in 52 counties, damages estimated at $350 million, half of that to agriculture; and
- **1990 May 1-4:** Major flooding on the Red, Canadian, and Arkansas Rivers.

Much of the farmland in eastern Arkansas is in the floodplains of major streams and rivers, and widespread flooding in low-lying areas is a continuing concern. The following is a flooding time line of eastern Arkansas between 1900-2001:

- **1833:** Record Arkansas River Flood at Little Rock, AR;
- **1844:** Greatest flood of record on Arkansas River at Pine Bluff, AR;
- **The Floods of 1927:** During the Spring of 1927 persistent heavy rains led to widespread river flooding in Arkansas. The worst flooding was on the Arkansas and Mississippi Rivers; many record high river stages were set that Spring and a lot of them still stand.
- **1941:** Flooding along the Arkansas River between Muskogee and Ft. Smith;
- **1943:** Flooding after 24 inches of rain in 6 days from McAlester to Muskogee. Some reports state that "half of Arkansas" was underwater;
- **The Little Rock Flash Flood of September 13 in 1978:** Torrential rains during the early morning resulted in a flash flood in western and southwestern Little Rock as well as adjacent areas of Saline into Garland Counties;
- **The storm system of December 2-3 in 1982:** This was a major river and flash flood even as a result of heavy rains and tornados. Serious river flooding followed which lasted for several days;
- **December 24, 1987:** Heavy Christmas Eve rains resulted in serious river flooding. West Memphis had flash flooding;
- **May 1990**: Major flooding on Arkansas and Red Rivers from torrential rains over several weeks; and
- **December 15-17, 2001:** Heavy rain fell across northern and western Arkansas, with more than 5 inches of rain measured. River flooding was already occurring in parts of southern and eastern Arkansas due to recent heavy rain events. The end result was widespread high water problems, with the worst flooding in 50 years in some areas.

4.5.1.3 Headcutting

Waterway deepening can initiate headcutting, which is the upstream movement of a locally steep channel bottom due to the erosion caused by rapidly flowing water. The headcutting process begins with excavation of the channel. A nick point is created in the bed at the point where the flow velocities increase due to the steeper gradient. If the increased flow velocities erode the streambed, the nick point migrates upstream. This continues until the gradient of the stream stabilizes or the nick point meets an obstacle, such as a rock outcrop. Headcutting releases large amounts of sediment from the streambed, which is transported and deposited, causing the habitat to change rapidly, usually to the detriment of fish and other communities.

The USACE Engineering Research and Development Center (ERDC) determined that headcutting is currently not an issue in the MKARNS system (Beidenharn, 2005). Navigation channel surface elevations remain unchanged accordingly, stream gradients are unaffected and the channel bottom remains geomorphologically stable at tributary confluences, which limits headcutting in the MKARNS system.

4.5.1.4 Water Quality

The 1972 amendments of the 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 updated lists every two years. Water quality standards defined by Federal regulations include beneficial uses, water quality objectives and anti-degradation requirements. Total Maximum Daily Loads (TMDL) must be established for all water bodies on the 303(d) list. The TMDL must document the nature of the impairment, determine the maximum amount of the pollutant that can be discharged and identify allowable loads contributed from each source. Section 305(b) of the CWA requires each state to perform a comprehensive inventory and analysis of the quality of waters of the state. This is also to be reported to Congress every two years.

Current EPA guidance recommends each state produce an integrated report combining the requirements of the Act for the Water Quality Inventory Report (Section 305(b) of the CWA) and the Impaired Waterbodies list (Section 303(d) of the CWA). The combined report is referred to as the Integrated Water Quality Monitoring and Assessment Report.

For purposes of this report, Arkansas is divided into water quality planning segments based on six river basins: the Red, Ouachita, Arkansas, White, St. Francis, and Mississippi river basins. Each basin is then divided into smaller segments for monitoring. According to the Arkansas Department of Environmental Quality (ADEQ) 2002 Integrated Water Quality Monitoring and Assessment Report a portion of the Arkansas River and Upper White River were reported on the state's proposed 303(d) list that notes limitations for use of certain waterbodies, however, only the portion on the Arkansas River is within the scope of work for this project.

An approximate 2-mile segment of the Arkansas River below Dardanelle Reservoir (pool #10) occasionally had dissolved oxygen (DO) values below the state's standard (<5 mg/L) during the summer period. This is related to hydropower releases from the upstream reservoir when very low DO values exist in the deeper levels of the reservoir. These low values recover quickly downstream of the reservoir under low to moderate generation flows and in the presence of photosynthesis activity from planktonic algae (ADEQ 2002). The reporting period for Arkansas' 2002 report is from October 1998 to January 2002.

All waters within the White River Basin segment were determined to meet designated uses, such as propagation of fish and wildlife, primary and secondary contact recreation, and domestic, agricultural, and industrial water supply.

According to the Oklahoma Department of Environmental Quality (ODEQ) 2002 Water Quality Assessment Integrated Report there are several segments of the MKARNS within Oklahoma with impaired water. Segments along the Arkansas River within the study area that are on the state's 303(d) list include a 15-mile segment in Muskogee County that did not reach attainment for primary contact recreation due to pathogens (disease-carrying fecal indicator bacteria such as fecal coliform, *E. coli*, or Enterococci) and a segment 29 miles long within Wagoner County that did not reach attainment for secondary contact (recreation) and agriculture due to pathogens and total dissolved solids. Segments along the Verdigris River within the study area that are on the 303(d) list include a 6-mile segment in Wagoner County that did not reach attainment for primary contact recreation and warm water aquatic community due to lead, pathogens, and turbidity and an 18-mile segment in Wagoner County that did not reach attainment for warm water aquatic community due to lead concentrations. All causes for impairment came from unknown sources (ODEQ 2002).

Eight reservoirs in Oklahoma are on Oklahoma's 303(d) list of waters impaired or threatened by a pollutant(s), including Oologah Lake, Hudson Lake, Fort Gibson Lake, Tenkiller Ferry Lake, Robert S. Kerr Lake, Keystone Lake, Kaw Lake, and Wister Lake. Oologah, Robert S. Kerr, Keystone, Kaw, and Fort Gibson Lakes did not reach attainment for warm water aquatic community because of turbidity. Hudson Lake did not reach attainment for warm water aquatic community due to low DO levels. Fort Gibson Lake and Tenkiller Ferry Lake did not reach attainment for Tenkiller Ferry Lake did not reach attainment for aesthetics or warm water aquatic community due to low DO and high phosphorus levels. Wister Lake did not reach attainment for aesthetics due to phosphorus. All of the causes of impairment are derived from unknown sources.

4.5.2 Upstream Reservoirs

The reservoir system of the MKARNS is part of a larger navigation and flood control plan for the Arkansas River in Oklahoma and Arkansas. The authorization for the construction of the reservoirs on the MKARNS came principally from the passing of the various Flood Control Acts (1936, 1938, 1944, and 1962) and subsequent amendments to the original legislation. Legislation was also passed through the River and Harbor Act to incorporate upstream reservoirs in Oklahoma that have the capacity to control flows on the MKARNS into the multipurpose plan for the system.

River flow and water storage of the MKARNS are primarily influenced and controlled by these 11 reservoirs in Oklahoma as well as the upper Arkansas River upstream of its confluence with the Verdigris River (river mile 394). The 11 Oklahoma reservoirs are:

- Keystone Lake;
- Oologah Lake;
- Grand Lake O' the Cherokees (Pensacola Dam);
- Lake Hudson (Markham Ferry Dam);
- Fort Gibson Lake;
- Tenkiller Ferry Lake;
- Eufaula Lake;
- Kaw Lake;
- Hulah Lake;
- Copan Lake; and
- Wister Lake.

The 11 reservoirs include nine USACE (Tulsa District) reservoirs as well as two Grand River Dam Authority (GRDA) electric utility reservoirs. The reservoirs provide flood control, water supply, power generation, recreation, and water quality maintenance (through sediment trapping) and fish and wildlife habitat. Information concerning various elements of the surface water features for each reservoir is detailed below. Information regarding the water supply, hydroelectric power and recreation resources for each reservoir is presented in subsequent sections.

The reservoirs also aid the MKARNS by assisting in the control of water release through spillways and power generating units. The rate at which water is released from each reservoir depends on many factors including available water storage, power requirements, navigation water requirements, inflow rates, river flow rates downstream and weather conditions.

A summary of the characteristics of each reservoir is presented in Table 4-7 including watershed drainage area, elevation, surface area, storage capacity and shoreline mileage. Within the reservoirs, three zones of water storage are present to assist these functions; they are the flood control, conservation and inactive pools. The flood control pool zone is reserved for retaining floodwaters and is only utilized during flood control periods. The conservation or power pool is the middle zone that provides water for power generation, MKARNS flow regulation and water supply. The bottom zone or inactive pool provides water pressure for water releases and power generation as well as sediment trapping. Water storage is measured in acre-feet, which is the amount of water available to cover one acre to a depth of one foot.

a. Keystone Lake - Keystone Lake has two major arms including the Cimarron River arm, which is characterized by gently rolling hills, and the Arkansas River arm, which is characterized by steep, broken hills to low rolling hills and many small valleys in its upper reaches. The lake was formed by the damming of the Arkansas River at river mile 538.8, approximately 15 miles east of Tulsa, in Tulsa County, Oklahoma. The terrain of the lake includes sandy beaches as well as wooded shorelines and high bluffs. Project lands surrounded the land vary from rugged rocky terrain and forests near the dam, to gently rolling hills and grasslands in the upper reaches.

The reservoir drains a 74,506 square mile area above the dam. The surface area for the lake is 54,320; 22,420; and 12,430 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 330 miles of shoreline. Approximately 251 miles of the shoreline is classified as protected lakeshore and 55 miles is designated for public recreation. The remaining shoreline includes 21 miles allocated for limited development and 3 miles is allocated as prohibited access.

b. Oologah Lake - Oologah Lake lies in the Cuesta Plains subdivision of the Interior Lowlands physiographic province at the western slope of the Ozark uplift and is characterized by gently rolling hills, isolated buttes, and low east facing escarpments separated by broad valleys. The lake was formed by the damming of the Verdigris River at river mile 90.2, approximately 2 miles southeast of Oologah, in Rogers County, Oklahoma. The reservoir extends northward 35 miles into Nowata County, Oklahoma. The topography of the lake reflects the edge of the Ozark uplift and is characterized by westward dipping rocks throughout both counties and results in a long irregular shoreline that varies from moderate slopes to steep banks. The topography is characterized in the lower portion of the lake by forested hills and limestone bluffs that transition into rolling grass covered plains in the upper reaches.

The reservoir drains a 4,339 square mile area above the dam. The surface area for the lake is 67,120; 31,040; and 880 acres for the top of the flood control, conservation, and inactive pools, respectively. Although the lake is relatively clear under normal conditions, the main river channel (the Verdigris) contributes higher turbidity during high flow periods. The lake has approximately 209 miles of shoreline with very little public development.

c. Grand Lake O' The Cherokees (Pensacola Dam) - Grand Lake forms the upper portion of the boundary line between the western slope of the Ozark uplift and the Cherokee Plains, which is the flat divide between the Verdigris and Grand (Neosho) Rivers. The area is characterized by rolling valleys on the west and ravines, bluffs and hillsides on the east. The lake was formed by the damming of the Grand (Neosho) River at the city of Langley in Mayes County, Oklahoma. The reservoir begins at the Pensacola Dam on the Grand (Neosho) River and extends northeast upriver into Delaware and Ottawa Counties, ending at the confluence of the Neosho and Spring Rivers.

The reservoir drains a 10,298 square mile area above the dam (including upstream projects). The surface area for the lake is approximately 146,500 acres and has approximately 1,300 miles of shoreline. The shoreline is available for private development.

d. Lake Hudson (Markham Ferry Dam) - Lake Hudson, which is also known as the Markham Ferry Dam Project, forms the middle of the boundary line between the western slope of the Ozark uplift and the Cherokee Plains, which is the flat divide between the Verdigris and Grand (Neosho) Rivers. The area is characterized by rolling valleys on the west and ravines, bluffs and hillsides on the east. The lake was formed by the damming of the Grand (Neosho) River at the city of Locust Grove in Mayes County, Oklahoma. The reservoir begins upstream of Fort Gibson Lake on the Grand (Neosho) River and extends northeast upriver to the Pensacola Dam (Grand Lake).

The reservoir drains a 11,553 square mile area above the dam (including upstream projects). The surface area for the lake is approximately 12,000 acres and has approximately 200 miles of shoreline. The shoreline is available for private development.

Table 4-7. Characteristics of Flood Control Reservoirs in the Upper MKARNS System.

Reservoir	Operated By	Drainage (sq mi)	Elevation (feet above msl)			Surface area (acres)			Storage Capacity (acre-ft)			Shoreline*
			Flood Control Pool	Conservation (or Power) Pool	Inactive Pool	Flood Control Pool	Conservation Pool	Inactive Pool	1	2	3	
									1,672,613 (lake total)			
Keystone Lake	USACE	74,506	754	723	706	54,678	22,420	12,430	1,167,232	278,122	227,259	330
									1,559,279 (lake total)			
Oologah Lake	USACE	4,339	661	638	592	67,120	31,040	880	1,007,060	545,284	6,935	209
									2,197,000 (lake total)			
Grand Lake O' the Cherokees (Pensacola Dam)[1]	GRDA, USACE	10,298	755	745	730	46,500	NG	NG	525,000	585,500	1,086,500	1,300
									444,510 (lake total)			
Lake Hudson (Markham Ferry Dam)	GRDA, USACE	11,553	636	619	599	12,000	NG	NG	244,210	151,670	48,630	200
									1,284,400 (lake total)			
Fort Gibson Lake	USACE	12,494	582	554	551	51,000	19,900	16,950	919,200	53,900	311,300	225
									1,230,800 (lake total)			
Tenkiller Ferry Lake	USACE	1,610	667	632	594.5	20,800	12,900	NG	576,700	371,000	283,100	130
									3,826,000 (lake total)			
Eufaula Lake	USACE	47,522	597	585	565	143,700	105,500	46,100	1,511,000	1,463,000	852,000	600
									1,348,000 (lake total)			
Kaw Lake	USACE	7,250	1,044.5	1,010	978	38, 000	17,000	5,600	919,400	343,500	85,100	168
									289,088 (lake total)			
Hulah Lake	USACE	732	765	733	710	13, 000	5,160	3,570	257,932	31,156	0	62
									227,734 (lake total)			
Copan Lake	USACE	505	732	710	687.5	17,850	13,380	4,850	184,318	42,820	596	30
									427,485 (lake total)			
Wister Lake	USACE	993	502.5	478	450	23,366	6,700	NG	366,056	61,037	392	NG

NG=Not given;

GRDA - Grand River Dam Authority

* Shoreline measured in miles.

[1] Elevations for Grand Lake are Pensacola datum utilized in HD 107. Add 1.1 ft. to convert to USC and GS datum.

Source: USACE Tulsa, Pertinent Data Book, March 2004

e. Fort Gibson Lake - Fort Gibson Lake forms the lower 26 miles of the boundary line between the western slope of the Ozark uplift and the Cherokee Plains, which is the flat divide between the Verdigris and Grand (Neosho) Rivers. The area is characterized by rolling valleys on the west and ravines and hillsides on the east. The lake was formed by the damming of the Grand (Neosho) River at river mile 7.7, approximately 5 miles north of Fort Gibson and 12 miles northeast of Muskogee in Mayes, Wagoner and Cherokee Counties, Oklahoma. The reservoir begins 7.7 miles above the confluence of the Grand (Neosho) and Arkansas Rivers, and extends northeast upriver to the Robert S. Kerr Dam (Lake Hudson).

The reservoir drains a 12,494 square mile area above the dam (including upstream projects). The surface area for the lake is 51,000; 19,900; and 16,950 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 225 miles of shoreline. Approximately 142 miles of the shoreline is classified as protected lakeshore and 57 miles is designated for public recreation. The remaining shoreline includes 23 miles allocated for limited development and 3 miles is allocated as prohibited access.

f. Tenkiller Ferry Lake - Tenkiller Ferry Lake is nestled in the Cookson Hills of eastern Oklahoma. The reservoir was formed by the damming of the Illinois River, which originates from the Ozark geological uplift region of northwest Arkansas. The Illinois River flows 145 miles through the low mountains of northeastern Oklahoma to its confluence with the Arkansas River; the dam is located on river mile 12.8. The reservoir is located in Cherokee and Sequoyah Counties, about 7 miles northeast of Gore and about 22 miles southeast of Muskogee, Oklahoma.

The reservoir drains a 1,610 square mile area above the dam and has a capacity of 1,230,800 acre-feet at the top of the flood control pool. The reservoir drains a 1,610 square mile area above the dam. The surface area for the lake is 20,800 and 12,900 for the top of the flood control and power pools, respectively. The lake has approximately 130 miles of predominantly rocky, rugged shoreline. The lake is a clear rocky-bottomed reservoir with a depth of over 165 feet.

g. Eufaula Lake - Eufaula Lake is located in a narrow valley and was formed by the damming of the Canadian River. The project is located at river mile 27, approximately 12 miles east of Eufaula, in McIntosh County, Oklahoma. The northern shoreline exhibits rugged, steep rocky hillsides and sharp bluffs that rise from the water on either side. The terrain of the southern portion of the lake graduates into more moderate to gently sloping shorelines with sandy beaches. The central portion of Eufaula Lake is the convergence of the Deep Fork, North Canadian and South Canadian Rivers. The Deep Fork converges with the North Canadian approximately 7 miles north of Eufaula. The Southern Canadian, that forms the main channel for the Canadian River, enters the lake just north of Eufaula. These rivers carry heavy silt loads that form deltas at their confluence and cause decreased clarity in the lake.

The reservoir drains a 47,522 square mile area above the dam. The surface area for the lake is 147,500; 105,500; and 46,100 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 600 miles of shoreline. Approximately 56% of the shoreline is classified as protected lakeshore and 21% is designated for public recreation. The remaining shoreline includes 22% allocated for limited development and 1% is allocated as prohibited access. Over 250 housing developments are in close proximity to the shoreline.

Mowing and boat dock permits allow property owners to maintain shoreline areas in front of their properties.

h. Kaw Lake - Kaw Lake lies in a wide, flat valley and was formed by the damming of the Arkansas River. The project is located at river mile 653.7, approximately 8 miles east of Ponca City, in Kay County, Oklahoma. The northern portion of the flood control pool extends as far north as Arkansas City in Cowley County, Kansas. The Kaw Lake project lies in the Northern Limestone Cuesta Plains subdivision of the Interior Lowlands physiographic province.

The reservoir drains a 7,250 square mile area above the dam. The surface area for the lake is 39,690; 16,750; and 5,240 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 168 miles of shoreline.

i. Hulah Lake - Hulah Lake lies in a relatively flat, broad valley and was formed by the damming of the Caney River, a tributary of the Verdigris River. The project is located at river mile 96.2, approximately 15 miles northwest of Bartlesville, in Osage County, Oklahoma. The upper end of the flood control pool to the north lies in Chautauqua County, Kansas. The Hulah Lake project lies in the upper reaches of the high rounded Osage Hills, which result from a gently dipping anticlinal fold with numerous folds superimposed upon it. This fold possesses oil deposits that include active wells around the project lands. The region surrounding Hulah Lake is typified by long, rolling, partially wooded ridges separated by broad, flat valleys.

The reservoir drains a 732 square mile area above the dam. The surface area for the lake is 13,000; 3,120; and 0 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 62 miles of shoreline. Approximately 49 acres are classified as protected lakeshore and 10 miles for public recreation. The remaining shoreline includes 2 miles for limited development and 1 mile is allocated as prohibited access.

j. Copan Lake - Copan Lake was formed by the damming of the Little Caney River, a tributary of the Caney River in the Verdigris watershed. The project is located at river mile 7.4, approximately 9 miles of Bartlesville, in Washington County, Oklahoma. The project area shoreline is generally flat and gently sloping in the northern portion of the reservoir to rolling and steep in the areas above the dam. The reservoir extends from the town of Copan Oklahoma, northward to the town of Caney in Kansas.

The reservoir drains a 505 square mile area above the dam. The surface area for the lake is 17,850; 4,449; and 110 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 30 miles of shoreline.

k. Wister Lake - Wister Lake was formed by the damming of the Poteau River in a mountainous region with steep and rocky valley slopes in an east west trend of long parallel ridges formed by severely faulted hard sandstones of the Ouachita Mountains. The project is located at river mile 60.9 of the Poteau River, approximately 2 miles south of Wister Oklahoma in Le Flore County.

The reservoir drains a 993 square mile area above the dam. The surface area for the lake is 23,366 and 7,386 acres for the top of the flood control and conservation pools, respectively.

4.6 Land Cover and Land Use

4.6.1 Land Cover

The course of the Arkansas River that comprises the MKARNS is comprised of rich floodplain soils well suited to cultivation. The wide bottomlands with fertile soil support many crops as well as pine and hardwood forests. Land cover varies throughout the project area and includes the following cover types as identified in Table 4-8 and Figure 4-6:

Table 4-8. Acreage of Land Cover Categories Within the MKARNS EIS Study Area*.

Description	Acres	Percent of Total
Cropland and Pasture	241,120	42.77
Orchards, Groves, Vineyards, Nursery	265	0.05
Confined Feeding Operations	37	0.01
Other Agricultural Land	90	0.02
Agriculture Total	**241,511**	**42.8**
Residential	9,921	1.76
Commercial Services	5,123	0.91
Industrial	3,731	0.66
Transportation, Communications	3,245	0.57
Mixed Urban or Built-Up Land	544	0.10
Other Urban or Built-Up Land	2,814	0.50
Developed Total	**25,380**	**4.5**
Deciduous Forest Land	83,526	14.79
Evergreen Forest Land	10,028	1.78
Mixed Forest Land	60,210	10.66
Forest Total	**153,764**	**27.2**
Sandy Areas Other than Beaches	7,692	1.36
Strip Mines, Quarries, and Gravel	1,571	0.28
Transitional Areas	758	0.13

Table 4-8. Acreage of Land Cover Categories Within the MKARNS EIS Study Area*.

Description	Acres	Percent of Total
Sandy and other transitional Total	**10,021**	**1.8**
Streams and Canals	12,189	2.16
Lakes	1,576	0.28
Reservoirs	107,883	19.11
Water Total	**121,648**	**21.6**
Forested Wetlands	8,842	1.57
Nonforested Wetlands	3,447	0.61
Wetlands Total	**12,289**	**2.2**
Grand Total	**564,613**	

* study area is defined as 1 mile radius from MKARNS river channel.
Source: USEPA, 1994

The land coverage of the majority of the study area is water bodies including the MKARNS and its 11 associated reservoirs. Adjoining land coverage varies depending on the land use. Land cover for lands that adjoin the study area include forests, wetlands, pasture, and agricultural lands, depending on the location of each individual project.

Land coverage in the western portion of the MKARNS study area includes smaller reservoirs in northern Oklahoma plains that include pasture and agricultural areas. The study lands in northeastern Oklahoma and northwestern Arkansas, which are located in mountainous areas, include higher percentages of forested land cover. The lower MKARNS through central Arkansas contains primarily agricultural lands. However, the land coverage in the extreme lower portion of the MKARNS is dominated by forested wetlands associated with the White River National Wildlife Refuge (NWR) and surrounding areas. Adjoining lands to non-USACE reservoirs include more residential and commercial development.

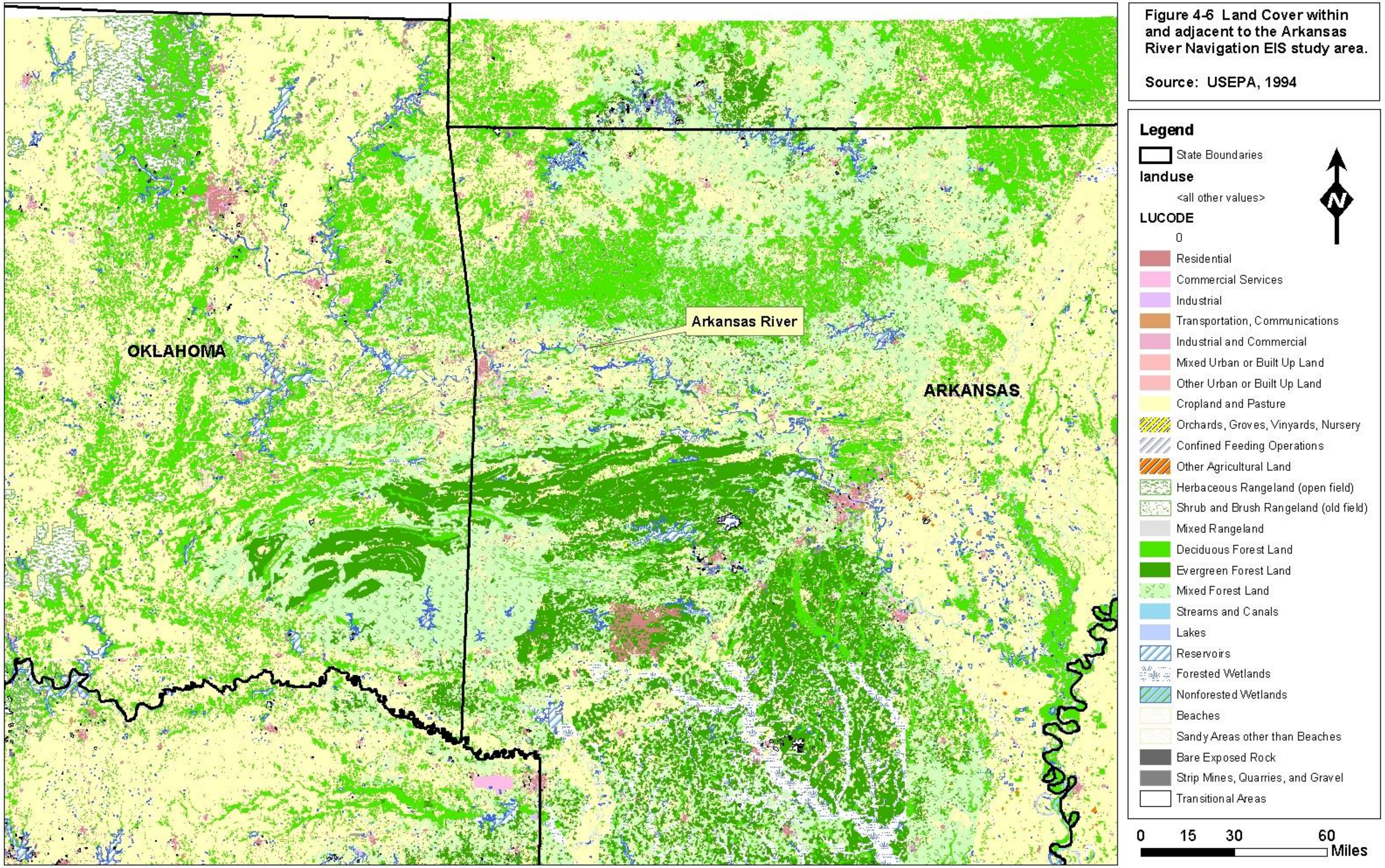


Figure 4-6 Land Cover within and adjacent to the Arkansas River Navigation EIS study area.

Source: USEPA, 1994

4.6.2 Land Use

A variety of land uses are found in the study area, these include:

- Urban (Residential, Commercial, and Industrial);
- Agricultural;
- Rangeland;
- Recreation and Parklands;
- Forested Lands and Wildlife Management Areas (WMA);
- Water bodies;
- Wetlands; and
- Barren Land.

4.6.2.1 Urban

The urban areas in the study area are primarily limited to the cities of Pine Bluff, Little Rock, Fort Smith, Muskogee, and Tulsa. Each of these urban areas grew in part, due to the economic benefits afforded by the Arkansas River. U.S. Census Bureau population estimates for 2000 for each of these cities are provided in Table 4-9 below.

Table 4-9. Population Estimates for Urban Areas in the Study Area

City and State	Population (2000 Estimates)
Fort Smith, Arkansas	80,268
Little Rock, Arkansas	183,133
Muskogee, Oklahoma	38,310
Pine Bluff, Arkansas	55,085
Tulsa, Oklahoma	393,049

Source: U.S. Census Bureau.

4.6.2.2 Agricultural

Roughly one-half of Arkansas' land is devoted to agriculture. Crop production is concentrated in the eastern one-third of the state and in the Arkansas and Red River Valleys. Agriculture is the state's largest industry, with more than $5 billion in farm income generated annually. When combined with the value of agricultural and food processing and related service industries, the agricultural community accounts for more than 25 percent of Arkansas' economy. In the 1997 crop year, Arkansas was ranked first in the nation in rice production, and was in the top ten for cotton (5^{th} among all states), sorghum for grain (8^{th}), hay (8^{th}), grapes (8^{th}), soybeans for beans (9^{th}), blueberries (9^{th}), and freestone peaches (10^{th}).

Similar to Arkansas, the climate and topography of Oklahoma makes it well suited for the production of a broad spectrum of commodities. Much of the fertile land in the Arkansas River Valley is devoted to agriculture. Based on the 1997 crop year, the State of Oklahoma ranks among the national leaders in several commodities, including winter wheat (2nd among all states), rye (2nd), all wheat (4th), hay (4th), pecans (4th), sorghum for grain (5th), peanuts (6th), and sorghum for silage (7th).

Crop acreage for each of the counties in the study area is shown below in Table 4-10. Other major commodities are produced in these counties as well. However, complete data are not available for all crops and counties. The Natural Resources Conservation Service has been coordinated with regarding prime farmland in the study area. This data can be found in Appendix C.9. The counties along the downstream terminus of MKARNS, such as Arkansas, Desha, Jefferson, and Lincoln Counties, have the most total cropland of any Arkansas county in the study area and are major producers of rice, soybeans and cotton. The leading soybean, wheat, and sorghum producing counties in the Oklahoma portion of the study area (primarily Wagoner, Kay, and Noble Counties) are located along the northwest end of the MKARNS.

Table 4-10. Major Crop Acreage by County in the Study Area for 1997.

County	Total Cropland (acres)[1]	Sorghum (acres)	Wheat (acres)	Rice (acres)	Cotton (acres)	Soybeans (acres)	Hay-alfalfa, (acres)[2]
Arkansas, AR	375,526	2,668	86,794	122,744	2,080	210,429	2,276
Conway, AR	96,363	0	7,190	(a)	0	21,204	33,053
Crawford, AR	78,007	0	3,853	0	0	17,595	24,122
Desha, AR	257,230	2,803	18,378	43,888	78,278	111,363	1,112
Faulkner, AR	120,064	0	2,495	2,047	0	11,280	40,284
Franklin, AR	86,214	(a)	(a)	0	(a)	2,298	35,859
Grant, AR	15,818	0	(a)	0	0	0	7,554
Jefferson, AR	258,344	1,103	21,790	51,084	56,256	116,618	3,234
Johnson, AR	65,605	433	673	0	0	5,522	24,867
Lincoln, AR	155,781	1,614	11,114	31,191	33,712	65,548	4,944
Logan, AR	106,932	150	1,799	0	(a)	7,816	41,289
Lonoke, AR	327,025	2,200	39,040	75,139	25,085	144,828	20,489
Perry, AR	45,380	(a)	379	1,532	0	7,809	13,700
Pope, AR	85,429	548	2,670	263	0	11,207	30,540
Pulaski, AR	77,266	2,120	11,816	4,462	1,319	33,217	9,632
Saline, AR	26,451	0	0	0	0	0	11,215
Sebastian, AR	64,021	(a)	1,743	0	0	4,206	21,737

Table 4-10. Major Crop Acreage by County in the Study Area for 1997.

County	Total Cropland (acres)[1]	Sorghum (acres)	Wheat (acres)	Rice (acres)	Cotton (acres)	Soybeans (acres)	Hay-alfalfa, (acres)[2]
Yell, AR	106,620	405	3,410	717	(a)	13,682	40,587
Adair, OK	99,857	(a)	154	NA	0	0	40,242
Cherokee, OK	90,943	0	731	NA	0	305	31,390
Creek, OK	122,406	599	1,272	NA	0	1,829	35,685
Delaware, OK	129,230	1,101	3,534	NA	0	2,145	51,231
Haskell, OK	116,300	0	(a)	NA	0	1,588	44,731
Kay, OK	330,944	34,448	200,096	NA	2,572	22,116	21,654
Le Flore, OK	189,068	440	4,562	NA	0	18,087	60,026
Mayes, OK	146,674	3,883	6,604	NA	0	8,960	59,781
McIntosh, OK	105,318	926	1,157	NA	0	2,575	34,796
Muskogee, OK	182,741	2,232	7,676	NA	0	22,528	63,926
Noble, OK	222,089	11,093	121,830	NA	0	5,661	31,981
Nowata, OK	99,192	2,223	4,176	NA	0	3,859	36,153
Okmulgee, OK	123,386	412	2,808	NA	(a)	6,241	45,535
Osage, OK	157,625	1,467	23,435	NA	0	9,014	37,665
Ottawa, OK	129,729	10,803	19,951	NA	0	20,965	38,846
Pawnee, OK	92,730	1,463	8,797	NA	0	12,281	20,159
Pittsburg, OK	148,310	86	732	NA	0	736	51,482
Rogers, OK	125,387	1,676	6,405	NA	0	6,312	50,748
Sequoyah, OK	94,665	(a)	1,912	NA	0	8,098	32,831
Tulsa, OK	72,496	390	2,960	NA	0	5,792	22,388
Wagoner, OK	139,162	2,266	10,388	NA	739	40,955	35,907
Washington, OK	74,434	1,229	6,034	NA	0	8,817	22,076

[1] Note: columns do not sum to equal total cropland. Additional crops exist in each county for which total acreage is minor or data are not available.

[2] Includes other small grain, wild grass

(a) Data withheld to avoid disclosing data for individual farm.

NA=Not available.

Source: Government Information Sharing Project, Oregon State University. Census of Agriculture. http://govinfo.library.orst.edu/

4.6.2.3 Rangeland

Rangeland primarily occurs to the northwest of the study area in Osage County, Oklahoma. Other rangeland areas are interspersed throughout the study area (e.g., Pawnee County, Oklahoma), however Osage County by far contains the largest concentration of land used for grazing livestock. Major types of livestock and poultry include the following: beef cows, milk cows, hogs, sheep, and broilers and other meat-type chickens. Oklahoma is among the national leaders in production for several commodities, including beef cattle (3rd among all states), all cattle (4th), all hogs and breeding hogs (8th), and chickens, excluding broilers (21st). Arkansas also ranks among the top producers in the nation for several livestock commodities, including broilers (2nd), turkeys (3rd), hogs (14th), beef cattle (16th), and milk cattle (34th) (cattle inventory as of January 1, 1998; hog and chicken inventory as of December 1, 1997).

4.6.2.4 Recreation and Parklands

Many parklands developed by the USACE and State agencies have been established with recreational facilities and opportunities as the primary focus. Thousands of acres of natural areas have been maintained for recreational activities and aesthetic values. The National Park Service (NPS) also operates several small parks near the MKARNS, predominantly at historical properties. There are numerous federally funded Land and Water Conservation Fund park properties within the study area.

4.6.2.4.1 U. S. Army Corps of Engineers

The USACE, Tulsa and Little Rock Districts maintain over one hundred small parks along the MKARNS varying in size from 10 to 900 acres. The associated reservoirs maintain developed recreational areas of similar sizes as those above, however, associated WMAs amount to over two hundred thousand acres. Although the primary land cover type for the USACE recreation areas is water, each facility includes a variety of other land cover types depending on their geographical location.

In addition to access ramps to water bodies for recreational boating, water sports and fishing, there are picnic and camping facilities as well as some trails. Some parks also have concessionaire-operated marinas. A description of USACE parks (including boat ramp recreation areas) along the MKARNS and at the component reservoirs in the study area is included in Section 4.9.1. Recreational opportunities for each area are also identified.

4.6.2.4.2 State Parks

Arkansas and Oklahoma State Parks within or near the study area provide a wide range of recreational opportunities including access to ramps and marinas, recreational boating, water sports and fishing, swimming, picnicking, camping, equestrian trails and facilities, rental and resort lodging, golf, tennis, hiking, interpretive nature centers and park guides. A listing of Arkansas and Oklahoma State Parks that are in the immediate vicinity of the study area are included in Section 4.9.2.

4.6.2.4.3 National Park Service

Three NPS properties are present within or near the study area. The three sites are each small in size and include the following:

- **Arkansas Post National Memorial**. The Arkansas Post Memorial is a NPS park and museum located on a peninsula bordered by the Arkansas River and two backwaters. The site commemorates the complex history of the site which includes: 1) the first semi-permanent French settlement in the lower Mississippi River Valley in the late 1600's, 2) location of French and Spanish Forts, 3) location of the Colbert Incident, the only Revolutionary War action in Arkansas, and 4) location of Fort Hindman, constructed by the Confederate Army during the Civil War.
- **Central High School National Historic Site** (Little Rock, Arkansas). Central High School National Historic Site is a national emblem of the often violent struggle over school desegregation. It was designated a unit of the National Park Service on November 6, 1998. It is located at the intersection of 14th and Park Streets in Little Rock, Arkansas.
- **Fort Smith National Historic Site** (Fort Smith Arkansas & Oklahoma). Fort Smith National Historic Site embraces the remains of two frontier forts and the Federal Court for the Western District of Arkansas. Commemorating a significant phase of America's westward expansion, it stands today as a reminder of 80 turbulent years in the history of Federal Indian Policy.

4.6.2.5 Forested Land and Wildlife Management Areas

Forested lands and WMAs are common throughout the MKARNS and associated components study lands. These natural areas have very limited recreational development and access and are managed by public agencies, such as the USACE, U.S. Fish and Wildlife Service (USFWS), National Park Service, and various State agencies. USACE and State Park Lands are included under the Recreation and Parkland land use category. Additional managed lands are identified below.

4.6.2.5.1 Forested Land

Oak-hickory forests dominate in northeastern Oklahoma, while post oak and blackjack are common throughout the central portion of the state and northwestern Arkansas. Bottomland hardwood forests are common in riparian areas immediately adjacent to tributaries in the upper portion of the study area; whereas more water tolerant species such as swamp oaks and bald cypress can be found in the lower reaches of the MKARNS. Section 4.8.5, Terrestrial Resources, provides the names of the common species. The U.S. Forest Service manages two large national forest tracts within or in the vicinity of the study area including:

- **Ozark National Forest**. The forest covers more than one million acres, located mostly in northwestern Arkansas. The southern portion of the forest runs along the Arkansas River Valley south to the Ouachita Mountains. The "Ozarks" are really part of the Boston Mountains and the southern end of the Springfield Plateau. The Boston Mountains are characterized by narrow V-shaped valleys that are bordered by a combination of steep-sided slopes and vertical bluffs of sandstone and limestone soaring beside clear streams. The vegetative cover is upland hardwood of oak-hickory with scattered pine and brushy undergrowth, dominated by such species as dogwood, maple, redbud, serviceberry and witch-hazel.

- **Ouachita National Forest**. The Ouachita National Forest comprises 1.76 million acres in Western Arkansas and Eastern Oklahoma is located south of the study area.

4.6.2.5.2 Wildlife Management Areas

The USFWS and the States of Arkansas and Oklahoma manage a variety NWRs are located within the study area. These areas total hundreds of thousands of acres and include the following:

USFWS Wildlife Refuges

- **White River NWR** (DeWitt, Arkansas). The refuge, located near the beginning of the MKARNS, is 155,126 acres in size and offers boating, camping, fishing, bird watching, wildlife photography, and hunting opportunities to the public. The White River NWR was established in 1935 and occupies 90 miles of the lower White River near its confluence with the Arkansas River.
- **Holla Bend NWR** (Dardanelle, Arkansas). The refuge is situated on a bend of the Arkansas River that was cut off when the USACE straightened the river in 1954 for flood control. Refuge lands include over 7,000 acres of agricultural fields, bottomland forest, and open water. The refuge supports wintering populations of ducks and geese each year. Holla Bend NWR provides environmental education, interpretation, and wildlife-oriented recreation for thousands of visitors annually.
- **Logan Cave NWR** (Dardanelle, Arkansas). This Ozark Mountain refuge provides habitat for the endangered gray bat, cave crayfish, and the threatened Ozark cavefish, as well as other significant cave dwelling wildlife species. To protect this very unique and sensitive cave ecosystem, the refuge is closed to the public, and entrance into the cave by Service personnel and others is very limited.
- **Ozark Plateau NWR** (formerly Oklahoma Bat Caves) (Vian, Oklahoma). Situated in the foothills of the Ozark Mountains, the refuge consists of seven widely-spaced tracts of oak-hickory forest scattered across several counties in northeastern Oklahoma. Terrain ranges from gently rolling hills to steep limestone cliffs. Pitkin limestone provides the particular geologic strata that contain karst formations that are home to populations of the endangered gray bat, endangered Ozark big-eared bat, and other cave species. Caves on the refuge have the precise temperature, humidity and substrate the bats choose for either hibernation or rearing young.
- **Sequoyah NWR** (Vian, Oklahoma). Sequoyah NWR is located on the upper end of Robert S. Kerr Reservoir in eastern Oklahoma (part of the MKARNS). Rich river-bottomland with numerous ponds and sloughs provides food and cover for waterfowl, other migratory birds and resident wildlife. Snow geese and mallards are abundant at the refuge. Refuge programs contribute to the recreational opportunities of eastern Oklahoma.

State Wildlife Management Areas

- **Trusten Holder State WMA.** This Arkansas WMA is 4,321 acres in size. This area adjacent to the White River NWR on the Arkansas Post Canal and is a multi-use area managed to provide public fishing and hunting opportunities.
- **McClellan-Kerr Navigation System WMAs.** This area consists of 7,875 acres of WMA in Wagoner, Muskogee, Sequoyah and Haskell Counties, Oklahoma.
- **Eufaula WMA.** This 48,469-acre WMA is located in Okmulgee, McIntosh, Pittsburg and Latimer Counties in Oklahoma.
- **Fort Gibson WMA.** This WMA consists of 21,798 acres of land in Wagoner and Cherokee Counties, Oklahoma.
- **Keystone WMA.** In addition to its wildlife management objectives, Keystone WMA also allows camping within 50 yards of public use roads. It consists of 16, 537 acres in Osage, Pawnee and Creek Counties, Oklahoma.
- **Oologah WMA.** This WMA consists of 14,155 acres of land in Nowata and Rogers Counties, Oklahoma.
- **Hulah WMA.** This WMA consists of 16,141 acres of land in Osage County, Oklahoma.
- **Copan WMA.** This WMA consists of 7,500 acres of land in Washington County, Oklahoma.
- **Wister WMA.** This WMA consists of 35,550 acres of land in LeFlore and Latimer Counties, Oklahoma.
- **Heyburn WMA.** This WMA consists of 4,615 acres of land in Creek County, Oklahoma.

4.6.2.6 Water Bodies

Surface water is a primary land use type within the study area incorporating hundreds of thousands of acres. Water bodies include MKARNS waterway, its component reservoirs and the associated study lands. For all system components the USACE has the primary responsibility for the water bodies and associated lands. However, Grand Lake and Lake Hudson, which are operated by the Grand River Dam Authority (GRDA), are essentially State waters with private developments and owners along the shorelines. At these two lakes, USACE involvement is limited to flood control only. Additionally, the Oklahoma Department of Wildlife Conservation manages lands dedicated to wildlife for the USACE. This includes waterfowl refuges as well as upland game areas. See Section 4.5 for a discussion of surface water bodies within the study area.

4.6.2.7 Wetlands

Numerous types of wetlands are scattered throughout the study area and represent a majority of the acreage in many of parklands and WMAs. See Section 4.8.3 for a discussion of wetlands.

4.6.2.8 Barren Lands

Barren lands are non-vegetated areas. These are located in relatively small areas throughout Arkansas and Oklahoma. Barren lands are uncommon in the study area. Several are located in disjunct patches towards the northwest of the study area near Oologah Lake.

4.7 Infrastructure

4.7.1 Commercial Navigation

The 445-mile MKARNS links Oklahoma and Arkansas with ports on the nation's 12,000-mile inland waterway system, and foreign and domestic ports beyond by way of New Orleans and the Gulf Intracoastal Waterway. In addition, being near the geographic center of the United States makes these ports accessible to the rest of the country via the nation's interstate highway system and railroads.

Essentially a series of navigation pools connected by locks, the waterway enables vessels to overcome a 420-foot difference in elevation from the Mississippi River to the head of navigation at Catoosa, Oklahoma. The navigation system was designed for ease of navigation by multi-barge tows, with ample channel and lock dimensions and bridge clearances. Necessary maintenance dredging is done promptly, and the 9-foot deep channel is open year round. The locks and dams are operated 24 hours a day by the USACE, and the Coast Guard maintains the channel markers and other navigation aids.

Since barges are perceived to be an energy-efficient form of transportation, there has been a resurgence of interest in shipping by inland waterway. Many types of commodities are now shipped on the waterway, and there is adequate capacity for future development. International trade is aided both by good access to foreign ports through the Gulf of Mexico and by the existence of three foreign trade zones on the waterway. The waterway will accommodate a variety of barges and towboats, and there is good access to road, rail, and air transportation.

The waterway has five major publicly-developed ports and numerous privately developed facilities that adjoin the system. A considerable amount of land suitable for development is available at the ports and in other areas. People interested in expanding, locating, or relocating along the MKARNS will find that there are many organizations able to advise and assist on development projects.

The five publicly-developed ports along the MKARNS include:

a. Port of Catoosa, OK - Situated only five miles from Tulsa, Oklahoma, the Port of Catoosa lies at the head of navigation for the MKARNS. A 2000-acre industrial park located at the port gives businesses direct access to the waterway. At the present time there are nearly 50 companies employing 2,600 people located in the port's industrial complex.

The Tulsa Port of Catoosa has five major terminal areas: a low water (roll/on-roll/off) wharf, liquid bulk, dry bulk, grain, and general dry cargo. Between them they can transfer from raw steel to fabricated equipment and from powder-dry materials to thick liquids.

The port is only five miles from Interstate 44, a major link in the nation's interstate highway system. A constant procession of trucks, representing many major carriers and rigging companies, enter and leave the port daily. They can be seen hauling everything from grain to steel to shipping containers.

For high-volume overland shipping, the Tulsa Port of Catoosa provides its businesses with easy access to major rail carriers. The port is served directly by the Burlington Northern/Sante Fe, and indirectly by the Union Pacific/Southern Pacific via the South Kansas and Oklahoma shortline. While the rail cars are on port property, the port's two switch engines can efficiently deliver them to and from port businesses over the 13 miles of internal railroad track.

In addition, Tulsa International Airport is only seven miles away from the Port of Catoosa. This airport is served by many of the larger carriers such as American Airlines, Delta, Southwest, Emery and Continental.

b. Port of Muskogee, OK - The Port of Muskogee is located at River Navigation Mile 393.8 R within the incorporated limits of the City of Muskogee, Oklahoma. The Port of Muskogee is a full-service facility that offers easy access to rail, truck, and barge transportation.

The 400-acre Port Industrial Park offers businesses access to the waterway via truck and rail. All-weather paved industrial roads extend throughout the port. Industrial roads connect to the Muskogee Turnpike and Highway 165 at the port entrance. The Port of Muskogee has a rail marshalling yard and an internal track system that is within the Muskogee switching limits of the Union Pacific Railroad. The port has 20 mooring dolphins, or marine structures designed to anchor boats. These structures are located along river channel frontage and barge terminal and dock facilities that provide access to the MKARNS.

Services provided at the port include a harbor towboat for switching and fleeting barges, overhead and mobile cranes for transloading shipments between barge, rail and truck, and a 94,000 square-foot dockside warehouse. In addition, Davis Field Airport is located 9 miles south of the port.

c. Port of Fort Smith, AR - The Port of Fort Smith, Arkansas is located at River Navigation Mile 308 on the MKARNS. The predominant cargo routinely handled by this facility includes in-bound steel coils and wire rod, scrap steel, bulk alloys, and out-bound steel shapes. The port can transfer nearly any cargo between barge, rail, or truck. Access to Interstate 40 and rail connections by the Arkansas-Missouri railroad are available.

d. Port of Little Rock, AR - The Port of Little Rock is a unique intermodal transportation center. It is located at Mile 112.8 on the right descending bank of the Arkansas River, approximately seven miles east of downtown Little Rock. The port is adjacent to Interstate 440, which connects Interstates 30 and 40. It is also less than one mile from Little Rock National Airport.

More than 2344 employees work in 39 industries located in the 1500-acre Port Industrial Park. The Port Industrial Harbor is a long slackwater harbor with frontage available for industrial development. The port operates a railroad, which switches approximately 5500 cars per year, and it connects to the Union Pacific and Burlington Northern Santa Fe Railroads.

The Little Rock Port Terminal's location on the MKARNS allows it to offer its customers a cost effective method of transporting cargo by barge. It provides water access to cargo heading both west and east on the MKARNS. The terminal is leased on a long term basis by Logistic Services, Inc. (LSI), a professional stevedoring company that specializes in the handling of bulk, steel, and general cargos. LSI can handle multiple cargos to and from railcars, trucks, containers, and barges or any combination thereof. LSI also offers warehousing/outside storage services and limited packaging services.

Facilities at the Little Rock Port Terminal include:

- 157,000 square feet of warehouse space with both rail and truck access;
- 45,000 square feet of paved outside storage area;
- Daily switching services are provided to Little Rock Industrial Park rail users by the Little Rock Port Railroad;
- Main terminal dock area has two river barge berths served by a 175-ton Manitowoc crane and a 125-ton American crane – an additional berth is available for rail/truck transfers of bulk products to river/Lighter Aboard Ship or LASH barge via LSI's river conveyor;
- Terminal area has a 30-ton rail mounted gantry crane for rail/truck cargo transfers;
- An additional dock with one river barge berth located on the Little Rock Port Authority Slackwater Harbor adjacent to the main port area;
- A variety of forklifts with capacities up to 30,000 pounds are included in the LSI equipment inventory; and
- Bulk Handling Capacity - Inbound: 200 tons/hour, Outbound: 350 tons/hour.

e. Port of Pine Bluff, AR - All major barge lines provide service to the Port of Pine Bluff. A 20-acre public terminal facility, located on the Arkansas River's largest slackwater harbor, provides convenient and economical access to barge transportation. The public terminal is equipped to handle virtually any product, and can provide in-transit storage and local drayage services. It offers barge loading and unloading, a 98,000 square foot in-transit warehouse, a 44,000 square foot dry bulk storage area, liquid storage, outside storage, 50- and 70-ton crawler cranes, a 20-ton covered overhead gantry crane, and forklifts with 5,000- to 50,000-lb lift capacity. Special facilities offer barge fleeting, barge cleaning and emergency repairs, pumps, boat and barge rental, towboat servicing and repairs, and crane service.

The Port of Pine Bluff's Harbor Industrial District has attracted capital investments of more than $97 million. There are more than 815 workers employed by river-related companies in the riverfront industrial park. Rail service is provided by Burlington Northern Santa Fe and Union

Pacific. The port also services the Jefferson Industrial Park. Daily commercial air freight and passenger services, along with scheduled commuter flights, are available at the Little Rock National Airport, some 40 minutes driving time from Pine Bluff via Interstate 530.

A complete list of river ports and terminals by river mile is presented on Table 4-11. Figure 4-7 shows the locations of ports along the MKARNS. Most of the port facilities along the MKARNS currently accommodate a 9-foot draft tow.

Table 4-11. River Ports and Terminals Along the MKARNS.		
River Mile	**Name**	**City**
21.6 R	Pendleton Warehouse, Inc.	Dumas
22.0 R	Pendleton Export Terminal, Riceland Foods	Dumas
54.5 R	Bunge Corporation Dock	Linwood
64.5 R	Victoria Bend Terminal, International Paper	Pine Bluff
71.2 R	Century Tube Corporation	Pine Bluff
71.2 R	Petroleum Fuel and Terminal Co.	Pine Bluff
71.2 R	Port of Pine Bluff Public Terminal	Pine Bluff
71.2 R*	Global Materials Services	Pine Bluff
71.2 R	Mid-South Terminal Co.	Pine Bluff
71.2 R*	Pine Bluff Sand and Gravel Co. Dock	Pine Bluff
71.2 R*	Turner Marine Service, Inc. Dock	Pine Bluff
73.5 R	#73 River Terminal, Inc.	Pine Bluff
75.2 L	Bunge Corporation Dock	Pine Bluff
112.8 R	Port of Little Rock Public Terminal	Little Rock
112.9 R	Little Rock Port Authority	Little Rock
112.9 R	River Cement Company	Little Rock
114.4 L	Arkansas Valley Dredging Co., Inc., Dock	North Little Rock
116.2 L	Farmland Industries, Inc.	North Little Rock
116.3 L	Oakley Port	North Little Rock
116.7 L	Petroleum Fuel & Terminal Co. Dock	North Little Rock
116.8 L	Dry Dock, Inc.	North Little Rock
117.3 L	Jeffrey Sand Co., Lincoln Avenue Dock	North Little Rock
118.0 L	Oakley Barge Line, Inc., Fleeting Area	North Little Rock
157.0 L	Sun Pipeline Company Dock	Conway
157.8 L	Jeffrey Sand Company Dock #3	Conway
158.7 L	Souter Construction Co., Inc. Mooring Facility (located on Cadron Creek)	Conway

Table 4-11. River Ports and Terminals Along the MKARNS.

River Mile	Name	City
172.2 L	Bruce Oakley, Inc., Mooring	Morrilton
172.7 L	Oakley Port, Bruce Oakley, Inc.	Morrilton
203.2 L	Mobley Construction Co., Inc. Dock	Dardanelle
203.3 L	Oakley Port, Bruce Oakley, Inc.	
232.8 R	Arkansas Valley Terminal	Morrison B
233.0 R	Five Rivers Distribution	Morrison B
255.9 L	Arkansas Electric Co-Op Corporation Dock	Ozark
296.5 R	Arkhola Sand and Gravel	Fort Smith
298.0 L	Five Rivers Distribution	Van Buren
298.8 L	Daily & Sons Marine Fleeting Area	Van Buren
299.3 L	Consolidated Grain & Barge	Van Buren
300.4 L	Arkhola Sand and Gravel Co. Dock	Van Buren
301.4 R	Mid-South Dredging Co. Yard	Fort Smith
308.7 R **	Global Materials Services-Port of Fort Smith	Fort Smith
308.7 R**	Yaffee Iron	Fort Smith
337.3 L	Jeffrey Sand Company Dock	Sallisaw, OK
342.0 R	Port Carl Albert	Keota, OK
342.0 R	Port of Keota	Keota, OK
344.1 L	Cherokee Nation Port	Sallisaw, OK
362.4 L	Jeffrey Sand Company Dock	Webber Falls, OK
363.2 R	Consolidated Grain and Barge	Webber Falls, OK
390.2 R	Fort James Corporation	Muskogee, OK
391.0 R	Frontier Terminal	Muskogee, OK
393.0 R	Koch Materials Company	Port of Muskogee
393.8 R	Consolidated Grain and Barge	Port of Muskogee
393.8 R	Johnston Terminal-Muskogee	Port of Muskogee

Table 4-11. River Ports and Terminals Along the MKARNS.		
River Mile	**Name**	**City**
393.8 R	Port of Muskogee Muskogee City-County Port Authority	Port of Muskogee
393.8 R	Uni-Steel, Inc.	Port of Muskogee
412.5 L	Consolidated Grain and Barge	Wagoner, OK
426.5 L	Inola Station Slip-Public Service Co.	Inola, OK
431.8 R	Johnston's Port 33, Inc.	Inola, OK
431.8 R	Total Petroleum	Inola, OK
431.8 R	Port Barge Cleaning	Inola, OK
443.8 R	Mid-America Port	Catoosa, OK
445.2***	Advance Chemical Distribution, Inc.	Tulsa Port of Catoosa
445.2***	Catoosa Fertilizer Terminal	Tulsa Port of Catoosa
445.2***	Safety Kleen Systems, Inc.	Tulsa Port of Catoosa
445.2***	Peavey Company	Tulsa Port of Catoosa
445.2***	Port Barge Cleaning	Tulsa Port of Catoosa
445.2***	Frontier Terminal and Trading Co.	Tulsa Port of Catoosa
445.2***	Southern Missouri Oil Co.	Tulsa Port of Catoosa
445.2***	Tuloma Stevedoring, Inc.	Tulsa Port of Catoosa
445.2	Tulsa Port of Catoosa City of Tulsa-Rogers County Port Authority	Tulsa Port of Catoosa
445.2	Terra Nitrogen	Tulsa Port of Catoosa
445.2	Westway Terminal Co., Inc.	Tulsa Port of Catoosa
445.2	Royal Training Co.	Tulsa Port of Catoosa

* These facilities are located on the Pine Bluff Slackwater Harbor
** Facilities located on Poteau River
*** Facilities located on Catoosa Basin, a slackwater harbor off the Verdigris River near Catoosa and Tulsa, Oklahoma.
Source*: USACE, Little Rock District*

Shipping on the MKARNS includes both foreign and domestic trade with the Ports of Little Rock, Catoosa, and Muskogee designated as Foreign Trade Zones. As indicated in Table 4-12, almost 11.9 million short tons of goods were transported on the MKARNS in 2002, of which approximately 2.1 million short tons were transported through the Port of Catoosa. There has generally been a gradual annual increase in the tonnage of goods transported on the MKARNS, with the exception of the year 2000 when the tonnage decreased from the previous year. Transportation of goods is expected to more than double in the next 60 years.

Table 4-12. Comparative Statement Of Traffic (Thousand Short Tons) on the MKARNS.

Year	Total	Year	Total
1993	9,382	2005	12,454
1994	10,706	2010	14,393
1995	10,348	2020	16,020
1996	10,551	2030	17,381
1997	11,154	2040	18,735
1998	12,036	2050	20,206
1999	11,716	2060	21,807
2000	10,733	2070	23,552
2001	11,206	2080	25,454
2002	11,704		
2003	11,881[1]		

Source: "2002 Waterborne Commerce of the United States, Part 2", USACE, Institute for Water Resources
[1] Estimate based on lock performance monitoring system statistics

Figure 4-7. Locations of Ports along the MKARNS in Arkansas and Oklahoma (*Source: The Port of Muskogee, www.muskogeeport.com, 2004*).

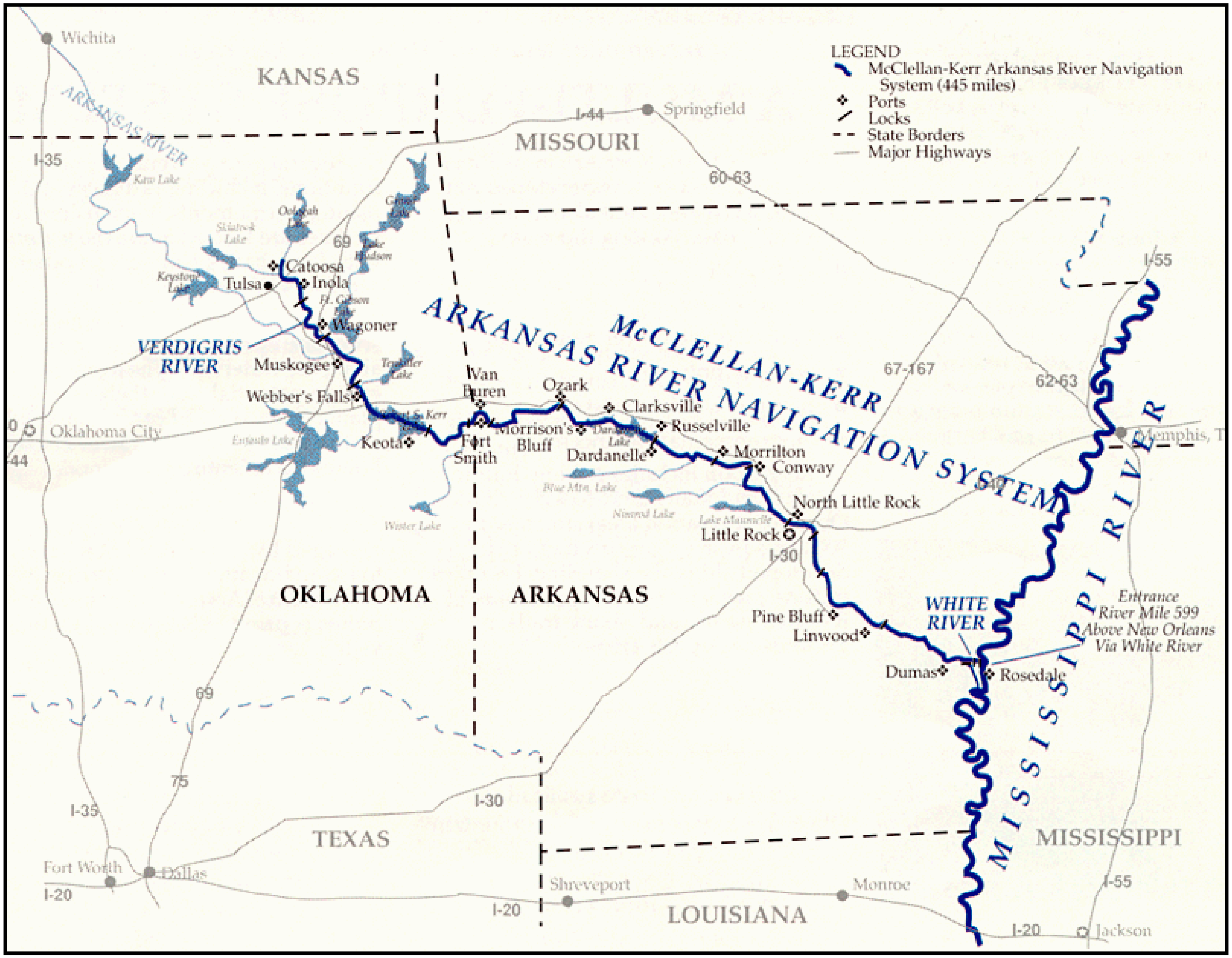


Table 4-13 shows the MKARNS freight traffic for 2002 divided into commodity classes. Non-metallic minerals (primarily sand, gravel, rock and stone), food and farm products, and agricultural chemicals comprise approximately eighty (80) percent of the tonnage of freight traffic.

Table 4-13. Freight Traffic on the MKARNS by Commodity, 2002.

Commodity	Total Traffic (thousand short tons)
Coal	199
Petroleum and Petroleum Products	523
Industrial Chemicals	243
Agricultural Chemicals	1,871
Forest Products	90
Non-Metallic Minerals (includes sand, gravel, rock, and stone)	4,746
Metals (includes iron and steel)	1,220
Food and Farm Products (including grain)	2,809
Other (includes machinery, rubber, plastic, cement, and glass products)	202
Total, All Commodities	11,903

Source: "2002 Waterborne Commerce of the United States, Part 2", USACE, Institute for Water Resources.

Table 4-14 portrays the directional flows of MKARNS freight traffic for 2001.

Table 4-14. Directional Flows of Traffic on the MKARNS, 2001 (000's Tons).

Commodity	Inbound	Outbound	Through		Internal		Total
	Up	Down	Up	Down	Up	Down	
Coal	143	6	0	0	0	0	149
Petroleum and Petroleum Products	278	211	0	0	1	17	507
Industrial Chemicals	154	30	0	0	0	0	184
Agricultural Chemicals	1,450	358	9	0	9	11	1,837
Forest Products	24	106	0	0	0	0	130
Non-Metallic Minerals	303	1,779	0	0	1,215	1,324	4,621
Metals	883	125	0	0	7	0	1,015
Food and Farm Products	292	2,016	0	269	1	0	2,578
Other	164	15	0	0	0	0	179
Total, All Commodities	3,691	4,646	9	269	1,223	1,352	11,200

Source: Waterborne Commerce of the United States, Part 2, 2002

Internal traffic represents traffic that moves between points on the MKARNS, while inbound/outbound traffic consists of traffic that moves onto or off the MKARNS system. Outbound shipments account for forty-one (41) percent of the tonnage, while inbound shipments account for thirty-three (33) percent and internal traffic for twenty three (23) percent of the tonnage shipments on the MKARNS. Farm products and non-metallic minerals constitute the major outbound shipments, while agricultural chemicals comprise the major inbound shipments. Non-metallic minerals, primarily sand and gravel, are the major internal shipments.

The Navigational Capabilities of the MKARNS include the following:

- Navigational channel depth: 9 feet minimum;
- Channel width: 300 ft on the White River Entrance Channel, Arkansas Post Canal, and Lake Langhofer; 250 ft on the Arkansas River; 150 ft on the Verdigris River; and 225 ft on Sans Bois Creek;
- For most of the MKARNS, channel width is sufficient to allow tows to pass each other at any location, but passing on the Verdigris River is restricted to designated wider locations;
- Bridge clearances: Horizontal – generally 300 ft or more, vertical – 52 ft or more;
- Lock size: 110 ft x 600 ft;
- Normal current velocity range: 2-4 m.p.h; and
- Size of tow accommodated: 8 jumbo barges without double lockage, more than 8 with double lockage using tow haulage.

The Lower Mississippi River channel is maintained from river mile 233.4 to 955.8 (Cairo, Illinois to Baton Rouge, Louisiana) to a depth of 9 feet during low water and a width of 300 feet. Although this channel is authorized to a depth of 12 feet it is maintained only to a depth of 9 feet. However, increased depths (12 feet) are available along portions of this channel during higher river stages.

Although the MKARNS has been authorized to a depth of 12 feet [Section 136 of the Energy and Water Development Appropriations Act of 2004 (PL 108-137)], the actual maintained channel depth throughout the MKARNS is 9 feet minimum. Due to ongoing maintenance dredging of the existing navigation channel and natural stream scour, approximately 80-90% of the MKARNS is already 12 feet deep over a portion of the channel width. A barge draft is defined as the depth a vessel sinks in water, particularly when loaded. Thus, a 9-foot deep channel can only accommodate barges with less than a 9-foot draft (approximately 8.5-foot draft with a 0.5 foot clearance).

4.7.2 MKARNS Operation and Maintenance

4.7.2.1 Water Management

The Arkansas River Basin comprises about 138,000 square miles of contributing drainage area; about 128,000 square miles are above Van Buren, Arkansas. The Arkansas River system currently consists of 48 Federal and 2 State (Oklahoma) constructed projects operated for flood control, hydropower, water supply, water quality, sediment control, navigation, recreation, and fish and wildlife. These projects were constructed from the 1940's into the 1980's.

Flows on the main stem of the Arkansas River are modified primarily by 11 reservoirs in Oklahoma that provide about 7.7 million acre-feet of flood control storage. This is more than 70 percent of the total flood storage in the basin. These reservoirs are Keystone, Oologah, Pensacola, Hudson, Fort Gibson, Tenkiller Ferry, Eufaula, Kaw, Hulah, Copan, and Wister. The Fort Smith/Van Buren, Arkansas area near the Oklahoma-Arkansas state line is the primary control point for the lower Arkansas River navigation system (Van Buren to mouth). The reservoirs are operated to maintain flow targets at the Van Buren gage, and all reservoir releases flow past this point. There is about 7,500 square miles of uncontrolled drainage area below these projects and the regulating control point at Van Buren, Arkansas. Section 4.7.6 lists these reservoirs and their corresponding flood control storage.

There are two primary issues with respect to water management: the authority of the USACE to operate the 11 principal reservoirs in the Arkansas River Basin for the benefit of navigation, and the USACE's authority to draw down into the conservation storage to augment low flows on the MKARNS. The Department of the Army's position is that the USACE is authorized to operate any of the reservoirs in the system to benefit navigation, and that the operating plan changes made to date have been within its discretionary authority. Also, that during a navigation emergency, the USACE has the authority to draw down into the conservation storage of five reservoirs – Kaw, Keystone, Eufaula, Oologah, and Tenkiller – to augment low flows on the navigation system if the drawdown does not impact contracted water supply storage.

The operating plan that is presently in place is the culmination of a process of balancing the authorized purposes of the several reservoirs within the specific navigation uses set forth in the MKARNS. This balancing is in response to the Congressional policy of authorizing USACE projects as part of a generally comprehensive plan for river basin development to serve multiple purposes, and not authorizing the projects in isolation of each other. The Tulsa and Little Rock Districts and the Southwestern Division, USACE, have the mission of operating the complex system to satisfy each project purpose as much as possible.

4.7.2.1.1 Taper Operation

Since the completion of the MKARNS in 1970, the USACE has modified the system operating plans several times to improve the flow regime and to enhance benefits to users of the system. Shortly after the completion of the system, it was noted that following a flood event shoaling would occur in the river channel and restrict navigation until maintenance dredging could be performed. To maintain navigation depths during dredging activities, a "taper" operation was implemented to gradually reduce flows following such flood events. This navigation taper operation required an increase in the time water was held in the lower few feet of the flood control pools in the Oklahoma lakes. The taper operation does not increase the level in the flood control pools but it does delay the timing for complete evacuation of the flood pool. The first such navigation taper plan was utilized from 1979 to 1986.

4.7.2.1.2 Bench Operation

The bench is the flow rate at Van Buren, Arkansas. The current operating plan provides for a transition of floodwater releases to normal power generation releases by including a 75,000 cfs flow "bench" at Van Buren. This "bench" varies from about three to five days in duration. The purpose of this "bench" was to increase the number of days of flow below 80,000 cfs for the benefit of navigation and low-lying farms along the river. In order to accomplish this flow "bench", a delay in the evacuation of the lower portion (18 percent or less) of the flood control storage is required. The degree of delay varies depending on the basin hydrologic conditions, season of the year, and the distribution of the flood control storage in use among the projects.

4.7.2.1.3 Existing Plan (1986 Fine Tuning Plan)

In 1985, the volume of water flowing down the Arkansas River past Van Buren was the second largest of record (at that time) and was the fourth year in succession of above normal flows. Because of the high flows, navigation interests experienced increased costs and delays; and farmers, who had been accustomed to farming land near the river, found it impossible to produce crops during this period.

To address these problems, the USACE restudied the operating plan and in June 1986, following a public comment period, implemented a new operating plan. The objective of the new plan (Fine Tuning Plan) was to increase the number of days of flow below 80,000 cfs for the benefit of the navigation system and low-lying farmland, while causing minimal impacts to hydropower, recreation, and flood control in Arkansas and Oklahoma.

The Fine Tuning Plan has been used since June 1986 and is the current or existing operating plan. Key features of this plan are:

1) A taper operation of 40,000 cfs to 20,000 cfs. When the flood storage remaining in the 11 controlling reservoirs reaches from 3% in the spring to 11% in the summer, the target flow at Van Buren is gradually reduced from 40,000 cfs to 20,000 cfs. This allows navigation to continue until dredging operations can remove the sediment deposited in the channel during high flow.
2) A 75,000 cfs bench (a range, 10%-18%, where the flow is held at or below 75,000 cfs). Storage is also adjusted seasonally to maximize benefits to farming and minimize flood impacts during the portions of the year that are more susceptible to floods.

4.7.2.2 Tow Haulage

Tow haulage is a procedure for drawing barges through a lock by using equipment on the lock itself to minimize the maneuvering of a towboat when a tow exceeds the length of the lock. Since the locks on the waterway can hold only eight jumbo (35 feet X 195 feet) barges plus a towboat, when a tow with a larger number of barges reaches a lock, the towboat must split the tow into units or "cuts" that fit the lock. The towboat must lock through with the first cut, push it out of the lock, and then lock back through to get the second cut of barges. Tow haulage equipment on a lock, on the other hand, can pull the first cut through by itself, so that the towboat can stay in its original pushing position and lock through with the second cut.

Lock operation for oversize tows is more efficient with tow haulage equipment. Towboats are used more expeditiously, and shippers can take advantage of the economy of large tows. Larger tows represent a potential for significant cost reduction for both shippers and their customers. Tow haulage equipment has been installed at all twelve locks on the MKARNS in Arkansas, but it has not been installed at any of the Oklahoma locks on the MKARNS.

The existing locks on the system are designed for barges that can operate on a 9-foot channel depth (the shallowest lock sills are at a depth of 14 feet) and for towboats to power through during locking procedures. When powering through, towboats propel water out of the locks, resulting in a reduced volume of water in the lock. In turn, the reduced volume of water in the lock lowers the tow, a process commonly called “squat”, and brings the bottom of the tow to the top of the lock sills. If the bottom of the tow or barge makes contact with the sill bottom during operations, damage to the sill or barge may occur.

EM 1110-2-1604, 30 June 1995, recommends a minimum sill depth of 1.5 times the tow draft (*d*) for safety reasons. Sills are often placed at 1.5 *d* to 2.0 *d* to allow normal entrance speed and vehicle control. The extra depth accommodates typical tow “squat” and allows safe entry/exit when non-typical conditions exist (e.g. debris, ice, overloaded tow, etc.). It is technically feasible for a 12-foot draft barge to enter a lock chamber with only a 14-foot depth over the sill, but entrance/exit velocities would have to be very low, and it would be a considerable operational challenge. Current criterion for minimum depth over sill is as follows: barge draft (9 feet) x 1.5 = 13.5 feet minimum.

4.7.2.3 Dredging Operations And Disposal

Regular maintenance dredging is conducted on the MKARNS to maintain the current navigation channel depth for commercial navigation purposes. Table 4-15 lists dredging quantities along the MKARNS for the USACE Little Rock and Tulsa Districts from 1995 to 2003.

For all of these dredging operations a pipeline dredge was used. A pipeline dredge sucks dredged material through one end, the intake pipe, and then pushes it out the discharge pipeline directly into the disposal site. Because pipeline dredges pump directly to the disposal site, they operate continuously and can be very cost efficient. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device that has rotating blades or teeth to break up or loosen the bottom material so that it can be sucked through the dredge. Some cutterheads are rugged enough to break up rock for removal. Pipeline dredges are mounted (fastened) to barges and are not usually self-powered, but are towed to the dredging site and secured in place by special anchor piling, called spuds.

Table 4-15. Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003.											
Navigation Mile	**Pool**	**Quantity Dredged (CY[1])**									**Average Amount Dredged**
		1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
0.1-1.3	WREC[2]	0	116,277.00	0	0	90,088.03	0	59,049.05	292,304.00	175,537.00	146,651.02
2.0-2.6	WREC	68,021.80	93,835.00	0	0	93,234.22	0	0	0	0	85,030.34
3.24-3.48	WREC	0	0	0	0	0	34,535.28	0	0	0	34,535.28
3.9-4.3	WREC	0	0	0	46,558.06	0	0	0	0	0	46,558.06
4.6-5.59	WREC	0	0	0	0	48,564.43	0	40,665.74	0	0	44,615.09
6.3-10.44	WREC	181,561.50	95,554.00	489566.54	207,129.19	509,838.17	280,754.63	225,640.08	339,207.00	365,355.00	299,400.68
Total WREC		**249,583.30**	**305,666.00**	**489,566.54**	**253,687.25**	**741,724.85**	**315,289.91**	**325,354.87**	**631,511.00**	**540,892.00**	**428,141.75**
18.8-18.9	2	6,248.60	0	0	0	0	0	0	0	0	6,248.60
23.1-23.7	2	0	73,509.00	0	0	0	0	0	0	0	73,509.00
43.0-44.8	2	216,507.50	0	18,960.31	0	105,555.48	55,335.56	37,936.39	96,615.00	119,562.00	92,924.61
46.2-46.6	2	0	0	0	0	0	0	0	0	26,536.00	26,536.00
48.3-48.9	2	0	0	0	0	0	0	0	0	48,319.00	48,319.00
49.5-50.0	2	78,485.80	54,561.00	44,977.13	36,948.10	21,019.36	0	10,092.96	0	11,813.00	36,842.48
Total Pool 2		**301,241.90**	**128,070.00**	**63,937.44**	**36,948.10**	**126,574.84**	**55,335.56**	**48,029.35**	**96,615.00**	**206,230.00**	**118,109.13**
65.1-65.83	3	0	24,434.00	5,688.61	19,772.41	16,260.77	0	4,424.81	0	10,243.00	13,470.60
Total Pool 3		**0**	**24,434.00**	**5,688.61**	**19,772.41**	**16,260.77**	**0**	**4,424.81**	**0**	**10,243.00**	**13,470.60**
85.8-86.2	4	0	5,305.00	3,263.43	8,060.93	10,178.72	0	3,754.54	0	19,721.00	8,380.60
Total Pool 4		**0**	**5,305.00**	**3,263.43**	**8,060.93**	**10,178.72**	**0**	**3,754.54**	**0**	**19,721.00**	**8,380.60**
94.8-95.2	5	0	0	0	40,568.09	0	0	0	0	0	40,568.09

Table 4-15. Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003.

Navigation Mile	Pool	Quantity Dredged (CY[1])									Average Amount Dredged
		1995	1996	1997	1998	1999	2000	2001	2002	2003	
6.2-97.0	5	0	0	0	0	0	0	0	0	116,428.00	116,428.00
107.6-107.94	5	0	0	0	0	0	0	6,990.05	0	7,085.00	7,037.53
Total Pool 5		**0**	**0**	**0**	**40,568.09**	**0**	**0**	**6,990.05**	**0**	**123,513.00**	**57,023.71**
124.8-125.1	7	0	0	0	0	0	0	0	0	18,395.00	18,395.00
146.0-146.63	7	0	0	0	0	0	0	19,046.30	26,233.00	0	22,639.65
Total Pool 7		**0**	**0**	**0**	**0**	**0**	**0**	**19,046.30**	**26,233.00**	**18,395.00**	**21,224.77**
175.2-175.5	8	37,703.40	0	0	0	0	0	0	0	0	37,703.40
Total Pool 8		**37,703.40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**37,703.40**
205.0-205.3	9	0	0	0	29,385.19	0	0	0	0	0	29,385.19
Total Pool 9		**0**	**0**	**0**	**29,385.19**	**0**	**0**	**0**	**0**	**0**	**29,385.19**
222.0-222.3	10	0	0	0	17,651.00	0	0	0	41,811.00	0	29,731.00
225.5-225.7	10	122,300.00	0	0	0	0	0	0	0	0	122,300.00
239.0-239.19	10	0	0	0	0	0	0	0	23,425.19	0	23,425.19
240.6-241.2	10	0	0	0	17,986.00	0	8,096.11	0	0	0	13,041.06
Total Pool 10		**122,300.00**	**0**	**0**	**35,637.00**	**0**	**8,096.11**	**0**	**65,236.19**	**0**	**57,817.33**
275.0-275.55	12	0	0	0	0	0	0	61,604.95	51,804.00	0	56,704.48
279.5-280.2	12	95,343.00	0	0	0	0	0	0	0	0	95,343.00
280.57-280.91	12	0	0	0	0	0	0	0	30,667.87	0	30,667.87
Total Pool 12		**95,343.00**	**0**	**0**	**0**	**0**	**0**	**61,604.95**	**82,471.87**	**0**	**79,806.61**

Table 4-15. Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003.

Navigation Mile	Pool	Quantity Dredged (CY[1])									Average Amount Dredged
		1995	1996	1997	1998	1999	2000	2001	2002	2003	
Poteau River 0.0-0.3	13	45,098.20	0	0	0	0	0	0	0	0	45,098.20
319.0	13	0	0	0	0	19,445.37	0	0	0	0	19,445.37
Total Pool 13		**45,098.20**	**0**	**0**	**0**	**19,445.37**	**0**	**0**	**0**	**0**	**32,271.79**
311.5-312.0	14	62,214.40	0	0	0	0	0	0	0	0	62,214.40
Total Pool 14		**62,214.40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**62,214.40**
393.0	16	0	0	0	0	64,892.41	0	0	0	0	64,892.41
394.0-395.0	16	0	143,894.00	102,893.52	0	0	0	0	151,606.00	0	132,797.84
400.0-400.6	16	75,486.00	4,094.00	0	0	17,637.41	0	0	0	0	32,405.80
Total Pool 16		**75,486.00**	**147,988.00**	**102,893.52**	**0**	**82,529.82**	**0**	**0**	**151,606.00**	**0**	**112,100.67**
402.7-403.0	17	0	3,328.00	0	0	0	0	0	0	0	3,328.00
421.0-421.6	17	50,171.02	0	0	0	91,862.41	0	0	91,403.61	0	77,812.35
Total Pool 17		**50,171.02**	**3,328.00**	**0**	**0**	**91,862.41**	**0**	**0**	**91,403.61**	**0**	**59,191.26**
444.6-445.1	18	42,777.30	0	0	0	0	0	0	0	0	42,777.30
Total Pool 18		**42,777.30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**42,777.30**
Total for Year		**1,081,918.52**	**614,791.00**	**665,349.54**	**424,058.97**	**1,088,576.78**	**378,721.58**	**469,204.87**	**1,145,076.67**	**918,994.00**	

[1]Cubic yards
[2]White River entrance channel
Source: USACE, Little Rock District, C.N. Mitchell, email correspondence dated June 9, 2004.

Congressionally-authorized projects for dredging and dredged material disposal conducted by the USACE do not receive permits but must comply with the Rivers and Harbors Act (RHA) and the CWA. Under the CWA, the EPA is responsible for developing the environmental criteria used by the USACE to evaluate proposed discharges of dredged material and for environmental oversight. The Section 404(b)(1) guidelines are the substantive criteria by which proposed dredged material discharge actions are evaluated. The EPA also maintains general environmental oversight, including Section 404(c) permit veto authority if there will be an "unacceptable adverse effect." Under Section 401, proposed discharges of dredged or fill material must comply with applicable State water quality standards.

In accordance with the USACE Operations and Maintenance (O&M) regulations published in Title 33 Code of Federal Regulations Parts 335 through 338, and Section 401 of the CWA, the USACE, Tulsa District prepared a Long Term DMDP for the operation and maintenance of the MKARNS. Although the USACE does not issue itself a CWA permit to authorize USACE discharges of dredged or fill material into waters of the United States, 404(b)(1) guidelines and other substantive requirements of the CWA and other environmental laws are applied. To this end, the USACE is seeking State water quality certification for the discharge of dredged material or fill material into waters of the United States.

Maintenance dredging is being performed on the MKARNS under the following planning constraints:

- Maintain all existing project purposes;
- Allow all existing locks to remain in operation;
- Allow no in-stream disposal in Oklahoma;
- Minimize/mitigate impacts to the entire aquatic ecosystem, i.e., fisheries, wetlands, etc;
- Minimize/mitigate flood damages; and
- Minimize stream bank erosion.

The USACE published a Final Environmental Statement for the O&M Program for the Oklahoma portion of the MKARNS in September 1974 (USACE 1974). O&M activities have been operating under this document since that time. Dredged material disposal has taken place in designated disposal areas such as on shore unconfined disposal areas; or behind bank stabilization and channel alignment structures; or in confined upland disposal areas. Currently, dredged material disposal areas along the Oklahoma portion of the MKARNS are scarce. Initial assessments show existing disposal areas are insufficient to accommodate maintaining a 9-foot channel in the future. The USACE Tulsa District, has avoided open water disposal in the past, however, it is anticipated in the new Long Term DMDP (USACE 2003a) that new dredged material disposal areas would be needed along with the expansion of five islands created by dredged material disposal from the original Sans Bois Creek Navigation Channel construction when the Robert S. Kerr Reservoir was built. The Oklahoma Long Term DMDP identifies twenty-six maintenance dredged material disposal sites that occur or are planned for the Tulsa District portion of the MKARNS (Pools 13 to 18).

Along the Arkansas portion of the MKARNS, there are 138 pre-approved dredged material disposal sites encompassing 12,709 acres. Of those sites, 42 sites encompassing 6,207 acres are open-water dredged material disposal sites. All of these sites fall within existing dike fields.

4.7.3 Locks and Dams

The development of the waterways of the MKARNS involved many in-stream modifications that produce stability and consistency to a naturally dynamic system. Navigation on the MKARNS is controlled by a series of 18 locks and dams (17 existing - 12 in Arkansas and 5 in Oklahoma - and one under construction). Dams were created along the length of the system in order to maintain a navigation pool, typically along the old river channel, that provided a constant minimum navigation depth to the channel. This series of navigation pools from dam to dam creates a stair step profile to the waterway from pool to pool, this allows the system traffic to "climb" or "ascend" the system's 420 foot elevation change with a consistent navigable channel.

Passage through a dam is achieved through a "lock" chamber system that lowers downstream traffic by reducing the water level in the chamber to that of the downstream navigation pool and raising the chamber elevation for upstream traffic.

The lock and dam structures along the MKARNS vary in design and include 14 “low-head” and 4 “high-head” locks and dams. The four high-head USACE-operated locks and dams are used for hydroelectric power production as well as navigation control. Hydroelectric power production occurs at additional locks and dams along the MKARNS, however these are not USACE-operated facilities.

The MKARNS lock system is illustrated on Figure 4.8. Table 4-16 lists each of the USACE lock and dam structures located on the MKARNS. Dams with hydroelectric power capabilities are also identified in Table 4-16 and discussed in more detail in the next section.

Figure 4-8. Lock Lift System.

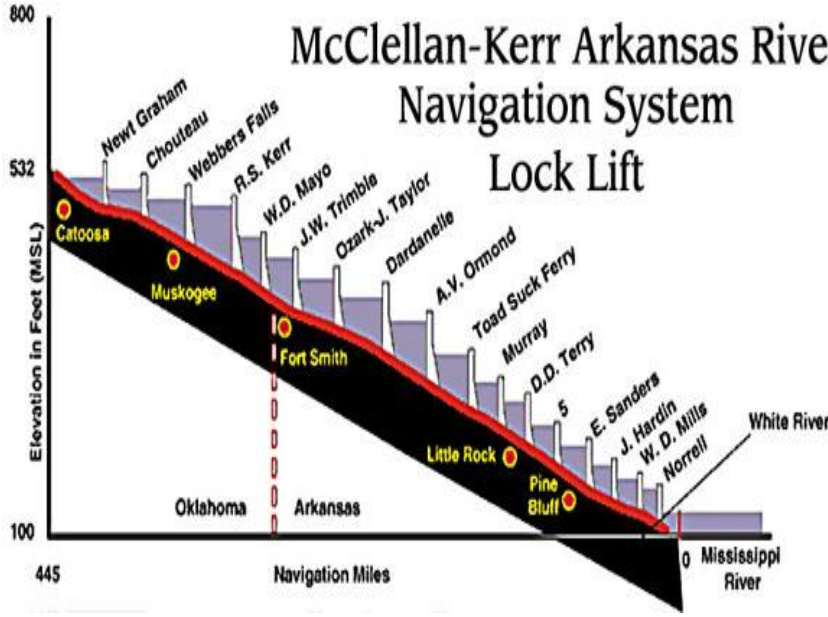


Table 4-16. Lock and Dam Structures of the MKARNS.

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)ϟ	1965 to 1970	368.9	490 to 460
Robert S. Kerr L & D (No. 15)ϟ	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. 13ϟ	1966 to 1969	292.8	392 to 372
Ozark-Jeta Taylor L & D (No. 12)ϟ	1964 to 1969	256.8	372 to 338
Dardanelle L & D (No. 10)ϟ	1957 to 1969	205.5	338 to 284
Arthur V. Ormond L & D (No. 9)ϟ	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)ϟ	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 (No. 2)ϟ	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 2005	0.6[4]	~115

[1] Navigation miles upstream from the mouth of the White River.

[2] Elevation in feet above msl from upper pool to lower pool.

[3] Miles upstream from the mouth of the Arkansas River at the Mississippi River.

[4] Navigation mile 0.6 of the White River Entrance Channel.

ϟ Hydroelectric power; * Verdigris River; ** Arkansas Post Canal.

Source: USACE and MKARNS, 2000.

Descriptions of each lock and dam structure along the MKARNS are provided below. This does not include a description of reservoir project dams.

a. Newt Graham Lock and Dam (No. 18) – Located on the Verdigris River at navigation mile 421.6, approximately 8 miles southwest of Inola in Wagoner County, Oklahoma, the Newt Graham Lock and Dam Project was authorized by the River and Harbor Act of 1946. Construction began in 1966 and was completed and operational for navigation in 1970.

Newt Graham Dam is a 1,630-foot embankment of rolled earthfill and concrete. The spillway is a gated, concrete ogee weir with a crest elevation of approximately 506 feet above mean sea level (msl). The elevation at the top of the spillway gates is approximately 532 feet above msl. The total width of the spillway is 220 feet with a net flow width of 180 feet. The lock is a 110- x 600-foot single lift chamber with miter gates and has a normal lift of 21 feet.

b. Chouteau Lock and Dam (No. 17) – The River and Harbor Act of 1946 authorized the creation of Chouteau Lock and Dam as part of the MKARNS. The lock is located on the Verdigris River at navigation mile 401.4, about 4 miles northwest of Okay in Wagoner County, Oklahoma. Construction of the dam began in 1966 and was completed in 1970. The first boats traveled through the lock only a few weeks later.

The 11,690-foot dam is a combined earthfill and concrete, gravity dam. The spillway is a gated, concrete, ogee weir with a crest elevation of 485 feet above msl. The tops of the spillway gates are at 512 feet above msl. There are left and right uncontrolled overflow sections. The total width of the spillway is 386 feet, with a net flow width of 346 feet. Chouteau Lock has a 110- x 600-foot single-lift chamber with miter gates. It has a normal lift of 21 feet and a maximum lift of 24 feet.

c. Webbers Falls Lock and Dam (No. 16) – Located at navigation mile 368.9, approximately 5 miles northwest of Webbers Falls, Oklahoma, the lock and dam were constructed for both navigation and hydroelectric power. Authorization to build the lock and dam came from the River and Harbor Act of 1946. Construction began in 1965 and completed and operational for navigation in 1970.

The Webbers Falls Lock and Dam Project is 4,370 feet long, including the spillway, powerhouse intake, and navigation lock. The dam is constructed of rolled-earth material and stands 84 feet above the streambed. The elevations from the upper and lower pools are 490 and 460 feet above msl, respectively. The spillway is a gated, concrete, ogee weir. The lock, an Ohio River-type with a normal lift of 30 feet, has a culvert and port filling system and side outlet discharge. The chamber is 110 feet wide by 600 feet long.

d. Robert S. Kerr Lock and Dam (No. 15) – The Robert S. Kerr Lock and Dam (No. 15) Project was authorized as part of the MKARNS by the River and Harbor Act of 1946. The project was originally named the Short Mountain Lock and Dam. The name was changed by Public Law 88-62 (approved July 8, 1963). The lock and dam are located at navigation mile 336.2, about 8 miles south of Sallisaw in Le Flore County, Arkansas. Construction was started in 1964 with the objectives of navigation, hydroelectric power, and recreation. Closure of the dam and navigable operation occurred in 1970.

The total length of the project is 7,230 feet, including the spillway, powerhouse intake, and navigation lock. The dam, constructed of rolled earthfill material, is 75 feet above the streambed. The gated, concrete, ogee weir-type spillway extends partly across the existing river channel and a portion of the right bank between the power improvements and the navigation lock. It is 900 feet long. The single-lift, Ohio River-type lock is located to the left of the spillway and has a culvert and port filling system. The chamber is 110 feet wide by 600 feet long and provides a normal lift of 48 feet.

e. W.D. Mayo Lock and Dam (No. 14) - Located at Navigation mile 319.6, approximately 9 miles southwest of Fort Smith, Arkansas, the W.D. Mayo Lock and Dam were authorized under the River and Harbor Act of 1946. Construction began in 1966 and was completed and operational in 1970.

The dam is 7,400 feet long and consists of a low concrete apron and sill. It is surmounted by twelve 60- x 21-foot tainter gates, each separated by 10-foot concrete piers. The piers hold the machinery that operates the gates. W.D. Mayo Lock has a 110- x 600-foot, single-lift chamber with miter gates. The normal and maximum lifts are 20 and 22 feet, respectively.

f. J.W. Trimble Lock and Dam (No. 13) – The J.W. Trimble Lock and Dam are located at navigation mile 292.8 about 3 miles east of Fort Smith, Arkansas. Also authorized by the River and Harbor Act of 1946, it is the first lock and dam as the Arkansas River enters the State of Arkansas. Construction began in 1966 and was completed and opened for navigation in 1969.

The spillway is composed of a low concrete apron about 1,050 feet long, surmounted by fifteen 60- x 30-foot tainter gates. The lock has a maximum lift of 22 feet.

g. Ozark-Jeta Taylor Lock and Dam (No. 12) – Situated at navigation mile 256.8 within Franklin County, Arkansas, the Ozark-Jeta Taylor Lock and Dam (No. 12) are one mile southeast of Ozark, Arkansas. Construction activities occurred from 1964 to 1969.

The dam has a spillway elevation of 327 feet above msl. The tops of the gates are at 373.0 feet above msl. The top of the lock wall and embankment reach 382 feet above msl. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

h. Dardanelle Lock and Dam (No. 10) – Dardanelle Lock and Dam are located at navigation mile 205.5 along the border of Pope and Yell Counties in Arkansas. Authorization to build the lock and dam came from the River and Harbor Act of 1946. Construction was initiated in 1957 and completed in 1969.

The spillway crest and top of the dam elevations are 300 and 355 feet above msl, respectively. The dam is 2,683 feet long and the spillway is 1,210 feet long. The dam has 20 gates, each of which is 50- x 39-feet is size and is located at 339 feet above msl. Dardanelle Lock has a 110 x 600 foot chamber with a maximum lift of 54 feet. The top of the lock wall is 348 feet above msl.

i. Arthur V. Ormond Lock and Dam (No. 9) – This lock and dam project is located at navigation mile 176.9 in Conway County, Arkansas. Construction began in 1966 and was completed for navigation in 1969. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

Arthur V. Ormond Dam is 1,800 feet long. The spillway is 980 feet long and consists of fourteen 60- x 35-foot gates. The elevations of the spillway crest and fully open gate lip are 253 and 313.5 feet above msl, respectively. The chamber of the Arthur V. Ormond Lock measures 110 x 600 feet. It has a 19 and 22-foot normal and maximum lift, respectively. The top of the lock wall is 297 feet above msl. The chamber floor stands at 247 feet above msl.

j. Toad Suck Ferry Lock and Dam (No. 8) -- Toad Suck Ferry Lock and Dam are located at navigation mile 155.9 west of Conway, Arkansas. Construction began in 1965 and was completed for navigation in 1969. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The spillway is 1,120 feet long and consists of sixteen 60- x 24-foot gates. The elevations of the spillway crest and fully open gate lip are 242 and 294 feet above msl, respectively. The chamber of the Toad Suck Ferry Lock measures 110 x 600 feet and has a 16-foot normal lift. The top of the lock, guard, and guide walls stands ranges in elevation from 247 to 279 feet above msl. The lock’s chamber floor ranges from 218 to 231 feet above msl.

k. Murray Lock and Dam (No. 7) -- Murray lock and dam are located at navigation mile 125.4 in Pulaski County, Arkansas. Construction was authorized by the River and Harbor Act of 1946, and began in 1965. It was completed for navigation in 1969.

The spillway is 980 feet long and consists of fourteen 60- x 33-foot gates. The elevations of the spillway crest and fully open gate lip are 218 and 268 feet above msl, respectively. The chamber of Murray Lock measures 110 x 600 feet and has an 18-foot normal lift. The top of the lock, guard, and guide walls stands at 259 feet above msl. The lock’s chamber floor ranges in elevation from 192 to 197 feet above msl.

l. David D. Terry Lock and Dam (No. 6) – The David D. Terry Lock and Dam construction began in 1965 at navigation mile 108.1. The project was completed for navigation several years later in 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam spillway section consists of seventeen gates, each 60- x 27-feet in size. The spillway itself is 1,190 feet long. The spillway crest is 206 feet above msl. The gate lip, when fully open, reaches 252 feet above msl. The David D. Terry Lock ranges in elevation from 196 feet above msl (chamber floor) to 243 feet above msl (top of lock wall). It has a single-lift chamber measuring 110 x 600 feet. The normal lift is 18 feet.

m. Lock and Dam No. 5 – Lock and Dam No. 5 are situated at navigation mile 86.3. Construction of the lock and dam began in 1965 and was complete and operable for navigation in 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam has fifteen 60- x 31-feet gates and a 1,050-foot spillway. The spillway crest and fully-open gate lip elevations are 183 and 242 feet above msl, respectively. The lock chamber measures 110 x 600 feet in size and has a normal lift of 17 feet. The top of the lock wall is at 225 feet above msl, while the chamber floor is at 179 feet above msl.

n. Emmett Sanders Lock and Dam No. 4 – The Emmett Sanders Lock and Dam construction began in 1964 at navigation mile 66.0. The project was completed and operable for navigation four years later in 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam spillway section consists of seventeen gates. Eight gates are 60- x 23-feet in size and nine gates are 60- x 28-feet in size. The spillway itself is 1,190 feet long. The spillway crests are 169 and 174 feet above msl. The gate lip, when fully open, reaches 217 feet above msl. The Emmett Sanders Lock ranges in elevation from 165 feet above msl (chamber floor) to 206 feet above msl (top of lock wall). It has a single-lift chamber measuring 110 x 600 feet in size. The normal lift is 14 feet.

o. Joe Hardin Lock and Dam (No. 3) – Joe Hardin Lock and Dam (No. 3) are situated at navigation mile 50.2. Construction of the lock and dam began in 1964 and was completed by 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam has eighteen 60- x 25-feet gates and a 1,260-foot spillway. The spillway crest and fully-open gate lip elevations are 158 and 207 feet above msl, respectively. The lock chamber measures 110 x 600 feet in size and has a normal lift of 20 feet. The top of the lock wall is at 194 feet above msl, while the chamber floor is at 147 feet above msl.

p. Wilbur D. Mills Dam (No. 2) – The Wilbur D. Mills Dam construction at river mile 40.5 (upstream from the mouth of the Arkansas River at the Mississippi River) began in 1963 and was completed for navigation several years later in 1967. Authorization to build the dam came from the River and Harbor Act of 1946.

The dam spillway section consists of sixteen gates, each 60- x 30-feet in size. The spillway itself is 1,120 feet long. The spillway crest is 134 feet above msl. The gate lip, when fully open, reaches 180 feet above msl.

q. Lock No. 2 – Lock No. 2 is situated at navigation mile 13.3 on the Arkansas Post Canal. Construction of the lock began in 1963 and was completed in 1967. Authorization to build the lock came from the River and Harbor Act of 1946.

The lock chamber measures 110 x 600 feet in size and has a normal lift of 20 feet. The top of the lock wall is at 174 feet above msl, while the chamber floor is at 127 feet above msl.

r. Norrell Lock and Dam (No. 1) – Norrell Lock and Dam (No. 1) are situated at navigation mile 10.2 on the Arkansas Post Canal. Construction of the lock and dam began in 1963 and was completed in 1967. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam has an ungated weir and a 227-foot spillway. The spillway crest elevation is 142 feet above msl. The lock chamber measures 110 x 600 feet in size and has a normal lift of 30 feet. The top of the lock wall is at 156 feet above msl, while the chamber floor is at 95 feet above msl.

s. Montgomery Point Lock and Dam – The construction of the Montgomery Point Lock and Dam, authorized by the River and Harbor Act of 1946, has recently been completed (in 2005). The decision to build the structure resulted from the chronic low water levels and subsequent dredging near the mouth of the White River. It was constructed near navigation mile 0.6 of the White River Entrance Channel.

Montgomery Point has bottom-hinged, torque-tube gates. Adjacent to a 300-foot wide gate and weir structure is the lock chamber, which is approximately 670 feet long. The entire dam (except the control tower) is submerged during high water conditions. The lock is employed when Mississippi River elevations fall below 115 feet above msl. When river levels exceed 115 msl the gates are kept in a lowered position, allowing vessels to pass over them without locking procedures.

4.7.4 Other In-River Structures

Other in-stream structures created for navigation channel and river stability include river training structures, such as dikes (Figures 4-9, 4-10) and revetments (Figures 4-11, 4-12). Dikes are shore-normal stone structures commonly used for training navigation channels and stabilizing inlets. Dikes prevent intrusion of long-shore sediment transport. Dikes also constrain the steady flow causing higher flow velocities and thereby scouring the channel to a depth required for safe navigation. Wing dikes force the water flow away from the bank from which they are built. Revetments are an orderly facing of stone or broken concrete along a slope to prevent erosion. Revetments, must be placed on opposite shores of wing dikes. River training structures have several functions including:

- direct the flow either toward the navigation channel;
- constrict the channel to increase velocity and thus deepen it (navigation);
- prevent erosion on susceptible banks; and
- create slack water for marinas and boat launches.

Recently, the USACE, Little Rock District has begun notching several dikes and revetments along the MKARNS to promote fish passage and create more diverse wildlife habitat. Forty-five notching projects in pools 4 through 10 of the MKARNS had been completed as of February 2002. Notching allows a fresh flow of water to get behind these structures. The calmer, more stable water created behind these structures give fish such as bass, crappie and bluegill a protected place to spawn. In-stream dike and revetment structures in the MKARNS are identified by pool in Tables 4-17 and 4-18.

Figure 4-9. Drawing of Wing Dikes Along Bank of River (*Source: USACE, St. Louis District 2005*).

Figure 4-10. Aerial Photograph of Sediment Build Up Behind Notched Wing Dikes (Source: *USACE, St. Louis District 2005*).

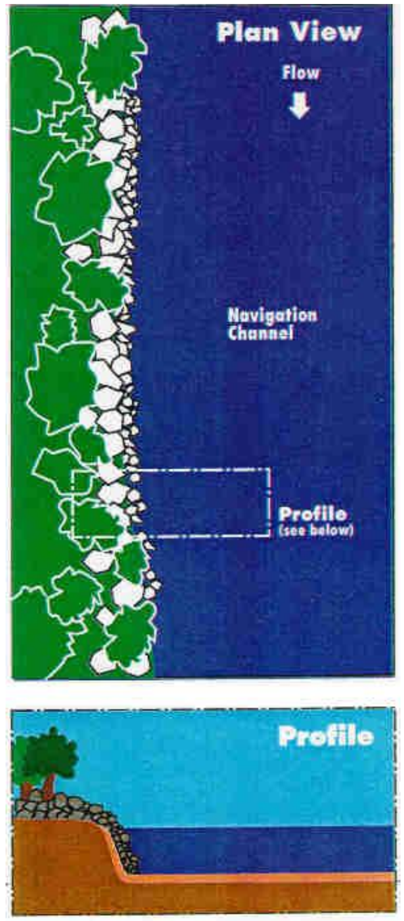


Figure 4-11. Plan View and Profile of a Shoreline Revetment (Source: *USACE, St. Louis District 2005*).

Figure 4-12. Photograph of a Shoreline Revetment (Source: *USACE, Memphis District 2005*).

Table 4-17. In-stream Dike Structures on the MKARNS by Pool.

Pool	Number of Structures
Total number in Pool 2	159
Total Number in Pool 3	92
Total Number in Pool 4	76
Total Number in Pool 5	84
Total Number in Pool 6	94
Total Number in Pool 7	148
Total Number in Pool 8	107
Total Number in Pool 9	111
Total Number in Pool 10	86
Total Number in Pool 12	81
Total Number in Pool 13	139
Total Number in Pool 14	93
Total Number in Pool 15	20
Total Number in Pool 16	23
Total Number in Pool 17	0
Total Number in Pool 18	1
Total Number of Structures in All Pools	1314

[1] Navigation miles upstream from the mouth of the White River (WR).
Source: *USACE, 2004*.

Table 4-18. In-stream Revetment Structures on the MKARNS by Pool.	
Pool	**Length of Revetments (mi)**
Total Length in Pool 2	32.8
Total Length in Pool 3	12.8
Total Length in Pool 4	22.1
Total Length in Pool 5	22.3
Total Length in Pool 6	17.2
Total Length in Pool 7	27.8
Total Length in Pool 8	18.4
Total Length in Pool 9	24.3
Total Length in Pool 10	23.9
Total Length in Pool 12	17.9
Total Length in Pool 13	35.0
Total Length in Pool 14	19.7
Total Length in Pool 15	8.1
Total Length in Pool 16	17.1
Total Length in Pool 17	19.4
Total length in Pool 18	11.2
Total Length of Revetments in All Pools	330.0

[1] Navigation miles upstream from the mouth of the White River.
Source: *USACE, 2004*.

4.7.5 Levees

Most of the current levees along the MKARNS were built in the late 1940s and early 1950s, replacing the original levees, which were built in the early 1900s and destroyed by the flood of 1927. The focus of the levee system was protection of agricultural lands from periodic flooding by the Arkansas River and its major tributaries. The levees along the MKARNS (Table 4-19), consequently, control the area of influence of the MKARNS to those lands within the levees.

Table 4-19. Levees within the Arkansas River Navigation Study Area.	
MKARNS POOL	**LEVEE**
White River	Levee Mile 7, 8.5, and 9.2
Pool 1	Levee Mile 11
Pool 2	Pendleton Levee
Pool 2	South Bend Levee
Pool 2	Farelly Lake Levee District
Pool 2	North Bank Levee Below Plum Bayou
Pool 2	Jefferson County Levee District No. 3
Pool 2	Southeast Arkansas Levee District
Pool 3	Jefferson County Levee District No. 3
Pool 3	Southeast Arkansas Levee District
Pool 3	North Bank Levee Below Plum Bayou
Pool 3	New Gascony Levee District
Pool 3	Linwood - Auburn Levee District
Pool 4	Linwood - Auburn Levee District
Pool 4	Non-Overflow Structure (USACE)
Pool 4	Tucker Lake Levee & Drainage District
Pool 4	Plum Bayou Levee District
Pool 5	T. A. Gibson Private Levee
Pool 5	Plum Bayou Levee District
Pool 5	Old River Drainage District
Pool 5	Woodson Levee District
Pool 5	Fourche Island Drainage District No. 2
D. D. Terry Lake	Fourche Island Drainage District No. 2
D. D. Terry Lake	Little Rock – Pulaski Drainage District No. 2
D. D. Terry Lake	North Little Rock Levee & Floodwall
D. D. Terry Lake	W. D. Cammack Private Levee
Pool 7	Roland Drainage District Levee
Pool 7	Faulkner County Levee District No. 2
Pool 7	Perry County Levee No. 1
Pool 7	Faulkner County Levee District No. 1
Pool 8	Conway County Levee District Nos. 1, 6, 8 and 10
Winthrop Rockefeller Lake	Conway County Levee District No. 1, 3 and 7
Winthrop Rockefeller Lake	Pope County Levee & Drainage District No. 2
Winthrop Rockefeller Lake	Galla Creek Levee
Winthrop Rockefeller Lake	Carden Bottoms Drainage District No. 2
Winthrop Rockefeller Lake	Holla Bend Levee District No. 1

Table 4-19. Levees within the Arkansas River Navigation Study Area.	
MKARNS POOL	**LEVEE**
Winthrop Rockefeller Lake	Point Bar Levee
Winthrop Rockefeller Lake	Flagg Lake Levee
Winthrop Rockefeller Lake	Dardanelle Drainage District Levee
Lake Dardanelle	Lower Hartman Bottom Levee
Lake Dardanelle	McLean Bottom Levee District No. 3
Ozark Lake	Crawford County Levee District
Pool 13	Crawford County Levee District
Pool 13	Van Buren Levee District No. 1
Pool 13	Southern Enterprises Private Levee
Pool 13	Fort Smith Levee Improvement District No. 1
Chouteau Lake	Highway 51
Chouteau Lake	Oxbow Island Park
Newt Graham	Rogers Point Park
Source: MKARNS Navigation Charts, 1997.	

4.7.6 Reservoirs

As designated components of the MKARNS, the eleven upstream reservoirs function to control flows on the waterway through water releases from the dam structures. In addition to functioning as a component of the MKARNS, the reservoirs provide many additional functions including local and downstream flood control, potable water supplies and hydroelectric power. A description of key structures and functions is provided below.

a. Keystone Lake - Keystone Lake was authorized by the Flood Control Act of 1950 in order to provide flood control, potable water, hydroelectric power, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The USACE began construction of the project in 1957 and it was completed and placed in operation in 1964. The hydroelectric power units became operational in 1968.

The dam is 4,600 feet long and rises to a maximum height of approximately 121 feet above the streambed and includes a 1,600-foot concrete section containing the spillway. The dam was constructed as a rolled impervious earthfill structure. The 856-foot spillway with a net width of 720 feet is a concrete, gated, ogee weir, surmounted by eighteen 40- by 35-foot tainter gates. Low-flow regulation is provided by nine 5-foot 8-inch by 10-foot sluices located between alternate intermediate piers. Oklahoma State Hwy 151 is located across the top of the dam to connect relocated U.S. Hwy 51 on the south, and U.S. Hwy 64 on the north.

The pool elevations are 754, 723, and 706 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of

1,672,613 acre-feet. The storage capacities of each pool are 1,167,232, 278,122, and 227,529 acre-feet for the flood control, conservation and inactive pools, respectively.

b. Oologah Lake - Oologah Lake was authorized by the Flood Control Act of 1938 and the River and Harbor Act in 1946 (power generation) in order to provide flood control, potable water, hydroelectric power, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The power generation element of the project was deauthorized in 1974 by Public Law (PL) 93-251. The USACE began a two-phase construction of the project in 1950. The separate phases of construction would allow for recovery of oil in the reservoir basin. After completion of the right abutment access road, the project was placed on stand-by status until after the Korean War. Phase one Construction resumed in 1955 and was completed in 1963. Construction of the second phase was initiated in 1967 and completed in 1974.

The dam is 4,000 feet long and rises to a maximum height of approximately 137 feet above the streambed. The dam was constructed as a rolled impervious earthfill structure. The controlled spillway, located approximately 2 miles east of the left abutment, consists of seven 40- by 21-foot radial gates mounted on a modified concrete ogee weir. The outlet works consists of two 19-foot diameter conduits each served by two 9-by 19-foot gates. A 48-inch low flow pipe is provided for small releases.

The pool elevations are 661; 638; and 592 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 1,559,279 acre-feet. The storage capacities of each pool are 1,007,060; 545,284; and 6,935 acre-feet for the flood control, conservation and inactive pools, respectively.

c. Grand Lake 'O the Cherokees (Pensacola Dam) - Grand Lake was authorized by the creation of the GRDA (a non-profit entity) in through the Grand River Dam Authority Enabling Act of 1935. The GRDA was established to create a water conservation and reclamation district for the waters of the Grand (Neosho) River. The GRDA was responsible for construction and operation of dams along the Grand (Neosho) River for the purposes of hydroelectric power production and flood control. This authorized the construction of the Pensacola Project (Dam), which began in 1938 and was completed in 1940. The Federal government took control of the Pensacola Dam during World War II (1941). The GRDA was again given control of the district in 1946 through an act of congress. The Flood Control Act of 1944 mandated that the USACE direct the operations of GRDA's dam(s) in order to minimize downstream flooding. The USACE controls all releases when the lake level is above 745 msl.

The total length of the dam, including the spillway is 6,565 feet with a maximum height above the streambed of 150 feet. The dam was constructed as a rolled impervious earthfill structure and includes a 4,284-foot concrete multiple arch spillway section. The spillway section includes 51 concrete arches with 21 gated spillways. The powerhouse is 279 feet in length and operates six hydroelectric turbine generator units. The Pensacola Project began a major hydroelectric power equipment upgrade in 1997 (scheduled for completion in 2003). The upgrade requires taking one unit out of service each fall and replacing it with upgraded equipment that includes newly designed turbine runners and shafts, rewound generators, new excitation equipment, transformers and cable.

The pool elevations are 755, 745, and 730 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 2,197,400 acre-feet. The storage capacities of each pool are 525,000, 585,500, and 1,086,500 acre-feet for the flood control, conservation and inactive pools, respectively.

d. Lake Hudson (Markham Ferry Dam) - Lake Hudson was authorized by the creation of the GRDA (a non-profit entity) by the Grand River Dam Authority Enabling Act of 1935, and is the second in a chain of three lakes on the Grand River. The GRDA was established to create a water conservation and reclamation district for the waters of the Grand River. The GRDA was responsible for construction and operation of dams along the Grand River for the purposes of hydroelectric power production and flood control. This authorized the construction of the upstream Pensacola Project in 1938. The GRDA was authorized to build a second dam on the Grand River through the Markham Ferry Coordinating Agreement of 1957. However, the Flood Control Act of 1944 still gives the USACE authority to direct the operations of GRDA's dam(s) during high flow periods in order to minimize downstream flooding. Construction began on the Markham Ferry Project in 1962 to create the Robert S. Kerr Dam, and was completed in 1964.

The total length of the dam, including the spillway is 3,900 feet with a maximum height above the streambed of 85 feet. The dam was constructed as a rolled impervious earthfill structure and concrete spillway section with 13 floodgates. The powerhouse has four 28.5 mega-watt (MW) units and is the operation center for all GRDA projects.

The pool elevations are 636, 619, and 599 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 444,510 acre-feet. The storage capacities of each pool are 244,210, 151,670, and 48,630 acre-feet for the flood control, conservation and inactive pools, respectively.

The Salina Pumpback Project, located on the Saline arm of Lake Hudson three miles east of the town of Saline, was developed as an experimental pumped-storage power plant. Construction of Stage 1 began in 1966 and was completed in 1968. Stage 2 construction followed immediately, and was completed in 1971, adding 260 MWs of production capability to the GRDA system. The dam is 2,300 feet in length with a maximum height above the streambed of 200 feet. The forebay gate structure is 336 feet long, and the penstock dimensions include a 14-foot diameter and 740-foot tunnel and a 251-foot vertical lift to the reservoir. The powerhouse operates a total of six forebay gates and six pump turbines and has a pumping capacity of 5,400,000 gallons per minute. The dam created the 785-acre Chimney Rock Reservoir, which was renamed in 1981 to honor the late W.R. Holway.

e. Fort Gibson Lake - Fort Gibson Lake was authorized by the Flood Control Act of 1941, incorporated into the Arkansas River multipurpose plan by the River and Harbor Act in 1946, and the Water Resources Development Act of 1986 in order to provide flood control and hydroelectric power. The USACE began construction in 1942, but construction was suspended by World War II and resumed by 1946. The completion of the dam construction and closure of the embankment occurred in 1949. The hydroelectric power capabilities became fully operational when the last of the four units began producing commercial power in 1953.

The total length of the dam, including the spillway is 2,990 feet with a maximum height above the streambed of 110 feet. The dam was constructed as a rolled impervious earthfill structure and includes two concrete, gravity, non-overflow sections. One section extends from the spillway to the earth embankment at the right abutment. The other, 460 feet long, extends from the intake structure to the earth embankment at the left abutment. The dam also includes two earth embankment sections, one of which extends approximately 374 feet from the natural ground at the right abutment, to the right bank concrete non-overflow section. The left embankment is 63 feet long and extends from the abutment to the left bank concrete non-overflow section. There are seven rolled earthfill dikes on the west side of the reservoir with a total length of 21,678 feet. Oklahoma State Hwy 251 crosses the dam across all of the sections.

The 1,490-foot spillway section is a concrete, gravity, ogee weir that extends across the existing river channel and a major portion of the right bank floodplain. The spillway is equipped with thirty 40- by 35-foot tainter gates operated by individual electric-motored hoists. The outlet works consists of ten 5-foot 8-inch by 7-foot rectangular sluices located throughout the weir. Flow through the sluices is controlled by means of hydraulically-operated cast-iron slide gates.

The pool elevations are 582, 554, and 551 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 1,284,400 acre-feet. The storage capacities of each pool are 919,200, 53,900, and 311,300 acre-feet for the flood control, conservation and inactive pools, respectively.

f. Tenkiller Ferry Lake - Tenkiller Ferry Lake was authorized by the Flood Control Act of 1938 in order to provide flood control, potable water, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The installation of the power generation feature of the project was authorized by the Rivers and Harbors Act of 1946. The Tulsa District USACE designed and built the reservoir at a total cost of $23,687,000. Construction of the project began in 1947 and was placed in full flood control operation in July of 1953, with power generation commencing in December of 1953.

The dam is 3,000 feet long and rises to a maximum height above the streambed of approximately 197 feet. The dam was constructed as a rolled impervious and semipervious earthfill structure. An additional 1,350-foot long earthfilled dike is located between the right end of the dam and the spillway. The concrete, gravity spillway is located in a narrow ridge comprising the right abutment of the dam approximately 800 feet west of the axis of the dam and has a total width of 590 feet. Oklahoma Sate Hwy 100 extends across the top of the Dam. Flow is controlled by ten 50- by 25-foot tainter gates with a 19-foot flood control outlet conduit. Flow through the conduit is controlled by two 9 by 19 foot tractor-type service gates installed at the upstream end of the conduit and operated by individual electric hoists located on the operating floor of the gate tower structure.

The pool elevations are 667, 632, and 594.5 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 1,230,800 acre-feet. The storage capacities of each pool are 576,700, 371,000, and 283,100 acre-feet for the flood control, conservation, and inactive pools, respectively.

g. Eufaula Lake - Eufaula Lake was authorized by the River and Harbor Act and approved in 1946 in order to provide flood control, potable water, hydroelectric power, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The USACE began construction of the project in 1956 and completed and placed in full flood control operation in 1964.

The dam is 3,200 feet long and rises to a maximum height of approximately 114 feet above the streambed. The dam was constructed as a rolled impervious earthfill structure. The 440-foot spillway has a gross width of 520 feet and is located across a portion of the existing river channel. The spillway is a concrete, gravity, ogee weir with eleven 40- by 32-foot electrically operated tainter gates. The gates are separated by ten 8-foot wide piers that support a bridge across the top of the structure. Low-flow regulation is provided by a 5-foot 8-inch by 7-foot sluice located near the left end of the spillway. The sluice intake invert is at an elevation of 500 feet and flows are controlled by a hydraulically-operated gate. Oklahoma State Hwy 71 is located across the top of the dam.

The pool elevations are 597, 585, and 565 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 3,826,000 acre-feet. The storage capacities of each pool are 1,511, 000, 1,463,000, and 852, 000 acre-feet for the flood control, conservation and inactive pools, respectively.

h. Kaw Lake - Kaw Lake was authorized by the Flood Control Act and approved in 1962 in order to provide flood control, potable water, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The Tulsa District USACE began construction of the project in 1966 and completed and placed in full flood control operation in 1976. Power generation was added in 1989.

The dam is 9,466 feet long and rises to a maximum height of approximately 125 feet above the streambed. The dam was constructed as a rolled impervious earthfill structure with 32-foot wide embankment top. A 24-foot wide bituminous-surfaced road traverses the length of the dam. The 470-foot spillway, located in the right abutment, is gate-controlled by eight 50- by 47-foot tainter gates. Low-flow regulation is provided by two 5-foot 8-inch by 10-foot sluices located through two intermediate piers. A 48-inch water supply pipe is located in the right non-overflow.

The pool elevations are 1,044.5, 1,010, 978 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 1,348,000 acre-feet. The storage capacities of each pool are 914,400, 343,500, and 85,100 acre-feet for the flood control, conservation and inactive pools, respectively.

i. Hulah Lake - Hulah Lake was authorized by the Flood Control Act and approved in 1936 in order to provide flood control, potable water, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The Tulsa District USACE began construction of the project in 1946 and completed and placed in full flood control operation in 1951.

The dam is 5,200 feet long and rises to a maximum height of approximately 94 feet above the streambed. The dam was constructed as a rolled impervious earthfill structure with a 1,115-foot long dike located in a saddle near the right abutment above the dam. The 472-foot spillway is a gate-controlled concrete, gravity, ogee weir with ten 40- by 25-foot tainter gates. The outlet works consists of nine 5- by 6-foot rectangular sluices, which pass through the spillway. Low-flow regulation is provided by two 24-inch diameter pipes, with an additional 10-inch diameter water supply pipe. Oklahoma State Hwy 10 is located across the top of the dam.

The pool elevations are 765, 733, and 710 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 289,088 acre-feet. The storage capacities of each pool are 257,932 and 31,156 acre-feet for the flood control and conservation pools, respectively.

j. Copan Lake - Copan Lake was authorized by the Flood Control Act of 1962 in order to provide flood control, potable water, sediment retention and water quality control, recreation, as well as fish and wildlife enhancement. The Tulsa District USACE began construction of the project in 1972 and completed and placed in full flood control operation in 1983.

The dam is 7,730 feet long and rises to a height of approximately 73 feet above the stream bed and has a top width of about 32 feet. The dam was constructed as a rolled impervious earthfill structure. The spillway is a gate-controlled concrete, gravity, ogee weir with four 50- by 35.5-foot tainter gates and stilling basin. The spillway is 495 feet in length with 263-foot long concrete, non-overflow sections connecting the spillway with the embankment. Oklahoma State Hwy 10 is located across the top of the dam via a 24-foot roadway with 4 shoulders. The spillway bridge has a 28-foot roadway and 4-foot sidewalks. Low-flow regulation is provided by a 36-inch diameter pipe, with an additional 12-inch diameter pipe for future water supply.

The pool elevations are 732, 710, and 687.5 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of 227,734 acre-feet. The storage capacities of each pool are 184,318 42,820, and 596 acre-feet for the flood control, conservation, and inactive pools, respectively.

k. Wister Lake - Wister Lake was authorized for flood control and conservation by the Flood Control Act of 1938. The Tulsa District USACE designed and built the project at a cost of $10.5 million. The project was initiated in 1946 and completed and placed in full flood control operation in 1949.

The dam is 5,700 feet long and rises to a maximum height of 99 feet above the stream bed. The dam was constructed as a rolled impervious earthfill embankment with rock protected sloped, with a rolled earthfill dike that extends 2,400 feet from the right abutment to a maximum height of 40 feet. The 600-foot wide spillway is an uncontrolled concrete chute-type. Low-flow regulation is provided by a 30-inch diameter gated pipe conduit. Oklahoma State Hwy 270 is located across the top of the dam.

The pool elevations are 502.5, 478, and 450 feet above msl respectively for the flood control pool, the conservation pool, and the inactive pool. The reservoir has a total storage capacity of

427,485 acre-feet. The storage capacities of each pool are 366,056, 61,037, and 392 acre-feet for the flood control, conservation, and inactive pools, respectively.

4.7.7 Hydroelectric Power and Energy

The generation of hydroelectric power is one of the several authorized functions of the dams and reservoirs associated with the MKARNS. Fifteen of the MKARNS dam structures have hydroelectric power generation capabilities. Eight of the power plants are owned and operated by the USACE with the electricity marketed by the Southwestern Power Administration (SWPA). SWPA is an agency of the Department of Energy whose mission was established by Section 5 of the Flood Control Act of 1944. The remaining seven power plants are operated through licenses issued by the Federal Energy Regulatory Commission. Pertinent data for the hydroelectric power facilities in the Arkansas River projects are shown in Table 4-20.

Table 4-20. Arkansas River Hydroelectric Power Projects Pertinent Data.

Dam / Reservoir	Number of Units	Type of Units	Installed Capacity, kW	Full Power Discharge, cfs	Year Last Unit On-line	Average Annual Energy, kWh	Marketing Agency
Kaw Dam*	1	Kaplan	25,600	5,000	1989	-	OMPA
Keystone Dam	2	Kaplan	70,000	12,000	1968	282,032,000	SWPA
Pensacola Dam (Grand Lake O' the Cherokees)*	6	Francis	96,000	11,200	1940	340,600,000	GRDA
Robert S. Kerr Dam (Lake Hudson)*	4	-	100,000	28,000	1964	190,000,000	GRDA
Fort Gibson Dam	4	Francis	45,000	9,800	1953	208,482,000	SWPA
Webbers Falls Lock & Dam (No. 16)	3	Slant-Axis	60,000	30,000	1973	228,007,000	SWPA
Tenkiller Ferry Dam	2	Francis	39,100	3,500	1953	114,000,000	SWPA
Eufaula Dam	3	Francis	90,000	13,100	1964	275,149,000	SWPA
Robert S. Kerr Lock & Dam (No. 15)	4	Kaplan	110,000	40,000	1971	600,740,000	SWPA
James W. Trimble Lock & Dam (No. 13)*	3	Pit	32,400	31,350	1988	127,000,000	AECC
Ozark-Jeta Taylor Lock & Dam (No. 12)	5	Slant-Axis	100,000	70,000	1974	314,224,000	SWPA
Dardanelle Lock & Dam (No. 10)	4	Kaplan	148,000	45,000	1966	629,503,000	SWPA
Arthur V. Ormond Dam (No. 9)*	3	Pit	32,400	31,350	1993	134,000,000	AECC
Murray Lock & Dam (No. 7)*	2	-	39,000	-	-	-	NLR
Wilbur D. Mills Dam (No. 2)*	3	Bulb	108,000	51,000	1999	351,000,000	AECC

* Denotes Federal Energy Regulatory Commission licensed projects.
OMPA – Oklahoma Municipal Power Authority SWPA – Southwestern Power Administration GRDA – Grand River Dam Authority
AECC – Arkansas Electric Cooperative Corporation NLR – City of North Little Rock, Arkansas

4.7.8 Roadways and Railways

The primary function of the MKARNS is as a transportation waterway. However, other transportation media are located throughout the study area including railroads and highways. Major roadways and rails that cross the MKARNS via bridge are included in Table 4-21.

Table 4-21. Railways and Highways Traversing the MKARNS.

Name	County (State)	Approx. MKARNS River Mile
Railroads		
Benzal (Union Pacific Railroad Co.)	Desha / Arkansas (Arkansas)	7.6
Rob Roy (St. Louis Southwest [Cotton Belt] Railroad Co.)	Jefferson (Arkansas)	67.4
Rock Island (C.R.I. & P. Railroad Co.)	Pulaski (Arkansas)	118.2
Junction (Mo. Pac. Railroad Co.)	Pulaski (Arkansas)	118.7
Baring Cross (Mo. Pac. Railroad Co.)	Pulaski (Arkansas)	119.6
St. Louis – San Francisco (Burlington Northern Railroad Co.)	Crawford / Sebastian (Arkansas)	300.8
Kansas City (Kansas City Southern Railroad Co.)	Sequoyah / Le Flore (Oklahoma)	324.4
M.K.T. & T. & P. (M.K.T. Railroad & T. & P. Railroad Cos.)	Wagoner (Oklahoma)	399.3
St. Louis – San Francisco (Burlington Northern Railroad Co.)	Rogers (Oklahoma)	444.4
Highways		
Tichnor – Nady (Norrell Lock & Dam No. 2)	Arkansas (Arkansas)	13.4
Pendleton (Highway 165)	Desha / Arkansas (Arkansas)	22.6
Highway 79	Jefferson (Arkansas)	74.8
I – 440	Pulaski (Arkansas)	113.0
I – 30	Pulaski (Arkansas)	118.5
Main Street	Pulaski (Arkansas)	118.8
Broadway	Pulaski (Arkansas)	119.1
I – 430	Pulaski (Arkansas)	126.6
Highway 60	Faulkner / Perry (Arkansas)	155.9
Highway 9	Conway (Arkansas)	173.0
Highway 7	Pope / Yell (Arkansas)	203.5
Clarksville (Highway 109)	Johnson / Logan (Arkansas)	234.8

Table 4-21. Railways and Highways Traversing the MKARNS.		
Name	**County (State)**	**Approx. MKARNS River Mile**
Highway 23	Franklin (Arkansas)	258.2
Highway 59 (James M. Trimble Lock & Dam No. 13)	Crawford / Sebastian (Arkansas)	292.8
I – 540	Crawford / Sebastian (Arkansas)	299.6
Highway 64 and 71	Crawford / Sebastian (Arkansas)	300.5
Highway 64	Crawford / Sebastian (Arkansas), Sequoyah / Le Flore (Oklahoma)	308.4
Highway 59	Sequoyah / Le Flore (Oklahoma)	335.8
Haskell County Road 11a	Haskell (Oklahoma)	Sans Bois Creek 4.5
Highway 9	Haskell (Oklahoma)	Sans Bois Creek 7.9
I – 40	Sequoyah / Muskogee (Oklahoma)	360.3
Highway 64	Sequoyah / Muskogee (Oklahoma)	363.1
Highway 62	Muskogee (Oklahoma)	392.5
Highway 16	Wagoner (Oklahoma)	398.1
Highway 69	Wagoner (Oklahoma)	404.1
Highway 51	Wagoner (Oklahoma)	412.3
Highway 412 Twin Bridges (Highway 33 Landing)	Rogers (Oklahoma)	431.6
I – 44 Twin Bridges	Rogers (Oklahoma)	443.2
Highway 66 Twin Bridges	Rogers (Oklahoma)	444.3
Source USACE, 1997.		

4.8 Biological Resources

4.8.1 <u>Threatened and Endangered Species</u>

Species listed as either “threatened” or “endangered” under the Federal 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. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct. “Taking” of a species includes willfully harming a threatened or endangered animal. It also includes habitat destruction or degradation that significantly interferes with an essential behavior, such as breeding, feeding, or seeking shelter. Threatened and endangered plants receive limited protection unless they are on Federal property. A summary of the list of federally threatened and endangered species is provided below in Table 4-22. In the sections following the table, pertinent information is provided for each species (e.g., historical and current distributions, life history information, primary threats to survival, and presence or absence within the study area). For information on State-listed species of concern, see Section 4.8.2.

4.8.1.1 Federally Threatened & Endangered Species

A Biological Assessment (BA), addressing sixteen federally listed threatened and endangered Species on the Arkansas, Canadian, and Red Rivers; Arkansas, Oklahoma, and Texas; and on the MKARNS Arkansas and Oklahoma was submitted to the USFWS in October 2003 by the USACE and is included in Appendix C. This comprehensive document addressed all federally listed species for those portions of the Arkansas River, Red River, and Canadian River impacted by operation and maintenance of USACE projects while taking into consideration other Congressionally authorized uses of the river and cumulative impacts. The BA was prepared prior to the finding of the ivory-billed woodpecker in Arkansas. The ivory-billed woodpecker was previously believed to be extinct throughout its range. Information on the ivory-billed woodpecker is included later in this chapter and potential impacts to this species are addressed in chapters 5, 6, and 7.

The BA determined that the proposed actions would have “no affect” on twelve out of sixteen federally listed species that were potentially within the geographical range of the project area. The finding of “no affect” was determined based on the fact that the range of many of these species is not associated with the projects, the species are no longer found within the project area, suitable habitat is not present on project lands, or the impacts were considered to be inconsequential. The unaffected species include: American alligator (*Alligator mississippiensis*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Ozark big-eared bat (*Corynorhinus townsendii ingénues*), whooping crane (*Grus americana*), pink mucket pearly mussel (*Lampsilis abrupta*), scaleshell mussel (*Leptodea leptodon*), Arkansas river shiner (*Notropis girardi*), piping plover (*Charadrius melodius*), *Geocarpon minimum* (no common name), western prairie fringed orchid (*Platanthera praeclara*), and harperella (*Ptilimnium nodosum*).

The BA determined that there is a potential for the proposed actions to have an “adverse affect” on the American burying beetle (*Nicrophorus americanus*), interior least tern (*Sterna antillarum*), bald eagle (*Haliaeetus americana*), and pallid sturgeon (*Scaphirhynchus albus*). In response to the BA, a Biological Opinion (BO) dated June, 2005 was prepared by the USFWS and is included in Appendix C. This document concluded that potential impacts to the bald eagle related to contaminants in the dredged material could not be assessed until testing of sediments to be dredged was completed. Also, the USFWS stated that it had inadequate information on the status of the pallid sturgeon within the Action Area to render an opinion on the species, declaring that it is unknown if the pallid sturgeon occurs in the study area or if the proposed changes in flows would have any affect on potential habitat. Therefore, the bald eagle and pallid sturgeon were not addressed in this BO. The USFWS does not anticipate that the proposed project would impact these two species, but if new information indicates they would be impacted the USACE should reinitiate consultation. However, the USFWS does anticipate that the American burying beetle and the interior population of the least tern would be affected by the proposed action. The BO emphasizes anticipated effects of the proposed action on the least tern and is based on the best available scientific evidence and commercial information, including the USACE BA, USFWS files, pertinent literature, discussions with recognized species authorities, and other reliable sources.

Information from the BA and the BO, the USFWS, the Arkansas Natural Heritage Commission, and the Oklahoma State Natural Heritage Inventory was used to create the following list of federally threatened and endangered species that have been found to occur in the counties covered by the study area.

Table 4-22. Federally Listed Threatened and Endangered Species in the Oklahoma and Arkansas Study Area.

Species	Federal Status	LOCATION WITHIN STUDY AREA		
		Oklahoma Co.	Arkansas Co.	Study Area
MAMMALS				
Florida panther (*Puma concolor coryi*)	E		Conway, Jefferson, Johnson, Yell	This species was not listed in the BA because it is unlikely to occur in the Arkansas River study area due to impacts of human disturbance and lack of remoteness and adequate cover.
Gray bat* (*Myotis grisescens*)	E	Cherokee	Pope	Roost sites are known to exist near the study area. This species may utilize the riparian habitats in study area for foraging.
Indiana bat* (*Myotis sodalis*)	E	Le Flore		Roost sites are known to exist near the study area. This species may utilize the riparian habitats in study area for foraging.
Ozark big-eared bat* (*Corynorhinus townsendii ingenues*)	E	Cherokee	Crawford, Franklin	Roost sites are known to exist near the study area. This species may utilize the riparian habitats in study area for foraging.
BIRDS				
Bald eagle* (*Haliaeetus leucocephalus*)	T	Cherokee, Creek, Delaware, Haskell, Kay, Le Flore, Mayes, McIntosh, Muskogee, Nowata, Osage, Ottawa, Pawnee, Pittsburg, Rogers, Sequoyah, Tulsa, Wagoner, Washington	Arkansas, Desha, Jefferson, Lincoln, Logan, Sebastian	Documented to occur along the Arkansas River system at many locations in both states. All of the reservoirs in OK and AR support winter migrants and some support known nesting sites.

Table 4-22. Federally Listed Threatened and Endangered Species in the Oklahoma and Arkansas Study Area.

Species	Federal Status	LOCATION WITHIN STUDY AREA		
		Oklahoma Co.	Arkansas Co.	Study Area
Interior least tern* (*Sterna antillarum*)	E	Creek, Haskell, Kay, Le Flore, McIntosh, Muskogee, Osage, Pawnee, Pittsburg, Rogers, Sequoyah, Tulsa, Wagoner	Conway, Crawford, Desha, Faulkner, Johnson, Logan, Perry, Pope, Pulaski, Sebastian, Yell	Documented to occur along the Arkansas River system at numerous locations in both states. Suitable habitat exists along river and reservoir shorelines.
Piping plover* (*Charadrius melodius*)	T	Cherokee, Creek, Delaware, Haskell, Le Flore, Mayes, McIntosh, Muskogee, Nowata, Osage, Ottawa, Pawnee, Pittsburg, Rogers, Sequoyah, Tulsa, Wagoner, Washington		This species is considered a migrant through the Oklahoma study area. This species has been documented using the Great Salt Plains NWR in Oklahoma as stopover habitat during migration; however, it is thought that many individuals fly nonstop to the Gulf Coast from breeding grounds to the north. This refuge is located to the west of the study area. The species has also been documented in the Winganon Flats at Oologah Reservoir during migration.
Red-cockaded woodpecker (*Picoides borealis*)	E		Grant, Perry, Pulaski, Saline	This species was not listed in the BA because it is unlikely to be found in the study area. It prefers terrestrial habitats with large blocks of open, old-growth pine stands.
Whooping crane* (*Grus americana*)	E	Muskogee, Osage, Pawnee, Rogers, Washington		This species is an uncommon migrant occasionally stopping along rivers, in grain fields, and shallow wetlands in western Oklahoma. This species breeds mainly in northern Canada and winters along the Texas Gulf Coast. It passes through western Oklahoma each spring and fall migration. The Great Salt Plains NWR, near Jet, Oklahoma, is an important stopover area. This refuge is located west of the study area.

Table 4-22. Federally Listed Threatened and Endangered Species in the Oklahoma and Arkansas Study Area.				
Species	Federal Status	LOCATION WITHIN STUDY AREA		
		Oklahoma Co.	Arkansas Co.	Study Area
Ivory-billed Woodpecker *(Campephilus principalis)*	E		Monroe	Species was thought to be extinct until recently found in Monroe County, Arkansas within the Cache River National Wildlife Refuge and adjacent areas.
REPTILES				
American alligator* *(Alligator mississippiensis)*	T (S/A)			This species was listed in the BA because it has been found sporatically in Oklahoma in McCurtain County along the Red River. In southwestern Arkansas it has been observed in Hempstead County along the Little River system. Suitable habitat exists along river and lake shorelines where they dig dens for the winter or during times of drought.
FISHES				
Arkansas River Shiner* *(Notropis girardi)*	T			This species was listed in the BA because of the potential habitat present in the study area. Its prefered habitat is the main channels of large rivers and streams with sandy substrates. However, this species is currently not known to dwell in any of these areas.
Neosho madtom *(Noturus placidus)*	T	Ottawa		This species was not listed in the BA because it is very unlikely to be found in the study area. It is believed to be restricted to the upper Neosho River, upstream of the upper reaches of Grand Lake.
Ozark cavefish (*Amblyopsis rosae*)	T	Delaware, Mayes		Cave habitat on the western lakeshores of Hudson and Grand Lakes may support populations.

Table 4-22. Federally Listed Threatened and Endangered Species in the Oklahoma and Arkansas Study Area.

Species	Federal Status	LOCATION WITHIN STUDY AREA		
		Oklahoma Co.	Arkansas Co.	Study Area
Pallid sturgeon* (*Scaphirhynchus albus*)	E			This species was listed in the BA because the study area provides potential habitat, offering areas at the bottom of large and swift rivers. However, the suitable areas are limited. Only the lower White River and the lower Arkansas River offer suitable habitat and there are no documented records of this species in these areas. The entire State of Arkansas has only two records of this species. One recording was on the Mississippi River and the other on the St. Francis River.
MUSSELS				
Pink mucket* (*Lampsilis abrubta*)	E		Arkansas	Could exist at the extreme lower reaches of the White River as it enters the MKARNS.
Scaleshell mussel* (*Leptodea leptodon*)	E		Crawford, Perry	This species was listed in the BA because it has been collected within the study area. In Oklahoma this species is believed to be found in southeastern portion of the state in the Red River Basin, while in Arkansas it has been found in Crawford and Perry counties.
INSECTS				
American burying beetle* *(Nicrophorus americanus)*	E	Cherokee, Haskell, Le Flore, Muskogee, Pittsburg, Sequoyah, Tulsa	Franklin, Logan, Sebastian	This species has been documented within the study area. Known extant populations occur in Cherokee, Muskogee, and Sequoyah counties. It prefers grasslands and upland forests with well-drained soils and a well-formed litter layer. However, this species has also been found in a variety of habitats, indicating that vegetation and soil type does not limit this species' distribution.

Table 4-22. Federally Listed Threatened and Endangered Species in the Oklahoma and Arkansas Study Area.

Species	Federal Status	LOCATION WITHIN STUDY AREA		
		Oklahoma Co.	Arkansas Co.	Study Area
SNAILS				
Magazine mountain shagreen (*Mesodon magazinensis*)	T		Logan	This species was not listed in the BA because this snail is only found on a single mountain located outside the study area.
PLANTS				
*Geocarpon minimum** (no common name)	T		Franklin	This species is unlikely to be found in the study area, which lacks its preferred habitat (i.e., sandy-clay prairies with bare mineral soils and high salinity).
Harperella* (*Ptilimnium nodosum*)	E		Perry, Yell	It is unlikely that this species exists along the Arkansas River, due to the reservoirs and controlled water regime, however it may exist along some of the smaller tributaries. The species was listed as occurring on Irons Fork in Yell County.
Western prairie fringed orchid* (*Platanthera praeclara*)	T	Rogers		This species is no longer believed to exist in Oklahoma, and the only locations in the study area that could potentially provide habitat is the area surrounding Oologah Lake and the area within MKARNS along the Verdigris River.

E = Endangered, facing extinction

T = Threatened, likely to become endangered

PCH = Proposed Critical habitat

T (S/A) = Species listed as threatened because of similarity of appearance.

* = This species was addressed in the Biological Assessment.

Sources: Arkansas Natural Heritage Commission county lists (dated 10/6/2000); Oklahoma Natural Heritage Inventory county lists (dated 1/18/2001); USACE Draft Biological Assessment Addressing Sixteen Federally Listed Threatened or Endangered Species on the Arkansas, Canadian, and Red Rivers; Arkansas, Oklahoma, and Texas; and on the McClellan-Kerr Arkansas River Navigation System Arkansas and Oklahoma (dated October, 2003), USFWS Draft Biological Opinion (dated 2/14/2004).

4.8.1.2 Profiles of Relevant Federal Species

a. Bald eagle (*Haliaeetus leucocephalus*) - The bald eagle's historical range was all of North America south of the Arctic Circle. After a long period of decline, migration populations and maternity colonies have increased in many counties in Oklahoma and Arkansas. The bald eagle was federally listed as endangered in 1978, however due to population increases, the population was downlisted to threatened in 1995. On July 6, 1999, the USFWS proposed delisting the bald eagle (64 FR 36453) but a final decision has not yet been made.

Bald eagle migration routes usually follow river systems or mountain ranges. Wintering eagles usually occupy river or lake habitats between November 15 and March 1, and use large diameter (>12 inch diameter at breast height) cottonwoods, sycamores, and other riparian trees as daytime perches and night roosts. The bulk of the eagles' diet is fish, but bald eagles are opportunistic and will supplement their diet with a variety of living and dead vertebrate species. These birds are sensitive to disturbance and pollution, and radical changes in the eagles' environment can be detrimental. While reservoir creation has caused the decline of some species, it has been beneficial to bald eagles.

In Oklahoma, the bald eagle is listed in approximately 13 counties that contain portions of the study area. Between 1991 and 2000, the number of Bald Eagle nests in Oklahoma increased annually, with over 25 occupied nests each year since 1998. Counties within the study area where nests have recently been reported include Haskell, Sequoyah, Muskogee, and Noble, among others. In addition, wintering eagles have been sighted at all of the reservoirs. Birds can be seen year-round in Sequoyah and Haskell Counties as well. The river and reservoir habitat that characterizes much of the Oklahoma study area is suitable for bald eagles.

The rivers and reservoirs in Arkansas are also favorite nesting and wintering areas for bald eagles. Many nests have been documented along various stretches of the Arkansas River Valley. In addition, over 1,000 birds are counted each winter in Arkansas. The bald eagle is listed for most of the Arkansas counties in the study area, including Arkansas, Desha, Faulkner, Franklin, Grant, Jefferson, Lincoln, Logan, Pulaski, and Sebastian Counties. Suitable bald eagle habitat exists along the river and reservoirs of the Arkansas River system in Arkansas.

Potential impacts to bald eagles could occur due to dredging operations and the creation of disposal sites for dredged materials. These actions could possibly result in a loss of habitat, temporary limited ability to feed in areas with increased turbidity, and increased levels of pollutants. One positive impact is the increase in shallow water habitat could increase the population of prey species (USACE BA 2003). A more detailed discussion of this species, its habitat, and possible impacts of the proposed action(s) is included in Appendix C.

b. Interior least tern (*Sterna antillarum*) – The interior population of the least tern inhabits several river systems in the West and Midwest, including the Arkansas River system. In both Arkansas and Oklahoma, this species is a summer resident within the study area, and the largest Oklahoma population of interior least terns occurs at the Salt Plains NWR.

Interior least terns nest during May through August on exposed river sandbars, islands, dike fields, and reservoir beaches. The sandy habitat needs to be fairly barren to sparsely vegetated. Two to three eggs are laid in shallow depressions on the open sandy area or exposed flat. Adults and juveniles make a fall migration to Central and South America. Interior least terns feed on small fish, insects, and crustaceans (USFWS 1990).

Several types of human actions threaten the survival of this species. The manipulation of river flow can destroy or alter sandbars and sandy flats outright, can prevent the creation of new river island habitat, and can allow the encroachment of woody vegetation (low flows) or the washing away of nests and chicks (high flows). River dredging, trampling of shoreline habitat by farm animals, and recreational activities (e.g., use of all-terrain vehicles) can also be detrimental to this species. In addition, low flows that cause land-bridging between river islands and the shore can contribute to predation and disturbance of nests on these islands.

Regarding their existence within the study area, interior least terns are listed in 13 of the Oklahoma counties and 11 of the study area counties in Arkansas. These birds are known inhabitants of the Arkansas River system.

In Oklahoma, interior least tern populations and nesting success are monitored annually by the USACE, Tulsa District. This is in accordance with the reporting requirements issued by the USFWS in their 1998 BO on the effects of the operation of Kaw and Keystone Dams on the interior least tern. Key tern nesting populations occur at three locations within the study area in Oklahoma. They include the Arkansas River between Kaw Dam and Keystone Lake, the Arkansas River between Keystone Dam and Muskogee, Oklahoma, and the Canadian River from Eufaula Dam to the upper end of Robert S. Kerr Lake.

In order to provide guidelines for the management and protection of interior least terns nesting at these key locations below USACE water resource projects in Oklahoma, the USACE, Tulsa District, in cooperation with the USFWS, formed a multi-agency Least Tern Committee in 2002 to develop and prepare the “Management Guidelines for Interior Least Terns”. This document details a comprehensive approach for both long term and short term compliance with the ESA to the maximum extent possible. Ongoing negotiations exist between the USACE and the USFWS to update and improve these guidelines.

The long term objective of the management plan includes providing suitable nesting habitat that is not adversely impacted by normal operation of water resource projects. The short term strategies to accomplish this objective include using management practices that minimize impacts to nesting birds. Such management practices include:

- Sufficient high flow releases during non-nesting periods to deposit sediments and periodically scour islands to remove vegetation;
- Removing vegetation from these islands during non-nesting periods by physical or chemical means;
- Use of dredged materials to replenish existing islands and deepening water around islands to remove land bridges during non-nesting periods;

- Limiting maximum water releases during the nesting season to prevent flooding of active nests; and
- Providing minimum water releases during the nesting season to prevent land-bridging of islands.

Due to annual variations in tern nesting patterns, specific management practices in the Tulsa District are coordinated with the USFWS and implementation is evaluated on a case-by-case basis.

Since issuance of the 1998 BO, additional least tern information became available that supported re-initiation of consultation with the USFWS and preparation of a new BA. Additional surveys were conducted on three river systems (The Arkansas River, the Canadian River, and the Red River), and the results of these surveys needed to be addressed in the new BA and considered in a new BO. Also, the least tern management guidelines and strategies developed and implemented by USACE, Tulsa District needed to be considered and addressed in the BO. Scattered colonies of least terns nest along the MKARNS in Arkansas. Nesting locations vary widely each year depending upon river conditions, and terns have even been observed nesting in crop fields during periods of high water within the nesting season (in 1995). Concentrations of nesting terns have been observed between 1991-2001 at Sample Island (navigation mile 34-35), Stane Reach Light area (navigation mile 161.4), Ellis Island Cutoff (navigation mile 170.9), Crane Island (navigation mile 187-189), Spadra Park area (navigation mile 230), Skaggs Island (navigation mile 236.2), and Frog Bayou (navigation mile 279).

Several historic nesting sites on the upper Arkansas River (above navigation mile 200) are apparently covered with too much vegetation for recent use by least terns. Before 1991, the lowest navigation mile where terns had been located was navigation mile 100.9, across from Wrightsville Park. In 1991, there were sightings at navigation miles 34.5 - 45.8 and below Dam 2, the first since the least tern surveys were begun in 1986. New nesting sites also were identified on the lower Arkansas River (navigation miles 35-60) in 2001; many were where no birds had been reported before.

Management of least tern nesting populations within the Arkansas portion of the MKARNS does not include manipulation of flow levels since there are no flood control pools in the region. Management practices in Arkansas consist of restrictions on dredging near nesting areas, using dredged materials to build nesting islands, and notching dikes to allow scouring flows to reach some nesting islands.

A BA included in Appendix C addressed all federally listed species, including the interior least tern, for those portions of the Arkansas River, Red River, and Canadian River impacted by operation and maintenance of USACE projects while taking into consideration other Congressionally authorized uses of the river and cumulative impacts. The BA determined that there is a potential for the proposed actions to have an "adverse affect" on the interior least tern, among other species. In response to the BA, a final BO was prepared by the USFWS which emphasizes anticipated effects of the proposed action on the least tern and is based on the best available scientific evidence and commercial information, including the USACE BA, USFWS files, pertinent literature, discussions with recognized species authorities, and other reliable source. This draft document is also included in Appendix C.

c. Pallid sturgeon *(Scaphirhynchus albus)* – This federally endangered species can weigh more than 80 pounds and exceed six feet in length. Its snout is flat and shovel-shaped. A toothless, protractible mouth is located on the underside of its snout. The back portion of its body, just before its tail, is known as the caudal peduncle, which in this species it is long and armored (USACE BA 2003).

This prehistoric fish evolved during the Paleozoic Era from a group of bony fishes of the subclass Paleopterygii. The majority of this subclass became extinct during the Mesozic Era. However, paddlefish (Polyodontidae) and eight species of sturgeon (Acipenseridae) are living descendants of this subclass.

The pallid sturgeon is well adapted to dwelling on the bottom of large and swift rivers. This species' evolution took place during a very dynamic period in which large rivers such as the Mississippi and Missouri were constantly changing. The changes that have occurred in more recent times however have proven more difficult. The construction of major dams, the channelization of rivers, the degradation of water quality, and its hybridization with the shovelnose sturgeon, have all contributed to this species decline.

Little is known about this species' historical range. However, in the study area, only the lower White River and the lower Arkansas River offer suitable habitat, and there are no documented collection records of this species from these areas. The entire State of Arkansas has only two records of this species. One recording was on the Mississippi River and the other was on the St. Francis River.

d. American burying beetle (*Nicrophorus americanus*) - This species was once found in over 30 states and Canada. Recently, it has only been found in Arkansas, Kansas, Massachusetts, Nebraska, Oklahoma, Rhode Island, and South Dakota. In Oklahoma, it is known from seventeen counties, including several that contain study area habitat: Cherokee, Haskell, Le Flore, Muskogee, Pittsburg, Sequoyah, and Tulsa Counties. In Arkansas, this species is listed in five counties. Three of these counties, Franklin, Logan and Sebastian, are within the study area. The largest populations in Arkansas are believed to be the Ouachita National Forest area, which borders the Arkansas River.

Specific habitat requirements are largely unknown. Collections in Oklahoma have come from level areas with relatively loose, well-drained soils and a well-formed litter layer. The beetle has been collected from oak-pine and oak-hickory forests, grasslands and open fields, and along forest edges. Current information suggests that this species is a habitat generalist, with a slight preference for grasslands and open understory oak / hickory forests.

This species is known for its practice of burying small animal carcasses and laying its eggs in a small access tunnel adjacent to the carcass. The larvae then feed on the carcass upon hatching. Some believe that carrion availability is more important for habitat selection than the type of vegetation or soil structure. Practices that cause declines in suitable carrion species such as mice or nestling birds are detrimental to this species. Habitat loss and fragmentation, insecticides, and disease may be major factors for declines in this species.

The American burying beetle is unlikely to be abundant along the floodplain of the Arkansas River Navigation System, but it is found within the study area. It generally prefers grasslands and upland forests with well-drained soils and a well-formed litter layer. It has been documented, however, to occur adjacent to the navigation channel on project area lands between Robert S. Kerr reservoir and Tulsa, Oklahoma.

e. **Ivory-billed Woodpecker (*Campephilus principalis*) –** This federally endangered species was thought to be extinct until recently and therefore was not included in the BA. The historic range for the ivory-billed woodpecker included forested swamps in portions of Texas, Louisiana, Arkansas, Tennessee, Mississippi, Alabama, Florida, Georgia, and the Carolinas. Due to habitat loss this woodpecker was thought to be extinct since the last confirmed sighting during the 1940s.

The ivory-billed woodpeckers are one of the largest woodpeckers in the world. They are approximately 20 inches in length and are similar in appearance to the pileated woodpecker. The ivory-billed woodpecker prefers swampy forests that contain large trees in which they can excavate tree holes for nesting. A pair of ivory-billed woodpeckers is believed to require approximately six square miles of habitat, a much greater area than the pileated woodpecker requires. The ivory-billed woodpecker extracts beetle larvae, their preferred food, from the bark and interior wood of trees. This woodpecker is believed to mate for life and each clutch is composed of approximately 3 china-white eggs (Big Woods Conservation Partnership, 2005).

Since January 2004 there have been 14 confirmed sightings of the ivory-billed woodpecker, all observed within Monroe County, Arkansas (within the Cache River National Wildlife Refuge and adjacent areas) (M. Harney, personal communication, May 2005). However, it is assumed that this woodpecker may be present throughout the White River Basin including the counties of Prairie, Woodruff, Monroe, and Arkansas (M. Harney, personal communication, May 2005). Monroe County is north of, and outside of, the study area boundaries. The White River National Wildlife Refuge is on the edge of the study area and is part of the “Big Woods”. The Big Woods consists of approximately 550,000-acres of bottomland forests that contain natural levees, meanders, oxbows, and sloughs where unique natural communities can be found. Within the Big Woods corridor, the floodplain forest follows the rivers and bayous that later flow into the Mississippi River. The Bayou DeView, the Cache River, the lower White River, and the lower Arkansas River are all found within the Big Woods. Approximately 17,405 acres of the study area lies within the Big Woods, which is about 3.2% of the Big Woods total acreage. The first two miles, approximately, of the Arkansas Post Canal lies within the White River National Wildlife Refuge. Although to date no sightings have occurred within the White River National Wildlife Refuge, the refuge is considered possible habitat for the ivory-billed woodpecker.

4.8.2 Other Protected Species

In addition to having protection at the Federal level under the ESA, species may have protection under a number of State statutes. The States of Oklahoma and Arkansas each have their own mechanisms by which rare species are protected within their State borders.

The sections below discuss the applicable State laws and regulations in Oklahoma and Arkansas. For each state, a list of State-listed rare, threatened, or endangered species is provided. In many cases, the State lists parallel the Federal list, as species protected at the Federal level are generally given similar protection by the states. For information on those species listed at both the State and Federal levels, please refer to Section 4.8.1, Threatened and Endangered Species.

4.8.2.1 Arkansas State Listed Species

The Arkansas Natural Heritage Commission (ANHC) is responsible for gathering, categorizing, and disseminating information on rare species and significant natural areas within the State of Arkansas. ANHC provided a list of Arkansas species, in addition to the federally listed species shown in Table 4-22, that are considered rare and are protected and monitored at the state level. The State-listed species for Arkansas are shown in Table 4-23.

Table 4-23. State-Listed Species That May Occur in the Arkansas Study Area.

Species	State Rank	Location Within Study Area
MAMMALS		
Brazilian free-tailed bat (*Tadarida brasiliensis*)	S3	This species occurs in central and southern Arkansas; it occupies buildings and forests.
Florida panther (*Puma concolor coryi*)	SH	Protected at the Federal level; please refer to Section 4.8.1
Gray bat (*Myotis grisescens*)	S2	Protected at the Federal level; please refer to Section 4.8.1
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	S2	Species is found statewide except Ozark mountains; this bat occupies buildings, barns, caves, and forests.
BIRDS		
Bald eagle (*Haliaeetus leucocephalus*)	S2B, S4N	Protected at the Federal level; please refer to Section 4.8.1
Interior least tern (*Sterna antillarum*)	S2B	Protected at the Federal level; please refer to Section 4.8.1
Swainson's warbler (*Limnothlypis swainsonii*)	S3B	Species may occur statewide; associated with swamp forests, bottomland hardwood forests, or riparian forests.

Table 4-23. State-Listed Species That May Occur in the Arkansas Study Area.		
Species	**State Rank**	**Location Within Study Area**
FISHES		
Flathead chub (*Platygobio gracilis*)	S1?	Occurs in eastern Arkansas; in sandy runs of rivers.
Goldeye (*Hiodon alosoides*)	S2?	Statewide; occurs in deep open pools, channels, lowland rivers, and lakes.
Lake chubsucker (*Erimyzon sucetta*)	S2?	Located in southern, east-central, and eastern Arkansas; in lakes, ponds, and swamps over silt, sand, or debris.
Lake sturgeon (*Acipenser fulvescens*)	S1	Occurs in eastern Arkansas; found in the bottom of lakes and large rivers.
Paddlefish (*Polydon spathula*)	S2?	Occurs statewide; in slow flowing deep water of large rivers.
Shorthead redhorse (*Moxostoma macrolepidotum*)	S2?	Located in the northern half of Arkansas; found in rocky pools and riffles of small and large rivers and in lakes.
Slenderhead darter (*Percina phoxocephala*)	S2	Occurs in the western part of Arkansas; in gravel runs and riffles of small creeks to medium rivers.
Suckermouth minnow (Phenacobius mirabilis)	S1	Occurs in west-central Arkansas; in gravel/rubble riffles and runs of creeks, and in small to large rivers
Swamp darter (*Etheostoma fusiforme*)	S2?	Located in south and eastern Arkansas; in standing or slow-moving water over sand or mud.
Alligator gar (*Atractosteus spatula*)	S2?	Potentially occurs in the Arkansas River
Blue sucker (*Cycleptus elongatus*)	S2	Potentially occurs in the Arkansas River
AMPHIBIANS		
Plains spadefoot (*Spea bombifrons*)	S1	Isolated population in north-central to northwest Arkansas, found mainly in grasslands.
Strecker's chorus frog (*Pseudacris streckeri streckeri*)	S2	Occurs in eastern and central Arkansas; found in moist woods, rocky ravines, riparian forests, lagoons, swamp forests, and croplands.
INVERTEBRATES		
Beach-dune tiger beetle (*Cicindela hirticollis*)	S2S3	Occurs on sandbars along the Arkansas River and other locations
Tiger beetle (*Cinindela lepida*)	S2S3	Occurs on sandbars along the Arkansas River and other locations
Sandy stream tiger beetle (*Cinindela macra*)	S2S3	Occurs on sandbars along the Arkansas River and other locations

Table 4-23. State-Listed Species That May Occur in the Arkansas Study Area.		
Species	**State Rank**	**Location Within Study Area**
Flat floater mussel (*Anodonta suborbiculata*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Rock pocketbook mussel (*Arcidens confragosus*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Fatmucket mussel (*Lampsilis siliquoidea*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Hickorynut mussel (*Obovaria olivaria*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Ohio pigtoe mussel (*Pleurobema cordatum*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Creeper mussel (*Strophitus undulatus*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Fawnsfoot mussel (*Truncilla donaciformis*)	S3	Found in the Arkansas River during the mussel survey conducted for this study
Paper pondshell mussel (*Utterbackia imbecillis*)	S3S4	Found in the Arkansas River during the mussel survey conducted for this study
PLANTS		
California bullrush (*Schoenoplectus californicus*)	S1S2	Known to occur in Hempstead, Johnson, and Conway Counties; found in wetlands.
Hairy water-fern (*Marsilea vestita* (*Cambarus tartarus*)	S3	Arkansas River Valley and in Bradley, Chicot, Washington, and Polk Counties; occurs in wetlands.
Lax hornpod (Mitreola petiolata)	S3	Occurs in wetlands.
Ridell's spike moss (*Selaginella arenicola*)	S3	Known from the Ozark Plateau; found on dry rocks and packed sand.
San Antonio false-foxglove (*Agalinis homalantha*)	S1	Occurs statewide; found in woodlands.
Scratch-daisy (*Croptilon hookerianum var. validum*)	S2	Limited to the Arkansas Valley and Mississippi Alluvial Plain
Showy prairie-gentian (*Eustoma russellienum*)	S2	Clark County and in the Arkansas River Valley.
Six-angle spurge (*Euphorbia hexagona*)	S2	Known to occur in Franklin and Pope Counties; found on sandy shores and bottoms.

Table 4-23. State-Listed Species That May Occur in the Arkansas Study Area.		
Species	**State Rank**	**Location Within Study Area**
Soapwart gentian (*Gentiana saponaria*)	S3	Western and central Arkansas; found in swamps and bogs.
Texas bergia (*Bergia texana*)	S2	Johnson, Perry, and Desha Counties; found in swamps, mud flats, and muddy pond shores.
Twistflower (*Streptanthus obtusfolius*)	S3	Restricted to the Quachita Mountains.

S1 = Extremely rare. Typically 5 or fewer estimated occurrences in the state, or only a few remaining individuals, may be especially vulnerable to extirpation.
S2 = Very rare. Typically between 5 and 20 estimated occurrences or with many individuals in fewer occurrences, often susceptible to becoming extirpated.
S3 = Rare to uncommon. Typically between 20 and 100 estimated occurrences, may have fewer occurrences but with many large number of individuals in some populations, may be susceptible to immediate threats.
S4 = Common, apparently secure under present conditions. Typically 100 or more estimated occurrences but with large number of individuals in some populations, may be restricted to only a portion of the state.
SH = Historically known from the state, but not verified for an extended period, usually 15 years.
? = Indecision regarding rank assignment.
B = Breeding status.
N = Non-breeding status.

Source: ANHC (dated 1/31/2001).

4.8.2.2 Oklahoma State-Listed Species

The Oklahoma statute pertaining to threatened and endangered species is Section 5-412 of Title 29. Under this statute, "no person may hunt, chase, harass, capture, shoot at, wound or kill, take or attempt to take, trap, or attempt to trap, any endangered or threatened species or subspecies…" Section 5-412 of Title 29 protects only wildlife species. Plants are not currently protected under Oklahoma statute, although the Oklahoma Natural Heritage Program maintains a ranked list of rare plants for Oklahoma. State-Listed species for Oklahoma are included in Table 4-24.

Table 4-24. State-Listed Species That May Occur in the Oklahoma Study Area.

Species	State Status	Location Within Study Area
MAMMALS		
Gray bat (*Myotis grisescens*)	E	Protected at the Federal level; please refer to Section 5.8.1
Golden mouse (*Ochrotomys nuttalli*)	SS2	East-central Oklahoma; found in greenbriar thickets and swamps
Indiana bat (*Myotis sodalis*)	E	Protected at the Federal level; please refer to Section 5.8.1
Long-tailed weasel (*Mustela frenata*)	SS2	Found statewide in a variety of habitats.
Marsh rice rat (*Oryzomys palustris*)	SS2	Eastern Oklahoma; found near wetlands and grasslands.
Mountain lion (*Puma concolor*)	SS2	Considered rare in eastern Oklahoma.
Ozark big-eared bat (*Corynorhinus townsendii ingens*)	E	Protected at the Federal level; please refer to Section 5.8.1
Rafinesque's big-eared bat (*Corynorhinus rafinesquii)*	SS2	East-central Oklahoma; found in forests with dense foliage.
Woodchuck (*Marmota monax*)	SS2	East-central and northeastern Oklahoma; found in open woodlands and woodland margins.
BIRDS		
Bald eagle (Haliaeetus leucocephalus)	E	Protected at the Federal level; please refer to Section 5.8.1
Barn owl (*Tyto alba*)	SS2	Occurs in woodlands, savannas, farmlands, and suburbs.
Bell's vireo (*Vireo bellii*)	SS2	Found in deciduous thickets typically surrounded by grasslands or old fields that occur along streams, ravines, and fence-rows. This species may avoid thickets located close to the edge of forests.
Interior least tern (*Sterna antillarum*)	E	Protected at the Federal level; please refer to Section 5.8.1
Prairie falcon (*Falco mexicanus*)	SS1	Found in dry plains and prairies.
Swainson's hawk (*Buteo swainsoni*)	SS2	Found in grassland habitats.
FISHES		
Arkansas darter (*Etheostoma cragini*)	SS2	Northeastern Oklahoma; found in spring fed, vegetated creeks and headwaters typically over mud substrates.

Table 4-24. State-Listed Species That May Occur in the Oklahoma Study Area.

Species	State Status	Location Within Study Area
Blackside darter (*Percina maculata*)	T	Eastern Oklahoma; occurs in pools of creeks or small to medium rivers. This species may currently exist in the study area. Its historic range includes several tributaries in the study area. The species is listed as potentially occurring in Haskell and Le Flore Counties in the study area.
Longnose darter (*Percina nasuta*)	E	In Oklahoma, this species is known to occur only in Lee Creek. It is unlikely to occur within the study area (e.g., at the confluence of Lee Creek and the Arkansas River) because there would not be suitable habitat (i.e., clear-flowing, silt-free streams and rivers). The species is listed as occuring in Le Flore, and Sequoyah Counties in the study area.
Ozark cavefish (*Amblyopsis rosae*)	T	Protected at the Federal level; please refer to Section 5.8.1
Shorthead redhorse (*Moxostoma macrolepidotum)*	SS2	Northeastern Oklahoma; found in clear streams or rivers with gravel bottoms.
Shovelnose sturgeon (*Scaphirhyncus platorynchus)*	SS2	Arkansas River and tributaries.
Southern brook lamprey (*Ichthyomyzon gagei*)	SS2	Found in clear streams of Ouachitas and Ozarks.
Spotted bass (*Micropterus punctulatus*)	SS2	Eastern Oklahoma in clear, spring-fed streams.
Stonecat (*Notorus flavus*)	SS2	Northeastern Oklahoma in clear bottom, gravel streams.
REPTILES and AMPHIBIANS		
Alligator snapping turtle (*Macroclemys temminckii*)	CS SS2	Eastern Oklahoma in lakes, rivers, oxbows, and sloughs; known to occur at Seqouyah NWR and near Eufala Reservoir.
Grotto salamander (*Typhlotriton spelaeus*)	CS SS2	Northeastern Oklahoma in limestone caves with springs.
Oklahoma salamander (*Eurycea tynerensis*)	CS SS2	Northeast Oklahoma in spring-fed creeks with gravel bottoms.
Rich Mountain salamander (*Plethodon ouachitae*	CS SS2	North facing talus slopes of Ouachita Mountains.
Texas horned lizard (*Phrynosoma cornutum*)	CS SS2	Grasslands with areas of sparse vegetation.
MUSSELS and SNAILS		
Neosho mucket (Lampsilis rafinesqueana)	E	This mussel is currently restricted to the upper Illinois River, above the upper reach of Tenkiller Ferry Reservoir, which is beyond the geographic extent of the study area. The species is listed as potentially occurring in Adair, Cherokee, Nowata, Osage and Ottawa Counties in the study area.
Rich Mountain slitmouth (Stenotrema pilsbryi) *(Snail)*	SS1	Found on talus slopes in the Ouachita Mountains.
Scaleshell (*Leptodea leptodon*)	SS2	Scattered populations in the Arkansas River basin

Table 4-24. State-Listed Species That May Occur in the Oklahoma Study Area.		
Species	**State Status**	**Location Within Study Area**
Spectacle-case shell (Rabbitsfoot) (*Quadrula cylindrica*)	SS2	Illinois River in Cherokee County.
Western fanshell (*Cyprogenia aberti*)	SS2	Historically occurred in Verdigris and Caney Rivers; may be extirpated from Oklahoma.
INSECTS		
American burying beetle (*Nicrophorus americanus*)	E	Protected at the Federal level; please refer to Section 5.8.1
Prairie mole cricket (*Gryllotalpa major*)	SS2	Found in prairies.

E = Endangered in Oklahoma
T = Threatened in Oklahoma
R = Rare in Oklahoma
CS = Statewide closed season. It is unlawful at any time to possess or kill individuals of these species.
SS1 = Species of Special Concern where current evidence indicates species is vulnerable because of limited range, low population, or other factors.
SS2 = Species of Special Concern that is possibly threatened or vulnerable but with little evidence to document current population levels and range.

Source: Oklahoma Natural Heritage Inventory county lists (dated 1/18/2001).

4.8.3 Wetlands

4.8.3.1 Introduction

Wetlands are present throughout the study area. They are primarily scattered across the floodplain of the Arkansas River valley. The USACE and the USEPA 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. Wetlands found within the study area include many different types. All wetlands must have a dominance of rooted wetland vegetation. The major wetlands within the area include, but are not limited to the following locally described types, swamps, emergent wetlands, marshes, and bottomland hardwood wetlands.

Regulatory wetlands have the following general diagnostic environmental characteristics:

(1) Vegetation. The prevalent vegetation consists of macrophytes that are typically adapted to areas having saturated or anaerobic soil conditions.

(2) Soil. Soils are present and have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.

(3) Hydrology. The area is inundated either permanently or periodically at mean water depths ≤ 6.6 ft, or the soil is saturated to the surface at some time during the growing season.

Based upon available USACE and USFWS information, a variety of wetland types dominate the MKARNS study area. The extents and type of wetlands habitats throughout the study area are described below.

4.8.3.2 Oklahoma

The Oklahoma portion of the MKARNS study area consists of broad floodplains and man-made reservoirs.

a. Floodplains - Broad floodplains along the Oklahoma portion of the MKARNS support bottomland forests of elm, oak, hackberry, cottonwood and sycamore. Because these streams slope gently, the forest floor is not 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. Surface water accumulation is from both river bank 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. Sedges, willows and buttonbush form thickets in poorly-drained areas along wetland edges.

b. Reservoir Shores - The areas near and adjacent the 11 Oklahoma reservoirs included in the study area are dominated by forested and riparian wetlands and marshes. Man-made 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 during late summer and through the fall. Some lakes develop a delta of sediment in their upper reaches where tributaries are confluent, and maintain wetland conditions as a consequence of both lake-level fluctuation and tributary inflow.

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. Upper lake reaches often contain a "dead timber" zone, where trees have been killed by prolonged inundation, but 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.

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.

4.8.3.3 Arkansas

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.

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 (Arkansas Multi-Agency Wetland Planning Team 2004).

In southeastern Arkansas the study area is within the region known as the Delta. The Delta is actually that part of the Gulf Coastal Plain that has been extensively modified by the Mississippi and Arkansas Rivers, and other flowing waters. 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. Such areas 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.

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

a. Floodplain Connected Depression Wetland - Floodplain depressions are hydrologically connected to the river during 5-year flood events either via backwater or overbank flow. Floodplain depressions are most commonly remnants of abandoned stream channels, or broad swales left behind by migrating channels. They typically have very thick clay soils, unless they are of very recent origin.

Floodplain depressions may support swamp forests or shrub swamps in zones that remain flooded most of the time. Less flooded areas typically have overcup oak-water hickory forests. Black willow, swamp privet, and eastern cottonwood are common components in depressions near the river. Species tolerant of disturbance, such as sugarberry and American elm, are likely to be common on the margins of floodplain depressions where sedimentation and scouring are major influences.

b. Floodplain Unconnected Depression Wetland - Unconnected depressions occur in major river floodplains that have been cut off from the channel by levees, and on terraces (former floodplains that are higher than the modern floodplain). They are not affected by river flooding during common flood events (1- 5-year flood frequency zone). This lack of connection to the river distinguishes this wetland type from floodplain depressions, but otherwise the two types are very similar. Unconnected alluvial depression wetlands typically occur in abandoned river channels and large swales. Depressions that are deep enough to hold water year-round will have an open-water zone in the center, with bald cypress and buttonbush in areas that are rarely dry, and relatively narrow zones of progressively "drier" plants, such as overcup oak, on both banks. Many of these wetlands have been altered by agricultural activities including drainage works that either reduce or increase water storage within the depression.

c. Connected Oxbow Lakes - Connected oxbow lake wetlands occur primarily near large rivers, where they are frequently inundated during floods (that is, they are within the 1-5-year flood frequency zone). Many lakes that would have met this criterion early in this century have gradually been disconnected from river flows due to the completion of large levees and other flood-protection works, and the wetlands in those lakes are now classified as unconnected lake margins. Connected lake margins differ from unconnected systems in that they routinely exchange nutrients, sediments, and fish with the river system. In addition to natural oxbows, there are man-made bodies of water that support connected fringe wetlands. Shoreline cypress-tupelo stands and fringe marshes are common, and the upper reaches of oxbow lakes often contain buttonbush swamps and expansive marsh systems.

d. Unconnected Oxbow Lakes: Unconnected lakes are lakes that are not within the portion of a floodplain that is inundated by a river on a regular basis (that is, they are not within the 1-5-year floodplain). They are similar in appearance to connected lake margins but are classified separately because they do not exchange nutrients, sediments, or fish with river systems. Most are associated with oxbow lakes, where bald cypress wetlands normally form in a narrow band along the shoreline. Shallow filled areas in the upper and lower ends of the lake sometimes develop more extensive wetland complexes of willows, buttonbush, and marsh species. Other types of natural lakes are also included in this category. Most of these natural lake systems have been modified in various ways. Frequently, their outlets have been fitted with control structures to allow added storage and manipulation of water. Inflows have been altered by farm drainage and other diversions, and adjacent lands have been cleared or developed in many areas. All of these actions have caused accelerated sedimentation within the lakes.

e. Wet Tallgrass Prairie: The wet tallgrass prairie community type typically occurs within broad basins, headwater draws that have poor drainage, or in minor swales within larger expanses of dry prairie. All of these sites tend to stay wet, with areas of standing surface water, through spring. They usually become extremely dry in late summer. Wet tallgrass prairie is dominated by typical prairie species such as big and little bluestem, Indian grass, switch grass, and numerous perennial forbs. However, it also includes wetland species such as beakrush, marsh fleabane, sundews and sphagnum moss. Wet prairie is also likely to support species that are rare or unusual in Arkansas, such as prairie cordgrass. Fire is essential to maintain prairies in Arkansas - without fire, trees will gradually establish. The original extent of prairie in Arkansas has been dramatically reduced by agriculture, development, fire control, and forest management practices.

Wet prairie occurs in all regions of the state, but the most extensive remaining examples are in the Coastal Plain and in northwestern Arkansas.

f. Flats: Flats have little or no gradient, and the principal water source is precipitation. There is minimal overland flow into or out of the wetland except as saturated flow. Wetlands on flat areas that are subject to stream flooding during a 5-year event are classified as Riverine rather than Flats. Small ponded areas within flats are considered to be normal components of the Flats Class, unless they are deep enough to meet the criteria for the Depression Class. Sites should be considered Slope wetlands rather than Flats if they have sufficient gradient to cause runoff in a single direction, or if groundwater discharge is the principal water source within the wetland.

g. Wildlife Management Impoundments: These areas managed specifically to provide habitat for waterfowl and other waterbirds. There are two versions of this management approach: greentree reservoirs and moist soil units. They are included in the Riverine Class because they usually draw water from and return it to stream systems, but the wetlands are contained within low levee systems that allow managers to create shallow flooding conditions suitable for use by foraging and resting birds. Greentree reservoirs are leveed sections of mature oak bottomland forest, which provide access to acorns and forest invertebrates. They are artificially flooded to provide shallow water for waterfowl foraging. Moist soil units are leveed cleared fields, where water management and farm machinery are employed to maintain marsh-like conditions, which provide small seeds and different invertebrates than are found in forested wetlands.

4.8.4 Aquatic Resources

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. ERDC has mapped the aerial extent of gravel in the navigation channel, and the boundaries (polygons) of contiguous gravel bars are shown on electronic maps. This information is presented in Appendix C. ERDC found that approximately 165 acres of gravel could potentially be impacted and would require mitigation through relocation or creation of gravel bars. In general, 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.

The Arkansas River maintains a continuous turbid appearance due to sand and suspended silt. The water is slightly saline due to 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. High-flow periods flooded riverbanks and adjacent low-lying areas, exposing new habitat and providing additional food sources for aquatic species. High flows during pre-MKARNS construction were also important in maintaining the river's hydrological connection to various oxbow lakes.

The pre-MKARNS River is reported to have contained fewer and smaller sport fishes, excluding catfishes, than currently have been assessed in the river. However, an evaluation of the impacts from construction of the MKARNS on the native biota of the Arkansas River is not possible because few pre-construction studies were conducted.

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 in current collections including the plains minnow, speckled chub, Arkansas River shiner, and suckermouth minnow. Conversely, the abundance of a variety of species including bluegill, crappie, largemouth bass, sauger, and several catfish species have increased in the river since the creation of the MKARNS (USACE 1997). Commercial fishing for catfishes and buffalo (suckers) has been an important industry along the river since the completion of the MKARNS.

The diverse aquatic environments throughout the MKARNS currently provide good habitat for a variety of fishes. Twenty-two families containing 126 species of fishes have been identified from the Arkansas River and its tributaries (Table 4-25; Robison and Buchanan, 1988). Common sporting species include bluegill, crappie, black bass species and blue, channel and flathead catfish.

Table 4-25. MKARNS Fish Families.

Family	Common name	Number of Species
Petromyzontidae	Lampreys	2
Acipenseridae	Sturgeons	1
Polyodontidae	Paddlefish	1

Table 4-25. MKARNS Fish Families.

Family	Common name	Number of Species
Lepisosteidae	Gars	4
Amiidae	Bowfin	1
Anguillidae	Freshwater Eels	1
Clupeidae	Herrings	3
Hiodontidae	Mooneyes	2
Salmonidae	Trouts	1
Esocidae	Pikes	2
Cyprinidae	Minnows	31
Catostomidae	Suckers	15
Ictaluridae	Catfishes and Madtoms	11
Aphredoderidae	Pirate Perch	1
Fudulidae	Killifishes and Topminnows	5
Poeciliidae	Livebearers	1
Atherinidae	Silversides	2
Moronidae	Temperate Basses	3
Centarchidae	Sunfishes	15
Elassomatidae	Pygmy Sunfishes	1
Percidae	Perches and Darters	22
Sciaenidae	Freshwater Drums	1

Source: Robison and Buchanan, 1988

Freshwater mussels are also present in the MKARNS. Little is 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 is most common in waters found outside the study area. Another species, 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 unionid species composition and distribution for MKARNS is limited, the USACE sponsored a Freshwater Mussel (Unionid) Survey conducted by Ecological Specialists, Inc. in 2004 (see Appendix C) to 1) to determine unionid distribution and species composition in the Arkansas River Navigation System, focusing on proposed dredge and dredge disposal areas, 2) project 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 river banks <1 m deep. A total of 5467 live unionids of 27 species were collected, and two additional species were found only as weathered shells. *Quadrula quadrula* (27.6%), *Plectomerus dombeyanus* (23.4%), *Obliquaria reflexa* (15.5%), and *Amblema plicata* (10.5%) were the most abundant species. No threatened or endangered mussel species were collected.

Other invertebrates 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 bue-geens, 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, cladocerans (Short and Schmitz 1976). 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.

4.8.4.1 Verdigris River to Chouteau Lock and Dam

This portion of the MKARNS is within the central prairie freshwater ecoregion (Abbell 2000). Oologah Lake is located in this portion of the study area. Aquatic communities in this portion of the study area include broad floodplain forests created by slow moving and muddy tributaries, headwaters, and lakes.

Extensive agricultural activities and resultant demands for irrigation water, coupled with the construction of numerous reservoirs in the Arkansas River basin, have restricted habitats of prairie fishes (Cross 1987).

Sport fisheries exist in the river and reservoirs. Species of sport fish include crappie, largemouth bass, white bass, channel and flathead catfish.

4.8.4.2 Arkansas River From Chouteau Lock and Dam to Little Rock

This section of the study area is within both the central prairie freshwater ecoregion and Ozark highlands freshwater ecoregion. The aquatic communities of this portion of the study area include lakes and bottomland hardwood forests along rivers and streams. The following lakes are located in this portion of the study area:

- Keystone Lake;
- Grand Lake O' the Cherokees (Pensacola Dam);
- Lake Hudson (Markham Ferry Dam);
- Fort Gibson Lake;
- Tenkiller Ferry Lake;
- Eufaula Lake;
- Kaw Lake;
- Hulah Lake;
- Copan Lake; and
- Wister Lake.

Habitat along this section of the Arkansas River is considered degraded, and only about 3 percent of the pre-settlement habitat is intact as a result of agriculture, logging, fire suppression, and grazing (Ricketts 1999).

Upstream reservoir components of the MKARNS contain a variety of fish species typical of central United States reservoirs including: largemouth bass, channel catfish, bluegill, common carp, emerald shiner, gizzard shad, as well as several abundant sport fish species including smallmouth bass, white bass species (white, striped and hybrid), black and white crappie, various sunfishes, and walleye.

4.8.4.3 Arkansas River From Little Rock to White River

This portion of the MKARNS is within the Mississippi embayment freshwater ecoregion. Aquatic communities include bottomland floodplains, river swamps, backwaters, and flats. Most (91-95%) of the original riparian and bottomland forest systems have been lost. The biological distinctiveness of the remaining Mississippi embayment is considered globally outstanding (Abell 2000). Due to the presence of productive soils, favorable water regimes, and juxtaposition with other habitats, the bottomland forests may be one of the most important wildlife habitat in the project area.

Prominent sport fish species inhabiting backwaters and river swamps include largemouth bass, catfish species, bluegill, carp, and crappie. Delta streams feeding the lower Arkansas River are inhabited by crappie, catfish, bluegill, largemouth bass, carp, and buffalo.

Pools formed by the locks and dams along the lower Arkansas River are stocked by the Arkansas Game & Fish Commission with sport fish such as bass, crappie, catfish and bream, making the river a popular location for major fishing tournament.

4.8.4.4 Commercial Navigation Traffic and Aquatic Resources

Commercial navigation traffic creates hydraulic disturbances in the form of changes in current velocity and direction, altered water levels, resuspension of sediments, and scour of the river bed. These disturbances tend to increase with decreasing size of the waterway. Waterway size also applies to changing river stages, with low flow impacts being greater than those at high flows. Altered flow velocities from tow boats occur from the jet propeller turbulence and as from the barges that displace water as the tow moves through the water. Altered water levels from navigation occur in the form of waves and drawdown. Resuspension of sediments tend to be greatest beneath the tow as a result of the propeller jet and in shallow, near shore zones as a result of wave activity. Scour of the riverbed is most significant near and beneath the tow as a result of the propeller jet. Based on studies conducted for the Upper Mississippi River-Illinois Waterway (UMR-IWW) System Navigation Feasibility Study (USACE, 2004), it appears that towboats contribute a very small percentage of the overall documented sedimentation rates in backwaters and secondary channels on the pooled portions.

Potential influences on aquatic organisms stem from the following four factors: (1) the effects of pressure changes resulting from the rapid mixing of the water column in the prop wash, (2) the effects of hull shear, which is the change in velocity between water directly affected by the barge hull and the surrounding water, (3) the effects of entrainment through the propellers, which occurs when aquatic organisms, eggs and larvae are drawn into the propeller, and then thrown back out, and (4) shoreline and side channel water drawdown and associated larval fish stranding.

Based on the results of studies for the Upper UMR-IWW System Navigation Feasibility Study and other published studies (Bishai 1961; Blaxter and Hoss 1979; Ginn et al.1978; Kedl and Coutant 1976) with a variety of fish species and early life stages, it appears that the range of pressure changes experienced by early life stages during towboat mixing of the water column does not result in high mortality.

Biological studies were also conducted for the UMR-IWW System Navigation Feasibility Study to determine if the calculated shear levels were high enough to cause mortality of larval fish (Keevin et al. 2000). The shear values were also compared with previously published values for shear related larval fish mortality (Morgan et al. 1976; Maynord 2000c). These studies indicated that the shear levels produced by a moving tow did not cause significant mortality.

The incremental increases in larval fish entrainment and mortality were estimated for commercial vessels that navigate the Upper Mississippi and Illinois Rivers. Thirty fish species were selected as representative of the diverse fish communities that characterize these two large rivers. These species of fish were selected to include different life histories, varied spawning behaviors, different trophic guilds, and diverse ecological functioning (e.g., forage fish species, keystone predators), and to include species important to the commercial and recreational fisheries within the UMR-IWW.

Fish characteristically produce large numbers of eggs and larvae. Most of this reproductive output is lost to a variety of sources of mortality, including entrainment by commercial vessels. The potentially billions of entrained larvae translate into substantially fewer adults lost through larval entrainment mortality because natural (or at least non-vessel induced) mortalities account for considerably greater losses to these populations as larvae progress to young-of-year, and then to adult fish.

A study by Killgore et al. (2004) suggests that instantaneous mortality of adult fish entrained through the propellers of moving towboats is negligible and only gizzard shad appear to be susceptible to entrainment in any measurable number. The conclusion is that impacts to adult fish associated with propeller entrainment do occur but are not substantial.

Drawdown along the length of backwaters and secondary channels has the potential to make otherwise suitable habitat unavailable for nesting and to strand larval and juvenile fishes during drawdown events. The amount of habitat within secondary channels and backwaters that would otherwise have been suitable for spawning but is impacted by repeated drawdowns is unknown. However, spawning fish, especially centrarchids (sunfish), generally tend to spawn at water depths greater than the navigation induced drawdowns and they generally avoid spawning in areas that are repeatedly dewatered. Species that spawn in or on submerged aquatic vegetation, which would generally be deeper than the dawdown zones, would also be unaffected. Additionally, larval and juveniles of typical backwater fish species have behavioral adaptations to avoid being stranded by receding water levels (Adams et al. 2000); thus, minimizing adverse effects.

4.8.5 Terrestrial Resources

4.8.5.1 Mammals

Common mammals present in the study area include: white-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus maniculatus*), least shrew (*Cryptotis parva*), southern short-tailed 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 (*Spilogale putorius*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), mink (*Mustela vison*), long-tailed weasel (*Mustella 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*).

4.8.5.2 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 tryrannus),*, 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*)..

4.8.5.3 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.

4.8.5.4 Vegetation

Vegetative communities within the study area include old fields, pastureland consisting of warm and cool season grasses, remnant native grasslands, bottomland hardwood forest, and upland forest.

4.8.5.4.1 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.

4.8.5.4.2 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 presettlement 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.

4.9 Recreation and Aesthetic Values

4.9.1 USACE Project Lands

The recreational areas associated with the MKARNS and its associated upstream reservoirs provide recreational and aesthetic opportunities to millions of visitors annually. Table 4-26 portrays the trends in annual visits to the lakes and reservoirs associated with the McClellan-Kerr Navigation System. Total annual visits at the twenty-six recreational lakes and reservoirs in 2002 approximated 18.5 million, with the lakes and reservoirs in Oklahoma accounting for sixty percent of the visitors. Fort Gibson Lake, Eufaula Lake and Tenkiller Ferry Lake in Oklahoma, and Dardanelle Lake in Arkansas each had two million or more visitors in 2002. These annual visitations translate into substantial economic impacts to the local economies in the form of direct and indirect employment, business volume and income.

Table 4-26. Trends in Annual Visits[1], MKARNS and Related Lakes.

Lake	2002	1999	1996	1993
Arkansas				
Dardanelle Lake	2,908,987	1,995,185	2,136,266	3,863,000
David D. Terry L & D No. 6	964,958	1,307,063	1,354,007	1,149,000
Emmett Sanders L & D No. 4	458,992	541,565	698,337	571,000
Hammerschmidt Lake (J.W. Trimble L & D No.13)	563,819	864,721	1,135,563	1,219,000
Joe Hardin L & D No.3	92,028	78,749	95,784	221,000
Lock & Dam 5	133,985	176,802	185,017	209,000
Murray L & D No. 7	747,327	745,971	1,124,289	1,713,000
Norrell L & D No. 1	19,493	39,669	34,992	64,000
Ozark Lake	431,784	463,231	502,802	471,000
Rockefeller Lake (Arthur Ormond L & D No. 9)	241,830	203,280	346,290	414,000
Toad Suck Ferry L & D No. 8	452,319	447,968	614,254	891,000
Wilbur Mills Dam	257,025	274,672	357,292	544,000
Total (Arkansas)	**7,272,547**	**7,138,876**	**8,584,893**	**11,329,000**
Oklahoma				
Chouteau L & D No. 17	164,882	184,948	124,482	204,373
Copan Lake	65,564	66,557	165,239	83,210
Eufaula Lake	2,064,190	2,127,130	2,446,503	2,102,164
Fort Gibson Lake	2,197,936	2,416,651	3,041,944	1,766,990
Hulah Lake	57,196	93,590	94,232	57,373
Kaw Lake	475,738	158,406	681,533	415,363
Keystone Lake	908,208	1,265,920	1,377,386	1,308,721
Newt Graham L & D No. 18	229,945	189,824	240,492	247,976
Oologah Lake	992,998	1,258,023	1,423,222	1,362,797
Robert S. Kerr L & D No. 15	1,022,396	923,622	770,960	579,856
Tenkiller Ferry Lake	2,080,299	1,149,237	1,224,694	1,472,630
W. D. Mayo L & D No. 14	112,729	109,767	114,921	103,453
Webbers Falls L & D No. 16	514,341	512,054	509,412	462,644
Wister Lake	361,420	415,962	317,764	276,753
Total (Oklahoma)	**11,247,842**	**10,871,691**	**12,532,784**	**10,444,303**
TOTAL	**18,520,389**	**18,010,567**	**21,117,677**	**21,773,303**

Source: USACE, Little Rock and Tulsa Districts.

Many of the recreational users included pleasure boaters along the MKARNS. Table 4-27 portrays the trend in the number of recreational vehicles that locked through the twelve Arkansas and five Oklahoma locks from 1991-2003.

Table 4-27. Trends in Recreational Vessel Usage of the MKARNS, 1991 to 2003 (Vessels Passing through MKARNS Locks).

Year	Arkansas	Oklahoma
2003	8,132	Na
2002	6,243	2,341
2001	7,420	1,846
2000	6,849	2,325
1999	9,018	1,978
1998	9,750	2,577
1997	12,248	2,319
1996	15,470*	2,941
1995	9,895	2,066
1994	10,426	2,688
1993	9,978	2,629
1992	12,111	3,155
1991	13,595	3,012

Source: USACE, Little Rock and Tulsa Districts.

4.9.1.1 USACE Park Areas

There are hundreds of park areas associated with USACE MKARNS project lands as well as numerous adjoining State and Federal facilities. The available USACE park areas along the MKARNS and the upstream reservoirs are presented in Table 4-28. Summaries of the recreational resources of project lands and adjoining park areas for the MKARNS and the 11 upstream reservoirs are also provided in greater detail below.

Table 4-28. USACE Parks Along the MKARNS.

	MKARNS Pools / Reservoir	No. of Parks
	White River (Montgomery Point)	None
Pool 1	(Norrell)	See Arkansas Post
Pool 2	(Lock 2 / Arkansas Post)	10
Pool 3	(Dam No. 2 / Wilbur D. Mills)	See Arkansas Post
Pool 3	(Joe Hardin)	See Pine Bluff
Pool 4	(Emmett Sanders / Pine Bluff)	13
Pool 5	(Lock & Dam 5)	See Pine Bluff
Pool 6	(David .D. Terry)	See Pine Bluff
Pool 7	(Murray)	See Toad Suck Ferry

Table 4-28. USACE Parks Along the MKARNS.

MKARNS Pools / Reservoir		No. of Parks
Pool 8	(Toad Suck Ferry)	10
Pool 9	(A.V. Ormond / Rockefeller Lake)	See Lake Dardanelle
Pool 10	(Lake Dardanelle)	16
Pool 12	(Ozark-Jeta Taylor)	11
Pool 13	(James W. Trimble)	See Ozark
Pool 14	(W.D. Mayo)	3
Pool 15	(Robert S. Kerr Reservoir)	5
Pool 16	(Webbers Falls)	3
Pool 17	(Choteau Lake)	5
Pool 18	(Newt. Graham Lake)	3
Reservoirs		
	Copan Lake	4
	Eufaula Lake	14
	Fort Gibson Lake	10
	Grand Lake	None
	Hulah Lake	5
	Kaw Lake	12
	Keystone Lake	16
	Lake Hudson	None
	Oologah Lake	10
	Tenkiller Ferry Lake	18
	Wister Lake	2

Source: USACE, Little Rock and Tulsa Districts 2000-2001.

4.9.1.1.1 USACE Parks along the MKARNS

a. Newt Graham Lock and Dam (No. 18) – Five parks are maintained near the Newt Graham Lock and Dam. Two parks, Bluff Landing and Highway 33 Landing, are maintained and operated by the USACE. The others include Rocky Point, Channel View Areas I and II, and Goodhope Ramp, which is located at the dam site. Another park located at the dam site, Bluegill Park, has been closed to the public.

Facilities at these parks include boat launching ramps, designated campsites, picnic areas, drinking water, and sanitary facilities. Fishing in Newt Graham Lake is a popular pastime. Channel and flathead catfish, crappie, largemouth and striped bass, various sunfish, bluegill, carp, buffalo, and walleye are commonly caught. Hunting for white-tailed deer, dove, quail, squirrel, rabbit, turkey and some species of migratory waterfowl are allowed in regulated areas.

b. Chouteau Lock and Dam (No. 17) – The Chouteau Lock and Dam area has five parks, including two maintained by the USACE (Afton Landing and Tullahassee Loop). Camping and picnicking are popular activities at these parks. Drinking water and sanitation facilities are provided. Sightseeing and photography are also popular activities, especially during the spring and fall season due to the colorful trees such as redbud, dogwood, sycamore, oak, and hickory.

Sportsmen find ample opportunities near Chouteau Lock and Dam. Public hunting is allowed on approximately 1,990 acres of land and water that have been designated as a WMA. Hunting is also allowed in the timbered cutoff loops along the navigation system, but not around structures and in public use areas. Fishermen find a diverse array of species, including channel and flathead catfish, crappie, largemouth and striped bass, various sunfish, bluegill, carp, buffalo, and walleye. In addition, an area on the north side of the Verdigris River one mile north of Chouteau Dam (between Highway 69 and Old Highway 69) is designated as wild Canada Geese habitat.

c. Webbers Falls Lock and Dam (No. 16) – Recreational areas maintained by the USACE near Webbers Falls Lock and Dam are Arrowhead Point, Brewers Bend, and Spaniard Creek. These areas include boat ramps, swimming beaches, picnic areas and sanitary facilities. Another USACE park, Greenleaf Cove, is a day use area only. An observation platform and visitor facilities are provided near the lock and dam site at Lock View Landing Park and Bluff View Park.

Year-round recreation is found in the Webbers Falls area. Hunting for game is allowed in many areas. Principal game species include white-tailed deer, dove, quail, squirrel, cottontail and swamp rabbit, raccoon, mink, opossum, and some species of migratory waterfowl. An Oklahoma State Game Refuge is located on the southern bank near Gooseneck Bend, which is located near Navigation mile 388. Fishing is possible year-round in the Arkansas River and its tributaries, cutoffs and backwaters. The striped bass population is rapidly growing and some individuals may reach forty or more pounds.

d. Robert S. Kerr Lock and Dam (No. 15) – The USACE maintains five recreational areas on Robert S. Kerr Reservoir above the lock and dam – Applegate Cove, Cowlington Point, Damsite, Keota Landing, and Short Mountain. Applegate Cove Marina is located at Applegate Cove Park, just a few miles upstream of the dam.

Nature viewing, picnicking, camping, water sports, and hunting and fishing are popular activities along Robert S. Kerr Reservoir. The USACE parks provide basic facilities, such as camp sites, drinking water, shower facilities, and sanitary facilities. Public boat ramps are provided at each of these parks. Hiking trails are available throughout the area. Opportunities for hunting for common game species (e.g., white-tailed deer, rabbit, squirrel, quail, dove, and some waterfowl) and angling for many fish species (e.g., largemouth and striped bass, white crappie, channel and flathead catfish, walleye, and sunfish) are abundant.

The Sequoyah NWR, located near by the Robert S. Kerr Lake by Navigation mile 353, is home to numerous waterfowl and wildlife, especially mallards, snow geese, songbirds, hawks, bobcat, and several reptile and amphibian species. Large numbers of geese overwinter at the refuge.

Nature viewing is a prime pastime at this refuge. Hunting for game and waterfowl are also allowed in certain areas.

e. W.D May Lock and Dam (No. 14) – The USACE has developed three parks in this area for day use only. Arkoma Park, Le Flore Landing, and Wilson's Rock each have public boat launching ramps but have no overnight facilities (i.e., campsites, showers).

Sight-seeing is a popular pastime along this stretch of the MKARNS. Spring colors are abundant due to the presence of redbud, dogwood, and wild plum. Fall foliage is equally attractive due to the changing colors of the hardwoods. Hunting is allowed in designated areas and is regulated by State and Federal Laws. Fishing for striped and white bass, largemouth bass, channel catfish, crappie, sunfish, walleye, and other species is also a popular activity.

f. Ozark Field Office – The USACE, Little Rock District's Ozark Field Office is responsible for recreational activities from the Oklahoma-Arkansas border downstream to Ozark-Jeta Taylor Lock and Dam (No. 12). This area includes John Paul Hammerschmidt Lake, which was formed by J.W. Trimble Lock and Dam (No. 13), and Ozark Lake, which was formed by Ozark-Jeta Taylor Lock and Dam.

Nine parks are located along the banks of Ozark Lake. Clear Creek, Aux Arc, Vine Prairie, Citadel Bluff, and River Ridge Parks have boat ramps and allow overnight camping, although not all have picnic shelters or shower facilities. Vache Grasse, White Oak, Bluff Hole, and Reed Mountain Parks are for day use only and provide boating access as well as different views and overlooks of Ozark Lake.

The Ozark Field Office only manages the Arkansas portion of John Paul Hammerschmidt Lake. Two parks and two fishing access areas, composing approximately 680 combined acres, are found along this lake. The Lee Creek area has a boat launching ramp only and is leased to the Arkansas Game and Fish Commission. The Fort Smith area has been leased to the City of Fort Smith. Springhill Park, managed by USACE, provides boat ramps, camping, bank fishing, and recreational facilities in the area and includes the Golden Eagle trail.

All game fish native to Arkansas are in abundance in Hammerschmidt and Ozark Lakes. The Arkansas Game and Fish Commission (AGFC) also stocked both lakes with striped bass and walleye. The tail waters below Ozark-Jeta Taylor and J.W. Trimble Locks and Dams provide some of the best sauger fishing in the nation. Hunting for common game species, including deer, quail, squirrel, rabbit, dove, wild turkey, ducks and geese during open State hunting season is possible in many areas. Ducks Unlimited Inc., in partnership with AGFC and USACE, built moist soil units near Vine Prairie Park to improve duck hunting opportunities within the area. The USACE land and water areas are managed under a license agreement with the Arkansas Game and Fish Commission.

g. Dardanelle Field Office – The USACE, Little Rock District's Dardanelle Field Office maintains the area along the Arkansas River downstream of the Ozark-Jeta Taylor Lock and Dam (No. 12) to the Arthur V. Ormond Lock and Dam (No. 9). This area includes Lakes

Dardanelle and Winthrop Rockefeller, which spread westward behind Dardanelle Lock and Dam (No. 10) and Arthur V. Ormond Lock and Dam, respectively.

Lake Dardanelle has 15 parks run by the USACE. Eight allow camping, with some restrictions. The seven others are for day use only. Several have boat launch ramps, trailer dump stations, electrical sites with water, and group picnic shelters. Public boat docks offer boat and motor rental services, fuel, food, and other supplies and services. Lake Dardanelle State Park has two separate units, one located within the Russellville city limits and the other located just outside of Dardanelle, Arkansas. Each unit has concessionaire-operated marinas. The City of Russellville operates three day-use parks on the lake. Washburn Park offers lake access, picnicking, playgrounds and access to Bona Dea trails. Shiloh, and Pleasant View parks offer softball fields, lake access and a remote controlled airplane strip.

Rockefeller Lake has two parks, Sweeden Island Park and Pontoon Park. Sweeden Island Park has designated camp spaces, vault toilets, trailer dump stations, and water. Pontoon Park is designated for day-use only. Both are open year-round.

There are many hiking opportunities within the Dardanelle Field Office region. In particular, two National Nature Trails are located on project lands – Bona Dea Trails and Sanctuary, and Bridge Rock Trail. Bona Dea Trails and Sanctuary, located adjacent to Lake Dardanelle in Russellville, is a USACE-operated facility consisting of 186 acres of wetlands and low woods and nearly six miles of trails. The area provides various recreational activities, including walking, jogging, nature photography, and nature study. The Bridge Rock Trail is found in USACE's Shoal Bay Park, also on Lake Dardanelle. The one-mile trail overlooks a portion of Shoal Creek known as the "Narrows." Old Post Road Park offers over eight miles of mountain biking trail in Russellville as well.

Wildlife viewing is another popular activity in the region, especially with regard to the bald eagles, which are often winter residents along the shorelines of the lakes. Several nesting pairs have been documented over the past five years on the lake. Good viewing areas include Old Post Road Park in Russellville and Holla Bend NWR, southeast of Dardanelle. The abundant fish and wildlife of the area also provide for ample fishing and hunting opportunities. Record flathead, blue, and channel catfish are caught from the Arkansas River. Sunfish, crappie, and largemouth bass are stocked by the AGFC, which reports that Lake Dardanelle is the most productive bass fishery in the State of Arkansas. Hunting for game is bolstered by the river's close proximity to the Ozark and Ouachita National Forests.

h. Toad Suck Field Office – The USACE, Little Rock District's Toad Suck Field Office maintains the area along the Arkansas River downstream of Arthur V. Ormond Lock and Dam (No. 9) to Murray Lock and Dam (No. 7). Located in between these two locks and dams are the pools formed by Toad Suck Ferry Lock and Dam (No. 8) and Murray Lock and Dam.

Seven USACE parks are located upstream of Toad Suck Ferry Lock and Dam. Cypress Creek Park is a Class C park, which has vault toilets, visitor protection, designated tent and trailer spaces, trash containers, and drinking water, but no trailer dump stations. Cadron Settlement Park, just 2 miles upstream of the dam, does not permit overnight camping. Old Ferry Landing and Toad Suck Ferry Dam Site Parks are located at the dam. Cherokee and Sequoyah Parks, located south of Morrilton, are Class A facilities (fully equipped, including trailer dump stations). Upstream of Murray Lock and Dam are Maumelle, Palarm, Bigelow, and Cook's Landing Parks. Maumelle and Bigelow Parks permit camping. Each of the lock and dams have parks at the dam sites as well, except Sequoyah Park. All of the USACE parks have a boat launch ramp. Pinnacle Mountain State Park is located along the Maumelle River near its confluence with the MKARNS.

The Toad Suck area provides approximately 19,000 acres of water and supports excellent fishing opportunities. Hunting for game species is also a popular activity. The Tollantusky Trail, named after the Cherokee chief, is located along the Arkansas River in Cadron Settlement Park. The 1.3-mile mountain bike and footpath is a popular outdoor destination. The park is of historic importance because of it's role in the massive Cherokee Nation forced migration to Indian Territory "the Trail of Tears" and because it was an early seat of government to the developing territory.

i. Pine Bluff Project Office – The USACE, Little Rock District's Pine Bluff Field Office maintains the area along the Arkansas River downstream of Murray Lock and Dam (No. 7) to Joe Hardin Lock and Dam (No. 3). Located in between these two locks and dams are the pools formed by David D. Terry Lock and Dam (No. 6), Lock and Dam No. 5, Emmett Sanders Lock and Dam (No. 4), and Joe Hardin Lock and Dam. The Arkansas Post Field Office, a sub-office of the Pine Bluff Project, maintains the area downstream to the confluence of the Arkansas, White, and Mississippi Rivers, and is discussed separately below.

The David D. Terry Lock and Dam area has several USACE recreational areas, including Willow Beach, Dam Site 6 West, and Dam Site 6 East. Burns, Riverview, River Front, Murray, and Rebsamen Parks are operated by local government entities. Lock and Dam No. 5 has three USACE parks – Tar Camp, Dam Site 5 and Wrightsville River Access. Dam Site 5 is for day use only and Wrightsville has a boat ramp and bank fishing area.. Two day-use only USACE parks are found near Emmett Sanders Lock and Dam, Sheppard Island and Ste. Marie. Pine Bluff Regional Park is located along Lake Pine Bluff and Lake Langhofer, both backwaters of the Arkansas River adjacent to the City of Pine Bluff. The Joe Hardin Lock and Dam area has two camping parks, Rising Star and Trulock, and one day-use only park, Huffs Island. All of the USACE parks have a boat launch ramp, except Dam Site 5 Park and Huffs Island Park.

Recreational activities are similar to those found along other stretches of the MKARNS. The fishing is excellent, especially in terms of snagging for catfish on the downstream side of the dams. Hunting, water sports, picnicking and photography are other popular pastimes. White Bluff, just upstream of Lock and Dam No. 5, is a striking geological formation that forms the natural geographic boundary between the Western Gulf Coastal Plain and the Mississippi Delta.

j. Arkansas Post Field Office – The USACE, Little Rock District's Arkansas Post Field Office is a sub-office of the Pine Bluff Project Office (see above). It maintains the area along the Arkansas River downstream of the Joe Hardin Lock and Dam (No. 3) to the confluence of the Arkansas, White, and Mississippi Rivers. This area includes the Wildbur D. Mills Lock and Dam, Lock No. 2, and Norrell Lock and Dam (No. 1).

Nine USACE parks are located near Wilbur D. Mills Lock and Dam along the Arkansas River and Arkansas Post Canal. Four parks permit overnight camping. Merrisach Lake Park is situated along the eastern shore of Merrisach Lake near Lock No. 2 on the Arkansas Post Canal. Two USACE parks, Wild Goose Bayou and Morgan Point, provide boat ramps and parking areas but no camping or picnic areas. Wild Goose Bayou Park is located on the White River near Norrell Lock and Dam. Morgan Point Park is located on Morgan Bendway below Wilbur D. Mills Dam on the Arkansas River. Water is held in the oxbow by a recently constructed weir near its confluence with the Arkansas River.

The Arkansas Post National Memorial, located on a peninsula near the western terminus of the Arkansas Post Canal (Navigation mile 19), provides a unique recreational experience for visitors. This monument was erected to recognize the many historical events that occurred in the area. The old trading post was the first semi-permanent French settlement in the lower Mississippi River Valley. It continued to be a critical trading post due to its position near the two major rivers, and had strategic military importance during the Revolutionary and Civil Wars.

Fishing is productive along this stretch of the MKARNS. Largemouth bass, crappie, sunfish, bluegill, catfish, and occasionally sauger and striped and smallmouth bass are caught. In particular, snagging for catfish on the downstream side of Wilbur D. Mills Dam is very productive.

The USACE manages about 10,000 acres downstream from Pendleton Bridge (at Navigation mile 22.5) for public hunting. This area is managed as part of the Trusten Holder WMA in conjunction with the Arkansas Game and Fish Commission. The main section of the Trusten Holder WMA is located a few thousand feet off the Arkansas Post Canal between Lock No. 2 and Norrell Lock and Dam (No. 1). In addition, the White River NWR, straddling the Arkansas Post Canal as it converges with the White River, provides additional fishing, hunting, and wildlife viewing opportunities.

4.9.1.1.2 USACE Parks on Reservoirs

The reservoirs that comprise key flood control units of the MKARNS offer some of the finest recreation waters in the country. Below are the primary recreational resources associated with each reservoir.

a. Keystone Lake - Sixteen recreational areas maintained by the USACE at Keystone Lake including Appalachia Park, Brush Creek, Cowskin Bay South, Keystone Ramp, New Mannford Ramp, Salt Creek North, and Washington Irving North and South. Recreational opportunities on the lake include boating, water sports, fishing, swimming, picnicking, hiking and camping. State parks located on the lake include Keystone State Park, which provides access to the Pier 51 Marina, as well as the Walnut Creek State Park. Additional marinas for the lake include the Keyport Marina and the Westport Marina. Five short-distance hiking trails are also accessed from the recreational areas. Two off-road vehicle (ORV) areas. Spring Cove and Whitewater, are available to ORVs in the spring and summer, but close for wildlife protection and observation in the fall and winter.

Approximately 13,317 acres of project lands are managed for wildlife resources by the State of Oklahoma with another 3,855 acres managed by the USACE. This includes areas set aside as waterfowl refuges and three seasonal green tree reservoirs, as well as areas managed for upland game and deer. Hunting is regulated by State law as well as park, and seasonal species restrictions. Game species prevalent in the area include white-tailed deer, mourning dove, bobwhite quail, turkey, various waterfowl, cottontail rabbit and gray and fox squirrels. Principal sport fish species include striped and white bass, black bass species, white crappie, catfish species, and various sunfish species.

b. Oologah Lake - Recreational areas maintained by the USACE at Oologah Lake including Big Creek, Blue Creek, Clermont, Hawthorne Bluff, Overlook, Redbud Bay, Spencer Creek, Sunnyside Ramp, Verdigris River and Winganon Ramp. The City of Nowata also maintains the Double Creek Cove Park, which also provides access to Oologah Lake. Recreational opportunities on the lake include boating, water sports, fishing, limited swimming, picnicking, hiking and camping.

Approximately 12,941 acres of project lands are managed for wildlife resources by the State of Oklahoma with another 5,219 acres managed by the USACE. This includes areas set aside as waterfowl refuges, as well as areas managed for upland game and deer. Hunting is regulated by State law as well as park, and seasonal species restrictions. Game species prevalent in the area include white-tailed deer, mourning dove, bobwhite quail, turkey, various species of waterfowl, cottontail rabbit and gray and fox squirrels. Principal sport fish species include striped and white bass, black bass species, white crappie, catfish species, and various sunfish species.

c. Fort Gibson Lake - Recreational areas maintained by the USACE at Fort Gibson Lake including Blue Bill Point, Damsite, Flat Rock, Rocky Point, Taylor Ferry Beach, Taylor Ferry North, Taylor Ferry South, Wagoner City Park, Wahoo Bay and Wildwood. The State also maintains Sequoyah (and the associated Western Hills Guest Ranch) and Sequoyah Bay Sate Parks. Recreational opportunities on the lake include boating, water sports, fishing, swimming, picnicking, hiking and camping. There are three heated fishing docks for winter crappie fishing. Principal sport fish species include white bass, largemouth bass, and spotted bass, white and black crappie, catfish species and various sunfishes. The Western Hills Guest Ranch offers lodge accommodations, golf course, swimming pool, horseback riding, and other activities.

Approximately 21,798 acres of project lands are managed for wildlife resources by the State of Oklahoma. This includes a 4,500 acre waterfowl refuge with the remainder of the lands managed for upland game. Additional lands are managed for wildlife enhancement where feasible by the USACE. Hunting is regulated by State law as well as park, and seasonal species restrictions. Game species prevalent in the area include white-tailed deer, wild turkey, mourning dove, bobwhite quail, various species of waterfowl, cottontail rabbit and squirrels.

d. Tenkiller Ferry Lake - The Tenkiller Ferry Lake study area has 20 park areas offering a wide array of recreational opportunities. Two parks are maintained by the Oklahoma Department of Tourism as State parks (Lake Tenkiller and Cherokee Landing State Parks) and eighteen park areas are maintained by the USACE. All park areas have boat launching ramps for water recreational activities including boating and various waters sports including Scuba diving. There are 14 campgrounds, as well as numerous swimming beaches and picnic areas available for public use. The park areas also have three nature trails for hiking and observing the flora and fauna of the study area. All of the reservoir's shoreline is public land and available for recreational purposes as designated.

Year-round fishing opportunities include various sport species such as striped and white bass, smallmouth and largemouth bass, spotted bass, channel catfish, crappie, various sunfishes, and walleye. There are also five heated docks for winter crappie fishing. The Illinois River provides a put-and-take cold-water trout fisheries below the dam. The Illinois River above the reservoir also provides excellent rafting and canoeing waters.

Designated areas for hunting wildlife game species are also available. There are upland and waterfowl management areas in both USACE and State park areas.

e. Eufaula Lake - Recreational areas maintained by the USACE at Eufaula Lake include Belle Starr North and South, Brooken Cove, Dam Site East and West, Elm Point, Gentry Creek, Hwy 9 East, North and South, Mill Creek, Oak Ridge and Porum Landing. Recreational opportunities on the lake include boating, water sports, hunting, fishing, swimming, picnicking, hiking and camping. Two large State parks located on the lake (Arrowhead and Lake Eufaula State Parks) offer additional recreational opportunities including golf courses, swimming pools as well as hotel lodges, which are large enough to support meeting and convention activities. The cities of Eufaula and Crowder also maintain parks on the lake. The City of Eufaula maintains Eufaula Cove North and South, which is 110 acres of leased land offering lake access, a swimming beach as well as a marina.

Approximately 48,000 acres of the project land is managed for wildlife resources by the State of Oklahoma with another almost 10,000 acres managed by the USACE. This acreage includes waterfowl management units and areas managed for upland game and deer. Hunting is also available as regulated by State law as well as park, and seasonal species restrictions. Game species prevalent in the area include white-tailed deer, turkey, mourning dove, bobwhite quail, various species of waterfowl, cottontail rabbit, and fox and gray squirrel. Principal sport fish species include largemouth bass, white bass, crappie, catfish, walleye and various sunfish species. In the tailwaters below the dam, striped bass are also an important sport fish in addition to the species present in the reservoir.

f. Kaw Lake - There are currently nine open public use recreation areas at Kaw Lake including Bear Creek Cove, Coon Creek Cove, McFadden Cove, Osage Cove, Pioneer Park, Sandy Park, Sarge Creek, Trader Bend Access Point, and Wasunga Bay. Marinas are located at McFadden Park and Pioneer Park. Recreational opportunities on the Lake include boating, water sports, and fishing. Principal sport fish species include channel and flathead catfish, white bass, crappie and walleye. In addition, there is a significant striped bass fishery in the stilling basin of Kaw Lake. Swimming beaches are available at Pioneer Park and Sandy Park.

Hiking and equestrian trails area available from Osage Cove to Burbank Landing (which is closed to public access), and from Burbank Landing to Sarge Creek Cove. The areas are closed, to these uses, during Oklahoma's deer rifle and primitive arms seasons. Hunting is also available as regulated by State law as well as park, and seasonal species restrictions. Game species prevalent in the area include white-tailed deer, morning dove, bobwhite quail, various species of waterfowl, cottontail rabbit, squirrel, and wild turkey.

g. Hulah Lake - Recreation areas at Hulah Lake include Caney Bend, Dam Site, Hulah Cove, Skull Creek, Turkey Creek, and Wa-Sha-She State Park East and West. Recreational opportunities include boating and water sports, fishing, camping, picnicking, hiking trails, playgrounds, as well as swimming beaches. Principal sport fish species include largemouth bass, white bass, crappie, channel catfish, flathead catfish, and bullhead catfish.

Approximately 8,900 acres of the project land is managed for wildlife resources. Two thousand acres of this have been set aside as a State waterfowl refuge, whereas the remaining acreage is managed for upland game and deer. Hunting is also available as regulated by State law as well as park, and seasonal species restrictions. Game species prevalent in the area include deer, morning dove, various species of waterfowl, cottontail rabbit, squirrel, and wild turkey.

h. Copan Lake - USACE recreational areas at Copan Lake include Copan Point, Osage Plains, Post Oak Park and Washington Cove. Facilities include a swimming beach, picnic sites, and boat ramps to provide boating, water sports, and fishing opportunities. Hunting is also available as regulated by State law as well as park, and seasonal species restrictions. The northern part of Copan is managed as a protected waterfowl habitat area.

i. Wister Lake - Public use areas Damsite-South (outlet works) and Conser Crossing. Damsite South is operated by the USACE and Conser Crossing is outgranted and operated by the Oklahoma Department of Wildlife Conservation. The State of Oklahoma operates two State parks on or near the project lands (Lake Wister and Heavener Runestone State Parks), as well as several recreation and natural areas including Damsite-North (outlet works), Fanny Creek, Victor Area, Wister Ridge, Quarry Island, and Overlook Area. Recreational opportunities include boating and water sports, fishing, camping, picnicking, hiking trails, playgrounds, a youth camp, rental cottages and commercial concession facilities.

Hunting is also available as regulated by State law as well as park, and seasonal species restrictions. Approximately 80 percent of the project acreage is managed for wildlife resources (33,000 acres). The USACE manages about 13,000 acres through a grazing land program. Located on the south side of the lake is the Wister Lake Waterfowl Refuge. The refuge comprises approximately 1,000 acres and includes about 100 acres of mud flats that are seeded for cover and forage food.

4.9.2 Other Recreational Resources

4.9.2.1 Non USACE Lakes

a. Grand Lake O' the Cherokees (Pensacola Dam) - The Grand Lake area includes many recreation opportunities for boating, water sports, fishing, swimming, picnicking and camping, with lake access provided by both public and private facilities. The Disney / Little Blue State Park, located near Disney, Oklahoma, provides lake access and the above recreational opportunities, as does Cherokee State Park, located at the northern end of Lake Hudson below the Grand Lake Dam (Pensacola). Bernice and Honey Creek State Parks, near Grove, Oklahoma, also offer scuba diving on Grand Lake. Principal sport fish include large and smallmouth bass and crappie, as well as various catfish and sunfish species. During the winter, the Grand Lake area affords visitors the opportunity to watch bald eagles feeding below the Pensacola Dam.

Numerous private resorts, marinas and landings provide access to the lake including facilities in the towns of Disney, Bernice, Ketchum, Grand Lake Towne, Cleora and Langley (below the Pensacola Dam). Seasonal hunting is available in many upland areas around the lake. Hunting is regulated by State law and seasonal species restrictions, as well as public and private rules and regulations. The GRDA also seeds mudflats along the shores of Grand Lake in the fall to provide an additional food source for migratory waterfowl.

b. Lake Hudson (Markham Ferry Dam) - The Lake Hudson area includes many recreation opportunities for boating, water sports, fishing, swimming, picnicking and camping, with lake access provided by both public and private facilities. Snowdale State Park, located near Salina, Oklahoma, provides lake access and the above recreational opportunities, as does Cherokee State Park, located at the northern end of Lake Hudson below the Grand Lake Dam (Pensacola). Also located off the upper reaches of Lake Hudson is Spavinaw State Park, located on Spavinaw Lake, which offers a less frequented recreational opportunity where swimming and internal combustion engines are prohibited. Principal sport fish include large and smallmouth bass and crappie, as well as various catfish and sunfish species. During the winter, the Lake Hudson area affords visitors the opportunity to watch bald eagles feeding below the Robert S. Kerr and Pensacola Dams.

Numerous private resorts, marinas and landings provide access to the lake including facilities in the towns of Salina and Locust Grove (below the Robert S. Kerr Dam). Seasonal hunting is available in many upland areas around the lake. Hunting is regulated by State law and seasonal species restrictions, as well as public and private rules and regulations.

4.9.2.2 Arkansas Department of Parks and Tourism

- **Arkansas Post Museum.** This museum collects, preserves and interprets the Territorial Era of Arkansas's development as a state and its relationship to the settlement of the lower Mississippi Valley.
- **Toltec Mounds, Arkansas.** Toltec preserves and interprets Arkansas's tallest Native American mounds. These mounds and the earthen embankment are the remains of a large ceremonial and governmental complex inhabited from A.D. 600 to 1050.
- **Plantation Agriculture Museum, Arkansas.** This park exhibits and programs interpret the history of cotton agriculture from 1836 through World War II.
- **Pinnacle Mountain, Arkansas.** Pinnacle Mountain is a day-use park with a diversity of habitats, from high upland peaks to bottomlands along the Big and Little Maumelle Rivers.
- **Petit Jean, Arkansas.** Located near Morrilton, the natural beauty of Petit Jean Mountain inspired the creation of the Arkansas State Park system.

- **Lake Dardenelle, Arkansas.** The park is located on Lake Dardanelle, a 34,000-acre lake on the Arkansas River.

4.9.2.3 Oklahoma Tourism and Recreation Department

- **Arrowhead State Park, Canadian, Oklahoma.** This park is located on Eufaula Lake. It contains approximately 2,202 acres and includes the following recreational facilities and opportunities: camping, swimming, boating, fishing, marina, golf course, hiking and horseback riding.
- **Bernice State Park, Grove, Oklahoma.** Situated on Grand Lake, this 88-acre State park offers a wide variety of recreational activities including camping, boating, water sports, scuba diving, fishing and swimming.
- **Cherokee State Park, Disney, Oklahoma.** Situated on Grand Lake, this 43-acre State park offers a wide variety of recreational activities including camping, boating, water sports, scuba diving, fishing and swimming.
- **Cherokee Landing State Park, Park Hill, Oklahoma**. Situated on Tenkiller Lake, this 146-acre State park offers a wide variety of recreational activities including camping, boating, water sports, fishing and swimming.
- **Disney / Little Blue State Park, Jay, Oklahoma.** Situated on Grand Lake, this 32-acre State park offers a wide variety of recreational activities including camping, boating, water sports, fishing and swimming.
- **Greenleaf State Park, Braggs, Oklahoma**. Located off of the Webbers Falls Pool of the MKARNS, this 900-acre State park offers a wide variety of recreational activities and facilities including the following: nature center, community building, cabins, camping, hiking, swimming, boating, fishing, a marina, miniature golf and paddle boats.
- **Heavener Runestone State Park, Heavener, Oklahoma.** Located east of Wister Lake, this State park offers a wide variety of recreational activities but features ancient runestone hieroglyphics for the Norse Vikings.
- **Honey Creek State Park, Grove, Oklahoma.** Situated on Grand Lake, this 30-acre State park offers a wide variety of recreational activities including camping, boating, water sports, scuba diving, fishing and swimming.
- **Lake Eufaula State Park, Checotah, Oklahoma.** This park is located on Eufaula Lake. It contains approximately 2,853 acres and includes the following recreational facilities and opportunities: nature center, camping, swimming, boating, fishing, marina, golf course, hiking and horseback riding.
- **Lake Keystone State Park, Mannford, Oklahoma.** This park is located on Keystone Lake. It contains approximately 714 acres and includes the following recreational facilities and opportunities: nature center, community building, cabins, camping, swimming, boating, fishing, marina, hiking and bike riding.
- **Lake Tenkiller State Park, Vian, Oklahoma.** Situated on Tenkiller Lake, this 1,190-acre State park offers a wide variety of recreational activities and facilities including nature center, community building, cabins, camping, swimming, boating, fishing, marina, hiking and bike riding.
- **Lake Wister State Park, Wister, Oklahoma.** This 3,428-acre park, situated on Wister Lake, offers a wide variety of recreational activities amidst the backdrop of the beautiful

Ouachita Mountains. Recreational facilities and opportunities include nature center, cabins, camping, swimming pool, boating, scuba diving, marina, fishing, and hiking.

- **Sequoyah Bay State Park, Wagoner, Oklahoma**. Located 5 miles south of Wagoner, this 303-acre State park is located on Fort Gibson Lake. It has a marina, campsites, RV area, swimming beach and pool, boating, water sports, marina, tennis and hiking trails.
- **Sequoyah State Park &Western Hills Guest Ranch, Wagoner, Oklahoma.** Located on Fort Gibson Lake, this 2,200-acre State park and resort offers many recreation opportunities and facilities including resort ranch, cabins, meeting rooms, nature center, a marina, boat tours, boating, water sports, campsites, swimming beach and pool, golf course, horse back riding, hayrides and numerous hiking trails.
- **Snowdale State Park, Salina, Oklahoma.** Situated on Lake Hudson, this 15-acre State park offers a wide variety of recreational activities and facilities including camping, swimming, boating, water sports and fishing.
- **Spavinaw State Park, Disney, Oklahoma.** Situated off of Lake Hudson on Spavinaw Lake, this 35-acre State park offers a wide variety of recreational activities and facilities including camping, swimming, boating and fishing.
- **Wah-Sha-She State Park, Copan, Oklahoma**. This 266-acre park is located on Hulah Lake. It contains approximately 1,400 acres and allows camping, swimming, boating, water sports, fishing, and hiking.
- **Walnut Creek State Park, New Prue, Oklahoma.** This 1,429-acre park is located on Keystone Lake and offers many recreational opportunities including camping, swimming, boating, fishing, hiking and horseback riding.

4.9.2.4 City, County, and Private Facilities

City, county, and private facilities located in the immediate vicinity of the study area also provide recreational and aesthetic opportunities including access to the reservoirs and navigation pools for boating, water sports, fishing and swimming, as well as camping and entertainment.

4.10   Cultural Resources

This section presents information on archaeological and architectural resources located in the MKARNS system and associated properties. The discussion includes a description of regulatory requirements, methods used to identify existing archaeological and architectural resources, research context, and the number and types of archaeological and architectural resources known or expected to occur within the project areas and the number of archaeological and architectural resources that are listed or eligible for the National Register of Historic Places (NRHP).

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 archaeological sites, which include both prehistoric and historical occupations either submerged or on land, and architectural resources. Archaeological sites can become submerged when they are inundated following impoundment of rivers, and shipwrecks are a specific type of submerged archaeological site.

4.10.1 Legal and Regulatory Background

Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470), governs Federal actions that could affect NRHP eligible properties. Section 106 requires Federal agencies to take into account the effects of their undertakings, including licensing and approvals, on NRHP eligible properties and to afford the Advisory Council on Historic Preservation and other interested parties a reasonable opportunity to comment. As defined broadly by the regulations implementing Section 106 (36 CFR 800), "historic property" means "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP maintained by the Secretary of the Interior." Section 101(b)(4) of National Environmental Policy Act (NEPA) requires Federal agencies to coordinate and plan their actions so as to preserve important historic, cultural, and natural aspects of the country's national heritage.

Properties that qualify for inclusion in the NRHP must meet at least one of the following four criteria:

Criterion A: be associated with events that have made a significant contribution to the broad patterns of our history,

Criterion B: be associated with the lives of persons of significance in our past,

Criterion C: embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components could lack individual distinction, or

Criterion D: have yielded, or could be likely to yield, information important in prehistory or history (36 CFR 60.4).

Properties that qualify for the NRHP also must possess integrity, defined by the following seven aspects: location, design, setting, materials, workmanship, feeling, and association. The term "eligible for inclusion in the NRHP" includes properties formally designated as eligible and all other properties determined to meet NRHP criteria. Normally, NRHP eligibility requires a property to be at least 50 years of age. Resources less than 50 years of age that are highly significant and meet the "special criteria considerations" as outlined in the regulations (36 CFR 60.4) also may be eligible for the NRHP.

4.10.2 Cultural History

Information regarding the past cultural chronology in the region assists in the assessment of the archeological potential, and provides an interpretive context for any potential archeological or architectural resources in the project area. The chronology presented below follows the major cultural traditions for the study region in Arkansas and the eastern portion of Oklahoma. Knowledge of local prehistory and history helps to place cultural resources within their historic context and are necessary for evaluating the importance of cultural resources within the Area of Potential Effect (APE).

4.10.2.1 Prehistoric Context

4.10.2.1.1 Paleoindian Period (10,000 - 8,000 B.C.)

The earliest well-documented era of human occupation in North America is the Paleoindian period. It is characterized by the colonization of the New World by nomadic bands of hunter-gatherers. Traditional chronologies estimate that, by 12,000 years ago, these peoples crossed the Bering Strait from Asia on land exposed by the lowering of sea levels during the peak of the last ice age. Although the founding populations were small, there were abundant natural resources and these people quickly spread out across the continent.

A mosaic of spruce, other conifers, and possibly deciduous forests with extensive open areas dominated most of Arkansas and eastern Oklahoma. Summers were cold and moist and winters were significantly colder than present. Paleoindians utilized now-extinct megafauna species, including mammoth, mastodon, giant ground sloth, and bison, although many other plant and animal resources were also used (O'Brien and Wood 1998; Sabo et al. 1990). Paleoindian sites are usually identified by diagnostic, finely worked lithic artifacts, specifically fluted and non-fluted projectile points, such as Clovis and Folsom types, made of high quality chert and flint. Hafted end- and side-scrapers, gravers, spokeshaves, adzes, and expedient tools were also used, and were curated (i.e., carried from place to place) (Anderson et al. 1996).

The Dalton Horizon, 8,500 to 7,500 B.C., is transitional between the Paleoindian and Archaic periods. Some researchers consider the Dalton period to be part of the Early Archaic (e.g., Dickson 1994), many others consider it a horizon within the Paleoindian period (e.g., Morse 1996), and still others treat it as a distinct period (e.g., Sabo et al. 1990). Regardless of temporal nomenclature, this period represents the transition between the "big-game" hunters of the Paleoindian period and the more generalized hunter-gatherers of the Archaic period. The Dalton period coincides with the warming trend that began at the end of the Pleistocene and continued to the Holocene and the beginning of generally modern climate in the region (Bryson et al. 1970). The final extinction of Pleistocene megafauna in North America occurred during this time; much of Arkansas was covered by oak/chestnut forest (Jeter and Williams 1989a).

Like the Paleoindian period, the Dalton horizon is recognized and defined by the presence of a unique stone projectile point. Dalton points are lanceolate artifacts primarily used as hafted knives, and were often reused and resharpened until the original lanceolate form resembles a church steeple (Jeter and Williams 1989a). Other stone tools associated with the Dalton horizon include woodworking tools, (e.g., the Dalton adz), bone- and antler-working tools, (e.g., *pieces esquilles*) and sandstone abraders/grinders (Jeter and Williams 1989a; Sabo et al. 1990). Dalton peoples are thought to have adapted to stream valley environments, and probably lived on stream terraces and in rockshelters, with periodic use of the uplands (Sabo et al. 1990:44). Dalton period sites are more common than Paleoindian sites (Jeter and Williams 1989a). Details of Dalton resource exploitation and settlement patterns are the subject of debate. Some researchers support the hypothesis that Dalton people occupied semi-permanent base camps (Morse 1982), while others argue for the seasonal occupation of winter-spring and summer-fall camps (Price and Krakker 1975). Faunal data suggest a reliance on forest edge species such as deer as a primary food source supplemented by smaller mammals (Sabo et al. 1990).

4.10.2.1.2 Archaic Period (8,000 – 500 B.C.)

The Archaic is characterized by the technological and social changes that accompanied the environmental changes following the retreat of the glacial ice sheets. People adapted to the resources of their local environment. Dalton societies continued into the early Archaic, but other, later populations used many new forms of tools as regional varieties of points increased. The fluted point tradition disappeared and was replaced by stemmed, side-, and corner-notched projectile points and large hafted bifaces. On the prairies, modern bison replaced the larger, Pleistocene *Bison antiquus.* Three subperiods have been defined for the Archaic Period: Early, Middle and Late.

Early Archaic (8000-7000 B.C.) peoples moved seasonally to exploit a wide variety of game and plants, including migratory species with limited periods of availability. Rice Lobed, Graham Cave, Cache River, and Hardin points were used in Arkansas, while in Oklahoma lanceolate point traditions continued, although these points were no longer fluted. The climate was warmer and drier than currently (Bryson et al. 1970). The Oak Savannah belt extended north towards northwestern Arkansas, while prairie grasslands extended eastwards from the plains (Jeter and Williams 1989a). Unlike the preceding Paleoindian and Dalton periods there is no single diagnostic artifact type for the Early-Middle Archaic, except there is a general trend for stemmed points appearing at the end of the Early Archaic (Jeter and Williams 1989a). Regional variation in notched and stemmed projectile points became widespread during this time. Archaic points exhibit a wide variety of blade shapes and hafting elements including expanding stems, contracting stems, bifurcated bases, side and corner-notched bases, as well as a variety of unfluted, unnotched lanceolate type points.

The Middle Archaic (7000-3000 B.C.), a period of drier and warmer weather, is characterized by an expansion of the prairies and grasslands at the expense of woodlands. This change was probably accompanied by a decrease in the deer population, and a resulting reliance on other animal and plant species, including fish and bison. Groups foraged and hunted over more restricted territories, focusing on the exploitation of specific resources. The Calf Creek culture in eastern Oklahoma and western Arkansas is characterized by heat-treated Calf Creek points, and heavy reliance on bison. Sites from this time period are relatively rare throughout the project area.

A regional tradition, the Toms Brook Culture (5000-4000 B.C.), was concentrated in southwestern Arkansas and surrounding areas, but defined by the type site Toms Brook bluffshelter in northwest Arkansas (Jeter and Williams 1989a). The diagnostic artifact for the Toms Brook culture, the Johnson point, is broad-stemmed with a concave base and is commonly found in the foothills of the Ozarks and in the Ouachita Mountains. This culture was the first in the region with evidence for a riverine subsistence focus, in the form of notched pebble netsinkers (Jeter and Williams 1989a). Semi-permanent base camps and the appearance of specialized resource extraction sites suggest that Early-Middle Archaic people gathered resources from prime areas. After partial or complete processing, those resources were transported back to a base camp for consumption and use. Hickory nuts (O'Brien and Wood 1998:158) and quality cherts, including the first evidence for use of novaculite quarries in the Ouachita Mountains (Early and Limp 1982; Wyckoff 1984) were favored resources. The continual reoccupation of resource procurement sites suggests that they were favored locations by groups familiar with the specific geographic area (Sabo et al. 1990). This implies a much greater degree of permanence of occupation than seen previously.

The Late Archaic (3000-500 B.C.) was a period of intense environmental, cultural, and technological changes. The climate became warmer and moister, and the prairie margin moved westward with forests once again dominating eastern Oklahoma. Evidence for increased sedentism is preserved as groups stayed in one place for longer periods of time, in a central based wandering settlement pattern. Smaller outlying camps were used to exploit seasonally available resources. Large midden accumulations, burned rock ovens, and non-portable grinding stones are characteristic features. Substantial midden deposits at many Late Archaic sites, attest to long term occupation, and reoccupation of base camps (Sabo et al. 1990).

The advent of horticulture in the region occurred during this time, as did the introduction of ceramic technology, distinct mound building episodes, 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 in Oklahoma. No single projectile point defines this subperiod. A variety of stemmed points such as Afton and Stone Square appeared, and boatstones and other forms of weights were present. The Gary point makes its first appearance and is found across Arkansas, eastern Oklahoma, and into Louisiana. In Oklahoma, the Wister Phase settlement pattern reflects a division between riparian base camps and short term special-use sites. The base camps contain substantial midden deposits, human and dog burials, pits, postholes, hearths, and burned clay concentrations (Williams et al. 1993). Late Archaic sites and site components are found primarily in rockshelters and open air settings.

During the Late Archaic, the course of the Arkansas River was significantly different from that of today. It joined the Mississippi River further south, in Louisiana (Jeter and Williams 1989a:95). Consequently, people along the lower Arkansas River at this time were influenced by Poverty Point, a Late Archaic culture centered on the Poverty Point site in northeastern Louisiana with elaborate earthworks and mounds (Gibson 2001).

4.10.2.1.3 Woodland Period (500 B.C. – A.D. 900)

The Woodland period is traditionally divided into three sub-periods: Early, Middle, and Late. The significant climatic event that occurred during the Woodland period, the Scandic episode (A.D. 400-900), represents a slight cooling trend over the previous Sub-Boreal climatic episode (Bryson et al. 1970). Aside from the slight cooling trend, the climate during this period was largely consistent and essentially modern. Pollen data suggests oak/hickory forests dominated upland settings, and elm/walnut forest dominated lowland settings (Henry 1978). 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 general, regional diversity increased substantially during the Woodland period. Sabo et al. state that "the archaeological expression of these changes, and the time of their appearance, vary from region to region within this broad area, and not all Woodland people incorporated the same array of cultural practices into their societies" (1990:73).

The use of pottery became more widespread and allowed for increased food storage and cooking capabilities, and the bow and arrow became common. Population gradually increased, and a variety of new points were adopted. Woodland groups in Arkansas and northeastern Oklahoma 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. In western Arkansas, researchers have noted that the Early Woodland subperiod is difficult to separate from the terminal Late Archaic (Imhoff et al. 1998).

The Fourche Maline 2 culture, 300 B.C. to A.D. 700, spans eastern Oklahoma and western Arkansas, and was an outgrowth of the preceding Wister Phase. It is characterized by Gary contracting-stemmed projectile points, single and double bitted chipped stone axes, ground and polished boatstones, pitted cobbles, and Williams Plain ceramics. Fourche Maline peoples cultivated several species of native annual plants and the first tropical cultigens may have been introduced at this time (Early and Limp 1982). The construction of burial mounds and the presence of exotic materials interred with the cultural elite indicate a more complex social order. The typical Fourche Maline settlement pattern contains major mound centers with midden accumulations along terraces with small sites on tributary streams (Early and Limp 1982). At higher elevations, short term hunting and collecting camps, quarries, and other special use sites were present (Sabo et al. 1990). Late in the period, however, a pattern of small, dispersed farmsteads prevailed.

Influence from the Hopewell Interaction Sphere, an interregional exchange and communication network that spread along the major waterways from the Eastern Woodlands was present in the Arkansas River valley following the demise of Poverty Point. The regional variations, part of the Fourche Maline 3-7 culture in the upper Arkansas valley, and Hopewellian/Marksville in the lower valley, differentially participated in long distance trade of exotic items such as copper ornaments, conch shells, mica objects and obsidian tools, functional goods such as decorated pottery and projectile points, and raw materials such as galena, copper, mica, obsidian, hematite, and chert. The widespread construction of burial and effigy mounds is taken as an indication of shared beliefs or ideas. Villages situated near perennial streams constituted the main population centers. Lithic tools from this period include Snyder and Stueben-type projectile points.

Around A.D. 400, there seems to have been a decline in the exchange of exotic goods and a decline in the construction and size of earthworks and burial mounds. In eastern Oklahoma, some areas with incipient horticulture developed into a village farming tradition, while in other areas populations seem to have decreased their horticultural activities and increased their reliance on hunting. The Baytown phase of the lower Arkansas River valley is characterized by the Reed variety of Baytown Plain pottery, and a high proportion of cord-marked ceramics (Jeter and Williams 1989b). Projectile point types continued to diversify. There was a general trend towards smaller projectile points probably relating to the introduction of the bow and arrow, concomitant with an increase in dependence on deer as a major food source. Projectile points, including the Langtry, Gary, Snyders, Dickson, Scallorn and others are considered both diagnostic of the Woodland period, and represent continuity between the preceding Late Archaic and subsequent Mississippian periods (Justice 1987). Digging implements become somewhat more common, as do grinding stones and axes. An increase in the frequency of ground-stone tools is interpreted as relating to increased horticultural activities (Brown 1984). Although evidence for increased horticulture during the Woodland is largely accepted, the exact nature and overall importance of horticulture is still the subject of some debate. Many sites have produced artifacts such as hoes and grinding stones that are consistent with intense horticulture no direct evidence of horticulture in the form of carbonized domesticated plants or seeds is present at those sites (Sabo et al. 1990). Similarly, other sites described by Michael Hoffman (1977a) produced argillite (siltstone) tools that exhibit polish consistent with gardening activities, however, this use has not been conclusively proven. Settlement data indicate that local groups were scattered along major waterways. More permanently settled sites were concentrated on terraces associated with fertile bottomlands (Sabo et al. 1990:82). Overall, Woodland cultures appear to undergo changes in subsistence strategies, technology, and social organization. In central Arkansas, the Late Woodland in the Arkansas River Valley is characterized by the Plum Bayou Culture and dates to A.D. 500-900. The type site for the Plum Bayou Culture is the Toltec site, located in the Plum Bayou drainage of the lower Arkansas River Valley, in Lonoke County. The site was initially occupied about A.D. 600 during Baytown times (A.D. 300-700). Diagnostic Baytown artifacts include ceramics, especially Mulberry Creek Cordmarked and Larto Red Filmed types, as well as types with incised, stamped, or brushed decoration. Dome-shaped mounds and deep midden deposits at some sites indicate that larger, more stable, and more sedentary populations were present. Toltec developed throughout the Late Woodland into a major mound center composed of two plazas, three large mounds, and at least 14 smaller mounds surrounded by an earthen embankment and ditch (Lewis and Stout 1998). Research suggests that by A.D 700-800, one mound played a role in some sort of ceremonial feasting event or events (Rollingson 1992). Researchers have identified a relationship between these mounds and the yearly solstice alignments suggesting a high degree of social organization as well as knowledge of yearly astronomical events (Sherrod and Rolingson 1987). This interpretation of the Toltec site implies a greater connection with the subsequent Mississippian Cultures than the preceding Woodland cultures. Occupation of Plum Bayou was coeval with and had ties to the final phase of the Fourche Maline culture.

4.10.2.1.4 Mississippian Period (A.D. 900 - 1500)

The widespread appearance of political and religious hierarchies between A.D. 900-1450 are hallmarks of the Mississippian 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. The control and redistribution of such resources in addition to the trade in exotic prestige goods allowed the rise of a hierarchical society ruled by an exclusive hereditary social elite (Blitz 1993). Mississippian settlement patterns 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. Some mounds functioned as repositories for the burial of social elites. All the mounds, however, served as visual reminders of the power of sociopolitical and religious leaders. Technological changes include the widespread use of shell-tempered ceramics, the manufacture and use of smaller "arrow" projectile points, as well as a variety of well made stone tools (Sabo et al. 1990; O'Brien and Wood 1998). Ceramic traditions continued to be refined, incorporating finely made shell-tempered wares in both utilitarian and special use forms, such as human and animal effigies, bottles, bowls, jars, and pipes.

The culture history of Arkansas is far more complex for this period, with many regional traditions arising out of the Mississippian cultures prevalent at this time. Some areas were densely populated while other areas were largely devoid of people (Sabo et al. 1990). The influence of the Southeast Ceremonial Complex is seen throughout Mississippian population centers, and there is additional evidence for long distance trade with the Cahokia Culture of the American Bottoms, and the Caddoan Culture of southwest Arkansas, eastern Oklahoma, northwest Louisiana, and northwest Texas (Lafferty 1994). Mississippian societies along the lower course of the Arkansas valley followed a similar cultural trajectory, but one that was more closely aligned with the Lower Mississippi Valley cultural sequence, with Coles Creek/Plaquemine growing out of the earlier Baytown and Plum Bayou cultures .

The westernmost Mississippian manifestation, the Arkansas Valley Caddoan (prehistoric) tradition had its roots in the preceding Fourche Maline culture (Jeter and Williams 1989b). It is part of the broader Trans-Missississippian South Caddoan cultural tradition. The development of Caddoan culture is divided into five periods: Formative Caddoan (A.D. 800 - A.D. 1000); Early Caddoan (A.D. 1000 - A.D. 1200); Middle Caddoan (A.D. 1200 - A.D. 1400); Late Caddoan (A.D. 1400 - A.D. 1680); and Historic Caddoan (A.D. 1680 - A.D. 1860) (Perttula 1996). The Formative is distinguished by the construction and use of earthen mounds as platforms for buildings. Mounds were also used for the burial of selected individuals implying the emergence of elite status positions. Caddoan sites 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. Most sites have been found in intermediate (10.1 to 100 square kilometers) to major (more than 100 square kilometers) basins. Sites are also found near fresh water springs, salt springs, and at resource extraction locations (Perttula et al. 1993). Evidence indicates long distance trade was present by A.D. 800, and intensified until A.D. 1400, but decreased afterwards. Local resources such as bison skins, wood for bows (Osage orange), and pottery were exported. Non-local materials such as turquoise and cotton were imported from the west, and copper, marine shell, and large chert bifaces were brought in from the northeast and east. Gradual intensification of the use of maize and beans occurred until they dominated the diet by A.D. 1300-1400. The use of hunted and foraged resources continued even after the adoption of cultivated plants. Caddoan shell-tempered ceramics, often richly embellished with Caddoan iconography, include bottle, plate, and carinated jar forms. The Spiro Mounds Site, one of the most important archeological sites in North America, is located along the W.D. Mayo Pool of the MKARNS project area. Evidence from the site indicates contact with Mesoamerica, Southwestern U.S. Pueblo cultures, the Gulf of California, and shared art styles of the Southeast Ceremonial Complex that connect it with Mississippian mound centers at Etowah, Georgia, Moundville, Alabama, and Cahokia, Illinois (Brown 1996; 2004).

Mississippian cultures continued to flourish in Arkansas, Oklahoma, and the southeastern United States until the arrival of European explorers in the sixteenth and seventeenth centuries. Their descendents became identified with a number of historically known American Indian groups, including the Quapaw in eastern Arkansas, and the Kitsai, Wichita, and the Caddo in western Arkansas and Oklahoma (Black and Perttula 2003).

4.10.2.1.5 Protohistoric (A.D. 1500-1700)

The exact end of the Mississippian Period and start of the Protohistoric cannot be clearly defined. The traditional view is that the arrival of European explorers, settlers, and the indirect influences that radiated into North America in the early 1700s marked the start of Protohistoric. However, some would argue that the end of Mississippian Period began in 1541 when two different entrada of Spanish explorers reached the region, the Hernando De Soto entrada, and the Coronado expedition. The consequences of De Soto's actions are not entirely known. It is possible that they introduced diseases such as smallpox, which could have ravaged the native populations that were encountered (Hudson 1997). Such an epidemic could easily have destroyed entire native societies, or classes within native societies (Sabo 1992). The native peoples and cultures encountered by French explorers 130 years later differed substantially from those described by the chroniclers of De Soto's expedition in the sixteenth century (Sabo 1992). Unfortunately, these changes occurred during the time span some have called dubbed the “protohistoric dark ages” (Sabo 1992:26), for which no ethnohistoric accounts exist.

Caddoan societies continue into the protohistoric and historic eras of the Arkansas River valley. Portions of the Late Caddoan (A.D. 1500-1680) represent the protohistoric era, when Caddoan groups were first contacted by European explorers, traders, and settlers. Historic Caddoan (after A.D. 1680) is the period when the historic Caddo Indians coalesced politically and culturally in the face of Euro-American expansionism, missionization, warfare, and trade.

4.10.2.2 Historic Context (post A.D. 1700)

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. Throughout the interior of North America, the impact of disease and new trading patterns often long preceded the arrival of European explorers. Old World diseases, such as smallpox, are believed to have killed as much as 90 percent of the Native American population. Introduction of European items and European demand for particular resources, such as beaver pelts and deer skins transformed Native trading systems.

4.10.2.2.1 Historical Period through the late 1800s

The cultural influences in operation in Arkansas and northeastern Oklahoma during the historical period derive primarily from continental Europe. 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 discovered 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 (Hudson 1997). 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 early 1700s establishing a fort at the mouth of the Arkansas named *Poste Aux Arcansas*. 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 ultimately, settlement of the region.

In order to protect the important inland waterways such as the Arkansas, George Washington signed the Ordinance of 1787 (also known as the Northwest Ordinance), which states in Article 4 that “navigable waters leading into the Mississippi and St. Lawrence, .shall be common highways and forever free" (U.S. Continental Congress 1787). This provided the cornerstone for the United States' free waterways policy that is still in effect today.

In 1796, a trading post was established on the Grand River, and in 1802, Jean Pierre Chouteau established his trading post there, which later became Salina, the first permanent settlement in later became Indian Territory and Oklahoma. After the Louisiana Purchase in 1803, the Army built a western military post, Fort Smith, established in 1817, at the western edge of the Arkansas River valley as the last outpost to the western plains. Official voyages of exploration resulted in mapping of the region’s rivers, Fort Smith military garrison was established in 1817, and settlements and homesteads began to appear in what is now northeast Arkansas.

Following the Louisiana Purchase, many settlers moved into Osage territory, provoking the Indians. The government established a treaty with the Osage Tribe, asking for the land east of Fort Osage between the Missouri and Arkansas Rivers for settlers. The Osage ceded fifty million acres, receiving $60,000.00 or a payment of less than one-tenth of a cent per acre. At the same time, the government promised the land of the Osage to the Cherokee and other Indian tribes displaced from their lands east of the Mississippi River. Conflicts with the eastern Indians and misunderstanding of the treaty caused more conflicts over territory. The Osage did not realize they were giving up all privileges to the land forever by signing the Treaty of 1808, and they continued to hunt the treaty lands until 1838. In 1818, the Osage ceded more territory north of the Arkansas River--a total of seven million acres for $4,000.00, or one-half cent an acre. In their final treaty of June 2, 1825, the Osage ceded all lands in Missouri, and moved west to Kansas and Oklahoma.

By the time that President James Monroe signed the act creating the Territory of Arkansas in 1819, there were 14,000 settlers in Arkansas. Meanwhile, 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. In 1836, the Arkansas Territory became a state, the way was cleared for settlers and the land was opened for public sale.

The Indian Removal Act was passed in May 1830. This act empowered the President of the United States to move eastern Native Americans west of the Mississippi, to what was then "Indian Territory" (what is now essentially 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 Five Civilized Tribes occurred from east of the Mississippi to new Indian Territory. Arkansas was traversed by thousands of Choctaw, Creek, Chickasaw, Cherokee, and Seminole in what came to be known infamously as the Trail of Tears.

During the period from 1840 to the end of the century, the population of Arkansas increased from the influx of European immigrants, and dispersed villages were founded around newly established rural post offices. With an economy dependent upon slave labor to keep its 1,393 plantations operable, Arkansas sided with the south when the Civil War began, and sent 60,000 able-bodied men to defend the institution of slavery. The subsequent 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. The river was the most economical way to ship cotton and produce to markets further east, and steamboats were common from the 1830s onward.

During this period in Oklahoma, the relocated tribes were establishing communities, schools and tribal governments. The settlers were mainly concentrated around the forts and trading posts.

The impact of the Civil War, with both Union and Confederate troops occupying both Arkansas and northeastern Oklahoma, divided many communities. The 1870s saw an influx of new settlement as many chose to resettle, rather than rebuild. The railroad was making its way toward the west, enabling a faster settlement of the lands west of the Mississippi River.

4.10.2.2.2 Historical Period from late 1800s

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.

After 1880, Arkansas underwent increasing commercialization and industrial activity. The construction of the railroad after 1855 enhanced the availability of timber and made logging a primary industry. Millions of acres of land were “cut and run” cleared in the decades between 1880 and 1920, before responsible forest management techniques were introduced. Maximal agricultural practices were also underway during this period, depleting the region’s already marginal soils.

In Oklahoma, designation of the state as Indian Territory, delayed widespread settlement and prevented establishment of more European traditions. The railroads reached the Cherokee Nation in 1870 and crossed the Red River into Texas in 1872. Shortly after opening the territory for settlement, shallow oil fields were discovered in northeastern Oklahoma, bringing economic boom times to landowners possessing the mineral rights.

In Arkansas, there was a major economic downturn in the 1890s, followed by a period of economic growth. The revolutionary impact to transportation resulting from the coming of the railroads by 1900, and automobiles shortly thereafter, allowed for greatly increased ease of travel and influx of goods into the region. However, the 1920s, towns were absorbing rural communities. The devastation wrought by overworked land, drought, and economic depression began a period of retraction. When cash crops became unprofitable and weevils attacked the cotton crops, farms failed and many farmers lost their lands because of unpaid taxes, and were forced to move to the cities. During World War II, these displaced farmers were employed in the factories and refineries that boosted production to meet wartime production needs.

4.10.2.3 MKARNS History

Early commerce on the waterway included boats of various types and sizes utilized in the early 1800s by French traders and explorers. In 1819, Auguste Chouteau built a boatyard near present day Muskogee to accommodate the shipping of furs to New Orleans. These boats were 50 to 60 feet in length and could carry approximately 50 tons of goods. The first steamboat to travel the Arkansas River was the Comet (154 tons), in 1820, and took eight days to reach Arkansas Post from New Orleans.

In addition to valuable trade commerce, steamboats were utilized for many military purposes including the transportation of supplies and equipment, troops, as well as movement of displaced Native Americans (Table 4-29).

Table 4-29. Major Military and Commerce Activities on the Arkansas River Through the 1800s.

Date	Port	Purpose
1541	Arkansas Post to Little Rock vicinity	Hernando de Soto Expedition traveled up the river from the mouth in search of the village of Coliqua
1686	Arkansas Post	Henri de Tonti founded trading post near Arkansas River mouth
1796	Grand River	Trading post founded which later became Salina, first town in Oklahoma
1819	Three Forks	Auguste Chouteau built a boatyard in the Three Forks area (near present day Muskogee), to accommodate the shipping of furs to New Orleans.
1820	Arkansas Post	Steamboat Comet was the first up the Arkansas River, traveling a short way beyond Arkansas Post
1822	Little Rock	Steamboat Eagle stopped on its way to deliver supplies for Dwight mission among the Cherokees

Table 4-29. Major Military and Commerce Activities on the Arkansas River Through the 1800s.

Date	Port	Purpose
1822	Fort Smith	Steamboat Robert Thompson delivered provisions for the garrison
1824	Fort Gibson	Steamboat Florence brought 100 recruits for the new military post at Fort Gibson
1828	Verdigris River	Steamboat Facility was the first to ascend the Verdigris River, bringing Creek settlers and picking up 500 barrels of pecans.
1832	Neosho River	First River Act authorization of snag boats to maintain navigation channel at the mouth of the Grand River.
1833	Fort Gibson	Seventeen boats dock regularly at Fort Gibson
1837	Fort Coffee	Removed Chickasaws are brought up the Arkansas on their way to new lands.
1838	Arkansas River	Removed Cherokee are brought upriver on flat boats on the "Trail of Tears"
1850	Little Rock	Eighteen steamers made 115 roundtrips from Napoleon (at the mouth of the Arkansas). However, low water prevents ships from reaching Fort Gibson; 4 steamers ran aground at Webbers Falls.
1859	Little Rock	317 steamboats docked at Little Rock in 8 month period
1862	Fort Hindman	Confederate Troops construct this earthen fortification on the Arkansas River.
1863	Fort Hindman	Union Troops destroy this fortification and the adjoining upriver port to ensure control of the river.
1870	Fort Gibson, Fort Smith, Little Rock	Twenty steamboats, averaging 300 tons of cargo, shipped goods between these cities and New Orleans, Memphis, St. Louis and Cincinnati
1870 to 1910		Steamboat traffic declines and virtually ends on the Arkansas River
Source: MKARNS 2000.		

In the early 1900s, the discovery of oil in the Indian Territory resulted in renewed interest in using the river for transporting oil. The Arkansas Navigation Company was started in 1905 to establish a commercial run between Fort Smith and Muskogee.

Additionally, the early 1900s held the hardship of many severe floods in the Arkansas River valley that hit rail transportation, levees and public works projects very hard. In 1923, the city of Tulsa led a seven-state commission to investigate flood control options for the Arkansas and Red Rivers. 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 a landmark flood control act in 1936. This established a Southwestern Division of the USACE and authorized 211 flood control projects in 31 states. This division began work on the Arkansas River the next year.

The Little Rock Office of the USACE, established in 1881, formed the Tulsa District in 1939, and received funding ($11 million) through the Tulsa District for work on eight flood control projects. During World War II, in 1941-1942, the Tulsa and Denison Districts were funded for $900 million in military construction and equipment procurements.

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 conceptualized by Hans Albert Einstein to reduce sedimentary flow (100 million tons of silt flowing 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 in January 21, 1971. The cargo was 650 tons of newsprint from the Bowater Paper Company. The MKARNS was officially dedicated by then President Richard M. Nixon on June 5, 1971.

The MKARNS was utilized for the first large inland mobilization of military equipment since World War II when the Arkansas Army National Guard traveled to Camp Grayling, Michigan for training.

Forty-two foreign countries have conducted commerce in the Arkansas River basin through the MKARNS. The first international ocean-going vessel to utilize the MKARNS was a West German cargo ship, the MV Frauke, which traveled to the Port of Catoosa in 1986.

4.10.3 Cultural Resources within the Project Area

Use of the Arkansas River system as a major means of travel, commerce, and for military purposes predates European contact. 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, so the known sites are only a sample of the total population of resources likely present in the system. The known cultural resources affected by the proposed actions and alternatives are discussed below for each project area. These resources include all archaeological sites and architectural resources, including those listed on and eligible for the NRHP or listed in State inventories.

4.10.3.1 MKARNS Navigation Channel Pools

The seventeen navigation pools in the MKARNS system are grouped into 6 segments for this project (Table 4-30). Previous archaeological research has focused on the resources associated with each pool, so for consistency, the resources will be generally discussed by pool, although the impacts will be presented by project segment.

Mouth of the White River

The MKARNS system's Mississippi River outlet is the mouth of the White River, which is linked to the Arkansas River by the Arkansas Post Canal. From river mile (RM) 0, this segment of the MKARNS runs upstream on the White River to just beyond the junction of the White and Arkansas Rivers, ending at Lock & Dam No. 1, RM 10.2, below the downstream end of the Arkansas Post Canal.

One archaeological site has been identified in the White River segment (3DE9), however it was not relocated and so has not been evaluated for NRHP eligibility (Table 4-31). There are also no NRHP-listed architectural resources within the APE in the White River segment of MKARNS (Table 4-32).

Little of this area has been previously surveyed prior to construction of the MKARNS system. Construction of a new lock and dam complex at Montgomery Point, RM 0.5, was recently completed (2005). Survey for cultural resources prior to the construction of the new lock and dam covering the river channel and banks from RM 0-2 occurred in 1989 (Bennett et al. 1989b); only one site was identified in this segment, primarily because most of the sediments are extremely young. Since much of the area has not been surveyed, it is likely that additional archaeological sites will be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Table 4-30. Correlation of Project Segment to MKARNS Pools.

MKARNS Project Segment	Navigation Mile	Pools Included
Segment 1 Mouth to Pine Bluff	0.0 to 75.2	Mouth of the White River; Pool 1, Norrell Lock & Dam No. 1; Pool 2, Wilbur Mills Lock & Dam; Pool 3, Joe Hardin Lock & Dam No. 3; portions of Pool 4, Emmett Sanders Lock & Dam, Lake Langhoffer
Segment 2 Pine Bluff to Little Rock	75.2 to 119.5	Portions of Pool 4, Emmett Sanders Lock & Dam, Lake Langhoffer; Pool 5, Lock & Dam No. 5; portions of Pool 6, David D. Terry Lock & Dam No. 6, David D. Terry Lake
Segment 3 Little Rock to Dardanelle	119.5 to 220.3	Portions of Pool 6, David D. Terry Lock & Dam No. 6, David D. Terry Lake; Pool 7, Murray Lock & Dam, Murray Lake; Pool 8,

Table 4-30. Correlation of Project Segment to MKARNS Pools.		
MKARNS Project Segment	**Navigation Mile**	**Pools Included**
		Toad Suck Ferry Lock & Dam, Toad Suck Ferry Lake; Pool 9, Arthur V. Ormond Lock & Dam, Winthrop Rockefeller Lake; portions of Pool 10, Dardanelle Lock & Dam, Lake Dardanelle
Segment 4 Dardanelle to Fort Smith	220.3 to 308.7	Portions of Pool 10, Dardanelle Lock & Dam, Lake Dardanelle; Pool 12, Ozark-Jeta Lock & Dam, Ozark Lake; portions of Pool 13, James W. Trimble Lock & Dam, John Paul Hammerschmidt Lake
Segment 5 Fort Smith to Muskogee	308.7 to 394.0	Portions of Pool 13, James W. Trimble Lock & Dam, John Paul Hammerschmidt Lake; Pool 14, W.D. Mayo Lake; Pool 15, Robert S. Kerr Lake; portions of Pool 16, Webbers Falls Lake
Segment 6 Muskogee to Catoosa	394.0 to 445.2	Portions of Pool 16, Webbers Falls Lake; Pool 17, Chouteau Lock & Dam No. 17; Pool 18, Newt Graham Lake

Table 4-31. Known Archaeological Resources and NRHP Status for Pools.						
Pool	**Sites Listed on the National Register**	**Determined to be Eligible for Listing**	**Sites Potentially or Recommend ed Eligible**	**Sites not Eligible**	**Sites not Evaluated**	**Total Sites in APE**
White River	0	0	0	0	1	1
Pool 1 –Arkansas Post Canal	0	0	0	0	0	0
Pool 2 - Wilbur Mills	1	0	0	1	1	3
Pool 3 - Hardin	0	0	0	0	0	0
Pool 4 - Lake Langhoffer	0	0	0	0	0	0
Pool 5 -	0	0	1	0	0	1
Pool 6 - David D. Terry Lake	0	0	1	2	0	3
Pool 7 - Murray Lake	0	0	1	4	31	36
Pool 8 - Toad Suck Ferry Lake	1	4	0	2	19	26
Pool 9 - Winthrop Rockefeller Lake	0	0	0	3	13	16
Pool 10 - Lake Dardanelle	0	0	16	59	119	194
Pool 12 - Ozark Lake	0	1	4	39	71	115
Pool 13 - John Paul Hammerschmidt Lake	0 0**	0 0**	0 0**	0 0**	100* 4**	100* 4**
Pool 14 - W. D. Mayo Lake	0	0	0	0	4	4

Table 4-31. Known Archaeological Resources and NRHP Status for Pools.						
Pool	**Sites Listed on the National Register**	**Determined to be Eligible for Listing**	**Sites Potentially or Recommended Eligible**	**Sites not Eligible**	**Sites not Evaluated**	**Total Sites in APE**
Pool 15 - Robert S. Kerr Lake	0	1	7	3	34	45
Pool 16 - Webbers Falls Lake (Segment 5 only)	1 (0)	10 (8)	0 (0)	3 (1)	26 (19)	40 (28)
Pool 17 – Chouteau Lake	0	0	0	0	2	2
Pool 18 - Newt Graham Lake	0	0	0	0	2	2
*Total sites in area of Pool **Sites in Oklahoma segment						

Table 4-32. Known Architectural Resources and NRHP Status for Pools.						
Pool	**Sites Listed on the NRHP (or nominated)**	**Determined to be Eligible for Listing**	**Sites Potentially or Recommended Eligible**	**Sites not Eligible**	**Sites not Evaluated**	**Total Sites in APE**
White River	0	0	0	0	0	0
Pool 1 –Arkansas Post Canal	0	0	0	0	0	0
Pool 2 - Wilbur Mills	4	0	0	0	3	7
Pool 3 - Hardin	0	0	0	0	0	0
Pool 4 - Lake Langhoffer	0	0	1	0	0	1
Pool 5 -	1	0	0	0	0	1
Pool 6 - David D. Terry Lake	2	0	0	1	0	3
Pool 7 - Murray Lake	0	0	0	0	0	0
Pool 8 - Toad Suck Ferry Lake	0	0	0	0	0	0
Pool 9 - Winthrop Rockefeller Lake	0	0	0	0	0	0
Pool 10 - Lake Dardanelle	0	0	0	0	0	0
Pool 12 - Ozark Lake	0	0	0	0	0	0
Pool 13 - John Paul Hammerschmidt Lake (Segment 5 only)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Table 4-32. Known Architectural Resources and NRHP Status for Pools.						
Pool	**Sites Listed on the NRHP (or nominated)**	**Determined to be Eligible for Listing**	**Sites Potentially or Recommend ed Eligible**	**Sites not Eligible**	**Sites not Evaluated**	**Total Sites in APE**
Pool 14 - W. D. Mayo Lake	0	0	0	0	0	0
Pool 15 - Robert S. Kerr Lake	1	0	2	0	0	3
Pool 16 - Webbers Falls Lake (all segment 6)	1	0	1	0	0	2
Pool 17 – Chouteau Lake	0	0	0	0	0	0
Pool 18 - Newt Graham Lake	0	0	0	0	0	0

Pool 1: Norrell Lock & Dam No. 1

No archaeological sites were identified below the top of the flood pool at Pool 1 (Table 4-30). This is probably due to the fact that Pool 1 is a short, artificial canal, excavated into the relatively recent river-deposited sediments of the Arkansas/White River floodplains and drainage divide. There are also no NRHP-listed architectural resources within the APE at Pool 1.

Previous archaeological investigations at the pool include emergency survey near the canal in 1965 (Davis and Baker 1975) initiated after the start of construction. The surveyed area began at Lock & Dam # 1, RM 10 and went to about RM 22.4, Pendleton Ferry, but no sites within the APE of Pool 1 were identified. Scholtz and Hoffman (1968) may have surveyed some portions of Pool 1 prior to construction of the MKARNS system, but no sites were identified in the area. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 2: Wilbur Mills Lock & Dam

Three archaeological sites have been identified below the APE in Pool 2 (Table 4-30). One site has been listed on the NRHP, the Arkansas Post National Memorial, 3AR47. Most of this historic town and trading post site are located above the APE, but portions extend into the 100-year floodplain. One site (3DE181), a historic Native American (possibly Quapaw) and Euro-American occupation, has not been evaluated for NRHP eligibility. One site that was destroyed by construction of the Arkansas Post Canal, 3AR33, is not eligible for inclusion on the NRHP.

Four architectural resources are located in Pool 2 and listed on the NRHP as part of the Arkansas Post National Memorial, however, with the exception of the memorial itself, the other 3 resources are above the APE. Three additional architectural resources on the Arkansas historic structure inventory are within the APE of Pool 2, but have not yet been evaluated for NRHP eligibility. These properties include the Colonel John Moore Mansion south of Gillet, also known as the Colonial Mansion, the Moore Place, or Mound Grove (AR21), a 19th century plantation site; the Old Taylor home site, northeast of Gould (LI39), also known as Lowden Plantation or South Bend Plantation, also a 19th century plantation site; and the Campshed Church, south of Tichnor, a frame church built in 1925 at a location that has been home to religious structures since the early 1800s. The original structures on both plantation sites have been destroyed.

Previous archaeological investigations at the pool include emergency survey of the Arkansas Post Canal in 1965 (Davis and Baker 1975) initiated after the start of construction. One site within the APE of Pool 2 had almost been destroyed by canal construction (3AR33) when it was identified. No features or undisturbed contexts were observed, and only a surface collection, primarily of ceramics, was made, indicating a middle-to-late Baytown occupation. Scholtz and Hoffman (1968) surveyed some portions of Pool 2 prior to construction of the MKARNS system. More recently, Bennett et al. (1989a) surveyed portions of Pool 2, examining the geomorphology with regard to identifying landforms that have some probability for containing archaeological sites; however no sites were identified within the APE of Pool 2. One landform, Coopers Island at RM 50, was identified as having low likelihood buried cultural deposits (Bennett et al. 1989a: 53), the most promising area identified in Pool 2. Numerous archaeological surveys and projects have occurred at the Arkansas Post National Memorial beginning in the 1950s. Bennett et al. (1989a) surveyed the margins of the site up to the 175 foot contour interval, and did not identify any sites there, either those already recorded or new ones. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 3: Joe Hardin Lock & Dam No.3

No archaeological sites or architectural resources were identified within the APE at Pool 3 (Table 4-30).

Previous archaeological investigations in Pool 3 include a survey of some portions by Scholtz and Hoffman (1968) prior to construction of the MKARNS system. More recently, Bennett et al. (1989a) surveyed portions of Pool 3, examining the geomorphology with regard to identifying landforms that have some probability for containing archaeological sites. However, no cultural resources were identified within the APE. Three landforms in Pool 3 were identified as having low likelihood of buried cultural deposits, Johnson Lake at RM 64, RM 60, and RM 55 (Bennett et al. 1989a: 53). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 4: Emmett Sanders Lock & Dam, Lake Langhoffer

No archaeological sites were identified within the APE at Pool 4 (Table 4-30). One architectural resource is located within the APE in Pool 4, Fort Pleasant, or Fort Weightman (JE0523) (Table

4-31). This location was a Civil War fort built with slave labor in 1863. Portions have already eroded into the river. This resource is considered potentially eligible for inclusion on the NRHP.

Previous archaeological investigations in Pool 4 include a survey of some portions by Scholtz and Hoffman (1968) prior to construction of the MKARNS system, however, no cultural resources were identified within the APE of Pool 4. More recently, Bennett et al. (1989a) surveyed portions of Pool 4, examining the geomorphology with regard to identifying landforms that have some probability for containing archaeological sites. However no cultural resources were identified within the APE. One landform, RM 82-85, was identified as having low likelihood for buried cultural deposits (Bennett et al. 1989a: 53); this was the most promising area identified in Pool 4. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 5: Lock & Dam 5

One archaeological site has been identified within the APE at Pool 5 (Table 4-30). This site, Greer Mound 3JE50, is a multicomponent site spanning the prehistoric, contact, and historical eras. Intact cultural deposits were present, so it is potentially eligible for listing on the NRHP. The mound had been eroding into the river, and portions were salvaged and mitigated (Rolingson 1987). There is one NRHP-listed architectural resource within the APE in Pool 5, the Plum Bayou Homesteads Historic District, also called Wright Plantation. This district, listed in 1975, was part of a planned agricultural community built in 1935-1936. Encompassing the town of Wright, it covers 5307 acres, has 50 buildings, and had approximately 200 40-acre tract farms for tenant farmers/ sharecroppers. Only portions of this district are within the APE.

Previous archaeological investigations in the area include a survey by Scholtz and Hoffman (1968) of some portions of Pool 2 prior to construction of the MKARNS system, and Bennett et al.'s geomorphological study (1989a) that included a pedestrian survey. Neither survey identified archaeological sites within the APE of Pool 5. Three landforms in Pool 3 were identified as having some likelihood of buried cultural deposits (Bennett et al. 1989a: 53). Georgetown Lake at RM 102-106 has high potential for buried sites, and Hensley Island at RM 86-88 and Cross Pond at RM 97 both have moderate potential for buried sites. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 6: David D. Terry Lake, David D. Terry Lock & Dam No. 6

Three archaeological sites were identified within the APE at Pool 6 (Table 4-30). One site has not been assessed for NRHP eligibility, the SFA Barge Wreck (3PU257) dating to 1840-1900. This site was damaged by a construction project, and may not retain enough integrity for inclusion to the NRHP. The remaining 2 sites are historical (3PU186, 3PU291) and both have been tested and found not eligible for inclusion to the NRHP because of lack of research potential.

Two NRHP-listed architectural resources occur within the APE in Pool 6, the Lincoln Avenue Viaduct/Cantrell Road Bridge in Little Rock (PU2025), and the Arkansas II Riverboat, located at the south end of Locust Avenue in Pool 6, in North Little Rock (PU3304) (Table 4-31). The viaduct is a single-span reinforced-concrete rainbow arch bridge built in 1928. The Arkansas II is a USACE snag boat built in 1940, which was used to keep the river channel free of snags and fallen trees that could impede navigation and damage ships. Both resources were listed on the NRHP in 1990. The remaining architectural resource, the Hohenschutz House (PU987) in Little Rock, was built ca. 1870. It has been recommend not eligible for inclusion to the NRHP, since it had been moved to its present location in the 1940s and lacks integrity of location and setting.

Previous archaeological investigations in the area include Scholtz and Hoffman's survey of the David D. Terry Lock & Dam site and some public use areas (1968), and Bennett et al.'s geomorphological study of MKARNS pools 1-9 (1989a). No sites in the project area were located during either project. Three landforms in Pool 6 were identified as having some likelihood of buried cultural deposits (Bennett et al. 1989a: 52-53). The mouth of the Fourche Creek floodplain has high potential for buried sites, the mouth of White Oak Creek has moderate potential, and RM 123 has low potential for buried sites. Lafferty and Otinger (1980) and later Zahn and Stewart-Abernathy (1988) surveyed portions of Adams Field Municipal Airport, and tested 3PU186, located in the MKARNS project area. Stewart-Abernathy also recorded a submerged cypress barge or wharf boat (3PU257) that was discovered during river dredging, but no report on this investigation was filed. Bennett et al. (1985) surveyed the Fourche Creek drainage upstream from the Arkansas River main channel and reported a historic artifact scatter (3PU291). Additional surveys passed through Pool 6, however none of these projects recorded sites that are within the APE. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 7: Murray Lake, Murray Lock & Dam

Thirty-six archaeological sites have been identified on USACE lands at Pool 7 (Table 4-30). These include isolated finds, deflated surface scatters of lithic debris, and some intact deposits. Eleven of the sites are prehistoric, dating to the Archaic, Dalton/Archaic, Woodland, Mississippian/Caddo, and Mississippian eras, and three are historic occupations. None of these sites are currently listed on the NRHP. One site has been recommended as potentially eligible for inclusion on the NRHP, and four are not eligible for inclusion. The remaining 31 sites have not been evaluated for NRHP eligibility. No architectural resources listed on the NRHP occur in Pool 7.

Only a small portion of Pool 7 has been surveyed for archaeological resources. Bennett et al.'s geomorphological study (1989a) included a pedestrian survey. Seven landforms in Pool 7 were identified as having some likelihood of buried cultural deposits (Bennett, et al 1989a: 52-53). Four locations have high potential for buried sites, including the Palarm Creek floodplain, the Maumelle River floodplain, the Little Maumelle River floodplain, and the Fourche La Fave Creek floodplain. Three locations have moderate potential for buried sites, including the mouth of the Maumelle River RM 130, south of Easterwood Mountain RM 147, and northeast of Beaverdam Island. RM 126 and RM 132 have low potential for buried sites. It is likely, given the limited survey work to date, that additional cultural resources may occur in unsurveyed areas. Some of the cultural resources may be NRHP-eligible. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 8: Toad Suck Ferry Lake, Toad Suck Ferry Lock & Dam

A total of 26 archaeological sites have been identified on USACE lands at Pool 8 (Table 4-30). The archeological record at these sites is composed primarily of isolated finds, deflated surface scatters of lithic debris as well as some intact deposits. It is estimated that seven of the sites represent the Archaic, Woodland and Mississippian eras. One is listed on the NRHP, the Cadron Settlement or Cedar Creek site (listed 5/17/1974), a French Trading post in the late 1700s which was later settled by Cherokee who immigrated to the area in the early 18th century until they were removed to Indian Territory. The site also has prehistoric components present. Four sites received formal Determinations of Eligibility on 1/7/1987, 3CN64, 3CN117, 3CN57, and 3CN92; their current condition is unknown. Two sites are not eligible for listing on the NRHP, and the remaining 19 sites have not been evaluated for NRHP eligibility.

No architectural resources are located in Pool 8 that are listed on the NRHP. However, both landings of the Toad Suck Ferry river crossing have been recorded on the Arkansas Historic Preservation Commission inventory, but their NRHP eligibility status is unknown.

A brief archeological survey at Pool 8 was conducted in 1968 by Scholtz and Hoffman. Bennett et al.'s geomorphological study of MKARNS (1989a) included a pedestrian survey in Pool 8. They identified two landforms in Pool 8 as having some likelihood of buried cultural deposits, including the Cadron Creek floodplain, which has high potential for buried sites, and the area southwest of Morrilton and north of Willow Bend, which has moderate potential for buried sites (Bennett et al. 1989a: 52). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 9: Winthrop Rockefeller Lake, Arthur V. Ormond Lock & Dam

A total of 16 archaeological sites have been identified on USACE lands at Pool 9 (Table 4-30). The archeological record at the 13 prehistoric sites is composed primarily of isolated finds, deflated surface scatters of lithic debris, as well as some intact deposits from the Archaic and Mississippian eras, and has not been evaluated for NRHP eligibility. Three of the sites are historic, and have been deemed not eligible for listing on the NRHP. There are no architectural resources in Pool 9 that are listed on the NRHP.

No comprehensive archaeological survey has been conducted on Pool 9 lands. Bennett et al.'s geomorphological study of MKARNS (1989a) included a pedestrian survey in Pool 9, and they identified one landform as having low/moderate potential of buried cultural deposits, the area north of Crane Island, at RM 189 (Bennett et al. 1989a: 52). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 10: Lake Dardanelle, Dardanelle Lock & Dam

Archaeological surveys have been conducted at the Lake Dardanelle reservoir bottom, at all non-inundated fee land, and at all of the public use areas. To date, 194 sites have been recorded on USACE lands at Pool 10 (Table 4-30). Of the sites, 78 were prehistoric, dating to the Archaic, Woodland, Mississippian and Caddoan periods. The archeological record at these sites is composed primarily of isolated finds, deflated surface scatters of lithic debris, as well as some intact deposits. Fourteen of the prehistoric sites are considered potentially eligible for listing on the NRHP. In addition, 26 archaeological sites that are historic were identified, and 2 are considered potentially eligible for listing on the NRHP. A total of 59 sites have been found to be not eligible for inclusion on the NRHP, and the remaining 119 sites have not been evaluated for NRHP eligibility.

No architectural resources occur within the APE of Pool 10 that are listed on the NRHP.

While large portions of Pool 10 have been surveyed, additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 12: Ozark Lake, Ozark-Jeta Taylor Lock & Dam

Archeological studies have been conducted on the Pool 12 reservoir bottom, fee land, and public use areas, resulting in the identification of 115 sites on USACE lands (Table 4-30). The easement land has not been surveyed. The archeological record at 103 prehistoric sites is composed primarily of isolated finds, deflated surface scatters of lithic debris, and locations at which intact deposits are documented or suspected, and are from the Archaic, Woodland, and Mississippian periods. Twelve historic period sites were also identified. None of the archaeological sites are listed on the NRHP. Five sites are considered potentially or recommended eligible for inclusion on the NRHP, and 39 sites have been determined to be not eligible for inclusion. The remaining 71 sites have not been evaluated for NRHP eligibility status. While large portions of Pool 12 have been surveyed, additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible. None of the surveys were undertaken with the goal of identifying historical sites, therefore the historical sites are underrepresented.

No architectural resources are located in Pool 12 that are listed on the NRHP.

Pool 13: John Paul Hammerschmidt Lake, James W. Trimble Lock & Dam

One hundred archaeological sites have been identified at Pool 13. Some may be located on private lands (Table 4-30). Four of these sites are in Oklahoma, and are within the APE; at least one is from the Mississippian/ Village Farming period, possibly with a mound (34SQ26). The identified sites are primarily prehistoric, and include isolated finds, deflated surface scatters of lithic debris, as well as locations at which intact deposits are documented. Archaic and Woodland sites are probably also present. None of these sites have been evaluated for eligibility for inclusion to the NRHP. No architectural resources occur in Pool 13 within the APE that are listed on the NRHP.

To date, little archeological work has been conducted at pool 13 other than a cursory dam construction survey. A small portion of the Oklahoma segment of the pool was included in Miller's 1977 survey of public use and multipurpose areas, but only one site was identified in this pool, but is outside the APE, and was destroyed by construction activity (Miller 1977). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 14: W. D. Mayo Lake

Four archaeological sites are located on lands near Pool 14 (Table 4-30). These sites have been evaluated for eligibility for inclusion to the NRHP, but two are not eligible for listing because they were destroyed during construction (Miller 1977). These sites included prehistoric and historic components. Spiro (34LF46), one of the most important and well-known Mississippian/Caddoan mound centers in North America, is located near the project area on USACE lands, but outside the APE. This project will not impact the site, but undiscovered sites from the Spiro time-period are likely within the APE and surrounding areas. No architectural resources that are located in Pool 14 are listed on the NRHP.

Miller's 1977 survey focused on public use and multipurpose areas, but only two sites were identified, and they were destroyed by construction activity. Areas adjacent to the pool have been surveyed because of the proximity of the Spiro site. Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 15: Robert S. Kerr Lake

Forty-five archaeological sites have been identified within the APE at Pool 15 (Table 4-30). None are listed on the NRHP, but the Hickory Ridge site (34HS075) has received a formal Determination of Eligibility for inclusion on the NRHP. This site dates to the Village Farming period and has intact house floors and middens present; areas were intensively excavated to mitigate the damage caused by wave erosion (Indeck et al. 1999). Seven sites within the APE are recommended eligible for listing on the NRHP by the Oklahoma State Historic Preservation Officer (SHPO), but nominations have not yet been submitted for review. Three sites were determined not eligible, due to lack of integrity or because they retained no potential for preserved archaeological deposits. The remaining 34 sites have not been evaluated for NRHP eligibility.

One architectural resource within the APE of Pool 15 is listed on the NRHP, the Tamaha Jail and Ferry Landing. The jail is standing, but the town is an unrecorded archaeological site; the 100-year flood line cuts through a portion of the site. Two additional architectural resources are located within the APE of Pool 15, and are listed on State architectural structure inventory, but have not yet been evaluated for NRHP eligibility. These are the J.R. Williams, a steamboat submerged during the Civil War, and the J.H. Wilson Coal Co. District, sites #1 and #2, part of an industrial site/ strip mine. The coal mine would likely only be eligible as part of a district NRHP nomination (Jim Grabbert, personal communication, 2004).

Surveys of Pool 15 focused on the banks and lake margins after the lake was impounded (Miller 1977). Some sites in Pool 15 that had been previously reported were excavated prior to inundation under the auspices of the Oklahoma River Basin Survey (ORBS) Program at the University of Oklahoma (Bell et al. 1969; Burton 1971; Burton and Stahl 1969; Burton and Neal 1970; Cartledge 1970; Eighmy 1969; Prewitt and Wood 1969), but the lake bottom was not systematically surveyed prior to inundation. Additional assessments of sites in the pool were investigated and evaluated in the 1980s by Keller (1985) and Swanda and Brockington (1983). Mitigation of sites occurs when warranted by destruction and erosion caused by the pool (Indeck et al. 1999). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 16: Webbers Falls Lake

Forty archaeological sites have been identified on USACE lands at Pool 16 that are below the flood pool elevation (Table 4-31). The sites vary in degrees of disturbance and eligibility status, and include components from the Archaic, Woodland, and Village Farming/ Mississippian, and historic periods One archaeological site is listed on the NRHP, Fort Davis, in Muskogee, 34MS029, a Confederate fort built in 1861 and burned by Union troops in 1862. However, there is disagreement between the documents at the Oklahoma SHPO and the Oklahoma Archeological Survey (OAS) about the location of the actual site. One site at Pool 16, the Cody Creek site (34MS031), a late Caddoan/ Mississippian village, is NRHP listed (Brockington 1984). Ten sites are recommended eligible for listing on the NRHP by the Oklahoma SHPO, but nominations have not yet been submitted for review. Three sites were determined not eligible for listing on the NRHP, because they were destroyed by construction activities. The remaining 26 sites have not been evaluated for NRHP eligibility.

One architectural resource within the APE of Pool 16 is listed on the NRHP, the site of the Koweta Mission, listed on 6/19/1973 (Table 4-32). A second resource, the U.S.S. Batfish, a submarine being installed in a riverfront park in Muskogee, is in the process of being nominated to the NRHP, and is considered eligible by the Oklahoma SHPO (Jim Grabbert, personal communication, 2004).

Surveys of Pool 16 in the 1960s focused on areas where feature were going to be constructed under the auspices of the ORBS at the University of Oklahoma (Barr 1965; Schneider 1967; and Wyckoff 1967), or on the banks and lake margins after the lake was impounded (Miller 1977). Some sites in Pool 16 that had been previously reported were excavated prior to inundation, also by the ORBS (Baugh 1970; Wyckoff and Barr 1967a, 1967b, 1968). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 17: Chouteau Lock & Dam No. 17

Two archaeological sites were identified within the APE in Pool 17 (Table 4-30). One is an undefined prehistoric site, and the other has both Late Archaic and historic occupations. Neither has been evaluated for eligibility to the NRHP. There are no architectural resources in Pool 17 within the APE that are listed on the NRHP.

Minimal survey of Pool 17 has taken place; the survey that was conducted was mainly focused on the banks and lake margins after the lake was impounded (Miller 1977). One site in Pool 17 that had been previously reported was excavated prior to inundation, by the ORBS (Baugh 1970). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

Pool 18: Newt Graham Lake

A search of the Tulsa District USACE archeological database indicates that there are two sites located below the top of the flood control pool for the reservoir (Table 4-30). Neither prehistoric site has been evaluated for eligibility for listing on the NRHP. There are no architectural resources in Pool 18 within the APE that are listed on the NRHP.

Minimal survey of Pool 18 has taken place; the survey that was completed was mainly focused on the banks and lake margins after the lake was impounded (Miller 1977). Additional archaeological sites are likely to be encountered in portions of the APE that have not been surveyed for cultural resources. Some of these resources may be considered NRHP-eligible.

4.10.3.2 Submerged Cultural Resources Along MKARNS

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 (Branam 2003; Wright 1930). 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. Consequently, the potential exists for the proposed actions to impact undiscovered shipwrecks in the MKARNS, both on dry land, and on land now submerged by the pools. Information on the shipwrecks was collected to facilitate future identification of these resources.

Branam (2003) provided a list of known wrecks in the Arkansas and nearby rivers. Culled from newspaper accounts and steamboat references, many of the locations are general and vague. In addition, some of the place names are no longer used. In order to locate the wrecks within the MKARNS project segments, it was necessary to run the unknown location names through GNIS. The AAS prepared an index of the locations shown on the 1870 USACE map of the Arkansas

River system. Of the 158 known wrecks in Branam's database, 89 had enough information to be assigned to 1 or 2 project segments (wrecks could be in 2 segments because the locations fell at a segment boundary, e.g. Little Rock, and Ft. Smith). One additional wreck was been identified by the Oklahoma SHPO in the project area (but has not yet been ground-truthed or reported as a site), bringing the known shipwreck total to 90 (Table 4-33). An additional 6 wrecks from Branam have location information found in the 1870 USACE map index, but the data are insufficient for generating project segments or RM locations at this time.

A survey for submerged cultural resources in the White River basin by Panamerican Consultants did not extend to the White River mouth, which is part of MKARNS (Buchner and Krivor 2001). Shipwrecks are more common in the lower reaches of the river, probably because there was more shipping activity there. Shipping in the upper portions of the river gradually extended from Ft. Smith in 1822, to Three Forks, near present day Ft. Gibson in 1827. It was not until 1878 that the first steamboat ascended the river as far as Arkansas City, Kansas (Wright 1930:71). Also, river flow was unpredictable, so in dry seasons, boats were often stranded and could not move upstream.

Ninety shipwrecks have known, general locations in MKARNS, but their actual remains have not been discovered (Table 4-33).

Table 4-33. Locations of 90 Known Shipwrecks in the Arkansas River Area (after Branam 2003).

Project Segment	Number of Wrecks
1*	25
2*	34
3*	32
4*	22
5*	6
6	1
Location Unknown	41**
Outside MKARNS	28

* Wrecks at locations that could be in adjoining pools were counted in both, e.g., 11 wrecks at Pine Bluff, the boundary between project segments 1 and 2, could be in either segment, and were included in both totals.
** Six of these have now been identified in the index to the 1870 COE Arkansas River system map at the AAS, Fayetteville, but RM and project segments have not yet been determined.

4.10.3.3 Upstream Reservoirs

Eleven reservoirs located in Oklahoma are used to maintain flow levels within the MKARNS system. Cultural resources associated with each of the reservoirs are summarized in the following paragraphs.

Keystone Lake

The USACE Tulsa District archeological database for the reservoir indicates that there are 362 sites located within the top of the flood control pool and below (Table 4-34). There is one NRHP-listed archaeological site located within the flood control pool, Camp Arbuckle or the Fort Arbuckle Site (1978-12-22). Fort Arbuckle was established near the junction of the two rivers in 1834 to assist the "Leavenworth Expedition", which was tasked with stopping the war that had broken out between the Osage and numerous Plains Indian tribes. The site is now underwater, and its current condition is unknown, but it is expected that portions at least, remain intact and are buried beneath lake-bottom sediments. The 361 remaining archaeological sites have not been evaluated for NRHP eligibility.

Impoundment of Keystone Lake inundated several towns including the original community of Keystone, as well as Mannford, Prue, Appalachia, and a portion of the city of Osage (Morris 1977). These locations may be considered unexamined archaeological sites of unknown integrity and extent, whose NRHP eligibility has not been evaluated, although they have not been reported to the OAS (they are not included in the known archaeological sites totals). Portions of the reservoir were surveyed for archaeological sites prior to inundation (Brighton 1952) and again in 1980 (Moore 1980). There are no NRHP listed architectural resources within the APE at Keystone Lake (Table 4-35).

Oologah Lake

The Tulsa District USACE archaeological database indicates that there are 186 sites located within the top of the flood control pool and below at Oologah Lake (Table 4-34). None of the archeological sites have been declared eligible for, or listed on, the NRHP. Identified were 73 sites with evidence of prehistoric occupation ranging from Early Archaic to Protohistoric and included campsites and lithic procurement sites. Also identified were 105 historic-period sites that included 19th and 20th century farmhouse sites and early oil industry sites. None of the archaeological sites in the lake are listed on, or were declared eligible for the NRHP, however, 6 sites are potentially or recommended eligible. The 99 remaining archaeological sites have not had their NRHP eligibility status evaluated. No architectural resources listed on the NRHP are within the APE at the lake.

Impoundment of the lake inundated several towns including Nowata, and the smaller communities of Alluwe and Coody's Bluff, and these should be considered archaeological sites that have not been reported, and have undetermined NRHP eligibility status. The birthplace of Will Rogers was also inundated, but his birth house and other structures were relocated to a bluff overlooking the lake, and are now part of a State historic site that is listed on the NRHP.

Large portions of Lake Oologah were surveyed prior to and after impoundment in the late 1960s (Prewitt 1968; Baldwin 1969) and in 1979 and 1980 (Espy et al. 1980). A reevaluation of the cultural resources at the lake was done in 1987 (S. Vehik 1987).

Grand Lake O' the Cherokees (Pensacola Dam)

A total of 78 archaeological sites have been recorded below the top of the flood control pool at Grand Lake O' the Cherokees (Table 4-34). Most of the sites were prehistoric, but several are historic sites, and one has both prehistoric and historic components. The prehistoric sites ranged in date from the Early Archaic through the Mississippian Periods, and include a concentration of unusual Woodland Hopewell sites. A number of prehistoric village sites and bluff shelters have been recorded, some containing burials. None of the archaeological sites are listed on, or recommended eligible for the NRHP. One site whose borders extend into the lake, the Seneca Indian School (34OT095), received formal Determination of Eligibility on 3/13/2003. One site was declared not eligible for the NRHP (34DL157), and the 76 remaining sites have not had their NRHP eligibility status evaluated.

Table 4-34. Known Archaeological Sites and NRHP Status for Reservoirs.							
Reservoir	**Max. Elevation - top of Flood pool**	**Sites Listed on the NRHP**	**Determined to be Eligible for Listing (or nominated)**	**Sites Potentially or Recommended Eligible**	**Sites not Eligible**	**Sites not Evaluated**	**Total Sites in APE**
Keystone Lake	754	1	0	0	0	361	362
Oologah Lake	661	0	0	6	0	180	186
Grand Lake O' the Cherokees (Pensacola Dam)	755	0	1	0	1	76	78
Lake Hudson (Markham Dam)	636	0	0	0	1	46	47
Fort Gibson	582	0	1	23	0	159	183
Tenkiller Ferry Lake	667	0	0	2	0	94	96
Eufaula Lake	596	1	0	7	0	238	246
Kaw Lake	1,044.5	1	2	0	11	204	218
Hulah Lake	765	0	0	0	0	23	23
Copan Lake	732	0	1	18	0	20	39
Wister Lake	502.5	18*	0	3	0	111	132

*18 archaeological sites make up the Lake Wister Archaeological Locality NRHP District.

Note: Data gathering procedures for Kaw, Grand, Hudson, and Hulah differed from that used on the rest of the lakes.

Table 4-35. Known Architectural Resources and NRHP Status at Reservoirs.

Reservoir	Maximum Elevation- top of Flood pool	Sites Listed on the NRHP	Determined to be Eligible for Listing (or nominated)	Sites Potentially or Recommended Eligible	Sites not Eligible	Sites not Evaluated	Total Sites in APE
Keystone Lake	754	0	0	0	0	0	0
Oologah Lake	661	0	0	0	0	0	0
Grand Lake O' the Cherokees (Pensacola Dam)	755	0	1	1	0	0	2
Lake Hudson (Markham Dam)	636	1	1	0	0	0	2
Fort Gibson	582	0	0	0	0	0	0
Tenkiller Ferry Lake	667	0	0	0	0	0	0
Eufaula Lake	596	0	0	0	0	0	0
Kaw Lake	1,044.5	0	0	0	0	0	0
Hulah Lake	765	0	0	0	0	0	0
Copan Lake	732	0	0	0	0	0	0
Wister Lake	502.5	0	0	0	0	0	0

Pensacola Dam, the first hydroelectric dam in Oklahoma, was listed on the NRHP in 2003. The Pensacola Dam is the only NRHP-listed architectural resource on Grand Lake. One Oklahoma State historic site inventory listing, the Route 69 Bridge over the Neosho River/Grand Lake, has not yet had its NRHP eligibility status evaluated (Table 4-35).

Two important NRHP-listed sites are just above the flood pool. The Bassett Grove Ceremonial Ground, located near Grove, Oklahoma, is included on the NRHP, listed 1983-07-20. The current property boundaries are above the flood pool, but it is possible that the original limits of this Seneca/Cayuga dance ground extended into the flood pool, but this possibility has not been evaluated. The second NRHP site, the Splitlog Church, is above the flood pool but sits within the boundaries of the archaeological site of Cayuga town (34DL194). The townsite of Cayuga was inundated by the impounding of Lake Hudson, and most of it is now below the flood pool.

The Works Progress Administration (WPA) sponsored excavations at archaeological sites in the Grand Lake basin prior to inundation in conjunction with the University of Oklahoma, 1937-1940 (Bell and Baerreis 1951). Later, the program continued these activities (Purrington 1971; Wyckoff 1964). The Stovall Museum at the University of Oklahoma (now called the Sam Noble Oklahoma Museum of Natural History) also sponsored excavations in the Grand Lake area.

Lake Hudson (Markham Ferry Dam)

Forty-seven sites have been recorded below the top of the flood pool at Lake Hudson, all of which are prehistoric and include unassigned prehistoric, Early, Middle, and Late Archaic, Eastern Woodland, Village Farming, and Mississippian sites (Table 4-34). Many camps and a few villages are present, as well as lithic scatters and at least one mound center, the Sparks Mound Group (34MY088), which has 10 mounds. The Packard Site, 34MY066, was a large stratified site with components from pre-Dalton Early Archaic through Mississippian Period occupations (Holmes 1973; Wyckoff 1985). One site was recommended as ineligible for NRHP listing because it was destroyed by bridge construction (34MY099). The remaining 46 sites have not had their NRHP eligibility status evaluated. No NHRP-listed archaeological sites are present within the flood pool.

One NRHP-listed architectural resource is present in the flood pool, the Lewis Ross/Cherokee Orphan Asylum Springhouse (Table 4-35). Listed 08/18/1983 under Criteria A, B, & C, this structure is not normally under water. It was the springhouse for the Lewis Ross house, and later for the Cherokee orphanage and sits just within the flood pool. A second architectural structure has had a formal Determination of Eligibility on 6/1/93, the Lake Hudson Bridge, which carries Strang Road over the Neosho/Grand River.

The WPA in conjunction with the University of Oklahoma sponsored excavations at archaeological sites in the Hudson Lake basin prior to inundation, 1937-1940 (Bell and Baerreis 1951). Later, the ORBS program continued these activities (Kerr and Wyckoff 1964; Purrington 1971; Wyckoff 1964a). The Stovall Museum at the University of Oklahoma (now called the Sam Noble Oklahoma Museum of Natural History) also sponsored excavations in the Lake Hudson area, including intensive excavations at the Packard Site (Holmes 1973).

Fort Gibson Lake

A search of the Tulsa District USACE archaeological database indicates that there are 183 sites located below the top of the flood control pool of this lake (Table 4-34). None of these sites are listed on the NRHP, but the Norman Site (34WG002) received formal Determination of Eligibility on 8/18/2000. An additional 23 sites have been recommended or declared potentially eligible for NRHP listing. The remaining 159 archaeological sites have not had their NRHP eligibility status evaluated. Approximately 19 archaeological sites have historic components, and the remaining sites are prehistoric in origin, spanning the Archaic, Woodland, Plains Village, and Mississippian periods. There are no NRHP listed architectural resources within the APE at Fort Gibson Lake.

Early archeological investigations at Fort Gibson Lake include a pre-construction survey by Dr. Forrest Clemens and the University of Oklahoma from 1934 to 1936, which included the recording of 30 village sites. They also excavated portion of a prehistoric Mississippian village and mound, the Norman Site (34WG002), which is today partially inundated (Finklestein 1940; Rogers 2000). During reservoir construction, Dr. Robert Bell and the University of Oklahoma excavated another Mississippian mound group, the Harlan Site (Bell 1972). Portions of the basin were subsequently surveyed in the 1970s (Cheek and Cheek 1978; Weakly 1972) and 1980s (Hayes et al. 1985).

Tenkiller Ferry Lake

A search of the Tulsa District USACE archaeological database indicates that there are 96 archaeological sites located below the top of the flood control pool at the lake (Table 4-34). The sites vary in degrees of disturbance and eligibility status, and span the periods from the Archaic through Mississippian/ Plains Village Period. None of the archaeological sites are listed on the NRHP, although 2 sites have been recommended or declared potentially eligible for listing. The 94 archaeological sites have not had their NRHP eligibility status evaluated. There are no NRHP-listed architectural resources within the APE at Tenkiller Ferry Lake.

The first archeological surveys of the Tenkiller Ferry area occurred in the 1930s and 1940s (Howard 1940; Wenner 1948b). The Archaic sites discovered during this time prompted the definition of a local, informal, Archaic tradition, the Tenkiller Archaic (Bell and Dale 1953). A resurvey conducted by the University of Oklahoma in 1973 identified 31 sites, eight of which had been previously recorded (Neal 1974). Of these 31 sites, two appear to have been almost totally destroyed, 21 were subjected to shoreline erosion and 6 were located in the flood control pool. Additional work in the basin occurred in the mid-1980s (Klinger and Cande 1986).

Eufaula Lake

A search of the Tulsa District USACE archaeological database indicates that there are 246 sites below the top of the flood control pool at Eufaula Lake (Table 4-34). The sites vary in degrees of disturbance and eligibility status. Seven sites have been recommended or declared potentially eligible for NRHP listing. The remaining 238 archaeological sites have not had their NRHP eligibility status evaluated. There are no NRHP listed architectural resources within the APE at Eufaula Lake.

The first surveys of the Eufaula Lake area occurred in the 1940s and 1950s prior to impoundment (Wenner 1948a; Johnson 1950). Dozens of sites were identified, and some were mitigated by salvage excavations (Proctor 1953). Some of the area was resurveyed in the 1970s (Perino and Caffey 1980). Currently, cultural resource management surveys penetrate the basin prompted by pending USACE activities on the lake (Largent 1995), and prior to other uses of the area by various entities (Cojeen et al. 1994, 1999). The impact of USACE activities on traditional American Indian properties have been evaluated, specifically regarding the Muscogee, who inhabited this area after Removal from the east (Cook and Vaughan 1997).

Kaw Lake

Over 200 archaeological sites have been identified below the top of the flood pool in the Oklahoma portion of Kaw Lake (Table 4-34). Most of the 218 recorded sites are prehistoric, although historic sites, and sites with both prehistoric and historic components are represented. Only one site is listed on the NRHP and is also a National Historic Landmark, the Deer Creek or Ferdinandina archeological site (3KA003). Listed 10-15-1966, this site was the location of a French trading post and Wichita village (Sudbury 1975). This site is associated with the Bryson Archeological Site, which is also listed on the NRHP (9-20-1979), but is located just above the APE on Kaw Lake. In addition, 2 archaeological sites that have received formal Determination of Eligibility (DOE) are within the APE at Kaw Lake, the Uncas and Sarge Creek sites. The Uncas Site, 34KA172, (DOE 9/27/1929), is a multicomponent site with a significant early Plains Village component (Galm 1979). The Sarge Creek Site, 34OS100, (DOE 8/16/2001), contains burned rock features and human burials, but has not been radiometrically dated at this time. Eleven sites were declared not eligible for the NRHP, primarily because they had been destroyed, or lacked integrity. The remaining 204 archaeological sites have not had their NRHP eligibility status evaluated. There are no NRHP-listed architectural resources within the APE at Kaw Lake.

Portions of the river basin were surveyed in the early 1960s and 101 sites were identified in the area (Wyckoff 1964b). Intensive surveys in the 1970s and 1980s identified many additional sites throughout the basin (Artz 1983; Hartley 1975; Rohn et al. 1982; Rohrbaugh 1973. 1974; Young 1979), especially on the banks of the lake when the water level was lower than normal (George 1982).

Hulah Lake

To date, 23 sites have been recorded below the top of the flood pool at Hulah Lake, including 13 prehistoric sites, 6 historic sites, and 4 with both historic and prehistoric components (Table 4-34). Many of the prehistoric sites were lithic scatters of indeterminate age, although several sites dated to the Archaic, Woodland, Village Farming and/or Mississippian periods. The historic sites dated mainly to the late 19th through early 20th centuries; some included stone or concrete foundation ruins from former farmsteads. None of the archaeological sites within the APE have had their NRHP eligibility status evaluated. Consequently, there are no NRHP-listed archaeological sites at Hulah Lake. There are also no NRHP-listed architectural resources within the APE at Hulah Lake.

Archaeological survey at Hulah Lake began in 1947, when an archeological-historical investigation was conducted by Charles E. Smith and David J. Wenner that located 4 sites (Bell and Baerreis 1951). Additional survey was done after impoundment (Klinger et al. 1987) when additional archaeological resources were identified.

Copan Lake

A search of the Tulsa District USACE archaeological database indicates that there are 39 sites located below the top of the flood control pool for the lake (Table 4-33). The sites vary in degrees of disturbance and eligibility status and include components from the Archaic, Woodland, and Plains Village periods. Historic sites are from Delaware and Osage Indian occupations, as well as early Anglo-American settlers. There are no NRHP-listed archaeological sites within the flood control pool. One archaeological site that has received formal Determination of Eligibility is within the APE at Copan Lake, (34WN068; DOE 3/20/1980). Eighteen sites have been recommended or declared potentially eligible for NRHP listing. The remaining 20 archaeological sites have not had their NRHP eligibility status evaluated. There are no NRHP-listed architectural resources within the APE at Copan Lake.

The relatively late construction period of this reservoir resulted in a series of intensive archaeological surveys in the Copan basin by a number of entities. Wichita State University started the archaeological surveys in 1971-72, and included portions of the lake that extended into Kansas, identifying approximately 58 sites (Rohn and Smith 1972, 1973). In 1973, the Archeology Lab at the University of Tulsa started a program of archaeological and paleoenvironmental survey in the basin that lasted until 1982 (Henry 1974, 1976; Kay 1981; Keyser and Farley 1979; Prewitt 1980, 1982). The Oklahoma Archaeological Survey contributed two surveys/excavations (Vaughan 1974; Reid and Artz 1983), and the Archaeological Research and Management Center at the University of Oklahoma contributed one excavation (Vehik and Pailes 1979).

Located within the Copan Basin, but not necessarily within the APE are two Delaware Indian "Big Houses", traditional ceremonial structures. They, along with additional sites in the area, have been recommended for listing to the NRHP as the ‘Delaware Indian District,’ but are not yet listed on or have been formally declared eligible for listing on the NRHP.

Wister Lake

A search of the Tulsa District USACE archaeological database indicates that there are 132 sites located below the top of the flood control pool for the lake (Table 4-34). The sites vary in degrees of disturbance and NRHP eligibility status, and are from the Archaic, Woodland, Mississippian/Village Farming periods. There are 18 NRHP-listed archaeological sites within the lake basin. These Archaic, Fourche Maline, and early Mississippian/Caddo I period sites are part of the Lake Wister Archaeological Locality NRHP District, listed 08/19/1975; some have been inundated. Three other sites have been recommended or declared potentially eligible for

NRHP listing. The remaining 111 archaeological sites have not had their NRHP eligibility status evaluated. There are no NRHP-listed architectural resources within the APE at Wister Lake.

Surveys conducted by the WPA during the 1930s and early 1940s were summarized by Bell and Baerreis (1951). They include Bell's 1947 survey (Bell 1948) and Watson's earlier work in the area (Watson 1947). In 1974-1975, additional surveys of the river basin were conducted by the ORBS to evaluate previously identified sites (Mayo 1975; Neal n.d.). In 1975, Wyckoff summarized the impact that fluctuating lake levels had on the archaeological resources along the lake (Wyckoff 1975). Galm's 1981 dissertation on Fourche Maline culture in the Wister Valley was based partly on the survey and excavations he did in the basin in 1978 (Galm 1978, 1981; Galm and Flynn 1978). More recently, Vehik discussed the management of the known archaeological resources at Lake Wister (Vehik 1988). In 1993 the USACE conducted a reconnaissance survey of the lake (USACE 1993).

4.10.3.4 Cultural Resources at Dredged Material Disposal Locations

Data on the known cultural resources at proposed dredged material disposal locations were examined (Tables 4-36 and 4-37). There are no proposed locations in Project Segments 2-4. Some of these locations are above the 100 year flood line, and are therefore outside the APE for the other project actions at MKARNS pools. Consequently, a different set of cultural resources (with some overlap of sites) has been identified for the dredged material disposal locations. A one-half-mile buffer zone was inscribed around each potential new disposal location, and was also checked for known cultural resources. The buffer zone provides a window into the types of sites found in the immediate vicinity of the APE, and similar sites might be present in the APE. Some of the proposed disposal locations are closely spaced, so a few of the identified cultural resources are within the buffer zone of more than one disposal location; they are counted only once in the project segment totals in Table 4-36.

The results of the search for cultural resources at the proposed disposal locations indicated that there are no known archaeological sites or architectural resources present either in the buffer zone or within the APE of the proposed locations in Segment 1.

In Segment 5, 37 archaeological sites were identified, however only 3 were within the APE. Of these sites, 2 have not been evaluated for NRHP eligibility (34SQ26, 34MS001), and one has been destroyed (34MS052). The remaining 34 buffer zone sites outside the APE include one NRHP-listed site, one site that has been determined eligible for NRHP listing, and 31 unevaluated sites. There are no known architectural resources for proposed dredged material disposal locations in Segment 5.

In Segment 6, 33 archaeological sites were identified, however, only 4 sites were within the APE. Of these 4 sites, 1 is potentially eligible for the NRHP (34WG016), and 3 sites have been destroyed or are not eligible (34WG017, 34MS249, 34MS314). The remaining 29 buffer zone sites outside the APE include one NRHP-listed site, four sites that are potentially eligible for NRHP listing, one site is not eligible for NRHP listing or destroyed, and 23 unevaluated sites. There is one known architectural resource within the buffer zone of a proposed dredged material disposal location in Segment 6 (the park for the U.S.S. Batfish in Muskogee), and none within the APE.

Table 4-36. Archeological Sites and NRHP Status at Dredged Material Disposal Locations.

Segment	Sites Listed on the NRHP	Determined to be NRHP Eligible (or nominated)	Sites Potentially or Recommended Eligible	Sites not Eligible or Destroyed	Sites not Evaluated	Total Sites
	In Buffer/ In APE	In Buffer/ In APE	In Buffer/ In APE	In Buffer/ In APE	In Buffer/ In APE	In Buffer/ In APE
Segment 1	0/0	0/0	0/0	0/0	0/0	0/0
Segment 2	0/0	0/0	0/0	0/0	0/0	0/0
Segment 3	0/0	0/0	0/0	0/0	0/0	0/0
Segment 4	0/0	0/0	0/0	0/0	0/0	0/0
Segment 5	1/0	1/0	3/0	1/1	31/2	37/3
Segment 6	1/0	0/0	5/1	4/3	23/0	33/4
Total	2/0	1/0	8/1	5/4	54/2	70/7

Table 4-37. Architectural Sites and NRHP Status at Dredged Material Disposal Locations.

Segment	Sites Listed on the NRHP	Total Sites
	In Buffer/ In APE	In Buffer/ In APE
Segment 1	0/0	0/0
Segment 2	0/0	0/0
Segment 3	0/0	0/0
Segment 4	0/0	0/0
Segment 5	0/0	0/0
Segment 6	1/0	1/0

4.11 Sociological Environment

4.11.1 Demographics

Table 4-38 portrays population trends during the 1980-2000 period within the study area, which encompasses the 40 counties contiguous to the MKARNS in Arkansas and Oklahoma. The 2000 U.S. Census indicates a population of 2,455,199 within the study area, which represents an eighteen percent increase since 1980 and a twelve percent increase since 1990.

Table 4-38. Population Trends, 1980-2000.				
County	2000 Population[1]	1990 Population[2]	1980 Population[2]	Percent Change (1980-2000)
ARKANSAS COUNTIES				
Arkansas	20,749	21,653	24,175	(14)
Conway	20,336	19,151	19,505	4
Crawford	53,247	42,493	36,892	44
Desha	15,341	16,798	19,760	(22)
Faulkner	86,014	60,006	46,192	86
Franklin	17,771	14,897	14,705	21
Grant	16,464	13,948	13,008	27
Jefferson	84,278	85,487	90,718	(7)
Johnson	22,781	18,221	17,423	31
Lincoln	14,492	13,690	13,369	8
Logan	22,487	20,557	20,144	12
Lonoke	52,828	39,268	34,518	53
Perry	10,209	7,969	7,266	41
Pope	54,469	45,883	39,021	40
Pulaski	361,474	349,569	340,613	6
Saline	83,529	64,183	53,161	57
Sebastian	115,071	99,590	95,172	21
Yell	21,139	17,759	17,026	24
Total	**1,072,679**	**951,122**	**902,668**	**19**
Arkansas (State)	2,673,400	2,350,624	2,286,435	17
OKLAHOMA COUNTIES				
Adair	21,038	18,421	18,575	13
Cherokee	42,521	34,049	30,684	39
Creek	67,367	60,915	59,016	14
Delaware	37,077	28,070	23,946	55
Haskell	11,792	10,940	11,010	7
Kay	48,080	48,056	49,852	(4)
Le Flore	48,109	43,270	40,698	18
Mayes	38,369	33,366	32,261	19
McIntosh	19,456	16,779	15,562	25
Muskogee	69,451	68,078	66,939	4
Noble	11,411	11,045	11,573	(1)
Nowata	10,569	9,992	11,486	(8)
Okmulgee	39,685	36,490	39,169	1
Osage	44,437	41,645	39,327	13
Ottawa	33,194	30,561	32,870	1
Pawnee	16,612	15,575	15,310	8

Table 4-38. Population Trends, 1980-2000.				
County	2000 Population[1]	1990 Population[2]	1980 Population[2]	Percent Change (1980-2000)
Pittsburg	43,953	40,950	40,524	8
Rogers	70,641	55,170	46,436	52
Sequoyah	38,972	33,828	30,749	27
Tulsa	563,299	503,341	470,593	20
Wagoner	57,491	47,883	41,801	38
Washington	48,996	48,066	48,113	2
Total	**1,382,520**	**1,236,490**	**1,176,494**	**18**
Oklahoma (State)	3,450,654	3,193,642	3,073,403	12
TOTAL (Study Area)	**2,455,199**	**2,187,612**	**2,079,162**	**18**

[1] U.S. Census Bureau, Census of Population and Housing, 2000.

[2] U.S. Census Bureau, Census of Population and Housing, 1990 and 1980.

( ) Indicates the percentage decrease in population from 1980 to 2000.

The greatest population increases have occurred in those counties within or near the major metropolitan areas of Tulsa, Little Rock, and Fort Smith. Tulsa County (Tulsa Metropolitan Statistical Area (MSA)) had the greatest absolute increase in population, while Faulkner County, Saline County, Lonoke County (Little Rock MSA), and Rogers County (Tulsa MSA) had the greatest relative population increases during the 1980-2000 period. Six of the 40 counties within the study area had a decrease in population since 1980, with Jefferson County (Arkansas) having the greatest absolute decrease, and Desha County and Arkansas County (Arkansas) having the greatest relative decreases.

Table 4-39 exhibits the components of population change (natural increase and migration) for each county within the study area during 1991-2002 period. During this period there was a population increase of over 230,000 within the study area, with in-migration accounting for 42 percent of this increase. In-migration accounted for approximately 50 percent of the population increase in the Oklahoma counties, while 70 percent of the increase in the Arkansas counties was due to natural increase.

Generally, in-migration accounted for the majority of the population increase in those counties within or adjacent to the three metropolitan areas within the study area. The exceptions to this were Pulaski County (Little Rock MSA) and Jefferson County (Pine Bluff MSA), both of which had substantial net out-migration during this period. However, Pulaski County's population loss due to out-migration (26,527) was more than off-set by a natural increase in population. Seven counties (four in Arkansas and three in Oklahoma) had a net out-migration of population during this period, with the majority of these being rural counties.

Table 4-39. Components of Population Change, 1991-2002.				
County	**Population Change[1]**	**Natural Increase[2]**	**Net Migration[2,3]**	**Percent Due to Migration**
ARKANSAS COUNTIES				
Arkansas	(1,476)	(112)	(1,364)	(92)
Conway	933	180	753	81
Crawford	10,843	2,986	7,857	72
Desha	(2,439)	651	(3,090)	(100)
Faulkner	23,706	5,797	17,909	76
Franklin	2,075	307	1,768	85
Grant	2,500	626	1,874	75
Jefferson	(5,363)	4,789	(10,152)	(100)
Johnson	3,598	648	2,950	82
Lincoln	506	298	208	41
Logan	604	121	483	80
Lonoke	14,672	2,628	12,044	82
Perry	1,963	137	1,826	93
Pope	7,752	3,151	4,601	59
Pulaski	3,192	29,719	(26,527)	(0)
Saline	17,220	3,455	13,765	80
Sebastian	9,291	7,276	2,015	22
Yell	1,462	539	923	63
Total / Avg.	**91,039**	**63,196**	**27,843**	**31**
Arkansas (State)	239,064	107,507	131,557	55
OKLAHOMA COUNTIES				
Adair	2,540	1,798	742	29
Cherokee	6,322	2,342	3,980	63
Creek	8,955	3,006	5,949	66
Delaware	7,667	(139)	7,806	100
Haskell	340	(192)	532	100
Kay	(1,874)	1,376	(3,250)	(100)
Le Flore	3,659	1,202	2,457	67
Mayes	5,495	1,323	4,172	76
McIntosh	2,821	(733)	3,554	100
Muskogee	2,253	2,320	(67)	0
Noble	223	172	51	23
Nowata	297	(32)	329	100
Okmulgee	2,585	487	2,098	81
Osage	2,2845	1,166	1,118	49
Ottawa	299	269	30	10
Pawnee	1,249	284	965	77

Table 4-39. Components of Population Change, 1991-2002.

County	Population Change[1]	Natural Increase[2]	Net Migration[2,3]	Percent Due to Migration
Pittsburg	2,727	(325)	3,052	100
Rogers	20,352	4,128	16,224	80
Sequoyah	5,004	1,643	3,361	67
Tulsa	54,523	46,471	8,052	15
Wagoner	11,180	3,691	7,489	67
Washington	(20)	512	(492)	(100)
Total / Avg.	**138,921**	**70,769**	**68,152**	**49**
Oklahoma (State)	253,947	172,906	81,041	32
TOTAL (Study Area)	**229,960**	**133,965**	**95,995**	**42**

( ) = Decrease in Population

[1] Represents the addition of the natural increase in population and net migration. The estimated components of population change will be less than the actual numerical population change because of a residual after controlling the national totals. In addition, population change due to natural increase and net migration for the year 2000 is not included in the above calculations.

[2] U.S. Census Bureau, Population Estimates Program, Population Division, July 2002.

[3] Includes both domestic and international migration.

Table 4-40 portrays the estimated 2003 population and the projected population for each county within the study area for the year 2010. The July 1, 2003, estimated population for the study area represents an approximate two (2) percent increase over the 2000 population. This population increase was almost equally distributed between the Arkansas and Oklahoma portions of the study area.

As indicated in Table 4-40 the overall population within the study area is projected to increase by approximately 143,571, or a six percent increase by the year 2010. Approximately 60 percent of this increase is projected to occur in the Oklahoma portion of the study area. The majority of the study area population increase is projected to occur in those counties within or adjacent to the metropolitan areas. Tulsa County (Tulsa MSA), and Pulaski County, Faulkner County, Saline County and Lonoke County (Little Rock MSA) are projected to have the greatest absolute increases in population during this period. Relative increases of 15 percent or more are projected for Lonoke County, Adair County, Cherokee County, Delaware and Haskell County. The four counties in the Arkansas portion of the study area, which lost population during the 1990-2000 period, are projected to continue to lose population during the 2002-2010 period.

Table 4-40. Population Estimates and Projections, 2003, 2010.

County	2003 Population Estimates[1]	2010 Projected Population[2]	Percent Change
ARKANSAS COUNTIES			
Arkansas	20,158	18,736	(8)
Conway	20,485	20,411	0
Crawford	55,647	61,243	11
Desha	14,623	12,779	(14)
Faulkner	92,060	100,358	12
Franklin	18,003	18,040	1
Grant	16,933	18,126	8
Jefferson	82,889	81,021	(3)
Johnson	23,592	24,922	8
Lincoln	14,403	14,247	0
Logan	22,808	23,179	4
Lonoke	56,718	64,588	17
Perry	10,461	11,323	8
Pope	55,185	60,622	10
Pulaski	364,567	372,163	2
Saline	87,554	96,785	12
Sebastian	117,252	126,797	8
Yell	21,459	22,786	6
Total / Avg.	**1,094,797**	**1,148,126**	**5**
Arkansas (State)	2,725,714	2,851,890	5
OKLAHOMA COUNTIES			
Adair	21,614	24,700	15
Cherokee	43,783	50,400	16
Creek	68,794	72,000	5
Delaware	38,709	43,400	15
Haskell	12,044	13,500	15
Kay	47,260	49,100	3
Le Flore	48,896	51,500	6
Mayes	38,870	42,100	8
McIntosh	19,735	21,700	10
Muskogee	70,255	70,900	1
Noble	11,251	12,000	6
Nowata	10,836	12,000	12
Okmulgee	39,681	42,100	6
Osage	45,249	47,500	5
Ottawa	32,761	34,900	6
Pawnee	16,789	18,200	8
Pittsburg	44,168	45,300	3

Table 4-40. Population Estimates and Projections, 2003, 2010.			
County	**2003 Population Estimates[1]**	**2010 Projected Population[2]**	**Percent Change**
Rogers	77,193	80,100	6
Sequoyah	39,979	43,500	9
Tulsa	570,313	598,900	5
Wagoner	61,827	65,100	8
Washington	49,121	49,700	1
Total / Avg.	**1,409,128**	1,488,600	6
Oklahoma (State)	3,511,532	3,707,000	6
TOTAL (Study Area)	**2,503,925**	**2,636,726**	**6**

[1] Based on July 1, 2003 estimates.

[2] Projections are trend extrapolations based on past population trends.

( ) Represents decrease.

Sources: U.S. Census Bureau, Population Division; Oklahoma Department of Commerce, Oklahoma State Data Center; and Institute for Economic Advancement, University of Arkansas at Little Rock.

Housing characteristics within the study area are portrayed in Table 4-41. According to the 2000 U.S. Census there were 1,065,586 housing units within the study area, of which ten percent were vacant. The highest housing vacancy rates, exceeding 30 percent, were in McIntosh County and Delaware County (Oklahoma), with the lowest vacancy rates in Rogers County (Oklahoma), Lonoke County and Saline County (Arkansas). Approximately 70 percent of the housing units were owner-occupied within the study area. Owner-occupancy rates ranged from over 80 percent in Perry County, Grant County and Saline County (Arkansas), and Osage County, Pawnee County, Rogers County, and Waggoner County (Oklahoma), to 65 percent or less in Desha County, Pulaski County and Sebastian County (Arkansas), and Tulsa County in Oklahoma. The median value of owner-occupied housing within the study area was approximately $70,550 in 2000, with a slightly higher median value in the Arkansas portion of the study area. The highest median values are in Rogers County, Tulsa County, and Waggoner County in Oklahoma, and Faulkner County, Saline County and Pulaski County in Arkansas. The lowest median values are in Desha County and Lincoln County in Arkansas, and Adair County, Haskell County and Nowata County in Oklahoma. The highest housing values are generally associated with the three metropolitan areas within the study area.

Table 4-41. Housing Characteristics, 2000.				
County	**Total Housing Units**	**Percent Vacant**	**Percent Owner Occupied[1]**	**Median Value (Owner Occupied)**
ARKANSAS COUNTIES				
Arkansas	9,672	13	68	$52,600
Conway	9,026	12	78	58,100
Crawford	21,315	8	76	68,000
Desha	6,663	11	63	42,400
Faulkner	34,546	8	69	85,000
Franklin	7,673	10	78	58,300
Grant	6,960	10	80	60,800
Jefferson	34,350	11	66	53,800
Johnson	9,926	12	73	56,500
Lincoln	4,955	14	76	45,000
Logan	9,942	13	77	54,000
Lonoke	20,749	7	76	76,900
Perry	4,702	15	82	55,700
Pope	22,851	9	71	66,600
Pulaski	161,135	8	61	82,200
Saline	33,825	6	81	82,300
Sebastian	49,311	8	64	71,300
Yell	9,157	13	73	56,700
Total / Avg.	**456,758**	**9**	**68**	**$71,780**
Arkansas (State)	**1,173,043**	**11**	**69**	**$67,400**
OKLAHOMA COUNTIES				
Adair	8,348	11	73	$46,900
Cherokee	19,499	17	67	62,500
Creek	27,986	10	78	63,200
Delaware	22,290	33	79	67,200
Haskell	5,573	17	77	46,900
Kay	21,804	12	72	53,900
Le Flore	20,142	11	75	51,500
Mayes	17,423	15	77	63,800

Table 4-41. Housing Characteristics, 2000.				
County	**Total Housing Units**	**Percent Vacant**	**Percent Owner Occupied[1]**	**Median Value (Owner Occupied)**
McIntosh	12,640	36	79	55,100
Muskogee	29,575	11	70	57,100
Noble	5,082	11	75	54,700
Nowata	4,705	12	78	47,700
Okmulgee	17,316	12	73	49,900
Osage	18,826	12	81	61,000
Ottawa	14,842	13	74	50,300
Pawnee	7,464	14	80	52,200
Pittsburg	21,520	20	76	51,400
Rogers	27,476	6	81	89,000
Sequoyah	16,940	13	75	56,600
Tulsa	243,953	7	62	85,000
Wagoner	23,174	9	81	83,000
Washington	22,250	9	74	63,400
Total / Avg.	**608,828**	**11**	**70**	**$69,630**
Oklahoma (State)	**1,514,400**	**11**	**68**	**$67,700**
TOTAL (Study Area)	**1,065,586**	**10**	**70**	**$70,550**

[1] Percent of occupied units that are owner-occupied.

Source: U.S. Census Bureau, Census of Population and Housing, 2000.

Median household income varies widely within the study area as reflected in Table 4-42, ranging from a low of $22,121 in Desha County, Arkansas, to a high of $44,471 in Rogers County, Oklahoma. According to the 2000 U.S. Census, the median household income was approximately $35,425 in the Arkansas portion of the study area and $34,065 in the Oklahoma portion. The median household incomes within the study area exceed those of the two respective states. Generally, higher household incomes are associated with the three metropolitan areas within the study area. Saline County and Lonoke County (Little Rock MSA), and Rogers County and Waggoner County (Tulsa MSA) have annual median household incomes exceeding $40,000, with the other counties within the three metropolitan areas having median household incomes exceeding $35,000. The lowest household incomes are in the more rural areas with Desha County (Arkansas), and Adair County and Haskell County (Oklahoma) having median household incomes under $25,000.

Table 4-42. Median Annual Household Income.

County	2000	1990
ARKANSAS COUNTIES		
Arkansas	$30,316	$19,516
Conway	31,209	20,538
Crawford	32,871	21,574
Desha	24,121	15,719
Faulkner	38,204	23,663
Franklin	30,848	18,408
Grant	37,182	24,278
Jefferson	31,327	21,322
Johnson	27,910	18,225
Lincoln	29,607	18,457
Logan	28,344	18.992
Lonoke	40,314	23,831
Perry	31,083	17,626
Pope	32,069	23,124
Pulaski	38,120	26,883
Saline	42,569	28,262
Sebastian	33,889	24,037
Yell	28,916	19,647
Total / Avg.	**$35,425**	**$24,500**
Arkansas (State)	**$32,182**	**$21,147**
OKLAHOMA COUNTIES		
Adair	$24,881	$16,886
Cherokee	26,536	21,800
Creek	33,168	23,795
Delaware	27,996	18,681
Haskell	24,553	15,592
Kay	30,762	24,295
Le Flore	27,278	18,832

Table 4-42. Median Annual Household Income.

County	2000	1990
Mayes	31,125	21,209
McIntosh	25,964	17,738
Muskogee	28,438	20,407
Noble	33,968	23,227
Nowata	29,470	18,274
Okmulgee	27,652	17,368
Osage	34,477	24,617
Ottawa	27,507	17,716
Pawnee	31,661	21,199
Pittsburg	28,679	18,906
Rogers	44,471	29,389
Sequoyah	27,615	18,441
Tulsa	38,213	27,228
Wagoner	41,744	28,544
Washington	35,816	28,857
Total / Avg.	**$34,065**	**$25,900**
Oklahoma (State)	**$33,400**	**$23,577**
TOTAL (Study Area)	**$34,675**	**$25,150**

Sources: U.S. Census Bureau, Small Area Income and Poverty Estimates Program, 1999; and U.S. Census Bureau, 1990.

4.11.2 Environmental Justice

On February 11, 1994, the President issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* (FR 1994). The Executive Order focused attention on Title VI of the Civil Rights Act of 1964 by providing that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations". It is the USACE's policy to fully comply with Executive Order 12898 by incorporating environmental justice concerns in decision-making processes supporting USACE policies, programs, projects and activities. In this regard, USACE ensures that it will identify, disclose, and respond to potential adverse social and environmental impacts on minority and/or low-income populations within the area affected by a proposed USACE action.

A minority or low –income community or population, is considered as any readily identifiable group of minority or low-income persons living in geographic proximity. A minority is classified by the U.S. Census as African American, Hispanic American, Asian and Pacific American, American Indian, Eskimo, or Aluet, and other non-Caucasian persons. A low-income community or population is classified as having a household income at or below the U.S. Department of Health and Human Services poverty guidelines, which for the year 2000 was $17,050 for a family of four. The U.S. Census Bureau also has established poverty guidelines, with the poverty threshold in 2000 being $17,603 for a family of four.

Factors initially considered in the selection of proposed dredge material disposal sites are identified in Appendix C of this document. These criteria did not include consideration of environmental justice concerns. In order to meet the requirements of EO 12898, race, national origin, income level, and other readily accessible and appropriate information for areas within the study corridor for this project were collected and analyzed. The distribution and frequency of minority and low-income population within the study area is portrayed in Table 4-43. Approximately 19 percent of the population consisted of minority populations in 2000 according to the U.S. Census Bureau, with African-American and American Indian being the primary minorities in Arkansas and Oklahoma respectively. The minority population exceeds 30 percent of the total population in Desha, Jefferson and Lincoln counties in Arkansas, and Adair and Cherokee counties in Oklahoma. The distribution and frequency of low-income population (income below the poverty level) generally reflects that of the minority populations as those counties with the greatest frequency of minority populations also have the highest poverty levels. The 2000 U.S. Census Bureau indicates that 13 percent of the total population within the study area is below the poverty level, which is less than the poverty level of approximately 16 percent in 1990.

Overall, the minority and low-income proportions of the study area population are similar to the respective State averages. This information, along with field observation, indicates that there is no disproportionate occurrence of minority or low-income communities within the study area. In addition, attempts were made to include all of the communities in the study are in the public involvement process are identified in Appendix B of this document.

Table 4-43. Minority and Low-Income Population.

County	Total Population 2000[1]	% Minority Population 2000[1]	%Minority Population 1990[2]	% Persons Below Poverty Level, 2000[3]
ARKANSAS COUNTIES				
Arkansas	20,749	25	22	16
Conway	20,336	16	16	16
Crawford	53,247	8	4	14
Desha	15,341	50	43	22
Faulkner	86,014	12	9	11
Franklin	17,771	5	2	16
Grant	16,464	4	3	10
Jefferson	84,278	52	44	19
Johnson	22,781	6	3	16

Table 4-43. Minority and Low-Income Population.

County	Total Population 2000[1]	% Minority Population 2000[1]	%Minority Population 1990[2]	% Persons Below Poverty Level, 2000[3]
Lincoln	14,492	34	37	24
Logan	22,487	4	2	16
Lonoke	52,828	9	10	10
Perry	10,209	5	2	14
Pope	54,469	6	4	15
Pulaski	361,474	36	28	12
Saline	83,529	5	3	8
Sebastian	115,071	18	11	13
Yell	21,139	14	4	16
Total / Avg.	**1,072,679**	**23**	**19**	**13**
Arkansas (State)	2,673,400	20	17	15
OKLAHOMA COUNTIES				
Adair	21,038	52	44	21
Cherokee	42,521	44	35	21
Creek	67,367	18	12	12
Delaware	37,077	30	26	17
Haskell	11,792	21	16	20
Kay	48,080	16	11	14
Le Flore	48,109	20	15	19
Mayes	38,369	28	19	15
McIntosh	19,456	28	24	19
Muskogee	69,451	36	28	17
Noble	11,411	14	11	12
Nowata	10,569	28	20	15
Okmulgee	39,685	30	25	19
Osage	44,437	33	26	13
Ottawa	33,194	26	20	17
Pawnee	16,612	18	12	13
Pittsburg	43,953	23	18	17
Rogers	70,641	20	14	8
Sequoyah	38,972	32	23	18
Tulsa	563,299	25	17	11
Wagoner	57,491	20	14	10
Washington	48,996	19	12	11
Total / Avg.	**1,382,520**	**24**	**19**	**13**
Oklahoma (State)	3,450,654	24	19	14
TOTAL (Study Area)	**2,455,199**	**24**	**19**	**13**

[1] U.S. Census Bureau, Census of Population and Housing, 2000.
[2] U.S. Census Bureau, Census of Population and Housing, 1990.
[3] U.S. Census Bureau, Small Area Income and Poverty Estimates Program, 2000. The poverty threshold in 2000 for a family of four was $17,603.

4.11.3 Native American and Other Ethnic Concerns

Native Americans, or American Indians, are considered a “minority” for purposes of Executive Order 12898 on Environmental Justice, and Title VI of the 1964 Civil Rights Act. An American Indian is defined as a person “having origins in any of the original people of North America and who maintains cultural identification though tribal affiliation or community recognition” *(Federal Register, Volume 62, Number 72*). Executive Order 12898 establishes Federal Agency-wide goals for addressing disproportionate adverse environmental and human health hazards to American Indian, Alaska Natives and other indigenous peoples resulting from Federal actions and programs.

Where Federal proposed actions or programs may affect tribal lands or resources (e.g. treaty protected resources, cultural resources and/or sacred sites), the Environmental Protection Agency will request that the affected Indian Tribe seek to participate as a cooperating agency. Specific factors that will be considered include the Federal trust responsibility to, and treaties, statutes and executive orders with, federally recognized Indian Tribes. Where differences occur regarding the preferred alternative or mitigation measures that will affect tribal lands or resources, the affected Indian Tribe may request that a dispute resolution process be initiated to resolve the conflict between the tribe and Agency (*Final Guidance for Incorporating Environmental Justice Concerns in EPA’s NEPA Compliance Analyses, April, 1998*).

According to the U.S. Census, the American Indian population in the State of Oklahoma was 273,230 or approximately eight percent of the state’s population. Only the State of California has a larger American Indian population. Table 4-44 portrays the American Indian population distribution by county within the Oklahoma portion of the study area. Approximately 60 percent of Oklahoma’s American Indian population is located within the 22 counties comprising the Oklahoma portion of the study area, and accounts for approximately 11 percent of this portion of the area’s total population. The greatest concentrations of Native American population are in Adair, Cherokee, Delaware and Sequoyah counties, with over 30 percent of the population being American Indian in Adair and Cherokee counties. The American Indian population within the Oklahoma portion of the study area increased 13 percent during the 1990-2000 period.

The American Indian population in the State of Arkansas totaled only 17,807 in 2000 according to the U.S. Census, or approximately.006 percent of the state’s population. American Indian population totaled 6,017 within the Arkansas portion of the study area, or 0.005 percent of the population. There is no concentration of American Indian population within the Arkansas portion of the study area.

Tribal Jurisdictional Statistical Areas (TJSA) are geographic areas delineated for 1990 U.S. Census data tabulation purposes in Oklahoma by federally recognized tribes that do not have a legally defined reservation. TJSA’s define areas only for data presentation purposes that generally contain American Indian population over which one or more tribal governments have jurisdiction**.** The Oklahoma portion of the study area is encompassed by the Cherokee TJSA, Tonkawa TJSA, Otoe-Missouri TJSA, Kaw TJSA, Pawnee TJSA, and a portion of the Creek TJSA in addition to the Osage Agency (Osage Reservation). According to the 1990 U.S.

Census, the Cherokee TJSA had the largest American Indian population (66,435) of the TJSA's within the study area.

Table 4-44. Native American Population, Oklahoma, 2000.		
County	**American Indian Population[1]**	**Percent of Total Population**
Adair	8,938	42
Cherokee	13,787	32
Creek	6,120	9
Delaware	8,273	22
Haskell	1,722	15
Kay	3,621	8
Le Flore	5,157	11
Mayes	7,330	19
McIntosh	3,152	16
Muskogee	10,331	15
Noble	864	8
Nowata	1,750	17
Okmulgee	5,099	13
Osage	6,410	14
Ottawa	5,488	17
Pawnee	2,015	12
Pittsburg	5,493	12
Rogers	8,533	12
Sequoyah	7,654	20
Tulsa	29,316	5
Wagoner	5,393	9
Washington	4,214	9
Total	**150,660**	**11**
Oklahoma (State)	273,230	8

Source: U.S. Census Bureau, 2000 Census; and Oklahoma Department of Commerce, Oklahoma State Data Center.
[1] Does not include American Indian in combination with one or more other races.

There is one American Indian reservation and numerous off-reservation American Indian trust lands within the Oklahoma portion of the study area. The Osage Indian Reservation is synonymous with the boundaries of Osage County in the northern portion of the study area. Keystone Lake and Hulah Lake, and a portion of Kaw Lake are located on the Osage Indian Reservation.

Table 4-45 portrays government owned lands and lands held in trust by the Federal government under the jurisdiction of the Bureau of Indian Affairs (BIA). Over 435,000 acres, or 41 percent of the lands under the jurisdiction of the BIA in Oklahoma, are located within the study area. Almost all of these lands consist of individual or tribal trust lands over which tribes hold primary jurisdictional authority. Trust lands are associated with the following tribes within the study area: Eastern Shawnee, Miami, Modoc, Ottawa, Peoria, Quapaw, Seneca-Cayuga, and Wyandotte, all located in Ottawa County; the Cherokee Nation of Oklahoma and the United Keetoowah Band of Cherokee, located in Cherokee County; the Kaw, Otoe-Missouri, Pawnee, Ponca and Tonkawa, located in Kay, Noble and Pawnee counties; and the Muskogee (Creek) Nation, and the Alabama-Quassarte Tribal Town in Okmulgee County.

Table 4-45. Lands Under the Jurisdiction of the Bureau of Indian Affairs, Oklahoma, 1997 (acres).

County	Total Acreage	Government Owned	Total Trust	Individually Owned	Tribal
Adair	23,979	18	23,961	10,589	13,372
Cherokee	11,230	447	10,783	9,682	1,101
Creek	49,270	0	49,270	48,979	291
Delaware	32,443	10	32,433	7,466	24,967
Haskell	7,507	0	7,507	7,411	96
Kay	16,392	11	16,381	6,974	9,407
Le Flore	10,681	0	10,681	10,468	213
McIntosh	18,981	0	18,981	17,034	1,947
Mayes	5,741	10	5,731	5,394	337
Muskogee	4,302	3	4,299	4,070	229
Noble	22,344	0	22,344	20,143	2,201
Nowata	610	0	610	610	0
Okmulgee	14,895	0	14,895	14,541	354
Osage	152,893	0	152,893	151,872	1,021
Ottawa	16,723	0	16,723	14,299	2,424
Pawnee	18,599	0	18,599	17,883	716
Pittsburg	12,825	161	12,664	9,305	3,359
Rogers	831	0	831	808	23
Sequoyah	7,909	40	7,869	5,850	2,019
Tulsa	2,293	0	2,293	2,157	136
Wagoner	3,501	0	3,501	3,491	10
Washington	1,785	0	1,785	1,785	0
Total	**435,735**	**701**	**435,034**	**370,811**	**64,223**
(Oklahoma)	1,057,093	850	1,056,244	951,513	104,731

Source: Bureau of Indian Affairs, U.S. Department of Interior.

4.11.4 Protection of Children

On April 21, 1997, the President issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (FR 1997). This Executive Order recognizes that a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because they eat, drink, and breathe more in proportion to their body weight; because their size and weight can diminish protection from standard safety features; and because their behavior patterns can make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that might disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is the USACE's policy to fully comply with Executive Order 13045 by incorporating these concerns in decision-making processes supporting USACE policies, programs, projects, and activities. In this regard, USACE ensures that it will identify, disclose, and respond to potential adverse social and environmental impacts on children within the area affected by a proposed USACE action.

4.12 Economics

4.12.1 Employment

Many major cities are located along the Arkansas River including Pueblo, Colorado; Garden City, Dodge City and Wichita, Kansas on the upper river; and Tulsa and Muskogee, Oklahoma; Fort Smith/Van Buren and Little Rock/North Little Rock, Arkansas on the lower river. These are also the major employment centers along the Arkansas River.

Table 4-46 portrays the civilian labor force, employment, and unemployment rates for the individual counties and overall study area based on the most recent data from the U.S. Department of Labor, Bureau of Labor Statistics, and the respective State Employment Security Departments. The average annual civilian labor force for 2003 totaled 1,211,695 within the study area, which represented an approximate seven percent increase since 1995. The labor force within the study area represented approximately 40 percent of the labor force in the States of Arkansas and Oklahoma. Ten counties, seven in Oklahoma and three in Arkansas, within the study area had a decrease in their labor force during the 1995-2003 period. These are generally the more rural counties, several of which have experienced population loss during the last decade. Faulkner, Lonoke and Saline Counties in Arkansas, and Cherokee, Haskell, Pawnee and Rogers counties in Oklahoma experienced the greatest increase in their labor force during this period.

The average annual unemployment rate for 2003 for the study area was approximately six percent, with a slightly higher unemployment rate in the Oklahoma portion of the study area. The unemployment rate for the Arkansas portion of the study area was lower than the State-wide unemployment rate, while the unemployment rate for the Oklahoma portion was higher than the respective State-wide unemployment rate. Highest unemployment tends to be in the more rural areas, with the unemployment rate approaching or exceeding ten percent in Desha County, Jefferson County and Perry County in Arkansas, and Adair County, Mayes County, Ottawa County and Okmulgee County in Oklahoma.

Table 4-46. Civilian Labor Force, Employment, and Unemployment Rates, 2003[1,2]

County	Labor Force, 2003	Employment, 2003	Unemployment Rate, 2003
ARKANSAS COUNTIES			
Arkansas	10,675	10,025	6.1
Conway	9,700	9,050	6.8
Crawford	24,600	23,200	5.7
Desha	6,575	5,875	10.7
Faulkner	46,125	43,475	5.7
Franklin	7,950	7,600	4.4
Grant	6,825	6,375	6.7
Jefferson	36,175	32,750	9.5
Johnson	11,025	10,500	4.9
Lincoln	5,450	5,075	6.8
Logan	9,450	8,900	5.9
Lonoke	26,900	25,650	4.6
Perry	3,975	3,600	9.3
Pope	26,650	25,100	5.8
Pulaski	191,675	181,775	5.2
Saline	44,100	42,075	4.6
Sebastian	56,675	53,900	5.0
Yell	9,850	9,350	5.0
Total	**534,375**	**504,275**	**5.6**
Arkansas (State)	1,264,500	1,186,400	6.2
OKLAHOMA COUNTIES			
Adair	9,500	8,540	10.1
Cherokee	19,880	18,820	5.3
Creek	33,120	30,640	7.5

Table 4-46. Civilian Labor Force, Employment, and Unemployment Rates, 2003[1,2]			
County	**Labor Force, 2003**	**Employment, 2003**	**Unemployment Rate, 2003**
Delaware	17,860	16,990	4.9
Haskell	5,620	5,230	7.0
Kay	21,800	20,080	7.9
Le Flore	20,120	18,770	6,7
Mayes	15,010	13,610	9.3
McIntosh	7,980	7,350	7.9
Muskogee	31,260	28,990	7.3
Noble	5,320	5,110	3.8
Nowata	4,090	3,780	7.6
Okmulgee	15,640	14,110	9.7
Osage	20,650	19,260	6.7
Ottawa	13,310	12,110	9.0
Pawnee	7,560	6,960	7.9
Pittsburg	19,400	18,180	6.3
Rogers	38,090	35,750	6.1
Sequoyah	17,350	16,150	6.9
Tulsa	303,480	283,990	6.4
Wagoner	30,220	28,400	6.0
Washington	20,140	18,910	6.1
Total	**677,320**	**631,730**	**6.7**
Oklahoma (State)	1,696,100	1,600,000	5.7
TOTAL (Study Area)	**1,211,695**	**1,136,005**	**6.2**

[1] By place of residence.
[2] Annual Averages.
Source: U.S. Department of Labor, Bureau of Labor Statistics; Arkansas Employment Security Department; Oklahoma Employment Security Commission.

The distribution of employment by major industry sector within the study area is portrayed in Table 4-47. The latest year for which employment by Standard Industrial Classification industry sector is available is 2000. The relative share of employment by individual industry sector generally reflects the national averages with services and retail trade accounting for almost 50% of total employment within the study area. Manufacturing and government related employment are relatively more important in the Arkansas portion of the study area, while service related employment, farming and mining are relatively more important in the Oklahoma Portion.

Table 4-47. Distribution of Employment by Major Industry Sector[1], 2000

	Percent of Total Employment		
Industry Sector[2]	**Arkansas Counties**	**Oklahoma Counties**	**Total / Average**
Farming	2	4	3
Agric., For., Fish.	1	1	1
Mining	Neg.	2	1
Construction	6	6	6
Manufacturing	14	11	12
Transp., Comm., Util.	6	6	6
Wholesale Trade	4	4	4
Retail Trade	16	17	17
Fin., Insur., Real Est.	6	7	6
Services	28	30	29
Government	16	12	13

[1] By place of residence.
[2] Standard Industrial Classification Industry.
Neg. = Negligible
Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Accounts, Local Area Annual Estimates, 2002.

The lower Arkansas River and the MKARNS provide a variety of economic benefits to adjoining communities including commercial navigation, water supply (municipal, industrial and agricultural), hydroelectric power generation, commercial fishing, and recreation. Employment represents a major economic impact, as the MKARNS has been responsible for the creation of 54,000 direct jobs over the past 25 years. This direct employment in turn has been responsible for the creation of thousands of indirect jobs in the transportation, industrial, trade and service sectors. The direct and indirect employment impacts the economy in the form of wages paid, business volume, tax revenue, etc.

4.12.2 Transportation Economics

Inland waterways such as the MKARNS offer an environmental and economical responsible mode of transportation for the movement of goods. Table 4-48 offers a comparison of the fuel cost and energy required to transport goods via waterways versus rail, truck and pipeline. As noted, transportation via waterways is considerably cheaper per ton of freight than by rail or truck, while the energy consumed (BTUs per ton mile) is much less costly than via rail, truck or pipeline.

Table 4-48. Transportation Costs and Energy Usage of Barge Versus Other Modes of Transportation

Transportation Mode	Cents per ton	BTUs per ton mile	No. miles/gallon of fuel/ ton
Barge	0.97	433	514
Rail	2.53	696	202
Truck	5.35	2,400	59
Pipeline	0.78	1,850	Na

Sources: USACE Annual Report, 1997, and USDOT Maritime Administration, 1997.

The MKARNS was utilized by over 14,000 barges for the shipment (upbound and downbound) of 11,903,000 short tons of freight in 2002. Commodities reported shipped in 2002 included 4,652,000 tons of sand, gravel, rock and stone; 1,871,000 tons of chemical fertilizer; 1,392,000 tons of wheat; 1,147,000 tons of manufactured goods; 888,000 tons of iron and steel products; 539,000 tons of soybeans; and 523,000 tons of petroleum products.

There are five public ports and over 50 private ports along the MKARNS on which both foreign and domestic trade is conducted. The public ports of Catoosa, Muskogee, Little Rock, Fort Smith and Pine Bluff handle the majority of the in-bound and out-bound tonnage of goods shipped. The Ports of Catoosa, Muskogee and Little Rock are also designated as Foreign Trade Zones, which are considered to be outside U.S. Customs territory.

The Tulsa Port of Catoosa is the largest and busiest port on the MKARNS. In 2002, 1,344 barges carrying 2,097,000 short tons of freight moved through the port, which is a full inter-modal transportation center with a 2,000-acre industrial park. The port is located only five miles from Interstate 44, and is also served directly or indirectly by major rail carriers, including the Burlington Northern/Santa Fe, and the Union Pacific/Southern Pacific via the South Kansas and Oklahoma shortline.

The Port of Muskogee is a full-service facility and also has over 400 acres in industrial parks. The port has easy access to Interstate 40 via the Muskogee Turnpike and Highway 65, and a rail marshalling yard and internal track system that is within the switching limits of the Union Pacific Railroad.

The Port of Little Rock is an inter-modal transportation center located adjacent to Interstate 440 which connects Interstate 30 and Interstate 40. The port has immediate access to the Little Rock National Airport, which is less than one mile away, and has direct rail access via the Little Rock Port Authority Railroad, which provides switching service to the Union Pacific Railroad and by trackage/haulage rights to the Burlington Northern Santa Fe Railroad. The port has a 4,500 foot slackwater harbor adjacent to the main port area, and a 1,500 acre industrial park.

The Port of Fort Smith, which has easy access to Interstate 40 and rail connections to the Arkansas-Missouri Railroad, is a much smaller port, which has less than fifty employees. This facility has port-side warehouses and a variety of specialty off-port public warehouses. Steel products are the predominant cargo handled at this port.

The Port of Pine Bluff is an inter-modal transportation facility, which has the Arkansas River's largest slackwater harbor, a 375-acre industrial park, and a 20-acre public terminal facility. The port has immediate access to Interstate 530, which connects to Interstate 30 and Interstate 40 at Little Rock. Rail service is provided by the Burlington Northern Santa Fe Railroad and the Union Pacific Railroad. More detailed information on the above ports is contained in Section 4.7.1, Commercial Navigation.

Over $3.5 billion in public and private investment has occurred along the MKARNS in Arkansas and Oklahoma since the inception of this inland waterway. The waterway has generated an investment of over $1.15 billion at the Tulsa Port of Catoosa alone. The five public ports of the MKARNS together support over 90 industries and 5,200 employees. The Oklahoma Department of Transportation reports that there are over 65 industries in the Oklahoma portion of the MKARNS, and that the segment between Catoosa and Muskogee provides direct employment for over 4,000 people ($85 million in payroll) and indirect employment for over 6,000 people ($90 million payroll). Almost 50 of these industries are in the Tulsa port of Catoosa with over 1,100 employees. Direct employment is provided for over 2,300 employees at the 39 industries in the Little Rock Port Industrial Park, while the Port of Pine Bluff's Harbor Industrial District employs more than 800 workers in the river-front industrial park. There are over 8,000 direct waterway-related jobs within those counties contiguous to the MKARNS in Arkansas.

A recently completed study (Gulf Engineers 2000) using the IMPLAN (Impacts Analysis for Planning) regional economic model estimated the direct, indirect and induced economic impacts of the MKARNS on the State of Oklahoma. It was estimated that in 1997 waterway-related business activity of the MKARNS generated a total (direct, indirect and induced) of $2.06 billion in annual business volume (sales), $492.9 million in personal income (wages), 15,634 man-years of employment, and $66.8 million in indirect business taxes in Oklahoma. The 15,634 man-years of employment include 6,375 direct jobs, 4,356 indirect jobs, and 4,903 induced jobs. Approximately one-third of the above total business volume, one-half of the personal income, and 40 percent of the employment was created at the Port of Catoosa.

4.12.3 Tourism

There are over 100 recreational areas associated with the MKARNS main channel including USACE-operated recreational facilities and commercial concessions under leasehold with the USACE. These facilities include campgrounds, marinas, boat ramps, etc. For example, there are 20 marinas associated with the MKARNS in the Arkansas portion of the study area and over 27 in Oklahoma. Recreational boating associated with these facilities has substantial economic impacts by generating employment, income and business for the local and regional economies.

The recreational areas associated with the MKARNS and its associated upstream reservoirs provide recreational and aesthetic opportunities to millions of visitors annually. Table 4-49 portrays the trends in annual visits to the lakes and reservoirs associated with the McClellan-Kerr Navigation System. Total annual visits at the twenty-six recreational lakes and reservoirs in 2002 approximated 18.5 million, with the lakes and reservoirs in Oklahoma accounting for sixty (60) percent of the visitors. Fort Gibson Lake, Eufaula Lake, and Tenkiller Ferry Lake in Oklahoma, and Dardanelle Lake in Arkansas each had two million or more visitors in 2002. These annual visitations translate into substantial economic impacts to the local economies in the form of direct and indirect employment, business volume and income.

Table 4-49. Trends in Annual Visits[1], MKARNS and Related Lakes

Lake	2002	1999	1996	1993
ARKANSAS				
Dardanelle Lake	2,908,987	1,995,185	2,136,266	3,863,000
David D. Terry L & D No. 6	964,958	1,307,063	1,354,007	1,149,000
Emmett Sanders L & D No. 4	458,992	541,565	698,337	571,000
Hammerschmidt Lake (J.W. Trimble L & D No.13)	563,819	864,721	1,135,563	1,219,000
Joe Hardin L & D No.3	92,028	78,749	95,784	221,000
Lock & Dam 5	133,985	176,802	185,017	209,000
Murray L & D No. 7	747,327	745,971	1,124,289	1,713,000
Norrell L & D No. 1	19,493	39,669	34,992	64,000
Ozark Lake	431,784	463,231	502,802	471,000
Rockefeller Lake (Arthur Ormond L & D No. 9)	241,830	203,280	346,290	414,000
Toad Suck Ferry L & D No. 8	452,319	447,968	614,254	891,000
Wilbur Mills Dam	257,025	274,672	357,292	544,000
Total (Arkansas)	*7,272,547*	*7,138,876*	*8,584,893*	*11,329,000*
OKLAHOMA				
Chouteau L & D No. 17	164,882	184,948	124,482	204,373
Copan Lake	65,564	66,557	165,239	83,210
Eufaula Lake	2,064,190	2,127,130	2,446,503	2,102,164
Fort Gibson Lake	2,197,936	2,416,651	3,041,944	1,766,990
Hulah Lake	57,196	93,590	94,232	57,373
Kaw Lake	475,738	158,406	681,533	415,363
Keystone Lake	908,208	1,265,920	1,377,386	1,308,721
Newt Graham L & D No. 18	229,945	189,824	240,492	247,976
Oologah Lake	992,998	1,258,023	1,423,222	1,362,797
Robert S. Kerr L & D No. 15	1,022,396	923,622	770,960	579,856
Tenkiller Ferry Lake	2,080,299	1,149,237	1,224,694	1,472,630
W. D. Mayo L & D No. 14	112,729	109,767	114,921	103,453
Webbers Falls L & D No. 16	514,341	512,054	509,412	462,644

Table 4-49. Trends in Annual Visits[1], MKARNS and Related Lakes				
Lake	**2002**	**1999**	**1996**	**1993**
Wister Lake	361,420	415,962	317,764	276,753
Total (Oklahoma)	*11,247,842*	*10,871,691*	*12,532,784*	*10,444,303*
TOTAL	**18,520,389**	**18,010,567**	**21,117,677**	**21,773,303**
Source: USACE, Little Rock and Tulsa Districts.				

Table 4-50 portrays the number of recreational vessels that locked through the twelve Arkansas and five Oklahoma locks from 1991-2003. As indicated, there has generally been an annual downward trend, with a few exceptions, in the number of recreational vessels on the MKARNS that have locked during this time period in both the Arkansas and Oklahoma portions of the study area. Approximately seventy-five (75) percent of recreational vessel usage is in the Arkansas portion of the MKARNS. Decreased lockages may be due to an increase in access points in the more popular recreational locations (such as a new ramp near Alltel Arena between Terry Lock & Dam #6 and Murray Lock & Dam #7).

Table 4-50. Trends in Recreational Vessel Lockage on the MKARNS, 1991 to 2003		
Year	**Arkansas**	**Oklahoma**
2003	8,132	Na
2002	6,243	2,341
2001	7,420	1,846
2000	6,849	2,325
1999	9,018	1,978
1998	9,750	2,577
1997	12,248	2,319
1996	15,470*	2,941
1995	9,895	2,066
1994	10,426	2,688
1993	9,978	2,629
1992	12,111	3,155
1991	13,595	3,012
Source: USACE, Little Rock and Tulsa Districts. ** The marked increase in lockage in 1996 coincides with the MKARNS 25th Anniversary Celebration.*		