ARKANSAS RIVER CORRIDOR

Appendix B: Biological Resources Report

ARKANSAS RIVER CORRIDOR, TULSA COUNTY, OKLAHOMA

Introduction

The Arkansas River is a water resource serving numerous nationally significant purposes. The river has historically served as a nationally significant resource for aquatic and terrestrial habitat of the nation's wildlife that live, breed, and migrate through the Arkansas River ecosystem. This includes federally endangered Interior Least Tern (Least Tern, *Sterna antillarum*), a nationally significant resource, and two federally threatened bird species, the Piping Plover (*Charadrius melodus*) and the Red Knot (*Calidris canutus rufa*) as well as a plethora of native species and migratory waterfowl that support a healthy and functional riverine ecosystem. Keystone Lake and its dam located along the Arkansas River also play vital roles in supporting the continued provision of many of those multi-purposes. In particular, the lake and dam provide flood risk management benefits, contribute to the eleven reservoir system operation of the McClellan-Kerr Arkansas River Navigation System, provide clean and efficient power through the associated hydropower plant, and provide a source of water for municipal and industrial uses. However, construction, operation, and maintenance of the Keystone Dam, lake, associated hydropower operations and other multi-purposes have significantly degraded the riverine ecosystem structure, function, and dynamic processes below Keystone Dam on the Arkansas River within Tulsa County, Oklahoma.

Stage of Planning Process

This is a feasibility study. A planning Charette was conducted in October 2013, and an Alternatives Milestone Meeting was completed in September 2015. The study is in the Alternative Formulation and Analysis Phase. Utilizing a reasonable level of detail, the PDT has analyzed, compared, and evaluated the array of alternatives to identify a Tentatively Selected Plan for consideration by the Vertical Team.

Study Authority

The Arkansas River Corridor study is authorized in the Water Resources Development Act (WRDA) of 2007, Section 3132.

> Section 3132. Arkansas River Corridor.
>
> (a) IN GENERAL. – The Secretary is authorized to participate in the ecosystem restoration, recreation, and flood damage reduction components of the Arkansas River Corridor Master Plan dated October 2005. The Secretary shall coordinate with appropriate representatives in the vicinity of Tulsa, Oklahoma, including representatives of Tulsa County and surrounding communities and the Indian Nations Council of Governments.
> (b) AUTHORIZATION OF APPROPRIATIONS. – There is authorized to be appropriated $50,000,000 to carry out this section.

Non-Federal Sponsor

Tulsa County is the non-federal sponsor for the Arkansas River Corridor feasibility study. An amended feasibility cost-sharing agreement was executed in May 2015.

Purpose

This study is in response to the Section 3132 authorization of the 2007 WRDA. The purpose of this study is to evaluate the aquatic ecosystem restoration components of the October 2005 Arkansas River Corridor Master Plan (ARC Master Plan) and determine if there is a Federal Interest that aligns with the Corps of Engineers ecosystem restoration mission.

D R A F T

Biological Resource Report
Ecosystem Restoration for the Arkansas River Corridor Feasibility Study
Tulsa County, Oklahoma

Prepared for

U.S. Army Corps of Engineers
Tulsa District

April 2016

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Acronyms and Abbreviations

ABC	American Bird Conservancy
ARC	Arkansas River Corridor
ARM	Arkansas River Mile
BO	biological opinion
CEQ	Council on Environmental Quality
cfs	cubic feet per second
EA	Environmental Assessment
ECOS	Environmental Conservation Online System
EDA	U.S. Economic Development Administration
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
I	Interstate
INCOG	Indian Nations Council of Governments
LWD	low-water dam
mi^2	square miles
NAS	Nonindigenous Aquatic Species
NEPA	National Environmental Policy Act
ODEQ	Oklahoma Department of Environmental Quality
ODWC	Oklahoma Department of Wildlife Conservation
OSU	Oklahoma State University
PMP	Project Management Plan
Project	Arkansas River Restoration Project
SMART	Specific, Measurable, Attainable, Risk-Informed, and Timely
TDS	total dissolved solids
TMDL	total maximum daily load
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WLA	waste load allocation
WRDA	Water Resources Development Act

SECTION 1

Introduction

This Biological Resource Report (Report) is part of the Environmental Compliance Services for Flood Damage Reduction and Ecosystem Restoration for the Arkansas River Corridor Feasibility Study Project, referred to collectively as the Arkansas River Restoration Project (Project), along the Arkansas River Corridor (ARC) in Tulsa County, Oklahoma. This Report summarizes the available information on the occurrence of federally protected species and suitable habitats along the ARC in Tulsa County, Oklahoma, and includes a literature review of publicly available and previously collected data and information. The Report does not include field observations, aerial photography, and habitat quantification procedures.

A formal Biological Assessment was not conducted for this report; however, this Report will be reviewed to assess the potential effects of various aquatic ecosystem restoration (and flood control) measures on federally protected species within the study area in Tulsa County, Oklahoma, as part of a draft Environmental Assessment (EA) in compliance with Section 7(c) of the Endangered Species Act (ESA). The Report will be reviewed to determine whether formal consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the ESA would be required prior to construction of the Proposed Action.

1.1 Project Description

The construction of Keystone Dam was completed in 1964. The dam has successfully reduced the negative impacts of flooding along the ARC in Tulsa County; however, the dam has altered the natural flow regime of the river and the sediment dynamics downstream of the dam. These changes, combined with land use changes in the watershed, have altered the river corridor ecosystem. For example, Keystone Lake acts as a sediment trap that significantly reduces the amount of sediment that maintains downstream island habitat for the endangered interior least tern. Also, frequent and extreme river flow fluctuations from hydropower operations at the dam have a drying effect on the aquatic habitat (USACE, 2009). The impacted geomorphology has resulted in streambank erosion problems at various locations, and the destruction of riverine wetlands and oxbow habitats that were once important fish nurseries and feeding/resting areas for migrant waterfowl. The loss of these habitats has decreased the species diversity and overall biological productivity of the remaining downstream habitat. The loss of slackwater nursery habitat for small fish has impacted the federally endangered interior least tern that primarily feed on fish. The scrub-shrub habitat within the ARC also has been degraded as a result of land use changes. Other watershed concerns include pathogens, pesticides, and organics from urban, municipal, commercial, and agriculture runoff that affect the water quality.

The U.S. Army Corps of Engineers (USACE), Tulsa District, is considering ecosystem restoration measures, referred to as the Arkansas River Restoration Project (the Project), below Keystone Dam along the ARC in Tulsa County, Oklahoma. The Project consists of structural and nonstructural ecosystem restoration measures to be implemented in a cost-share partnership with Tulsa County, and in cooperation with the USFWS and Oklahoma Department of Wildlife Conservation (ODWC).

The absence of adequate instream flows is considered fundamental to the ARC's environmental problems. In addition to the adverse impacts resulting from Keystone Dam's operations, the aquatic ecosystems of the Arkansas River have been further impaired by the partial levee system, upland development, urbanization, industrialization, constructed banks, and active sand-mining. Based on consultation with the key partner agencies, a critical element providing ecosystem restoration benefits, would be to stabilize instream flows within the Arkansas River Corridor. Without sufficient instream flows, other standalone aquatic ecosystem restoration measures, such as riparian corridor plantings,

would not be as effective or extensive, and thus unable to provide a comprehensive solution. An instream flow measure would provide ecosystem benefits to the seven key development sites and downstream of the Keystone Dam within the Tulsa County line identified in the 2005 ARC Master Plan (Guernsey et al., 2005), which was primarily developed to address these issues. The purpose and need of the Project are consistent with those of the ARC Master Plan, but the Project focuses on management measures of federal interest.

The purpose of the Project is to implement management measure(s) to restore riverine and riparian ecological functions in the ARC below Keystone Dam. The Proposed Action will consist of measure(s) to minimize instream flow fluctuations during low-flow periods, while continuing to support Keystone Dam's flood risk management and hydropower generation authorizations, and ecological restoration measures at key sites identified in the 2005 ARC Master Plan to improve riverine and riparian ecological functions within the ARC (Guernsey et al., 2005).

The USACE will screen the different proposed measures to determine preferred aquatic restoration measure(s) (and flood damage restoration). The recommended measure(s) would be required to meet federal planning criteria and be acceptable to the Project sponsor, key agencies, and local residents. The proposed measures consists of structural and nonstructural ecosystem restoration measures and improvements.

Instream flow alternatives include the following two instream flow alternatives:

Alternative 1: Operational management of Keystone Dam to supply additional flows below the dam

Alternative 2: Downstream water control structure at Sand Springs

Of the two instream flow alternatives, Alternative 2, water control structure concept at Sand Springs, is based on the original Lake Keystone Project that included a downstream re-regulating dam, flowage easements, and fee lands along 7.8 miles of the Arkansas River. The re-regulating dam, which provided a water quality control function, was removed in 1985 because of safety and function issues.

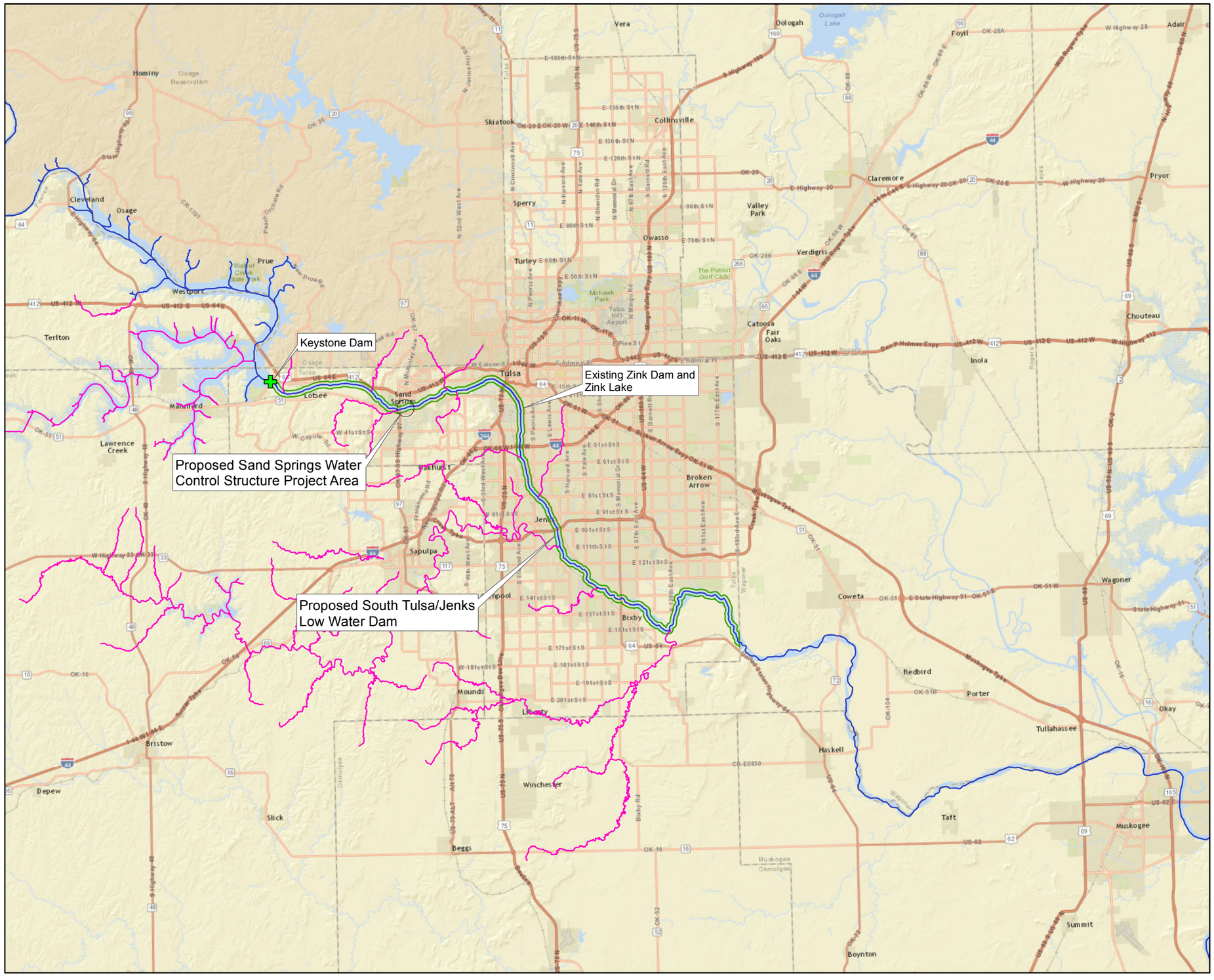
In this Report, a site just downstream of the State Highway 97 bridge, located in the Sand Springs area, is evaluated. The site upstream of the State Highway 97 bridge, where a re-regulation dam was located, was not included in the Project level analysis because there was limited information available when this Report was prepared. The greater study area comprises 42 miles of ARC from Keystone Dam to the Tulsa/Wagoner County, and is shown on Figure 1.

The other ecosystem restoration measures considered include construction of least tern islands at various locations in the ARC, and aquatic habitat restoration and tributary stream restoration. The potential locations for tributary stream restoration and least tern island construction measures, and the instream flow measures are within or near the seven key planning sites below Keystone Dam identified in the 2005 ARC Master Plan (Guernsey et al., 2005). The ecosystem restoration measures considered are included in Table 1.

Table 1. Description of Instream Flows with Aquatic Ecosystem Restoration Management Measures
Biological Resources Report, Ecosystem Restoration for the ARC Feasibility Study Environmental Assessment

	Instream Flow	Habitat Restoration	Arkansas River and Tributary Stream Restoration
Federal cost-share components	Keystone Dam operational changes, or A water control structure at Sand Springs	Least tern island construction in Sand Springs, Bixby, and Broken Arrow Zink Lake aquatic habitat improvements (boulder clusters, spider blocks)	Prattville Creek confluence, Cherry Creek confluence, Left Bank Slack Water Side Channels (immediately upstream of I-44 bridge).

I-44 = Interstate 44



VICINITY MAP

LEGEND

- Proposed Sand Springs Water Control Structure Project Area
- Keystone Dam
- Arkansas River
- Named Tributaries
- Study Area

Notes:
1. The Study Area (in green) is a preliminary project boundary that will be adjusted once the effects of the project are better understood.

FIGURE 1
Study Area
Arkansas River Corridor Feasibility Study Environmental Assessment – Biological Resources Report

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The management measures included in Table 1 would be used to improve aquatic ecosystem benefits (and flood damage reduction). The measures will be screened on the basis of cost, effectiveness, acceptability, and environmental impact. The screening will be performed using planning level cost estimates and professional judgment.

1.2 Project Background

Following the 2003 voter-approved *Vision 2025: Foresight 4 Greater Tulsa*, Proposition 4, Capital Improvements for Community Enrichment (Tulsa County Board of County Commissioners, 2003), the Indian Nations Council of Governments (INCOG) began a comprehensive public involvement and planning effort that culminated in the *Final ARC Master Plan, Phase II Master Plan and Pre-Reconnaissance Study* (Guernsey et al., 2005). In response to multi-community support for the ARC Master Plan concepts, the U.S. Congress created special authorization language in Section 3132 of the Water Resources Development Act (WRDA) of 2007. Section 3132 authorized construction of ecosystem restoration, recreation, and flood risk management components identified in the 2005 ARC Master Plan. Implementation guidance for the project was provided on February 4, 2009, which directed the completion of a feasibility study for the project. The effects of two proposed low-water dams (LWDs) (Sand Springs and South Tulsa/Jenks) and modification of an existing LWD (Zink), identified in Vision 2025, Proposition 4 (Tulsa County Board of County Commissioners, 2003), would be included in the feasibility analysis of a comprehensive ecosystem restoration project to improve riverine, riparian corridor, and open water habitats; stabilize streambanks; and improve water quality.

The Preliminary Project Management Plan (PMP) for the Project was developed in 2010 to provide guidance to the multiple sponsors (Tulsa County, INCOG, U.S. Economic Development Administration (EDA), and USACE) as the Project proceeded through future phases (CH2M, 2010). The overall Project was originally identified by the citizens of Tulsa County, Oklahoma, and involved ecosystem restoration along a 42-mile reach of the Arkansas River, between Keystone Dam and the Tulsa County/Wagoner County line.

A detailed description of the project history, previous studies, and regional considerations are included in the Preliminary PMP. The components of the Project were outlined in the Baseline Project Summary (Appendix A to the 2010 Preliminary PMP), including improvements at Zink Dam, South Tulsa/Jenks, and Sand Springs. Detailed technical studies and investigations for three key development sites completed through 2010 were included in Appendixes B through X of the 2010 Preliminary PMP.

The Preliminary PMP also established procedures for completing the next phase of the Project and was designed to serve as the basis for the Final PMP, which would be developed by USACE in accordance with National Environmental Policy Act (NEPA) and other applicable regulations, and USACE and Council on Environmental Quality (CEQ) guidance documents.

The feasibility study was initiated with a re-scoping charrette held by the USACE in October 2013 to revisit the Project to align with the specific, measurable, attainable, risk-informed, and timely (SMART) planning approach issued by Major General Walsh in 2012 (USACE, 2013a). The only measures identified during the charrette that reflected a federal interest were the ecosystem restoration measures outlined in Section 8.10 (with the exception of the LWDs) and the flood risk management measures outlined in Section 8.11 of the ARC Master Plan (Guernsey et al., 2005).

The results of the re-scoping charrette and agency coordination indicate that the only measures with the potential to provide the benefits necessary to justify federal implementation are increasing the consistency and duration of instream flows downstream of Keystone Dam, combined with other nonstructural ecosystem restoration measures. The Project study area reflects those measures identified in the ARC Master Plan (Guernsey et al., 2005) that are candidates for potential federal implementation.

1.3 Project Alternatives

Extreme flow variability, resulting from Keystone Lake operations, has negatively impacted the aesthetic, environmental, and water quality conditions of the Arkansas River, which limits the economic development potential along the ARC. Proposition 4, Capital Improvements for Community Enrichment, of Vision 2025 began the process to address these issues (Tulsa County Board of County Commissioners, 2003). A broad range of solutions were proposed by the USACE, Tulsa District, from which initial alternatives were developed to restore instream flows and aquatic and wetland habitat within the ARC, consistent with providing life requisite needs for the interior least tern. The USACE screened out some of the initial alternatives, and the final alternatives were prepared during the alternatives milestone meeting held on January 29, 2016, with the sponsors (USACE, Tulsa County; INCOG; and EDA).

The two project alternatives developed include modification and restoration of instream flows within ARC. In addition, both instream flow measures could include various aquatic ecosystem restoration measures. The USACE is developing the various ecosystem restoration measures are being developed; therefore, project-level details were not available for this Report. However, the 42-mile study area encompasses the Project considered for the ecosystem restoration. The two alternatives are described as follows:

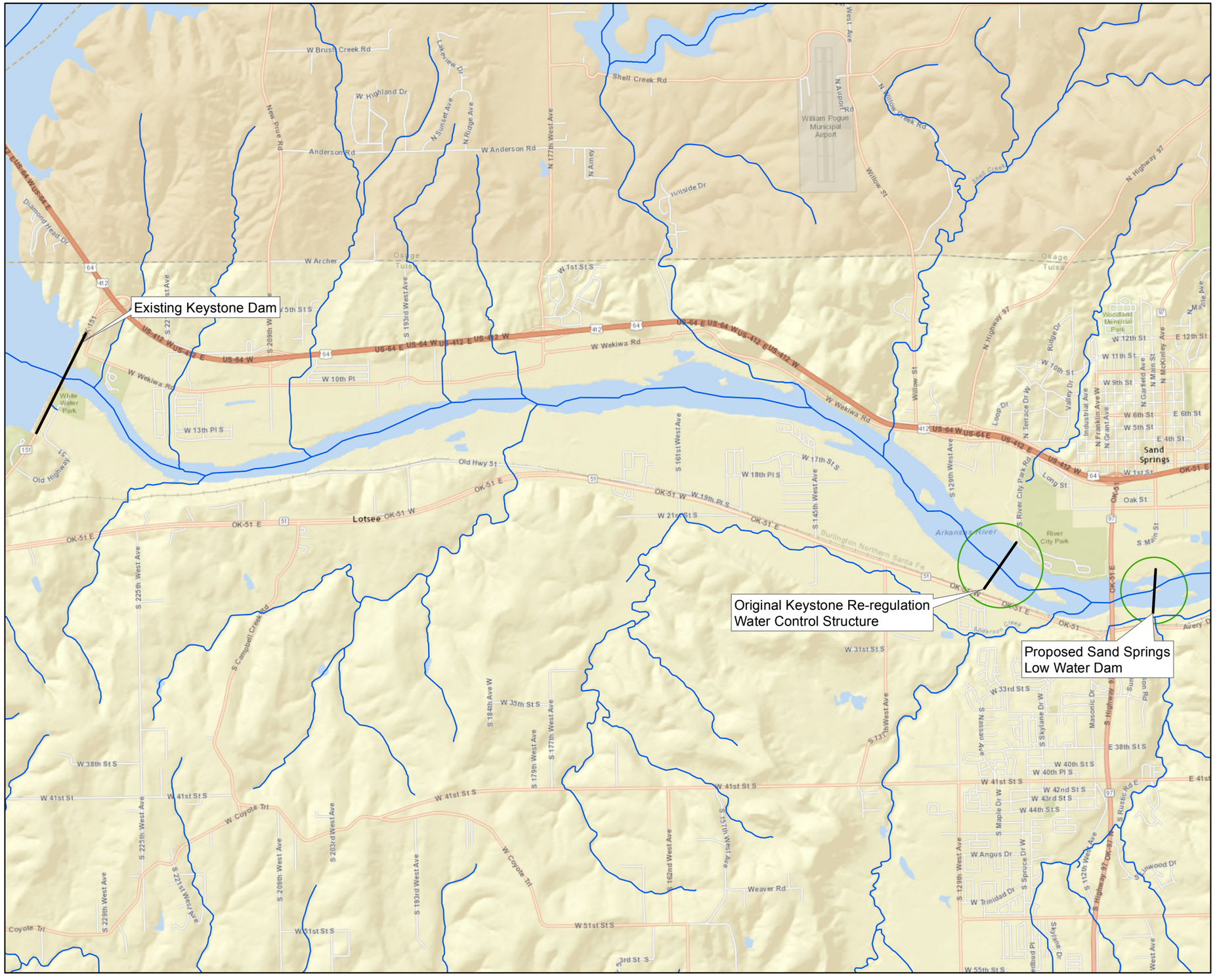
- Alternative 1 includes reallocation of water from Keystone Lake (reallocation of storage from municipal and industrial water supply and hydropower) for instream flows. The USACE is currently developing further detail for this alternative.
- Alternative 2 includes constructing a water control structure at Sand Springs. The final location of the water control structure is to be determined. The LWD proposed by Tulsa County (CH2M, 2015) was used in this Report as a proposed project location.

The original location of the Keystone re-regulation dam is shown on Figure 2 (River Mile 583.3). Approximately 1 mile downstream of the re-regulation dam, just downstream of the Highway 97 bridge (River Mile 530.53), is the Sand Springs LWD location included in the 2015 Schematic Design report proposed by Tulsa County (CH2M, 2015). This water control structure alternative could potentially include implementing a combination of ecosystem restoration measures along the ARC as included in Table 1. The final location of the water control structure will be determined based on the alternatives screening of the USACE.

The proposed Sand Springs water control structure (also referred to as an LWD) is located on the Arkansas River near the cities of Sand Springs and Tulsa, Oklahoma, approximately 1,500 feet downstream of the Highway 97 bridge and 9 miles downstream of Keystone Dam (CH2M, 2015). The Proposed Action includes construction of an LWD for water impoundment at Sand Springs located on the Arkansas River near Tulsa and Sand Springs, Oklahoma, and is a combination of the following elements:

1. Construction of a new LWD.
2. Establishment of new static pool upstream of the Sand Springs with a dam fixed crest elevation of 638.5 feet, resulting in a lake depth at the dam of 10 feet.

The proposed LWD would impound up to 142,379,000 cubic feet (19 million gallons) of water. Release of this water would provide a release duration of 3 days at a flow rate of 550 cubic feet per second (cfs) at the low end, a release duration of 1.65 days and flow rate of 1,000 cfs at the high end, and would supplement the existing flow.



VICINITY MAP

LEGEND

- Water Control Structures
- River and Tributary Line
- Study Area

N

0 1,000 2,000 4,000

Feet

FIGURE 2
Original Keystone Re-regulation Water Control Structure and Proposed Sand Springs Low Water Dam
Arkansas River Corridor Feasibility Study Environmental Assessment – Biological Resources Report

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1.4 Study Area Description

This section provides a summary of the geographic area (study area) that may be affected by the Proposed Action. This study area description includes the geographic delineation and regional setting, natural communities, and biological resources.

1.4.1 Geographic Delineation and Regional Setting

The study area is located on the mainstem of the Arkansas River within Tulsa County, Oklahoma, which includes its banks from the Keystone Dam downstream to the Tulsa/Wagoner County line (42 miles), and is located entirely within the Polecat-Snake Watershed (HUC 11110101) as shown on Figure 1. Much of the surrounding land use includes the urbanized Tulsa metropolitan area, which includes the cities of Bixby, Owasso, Broken Arrow, Jenks, and Sand Springs. The remaining watershed land use is primarily agricultural with some commercial land use. Zink Dam and its associated reservoir pool are located near 31st Street and Riverside Drive in Tulsa, Oklahoma.

The proposed location for this Project alternative is in northeast Oklahoma within the Arkansas River drainage basin, downstream of Keystone Dam, with the westernmost portion of the study area beginning at the Keystone Dam, and most of the study area west of Sand Springs (see Figure 2). The 42-mile study area is generally located within urbanized environment; therefore, the natural landscape has been heavily altered. Examples of modifications within the study area include riprap and graded banks, fill, concrete channels, commercial and residential development, and industrial facilities. Keystone Dam was built in 1964 along the Arkansas River upstream from Tulsa to control flooding and stabilize river flow. This has affected the ARC within Tulsa and its suburbs, changing the normal water levels downstream, and facilitating development along the banks.

The tributaries Euchee Creek, Fisher Creek, and old Prattville Creek, enter the Arkansas River within the study area. Of these tributaries, the Prattville Creek confluence and the surrounding area is the only area where additional restoration and ecosystem improvement work is required for this alternative. The Arkansas River flows west to east where the old Prattville Creek meets with the river, and the confluence is located on the south side of the Arkansas River directly north of Prattville and south of Sand Springs.

The Arkansas River is the fourth longest river in the U.S. It flows from the headwaters near Leadville, Colorado, to the confluence with the Mississippi River near Rosedale, Mississippi. The river flows 1,450 miles through Colorado, Kansas, Oklahoma, and Arkansas. The Arkansas River has a watershed area of almost 195,000 square miles (mi^2) at the confluence of the Mississippi River and a watershed area of 74,615 mi^2 at the Tulsa gaging station maintained by the U.S. Geological Survey (USGS). The Arkansas River drains most of Tulsa County, but tributaries of the Verdigris, principally Bird Creek and the Caney River, drain the northern portion.

Tulsa County contains 587 mi^2 of land and water area. The landscape includes prairies and sandstone hills, with the lowlands of the Arkansas River Valley providing excellent farming soil. The Arkansas River flows through the study area in a wide, braided, sandy-bottomed channel referred to as a prairie river. Prairie rivers are a mix of runs and riffles that change within the larger river channel when higher flows move and redeposit sand. At lower flow conditions, these sand bars are exposed and may establish rooted vegetation or remain barren. Reservoirs such as Keystone and Kaw, which provide flood control and hydropower generation, have altered the seasonal pattern of hydrologic inputs from rainfall. Changes in river hydrology below Keystone Dam are the result of daily releases from hydropower generation. The Arkansas River does support navigation up to Muskogee, Oklahoma, but is considered non-navigable within the study area.

While the Arkansas River has long been a significant natural resource for the surrounding land and its inhabitants, historical alterations have substantially altered watershed conditions and degraded the

river's ecosystem. Keystone Dam, which was constructed in 1964 to protect nearby communities from extreme flood events, significantly changed the natural hydrology of the Arkansas River. Additionally, growth and development associated with the Tulsa metropolitan area, and related intensive land use practices, have led to streambank erosion, destruction of riverine wetlands, increased stormwater runoff, and a high degree of sediment transport to the river. As a result, ecosystems native to the Arkansas River area have been compromised, and instream habitats continue to be depleted and degraded.

INCOG is the designated Water Quality Management Planning Agency for the Tulsa, Oklahoma region. In that capacity, INCOG has modeled water quality impacts in streams and rivers for several decades and provided recommended waste load allocations (WLAs) and discharge permit limits for dischargers in the INCOG service area. State and federal permitting agencies use the INCOG WLA information to set discharge permit limits for direct wastewater dischargers. INCOG has developed a water quality model for each stream containing a direct wastewater discharge. The water quality model for the Arkansas River has been used extensively for developing WLAs for discharges into the Arkansas River and also for performing the impact analysis to construct a new LWDs along Arkansas River in Tulsa County (Guernsey et al., 2005).

In 2005, INCOG performed an update of the water quality model for the Arkansas River as art of Vision 2025. INCOG coordinated with the design engineers and the USACE, Tulsa District to modify the water quality model with new cross sections reflecting new dam and pool locations. The following conclusion was reached based on the final ARC Master Plan LWD water quality evaluation results LWDs performed by INCOG in 2005 resulted in the following conclusion:

> *The two Tier 1 LWDs, Dam Number 4 south of the 96th Street bridge in Jenks/South Tulsa and Dam Number 7 east of Highway 97 in Sand Springs, did not exhibit unacceptable dissolved oxygen levels (Guernsey et al., 2005).*

In 2010, INCOG performed further water quality analysis on the study area and prepared a summary table that includes the past several approved versions of the 303(d) list of impaired waters for Arkansas River segments. Table 2 shows the Arkansas River water quality improvement since the 1998 Final 303(d) list. The approved 2014 303(d) list indicates that each segment from Keystone Dam to Muskogee Creek only has one or less pollutant of concern remaining to be addressed. With significant improvements to local wastewater plant discharges to the river, elimination of storm sewer and sanitary sewer cross connections, and implementation and maintenance of areawide stormwater management programs in the cities discharging to the Arkansas River, these demonstrated water quality improvements are anticipated to continue (ODEQ, 2015).

Recent and previous water quality modeling studies by INCOG have consistently predicted water quality standards compliance and designated beneficial use attainment in the Arkansas River with or without the proposed South Tulsa/Jenks LWD and Lake. Coincidentally, the progression of 303(d) lists over the past 16 years shows a consistent improvement in water quality in the river, likely attributable to the significant improvements and infrastructure investments made to local treatment facilities and urban stormwater management activities (ODEQ, 2015).

1.4.2 Natural Communities

Natural community habitats found within the study area include various wetland types, riverine sand bars, streams, and intermittently and permanently inundated open water areas.

1.4.2.1 Wetlands

The mainstem of the Arkansas River within the study area contains much wetland habitat, including emergent herbaceous wetlands, riparian shrub habitat, and bottomland hardwood forests, which are described in this section.

Table 2. Status of 303(d) Listing for Arkansas River - 1998 through 2014 Lists

Biological Resources Report, Ecosystem Restoration for the ARC Feasibility Study Environmental Assessment

River Segment	Location	1998 Final List	2002 Final List	2004 Final List	2006 Final List	2008 Final List	2010 Final List	2012 Final List	2014 Final List
OK120420010130_00	Keystone Dam to Berryhill Creek	303(d) - metals, pathogens, pesticides, priority organics	Category 2	Category 2	Category 2	Category 5a - oil and grease, TDS	Category 5a - turbidity, thallium, oil and grease	Category 5a - turbidity, oil and grease Category 4a - enterococcus	Category 5a - turbidity Category 4a - enterococcus
OK120420010010_10	Berryhill Creek to Cherry Creek	303(d) undivided - metals, pathogens, pesticides, priority organics	Not listed in 2002 Integrated Report	Category 3	Category 5a - cadmium, fecal coliform	Category 5a - cadmium, fecal coliform	Category 5a - cadmium, fecal coliform	Category 5a - cadmium	Category 5a - cadmium
OK120420010010_00	Cherry Creek to Snake Creek		Category 5 - lead	Category 5 - enterococcus, E. coli, fecal coliform	Category 5a - enterococcus, E. coli, fecal coliform	Category 5a - fecal coliform, enterococcus, TDS, lead, oil and grease	Category 5a - turbidity, thallium, oil and grease (bacteria TMDL completed)	Category 5a - turbidity, oil and grease Category 4a - Enterococcus	Category 5a - turbidity Category 4a - enterococcus
OK120410010080_10	Snake Creek to Broken Arrow Creek	303(d) undivided - pathogens, pesticides, priority organics	Category 3	Category 3	Category 5a - fecal coliform	Category 5a - fecal coliform	Category 5a - fecal coliform	Category 2 (delisted fecal coliform)	Category 2
OK120410010080_00	Broken Arrow Creek to Muskogee Creek, North		Category 5 - pathogens, TDS	Category 5 - TDS, turbidity, enterococcus	Category 5a - TDS	Category 5a - enterococcus, TDS, oil and grease	Category 5a - thallium, oil and grease (bacteria TMDL completed)	Category 4a - enterococcus	Category 4a - enterococcus

Source: INCOG, 2015.

TDS = total dissolved solids

Category 2 = Attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened.

Category 3 = Insufficient or no data and information to determine if any designated use is attained.

Category 4a = Total maximum daily load (TMDL) has been completed.

Category 5 = Impaired (equivalent to 303(d) list) and needing a TMDL.

Category 5a = TMDL is underway or will be scheduled.

Wetland habitats within the study area also provide essential habitat for amphibians, reptiles, birds, and mammals. Frogs and salamanders use these wetland areas for breeding grounds and egg laying. Ducks and migratory birds use them for resting areas on migrations routes for nesting.

1.4.2.1.1 Emergent Herbaceous Wetlands

Emergent wetland areas, characterized by usually flooded areas with rooted, herbaceous hydrophytes, also occur within the study area. They can be found either along the edge of the Arkansas River or in depressional areas within the floodplain. Dominant perennial vegetation in these emergent wetlands may include rushes (*Juncus* spp.), smartweed (*Polygonum* spp.), spikerush (*Eleocharis* spp.), grassy arrowhead (*Sagittaria graminea*), cattail (*Typha latifolia*), and various sedges (*Carex* spp.). Buttonbush (*Cephalanthus occidentalis*) is also commonly found scattered throughout wetland areas where inundation is less frequent (Oklahoma State University, 1998).

1.4.2.1.2 Riparian Shrub Habitats

Riparian shrub wetlands, characterized by occasionally flooded areas with shrub and young woody vegetation, also occur within the study area. These are open areas dominated by shrub and hardwood saplings mixed with emergent herbaceous vegetation. Riparian shrub wetlands provide shelter, food, and nesting habitat for a variety of wildlife. Common vegetation in these wetland areas includes buttonbush (*Cephalanthus occidentalis*), hawthorn (*Crataegus crus-galli*), deciduous holly (*Ilex decidua*), big bluestem (*Andropogon gerardii*), and soft rush (*Juncus effusus*). Young hardwoods common to this habitat may include black willow (*Salix nigra*), cottonwood (*Populus deltoides*), oaks (*Quercus* spp.), sandbar willow (*Salix exigua*), and sycamore (*Plantanus occidentalis*) (Oklahoma State University, 1998).

1.4.2.1.3 Bottomland Hardwood Forests

Bottomland hardwood forests are an extensive component of the Arkansas River riparian corridor, occurring largely within the floodplain of the river and adjacent to small tributaries. This forest habitat is regarded as extremely important because of the wildlife diversity it supports, high soil productivity, and hydrologic regimes. The forested bottomland in the study area consists of large- to medium-sized trees with a moderate understory. The overstory is dominated by cottonwood, sycamore, green ash (*Fraxinus pennsylvanica*), pecan (*Carya illinoensis*), box elder (*Acer negundo*), river birch (*Betula nigra*), black willow, silver maple (*Acer saccharinum*), black walnut (*Julgans nigra*), sugarberry (*Celtis laevigata*), water oak (*Quercus nigra*), overcup oak (*Quercus lyrata*), and willow oak (*Quercus phellos*). The bottomland understory is largely dominated by swamp privet (*Forestiera acuminata*), greenbriar (*Smilax* spp.), poison ivy (*Toxicodendron radicans*), violets (*Viola* spp.), and trumpet-creeper (*Campsis radicans*), along with young hardwood species (Oklahoma State University, 1998).

1.4.2.2 Riverine Sand Bars

Riverine sand bars dominate the river channel habitats during lower flow conditions. Riverine sand bar habitat structure and function are influenced directly by the hydrology of the Arkansas River. The riverine sand bar size, location, and stability are dependent on the controlled flow conditions of the Arkansas River through releases from the Keystone Dam upstream. During typical river-stage conditions (less than 12,000 cfs), the sand bars within the study area are dry and not inundated by surface water. During higher river stages, the sand bars are partially or fully inundated by surface water.

Riverine sand bar habitats within the study area are mostly unvegetated. By their nature, the sand bars are subject to cycles of scour and deposition. At slightly higher elevations nearer the river banks, the riverine sand bars are less frequently inundated by surface waters and become more vegetated. Where established along the banks, vegetation is typically herbaceous shrubs, or smaller trees such as black willow, sandbar willow, buttonbush, sycamore, and big bluestem. The invasive species Johnson grass (*Sorghum halepense*) is readily abundant within these habitats because it quickly colonizes areas disturbed by the shifting river sands. The highest elevations within the riverine sand bar habitats include

the bank slopes of the Arkansas River. The majority of the riverbanks are steep to near vertically sloped with areas that are sloughing and/or eroding or are reinforced with riprap or concrete rubble.

The primary ecological functions that the riverine sand bars provide within the study area include floodwater attenuation during high-river stage events; sediment source for downstream habitats; habitat for listed species; and foraging habitat for wading birds, waterfowl, and terrestrial species

Arkansas River riverine sand bars within the study area have the potential to provide habitat for three federally listed species: the interior least tern (*Sterna antillarum*), the piping plover (*Charadrius melodus*), and the red knot (*Calidris canutus rufus*). The bald eagle (*Haliaeetus leucocephalus*), which was recently removed from federal listing, is also known to use habitats within the study area.

1.4.2.3 Open Water

Open water habitats within the mainstem of the ARC include riffle and pool run complexes, isolated pools, and a reservoir pool (Zink Lake). The riffle and pool run complexes are features typical of a prairie river system. They are braided and relatively nonpermanent features that become repositioned within the river channel during higher flow conditions. Substrates are typically sand or bedrock with little gravel or cobble. At locations where the river channel substrate is bedrock, the riffle runs are more permanent features.

Isolated pools of open water are less common throughout the study area. They include features created through natural processes such as oxbows, which are relics of meandering riffle and pool run complexes and those created through anthropogenic activities such as sand mining and at locations below stormwater outfalls entering the river. Many of these isolated pools are temporary, as braided riffle and pool run complexes meander under various river flow conditions and as riverine sand bars shift and are redeposited. The more permanent pools are found adjacent to the ARC banks and are connected to other surface waters under higher river stages. Many of these have emergent and shrub wetland vegetation present, creating a littoral fringe that helps stabilize the substrate. Water quality within the more permanent pools are typically reduced because of stormwater inputs and little to no mixing with other surface waters. Substrates within these pools include sand and organic sediments.

Zink Dam is located near 31st Street and Riverside Drive. The dam was constructed in 1983 creating a permanent reservoir pool known as Zink Lake. The backwater, or impounded area, extends upstream approximately 2 miles and encompasses approximately 298 acres when the dam is at the control elevation of 617 feet. The existing dam structure limits fish and fish egg passage, and reduces sediment transport downstream by trapping sediments in the reservoir.

The open water habitats within the study area provide foraging areas for wading areas and shorebirds, including the listed species interior least tern, piping plover, and red knot. They provide resting areas for waterfowl. The deeper and more permanent open water features provide habitat for fish communities. Wildlife species typically associated with these habitats are described in the Biological Resources section of this Report.

1.4.2.4 Streams

Stream habitats within the study area include named tributaries of the Arkansas River. Stream channels identified for potential restoration activities include the confluence of the perennial streams, Prattville Creek and Cherry Creek, along with slack water side channels of the Arkansas River along the left bank, upstream of Interstate 44 (I-44). These creeks drain rural watersheds within their upper segments and primarily urban watersheds in lower segments near their confluence with the Arkansas River. The lower segments of these creeks have been altered for flood control over the years, which typically include concrete-lined beds and banks and, in some instances, the relocation of stream channels. In unaltered segments of the stream channels, substrates are typically sand, gravel, and some cobble. Riparian buffers vary from intact, reduced, and removed depending on the proximity of the stream channel to

development or agricultural areas. Many of the stream banks are unstable and exhibit moderate to severe erosion, primarily from a lack of vegetated banks/buffers, and flashy hydroperiods from increased runoff caused by watershed development. Of these streams, a segment of Polecat Creek is listed by the State of Oklahoma as impaired for pathogens (EPA, 2016). None of the named streams provide habitat for protected species. Some listed species, such as interior least terns, piping plovers, and red knots, may forage along the sand bars and more permanent pools at the mouth of the streams at their confluence with the Arkansas River; however, use of the stream habitat farther upstream into the urbanized watershed is unlikely.

1.4.3 Biological Resources

Emergent wetland habitats found within the study area provide food and shelter for fish and other species including macroinvertebrates, which make up the foundation of the aquatic food chain. These wetland areas also provide habitat for amphibians, reptiles, birds, and insects. Frogs and salamanders use these wetland areas for breeding grounds and for egg laying. Ducks and migratory birds use them for resting areas on migration routes and for nesting. Insects associated with open water and emergent habitats include true flies (order Diptera), mayflies (order Ephemeroptera), caddisflies (order Trichoptera), dragonflies and damselflies (order Odonata), and beetles (order Coleoptera). These aquatic insects not only provide a food source for fish, aquatic invertebrates, amphibians, reptiles, and birds, they also break down organic material present in riverine and riparian wetland areas common throughout the study area.

Many species of reptiles and amphibians inhabit the riparian bottomland forests and emergent wetlands along the Arkansas River, with amphibians being more prevalent in the bottomland swamp areas and other aquatic habitats. Common reptiles include the western ribbon snake (*Thamnophis proximus*), eastern hognose snake (*Heterodon platyrhinos*), fence lizard (*Sceloporus undulates*), timber rattlesnake (*Crotalus horridus*), common snapping turtle (*Chelydra serpentina*), red-eared slider (*Chrysemys scripta elegans*), and three-toed box turtle (*Terrapene carolina triunguis*). Common amphibians include the southern leopard frog (*Rana sphenocephala*), northern spring peeper (*Hyla crucifer*), American toad (*Bufo americanus*), bullfrog (*Rana catesbeiana*), and green frog (*Rana clamitans melanota*) (CH2M, 2010).

Bird species commonly found in forested habitats surrounding the area include pileated woodpecker (*Dryocopus pileatus*), belted kingfisher (*Ceryle alcyon*), wood duck (*Aix sponsa*), herons and egrets (*Ardea* spp. and *Egretta* spp.), barred owl (*Strix varia*), and red-shouldered hawk (*Buteo lineatus*). Birds common in the wetland areas are similar to those that occur in upland forested habitats, particularly waterfowl such as herons, egrets, and cormorants (*Phalacrocorax* spp.).

The Arkansas River and its tributaries within the study area support a prominent fishery providing valuable recreational opportunities to area residents. Additionally, populations of suitable forage species for interior least terns and wading birds are relatively abundant in the Arkansas River. Sources cited in the interior least tern recovery plan (USFWS, 1990) identify species of *Notropis, Pimephales, Gambusia, Dorosoma*, and *Carpiodes* among important fish genera in the diet of least tern. Species of *Cyprinella* and *Labidesthes* also are small fish that are potentially suitable as prey. These smaller forage fishes are most abundant in pool runs, Zink Lake, and temporary and permanent isolated pools. Their local seasonal abundance is dependent on river flows, pool connections to other river channel surface waters, and water quality.

A seasonal fisheries survey conducted by ODWC biologists from October 2006 through September 2007 (Cherokee CRC, 2009) reported the occurrence of 41 species of fish in 12 families from the Arkansas River in Tulsa County. Of these reported species, four are listed as invasive exotics: grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio)*, white perch (*Morone americana*), and flathead catfish (*Pylodictis olivaris*). The families represented by the most species were sunfish (*Lepomis*

spp.)(9 species), carp (family Cyprinidae) and minnows (8 species), and suckers (7 species). The principal sport fishes collected included largemouth bass (*Micropterus salmoides*), spotted bass (*Micropterus punctulatus*), striped bass (*Morone saxatilis*), channel catfish (*Ictalurus punctatus*), flathead catfish, white crappie (*Pomoxis annularis*), a variety of sunfish, and sauger (*Sander canadensis*). ODWC collected 29 species from the reach between Keystone Dam and Zink Dam and 37 species from the reach downstream of Zink Dam. Eleven species were collected exclusively downstream of Zink Dam, potentially indicative of habitat differences, water quality conditions, or Zink Dam as an impediment to upstream dispersal (as currently operated). The 11 species included 4 native minnows, and the larger native riverine species paddlefish (*Polyodon spathula*), river redhorse (*Moxostoma carinatum*), golden redhorse (*Moxostoma erythrurum*), sauger (*Sander canadensis*), and walleye (*Sander vitreus*). Recent occurrence (2015) of paddlefish in the Arkansas River in Tulsa County have also been reported. Numerous paddlefish were observed in pools below Zink Dam in late summer and early fall 2015, following elevated river stages throughout most of the summer, which likely allowed the paddlefish to travel farther upstream than during typical river stages.

From October 2006 to April 2008, Eagle Environmental Consulting, Inc., conducted aquatic macroinvertebrate surveys along the Arkansas River at locations upstream and downstream of the study area. The most common species collected were Chironomids (midges), Naiads (dragonflies and mayflies), Hyalellans (amphipods), and Daphnia (water fleas). Freshwater mussels with the potential to occur within the action area of the Arkansas River and its tributaries include white heelsplitter (*Lasmigonia complanata*), fragile papershell (*Leptodea fragilis*), giant floater (*Pyganodon grandis*), pink papershell (*Potamilis ohiensis*), and mapleleaf (*Quadrula quadrula*) (Eagle Environmental Consulting, Inc., 2008). The shifting substrate of the river in most locations likely provides poor habitat for mussels, which generally prefer a stable substrate; however, this is not the case in Zink Lake.

According to the USGS Nonindigenous Aquatic Species (NAS) database, a record from 2006 indicated that zebra mussels (*Dreissena polymorpha)* in the Polecat Snake Watershed (HUC 11110101) of the Arkansas River downstream of the Zink Dam, had an established population (reproducing and overwintering) (USGS, 2016; ODWC, 2012). The infestation of zebra mussels in the Arkansas Rivers appears to have come from a commercial vessel in 1992 (USACE, 2010b). The infestation has continued down the Arkansas River, through Tulsa County, to the already infested navigation system.

SECTION 2

Description of Protected Species and Status within Study Area

This section provides an assessment of the existing biological resources within the 42-mile ARC study area to address the potential effects of implementing the two alternatives. The federally protected species potentially present in the study area are listed in Table 3.

Table 3. Potentially Occurring Federally Protected Species within the Study Area
Biological Resources Report, Ecosystem Restoration for the ARC Feasibility Study Environmental Assessment

Name	Scientific Name	Federal Protection Status
Birds		
Interior least tern	*Sternula antillarum athalassos*	Endangered
Piping plover	*Charadrius melodus*	Threatened
Red knot	*Calidris canutus rufa*	Threatened
Insects		
American burying beetle	*Nicrophorus americanus*	Endangered
Mammals		
Northern long-eared bat	*Myotis septentrionalis*	Threatened

Sources: USFWS, 2016a

The following section provides a description of these species and their status within the study area.

2.1 Interior Least Tern

The interior population of least tern (interior least tern) is one of three subspecies of least tern, which is the smallest of the species in the tern family (*Sternidae*). The three subspecies of least tern are identical in appearance, morphology, habitat preferences, vocalization, and behavior and are distinguished only by their breeding ranges. The interior least tern is distinguished by being localized in the interior of the U.S. where it breeds along major tributaries in the Mississippi River basin.

USFWS (1985a) lists the interior least tern population as federally endangered. As of May 2015, critical habitat has not been designated for interior least tern (USFWS, 2015a). Tulsa County is located within the probable migratory path for interior least tern and provides stopover habitat. Since 2005, the USACE, Tulsa District has annually monitored least terns in the Arkansas, Canadian, and Red Rivers in accordance with the USFWS 2005 Biological Opinion on the effects of USACE multipurpose projects (USFWS, 2005). Least tern monitoring by the USACE and USFWS is accomplished by conducting onsite surveys during the summer nesting season (June through August). There are documented occurrences, including breeding and nesting activities, of the interior least tern in Tulsa County, Oklahoma. **Figure 3** shows the locations where terns were observed within the study area during the 2005-2014 monitoring period and nearby Arkansas River Miles (ARMs) (USACE, 2015). There are no results in 2007 and 2015 because of the high flows during those years preventing a survey. The location of nesting colonies varies slightly depending on the flow conditions. Table 4 provides a summary of the least tern survey results for the past 5 years (2010-2014).

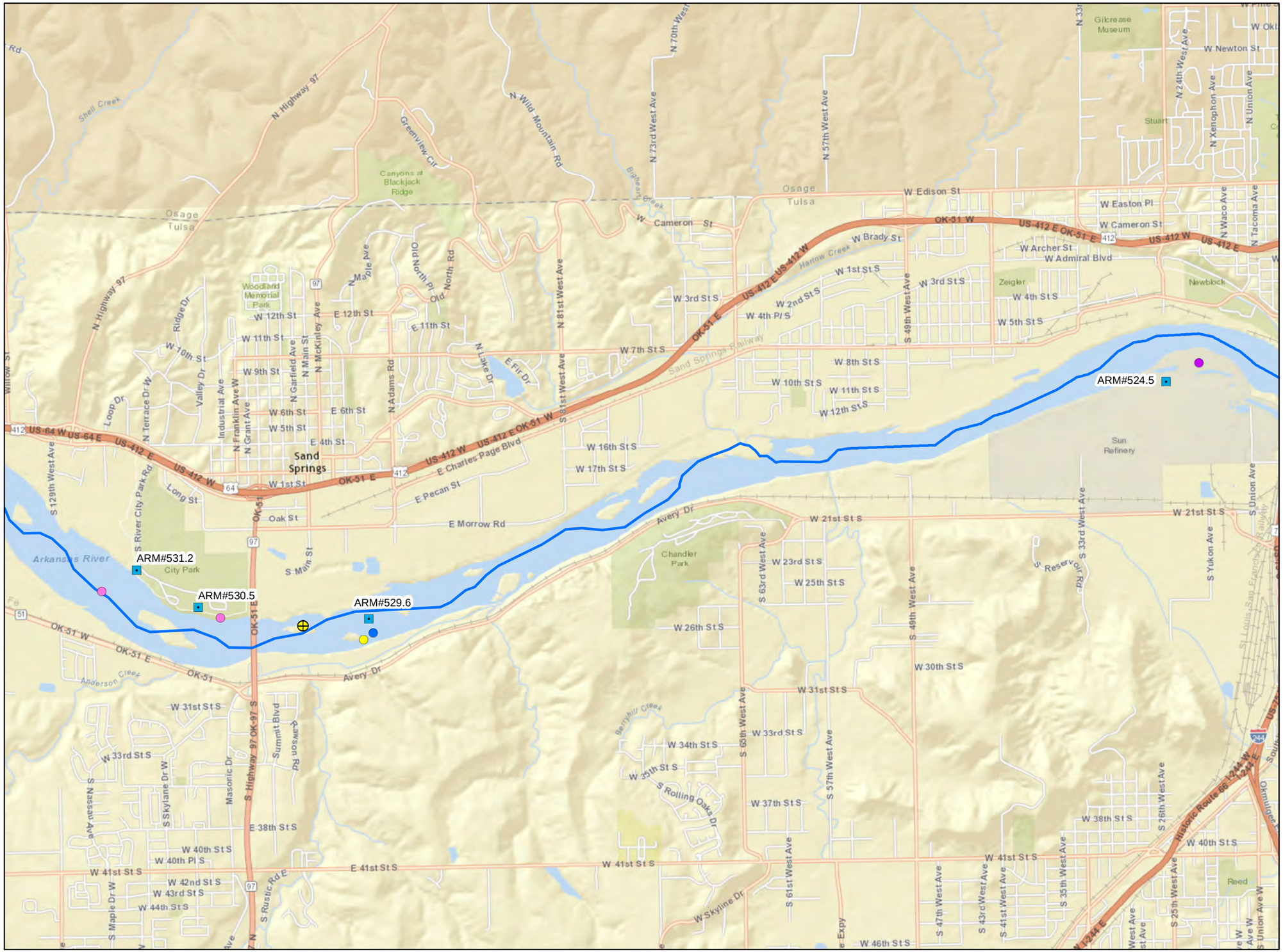
Table 4. Interior Least Tern Survey Results 2010-2014
Biological Resources Report, Ecosystem Restoration for the ARC Feasibility Study Environmental

Survey Year	Adults	Fledglings
2010	255	68
2011	356	235
2012	307	194
2013	216	100
2014	557	211
5-year average	**338.2**	**161.6**

Source: USACE, 2010a, 2011, 2012, 2013b, and 2014.

High-river flows from rainfall wash away nests or inundate colonies, causing the population results to vary annually. Other factors that impact populations include human disturbance, geese disturbance, and predators. Historically there are approximately 30 colony sites between ARMs 530 and 462. Colony sites vary in island density and size. Large islands may have nesting activity in one area or scattered over a large area. Colonies in areas of several smaller islands, which are typical of a braided river system, may have nesting occur on the different islands in close proximity, or scattered farther downstream. Although the islands may change in size, elevation, and even location, terns normally use the same general areas each year.

Least terns typically arrive in the study area around May 15 and leave by August 22 (Lott, 2009). The least tern breeding season is approximately 100 days. They nest in colonies on barren to sparsely vegetated sand and gravel bars within braided streams and rivers, as well as on manmade structures (such as inland beaches, wastewater treatment plants, and gravel mines). They lay two to three eggs in shallow nests, guard and care for their chicks, and hover over and dive into shallow flowing or standing water to feed on small fish (USFWS, 1990). Additionally, least terns tend to forage no farther than 2 miles from their nest sites, although some may fly up to 4 miles to fish (USFWS, 1990). Peak nesting activity tends to occur in late June and early July (Lott, 2006). Least tern adults and fledglings depart the study area by September for wintering grounds, flying south into Central and South America.



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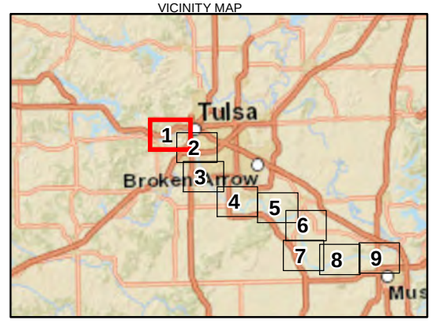

LEGEND

Colony Sites by Year

- 2005
- 2006
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

N

0 1,500 3,000 6,000

Feet

Figure 3 (Map 1 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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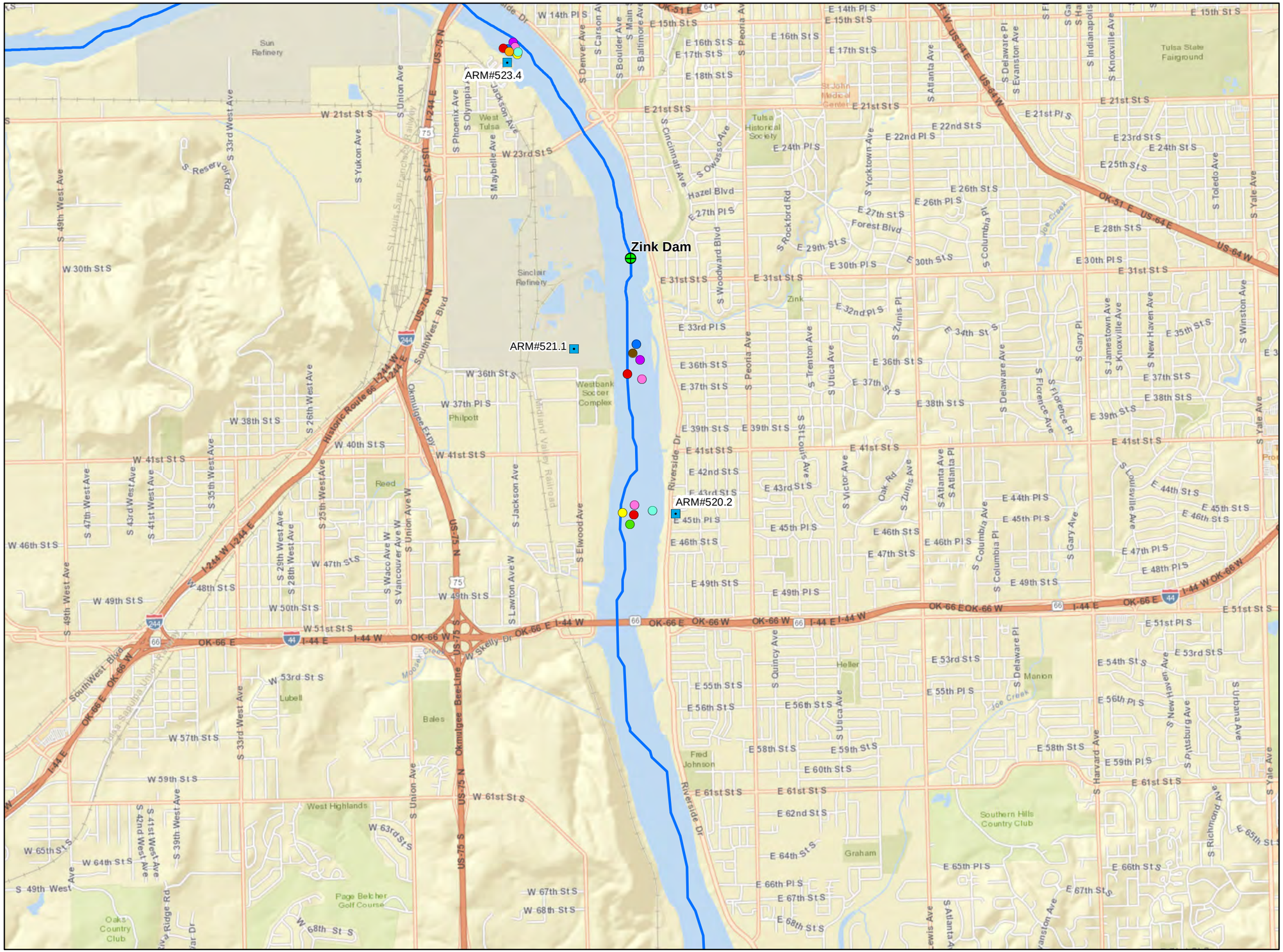

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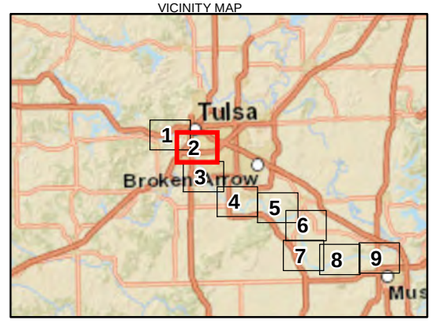

LEGEND

Colony Sites by Year

- 2005
- 2006
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

Figure 3 (Map 2 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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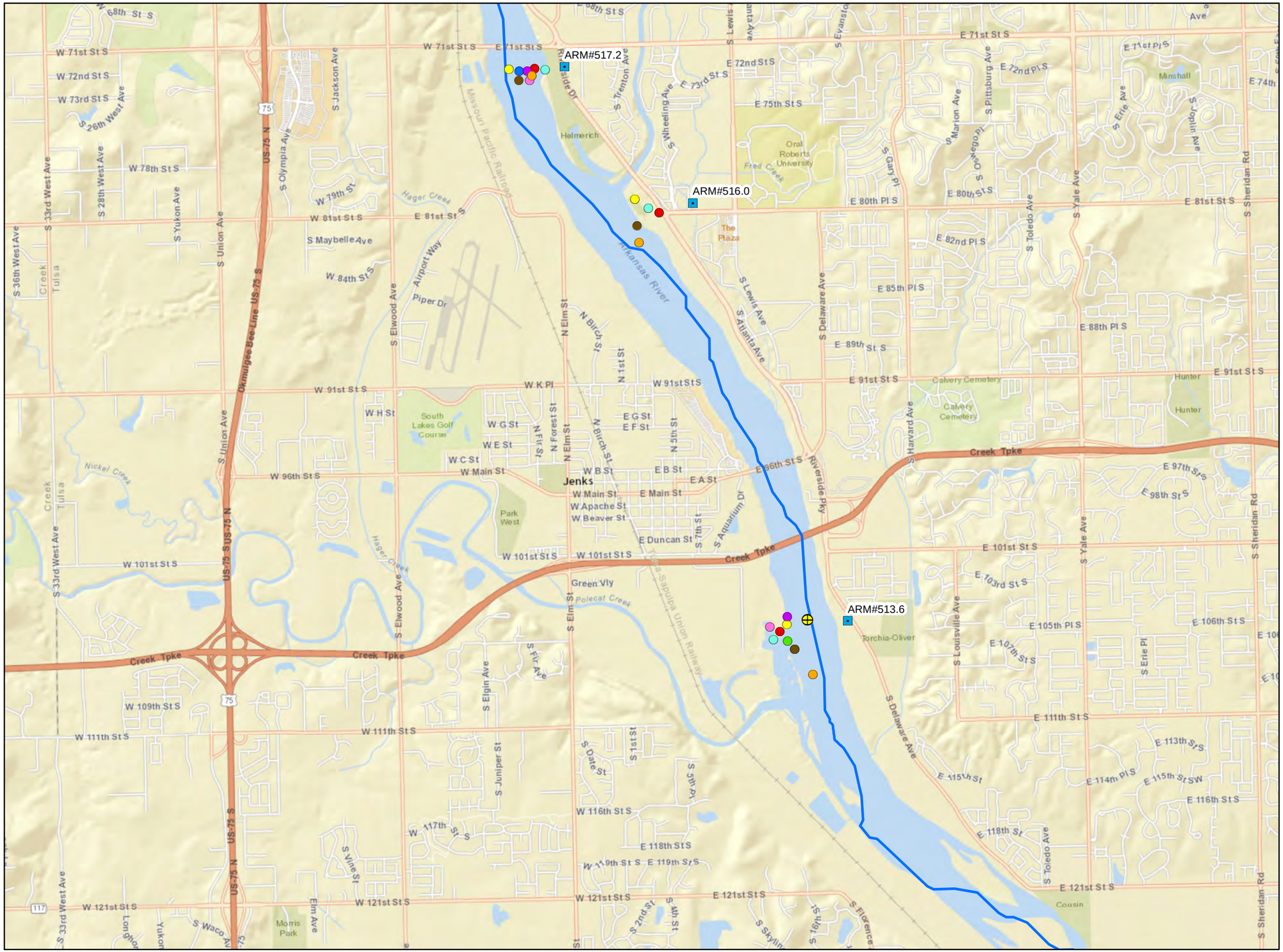

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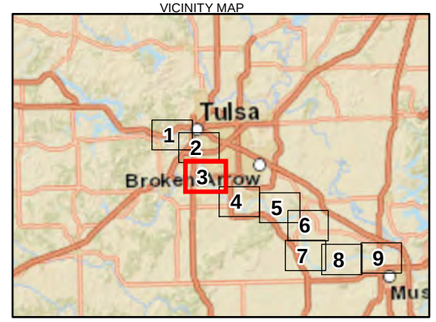

LEGEND

Colony Sites by Year

- 2005
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- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Figure 3 (Map 3 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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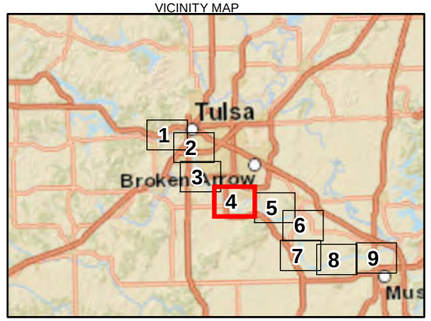

LEGEND

Colony Sites by Year

- 2005
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- 2011
- 2012
- 2013
- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Feet

Figure 3 (Page 4 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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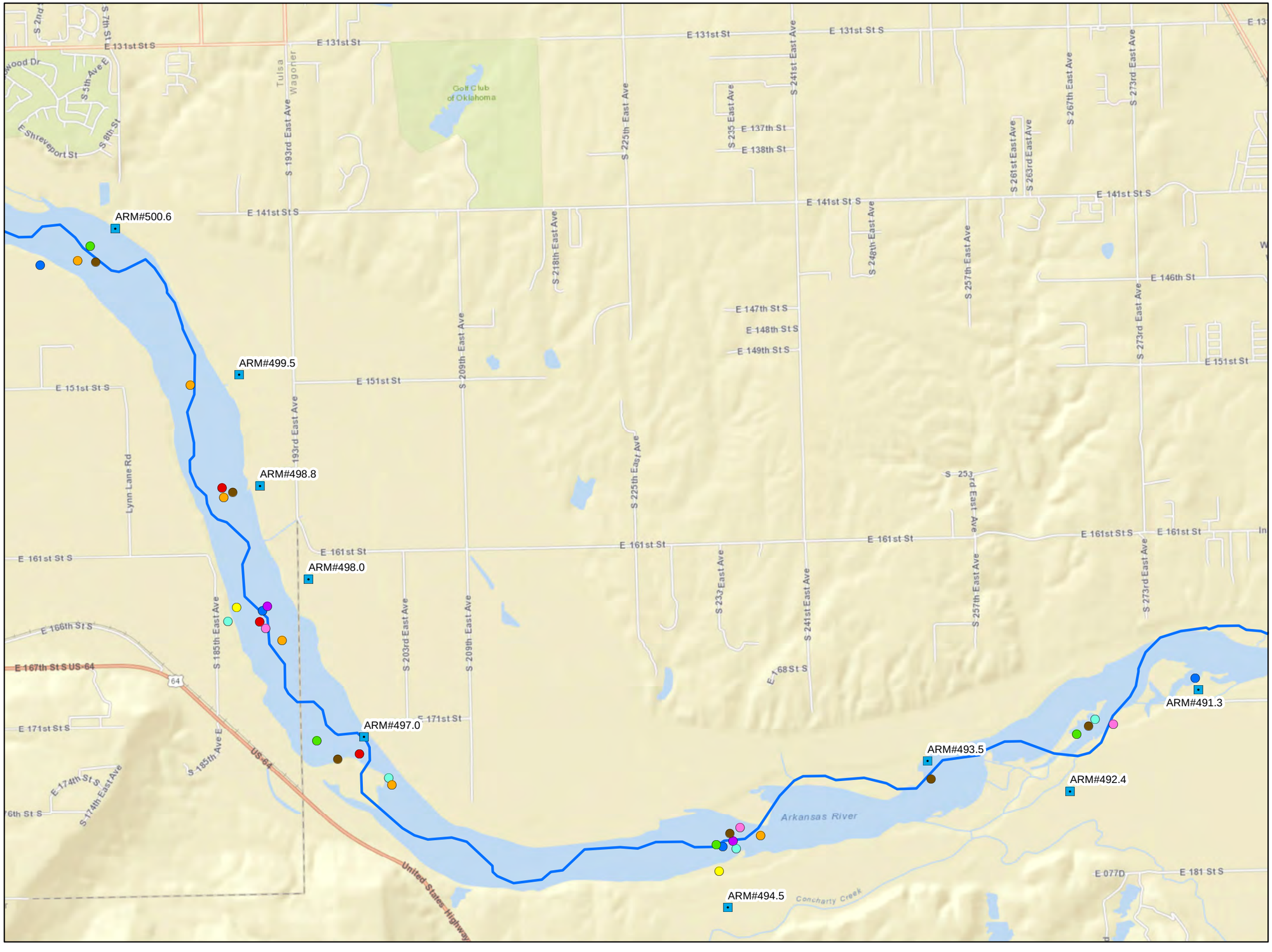

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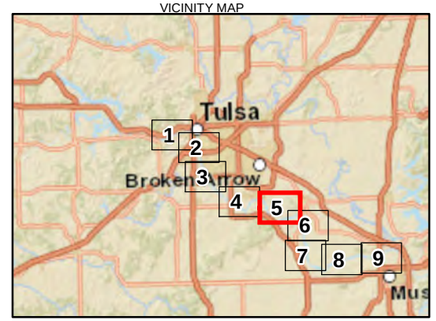

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Colony Sites by Year

- 2005
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- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Figure 3 (Map 5 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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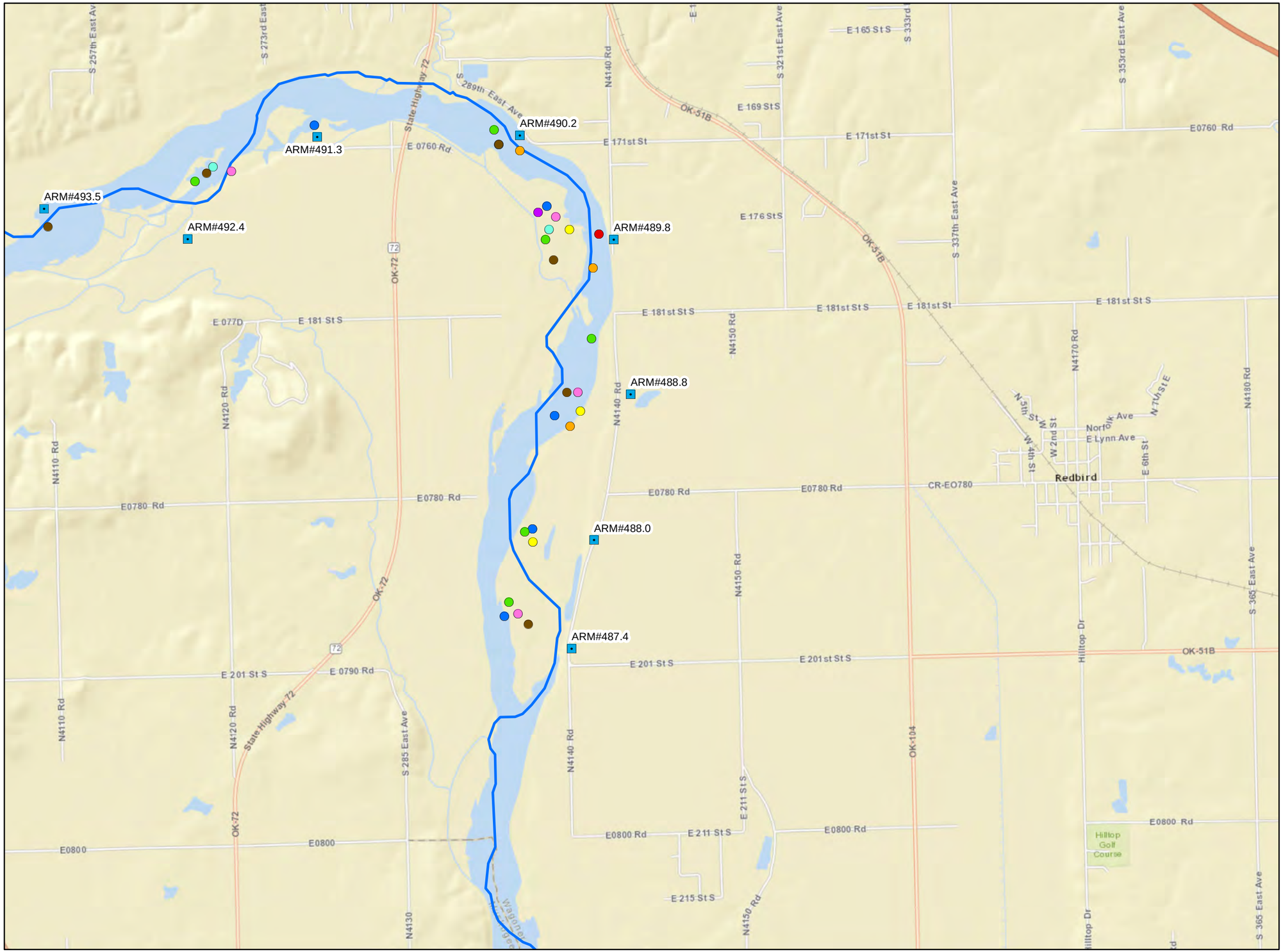

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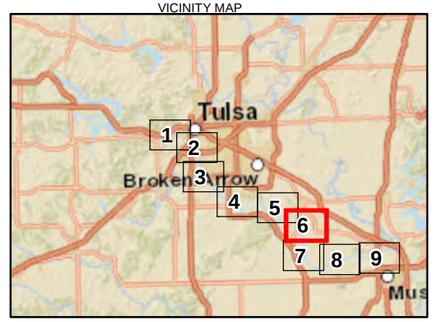

LEGEND

Colony Sites by Year

- 2005
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- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Figure 3 (Map 6 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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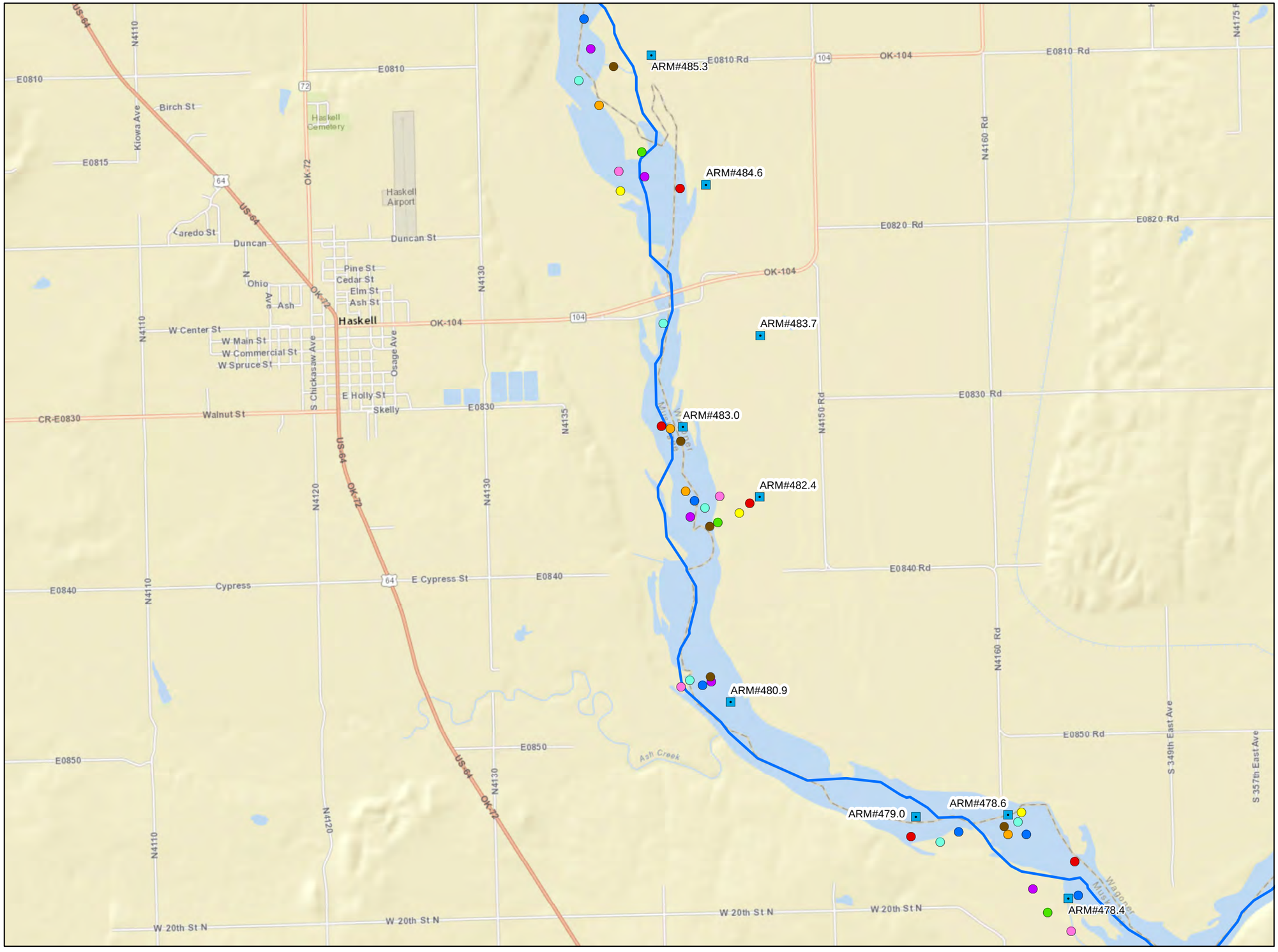

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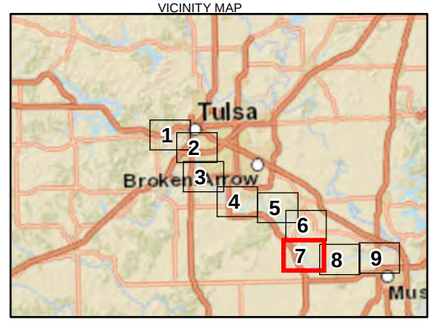

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Colony Sites by Year

- 2005
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- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Figure 3 (Map 7 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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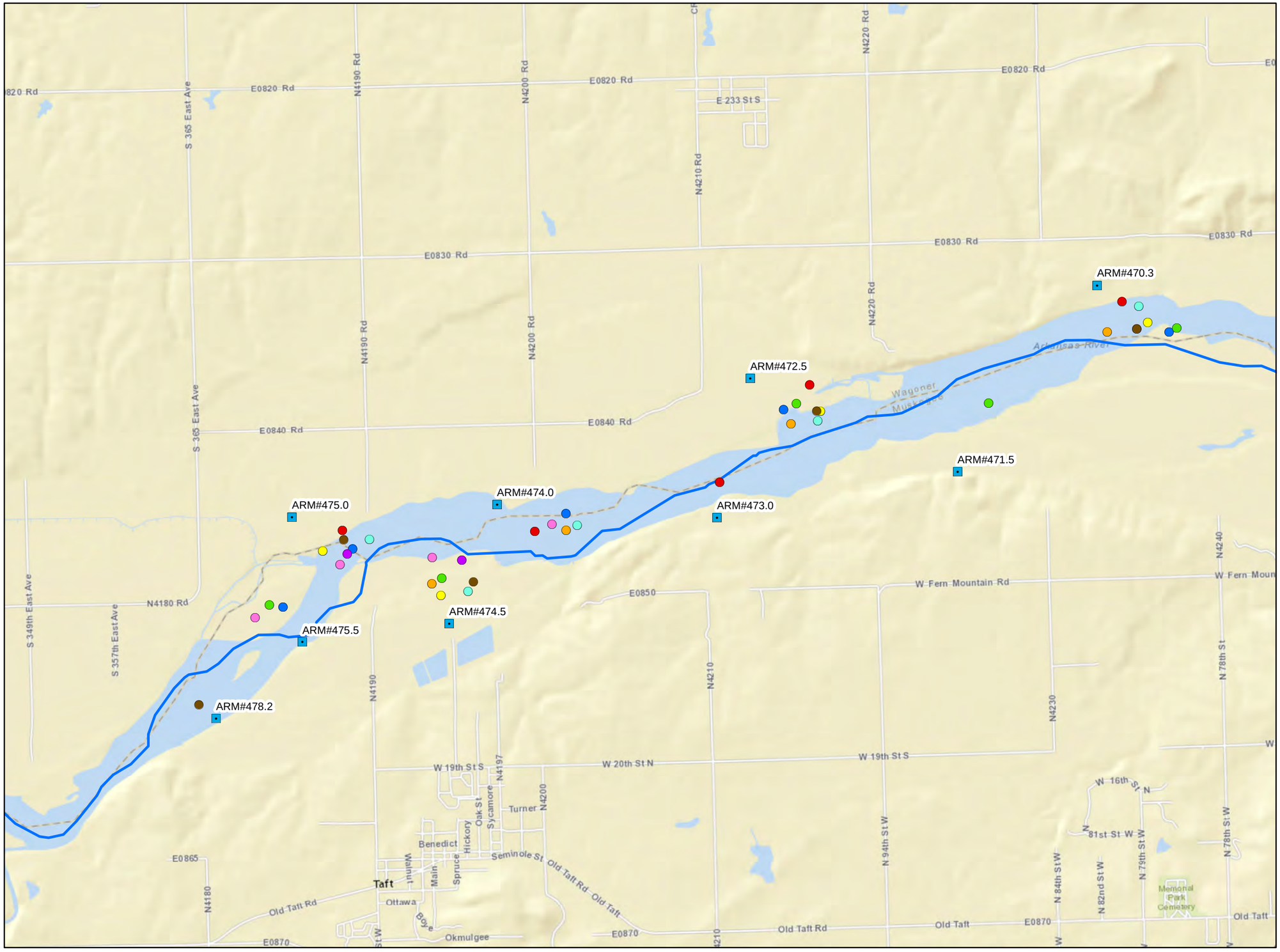

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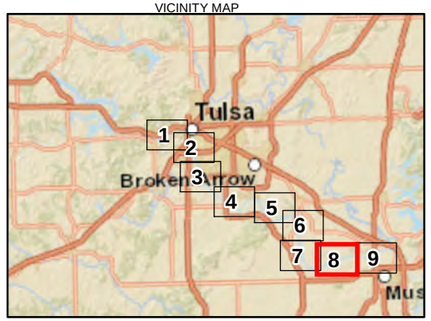

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Colony Sites by Year

- 2005
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- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Figure 3 (Map 8 of 9)
Yearly Locations of Least Tern Nesting Sites 2004-2015
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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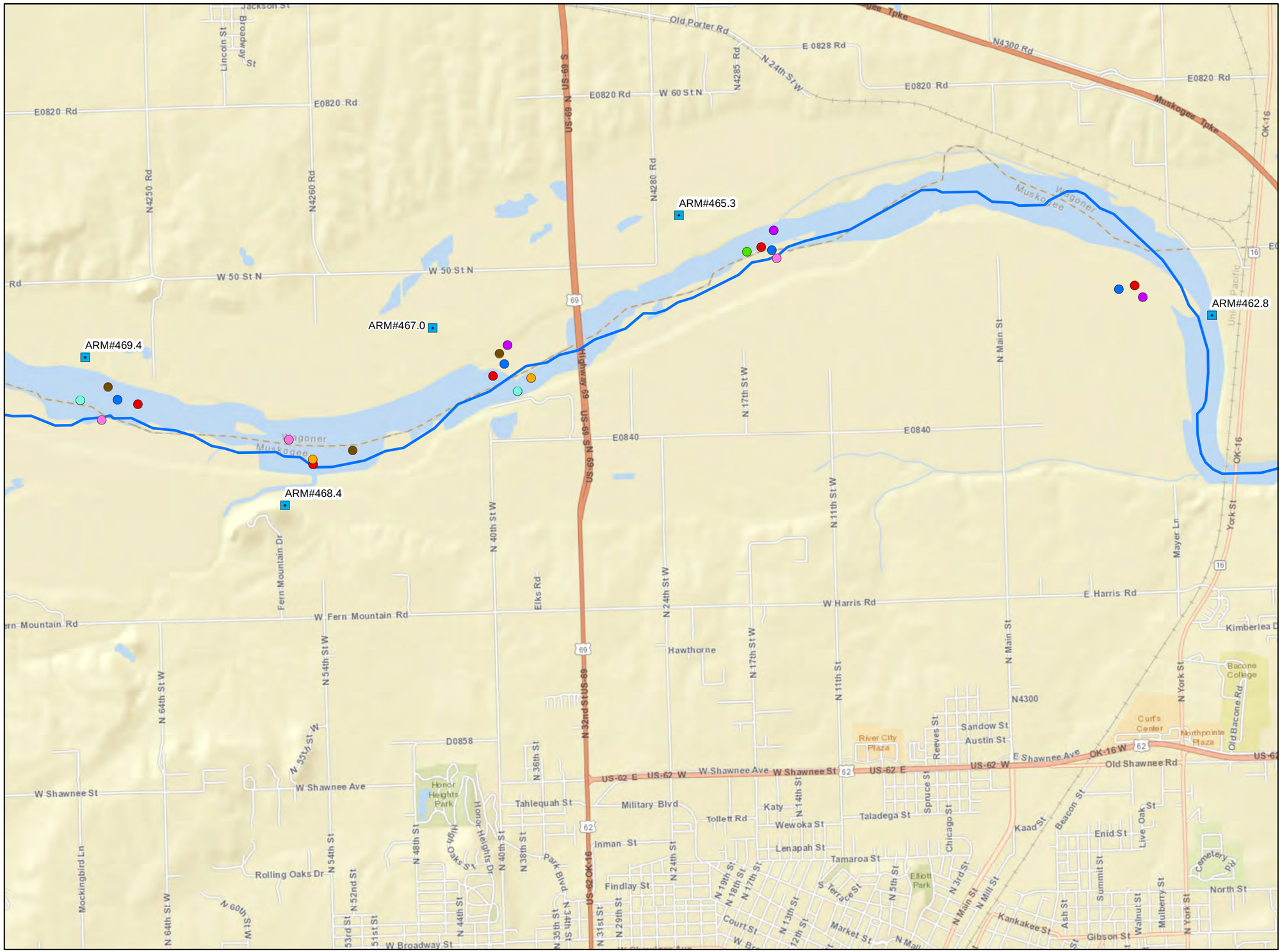

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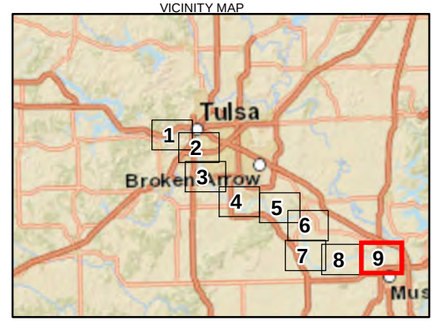

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Colony Sites by Year

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- 2014

- Existing Dam
- Proposed Dam
- River Mile Marker
- Arkansas River
- Keystone Lake

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Feet

Figure 3 (Map 9 of 9)
Yearly Locations of Least Tern Nesting Sites 2005-2014
Arkansas River Corridor Feasibility Study Environmental Assessment - Biological Resources Report

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2.2 Piping Plover

The piping plover is a migratory shorebird listed as endangered in the watershed of the Great Lakes and threatened in the remainder of its range (the Northern Great Plains, Atlantic coast, Gulf coast, the Bahamas, and the West Indies) (USFWS, 1985b). USFWS (2016a) identifies Tulsa County as "…*situated within the probable migratory pathway between breeding and winter habitats [of the Northern Great Plains population], and contain[ing] sites that could provide stopover habitat during migration."* The Northern Great Plains population of piping plover spends up to 10 months a year on its wintering ground along the Gulf coast and arrives on prairie breeding grounds in early May. During migration periods, they use large rivers, reservoir beaches, mudflats, and alkali flats (Haig, 1986; Schwalbach, 1988). They feed on aquatic and terrestrial invertebrates. The sandbars and bare gravel islands along the Arkansas River within the study area could provide suitable habitat during the plovers' spring and fall migrations (USFWS, 2011). Critical habitat for the piping plover has been designated, but Oklahoma is not included in the critical habitat designation (USFWS, 2015b).The piping plover, if it occurred in the study area, would be considered a migrant through the area.

2.3 Red Knot

The red knot is a migratory shorebird listed as threatened wherever it is found (USFWS, 2016a). Tulsa County is listed as a location where the red knot is "known or believed to occur" and is located within the probable migratory path, between breeding in the Arctic tundra and winter habitats in the southern U.S., Central, and South America (USFWS, 2015c). Red knots forage along sandy beaches and mud flats; therefore, there is the potential for this species to use the study area for foraging. The sandbars and bare gravel islands along the Arkansas River within the study area could provide suitable habitat during the red knot's spring and fall migrations. No critical habitat for the red knot has been designated (USFWS, 2015c).

2.4 American Burying Beetle

The American burying beetle is a member of the family Silphidae (carrion, or burying beetles) and is the largest species of *Nicrophorus* in North America. USFWS (1989) lists the American burying beetle as federally endangered. The historical range of the American burying beetle once included much of eastern temperate North America. Existing populations of this species include eastern Oklahoma and the study area. The presence of the species has been documented in Tulsa County within the last 15 years (USFWS, 2010). In 2007, a survey for American burying beetle was conducted over three nights, in representative habitats along the Arkansas River corridor, from Keystone Lake to downstream of the City of Bixby (Eagle Environmental Consulting, Inc., 2007). The survey included five baited pit-fall trap lines, with trapping methods performed according to the *Survey Methods for the American Burying Beetle in Oklahoma and Arkansas* (Creighton et al., 1993). Four individual American burying beetles were documented, with each occurring east of the river near the City of Bixby. As of 2016, critical habitat has not been designated for the American burying beetle (USFWS, 20016b).

The habitat in the study area includes instream aquatic habitat and riparian streambanks. The riparian streambanks occurring within the study area are potentially suitable habitat for American burying beetle. The American burying beetle is known to inhabit level areas in grasslands, grazed pastures, bottomland forest, open woodlands, and riparian areas. Wetlands with standing water or saturated soils and vegetation typical of hydric soils and wetland hydrology are listed by the USFWS (2015d) as unfavorable habitats. American burying beetles are habitat generalists; however, it is thought that undisturbed habitat and the availability of carrion is the most likely influence on species distribution (USFWS, 1991).

2.5 Northern Long-eared Bat

The USFWS lists the Northern long-eared bat threatened wherever it is found (USFWS, 2016c). It was federally listed in 2015 following studies that revealed a decline in populations from the spread of white nose syndrome. The Northern long-eared bat is found across much of the eastern and north central U.S., occurring in 37 states. The impact from the spread of white nose syndrome has been greatest in populations occurring in the northeastern U.S. where it is estimated that approximately 99 percent of the population has been affected. Currently, white nose syndrome is known to occur in 25 of the 37 states where Northern long-eared bats occur and is expected to spread to the remaining states (USFWS 2016c). The USFWS lists Tulsa County as a location where Northern long-eared bats occur; however, no specific occurrence of the bats or hibernacula are provided (USFWS, 2016a). No occurrences of white nose syndrome have been observed within Tulsa County; however, Tulsa County is listed as a county within 150 miles of a county with a known infected hibernacula (Delaware County, Oklahoma) (USFWS 2016d).

Most Northern long-eared bats seasonally migrate between winter hibernacula and summer maternity or bachelor colonies. Roosting may take place in tree bark, tree cavities, caves, mines, and barns. Mating takes place prior to hibernation, and delayed implantation of the embryo occurs in spring/summer. Each female gives birth to a single offspring during late May to late July (USFWS, 2016c).

Northern long-eared bats forage along forested hillsides and ridges near roosting and hibernating caves. They emerge at dusk and feed on various insect species such as moths, flies, leafhoppers, caddisflies, and beetles from vegetation and water surfaces (USFWS, 2016c).

2.6 Federal Candidate Species

No federal listed candidate species occur within the study area (ODWC, 2016).

2.7 Critical Habitats

No critical habitats for protected species have been designated within the study area (USFWS, 2016a).

SECTION 3

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