

Arkansas River Corridor Projects

Least Tern Data Review and Analysis

TO: Tulsa County

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Introduction

Tulsa County, as part of a master plan for the Arkansas River Corridor, is undertaking an improvement project on the Arkansas River (Carter Burgess, 2004; Guernsey et al., 2005; U.S. Army Corps of Engineers [USACE], 2009a). The primary goals of the project are to increase connectivity between the river and surrounding communities, improve habitat for the federally endangered interior population of the least tern (*Sternula antillarum*)¹, improve the function of the river system itself, and improve recreational opportunities. Key components of the proposed project include:

- Design of a new Sand Springs low-head dam, pedestrian bridge, and amenities
- Design of modifications to Zink Dam and lake with whitewater features
- Design of a new South Tulsa/Jenks low-head dam, pedestrian bridge, and amenities
- Design of bank stabilization and habitat improvements in selected areas

This Technical Memorandum (TM) summarizes information on the distribution and habitat use of the least tern in the Arkansas River Corridor project area and identifies potential constraints for consideration in the engineering design of the project components. The findings of this evaluation will support Tulsa County in preparing for consultation with the U.S. Fish and Wildlife Service (USFWS) on potential project effects to interior least terns pursuant to Section 7 of the Endangered Species Act (ESA). This review identifies potential constraints but does not propose any design concepts or include any proposed alternatives. Specific design concepts and alternatives will be identified and evaluated in subsequent steps of project implementation.

Objectives

The objectives of this evaluation are to:

- Describe the current distribution and habitat use of interior least terns in the project area

¹ Formerly referred to as *Sterna antillarum*.

- Analyze potential project effects to interior least tern nesting and foraging habitat
- Identify potential constraints for project engineering design, construction, and operation
- Identify potential opportunities for habitat enhancement or restoration

Interior Population of Least Tern

USFWS (1985) lists the interior population of the least tern (interior least tern) as federally endangered. The interior least tern breeds on alluvial islands and sandbars in the Arkansas River Corridor project area and other rivers in central North America. Least terns arrive to the Arkansas River in late April or May. They nest in colonies on barren to sparsely vegetated sand and gravel bars; 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). Peak nesting activity tends to occur in late June and early July (Lott, 2006). Least tern adults and fledglings depart the project area by September for wintering grounds south into Central and South America.

Federal Protection Status

USFWS (1985) lists the interior least tern as endangered based on its suspected low numbers and the following types of threats to its continued survival:

- Destruction of emergent riverine sandbar habitat by reservoirs and channelization
- Alteration of natural river dynamics, causing unfavorable vegetation succession on remaining sandbars and curtailing their use as nesting sites by interior least terns
- Recreational use of sandbars and associated disturbance to nesting habitat
- Delayed timing of spring floods past the onset of normal breeding, with many sandbars not exposed as suitable sites in time for nesting

Recovery Plan

The recovery plan for the interior least tern establishes recovery criteria for increasing the population to 7,000 birds throughout its range, with adult birds in the Arkansas River to increase to 1,600 and remain stable for 10 years (USFWS, 1990). The recovery plan identified the following actions as necessary to achieve the recovery criteria:

- Determine population trends and habitat requirements
- Protect, enhance, and increase populations during breeding
- Manage reservoir and river water levels to the benefit of the species
- Develop public awareness and implement educational programs about the least tern
- Implement law enforcement actions at nesting areas where high public use would conflict with nesting activity

USFWS has not designated critical habitat for the interior least tern.

Current Monitoring Efforts

An Interior Least Tern Working Group was established in 2004 to facilitate the standardization of monitoring protocols for interior least tern populations and to coordinate the compilation of range-wide monitoring data (Guilfoyle et al., 2004). The Working Group included representatives from 11 USACE districts, 4 USFWS regions, 14 state wildlife agencies, 8 academic institutions, 4 U.S. Geological Survey science centers, 3 Joint Ventures, and several non-profit organizations (Lott, 2006).

A coordinated team of federal and state agencies, non-governmental organizations, and private citizens conducted the first complete range-wide survey of interior least tern in June-July 2005, during peak nesting activity (Lott, 2006). The survey objectives were to estimate the number of adult interior least terns occurring in North America during the breeding season, document the range-wide distribution of nesting colonies, and describe the nesting habitats used. The survey area included the main-stem Arkansas River throughout the project area.

The USACE Tulsa District and USFWS have conducted surveys of the interior least tern in the Arkansas River since 1991 (USFWS, 2005). Since 2005, the 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.

Biological Opinion

The Biological Opinion issued by USFWS (2005) addresses the effects of operation of USACE multipurpose projects in the Arkansas, Canadian, and Red Rivers on the interior least tern and another federally listed species, the American burying beetle (*Nicrophorus americanus*). The USACE action area includes the Arkansas River between Keystone Dam and Muskogee, Oklahoma (the Arkansas River Corridor project area). The Biological Opinion found that the operation of these USACE multipurpose projects would not jeopardize the continued existence of the species or result in destruction or adverse modification of critical habitat, but that it would likely result in incidental take of the two species. USFWS was unable to quantify take of the species resulting from USACE activities and, therefore, the Biological Opinion set forth Reasonable and Prudent Measures (RPMs) for USACE implementation. The RPMs for the least tern included the following activities (USACE, 2006a):²

- Maintain suitable habitat for nesting least terns in the action area by providing adequate flows to create and maintain nesting habitat, and/or artificially or mechanically enhance, construct, and maintain nesting habitat.
- Monitor, evaluate, and adjust operations as needed to minimize take of least terns.
- Monitor and evaluate least tern habitat conditions.
- Reduce predation and human disturbance of least terns in the action area.

The Biological Opinion requires USACE to use adult population and reproductive success to measure the annual level of incidental take. USFWS (2005) uses a hypothetical, literature-

² The RPM for American burying beetle established 1,100 acres as the limit of potential disturbance activities, primarily associated with construction of dredge material disposal areas (USFWS, 2005; USACE, 2006).

based reproductive success level of 0.5 fledgling per adult pair. USFWS (2005) then estimated an annual reproductive success goal for each river using a 5-year moving average for adults and fledglings. The goal for the Arkansas River from Kaw Lake (upstream of Keystone Lake) downstream to the Arkansas state line is 500 adults and 125 fledglings.

USACE Management Guidelines

The USACE Tulsa District implements comprehensive guidelines for managing and protecting interior least terns nesting downstream of USACE water resource projects on the Arkansas, Canadian, and Red Rivers. The guidelines (USACE, 2009b) set forth long-term and short-term management strategies to achieve compliance with the ESA in accordance with the Biological Opinion (USFWS, 2005). USACE coordinates its operations and activities with representatives of USFWS, Oklahoma Department of Wildlife Conservation, Southwestern Power Administration, and Oklahoma Municipal Power Authority to protect the least terns while preserving authorized project purposes.

Long-term management strategies include investigating the feasibility of creating or enhancing islands to provide suitable nesting habitat and evaluating and monitoring project impacts. Short-term strategies during non-nesting periods include such practices as: managing high-flow releases to periodically inundate and scour islands for maintenance of favorable sandbar habitat; using dredge materials to replenish sand on existing islands and deepen water around islands to reduce land-bridging; and removing vegetation from islands using physical or chemical methods. Short-term strategies during the nesting season include: limiting maximum water releases to prevent flooding of active nests; and providing minimum water releases to prevent land-bridging of habitat.

Methodology

The current distribution and habitat use of the interior population of the least tern were described based on review of existing literature and information sources. Key sources of information for this review included:

- A site reconnaissance conducted by CH2M HILL, which included ground surveys and a helicopter survey of the study area, from March 30 through April 1, 2009
- A site reconnaissance and 360-degree video documentation by multiple low-level helicopter flights conducted by Tulsa County and Program Management Group, LLC on March 24, 2009
- A meeting between CH2M HILL biologists and Kevin Stubbs of USFWS on March 31, 2009
- The USFWS (1990) recovery plan for the species
- The USFWS (2005) Biological Opinion addressing the effects of operation of USACE's multipurpose projects
- The Tulsa District management guidelines for interior least terns (USACE, 2009b)
- The 2005 range-wide survey of the least tern (Lott, 2006)

- Annual least tern monitoring reports prepared by the Tulsa Audubon Society (TAS) in 2000-2003 for Zink Island (Harwood, 2000, 2001, 2002; Davy, 2003)
- A telephone conversation with Steve Nolen of USACE's Tulsa District on May 11, 2009, concerning annual monitoring of least tern
- Annual least tern monitoring reports prepared by the Tulsa District in 2006-2008 (USACE, 2006, 2007, 2008) and associated mapping information provided by the Tulsa District for least tern yearly locations in the Arkansas River for the period 2005-2008
- The Ecosystem Restoration Plan for the Arkansas River Corridor Project prepared by USACE (2009a)
- Participation in the Tulsa District (USACE) Interior Least Tern Committee 2009 Pre-season Meeting in Tulsa, Oklahoma, on May 20, 2009, which included a presentation by Casey Lott of the American Bird Conservancy (ABC) on "Defining and Measuring Sandbar Breeding Habitat for Interior Least Terns in Oklahoma"

The study area for this analysis was defined as the Arkansas River corridor in Oklahoma extending from the USACE's Keystone Dam downstream through Tulsa, Wagoner, and Muskogee Counties approximately 84 river miles (RM) to the confluence of the Verdigris River at the McClellan-Kerr Arkansas River Navigation System (MKARNS). This study area was established, based upon professional judgment, to include the extent of possible effects on least tern breeding habitat. As the understanding of the project evolves, the study area may be refined.

Current Least Tern Distribution and Habitat Use

The interior least tern is a migratory shorebird. Historically, it bred on riverine, emergent sandbar habitats in the Mississippi, Missouri, Ohio, Arkansas, Red, and Rio Grande River systems, and rivers of central Texas (USFWS, 1990). The breeding range extended from Texas to Montana, and from eastern Colorado and New Mexico to southern Illinois. The species continues to breed in most of these river systems, but its distribution has become more restricted due to widespread alteration of its riverine habitat (USFWS, 1990).

The following sections characterize the distribution, abundance, and known habitat use of interior least tern in its breeding range, in the Arkansas River system, and in the Arkansas River Corridor study area. The annual reproductive success of interior least terns varies naturally along a given river segment because of the ephemeral nature of the emergent sandbar habitats used by breeding adults. These habitats are subject to inundation, scouring, and redistribution by dynamic river flows, encroachment of woody vegetation during low-flow periods, and other changing conditions from year to year (USFWS, 1990, 2005).

Breeding Range

During the 2005 range-wide survey of interior least terns, 17,591 breeding adults in 489 colonies were counted (Lott, 2006). The vast majority of adult terns (89.9 percent) were observed on rivers. Much smaller numbers occurred at sand pits, reservoirs, salt flats, industrial sites, and rooftops. Average colony sizes ranged from 4 to 25 birds, with the exception of the Mississippi River, where colony size averaged 119 birds. Just over 62

percent of all adult interior least terns were counted on the lower Mississippi River (Cape Girardeau, Missouri, to Baton Rouge, Louisiana).

The range-wide estimate exceeded the recovery plan criterion of 7,000 adult terns, and some river basins such as the Arkansas River system exceeded their recovery goals (see below). However, not all basins have reached their goals, and most areas have not yet been monitored for 10 years as prescribed by the recovery plan (USFWS, 1990, 2005).

Arkansas River System

The 2005 range-wide survey was the first time all known breeding areas of the interior least tern in the Arkansas River system were surveyed within the same year (Lott, 2006). Survey segments included the Arkansas, Cimarron, and Salt Fork Arkansas Rivers in Colorado, Kansas, Oklahoma, and Texas. The Arkansas River portion of the species' range is part of the Southern Plains population, which also includes the Canadian and Red Rivers (C. Lott, ABC, May 20, 2009, Tulsa District Interior Least Tern Committee Meeting). The 2005 survey counted 2,129 adults in 126 colonies in the Arkansas River system. These birds comprised 12 percent of the range-wide total and exceeded the river-specific recovery plan goal of 1,600 adult terns (USFWS, 1990).

Nearly half of the adult terns counted in 2005 from the Arkansas River system were from the main-stem Arkansas River (Lott, 2006). Major breeding areas were found on riverine segments below Kaw and Keystone Dams in Oklahoma and along the MKARNS in Arkansas.

For the Oklahoma portion of the Arkansas River (Kaw Lake to Arkansas state line), the numbers of adults and fledglings observed during both the 2005 and 2006 monitoring efforts (Lott, 2006; USACE, 2006) substantially exceeded the annual reproductive success goal set forth in the Biological Opinion (USFWS, 2005). Although high river flows precluded monitoring of the Oklahoma portion of the Arkansas River in 2007 and limited monitoring activities in 2008, both the adult and fledgling goals are currently being met (582 adults, 188 fledglings) based on a 4-year running average (USACE, 2007, 2008).

Arkansas River Corridor Study Area

The 2005 range-wide survey counted 496 adult terns in 16 colonies in the Arkansas River study area downstream of Keystone Dam (Lott, 2006). Table 1 provides the counts for each of three survey segments on the Arkansas River between Keystone Dam and Muskogee in Oklahoma and provides comparative historical count data for the same segments. Based on the 2005 counts, this segment of the Arkansas River below Keystone Dam ranked third in the number of adults counted among 14 major river segments range-wide that provide emergent sandbar habitat for interior least tern (Lott, 2006).

The reach downstream of Keystone Dam extending to Muskogee consistently supports some of the highest densities of breeding terns in the species' entire range (C. Lott, ABC, May 20, 2009, Tulsa District Interior Least Tern Committee Meeting). Appendix A provides maps of the Arkansas River Corridor study area showing the yearly locations of least tern nesting sites observed by USACE during the monitoring period 2005-2008 and nearby Arkansas River mileposts (ARM#). The maps are lettered sequentially according to the

TABLE 1
Survey Counts of Interior Least Tern Adults for the Arkansas River from Keystone Dam to Muskogee, Oklahoma

Arkansas River Survey Segment	Length (RM)	2005 Survey		Historical Adult Counts		
		# Adults	# Colonies	Mean	Range	Years
Keystone Dam (RM 539) to Zink Lake (RM 522), OK	17	54	1	38	NA	1998 only
Zink Island, OK	NA	25	1	51	23-93	2000-2004 ^a
Tulsa, OK (RM 522) to Muskogee, OK (RM 458)	64	417	14	404	282-472	2000-2004
Total, Keystone Dam to Muskogee, OK	81	496	16			

Source: Lott (2006)

NA = not available

^a Monitored by TAS.

vicinity map provided in the legend. Only those maps containing yearly locations of nests are presented in the appendix.

Keystone Dam to Zink Lake

Since the completion of Keystone Dam in 1964, substantial channel incision has occurred in the Arkansas River between Keystone Dam and Zink Lake (USFWS, 2005). With the trapping of sediment bedload behind Keystone Dam, sand has been lost from the reach and cobble substrates have become more common (Stubbs, 2009, personal communication). Primary inputs of sand to the reach likely include tributary inflow, bank erosion, and bed incision.

The distribution of least terns in the 2005 survey indicates that suitable emergent sandbar nesting sites in the study area occur primarily downstream of Zink Dam, the Tulsa to Muskogee reach (Table 1). Only 1 of the 16 colonies observed in 2005 occurred between Keystone Dam and Zink Lake. It was found in Sand Springs upstream of the proposed site of the Sand Springs low-head dam (Appendix A, Map G). During 2006 monitoring, USACE (2006) observed one colony in this upper reach near the Sunoco Refinery (USACE, 2006). This colony contained 14 nests and as many as 32 adult terns. Figure 1 shows a sandbar island located upstream of Oklahoma Highway 97 near Sand Springs. Figure 2 shows the river next to the Sunoco Refinery. Both photographs were taken in March 2009 (outside of the least tern breeding season) at a river flow of about 17,500 cubic feet per second (cfs), a relatively high flow which inundates and eliminates from view many of the sandbars that typically would be available at lower flows during the breeding season.

Zink Island

Monitoring by TAS has documented annual least tern nesting on Zink Island, a relatively high island in the upper end of Zink Lake, since 1992 (Harwood, 2000, 2001, 2002; Davy, 2003) (Figures 3 and 4; river flow of 17,500 cfs). Table 2 summarizes TAS counts for the period 1992 through 2002 (Harwood, 2002). USACE annual monitoring conducted since 2005 includes survey information collected by TAS at Zink Island. Least tern nesting has been observed on Zink Island every year USACE has conducted monitoring since 2005 (Appendix A, Map I, ARM# 523.4).

TAS observed a decline in the reproductive success of least terns using Zink Island after 1999 (Table 2). TAS attributed the decline to negative impacts of flooding, which delayed nesting by about 2 weeks in 2002, crowding by Canada geese, and the regeneration of vegetation on the island, which deters least tern nesting (Davy, 2003; Harwood, 2001, 2002). The ratio of fledged young to nests in 2002 was 0.35, compared to 0.61 to 1.44 fledged young

TABLE 2
Survey Counts of Interior Least Tern Adults, Fledged Young, and Nests on Zink Island in the Arkansas River, 1992-2002

Year	# Adults	# Fledged Young	# Nests	Fledged Young per Nest
1992	NA	46	32	1.44
1994	85	47	40	1.18
1995	50	23	22	1.05
1996	55	30	21	1.43
1997	80	21	34	0.62
1998	75	37	33	1.12
1999	115	33	54	0.61
2000	80	20	45	0.44
2001	93	18	42	0.43
2002	59	6	17	0.35

Source: Monitoring conducted by TAS (Harwood, 2002).

NA = not available.

per nest from 1992 through 1999. In 2003, Canada geese were rounded up and transported from the island to relieve pressure on the nesting terns (Davy, 2003).

USFWS (2005) suggested that the decline in nesting on Zink Island was due to the encroachment of woody vegetation and the reduction of available nesting habitat. In April 2005, extensive habitat restoration efforts were conducted. USACE, USFWS, and local volunteers removed all of the vegetation and debris, and Tulsa County then covered the island with new sand using heavy equipment (USACE, 2006a). The island supported at least 36 nests in June 2005, indicating the success of these efforts (USFWS, 2005). USACE and Tulsa County have removed vegetation and refreshed the sand on the island every year for the past several years (Nolen, 2009, personal communication).

In contrast to Zink Island, interior least terns have not been observed nesting on the heavily vegetated island next to it (Figures 3 and 4) (Harwood, 2001). Least terns nest where vegetation is sparse, with coverage generally less than 30 percent (USFWS, 1990; Stubbs, 2009, personal communication). However, the vegetated island also is closer than Zink Island to the shoreline containing mature trees and the nearby highway bridge (Figure 3). Evidence from habitat surveys in the Missouri River system (R. Wiley, ABC, May 20, 2009, Tulsa District Interior Least Tern Committee Meeting) and USACE observations at created islands (Nolen, 2009, personal communication) suggest that least terns avoid nesting in close proximity to gallery forest and other structures rising above the water line, whether open sand is available or not, possibly because of a perceived risk from perching avian predators.

Zink Dam to Muskogee

The 2005 survey documented 417 least tern adults in 14 nesting colonies on the Arkansas River in the 64-mile reach between Zink Dam in Tulsa and Muskogee (Table 1). USACE monitoring in 2006 documented the occurrence of 15 nesting colonies in the same reach of river (USACE, 2006). The 2006 survey identified 345 adults and 182 fledglings.

Sandy conditions become more prevalent in the river downstream of Zink Dam. Downstream of the City of Jenks the floodplain widens as the river flows away from the urban development and levees of the Tulsa area and enters the plains topography of the Osage Cuestas ecoregion (part of the Central Irregular Plains province). The Osage Cuestas ecoregion is characterized by low, forested hills and cuestas (gently sloping ridges with a steep escarpment) and undulating plain near the river (Figure 5). Emergent, unvegetated sandbars generally are more widely available in this reach of the river.

Least tern nesting colonies have been documented by recent monitoring efforts in the following areas between Zink Dam in Tulsa and the Tulsa County-Wagoner County line:

- The reach between Zink Dam and the I-44 bridge downstream in Tulsa (Harwood, 2001, 2002; Davy, 2003; Lott, 2006; USACE, 2006, 2008) (Appendix A, Map I)
- An area just downstream of the 71st Street bridge in Tulsa (Harwood, 2001, 2002; Lott, 2006; USACE, 2006) (Appendix A, Map I)
- The area of the proposed site of the South Tulsa/Jenks low-head dam between Creek Turnpike and Polecat Creek in Jenks (USACE mapping information for 2005, 2006, and 2008 surveys) (Appendix A, Map J)
- An area along the east/north shoreline upstream of U.S. Highway 64 near Bixby (USACE mapping information for 2005, 2006, and 2008 surveys) (Appendix A, Map J)
- Four areas between U.S. Highway 64 in Bixby and the Wagoner County line (USACE mapping information for 2005, 2006, and 2008 surveys) (Appendix A, Map K)

In addition, the recent monitoring by the Tulsa District has documented numerous least tern nesting colonies distributed rather evenly throughout the reach extending from the Tulsa County-Wagoner County line all the way downstream to near the Verdigris River and the MKARNS at Muskogee. These yearly locations have all been mapped by the Tulsa District (Appendix A, Maps L, M, N, and O).

In 2008, the Tulsa District began habitat mapping studies to address RPM 3 (Monitor and Evaluate Least Tern Habitat Conditions) of the USFWS (2005) Biological Opinion. Topographic mapping techniques are being used to characterize known and potential least tern nesting sites. The goal of the study is to develop a habitat model relating river stage to the availability of nesting sites. The model will be used to assist river managers, primarily USACE, with decisions on operational procedures, methods, and practices that would protect the least tern (USACE, 2008). The work will be completed and a report provided by ABC later in 2009.

Potential Project Effects

The construction and operation of the key components of the Arkansas River Corridor Project have the potential to affect habitat of the interior least tern in the following ways. These potential effects have not been assessed yet for their significance or duration of effect and would need to be evaluated further as project alternatives are refined.

- Potential loss of least tern nesting habitat as a result of dam construction
- Potential loss or reduction in least tern nesting habitat as a result of inundation by the Sand Springs and South Tulsa/Jenks Dam pools and the newly expanded Zink Dam pool
- Potential effects of the new and expanded pools on fish populations serving as the food base for least terns and the distance to suitable forage fish populations
- Potential effects of project operations on sediment transport and the distribution of sandbars immediately downstream of the dams and in the study area
- Potential beneficial effects of project operations on moderating low-flow conditions and reducing land-bridging of least tern nesting sites
- Potential beneficial effects of measures taken to restore and enhance least tern habitat in the Arkansas River, such as the construction of islands for least tern nesting

Potential Constraints to Project Design

Based on the review of existing information on the occurrence and habitat use of the interior least tern in the Arkansas River Corridor study area, the 2005 Biological Opinion, and the preliminary analysis of potential project effects, potential constraints for project engineering design, construction, and operation may include the following:

- USFWS may determine that the Arkansas River Corridor Project may adversely affect the federally endangered interior least tern. This determination would require formal consultation with USFWS under Section 7 of the ESA. Formal consultation requires the preparation of a Biological Assessment and USFWS' issuance of a Biological Opinion under a pre-determined timeline that would directly affect project schedule and could result in additional RPMs for implementation in the river.
- The abundant existing information and ongoing USACE data collection on interior least tern distribution, abundance, and habitat use in the study area would likely provide a sufficient basis for the preparation of a Biological Assessment without the need for new field studies. However, should additional field study be needed, this work could be required to occur when least terns are present in the study area. The least tern breeding season is approximately 100 days long. Least terns typically arrive in the study area around May 15 and leave by August 22 (C. Lott, ABC, Tulsa District Interior Least Tern Committee Meeting).
- Integrated operation of the proposed system of low-head dams to enhance sandbar breeding habitat for least terns would need to target the May 15-August 22 breeding

season, and would be further constrained by the time needed by breeding pairs to successfully reproduce within that period. Breeding pairs require approximately 50 days to complete successful reproduction, from pair formation to the fledging of young. July 3 is considered the latest a breeding pair can begin courtship and be assured of completing nesting and the rearing of young by the end of the breeding season (C. Lott, ABC, Tulsa District Interior Least Tern Committee Meeting). Therefore, project operations need to consider this 50-day duration in determining the magnitude and timing of releases for protecting or enhancing sandbar breeding habitat for least terns.

- Least tern islands may need to be built in or in the vicinity of the new and expanded pools to offset the loss or alteration of emergent sandbar habitat. For example, the USACE (2009) Ecosystem Restoration Plan proposes the construction of an island for least terns in the South Tulsa/Jenks Dam pool. If there is a sediment deficit downstream of Keystone Dam, island habitat restoration would likely require long-term sediment augmentation, such as that currently being implemented at Zink Island. In addition, the maintenance of these islands would likely require periodic high-flow releases to provide for scouring and removal of vegetation and debris. These activities would need to be conducted in a manner consistent with the Tulsa District's least tern management guidelines (USACE, 2009b).
- The location and high-flow elevation of islands created for least tern nesting would need to be coordinated with USACE Tulsa District and USFWS. The design specifications for islands would be guided in part by the Tulsa District's recent and ongoing experience in creating and maintaining islands in Kerr Reservoir of the MKARNS. Design specifications would need to include the provision for a sufficient rock chevron at the upstream end of the island to withstand river flows, and the layout and elevation of the rock would need to be such that river flows would pass around and over it to allow sedimentation to deposit downstream of the rock and thus maintain the island (USACE, 2009a). Current thinking is that created islands should be designed at an elevation to become inundated at a flow of about 40,000 cfs (Laney, 2009, personal communication). In addition, measures would need to be taken to avoid human disturbance, especially if the island was located in the Tulsa area.
- Based on the Tulsa District's experience with a newly created island in Kerr Reservoir, the use of rip-rap armoring in the island's construction should be limited in its height so that it does not extend above the elevation of the island. Least terns avoid nesting in areas close to larger objects, apparently perceiving the structure as perch areas for avian predators (Nolen, 2009, personal communication). Habitat surveys conducted in the Missouri River system indicate that islands should be located at least 550 feet away from the nearest forest edge, bridge, public viewing platform, or other large structures rising above the waterline (R. Wiley, ABC, May 20, 2009, Tulsa District Interior Least Tern Committee Meeting).
- The efficacy of creating or enhancing least tern islands in the project pools could be affected by the distance adults would have to forage for minnows and other small fish they feed on. The forage fish base typically is most abundant in shallow, flowing riverine habitats. Least terns tend to forage no farther than about 2 miles from their nest sites, although some may fly up to 4 miles to fish (USFWS, 1990). Opportunities for enhancing aquatic habitats for small forage fish near these islands would be limited by

the availability of suitable shallow stream habitats and sources of human disturbance in the densely populated Tulsa metropolitan area.

- Without a sediment budget for the Arkansas River downstream of Keystone Dam, it would be difficult to quantify how the proposed project structures and operations may affect sediment transport and the distribution of least tern nesting habitat in the river. A sediment budget would improve predictions and quantification of the effects of project operation on least tern habitat and could assist the development of specifications for the construction of any least tern islands.
- Understanding the relationship between river stage and the availability of emergent sandbar habitat in the river and the occurrence of land-bridging would help to assess the potential beneficial project effects on least tern nesting habitat during low-flow periods. USACE and its contractor ABC are presently conducting topographic mapping of known nesting sites, and this information will become available later in 2009.
- The construction of least tern islands in the free-flowing, riverine environment of the Arkansas River would be complicated by the dynamic flow regime of the river and would require frequent and extensive maintenance. Although the Tulsa District recently constructed a least tern island made with dredged material in the MKARNS and it has been highly successful in attracting least terns, it was built in a reservoir with much more consistent water levels than a free-flowing river. The construction and maintenance of islands in a highly fluctuating riverine environment could be more problematic.

Potential Opportunities for Habitat Restoration or Enhancement

Potential opportunities for restoring or enhancing habitat for the interior population of the least tern in the Arkansas River Corridor study area include:

- Designing the low-head dam structures to seasonally pass sand loads and promote the development of downstream sandbar habitat when the dam is open to river flows.
- Reregulating low-flow conditions during the tern nesting season to maintain emergent sandbar habitat and minimize land-bridging of islands and the risk of predation and human disturbance.
- Constructing least tern safe islands in the pools created by the new low-head dams and possibly extending (away from the shoreline and highway bridges) and enhancing Zink Island in the expanded Zink pool.
- Constructing or enhancing least tern islands in the Arkansas River downstream of the project between Jenks and the Tulsa County-Wagoner County line.
- Restoring tributary streams near their confluence with the main-stem river to provide shallow, free-flowing habitat conditions more favorable to native, small-bodied riverine species as a forage base for nesting terns. Potential sites close to the newly constructed pools include Prattville Creek next to the proposed site of the Sand Springs Dam and Polecat Creek just downstream of the proposed site of South Tulsa/Jenks Dam.

- Planning river corridor future development to reduce predation and human disturbance of least terns in proximity to recreational areas and activities.

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Figure 1. Downstream View of Sandbar near Wekiwa (upstream of Sand Springs)



Figure 2. Upstream View of Islands adjacent to Sunoco Refinery.



Figure 3. Downstream View from I-244 Bridge in Tulsa, including Zink Island



Figure 4. Upstream View of Zink Islands; Interior Least Terns Nest on Unvegetated Island



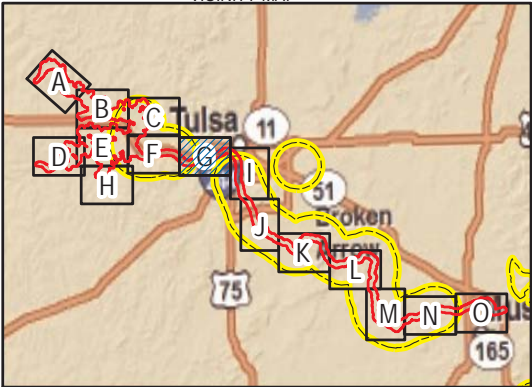
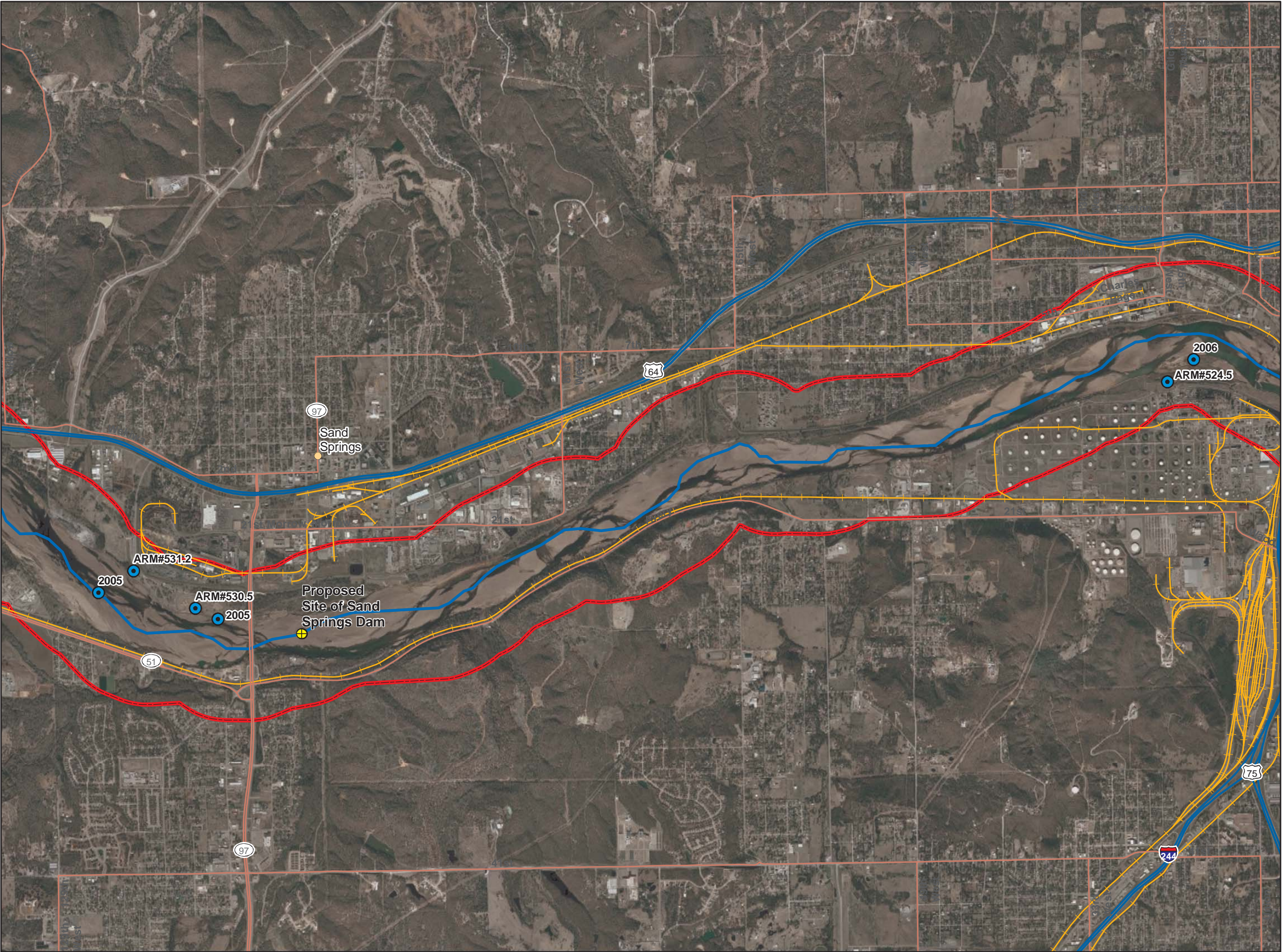
Figure 5. Downstream View of Arkansas River from Vicinity of E 121st Street



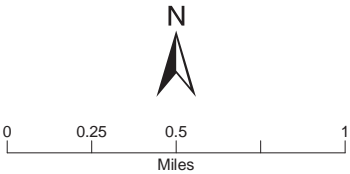
Figure 6. Downstream View of Proposed Site of Low-head Dam at South Tulsa/Jenks

Appendix A

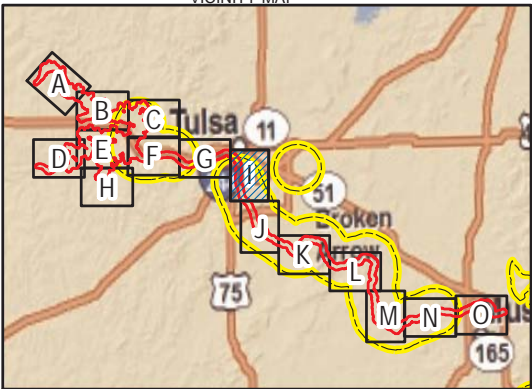
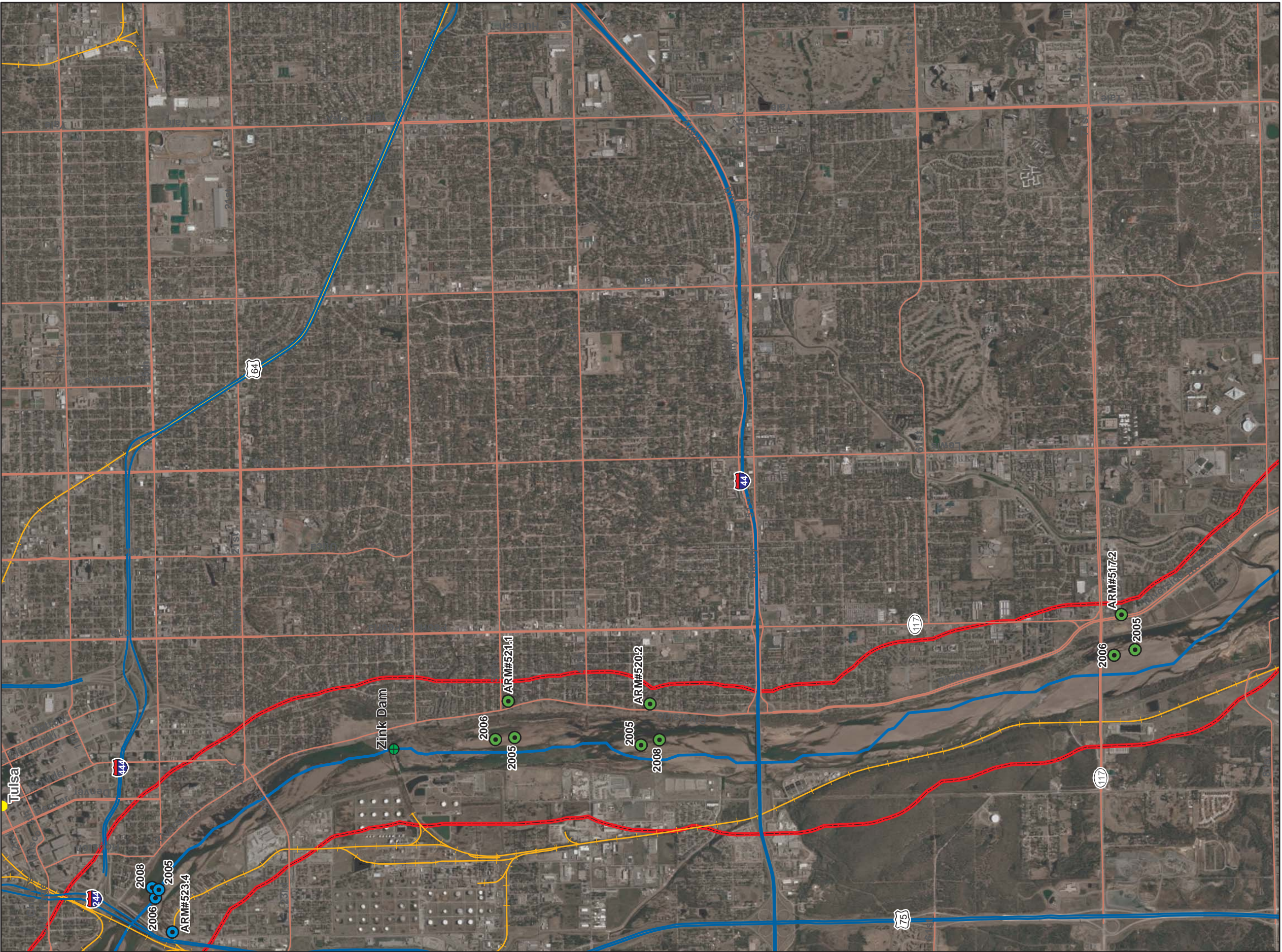
Yearly Locations of Least Tern Nesting Sites, 2005-2008



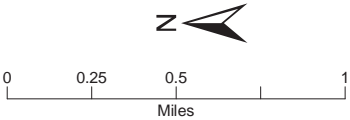
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- Keystone to Tulsa Yearly Locations
 - Kaw to Keystone Yearly Locations
 - Tulsa to Muskogee Yearly Locations
 - Interstates
 - US & State Highways
 - Secondary State & County Roads
 - Railroads
 - Arkansas River
 - ▭ Keystone Lake
 - ▭ Arkansas River Buffer
 - Existing Dam
 - Proposed Dam



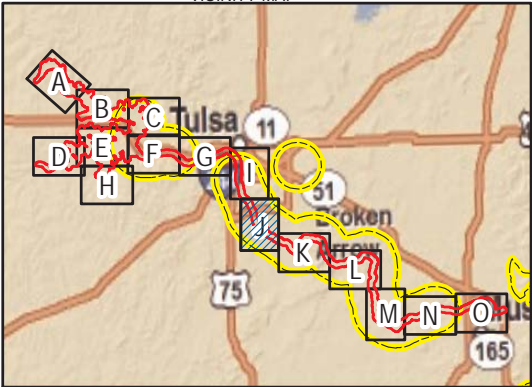
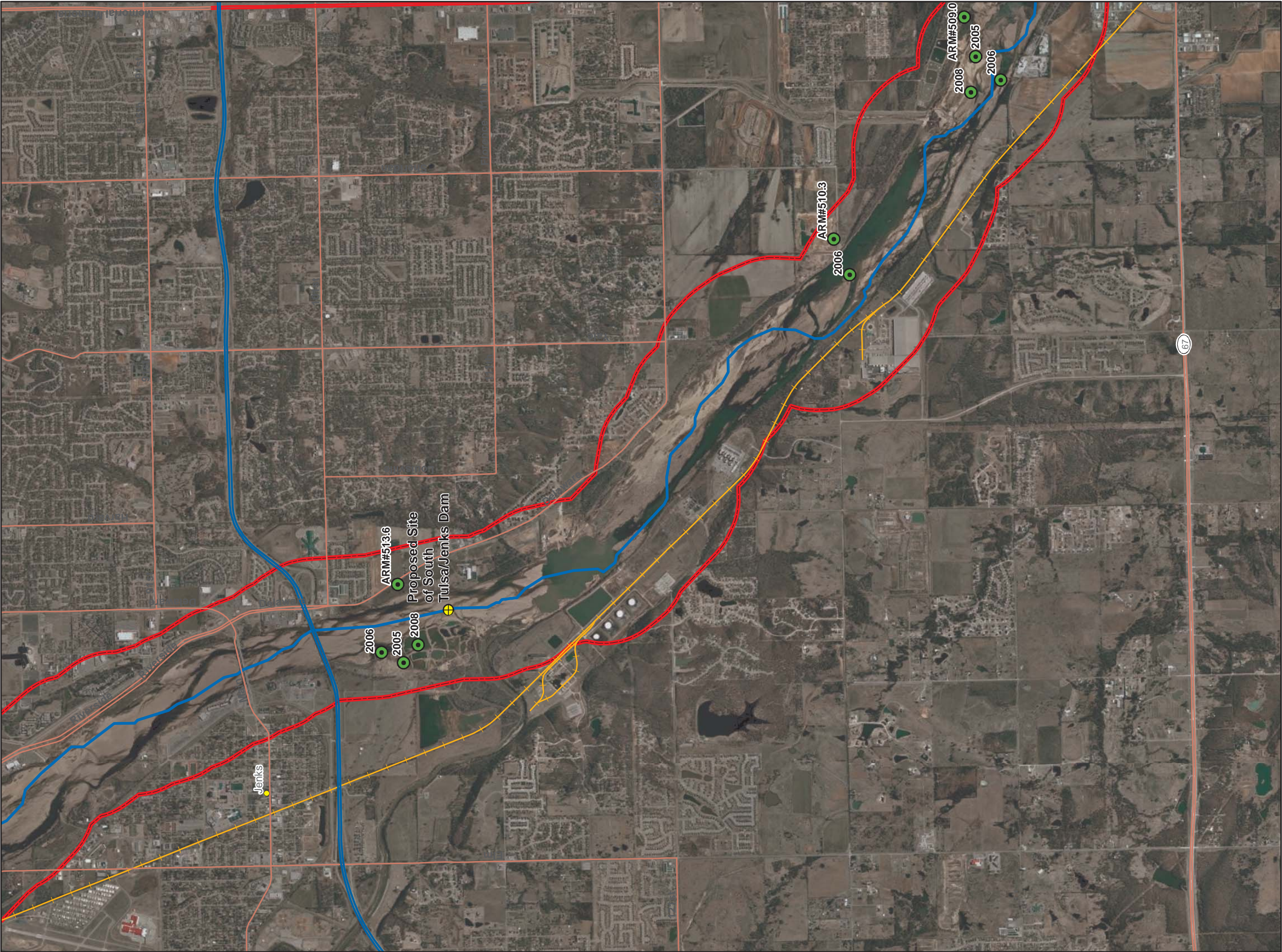
Yearly Locations of Least Tern Nesting Colonies Map G
Arkansas River Corridor
Tulsa, OK



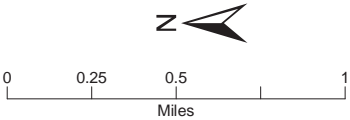
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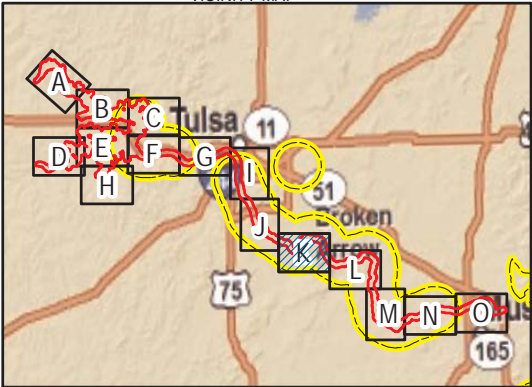
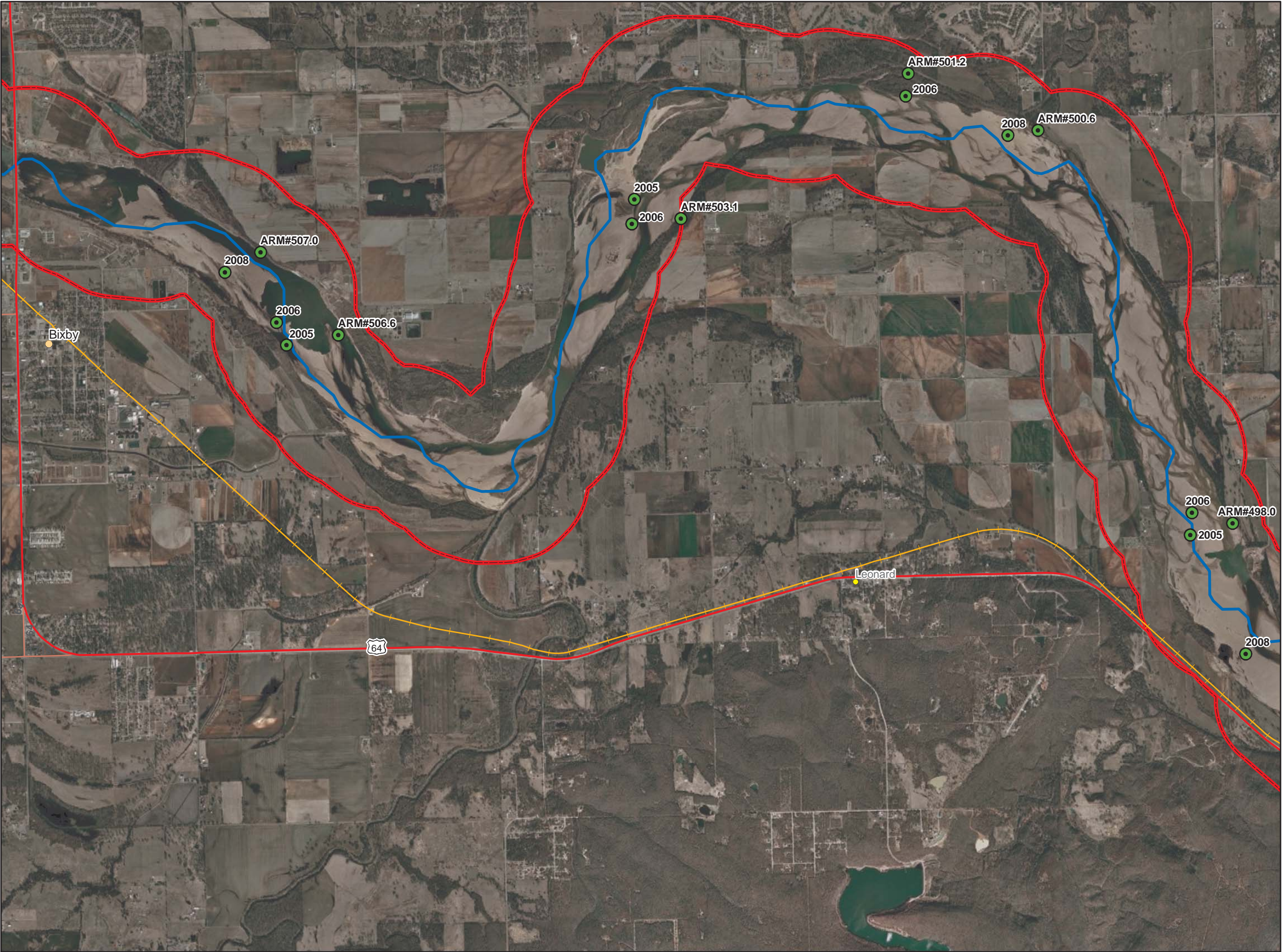
Yearly Locations of Least Tern Nesting Colonies Map I
Arkansas River Corridor
Tulsa, OK



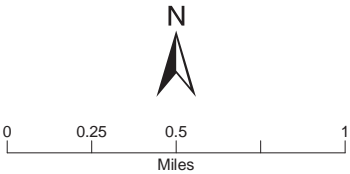
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Yearly Locations of Least Tern Nesting Colonies Map J
Arkansas River Corridor
Tulsa, OK

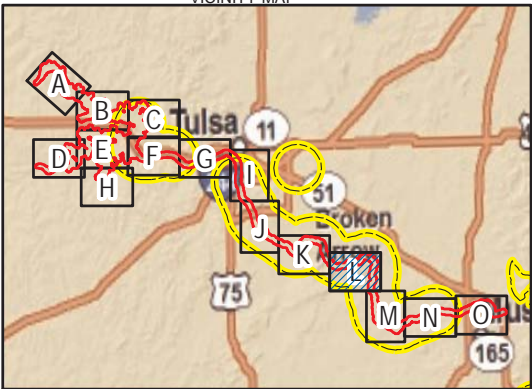
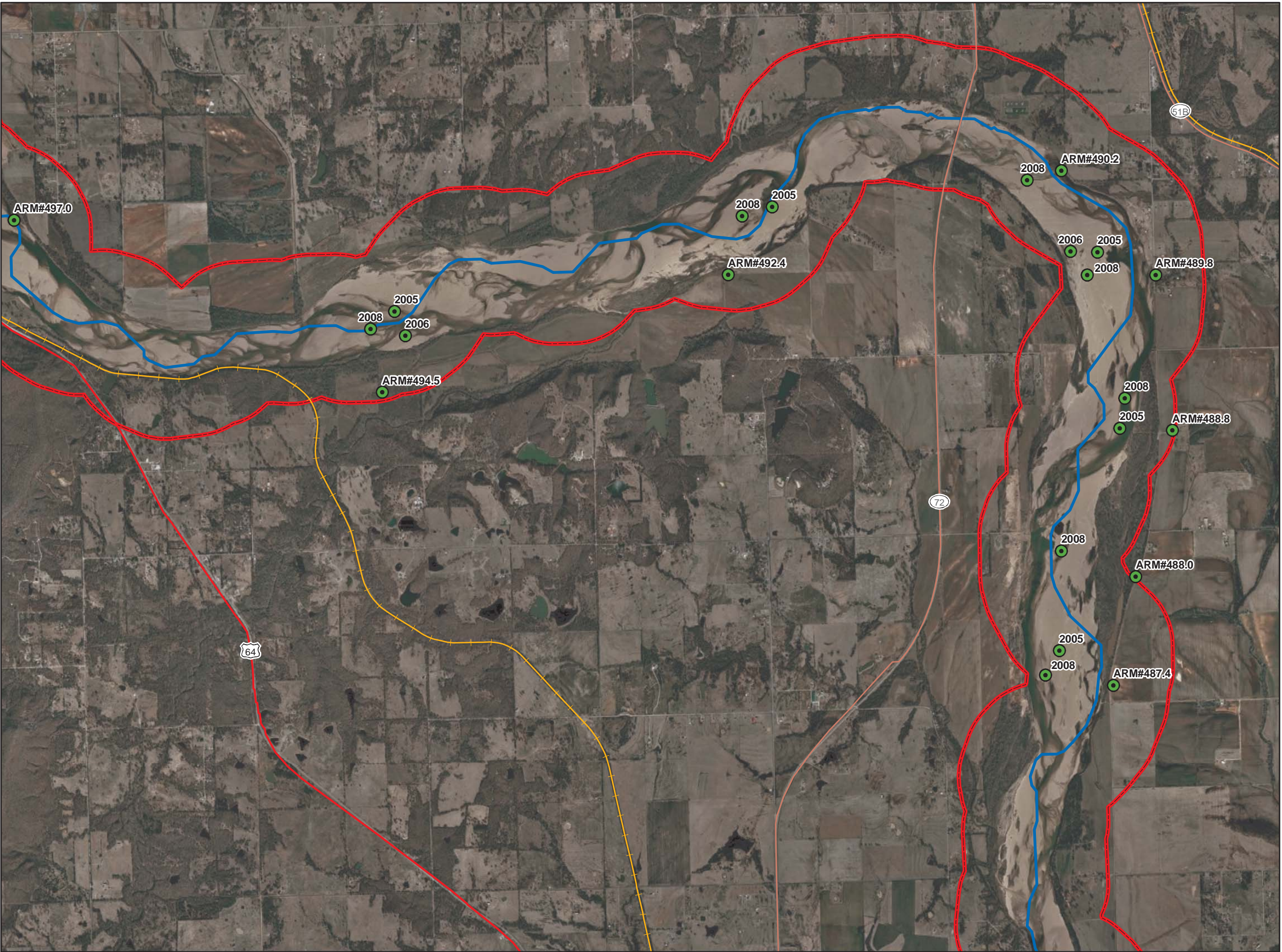


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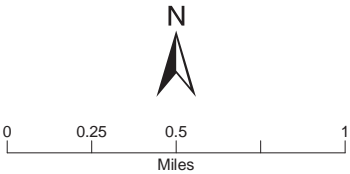


Yearly Locations of Least Tern Nesting Colonies
Arkansas River Corridor
Tulsa, OK

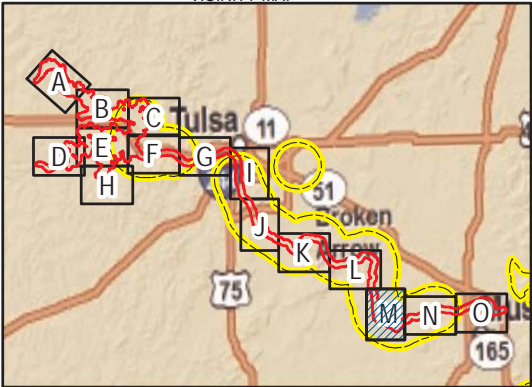
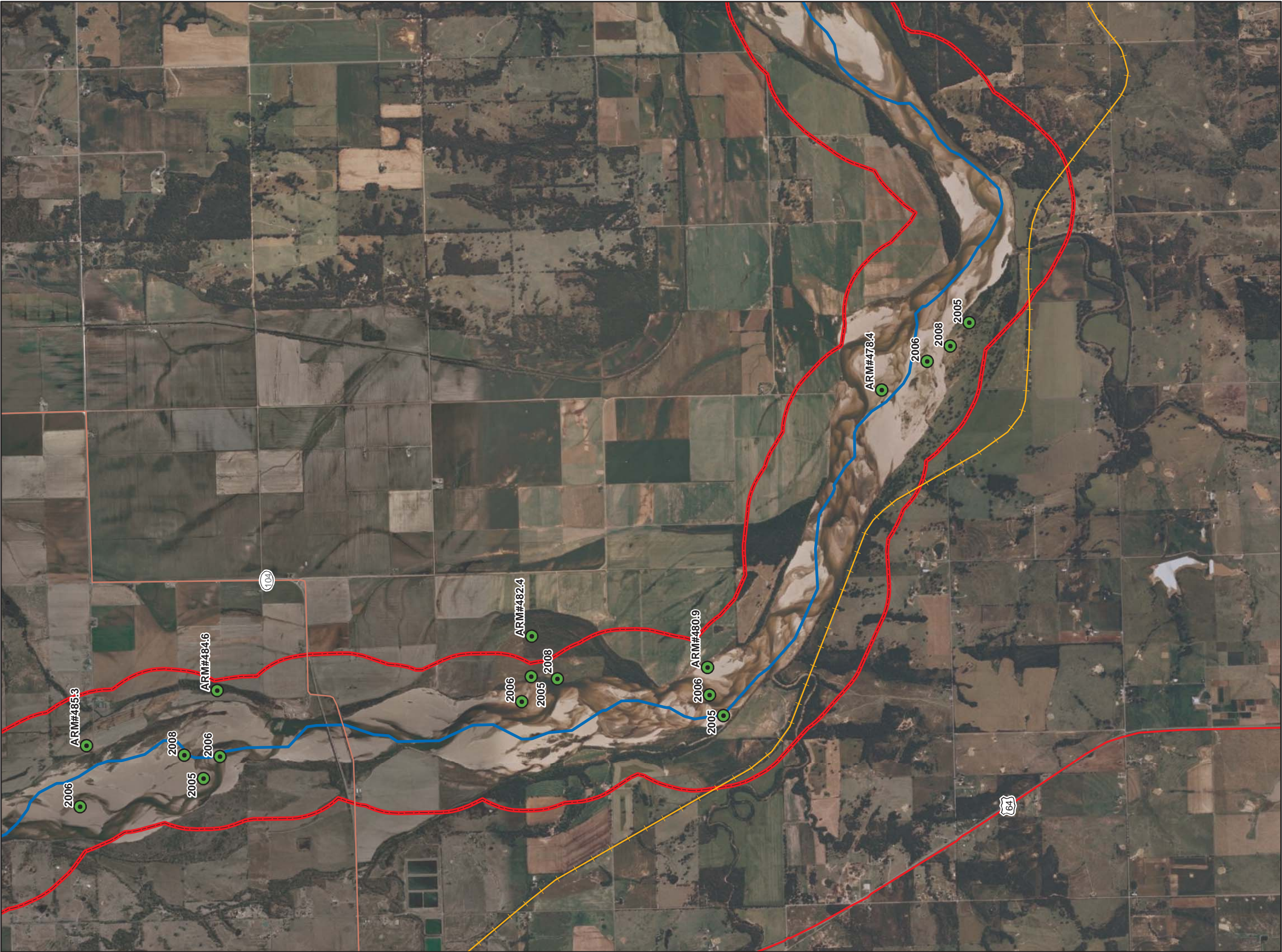
Map K



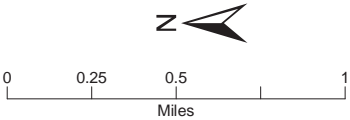
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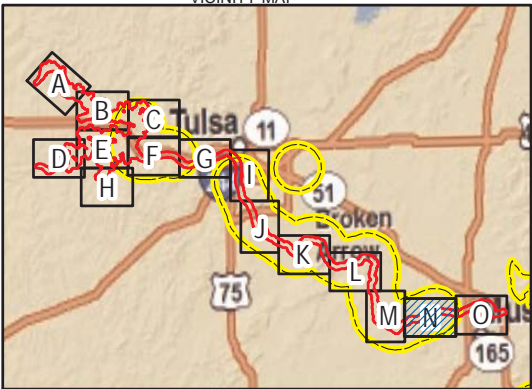
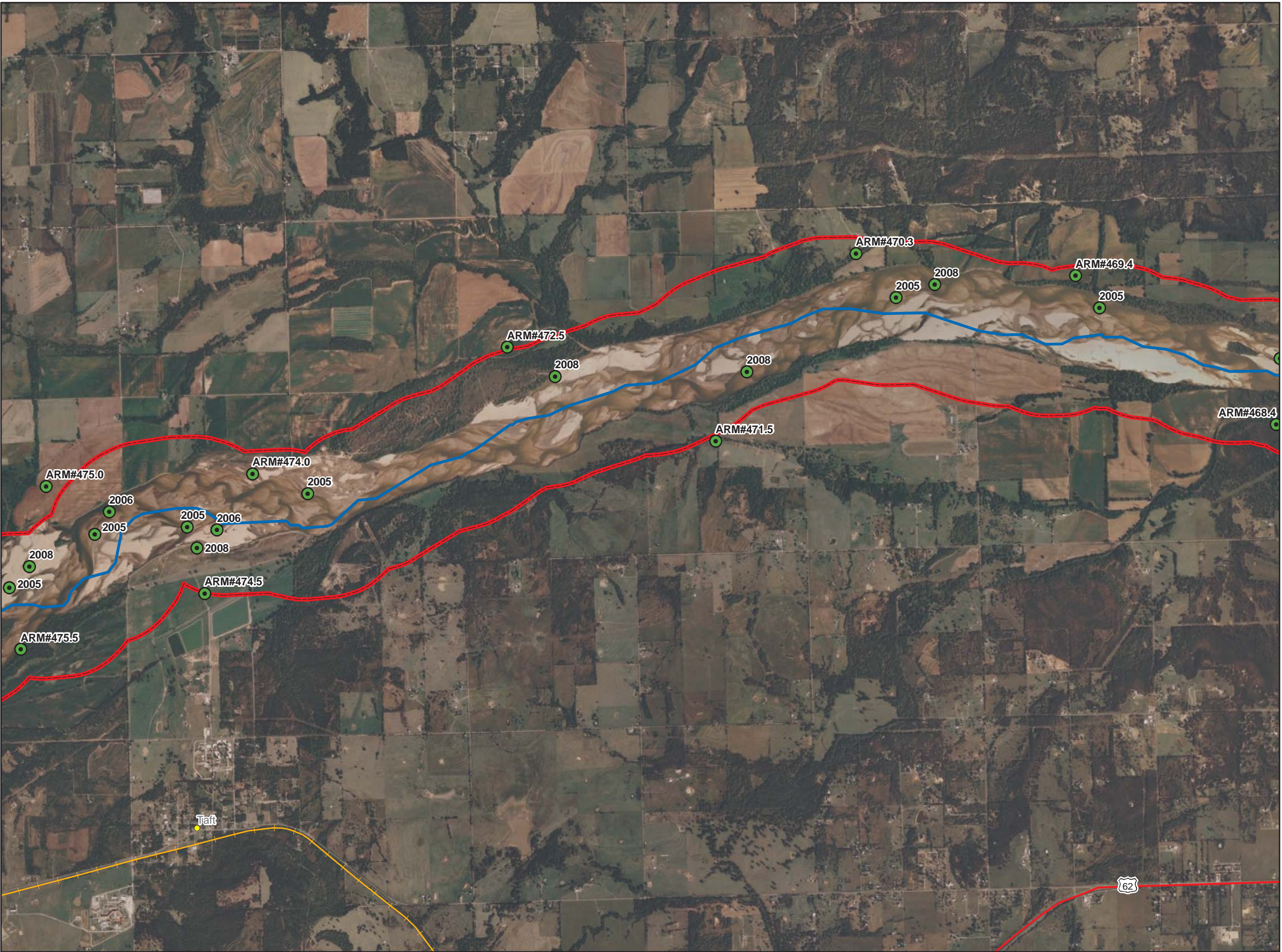
Yearly Locations of Least Tern Nesting Colonies Map L
Arkansas River Corridor
Tulsa, OK



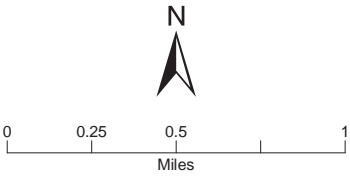
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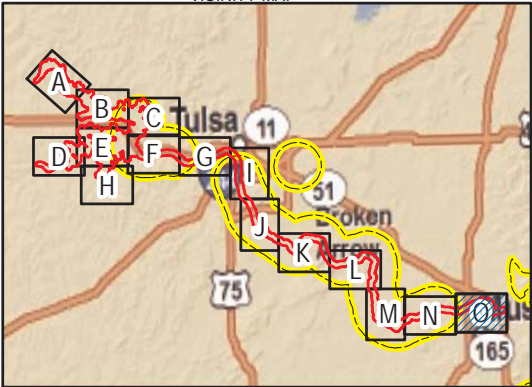
Yearly Locations of Least Tern Nesting Colonies Map M
Arkansas River Corridor
Tulsa, OK



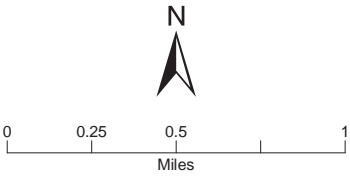
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Yearly Locations of Least Tern Nesting Colonies Map N
Arkansas River Corridor
Tulsa, OK



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Yearly Locations of Least Tern Nesting Colonies Map O
Arkansas River Corridor
Tulsa, OK