Arkansas River Corridor Project

Preliminary Project Management Plan

Investigation and Feasibility Study for Ecosystem Restoration

Prepared for

Tulsa County, OK

February 2010

CH2MHILL

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Acronyms and Abbreviations

ac-ft	Acre-Foot
AFB	Alternative Formulation Briefing
ASA	Assistant Secretary of the Army
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
CEQ	Council on Environmental Quality
cfm	Cubic Feet per Minute
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CW	Civil Works
CWA	Clean Water Act
DO	Dissolved Oxygen
EDA	U.S. Economic Development Administration
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
FEMA	Federal Emergency Management Agency
ft	Foot
ft/s	Feet per Second
GIS	Geographic Information System
gpm	Gallons per Minute
hp	Horsepower
HTRW	Hazardous, Toxic, and Radioactive Waste
INCOG	Indian Nations Council of Governments
kg	Kilogram
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
lb	Pound
lb/d	Pounds per Day
lf	Linear Foot
m/s	Meters per Second
mg/L	Milligram per Liter
mgd	Million Gallons per Day
MKARNS	McClellan-Kerr Arkansas River Navigation System
mm	Millimeter
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance

ODEQ	Oklahoma Department of Environmental Quality
ODWC	Oklahoma Department of Wildlife Conservation
OMB	Office of Management and Budget
OMRR&R	Operation, Maintenance, Replacement, Repair, and Rehabilitation
OWRB	Oklahoma Water Resources Board
PAS	Planning Assistance to States
PED	Preliminary Engineering Design
PLC	Programmable Logic Controller
PMP	Project Management Plan
ppm	Parts per Million
psi	Pounds per Square Inch
psig	Pounds per Square Inch Gauge
RPM	Reasonable and Prudent Measure
SCADA	Supervisory Control and Data Acquisition
sf	Square Feet
SHPO	State Historic Preservation Office
SMP	Shoreline Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TM	Technical Memorandum
TMDL	Total Maximum Daily Load
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WRF	Water Reclamation Facility
WSE	Water Surface Elevation

Executive Summary

Overview

This Preliminary Project Management Plan (PMP) is intended to provide guidance for the progression of the Arkansas River Corridor Projects to the multiple sponsors, including Tulsa County, the Indian Nations Council of Governments (INCOG), the U.S. Economic Development Administration (EDA), and the U.S. Army Corps of Engineers (USACE). The overall project was originally identified by citizens of Tulsa County, Oklahoma and involves ecosystem restoration along a 42-mile reach of the Arkansas River, between Keystone Dam and the Tulsa County/Wagoner County line. While ecosystem restoration may occur throughout a broader area of the 42-mile reach, the current phase of the project focuses on a smaller area, as described in this Preliminary PMP. This document addresses those areas identified for funding by Tulsa County and USACE, including modification of Zink Dam and the addition of two low-head (also referred to as low-water) dams: one at Sand Springs and one at South Tulsa/Jenks.

This document includes: a summary of additional studies to be conducted; study assumptions; the anticipated project schedule; identified problems, opportunities, and constraints; and alternatives recommended for further study. This Preliminary PMP also establishes procedures for completing the next phase of the Arkansas River Corridor Projects and is designed to serve as the basis of the Final PMP, which will be developed by USACE in accordance with National Environmental Policy Act (NEPA) and other applicable regulations, as well as USACE and Council on Environmental Quality (CEQ) guidance documents.

Background

In recent years, citizens of Tulsa County have recognized both the potential of the Arkansas River as a resource and the need to address its declining water quality and aquatic ecosystems. In accordance with this increased awareness, a Dialog/Visioning 2025 Citizen's Summit was held in early 2002 to identify potential improvements to the Arkansas River and the Arkansas River Corridor. From this Citizen's Summit, the project was initiated and has included a wealth of research, planning, and design initiatives for the beautification and improvement of 42 miles of the Arkansas River Corridor, between Keystone Dam and the Tulsa County/Wagoner County line.

The Arkansas River Dialog/Visioning 2025 Citizen's Summit identified a path forward for improvement of the Arkansas River Corridor and was the impetus for multiple subsequent studies. Since the Citizen's Summit, additional work has been authorized by INCOG and USACE for the following studies:

- Arkansas River Corridor Master Plan, Phase I Vision Plan (Carter Burgess, 2004)

- Arkansas River Corridor Master Plan, Phase II Master Plan and Pre-Reconnaissance Study (Guernsey et al., 2005)
- Conceptual Planning, Tulsa Wave Whitewater Park (McLaughlin Whitewater Design Group, 2007)
- Vision for the Arkansas River Corridor at Tulsa (Tennessee Valley Authority [TVA], 2008)
- Vision 2025 Arkansas River Corridor Ecosystem Restoration Plan (USACE 2009)

The project, as initially envisioned, involves enhancement and restoration at seven key development sites within the 42-mile project area and includes modifying the existing Zink Dam and adding two low-head dams, at Sand Springs and South Tulsa/Jenks. Restoration along the entire 42-mile stretch of the Arkansas River will involve portions of several communities, including Sand Springs, Tulsa, Jenks, Bixby, and Broken Arrow. However, since the initial planning stages, a refined smaller project (Phase III) of the project has been identified based on sponsor and stakeholder input, preliminary feasibility analysis, budget considerations, and funding opportunities. The current project is outlined in the Technical Memorandum (TM) entitled *Baseline Project Summary for the Arkansas River Corridor Project* (Appendix A) and includes project components at three key development sites: Zink Dam, South Tulsa/Jenks, and Sand Springs. Individual aspects of the project and preliminary studies completed in this phase of the project are discussed in Appendices B through X.

Investigation and Feasibility Study Implementation

Since development of the Phase I Vision Plan (Carter Burgess, 2004) and Phase II Master Plan and Pre-Reconnaissance Study (Guernsey et al., 2005), CH2M HILL and the Program Management Group, LLC (the designated representative of the Tulsa County Board of County Commissioners for the project) have conducted multiple reviews and data analyses and have refined the proposed project design. Activities that have been conducted as part of the current phase of the project include:

- Stakeholder involvement– includes sponsor and agency workshops, public meetings, and development of a public involvement plan.
- Constraint and existing conditions analyses–includes identification of potential constraints to be considered during design so that impacts can be avoided, minimized, or mitigated where practical. Potential constraints were identified based on literature review, environmental data review, and field reconnaissance. Habitat, natural features, existing utilities, outfalls, and other structures were among the constraints noted.
- Physical and environmental analyses–includes survey and mapping of the project area; geotechnical, geomorphic, floodplain management, vegetation and streambank stability assessments; and water quality modeling.
- Updated concept definition–includes schematic concepts of engineering and architectural components of the projects. Design concepts were informed by reach-scale hydraulic and hydrologic modeling, streambank stabilization concept development, and water quality modeling.

- Environmental constraints for fish passage–integrates design elements for the low-water dams with technologies to allow fish passage through the project area.
- Least tern requirements–includes assessment of interior least tern (*Sterna antillarum*) habitat and formulation of conceptual preliminary conceptual mitigation strategies.
- Development of conceptual cost estimates–includes cost estimates for future phases of the project, including capital requirements.

TMs detailing findings and results of these activities are presented in the appendices and are referenced throughout this document. Through these activities, four alternatives configurations that include many common elements have been selected for consideration in a feasibility study. These alternative configurations, including the "Master Plan," "Environmental Maximum," "Maximum Economic Development," and "Balanced" alternatives, are summarized in Table E-1.

Study Area and Focus

The proposed Arkansas River Corridor Project is located on the mainstem Arkansas River in the Tulsa metropolitan area in Tulsa County, Oklahoma. The study area includes the Arkansas River corridor extending from, and including, USACE's 26,000-acre Keystone Lake (located in portions of Osage, Pawnee, Creek, Tulsa, and Payne Counties) downstream to the Tulsa/Wagoner County line. This reach includes a 17-mile segment from Keystone Dam to the existing low-head Zink Dam in Tulsa and a 64-mile segment from Zink Dam to the McClellan-Kerr Arkansas River Navigation System (MKARNS) near Muskogee in eastern Oklahoma. The study area includes a corridor extending 2,200 feet (ft) on each side of the centerline of the river, and a 1,500-ft-wide zone around Keystone Lake. The study area intersects portions of several communities, including Sand Springs, Tulsa, Jenks, Bixby, and Broken Arrow.

The purpose of the Arkansas River Corridor Project is to:

- Achieve a net beneficial effect on the riverine and riparian ecological functions within the Arkansas River in the vicinity of Zink Dam, Sand Springs, and South Tulsa/Jenks while maintaining flood risk management and hydropower generation within the corridor.
- Improve the riverine system's functionality, which may include sediment transport, fish habitat, pedestrian access to public facilities, and safety features for small, recreational watercraft.

The restoration of the riverine and riparian ecological functions may include management of erosion and sedimentation, as well as sediment transport; sustainable habitat for the interior least tern and bald eagle (*Haliaeetus leucocephalus*); riparian habitat for migratory waterfowl, resident shorebirds, and neotrophical migrants; fish passage to support upstream migration of striped bass (*Morone saxatilis*), sauger (*Sander canadensis*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), and paddlefish (*Polyodon spathula*); downstream transport of eggs and larvae during the spawning season; increased diversity and abundance of macroinvertebrate and fish assemblages; foraging habitat for species of concern; and water quality suitable for aquatic habitat and recreational contact.

Study, Design, and Implementation Cost Sharing

Sponsors of the first phase of the Arkansas River Corridor Projects included Tulsa County, INCOG, and USACE. The Arkansas River Dialog/Visioning 2025 Citizen's Summit, which was held in 2002 to identify a path forward for improvement of the Arkansas River Corridor, resulted in the addition of Proposition 4 to the Tulsa County 2025 sales tax initiative. On September 9, 2003, voters in Tulsa County approved a sales tax rate increase that resulted in four propositions. Proposition 4 allocated $157.4 million of County sales tax revenue to improve County infrastructure, including $9.5 million allocated specifically for: (1) construction of two low-water dams downstream of Keystone Dam, (2) Zink Lake shoreline beautification, and (3) Zink Lake silt removal improvements. The current phase of the project will be partially funded by revenue generated from Proposition 4. In addition, the project will utilize funds from the EDA and Water Resources Development Act (WRDA) funds that were authorized in 2007 when these funds are appropriated. Project sponsors have taken steps to obtain funding from USACE, specifically from the USACE Floodplain Management Services and Planning Assistance to States (PAS) programs, and are expected to obtain partial funding from these programs.

TABLE E-1
Summary of Alternative Project Configurations to be Considered in the Feasibility Study

Alternative	Project Summary	Alternative Elements [a]			
		Sand Springs	**Zink Dam**	**South Tulsa/Jenks**	**Additional Components Common to All Three Areas**
Alternative Project Configuration 1: **Master Plan/TVA/ Phase III**	Alternative 1 includes project components for Sand Springs, Zink Dam, and South Tulsa/Jenks that were developed in the following project documents: • Arkansas River Corridor Master Plan, Phase I Vision Plan (Carter Burgess, 2004) • Arkansas River Corridor Master Plan, Phase II Master Plan and Pre-Reconnaissance Study (Guernsey et al., 2005) • Vision for the Arkansas River Corridor at Tulsa (TVA, 2008)	• Dam height 11 ft (minimum storage 8 ft) • Least tern island restoration in Sand Springs pool • Prattville Creek & River City Park (Franklin Creek) bank restoration	• Dam height increase of 3 ft with crest gates • Recreational whitewater/roughened channel through dam on east bank; Tulsa Wave on west bank • Least tern habitat: existing island may need restoration, addition of island between Sand Springs and Zink Dam and possibly another downstream	• Dam height 8 ft (design to meet "No Rise" condition; no extra channel to mitigate minimum rise) • Seasonal gate operations • Polecat and Vensel Creeks restoration	• Bank stabilization limited to dams and areas next to dams • Wetland and riparian restoration on each pool area. • Full height gates 50% of length • Fish stocking
Alternative Project Configuration 2: **Focused Environmental Benefits**	Alternative 2 was developed with consideration to providing the greatest environmental benefits. Elements at all dams include gates across entire heights and lengths of the dam, roughened channel fish passage, fish stocking to mitigate fish loss, least tern habitat/islands in pools and riverine areas, and enhanced restoration along pools.	• Dam height 11 ft (minimum storage 8 ft) • Reduced inundation through operations • Improved bald eagle habitat • Prattville Creek & River City Park (Franklin Creek) bank restoration	• Rehabilitation or restoration of old gates • Tulsa Wave on west bank	• Dam height 9 ft • Polecat and Vensel Creeks restoration	• Roughened channel passage • Gates – full height and length of dams • Seasonal gate operations for maximum fish and egg passage • Addition of least tern habitat/islands in pools and downstream riverine areas • Enhanced restoration along pools • Bank bio-stabilization for protection above 40,000 cubic feet per second (cfs) • Fish stocking to mitigate fish loss
Alternative Project Configuration 3: **Focused Socioeconomic Benefits**	Alternative 3 was developed with consideration to the socioeconomic benefits that the project would provide for the nearby communities. Project components include enhanced terraced dam design, enhanced access to pool for fishing and other recreation, and dams designed for maximum water storage.	• Dam height 11 ft (minimum storage 8 ft) • Marina boating access • River City Park (Franklin Creek) recreational development • Rowing venue • Prattville Creek & River City Park (Franklin Creek) bank restoration	• Gate height increase of 3 ft • Recreational whitewater (east bank) • Tulsa Wave (west bank) • Restoration/replacement of existing gates • Addition of new gates	• Dam height 9 ft • Whitewater on one or both sides • Additional recreational access and amenities • Polecat and Vensel Creeks restoration	• Bank stabilization limited to dams and areas next to dams • Wetland and riparian restoration on each pool area. • Full height gates 50% of length • Continuous whitewater channel to connect all 3 projects • Enhance terrace dam at each location • Same restoration as Master Plan • Enhanced access to pool for fishing and other recreation
Alternative Project Configuration 4: **Balanced**	Alternative 4 was developed to combine Alternatives 1, 2, and 3, to meet the objectives of: the original project's vision, environmental benefits, and socioeconomic benefits. Project elements include components of the original plans, streambank and riparian restoration to benefit the local communities, and seasonal gate operations to provide environmental benefits to fish communities.	• Dam height 11 ft (minimum storage 8 ft) • Least tern island in Sand Springs pool • Prattville Creek restoration • Bank restoration and/or vegetation (River City Park) • Marina/Franklin Creek water feature	• Gate height increase of 3 ft • Rehabilitation or restoration of old gates • Whitewater roughened channel through dam and both sides • Least tern habitat: existing island may need restoration, addition of island between Sand Springs and Zink Dam	• Adaptive management of fish/egg passage via roughened channel and gate operation • Enhanced fish monitoring and/or stocking • Polecat and Vensel Creeks restoration	• Recreation/bank/riparian restoration • Seasonal gate operations for fish passage

[a] The following elements are included in all 4 alternatives: (1) Repair and Restoration of Gates at Zink Dam, (2) Restoration of Least Tern Habitat Downstream of South Tulsa/Jenks, (3) Emergency, Maintenance, and Public Access at All Facilities, (4) Maintenance and Restoration of Existing Habitat, (5) Compliance with Minimum Rise of Floodways and Local Floodplain Ordinances, (6) Sediment Transport/Management, and (7) Recreational Access to Water and Acceptable Water Quality

SECTION 1

Introduction

Purpose of the Report

This Preliminary Project Management Plan (PMP) is intended to provide guidance for the progression of the Arkansas River Corridor Projects to the multiple sponsors, including Tulsa County, the Indian Nations Council of Governments (INCOG), the U.S. Economic Development Administration (EDA), and the U.S. Army Corps of Engineers (USACE). The overall project was originally identified by citizens of Tulsa County, Oklahoma and involves ecosystem restoration along a 42-mile reach of the Arkansas River, between Keystone Dam and the Tulsa County/Wagoner County line. While ecosystem restoration may occur throughout a broader area of the 42-mile reach, the current phase of the project focuses on a smaller area, as described in this Preliminary PMP. This document addresses those areas identified for funding by Tulsa County and USACE, including modification of Zink Dam and the addition of two low-head (also referred to as low-water) dams: one at Sand Springs and one at South Tulsa/Jenks.

This document includes: a summary of additional studies to be conducted; study assumptions; the anticipated project schedule; identified problems, opportunities, and constraints; and alternatives recommended for further study. This Preliminary PMP also establishes procedures for completing the next phase of the projects and is designed to serve as the basis of the final PMP, which will be developed by USACE in accordance with National Environmental Policy Act (NEPA) and other applicable regulations, as well as USACE and Council on Environmental Quality (CEQ) guidance documents.

An evaluation of potential regulatory compliance issues and applicable regulations is included in the *Preliminary Regulatory Review, Data Gaps Analysis, and Summary of Potential Project Effects* Technical Memorandum (TM) (Appendix B).The regulations and associated next steps are summarized in this Preliminary PMP and include the Clean Water Act (CWA), Endangered Species Act, National Historic Preservation Act, and Executive Orders (EOs) for the protection of wetlands and floodplain management.

Project History

In recent years, citizens of Tulsa County have recognized both the potential of the Arkansas River as a resource and the need to address its declining water quality and aquatic ecosystems. In accordance with this increased awareness, a Dialog/Visioning 2025 Citizen's Summit was held in early 2002 to identify potential improvements to the Arkansas River and the Arkansas River Corridor. From this Citizen's Summit, the project was initiated and has included a wealth of research, planning, and design initiatives for the beautification and improvement of 42 miles of the Arkansas River Corridor, between Keystone Dam and the Tulsa County/Wagoner County line (Figure 1). While ecosystem restoration may occur throughout a broader area of the 42-mile reach, the current phase of the project, and the

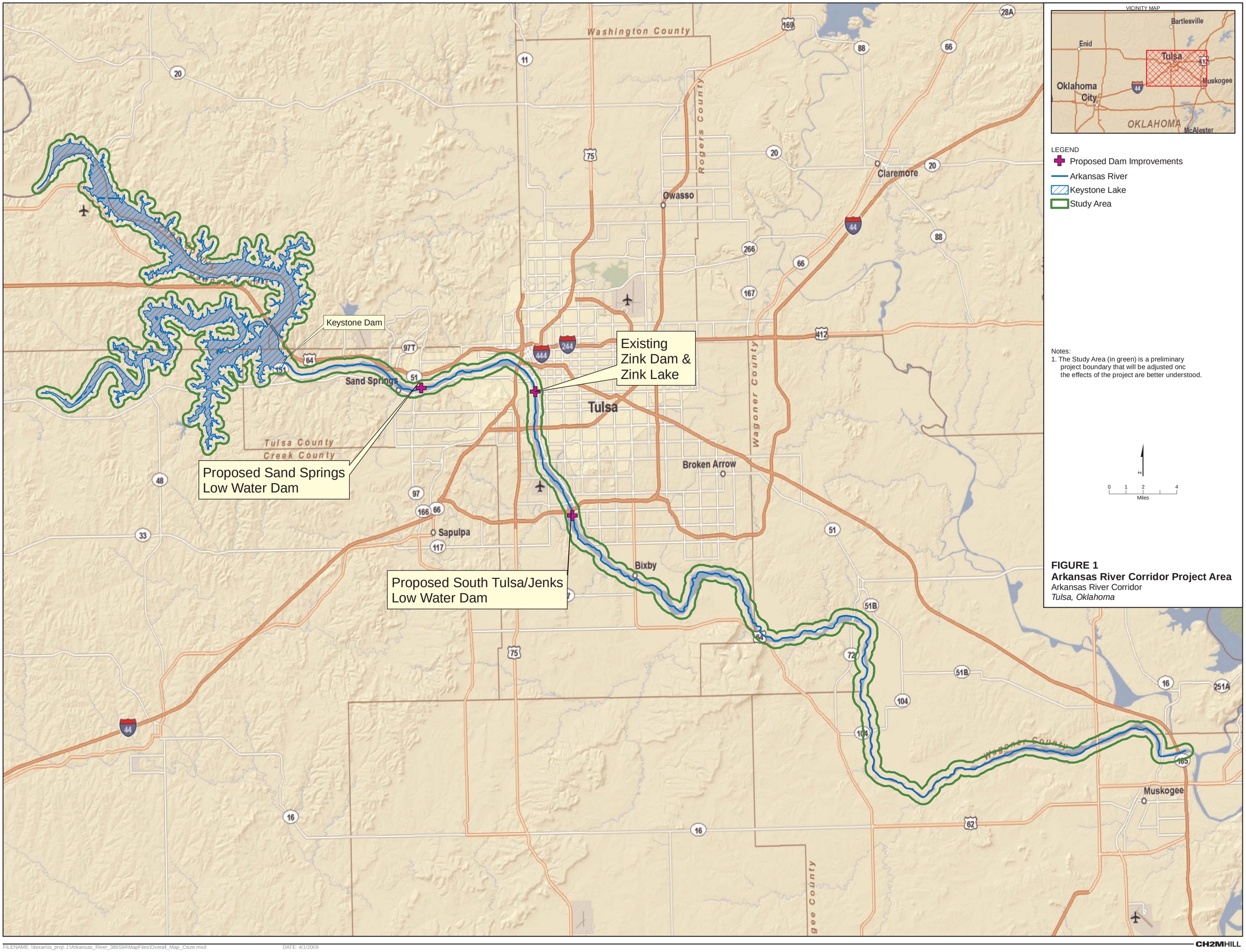

FIGURE 1
Arkansas River Corridor Project Area
Arkansas River Corridor
Tulsa, Oklahoma

focus of this Preliminary PMP, is concentrated in a smaller area, as described in this document. This Preliminary PMP includes those areas identified for funding by Tulsa County and USACE, including modification of Zink Dam and the addition of two low-water dams, at Sand Springs and South Tulsa/Jenks.

The Arkansas River Dialog/Visioning 2025 Citizen's Summit identified a path forward for improvement of the Arkansas River Corridor and was the impetus for multiple subsequent studies. Since the Citizen's Summit, additional work has been authorized by INCOG and USACE for the following studies:

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- Physical and environmental analyses–includes survey and mapping of the project area; geotechnical, geomorphic, floodplain management, vegetation and streambank stability assessments; and water quality modeling.
- Updated concept definition–includes schematic concepts of engineering and architectural components of the projects. Design concepts were informed by reach-scale hydraulic and hydrologic modeling, streambank stabilization concept development, and water quality modeling.
- Environmental constraints for fish passage–integrates design elements for the low-water dams with technologies to allow fish passage through the project area.
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TMs detailing findings and results of these activities are presented in the appendices and are referenced throughout this document. Through these activities, four alternatives configurations that include many common elements have been selected for consideration in a feasibility study. These alternative configurations, including the "Master Plan," "Environmental Maximum," "Maximum Economic Development," and "Balanced" alternatives, are summarized in Table E-1.

The next steps of the project are outlined in Section 5.

Purpose and Need of the Project

Purpose

The purpose of the Arkansas River Corridor Project is to:

- Achieve a net beneficial effect on the riverine and riparian ecological functions within the Arkansas River in the vicinity of Zink Dam, Sand Springs, and South Tulsa/Jenks while maintaining flood risk management and hydropower generation within the corridor.
- Improve the riverine system's functionality, which may include sediment transport, fish habitat, pedestrian access to public facilities, and safety features for small, recreational watercraft.

The restoration of the riverine and riparian ecological functions may include management of erosion and sedimentation, as well as sediment transport; sustainable habitat for the interior least tern and bald eagle (*Haliaeetus leucocephalus*); riparian habitat for migratory waterfowl, resident shorebirds, and neotrophical migrants; fish passage to support upstream migration of striped bass (*Morone saxatilis*), sauger (*Sander canadensis*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), and paddlefish (*Polyodon spathula*); downstream transport of eggs and larvae during the spawning season; increased diversity and abundance of macroinvertebrate and fish assemblages; foraging habitat for species of concern; and water quality suitable for aquatic habitat and recreational contact.

Need

While the Arkansas River has long been a significant natural resource for the surrounding land and its inhabitants, historical alterations have degraded watershed conditions and masked the river's unique potential. The 1964 construction of Keystone Dam, 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.

Project Description

The originally identified Arkansas River Corridor Project involved restoration components at seven key development sites between Keystone Dam and the Tulsa County/Wagoner County line. Restoration along this 42-mile reach of the Arkansas River will positively affect portions of several communities, including Sand Springs, Tulsa, Jenks, Bixby, and Broken Arrow, and will provide a variety of benefits outlined in the Phase II Master Plan. The current phase of the project (Phase III) includes modifying Zink Dam and adding two low-head dams, at Sand Springs and South Tulsa/Jenks. These elements have been identified for funding by Tulsa County and USACE and are discussed below.

Because Keystone Dam, at the upstream end of the project area, currently blocks sediment transport, sediment is supplied from only three sources in the project area: the channel bed, the channel banks, and the tributary inputs. The project will aim to minimize the sediment contribution from these sources and will also focus on sediment transport throughout the dam system. The low-water dams will be operated in an integrated manner to optimize flow control through each individual dam, as well as through the overall river/lake system along the 42-mile reach of the Arkansas River. Dams will be engineered to eliminate safety hazards and to consider potential impacts from anthropogenic sources, sedimentation, debris, zebra mussels, and historic flow regimes (USACE, 2009). Dams will also be engineered with consideration of public safety, fish passage, and habitat restoration.

In addition to dam construction and modification, other components envisioned for the project include: boating amenities in dam impoundments, fishing piers, pedestrian bridges, hiking and nature trails, and whitewater recreation areas. Public access to all new project components will require linking the existing trail system to new access roads and trails. Trails, boardwalks, and pedestrian bridges will be developed to provide convenient access to river crossings and to improve connectivity between the Arkansas River and nearby communities.

Proposed project components for the three key development sites included in this phase of the project are outlined below.

Zink Dam Modification and Riverfront

Zink Lake is a popular outdoor area that provides recreational opportunities and a festival venue for the Tulsa area. However, due to the lack of initial capital funding, Zink Dam has

limited functionality to transport sediment downstream, resulting in sedimentation within Zink Lake and scour near the edges of the dam. Additionally, the dam structure, an ogee weir, has the potential to create an unstable and potentially unsafe hydraulic "roller" effect which acts as an undercurrent and continuously pulls surface water to the bottom of the channel.

Proposed improvements to Zink Dam include (1) the installation of weir gates to improve sediment transport and fish passage and (2) flow attenuation to reduce flood risk, and (3) modifications to correct the roller effect. Zink Dam will be operated at a fixed or variable pool elevation as needed, made possible by equalizing low flow releases from the Sand Springs Dam. The dam could also be raised by 2 to 3 ft to expand the area of Zink Lake and provide additional recreational opportunities, including boating amenities and, potentially, a whitewater wave park. This will be achieved by installing 2- to 3-ft high gates on the top of the existing dam. Their operation will control water depth as needed for rowing and paddling events, whitewater releases, and low flow storage and augmentation. These concepts are discussed in more detail in Appendix C.

The McLaughlin Whitewater Design Group (2007) conducted a preliminary engineering analysis on rehabilitating the "Tulsa Wave," a unique whitewater wave effect that forms downstream of Zink Dam, in conjunction with developing a whitewater wave park. Other potential features at Zink Dam could include integration of design concepts that will yield benefits in addition to whitewater recreation, in conjunction with fish passage, flow management, and sediment control.

In addition to dam modification, a major goal for the Zink Lake area is to "enhance physical and visual connections between the east and west banks" (Guernsey et al., 2005). The Phase II Master Plan involves improvements to the Zink Lake Riverfront as well as the development of new recreational opportunities. Currently proposed project components in the Zink Lake area include:

- Improved riparian habitat and shoreline beautification
- Lake depth increase to enhance boating, rowing, and paddling opportunities
- Consideration of a whitewater recreation facility and/or improvements to the existing "Tulsa Wave"
- Hiking and nature trails, with overlooks and observation points, on the east bank, including maintenance and access
- Gathering places for rowing, whitewater, paddling, and boat launching activities or observation

Sand Springs Low-Water Dam and Riverfront

The site proposed for construction of Sand Springs Dam is located downstream of Oklahoma Highway 97, at least 150 ft upstream of the confluence of Prattville Creek to avoid erosion impacts (USACE, 2009). The dam will be approximately 11 to 12 ft high and will create a lake extending 5 miles upstream of the dam, to the Shell Creek area. A minimum downstream flow would be maintained by alternating the storage and release from the top 2 to 3 ft of the lake with the flows from Keystone Dam, and during periods of

non-generation at Keystone Dam. Assuming a daily release from Keystone Dam, Sand Springs Dam would allow between 400 and 1,000 cfs of flow and provide sufficient water for daily activities in the Tulsa and Jenks area (USACE, 2009).

Based on TVA guidance, an adjustable dam will be designed to allow for seasonal changes in flow and the creation of either a lake or river system (TVA, 2008). Sand Springs Dam will be designed to allow for a river system during the typical spawning season of the local fishery (March to June) and to allow for a lake system, providing recreational opportunities, during other months. The seasonal river system would allow upstream fish migration as well as downstream transport of eggs and larvae to sustain fish propagation. The river system would also prevent land bridging and allow downstream sediment transport to maintain nesting island habitats for interior least terns. Additionally, when the lake is impounded, the bald eagle population would be able to use both the lake and the area downstream of the dam for feeding.

While Sand Springs Lake would reduce downstream erosion, additional streambank stabilization methods would be used to protect streambanks during the spring season, when the water level is lowered, as discussed in Appendix D. Streambank stabilization would involve a mix of bank "armor" and bio-remediation measures, as appropriate. "High risk areas" that could compromise the functioning of the dam, such as Prattville Creek, would be prioritized for erosion control. Eroding streambanks would also be prioritized for stabilization based on field reconnaissance of physical parameters and results of modeling analyses. Additionally, 3 acres of the creek would be converted to a created wetland to provide habitat for aquatic ecosystems and water quality improvement through vegetative filtering. Native planting to replace vegetation removed during project implementation, including the planting of American sycamores (*Platanus occidentalis*), or other tall trees, would provide additional habitat for bald eagles.

The Phase II Master Plan primary development goal for the Sand Springs Riverfront is "to provide a riverfront destination for retail and commercial services, and to improve the appearance of the City...and to provide recreational opportunities and aesthetic improvements to the area" (USACE, 2009). Development proposed in the Sand Springs area for the current phase of the project includes:

- New low-water dam with pedestrian bridge and fishing piers along with potential whitewater recreation opportunity.
- Boat ramp on the south bank to access the river below the dam, for public use, fishing, and emergency access
- Hiking and nature trails and overlooks on the north and south banks

South Tulsa/Jenks Low-Water Dam and Riverfront

The proposed South Tulsa/Jenks Dam will be constructed within a mile downstream of the dam and upstream of the Polecat Creek confluence. The low-water dam will be approximately 8 to 9 ft in height and will create an impoundment approximately 3 miles long. In addition to ecosystem restoration benefits, the impoundment would also afford boat access to the Creek Nation Casino. The South Tulsa/Jenks Dam would be operated at a fixed pool elevation, made possible by flow from Sand Springs Dam. As with Sand Springs

Dam, TVA recommends an adjustable dam design in the South Tulsa/Jenks area, to allow for a river or lake system and to support fish passage. The South Tulsa/Jenks Dam design would be similar to the Sand Springs Dam design.

Erosion control methods will be used on nearby river reaches to reduce sedimentation and protect streambanks. These would consist of bank "armor" as well as vegetation measures to assure protection while maintaining both view and access. Bank stabilization measures would be implemented to protect Vensel Creek, primarily when the water level is lowered, and to protect Arkansas River embankments upstream and downstream of Jenks RiverWalk. For ecosystem restoration, USACE recommends the planting of native shrubs and trees near the commercial development upstream of the Creek Turnpike and continued preservation of the existing Habitat Restoration and Bald Eagle Preserve near the 96th Street Bridge (USACE, 2009).

The Phase II Master Plan primary development goal for the South Tulsa/Jenks area is the "creation of a retail and entertainment district on both sides of the river" (USACE, 2009). Proposed development in the South Tulsa/Jenks area, for the current phase of the project, includes:

- Low-water dam with pedestrian bridge and fishing piers along with potential whitewater recreation opportunity
- Boat ramp for public use, fishing, and emergency access
- Constructed habitat beyond the upper reach of the lake and/or downstream of the dam to provide nesting habitat for interior least terns
- Ecosystem restoration with integrated hiking and nature trails

Study Sponsors

Sponsors of the first phase of the Arkansas River Corridor Project included Tulsa County, INCOG, and USACE. The Arkansas River Dialog/Visioning 2025 Citizen's Summit, which was held in 2002 to identify a path forward for improvement of the Arkansas River Corridor, resulted in the addition of Proposition 4 to the Tulsa County 2025 sales tax initiative. Approval of Proposition 4 in 2003 authorized $9.5 million in sales tax revenues for: (1) construction of two low-water dams downstream of Keystone Dam, (2) Zink Lake shoreline beautification, and (3) Zink Lake silt removal improvements. The current phase of the project will be partially funded by revenue generated from Proposition 4. In addition, the project will utilize EDA funds and Water Resources Development Act (WRDA) funds that have been authorized for the project, when these funds are appropriated. Project sponsors are also evaluating the potential for obtaining USACE funding under the Floodplain Management Services and the Planning Assistance to States (PAS) programs.

Study Authority

As noted previously, the project was authorized under WRDA 2007. The first appropriation of funding to USACE for this project was received in early fiscal year (FY) 2010, but actual funding has not been awarded to USACE at this time. Project sponsors have taken steps to

obtain funding from USACE, from the Floodplain Management Services and PAS programs, and are expected to obtain partial funding from these programs.

Study Area

The proposed project is located on the mainstem Arkansas River in the Tulsa metropolitan area in Tulsa County, Oklahoma. The Arkansas River is a major tributary of the Mississippi River, flowing to the east and southeast a distance of 1,450 river miles. The river drains an area of about 195,000 square miles. The Arkansas River forms on the eastern slope of the Rocky Mountains in southeastern Colorado, enters the Great Plains, and flows through Kansas, Oklahoma, and Arkansas to the Mississippi River.

The study area includes the Arkansas River Corridor extending from, and including, USACE's 26,000-acre Keystone Lake (located in portions of Osage, Pawnee, Creek, Tulsa, and Payne Counties) downstream to the Tulsa/Wagoner County line (see Figure 1). This reach includes a 17-mile segment from Keystone Dam to the existing low-head Zink Dam in Tulsa and a 64-mile segment from Zink Dam to the McClellan-Kerr Arkansas River Navigation System (MKARNS) near Muskogee in eastern Oklahoma. The study area includes a corridor extending 2,200 ft on each side of the centerline of the river, and a 1,500-ft-wide zone around Keystone Lake. The study area intersects portions of several communities, including Sand Springs, Tulsa, Jenks, Bixby, and Broken Arrow.

Previous Studies (Reconnaissance Overview)

Since the Arkansas River Dialog/Visioning 2025 Citizen's Summit was held in 2002, a number of studies have been conducted to further develop a plan for improvement to the Arkansas River and Arkansas River Corridor. The Arkansas River Corridor Phase I Vision Plan, initiated by INCOG in 2003, is a preliminary plan to "enhance the river and the citizens' lives" (Carter Burgess, 2004). The Phase I Vision Plan evaluated seven major features with the potential to maximize the beneficial use of the Arkansas River Corridor while integrating ideas supported by the community: bridges and crossings, natural features and resources, low-water dams, multi-use trails and parks, traffic network and gateways, river-oriented activities, and community development opportunities. The Phase I Vision Plan is primarily based on citizen input and presents a conceptual design and provided the necessary framework for the comprehensive Phase II Master Plan (Guernsey et al., 2005).

The Phase II Master Plan (Guernsey et al., 2005) addresses economic, physical, environmental, ecological, and legal issues related to the project. Through the comprehensive Pre-Reconnaissance study, a number of opportunities associated with the Arkansas River and Arkansas River Corridor were identified, including low-water dams, mixed-use areas, parks, fishing piers, boating access, new and expanded trails, and bridges. The Master Plan includes conceptual plans, estimated costs, and potential funding sources for seven selected key development sites, construction of two new low-water dams, and modifications to Zink Dam.

After completion of the Phase II Master Plan, TVA provided a technical review of the low-water dam construction and dam modifications proposed in the Phase II Master Plan. The

Vision for the Arkansas River Corridor at Tulsa (TVA, 2008) outlines the findings and recommendations of this study, which was aimed at identifying a hydraulic system that meets project goals while also ensuring safety and complying with floodplain regulations. Based on engineering and environmental data analysis, TVA recommended the design of adjustable dams that would allow for seasonal changes in flow to promote upstream fish migration, as well as downstream transport of eggs and larvae to sustain fish propagation

The Tulsa Wave Whitewater Park conceptual planning document (McLaughlin Whitewater Design Group, 2007) details potential whitewater recreational opportunities that could be made possible by the modified and newly created low-water dams. McLaughlin conducted a preliminary engineering analysis on rehabilitating the "Tulsa Wave" in conjunction with developing a whitewater wave park.

Phase III of the project includes a baseline environmental study associated with an Ecosystem Restoration Plan (USACE, 2009). The Phase III study, which was limited to the Sand Springs and South Tulsa/Jenks low-water dam and lake systems, presents ecosystem restoration recommendations for consideration during the development of these project components. The study evaluates dams that would be engineered with a focus on public safety, fish passage, and habitat restoration, taking into consideration potential impacts from anthropogenic sources, sedimentation, debris, zebra mussels, and historic flow regimes. The study focuses on the protection of aquatic and riparian ecosystems, including the maintenance of a river/lake system to maintain nesting island habitats for interior least terns and to provide areas upstream and downstream of the dams for bald eagle feeding. The Ecosystem Restoration Plan will be submitted as part of the USACE regulatory permit application process during the next phase of the project.

Regional Considerations

The following regional considerations were identified for the Arkansas River Corridor Project and are discussed below: hydropower, flood risk management, water quality, existing plans for the project area, presence of tribal lands, threatened and endangered species, species of concern, and neotrophical migration, and the local economy.

Hydropower

As noted previously, the purpose of the Arkansas River Corridor Project will be met "while maintaining hydropower generation within the corridor." Existing hydropower operations will not be altered by implementation of the project. Hydropower production is federally managed at multiple locations along the Arkansas River, including Keystone Dam, which provides electricity to Tulsa County during periods of critical peak usage.

Peak production occurs through one turbine (approximately 6,000 cfs) or two turbines (approximately 12,000 cfs), based primarily on demand within the regional electrical distribution grid. Although peaking may occur at any time, it most often occurs between 2:00 p.m. and 10:00 p.m., Monday through Friday. However, peaking may occur throughout an entire day, may last several days, or may occur twice per day (e.g., once in the morning from 4:00 a.m. to 10:00 a.m., and again in the evening from 2:00 p.m. to 10:00 p.m.). It may also occur on the weekends, or not at all, depending on demand. The highest demand periods historically occur during warm to hot weather (April to September). During periods

of drought, although the demand may exist, peak hydropower production does not occur due to lack of sufficient water in the reservoir. More detail regarding existing river flows is presented in Appendix E.

Flood Risk Management

The *Floodplain Ordinances* TM (Appendix F) presents a review of regulations, ordinances, and requirements related to floodplain management that was developed for the project. The proposed project will be designed in accordance with the USACE Flood Risk Management Program, established in 2006 for the purpose of integrating state, federal, and local agencies for flood management activities. The proposed project will be designed and constructed in compliance with all applicable floodplain ordinances and/or regulations, as provided by USACE, the City of Tulsa, and the Federal Emergency Management Agency (FEMA). Modifications to Zink Dam, as well as construction of Sand Springs and South Tulsa/Jenks Dams, will be designed in accordance with FEMA National Flood Insurance Program (NFIP) regulations. Existing levees along the Arkansas River Corridor, which have been put into place to provide protection from a 350,000-cfs flood event, will not be disturbed by the project, except where changes include improvements to levees. Coordination with appropriate agencies during project planning and design will be conducted to ensure compliance with applicable regulations.

Water Quality

The Arkansas River and its major tributaries within the project area have a combination of beneficial use designations, including: emergency water supply; fish and wildlife propagation, warm water aquatic community; agriculture Class I irrigation (which indicates an "Excellent" level of water quality for irrigation purposes and low sodium content); primary body contact recreation (e.g., swimming, skin diving, and water skiing) or secondary body contact recreation (e.g., fishing and boating); and aesthetics.

The Oklahoma Department of Environmental Quality (ODEQ) 2006 and 2008 Water Quality Assessment Integrated Reports list significant portions of the Arkansas River as impaired due to elevated levels of fecal coliform, *Enterococcus*, and *Escherichia coli (E. coli*) bacteria; lead; cadmium; oil and grease; and total dissolved solids. A total maximum daily load (TMDL) for bacteria in the Arkansas River near Tulsa was developed by INCOG in 2008, and water quality standards outlined in the TMDL report will be considered during project design and implementation. The *Water Quality* TM (Appendix G) provides an analysis of water quality conditions in the project area.

Existing Plans for Project Area

Oklahoma Department of Wildlife Conservation (ODWC)

The ODWC developed the Lake Keystone Management Plan, in 2008, to guide its management of the lake, in terms of fish species protection. The OWDC implemented a striped bass stocking program in Keystone Lake, between 1965 and 1969, and is committed to maintaining the lake for recreational fishing opportunities. Keystone Lake is included in the Keystone Wildlife Management Area (WMA), which provides access to the lake and its tributaries for fishing for largemouth bass, flathead catfish, striped bass, blue catfish,

channel catfish, sand bass, and crappie. The Arkansas River at Zink Dam is also a popular location for catfish and striped bass fishing, which is allowed in most areas of the lake. The project design and implementation will ensure protection of this valuable natural resource as well as compliance with the ODWC Lake Keystone Management Plan. Appendix H presents a discussion of approaches to incorporate fish passage into the dam design.

USACE Keystone Lake Shoreline Management Plan (SMP)

In 1996, the USACE Tulsa District developed the Keystone Lake SMP "to establish policy and guidance for the protection of desirable environmental characteristics of the lake and restoration of the shoreline where degradation has occurred…" (USACE, 1996). The plan designates limited development areas, public recreation areas, protected shoreline areas, and prohibited access areas of Keystone Lake. The project will comply with guidelines set forth in the SMP for recreation promotion, operation and maintenance of water resources, and shoreline management.

Presence of Tribal Lands

In accordance with EO 13175, Consultation and Coordination with Indian Tribal Governments, input must be obtained from tribal officers in the development of regulatory policies that have tribal implications. As part of the proposed project, communication and coordination with tribal governments by the lead agency are required. Coordination with the State Historic Preservation Office (SHPO) as part of the NEPA process could identify additional needs for tribal input.

Threatened and Endangered Species, Species of Concern, and Neotrophical Migration

Federal agencies must ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of an endangered or threatened species, or result in destruction or adverse modification of a critical habitat of such a species. The U.S. Fish and Wildlife Service (USFWS) has identified one federally threatened bird species, the piping plover (*Charadrius melodus*), and one federally endangered species, the interior least tern, that utilize the Arkansas River Corridor in the project area. In addition, the bald eagle, which was removed from the federal list of threatened and endangered species in 2007, maintains a habitat in the project area, and state species of concern, such as shovelnose sturgeon, may seasonally occur there.

Potential direct impacts to threatened and endangered species include temporary disruptions to habitat as a result of land clearing and disturbance from project construction (e.g., habitat alteration, erosion, noise) and loss or alteration of habitat as a result of project construction, inundation by new or expanded pools, and project operation. With increased river corridor development, there is potential for indirect impacts to habitats of species of concern. However, the project is expected to have positive impacts on any threatened and endangered species that may occupy the project area, as primary goals of the project include restoration of riverine and riparian ecological function by providing sustainable habitat for the interior least tern and bald eagle; riparian habitat for migratory waterfowl, resident shorebirds, and neotrophical migrants; fish passage to support upstream migration of and downstream transport of eggs and larvae during the spawning season; increased diversity

and abundance of macroinvertebrate and fish assemblages; foraging habitat for species of concern; and water quality suitable for aquatic habitat and recreational contact. USFWS will need to be contacted during the design process and as part of the agency coordination during the NEPA process. Appendices H and I present additional information on fish passage and least tern habitat issues, respectively.

Local Economy

The proposed project will have impacts on nearby communities and will enhance the local economy by providing recreational opportunities and enhancing riverfront areas located near downtown business districts. In addition to benefits to aquatic ecosystems and water resources, the current phase of the project is focused on community benefits, including the addition of trails, boardwalks, and piers, as well as a whitewater park downstream of Zink Dam, and potentially upstream of Sand Springs and South Tulsa/Jenks Dams. Public access to all new project components would require linking the existing trail system to new access roads and trails. Trails, boardwalks, and pedestrian bridges would be developed to provide convenient access to river crossings and to improve connectivity between the Arkansas River and nearby communities. Future phases of the project will incorporate economic development and aesthetic improvements for nearby communities and may include new mixed-use, retail, and commercial development as well as the conversion of industrial land to park space. Detailed socioeconomic analyses will be conducted during future phases of the project.

SECTION 2

Problems and Opportunities

Statement of Problems and Opportunities

Study Area Problems

Changes to the natural hydrology of the Arkansas River, resulting from the construction of Keystone Dam and the subsequent urbanization of the watershed, have resulted in public health and environmental issues related to water quality, public safety, aquatic habitat, and instream and riparian ecosystems. Since the completion of Keystone Dam in 1964, substantial channel incision has occurred in the Arkansas River between the dam and Zink Lake (USFWS, 2005). The river has since been substantially impacted by anthropogenic alteration, development of surrounding land use, and streamflow fluctuations resulting from hydropower operations. Intensive land use practices associated with urbanization in the study area have led to streambank erosion, destruction of riverine wetlands, increased stormwater runoff, and a high degree of sediment transport to the river.

As noted previously, significant portions of the Arkansas River are included in the ODEQ Water Quality Assessment Integrated Reports as impaired due to violations of State water quality standards. Potential watershed pollutants include pesticides and organic compounds from urban, municipal, commercial, and agricultural runoff. As a result of water quality impairment and hydrologic alternations noted above, ecosystems native to the Arkansas River area have been compromised, and instream habitats continue to be depleted and degraded. These are discussed in more detail in the "Limiting Factors for Restoration" sub-section of this Preliminary PMP.

Due to a lack of initial capital funding, Zink Dam has limited functionality to transport sediment downstream, resulting in sedimentation within Zink Lake and scour near the edges of the dam. Zink Dam is also currently impeding the upstream migration of primary fish species of interest, as identified in the Arkansas River Corridor vision document (TVA, 2008). Two of the species, paddlefish and sauger, appear to be restricted in their current distribution to the reach downstream of Zink Dam, and it is possible that the dams block their upstream migration. If the shovelnose sturgeon still occurs in the area, Zink Dam also would likely impede upstream migration. Allowing upstream migration during critical seasons is essential for the propagation of these primary fish species of interest, and current conditions jeopardize the species' life cycles. Lastly, the Zink Dam structure, an ogee weir, has the potential to create an unstable hydraulic "roller" effect, which is potentially unsafe for surrounding recreation. The American burying beetle is also a consideration if its habitat is inundated.

USFWS has identified one federally threatened bird species, the piping plover, and one federally endangered species, the interior least tern, that utilize the Arkansas River Corridor in the project area. In addition, the bald eagle maintains a habitat in the project area. Hydrologic changes impacting habitat and fish populations have also affected these

federally endangered and threatened bird species that utilize the Arkansas River's food sources and corridor. Monitoring by the Tulsa Audubon Society (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). TAS observed a decline in the reproductive success of least terns using Zink Island after 1999; USFWS (2005) suggested that the decline in nesting on the island was due to the encroachment of woody vegetation, a reduction of available nesting habitat, and alterations to the natural floodplain resulting in land bridging and increased predation.

Project Opportunities

Through the creation of an integrated system of dams that optimize the functionality of the Arkansas River, in conjunction with beautification of its shorelines, the project has the potential to restore and enhance aquatic, riparian, and terrestrial habitats as well as to improve the quality of life in nearby communities. Table 1 summarizes the project's anticipated opportunities for Tulsa County communities; aquatic and riparian ecosystems; and water quality improvement. Key opportunities are also summarized below.

The primary opportunities driving the Arkansas River Corridor Project are to reduce flood damage; improve, protect, and restore habitat for interior least terns; improve the riverine system's functionality; improve recreational opportunities; and establish greater connectivity between the river and surrounding communities. Other opportunities that may be provided by the current phase of the project include:

- Providing riverine habitat for small, non-migratory fish, such as shiners, minnows, darters, and silversides and for recreationally important fish species such as bass, sunfish, and catfish
- Allowing upstream migration of striped bass, sauger, shovelnose sturgeon, and paddlefish and downstream transport of eggs and larvae during the spawning season
- Improving aquatic habitat in the Arkansas River
- Increasing the diversity and abundance of macroinvertebrate and fish assemblages
- Allowing sediment transport downstream of dams and reducing lake sedimentation
- Minimizing impacts to fish species that are a source of food for interior least terns and other bird species
- Developing a recreational whitewater park at Zink Dam, and potentially at Sand Springs and Jenks/South Tulsa Dams

Modification and construction of the low-water dams would provide resource managers the opportunity to operate the Arkansas River in an integrated manner to optimize flow control through each individual dam, as well as through the overall river/lake system. The project will aim to minimize the sediment contribution from tributary and streambank inputs and will also focus on sediment transport throughout the dam system. Proposed improvements to Zink Dam include (1) the installation of weir gates to improve sediment transport and fish passage and (2) flow attenuation to reduce flood risk, and (3) modifications to correct the roller effect.

TABLE 1
Expected Opportunities Identified in Master Plan for Arkansas River Corridor Project

Opportunities	Project Component Related to Opportunity
Community Opportunities	
Improve the aesthetics of riverfront areas	Creation of new lake systems; pedestrian bridges, and riverfront access; erosion control measures
Increase recreational opportunities	Creation of river/lake systems for fishing and boating; whitewater sporting venue from dam releases; boat access and fishing piers for accessible fishing; expansion of hiking and nature trails
Provide connectivity between communities and the resources of the Arkansas River	New road, trail, and bridge systems
Reduce flood-related hazards	Creation of integrated dam system engineered in compliance with FEMA and local floodplain regulations, to allow downstream flow without impacting the 100-year flood elevations
Increase habitat for recreationally important species, such as, bass, sunfish, crappie, gar, and catfish	Creation of weir pools
Ecosystem Opportunities	
Allow upstream migration of fish species, such as striped bass, sauger, shovelnose sturgeon, and paddlefish during critical seasons	Adjustable dams, with weir gates, that allow for lake or river systems
Allow downstream transport of eggs and larvae from spawning habitat to nursery habitat	Adjustable dams that allow for river systems and maintained minimum flow during spawning season
Improve and maintain habitat for smaller non-migrating fish species (shiners, minnows, darters, silversides)	Minimum flows provided by dams; mitigation of flashy flow caused by hydropower operations
Protect least tern nesting areas	Minimum flows provided by dams to eliminate land bridging; downstream sediment transport provided by dams; protection of nesting islands through the creation of river/lake system
Increase the foraging areas for bird species, such as least tern, bald eagle, and piping plover	Seasonal dams to allow continued spawning of minnow species; minimum flows provided by dams to increase the habitat for fish that contribute to least tern food resources
Increase aquatic habitat	Construction of created wetlands
Improve habitat for bald eagles	Riparian planting of American sycamores or other tall trees
Restore and maintain ecosystems	Preservation of riparian areas, native plantings, expansion of parks and nature areas
Provide stable habitat during low flow conditions	Minimum flows provided by dams; mitigation of flashy flow caused by hydropower operations; addition of weir pools
Increase fish production to benefit predators found along the Arkansas River Corridor, such as bald eagle, piping plover, and interior least tern	Minimum flows provided by dams; mitigation of flashy flow caused by hydropower operations; addition of weir pools
Water Quality Opportunities	
Improve water quality to restore the river to meet its designated use	Riparian preservation and plantings to reduce stormwater runoff; streambank stabilization. Involvement and actions by other partners required
Reduce streambank erosion and instream sedimentation	Streambank stabilization methods
Improve the riverine system's functionality and restore the river to a more natural state	Integrated network of dams
Increase dissolved oxygen (DO) concentrations for fish species	Minimum flows provided by dams

TABLE 1
Expected Opportunities Identified in Master Plan for Arkansas River Corridor Project

Opportunities	Project Component Related to Opportunity
Decrease sedimentation in impoundments	Modified and new dams engineered with consideration of sandy nature of substrate and soil in floodplains

Each of the low-head dams will be designed to allow for a seasonal river system, which will promote upstream fish migration as well as downstream transport of eggs and larvae to sustain fish propagation.

The Arkansas River supports a prominent fishery providing valuable recreational opportunities to area residents. The project design phase will refine concepts developed during the current phase for upstream and downstream fish passage needs of migratory riverine species of potential interest to the ODWC, USFWS, and other stakeholders. The general consensus, based on a review of life cycles, seasonal habitat needs, and the availability of potentially suitable habitat, is that the low-water dams will be engineered taking into account fisheries management goals and objectives for striped bass, paddlefish, sauger, shovelnose sturgeon, and other native riverine species in the project area. Adjustable dams would promote fish propagation and protect other riverine ecosystems.

The project would improve the habitat conditions of the interior least tern by preventing land bridging and protecting nesting islands from riparian predators. Plantings and preservation in riparian areas would increase the available habitat for the piping plover and bald eagle. The increase in fish assemblages associated with the project would also contribute to food resources available to threatened and endangered bird species. During periods when the lake is impounded, the bald eagle population would be able to use both the lake and the area downstream of the dam for feeding. Additionally, 3 acres of created wetland will be constructed to provide habitat for aquatic ecosystems and water quality improvement through vegetative filtering. Native planting to replace vegetation removed during project implementation, including the planting of American sycamores, or other tall trees, would provide additional habitat for bald eagles. Conceptual ecosystem restoration and potential mitigation strategies will be refined in future phases of the project.

Other benefits of the Zink, Sand Springs, and South Tulsa/Jenks low-water dams and lakes include waterfront beautification, recreational opportunities such as fishing, boating, and potential whitewater activities, flow attenuation, flood risk reduction, downstream sediment transport, improvement of downstream habitat, mitigation of flashy river flows due to hydropower releases, and protection of smaller non-migratory fish species.

Additional Analyses Needed

In June 2009, CH2M HILL conducted an environmental data review to: (1) identify data gaps affecting project analyses and design, (2) list possible direct, indirect, and cumulative effects of the project, and (3) identify major federal and state statutes and EOs applicable to the project. The *Preliminary Regulatory Review, Data Gaps Analysis, and Summary of Potential Project Effects* TM is included as Appendix B. The data gap analysis involved an assessment, by a multi-disciplinary team, of data sets provided by INCOG, USACE, and others. The analysis identified the following data gaps and potential additional studies needed to obtain critical data:

- **Biological Surveys**: Existing biological data are adequate for most impact analyses; however, the ODWC and USFWS may require additional data collection related to the minnow species on which the interior least tern rely for food. If required, surveys will include a review of existing data for seasonal variation and forage fish abundance and will be conducted prior to refining the conceptual design. The goal of this effort will be to obtain information on how to ensure the survival of these minnow species both during and after project implementation.
- **Sediment Supply and Transport:** Understanding the availability of sediment and transport patterns is critical for design of the project, including bank stabilization efforts. Additional sediment modeling and development of a conceptual sediment budget are likely to be required.
- **Cultural Resources Surveys**: Considering the need for unobstructed views of buildings and land, the cultural resource surveys should be conducted in clear weather conditions. Information from existing cultural resource surveys will be used wherever available; however, the vast majority of the 84 known historic and prehistoric-era archaeological sites in the study area have not been assessed for NRHP designation. Due to the regulatory costs of potential mitigation, the goal of this effort is to use that information to avoid NRHP-listed or –eligible historic properties or cultural resources during preliminary design.
- **American Society for Testing and Materials (ASTM)-Compliant Phase I Environmental Site Assessments (ESAs):** Avoidance of potentially contaminated sites is considered a key design issue with a direct effect on project costs and regulatory compliance burdens. Due to the industrial land uses and the known presence of illicit dump sites throughout the project area, it is recommended that Phase I ESAs be conducted for potential real property acquisitions associated with alternative configurations proposed for further study.
- **Water Quality Analyses:** Maintaining recreation contact standards is critical to the long-term success of the project. A more robust, complex water quality model and/or additional sampling data may be necessary to address all potential project impacts.
- **Groundwater Analysis:** A groundwater analysis is necessary to prevent adverse effects on groundwater levels in subsurface portions of buildings and also to address possible groundwater pollution concerns. Evaluation of existing potential groundwater impacts resulting from the installation the low-head dams and changing river hydrology will consist of a multi-stage hydrogeologic investigation that includes assembling existing data, developing a conceptual hydrogeologic model, and identifying areas of shallow groundwater more likely to be affected by the project or to affect ecosystem restoration efforts.

Limiting Factors for Restoration

The purpose of the Arkansas River Corridor Projects is to achieve a net beneficial effect on the riverine and riparian ecological functions and improve the riverine system's functionality. Several factors have the potential to limit the success of restoration. While these factors will be evaluated and managed to the maximum extent practicable, others may

be unforeseen. Some factors that have the potential to limit the success of restoration include:

- **Seasonal Flow:** Seasonal flow limitations may adversely impact the extent to which land bridging can be avoided and impact the ability to promote fish migration. Low flow stream conditions could occur naturally and limit the success of the restoration.
- **Flow Diversions:** Levees and other flood control measures that have been put into place in the Arkansas River have significantly reduced the degree of flooding in the river. However, these diversions have also altered the channel's hydrology and may continue to impact the natural conditions of aquatic ecosystems.
- **Temperature:** Unsuitable stream temperatures may limit the production of fish species in the Arkansas River. The restoration will have no effect on or control of stream temperatures, and therefore this impact is unavoidable.
- **Quality of Habitat Diversity:** Restoration will include bank stabilization measures and riparian plantings that will improve the quality of the habitat in the Arkansas River and Arkansas River Corridor. However, restoration may not have the potential to provide and/or maintain certain types of habitat, such as those that are not naturally occurring in the system. The lack of certain habitats may impact certain species in the study area.
- **Riparian Degradation:** While restoration includes riparian enhancement and, in places, preservation, future phases of the project may include retail development in limited areas of the corridor. This development may have indirect long-term effects on the availability of spawning and rearing habitats for migratory fish species. Local development regulations may be needed to protect habitat restoration efforts in these future development areas.
- **Fish Passage:** Construction and operation of the proposed South Tulsa/Jenks Dam could lead to loss or disruption of existing spawning and rearing habitats for migratory fishes in a 7.4-mile reach below Zink Dam unless seasonal upstream and downstream fish passage is provided at the South Tulsa/Jenks Dam. In addition, there may be effects on fish passage during dam construction, but these are expected to be temporary.
- **Sedimentation:** Since the completion of Keystone Dam in 1964, substantial channel incision has occurred in the Arkansas River between Keystone Dam and Zink Lake, and years of sediment have been stored in Keystone Lake. Improved sediment removal will be achieved through dam modification and gate improvements. However, additional sediment removal will be required periodically to address potential sediment accumulations.
- **Water Quality**: The Arkansas River is currently listed as an impaired water (i.e., 303(d) listed) by the ODEQ for water quality impairment (fecal coliform bacteria) related to nonpoint source runoff. While proposed riparian restoration will reduce the impact of runoff, the restoration is not anticipated to improve water quality sufficiently to reduce fecal coliform bacteria to the extent that water standards can be met. Additional watershed protection measures, outside the scope of this project, will be needed to adequately address the existing fecal coliform loadings. Overall, the existing and

anticipated water quality conditions in the corridor are not expected to affect the potential for successful implementation of the restoration project.

Constraints

As a result of the site reconnaissance and associated data collection, several areas have been identified as areas of constraints (areas where avoidance is preferred). Appendices I and H detail the data review related to fish passage and least tern protection, respectively, and the identification of associated project constraints. The *Arkansas River Corridor Projects Site Reconnaissance Summary* TM (Appendix J) identifies locations within the study area that were noted as being potential constraints based on existing unstable conditions. The project constraints that have been identified are summarized below.

Low-Head Dam Design

During the site reconnaissance, severe active erosion and bank failure were noted on Prattville Creek, which enters from the south just downstream of Highway 97, and at the proposed site of the Sand Springs low-head dam. The existing narrow peninsula of eroding land between Prattville Creek and the Arkansas River would pose a potentially significant constraint to dam design and construction at this location. Polecat Creek, which enters from the west just downstream of the proposed site of the South Tulsa/Jenks low-head dam, also has a highly unstable, eroding stream channel, which apparently conveys high volumes of stormwater. The instability of this tributary confluence and the filling and grading of the adjacent floodplain site (formerly occupied by a sand mining operation) would pose constraints to dam design. It should be noted, however, that reconfiguring and stabilizing either of the constraint areas identified would present an opportunity for restoring riparian habitat as part of the project design.

Interior Least Tern

Based on a 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 (USFWS, 2005), and the preliminary analysis of potential project effects, potential constraints for project engineering design, construction, and operation may include the following:

- If USFWS deems a formal consultation necessary for the project, the abundant existing information and ongoing USACE data collection on interior least tern distribution, abundance, food sources (e.g., foraging minnows), 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.
- 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 (Lott, 2009). 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 near 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, 2009).

- 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 will 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 will need to be such that river flows will pass around and over it to allow sedimentation to deposit downstream of the rock and thus maintain the island (USACE, 2009). According to current thinking among project management, 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 were 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 ft away from the nearest forest edge, bridge, public viewing platform, or other large structures rising above the waterline (Wiley, 2009).

- The efficacy of creating or enhancing least tern islands in the project pools could be affected by the distance adults would have to travel to forage for minnows and other small fish on which they feed. 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 forage (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. In addition, the USFWS and ODWC have expressed concern that the existing minnow population is not sufficient for sustaining the least tern.

- 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, which 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.

Fish Passage

Potential biological constraints to providing successful upstream passage include the availability of suitable habitat upstream of the dams, the status of affected populations, the seasonal timing of spawning migrations, and the differing spawning behaviors, habitat use, and swimming abilities of the migratory species of interest. Considerations for project design and operation are detailed in Appendix H. Table 2 summarizes a variety of factors that may be important to the preliminary design of the proposed project and will be considered during design and implementation.

As outlined in Appendix H, providing for fish passage from March through May would protect the peak spawning periods of all of the migratory species of interest (see Table 2). The greatest overlap in spawning period occurs among striped bass, paddlefish, and shovelnose sturgeon, which spawn from April through June. However, April and May likely include peak spawning periods of all three species. Sauger spawn earlier than the other three species. They congregate near spawning areas in late winter and begin spawning in late February or March. Including March in the fish passage window would likely capture peak spawning activity of the sauger.

Table 2 also summarizes the swimming performance information found in a literature review for species of interest. Fishway passage constraints will be determined based on these data, and design will take into account the swimming capabilities of all target species. Parameters that will be determined based on swimming performance include: velocity patterns, minimum flow depth, pool velocity, maximum passage velocity, and maximum step heights.

Additionally, TVA identified a variety of gated spillway methods to lower the proposed Sand Springs and South Tulsa/Jenks Dams for passing heavy sand loads or fish (TVA, 2008). These included inflatable rubber dams, Obermeyer gates, conventional mechanical gates, and fusegates. The focus on gates as the preferred method of fish passage was based in part on concern for the downstream passage of striped bass eggs. Obermeyer gates were identified as the preferred concept (TVA, 2008). Although a variety of conventional fishway designs (ladders) are in use throughout North America (Clay, 1995), and also may warrant consideration during the preliminary design as fish passage priorities become more firmly established, the migratory species of interest in the Arkansas River tend not to pass readily through fish ladders even though velocity criteria may be considered favorable.

TABLE 2
Potential Biological Constraints to Preliminary Design of Low-head Dams for Upstream and Downstream Passage of Migratory Species of Interest

Species	Spawning Period	Spawning Behavior	Swimming Performance	Other Relevant Factors
Shovelnose sturgeon	April-June	Eggs deposited in strong current over coarse substrates	Adults actively swam for 10 minutes (min) or more at fishway velocities of 3 to 4 feet per second (ft/s); average success rate negotiating fishway designs declined from 81-87 percent at 4 ft/s to 47 percent at 6 ft/s (White and Mefford, 2002).	Unique among the species of interest in its bottom-dwelling habits, which could prove problematic in fish passage design Lack of firm spawning substrates could limit reproductive success.
Paddlefish	April-May	Eggs adhere to silt-free gravel, hatch in about 9 days	Juveniles exhibited higher sustained swimming speed than juvenile sturgeon, but modeled ranges of prolonged swimming speeds and burst speeds ranged higher in sturgeon (Hoover et al., 2005).	Upstream migrants move high in water column and are capable of leaping clear of the water. Consistent releases from the Sand Springs Dam could promote reproductive success if they were to result in sustained inundation of gravel bars through the egg incubation period.
Striped bass	April-early June	Eggs broadcast in currents, drift downstream for 36-75 hours until hatching	Sprint performance in open-channel flow stronger than that of walleye at velocities ranging from 1.5 to 3.5 meters per second (m/s) (4.9 to 11.5 ft/s) (Haro et al., 2004); length of adults highly correlated with stronger swimming performance.	Exacting spawning requirements could limit reproductive success; the free-flowing reaches between dams would be too short and the new pools unfavorable for egg survival. Adults need a minimum depth of 1.5 ft to swim upstream to spawning areas (Crance, 1984). A minimum current velocity of about 1 ft/s is required to hold drifting eggs in suspension until hatching (Crance, 1984).
Sauger	February-April	Adhesive eggs deposited over firm rubble substrates, hatch in 2 weeks	Walleye as surrogate (Peake et al., 2000): • Maximum sustained speed for 60 min: 0.30-0.73 m/s (1.0-2.4 ft/s) • Maximum sustained speed for 10 min: 0.43-1.14 m/s (1.4-3.7 ft/s) • Burst speed: 1.60-2.60 m/s (5.2-8.5 ft/s)	Sauger numbers increased substantially in Arkansas after construction of the MKARNS (Robison and Buchanan, 1988), indicating a relatively high probability of success for upstream and downstream passage.

SECTION 3

Alternative Restoration Measures/Project Configurations

This section presents a discussion of alternative restoration measures and project configurations both without and with project conditions.

Without Project Conditions

Existing Conditions

The existing conditions are described based on information from previous studies, data analyses and literature research, and a site reconnaissance conducted by a multidisciplinary team of subject matter experts to evaluate the existing project area resources. The site reconnaissance was conducted from March 30 through April 1, 2009, and involved a series of visual surveys conducted by helicopter, car, and foot throughout the 42-mile project area. Existing conditions include:

- **Topography:** The project area encompasses two ecoregions--the Northern Cross Timbers in the west and the Osage Cuetas of the Central Irregular Plains in the east. The topography of the two ecoregions is characterized by a combination of low, forested ridges and hills, steep, rocky faces, and low, wide floodplains.
- **Floodplain:** The floodplain within the project area varies from a wide, undeveloped floodplain with established riparian corridor in the upstream portions to a more urbanized floodplain in lower reaches. Downstream of Jenks, land uses adjacent to the floodplain become less urbanized.
- **Water Resources:** During the site visit, river flows ranged between 7,470 and 30,000 cfs. Based on a comparison to daily average flow duration curves, this flow is moderate to relatively high for the March through May period. In addition to observations of the main river, staff visited several tributaries, including Prattville and Polecat Creeks. Much of the river exhibited the effects of variable flows, including severe erosion. Several drinking water wells were documented in the project area during the Geographic Information System (GIS) data review.
- **Biological Resources:** Two bald eagles were observed during the site visit. Other water birds were also observed, although the interior least terns were not present at their nesting sites.
- **Hazardous Waste Contamination/Hazardous Waste Sites:** Several illicit dumping sites, landfills, or current or delisted Superfund sites, including the Sand Springs Petrochemical Complex, were observed within the project area.

- **Utilities:** Several wastewater treatment plants and electrical service lines were observed within the river corridor. A very large electrical transmission line crosses the river near its confluence with Prattville Creek.
- **Community Services:** Significant recreational lands within the corridor include Keystone State Park adjacent to Keystone Dam; Chandler Park and Sand Springs River City Park; and Boulder, Johnson, and Tulsa River Parks within Tulsa. There are also several schools and churches located within the study area. The initial review suggests that no hospitals are located within the project area.
- **Transportation:** Several highways and railroads are present within the study corridor, including numerous bridges across the Arkansas River.
- **Land Use:** Land uses range from woodland, pastureland, and more rural patterns of residential, commercial, and industrial development to more urbanized high density residential, commercial, and industrial uses. Within the Tulsa metropolitan area, the river corridor is severely encroached by existing and historical development.
- **Cultural Resources:** Although not visited during the site reconnaissance, 84 known and prehistoric-era archaeological sites, 6 historic districts, and areas with Native American properties with cultural or spiritual significance have been identified in the area.

Future Conditions (No Action Alternative)

Future conditions in the study area, with the No Action Alternative, would likely show negligible change, in terms of topography; hazardous waste contamination and hazardous waste sites; utility service availability; community services; transportation; land use; and cultural resources. However, with the No Action Alternative, the Arkansas River would continue to undergo degradation if existing environmental issues are not addressed. The sustained impacts associated with altered hydrology may continue to negatively impact the floodplain, water resources, and biological resources. The project includes restoration components that are intended to mitigate the impacts of growth and development, improve physical habitat and aquatic ecosystems, improve and maintain water quality, and enhance public enjoyment of the river. Under future conditions, without project implementation, these goals would not be met.

Alternatives Considered But Not Carried Forward

As noted previously, the original plan for the project involved restoration components at seven key development sites between Keystone Dam and the Tulsa County/Wagoner County line. Restoration projects identified involved several communities along a 42-mile reach of the Arkansas River, including Sand Springs, Tulsa, Jenks, Bixby, and Broken Arrow. For the current phase of the project, each of the project components detailed in the Phase I Vision Plan and Phase II Master Plan was evaluated. Based on sponsor input, budget considerations, funding opportunities, and feasibility, certain alternatives were not carried forward for project consideration at this time. These alternatives are summarized below and may be implemented by third parties using separate funding sources. If these alternatives are deemed to be reasonably foreseeable, potential cumulative effects may be

assessed during the impact assessment stage of the project. Throughout this section, "alternative" and "alternative configuration" are used interchangeably.

Alternative 1: Zink Lake Riverfront

The Phase II Master Plan involves improvements to the Zink Lake Riverfront, a popular outdoor area that provides recreational opportunities and a festival venue for the Tulsa area. Alternative components that were considered for the Zink Lake area, but not carried forward, include:

- Expansion of the River West Festival Park
- New outdoor amphitheater
- Conversion of industrial properties to recreational land use on the west bank
- Mixed-use and residential development on the east bank
- New public activity center
- Bridge lighting
- Expansion of marina and boat docks on the west bank
- Pedestrian promenade

Alternative 2: Sand Springs Low-Water Dam and Riverfront

The Phase II Master Plan primary development goal of the Sand Springs Riverfront is "to provide a riverfront destination for retail and commercial services, and to improve the appearance of the City...and to provide recreational opportunities and aesthetic improvements to the area" (USACE, 2009, p. 8). Project components proposed in the Sand Springs area that were considered, but not carried forward, include:

- Extension of Main Street to the Arkansas River between first set of piers (potential to extend Main Street into east end of park, and ultimately connect to west end)
- Addition of marina, boat ramp, and parking lot on the north bank, for local boating and fishing access

Alternative 3: South Tulsa/Jenks Low-Water Dam and Riverfront

The Phase II Master Plan primary development goal of the South Tulsa/Jenks area is the "creation of a retail and entertainment district on both sides of the river" (USACE, 2009, p. 16). Alternative components considered but not carried forward for the South Tulsa/Jenks area include:

- Expansion of the Oklahoma Aquarium campus
- Public park and overlook structure upstream of the east end of the dam
- Retail area between the upper end of the public park and the Creek Turnpike
- Commercial development upstream of the Creek Turnpike to Vensel Creek
- Pedestrian bridge across Vensel Creek
- Jenks Riverfront and Retail Development on the west shoreline, overlooking the lake

- Riverfront Retail and Cultural Arts area on the west side of the river between the Creek Turnpike and the 96th Street Bridge
- Expansion of Jenks RiverWalk and construction of an associated parking lot
- Water taxi system to connect developments on both shorelines

Alternative 4: 71st Street Riverfront

The 71st Street Riverfront was selected as a key development area due to its "accessibility and high visibility [and] special prominence within the Arkansas River Corridor" (Guernsey et al., 2005). Alternative components considered, but not carried forward, in this area include:

- Mixed-use development at the south end of Helmerich Park on the east bank
- Expansion of the Turkey Mountain Urban Wilderness Area and incorporation of the proposed Native American Cultural Center
- Additions to Helmerich Park, including a health and fitness center, meeting facility, classrooms, cafés, expanded playground, and landscaped parking facilities
- Development of new sports complex with soccer fields and a parking lot
- Creation of 7-acre lake with fishing piers, restaurant, overlooks, and trails, south of the future health and fitness center

Alternative 5: Bixby Riverfront

The 300-acre Bixby Riverfront area includes a combination of developed and undeveloped property with the potential to provide panoramic views of the Arkansas River and to accommodate new development. Alternative components considered, but not carried forward, for the Bixby Riverfront include:

- New Bentley Park sports complex, with baseball and softball fields, hard surface courts, and other recreational facilities
- "Bixby Landing" development to include a pedestrian promenade, restaurants, and retail and entertainment areas
- Commercial redevelopment along Memorial Drive
- Boardwalk along the Arkansas River

Alternative 6: Broken Arrow Riverfront

The Broken Arrow Riverfront development site is approximately 2 miles long and includes the 164-acre Indian Springs Sports Complex. Alternative components considered, but not carried forward, at Broken Arrow include:

- Improved access to the Arkansas River from Aspen Avenue
- Expansion of Aspen Avenue
- Enhancements to the Indian Springs Sports Complex

- Enhancement/restoration of riparian habitats
- Nature center and trails for recreation and environmental education
- New activity center near the riverfront

Alternative 7: Crow Creek Corridor

Crow Creek was identified as a key development area because it is a "significant natural feature connecting the vibrant Brookside neighborhood to the river corridor" (Guernsey et al., 2005). Alternative components for the Crow Creek Corridor that were not carried forward include:

- Pedestrian walkway along Crow Creek
- Streambank restoration on Crow Creek
- Hiking/nature trail system

Alternative Configurations to be Considered in the Feasibility Study

Four potential project configuration alternatives, each with common elements at three locations, will be considered in the feasibility study. These include options described as the "Master Plan," "Environmental Maximum," "Maximum Economic Development," and "Balanced" alternative project configurations. The four alternatives that will be considered are summarized below. Throughout this section "alternative" and alternative configuration" are used interchangeably. The following elements are included in each:

- Repair and Restoration of Gates at Zink Dam
- Restoration of Least Tern Habitat Downstream of South Tulsa/Jenks
- Emergency, Maintenance, and Public Access at All Facilities
- Maintenance and Restoration of Existing Habitat
- Compliance with Minimum Rise of Floodways and Local Floodplain Ordinances
- Sediment Transport/Management
- Recreational Access to Water and Acceptable Water Quality

Alternative Project Configuration 1: Master Plan/TVA/Phase III

This alternative project configuration includes improvements at three locations within the study area: Sand Springs, Zink Dam/Lake, and South Tulsa/Jenks Dam. Design elements are generally consistent with those presented in the following documents:

- Arkansas River Corridor Master Plan, Phase I Vision Plan (Carter Burgess, 2004)
- Arkansas River Corridor Master Plan, Phase II Master Plan and Pre-Reconnaissance Study (Guernsey et al., 2005)
- Vision for the Arkansas River Corridor at Tulsa (TVA, 2008)

Sand Springs

- Dam height 11 ft (minimum storage 8 ft)
- Least tern island restoration in Sand Springs pool

- Prattville Creek & River City Park (Franklin Creek) bank restoration

Zink Dam

- Dam height increase of 3 ft with crest gates
- Recreational whitewater/roughened channel through dam on east bank; Tulsa Wave on west bank
- Least tern habitat: existing island may need restoration, addition of island between Sand Springs and Zink Dam and possibly another downstream

South Tulsa/Jenks Dam

- Dam height 8 ft (design to meet "No Rise" condition; no extra channel to mitigate minimum rise)
- Seasonal gate operations
- Polecat and Vensel Creeks restoration

Additional Components Common to All Three Areas

- Bank stabilization limited to dams and areas next to dams
- Wetland and riparian restoration on each pool area.
- Full height gates 50% of length
- Fish stocking

Alternative Project Configuration 2: Focused Environmental Benefits

This alternative project configuration was developed with consideration to providing the greatest environmental benefits. Elements at all dams include gates across entire heights and lengths of the dam, roughened channel fish passage, fish stocking to mitigation fish loss, least tern habitat/islands in pools and riverine areas, and enhanced restoration along the banks of the pools.

Sand Springs

- Dam height 11 ft (minimum storage 8 ft)
- Reduced inundation through operations
- Improved bald eagle habitat
- Prattville Creek & River City Park (Franklin Creek) bank restoration

Zink Dam

- Rehabilitation or restoration of old gates
- Tulsa Wave on west bank

South Tulsa/Jenks Dam

- Dam height 9 ft
- Polecat and Vensel Creeks restoration

Additional Components Common to All Three Areas

- Roughened channel passage
- Gates – full height and length of dams
- Seasonal gate operations for maximum fish and egg passage
- Addition of least tern habitat/islands in pools and downstream riverine areas
- Enhanced restoration along pools
- Bank bio-stabilization for protection above 40,000 cfs
- Fish stocking to mitigate fish loss

Alternative Project Configuration 3: Focused Socioeconomic Benefits

This alternative project configuration was developed with consideration to the socioeconomic benefits that the project would provide for the nearby communities. Project components include enhanced terraced dam design, enhanced access to pool for fishing and other recreation, and dams designed for maximum water storage.

Sand Springs

- Dam height 11 ft (minimum storage 8 ft)
- Marina boating access
- River City Park (Franklin Creek) recreational development
- Rowing venue
- Prattville Creek & River City Park (Franklin Creek) bank restoration

Zink Dam

- Gate height increase of 3 ft
- Recreational whitewater (east bank)
- Tulsa Wave (west bank)
- Restoration/replacement of existing gates
- Addition of new gates

South Tulsa/Jenks Dam

- Dam height 9 ft
- Whitewater on one or both sides
- Additional recreational access and amenities
- Polecat and Vensel Creeks restoration

Additional Components Common to All Three Areas

- Bank stabilization limited to dams and areas next to dams
- Wetland and riparian restoration on each pool area
- Full height gates 50% of length
- Continuous whitewater channel to connect all 3 projects
- Enhance terrace dam at each location
- Same restoration as Master Plan
- Enhanced access to pool for fishing and other recreation

Alternative Project Configuration 4: Balanced Approach

This alternative project configuration was developed to combine configurations 1, 2, and 3, to meet objectives related to the original project's vision, environmental benefits, and socioeconomic benefits. Project elements include components of the original plans, streambank and riparian restoration to benefit the local communities, and seasonal gate operations to provide environmental benefits to fish communities.

Sand Springs

- Dam height 11 ft (minimum storage 8 ft)
- Least tern island in Sand Springs pool
- Prattville Creek restoration
- Bank restoration and/or vegetation (River City Park)
- Marina/Franklin Creek water feature

Zink Dam

- Gate height increase of 3 ft
- Rehabilitation or restoration of old gates
- Whitewater roughened channel through dam and both sides
- Least tern habitat: existing island may need restoration, addition of island between Sand Springs and Zink Dam

South Tulsa/Jenks Dam

- Adaptive management of fish/egg passage via roughened channel and gate operation
- Enhanced fish monitoring and/or stocking
- Polecat and Vensel Creeks restoration

Additional Components Common to All Three Areas

- Recreation/bank/riparian restoration
- Seasonal gate operations for fish passage

SECTION 4

Work Elements of USACE Process Integrated Feasibility Study

Introduction

To facilitate review of the findings of the feasibility study and previous studies associated with the project, the work completed to date is summarized in this document. The intent is to provide information generally consistent with USACE report preparation methodology to support USACE future preparation of a Final PMP. This section provides a comparison of the contents of this Preliminary PMP with the anticipated Final PMP to be developed in the next phase of study.

Preliminary PMP Contents

While studies to date have included many of the analyses required in a Final PMP, not all of the work elements have been completed to date. Table 3 provides a comparison between the contents of this PMP and those anticipated in the next phase of work.

TABLE 3
Comparison of Preliminary PMP and Final PMP Contents

Project Management Plan Component	Preliminary PMP	Final PMP[a]
Engineering Appendix[b]	X	X
Surveying and Mapping	X	X
Geographic Information Systems	X	X
Geophysics with Ground Truth Sampling	X	X
Topographic Mappings	X	X
Stream Bed Profiles and Cross-Section	X	X
Hydrology and Hydraulics Studies/Reports	X	X
Hydrology and Hydraulics Modeling	X	X
Geotechnical Studies/Report	X	X
Site Development Analysis/Report	X	X
Engineering and Design Analysis Report with Preliminary Drawings	X	X
Preliminary Design	X	X
Detailed Design	X	X
Design Appendix	X	X
Feasibility Modeling Studies (Water Quality Modeling)	X	X
Value Engineering Report		X
External Technical Review		X
Socioeconomic Studies/Report	X	X
Economic Analyses/Report	X	X
Social Studies/Report		X
Institutional Studies/Report		X
Ability to Pay Report		X
Financial Analysis Report	X	X
External Technical Review		X
Real Estate Analyses/Documents		X
Real Estate Supplement Plan		X
Gross Appraisal/Report		X
Preliminary Real Estate Acquisition Maps		X
Physical Takings Analysis		X
Preliminary Attorney's Opinion of Compensability		X

TABLE 3
Comparison of Preliminary PMP and Final PMP Contents

Project Management Plan Component	Preliminary PMP	Final PMP[a]
Rights of Entry		X
Other Real Estate Documents/External Technical Review		X
Environmental Studies/Reports	X	X
Scoping Minutes	X	X
Environmental Assessment or Environmental Impact Statement (NEPA Document)	X	X
Coordination Documents with Other Agencies	X	X
Environmental Resource Inventory Report	X	X
Define Human & Ecological Use of Study Area	X	X
Assessing Human and Ecological Risk	X	X
Mitigation Analysis Report	X	X
Endangered Species Analysis	X	X
§404(b) (1) Analysis Report	X	X
401 State Water Quality Certification	X	X
Corps of Engineers Record of Decision [c]		X
Other Environmental Documents and External Technical Review		X
Sediment Management Plans	X	X
Ecological Functional Assessment	X	X
External Technical Review		X
Fish and Wildlife Coordination Act Report [d]		X
HTRW (Hazardous, Toxic, and Radioactive Waste) Studies/Report		X
Cultural Resources Plan	X	X
Site Survey Field Report	X	X
Data Collection and Analysis/Report	X	X
Mitigation Plan Report	X	X
Memorandum of Agreement	X	X
One Percent Waiver		X
External Technical Review		X
All Other Cultural Resources Studies/Reports	X	X
Cost Estimates		X
Cost Estimates	X	X[E]
Study Cost Estimate Updates	X[F]	X

TABLE 3
Comparison of Preliminary PMP and Final PMP Contents

Project Management Plan Component	Preliminary PMP	Final PMP[a]
Construction Preliminary Engineering Design (PED) Cost Estimate		X
Project Cost Estimate		X
OMRR&R (Operation, Maintenance, Replacement, Repair, and Rehabilitation) Cost Estimate		X
Baseline Fully Funded Cost Estimate		X
External Technical Review		X
Public Involvement Documents		X
Notices and Public Meetings		X
Minutes of Public Meetings		X
Public Comment Reports		X
Newsletters		X
Other Public Documents		X
Stakeholder Webpage		X
Plan Formulation and Evaluation Report		X
District Coordination Meeting		X
Establish “Without Project” Conditions		X
Preliminary Formulation and Screening of Alternatives	X	X
Develop Preliminary Goals	X	X
Assemble and Document Alternatives	X	X
External Team Review		X
Alternatives Development and Screening Deliverables	X	X
Detailed Evaluation	X	X
Compare Alternatives against Each Other & Document the Comparison of Alternatives	X	X
Plan Formulation Management and Report		X
Alternative Formulation Briefing (AFB)		X
AFB Project Documentation		X
AFB Technical Review Documents		X
AFB Policy Compliance Review Documents		X
AFB Guidance Memorandum		X
Draft Report Documentation		X
Draft Feasibility Report and NEPA Document	X	X

TABLE 3
Comparison of Preliminary PMP and Final PMP Contents

Project Management Plan Component	Preliminary PMP	Final PMP[a]
Public Review Comments	X	X
Project Guidance Memorandum		X
All Other Draft Feasibility Report Documents		X
Technical Review Documents		X
Policy Compliance Review Documents		X
Final Report Documentation		X
Division Commander's Notice		X
All Other Feasibility Report Documents		X
Final Feasibility Report and NEPA Document	X	X
Technical Review Documents		X
Washington Level Report Approval		X
Policy Compliance Review Documents		X
Chief of Engineers' Report		X
OMB (Office of Management and Budget) Letter to ASA (Assistant Secretary of the Army) (Civil Works [CW])		X
ASA (CW) Transmittal to Congress		X
State and Agency Review and NEPA Document Filling Letters [g]		X

[a] To be prepared by USACE Tulsa District.

[b] This assumes that Treatability Studies are not included in this analyses.

[c] Typically, USACE would include an evaluation of §103 and Coastal Zone Management. This project does not involve ocean disposal of dredged materials or coastal zone management and therefore these are excluded.

[d] Typically, USACE would include HTRW Studies/Report in relationship to the Environmental Studies and a major subsection of Preliminary Assessment, HTRW Preliminary Assessment Report. Due to possible changes in the alternatives, it is recommended that this section be scoped later.

[e] USACE cost estimates will be prepared using M-CACES.

[f] Cost estimates will be prepared for elements of the next phase of work.

[g] Other Feasibility Studies/Investigations would follow if needed.

SECTION 5

Scope of Future Studies

Since development of the Phase I Vision Plan (Carter Burgess, 2004) and Phase II Master Plan and Pre-Reconnaissance Study (Guernsey et al., 2005), CH2M HILL and the Program Management Group, LLC have conducted multiple reviews and data analyses and have refined the proposed project design. Activities that have been conducted as part of the current phase of the project are outlined in the Introduction (Project History subsection), summarized in this Preliminary PMP, and detailed in the TMs included as appendices. Based on these studies, potential issues and next steps/considerations for the next phase of the project were identified (see Table 4).

Description of Tasks Required to Produce Products, Analyze Alternatives, Determine Feasibility, and Assess Potential Impacts

While much analysis has been completed to advance the project, additional work elements are required for technical purposes, to ensure compliance with local, state and federal regulations, and to assess potential impacts. These future work elements include:

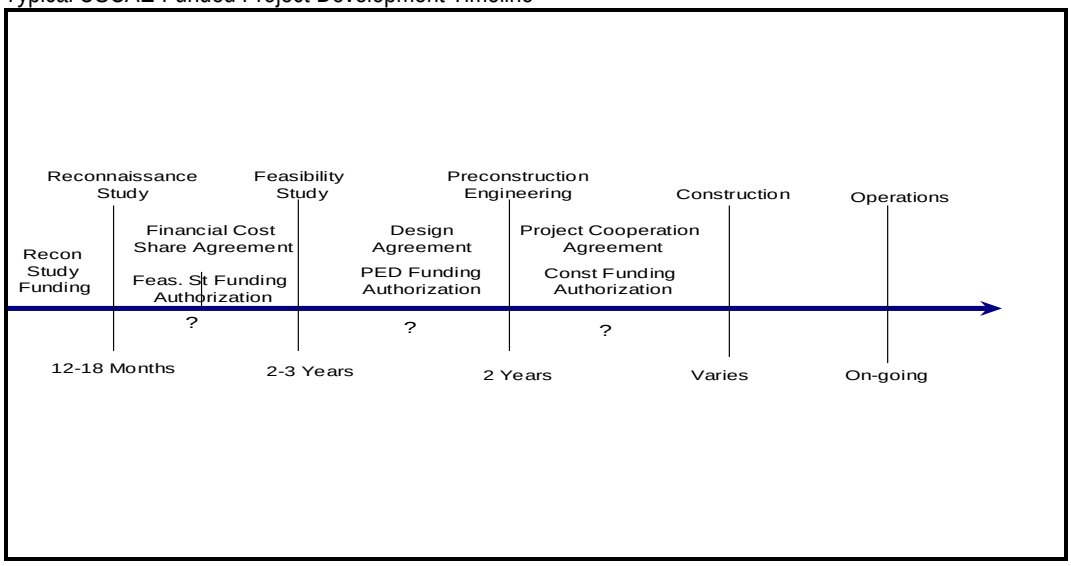
- Biological Studies
  - Least term habitat protection/restoration planning
  - Habitat protection/restoration for other migratory birds
  - Wetlands/riparian habitat restoration
  - Fish passage requirements
- Hydrologic Studies
  - Sediment transport modeling
  - Water quality sampling
  - Floodplain modeling
  - Groundwater modeling (potentially)
  - Stormwater Pollution Prevention Plan
- Engineering Studies
  - Bank stabilization
  - Dam safety analysis
  - Preliminary and final design
  - Cost-estimation
  - Value engineering
  - Real estate matters (survey, appraisals, acquisition plan, rights-of-entry, parcel acquisition, ASTM-compliant ESA)

- Other Studies/Activities
  - Phase 1 and 2 cultural resources surveys on identified sites
  - Economic analysis
  - Social studies/reports
  - Institutional studies/reports
  - Recreation plan
  - Independent External Peer Review Panel for USACE

Conceptual Schedule

Typically, a project funded by the federal government through USACE requires approximately 5 years from initiation of a Reconnaissance Study to the start of construction. The major steps are illustrated in Figure 2.

FIGURE 2
Typical USCAE-Funded Project Development Timeline



Because many of the analyses associated with the standard Reconnaissance-level and Feasibility-level phases of the project have been conducted, it is anticipated that the project timeline can be substantially reduced.

The sponsors will continue to conduct feasibility analyses in coordination and consultation with USACE during 2010. Initial work elements for 2010 include:

- Sediment management study
- Groundwater evaluation
- Preliminary design of a whitewater park at Zink Dam
- Water quality modeling
- Preliminary project evaluation
- Public information and workshops
- Development/maintenance of a project Website

Federal funds to conduct the required USACE Reconnaissance Study are anticipated to be available by spring 2010. These funds will likely be used to prepare the following documents as required:

- Peer Review Plan (including independent peer review panel)
- Reconnaissance Study Report
- Programmatic Work Plan
- Final Project Management Plan
- Feasibility Cost Share Agreement

Potentially, the Feasibility Cost Share Agreement could be completed and approved late in the third quarter of 2010, which would reduce the timeframe from 12-18 months to approximately 9 months. Depending on additional federal appropriations, a formal EIS process could then begin during 2011. The proposed schedule is expected to be refined by USACE in spring 2010. Given the timeframe discussed above, the County could be ready for construction by approximately 2014.

TABLE 4
Summary of Regulatory Compliance Requirements

Regulation/Project Driver	Summary of Requirements	Summary of Potential Issues	Next Steps/Schedule Considerations
Federal Statutes			
Endangered Species Act	Federal agencies must ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of an endangered or threatened species, or result in destruction or adverse modification of a critical habitat of such a species.	Threatened or endangered species have been identified in the county (i.e., interior least tern, piping plover, and American burying beetle).	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 the project schedule and could result in additional reasonable and prudent measures (RPMs) for implementation in the river.
Bald and Golden Eagle Protection Act	With regard to bald eagles and golden eagles, taking, possession, and commerce are prohibited, except under certain specified conditions. Prohibited activities include those that cause disturbance to eagles.	The bald eagle is known to occur in the county and along the river.	The USFWS will need to be contacted as part of the agency coordination during the design process and the NEPA process.
Fish and Wildlife Coordination Act	Consultation with the USFWS and the appropriate state wildlife agency is required whenever the waters or channel of a body of water are modified. Prior to modification, provision must be made for the conservation, maintenance, and management of wildlife resources and habitat.	Installation of two new low-head dams and modification to an existing dam will alter the waters and channel of the Arkansas River. This has the potential to cause loss or disruption of existing spawning and rearing habitats for migratory fishes and disruption of existing striped bass habitat in the reach between Keystone Dam and Zink Dam.	The USFWS and ODWC will need to be contacted as part of the agency coordination during development of the project design and the NEPA process.
Migratory Bird Treaty Act	The Act implements various treaties and conventions for the protection of migratory birds. Taking, killing, or possessing migratory birds is prohibited.	The project will disturb riparian corridors used by migratory birds.	Coordination with USFWS as part of the design and NEPA processes should address any migratory bird issues.
Clean Water Act	National Pollutant Discharge Elimination System (NPDES) permits are required for discharges to waters of the U.S. A §404 permit is required from USACE for dredge and fill activities. Water quality certification (§401) is also required from the ODEQ for those activities. A stormwater NPDES permit from the ODEQ must be obtained and stormwater must be treated during construction and post-construction for impacts greater than 1 acre. A stormwater pollution prevention plan (SWPPP) must be developed prior to construction.	Preparation of a USACE permit application will be required for dredge and fill activities associated with implementation of the Proposed Action. Mitigation will be required for any river and wetland impacts. Mitigation could include the planned bank stabilization, wetland creation, and habitat improvements. The USACE §404 permit application process will include ODEQ review under §401. If a §404 permit and §401 certification are granted, design, construction, and operation requirements must be met to protect water quality and maintain the designated use of the Arkansas River. The Arkansas River is on the 303(d) list for impairment due to fecal coliform bacteria and a draft TMDL has been prepared. An evaluation of potential effects on the fecal TMDL implementation will be needed. The USFWS and ODWC have voiced concerns about the potential for low DO levels during low flow-high temperature conditions after the project is implemented.	An evaluation of sediments may be required under §401(b) (1). According to INCOG, ODEQ has stated that INCOG's models should be sufficient if a §401 water quality certification is required. To address the USFWS concerns, INCOG will perform water quality sampling activities during low flow-high temperature conditions. An SWPPP must be prepared and implemented prior to construction as part of the requirements under ODEQ's Stormwater General Permit. If storm drainage patterns will be altered in any way, coordination with local authorities (Tulsa, Sand Springs, and South Tulsa/Jenks) will be required.
Rivers and Harbors Act	§9 of the Act prohibits the construction of any bridge or dam in navigable waterways of the U.S. without USACE or U.S. Coast Guard approval, depending on the location of the construction. Structures authorized by state legislatures may be built if the affected navigable waters are totally within one state, provided that the plan is approved by the Chief of Engineers and the Secretary of the Army. Under §10 of the Act, the construction of any structure in or over any navigable water or any other work that affects the course, location, condition, or capacity of a navigable water must be approved by USACE.	A §10 permit will be required from USACE. Review of impacts under §10 is typically conducted in conjunction with the USACE CWA §404 process.	The project will require coordination and an application with USACE to ensure compliance under §9.

TABLE 4
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Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 as amended by the National Invasive Species Act of 1996	The project must provide confirmation that the restoration projects generally conform to the voluntary guidelines to prevent the introduction and spread of aquatic nuisance species.	The Arkansas River in Oklahoma is cited as a water body infested with zebra mussels and potentially other invasive species. Restoration design should address voluntary guidelines to prevent invasion of invasive species.	Confirmation of the project's consistency with the voluntary Management Plan
Water Project Recreation Act	This Act requires that recreation and fish and wildlife enhancement be given full consideration as purposes of federal water development projects. This Act also authorizes the use of federal water project funds for land acquisition in order to establish refuges for migratory waterfowl and to provide facilities for outdoor recreation and fish and wildlife.	The project already includes components to enhance recreation and fish and wildlife. Once details are developed, those may be sufficient.	Fish and wildlife enhancement will need to be demonstrated.
Land and Water Conservation Fund Act	Establishes a fund to subsidize state and federal acquisition of lands and waters for recreational and conservation purposes. The fund provides financial assistance to states for outdoor recreation planning, acquisition of land or waters, and facilities development. States must submit a comprehensive statewide outdoor recreation plan. The plan must address wetlands within the state as a recreation resource.	No issues identified.	Confirmation of the project's consistency with the state outdoor recreation plan is required if funds authorized under this Act will be utilized.
Watershed Protection and Flood Prevention Act	Provides for Natural Resources Conservation Service (NRCS) assistance with planning and construction funding for projects constructed by project sponsors, often in the form of flood control districts and flood protection measures. The Secretary of the Interior provides consultation regarding plans that affect reclamation, irrigation, or public lands and prepares fish and wildlife reports to be incorporated in project plans. This Act stipulates project cost-sharing for lands, easements, and rights-of-way where localities agree to operate and maintain a reservoir or other area for fish and wildlife, recreational development, and water quality improvement projects.	Confirmation that applicable components of fish and wildlife plans are incorporated will be required if funds or technical assistance from NRCS are utilized. Confirmation provided through consultation with USFWS.	If NRCS assistance is utilized, consultation with the USFWS for other regulations should also involve confirmation of the fish and wildlife plans.
Wild and Scenic Rivers Act	This Act establishes a National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers may be identified and added to the system. This Act establishes procedures and limitations for control of lands in federally administered components of the system and for dealing with disposition of lands and minerals under federal ownership.	No potential issues are expected. The Arkansas River is not listed as a wild or scenic river.	No further action expected.
Coastal Zone Management Act	This Act requires that any federal activity within or outside of the coastal zone that affects any land or water use or natural resource of the coastal zone be consistent with a state's Coastal Zone Management Plan.	No potential issues are expected. The project area is not within and would not affect a coastal zone.	No further action expected.
Farmland Protection Act of 1981 (7 USC 4201 et seq., as amended) and CEQ Policy on Prime and Unique Farmland	Federal agencies must minimize the unnecessary and irreversible conversion of farmland (prime farmland, unique farmland, and land of statewide or local importance) to nonagricultural uses. Impacts to prime farmland must be assessed as part of the environmental assessment process.	Confirmation that unnecessary and irreversible conversion of farmland would be minimized with the project.	NRCS soil survey will need to be checked to confirm that no prime farmland would be impacted by the project. If prime farmland is present, the NRCS will need to be contacted. It may be necessary to complete a Farmland Conversion Impact Rating Form.
Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act	This Act authorizes removal and remedial actions to clean up sites contaminated by hazardous substances. This Act addresses the National Contingency Plan, which provides the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances.	The regulations will apply if the locations of the Proposed Action contain hazardous waste sites or are used for storage of hazardous materials.	A Phase I ASTM-compliant ESA is recommended for project locations to provide information on the potential presence of hazardous substances.

TABLE 4
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Resource Conservation and Recovery Act	This Act provides for cradle-to-grave regulation of hazardous waste and addresses used oil management and recycling, storage of hazardous materials, underground storage tanks, handling of medical wastes, and disposal of hazardous waste. This Act requires that federal agencies establish programs for the procurement of recovered or recycled material.	The regulations will apply if the locations of the Proposed Action contain hazardous wastes or are used for storage of hazardous materials. Waste will be generated during construction. However, the volume of regulated wastes generated, stored, or shipped as a result of construction/operation of the dams is anticipated to be low.	A Phase I ASTM-compliant ESA is recommended for project locations to identify the potential presence of hazardous substances.
Toxic Substances Control Act (TSCA)	TSCA limits or prohibits the manufacture, processing, distribution, use, and disposal of certain toxic substances. TSCA contains requirements specific to asbestos, indoor radon abatement, and lead exposure reduction.	The regulations will apply if the locations of the Proposed Action contain regulated substances or are involved with the use of hazardous materials. Construction and operation of the dams are not expected to result in activities regulated by TSCA.	Preliminary engineering plans and maintenance approaches should be reassessed for potential compliance issues.
National Historic Preservation Act	Before an action involving any historic district, site, building, structure, or object is undertaken, the designated Advisory Council on Historic Preservation established under the Act must have a reasonable opportunity to comment.	A literature review and site visit conducted during the current phase of the project revealed 6 NRHP-listed or -eligible historic districts in the survey area. A literature review and site visit conducted during the current phase of the project revealed at least 84 known historic and prehistoric-era archaeological sites spread throughout the study area (3 of which are listed on the NRHP).	A Phase 1 cultural resources survey will likely be required for the project sites unless previous pedestrian surveys have been completed recently. Portions of the project within the Sand Springs/Tulsa U.S. Geological Survey (USGS) Topographic Quadrangles are the most likely to have previous studies that may be adequate (USACE , 2009). The SHPO will need to be contacted as part of the agency coordination for CWA §404 permitting and the NEPA process.
Archaeological Resources Protection Act	A permit is required to excavate or remove any archaeological resource located on public lands and to carry out activities associated with such excavation or removal. If the removal may result in harm to, or destruction of, a religious or cultural site, Native American tribes that may consider the site important must be notified.	A literature review and site visit conducted during the current phase of the project revealed at least 84 known historic and prehistoric-era archaeological sites spread throughout the study area (3 of which are listed on the NRHP).	A Phase 1 cultural resources survey will likely be required for the project sites to determine the potential presence of archaeological resources. The SHPO will need to be contacted as part of the agency coordination for the NEPA process.
Clean Air Act	Preconstruction and operating permits are required for stationary sources of air pollutants and related activities. For areas in non-attainment for criteria pollutant, compliance with the State Implementation Plan must be demonstrated.	No potential issues are expected. No new permanent sources of air emissions will be constructed. Tulsa County is currently in attainment for ambient air quality standards.	No further actions expected. Confirm that effects are negligible during impact assessment.
Noise Control Act	Each federal agency is required to limit noise emissions to within compliance levels in federal regulations and state and local laws.	No potential issues are expected. Significant noise levels are not expected to be generated during operation of the proposed dams.	No further actions expected. Confirm that effects are negligible during impact assessment.
Federal Regulations			
CEQ Regulations for Implementing NEPA (Title 40 Code of Federal Regulations [CFR], Parts 1500-1508 [40 CFR 1500-1508])	Activities involving a federal action must integrate the NEPA process with other planning to evaluate potential environmental impacts prior to implementation.	No potential issues identified.	The requirements of these regulations will be addressed by the preparation of the NEPA documentation.
Protection of Historic Properties (36 CFR Part 800)	Before an action involving any district, site, building, structure, or object is undertaken, the Oklahoma SHPO must have a reasonable opportunity to comment. Indian tribes that attach religious and cultural significance to historic properties that may be affected by an undertaking must be consulted.	A literature review and site visit conducted during the current phase of the project revealed 6 NRHP-listed or -eligible historic districts in the survey area. The Osage Indian Reservation is located to the north and east of Keystone Dam. During public meetings in October 2005, a member of the Osage Nation commented that the project area may have religious and/or cultural significance to that tribe	A Phase 1 cultural resources survey will likely be required for the project sites. The SHPO will need to be contacted as part of the agency coordination for the NEPA process. Coordination with Native American tribes that could be affected will be required during future phases of the project. Further research and consultation with tribes in the area will be required to identify Native American cultural and spiritual properties.

TABLE 4
Summary of Regulatory Compliance Requirements

Regulation/Project Driver	Summary of Requirements	Summary of Potential Issues	Next Steps/Schedule Considerations
		(Guernsey at al., 2005).	
Flood Protection Works and Maintenance (33 CFR 208.10)	Flood control structures and facilities constructed by the United States must be maintained and operated to obtain the maximum benefits.	The proposed project will impact the hydrology of the Arkansas River. However, improvements, modifications, or construction of flood control structures or work within floodways or rights-of-way require prior determination by USACE that the work will not adversely affect the functioning of the protective facilities.	Coordination with USACE and local levee districts will be required to meet the regulatory requirements.
Executive Orders			
EO 11312, Invasive Species	Confirmation that the restoration projects conform to the Management Plan may be required.	Bank stabilization design and implementation will involve vegetative plantings.	Coordination and consul**ta**tion with USACE to comply with the Management Plan
EO 11514, Protection and Enhancement of Environmental Quality (amended by EO 11991)	Agencies must develop procedures to ensure the provision of timely public information and understanding of plans and programs with environmental impacts. Information regarding existing or potential environmental problems or control methods must be made available to other governmental entities or institutions.	No potential issues are expected. The requirements of this EO will be addressed by the NEPA process and through agency coordination included as part of the project.	No further actions expected.
EO 11593 Protection and Enhancement of the Cultural Environment	Agencies must administer the cultural properties under their control, initiate measures to preserve federally owned sites, structures, and objects of historical, architectural, or archaeological significance, and institute procedures to assure that federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures, and objects of historical, architectural, or archaeological significance.	No potential issues are expected. There are no identified cultural resources in the areas proposed for the dams, bank stabilization, or habitat improvement areas; however, GIS information from previous studies has not been assessed.	Obtain USACE GIS data if possible and confirm that cultural resources will be avoided during design process.
EO 11988, Floodplain Management	For actions occurring on floodplains, alternatives must be considered, proper floodplain management implemented, and flood protection measures used.	The project will affect water flow in the Arkansas River. FEMA floodplain and floodway requirements will need to be met. The project will also need to comply with local criteria and ordinances.	Coordination will need to occur with FEMA, USACE, and local floodplain and water management authorities.
EO 11990, Protection of Wetlands	Federal agencies must avoid new construction in wetlands, unless there is no practicable alternative. An evaluation of alternatives should consider the loss or degradation of wetlands as it relates to public health, maintenance of natural systems, and other uses of wetlands in the public interest. The Proposed Action must include all practicable measures to minimize impacts. Plans or proposals for construction activities in wetlands must be open to public review.	Construction could impact floodplain or riparian wetlands. The locations proposed for the dams, pools, streambank stabilization, and habitat improvements will need to be surveyed.	If wetlands are located, they will need to be identified and addressed during the USACE CWA §404 permit application process.
EO 12088, Federal Compliance with Pollution Control Standards	Sufficient funds must be allocated for compliance with applicable pollution control standards. Violations must be addressed through consultation with regulating agency and development and implementation of a compliance plan.	Construction and operation of the Proposed Action will need to include sufficient funds to comply with any applicable standards.	Confirmation that the project would comply with pollution control standards will need to be documented.
EO 12372, Intergovernmental Review of Federal Programs	Agencies must cooperate and communicate with state and local governments to review and coordinate proposed federal development.	Communication and coordination with state and local entities is required. The communication planned for the project should be reviewed. Currently, the project includes public outreach and stakeholder involvement. In addition, the NEPA document prepared for the project will be distributed to appropriate governmental entities and be made publicly available for comment.	No further actions expected.
EO 12580, Superfund Implementation	This EO established the National Contingency Plan, National Response Team, and Regional Response Teams for protection and response to any release or threatened release. It includes cleanup schedules and enforcement.	This EO would only be applicable if the location of the Proposed Action contains hazardous waste sites or is used for storage of hazardous materials.	No further actions expected.
EO 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building	New buildings must be designed and constructed with appropriate seismic design and construction standards.	Design, construction, and modification of the dams will need to factor in seismic risk.	No further actions expected

TABLE 4
Summary of Regulatory Compliance Requirements

Regulation/Project Driver	Summary of Requirements	Summary of Potential Issues	Next Steps/Schedule Considerations
Construction			
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Programs, policies, and activities must be conducted in a manner that ensures they do not exclude, deny benefits to, or adversely impact people/populations because of their race, color, economic status, or national origin.	Installation and modification of the dams, bank stabilization, and habitat improvements are part of a larger plan for improvements along the Arkansas River. Positive impacts to populations located adjacent to the river would be expected.	Potential Environmental Justice considerations will be addressed in future socioeconomic evaluations.
EO 13045, Protection of Children from Environmental Health Risks and Safety Risk	Health and safety risks that affect children must be identified and assessed. Policies, programs, activities, and standards must be implemented in such a manner that those risks are addressed.	The dams and pools could create an attraction for children.	Potential impacts and dam safety steps will need to be addressed as part of the design and NEPA processes.
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	Actions having measurable negative impacts on migratory bird populations must develop and implement (within a 2-year period) a Memorandum of Understanding designed to protect against the taking of migratory birds and their critical habitat.	The project will disturb riparian corridors used by migratory birds.	Coordination and consultation with USFWS as part of the design process and NEPA process will be required to address any migratory bird issues.
EO 13327, Federal Real Property Asset Management (amended by EO 13423)	Federal real property resources must be managed to ensure efficient and economical use of real property assets.	No potential issues are expected. The overall project for the Arkansas River, including the three dams, would represent an enhancement of any federal real property.	Coordination and consultation with affected agencies will be conducted during the design process.
EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management	Environmental, transportation, and energy-related activities must be conducted in an environmentally responsible and economically efficient manner. These include reducing greenhouse gas emissions, consumption of water and petroleum products and electricity, and the quantity of hazardous materials. Construction activities should comply with high performance and sustainable buildings guidelines.	No issues identified.	The design process and NEPA process should include information on any efforts and features planned for the project that address this EO.
EO 13175, Consultation and Coordination with Indian Tribal Governments	Input must be obtained from tribal officers in the development of regulatory policies that have tribal implications.	Communication and coordination with tribal governments by the lead agency is required. The project currently includes stakeholder involvement. Coordination with the SHPO as part of the NEPA process could identify additional needs for tribal input.	The communication planned for the project should be reviewed.
State and Local Regulations			
City of Jenks Planning and Zoning Requirements	The City of Jenks regulates activities that have the potential to affect stormwater runoff or impact a floodplain or floodway.	An earth change permit and floodplain development permit will be required.	Permit application activities will need to be initiated in the next phase of the project.
City of Sand Springs Planning and Zoning Requirements	The Public Works Department regulates activities that impact flood zones.	A development permit from the Public Works Department will be required for the project.	Permit application activities will need to be initiated in the next phase of the project
City of Tulsa Stormwater Management and Hazard Mitigation Program	The Director of Public Works and the Stormwater Drainage and Hazard Mitigation Advisory Board regulate activities that have the potential to affect stormwater runoff or impact a floodplain or floodway.	Floodway, floodplain, and earth change watershed development permits will be required for the project.	Permit application activities will need to be initiated in the next phase of the project
Local Drainage District/Levee District Requirements	Local levee districts could have authority for maintaining flood protection structures as described under “Flood Protection Works and Maintenance (33 CFR 208.10)” above.	The project will impact the hydrology of the Arkansas River.	Local districts will need to be identified and consulted. Any local requirements that differ from 33 CFR 208.10 will need to be identified and included.
Tulsa County Planning and Zoning Requirements	The County Inspections Division regulates construction, alteration, and use of residential and commercial buildings and land. It issues building, electrical, zoning, mechanical, plumbing, house moving, earth change, and sign installation permits for Tulsa County. The division also administers and provides floodway and floodplain management rules.	Applicable Tulsa County Planning and Zoning requirements will need to be met, based on disruptions during construction and on changes made by project implementation.	Tulsa County Planning and Zoning requirements will need to be evaluated during design phase.
Oklahoma Dam Safety Act	This Act specifies design and construction requirements for dams, including required safety features. Dams above 25 ft in height impounding 15 acre-feet (ac-ft) of water or above 6 ft in height impounding more than 50 ac-ft of water require approval from the Oklahoma Water	Design, application, and notification procedures associated with the application process will have to be followed during the project’s development.	Coordination with OWRB will need to be conducted to obtain approval.

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	Resources Board (OWRB).		
Oklahoma Water Use Requirements	Oklahoma water law and OWRB regulations require that a permit application be filed prior to the diversion of water. Obtaining a permit requires that the use of water not interfere with domestic or existing appropriations of water or existing or proposed uses within the stream system. The permit review includes publication of a public notice in newspapers.	A permit will be required from OWRB. If granted, the OWRB may condition the permit to protect existing rights and uses and current stream flows.	Previous DO modeling of this portion of the Arkansas River, performed by INCOG, has been approved by ODEQ and U.S. Environmental Protection Agency (EPA) Region VI when used to set wasteload allocations for oxygen demanding substances for wastewater dischargers within the corridor, where appropriate. According to INCOG, ODEQ has stated that INCOG's models should be sufficient if a §401 water quality certification is required (INCOG, 2009).
Oklahoma Department of Mines Permit	A permit is required prior to the commencement of sand and gravel mining operations. The required permit application must include legal and financial compliance information, safeguards for environmental resources, and an operation and reclamation plan. The minimum reclamation bond which must be posted with the department is $2,000.00.	This requirement could be triggered if mining is used to obtain sand to develop least tern habitat.	If mining is selected as part of the construction process, permit application activities will need to be initiated during the next project phase.
Other Project Objectives			
Bank Stabilization	CWA (§401 and 404), floodplain management requirements and habitat requirements may all apply.	An NRCS soil survey investigation concluded that there are three soil types that dominate the streambanks: the Choska-Severn very fine sandy loam, the Kiomatia loamy fine sand, and the Severn very fine sandy loam.	Location-specific investigations based on the final river configurations and water surface elevations will be needed to assess soil physical properties at locations where hydraulic analyses indicate shear stress may initiate erosion. Site-specific bioengineering solutions will be designed for each location based on soil properties, slope steepness, and river hydraulics.

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