ARKANSAS RIVER CORRIDOR

Appendix M: 1,000 cfs Test Release From Keystone Dam

ARKANSAS RIVER CORRIDOR, TULSA COUNTY, OKLAHOMA

Introduction

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

Purpose

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

Study Authority

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

Section 3132. Arkansas River Corridor.

(a) IN GENERAL. – The Secretary is authorized to participate in the ecosystem restoration, recreation, and flood damage reduction components of the Arkansas River Corridor Master Plan dated October 2005. The Secretary shall coordinate with appropriate representatives in the vicinity of Tulsa, Oklahoma, including representatives of Tulsa County and surrounding communities and the Indian Nations Council of Governments.

(b) AUTHORIZATION OF APPROPRIATIONS. – There is authorized to be appropriated $50,000,000 to carry out this section.

Non-Federal Sponsor

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

Recommended Plan

Alternative 5 is the National Ecosystem Restoration (NER) Plan and includes construction of a pool structure at River Mile 530 to regulate flow in the Arkansas River, a rock riffle feature associated wetland plantings at Prattville Creek, and construction of a sandbar island near Broken Arrow, OK. With the implementation of the NER plan, more natural river flow would return to 42 river miles of the Arkansas River within the study area. The NER plan would provide approximately 2,144 acres of additional riverine habitat, nearly doubling the amount of currently available habitat under low flow conditions. Also five acres of restored wetlands, and three acres of reliable sandbar island habitat where none currently succeed, would be restored as part of the NER plan. Shoreline, river, backwater, slackwater, wetland, and sandbar island habitat quality would all be improved generating an overall increase in the ecosystem quality and carrying capacity of the corridor. Current operation of Keystone Dam would not be changed. Additional water and flow would remain within the existing banks of the river and would not increase the flood elevation, nor downstream or backwater flooding.

Arkansas River Corridor Ecosystem Restoration Study in Tulsa County, Oklahoma

1,000 CFS TEST RELEASE FROM KEYSTONE DAM

SEPTEMBER 2017

INTRODUCTION

The Arkansas River Corridor Ecosystem (ARC) Restoration Feasibility Study identifies ecosystem restoration opportunities along a 42-mile stretch of riverine ecosystem that has been in decline since construction of Keystone Dam and continues to degrade with hydropower operations and increased urbanization. The impacts on the aquatic and riparian ecosystem within the study area include loss of natural river flow which reduces habitat connectivity critical to migratory and spawning life histories of native fauna, fosters invasive species encroachment, and subjects the shorelines to increased erosion. As well, sediment transport is severely restricted particularly immediately downstream of the dam.

Under current dam operations, flood pool and hydropower releases are the primary supply of river flow in the ARC study area. Hydropower increases river flow from 6,000-12,000 cubic feet per second (CFS) during peak use periods, flood pool releases occur during monsoon seasons and following local rain events. Outside of these periods, river flow in the ARC is dramatically reduced exposing large sections of riverbed. Flood pool releases from the dam maintain river flow between hydropower periods during the spring, but as summer progresses and precipitation becomes less frequent, the only water released is from hydropower. Without releases from Keystone Dam, the Arkansas River within the study area is reduced from a flowing river to isolated pools and disconnected floodplain habitat lasting from several hours during the week to several days over the weekend. In the study area, natural flooding and drought conditions of the riverine system are exacerbated by the timing and type of releases from Keystone Dam.

Keystone Dam also traps a significant amount of sediment resulting in downstream sediment-starved flows causing channel and tributary incision and bank erosion. The impacted geomorphology has resulted in streambank erosion and loss of riverine wetland, backwater, and slackwater habitats that were once important fish nurseries and feeding/resting areas for resident and migratory waterfowl.

The feasibility study identifies measures for ecosystem restoration of the Arkansas River Corridor that provide a more resilient and sustainable condition. Measures include: a pool control structure located at river mile 530 to help sustain minimum river flows between flood pool and hydropower releases, rock riffle and wetland plantings at Prattville Creek, and a constructed sandbar island located just upstream of the Tulsa/Wagoner County line. Alternative 5 includes all three measures. This alternative would provide approximately 2,144 acres of additional riverine habitat, nearly doubling the amount of currently available habitat under low flow conditions. Implementation of Alternative 5 would increase the river's surface water from 1,591 acres to 3,735 acres and most importantly, provide a more continuous minimum river flow of 1,000 cfs from the pool structure to the Tulsa/Wagoner County line.

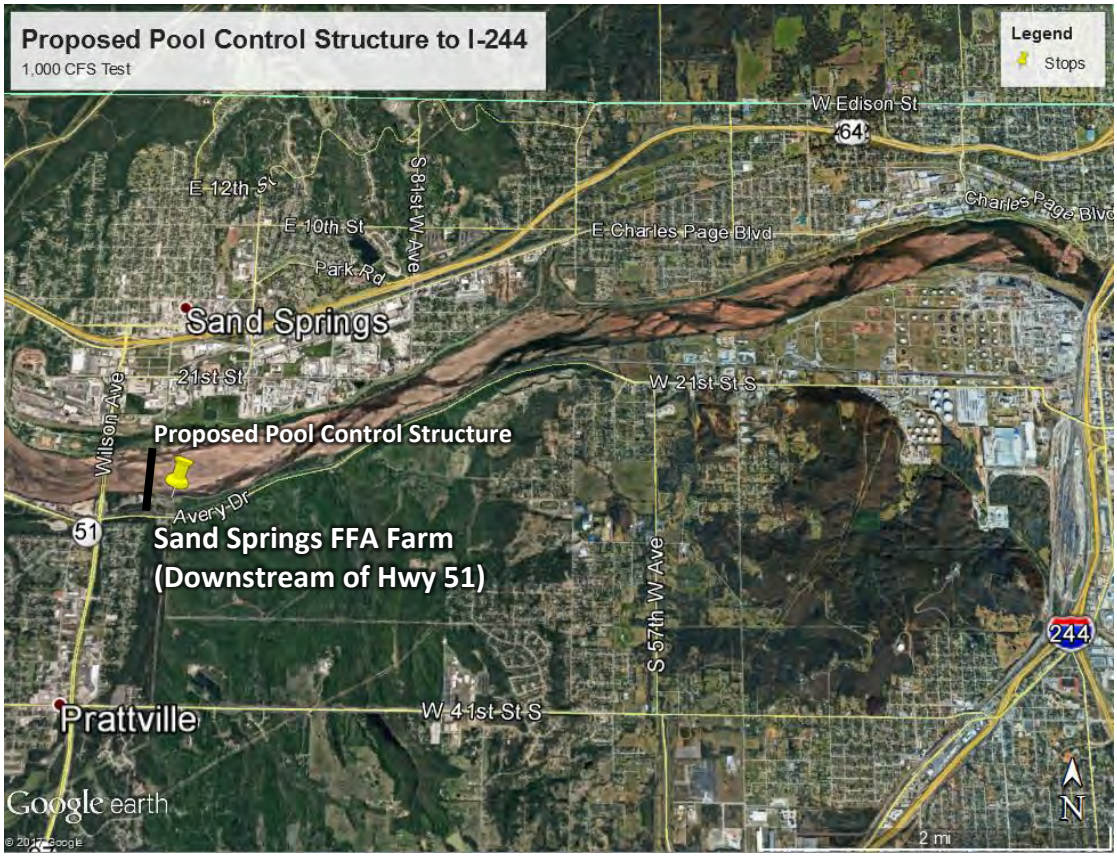
To identify and quantify the benefits of each of the alternatives a model was run to determine the extent of surface water and the level of connectivity each alternative would create. For more information see Appendix J Hydrology and Hydraulics of the ARC Feasibility Study Report.

METHODOLOGY

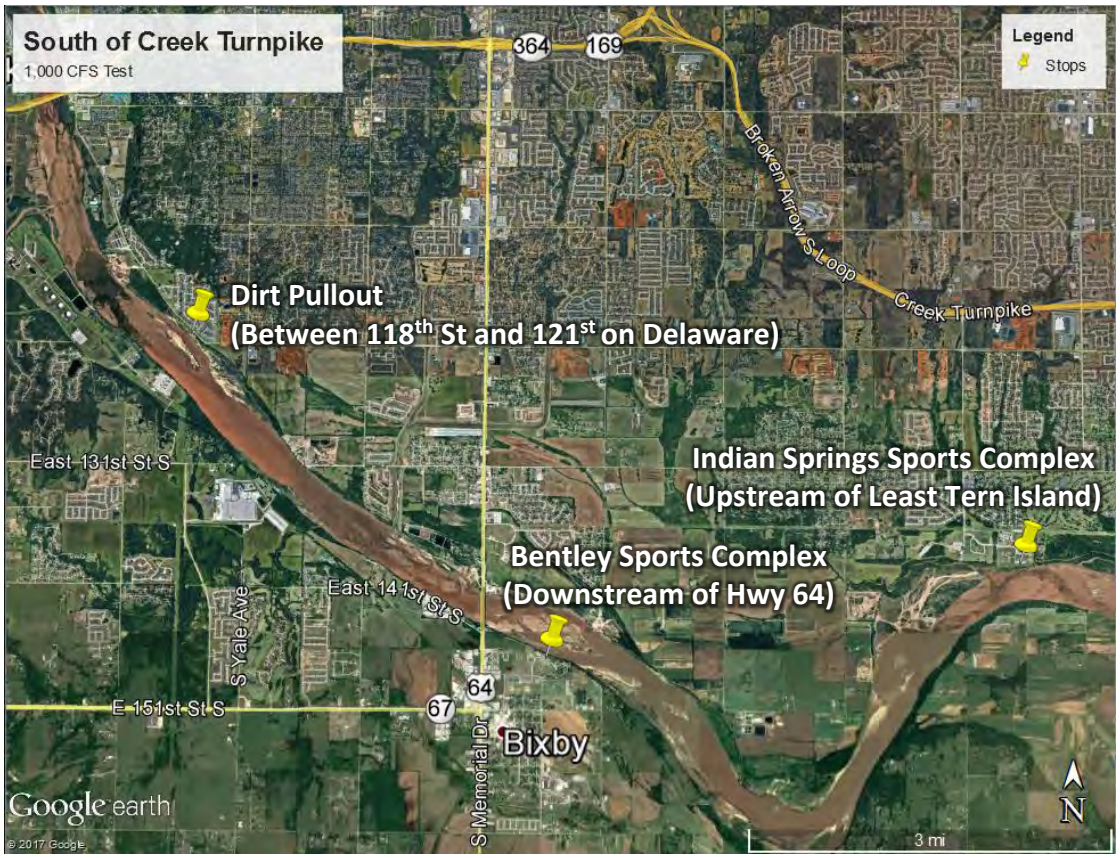
Largely thanks to the efforts of the Southwestern Power Administration, Keystone Dam began releasing 1,000 cfs on Friday, 08 September 2017, to resemble the future with-project condition once the pool control structure is constructed and operating to maintain 1,000 cfs between releases from Keystone Dam. Releases from Keystone Dam can take up to 28 hours to reach the lower portion of the corridor, therefore Monday morning (11 September 2017) was determined be the ideal time to observe flows in the corridor and compare them to the model outputs that were used to evaluate environmental benefits of the pool structure.

Eight observation points, identified in the three maps below, were selected along the 42-mile corridor. Observation points were selected based on accessibility and distance from bridges to avoid bridge flow influences. At each point, photographs were taken at the cross-section, upstream, and downstream. All in attendance were provided with a map of the modeled outputs and asked to compare what they were observing in the river with the modeled output. A general consensus was reached on differences and similarities and the result was recorded. The field outing did not involve collection of any hard data (e.g. water depth, width of surface water areas, temperature, etc.) except for the pictures.

The Tulsa County representative was able to provide the team with drone photographs taken on Sunday (10 September 2017) from the proposed pool construction location to just downstream of I-44. The photographs were used to see opposite bank surface flows that could not be observed from the selected observation point.




I-244 to Creek Turnpike
1,000 CFS Test
Legend
Stops
River West Festival Park
@ Boat Ramp
41st St Plaza
(41st St and Riverside)
56th St and Riverside
Helmerich Park
(Between 71st St and 81st St
and Riverside)
Southwest Blvd
Oakhurst
Okmulgee Expy
Jenks
Creek Turnpike
64
51
244
66
44
75
36
N
4 mi
Google earth
© 2017 Google



RESULTS

There were a total of nine people who attended the field visit including two from Oklahoma Department of Wildlife, two from Southwestern Power Administration, one from Tulsa County, and four from USACE (2 from Hydraulics and Hydrology & Hydraulics, 1 from Regional Planning and Environmental Center, and 1 from Geographic Information Systems). The team worked their way from the Sand Springs FFA Farm location downstream ending at the Indian Springs Sports Complex.

Sand Springs FFA Farm

At the Sand Springs FFA Farm site, just downstream from the proposed pool control structure location, the team observed more contiguous water along the south bank than the model shows (black arrow on Figure 1). Surface water along the south bank was at a minimum 100 yards wide, spanning to more than half the width of the channel at the pool control structure location. The model does not show nearly enough surface flow along the south bank when compared to what was observed in the field. Drone photographs were used to confirm that north bank surface water was similar to the model outputs with broken surface flows. It appears that the model outputs for the north bank are very similar to the field conditions captured in the drone photographs.

Assessment: Model outputs significantly underestimate the amount of surface water along the south bank and are within reason along the north bank. Resource agencies are satisfied with the created connectivity.

Figure 1. Model Output from Proposed Pool Control Structure to Zink Dam (Yellow Stars=Stops)

Figure 2. Arkansas River Looking Upstream at Sand Springs FFA Farm

Figure 3. Arkansas River Looking at Cross-Section at Sand Springs FFA Farm

Figure 4. Arkansas River Looking Downstream at Sand Springs FFA Farm

Figure 5. Drone Photograph--Arkansas River Looking Upstream at Sand Springs FFA Farm (Yellow Star= Observation Point, Black Line= Approximate location of proposed structure)

Figure 6. Drone Photograph—Arkansas River Looking at Cross-Section at Sand Springs FFA Farm.

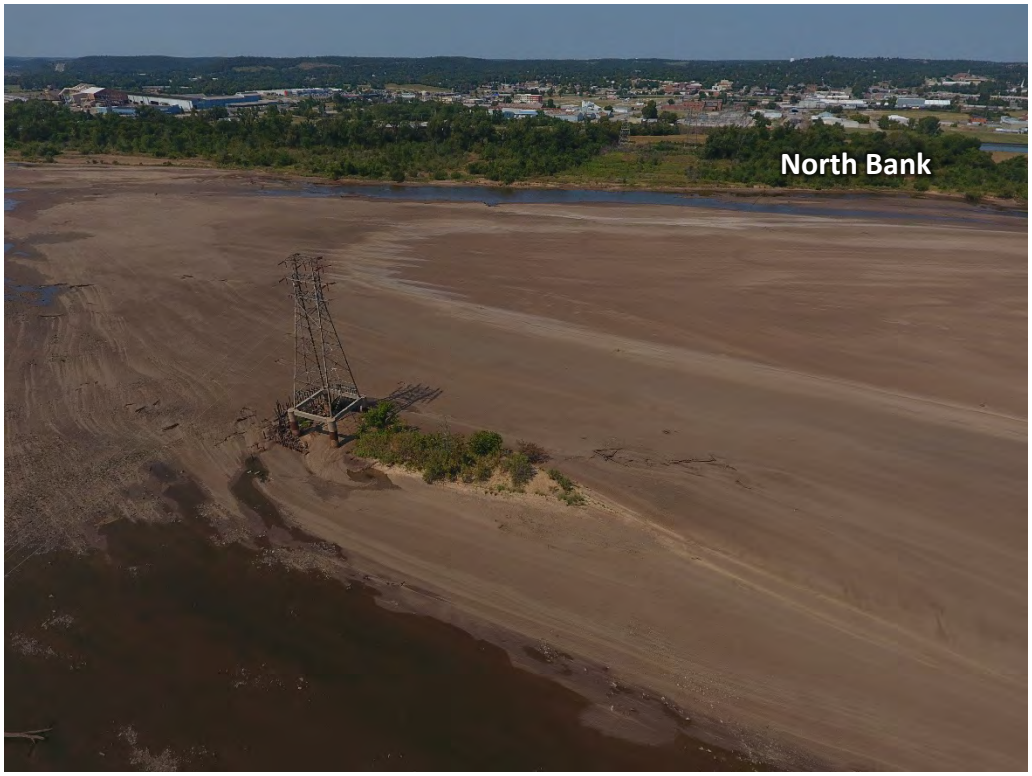


Figure 7. Drone Photograph—Arkansas River Looking Downstream at Sand Springs FFA Farm.

The model data provided did not show any outputs in Prattville Creek; however, the resource agencies were hoping that the 1,000 cfs conditions created by the pool control structure would back into Prattville Creek and begin forming backwater and wetland habitats. As can be seen in the next several figures, a good amount of water is observed within Prattville Creek; much more than under typical conditions. The resource agencies felt that the conditions observed in the field would likely lead to wetland creation and subsequent spawning and nursery habitat for a variety of fish species.

Figure 8. Entrance to Prattville Creek Looking Towards Arkansas River at Sand Springs FFA Farm

Figure 9. Cross-section of Prattville Creek at Sand Springs FFA Farm

Figure 10. Prattville Creek Looking Upstream at Sand Springs FFA Farm

Figure 11. Drone Photograph--Arkansas River and Prattville Creek Confluence Looking Upstream at Sand Springs FFA Farm (Yellow Star= Observation Point)

Figure 12. Drone Photograph-- Prattville Creek Midstream at Sand Springs FFA Farm

Figure 13. Drone Photograph--Prattville Creek Looking Upstream at Sand Springs FFA Farm

River West Festival Park

The second stop was at the River West Festival Park boat ramp. This location is just upstream from the Zink Dam. Conditions observed in the field were significantly different than the model outputs. A braided channel with a significantly smaller amount of water is observed throughout this stretch, where the model shows bank full, “lake” conditions. However, this is not a detriment to the model, rather a difference in how the model was calibrated and the conditions on the ground that weekend. The model was calibrated with the Zink Dam gates closed. On the day of the trip, and for several months prior, the Zink Dam gates have been fully open to keep a nearby construction area free of standing water. After construction is complete, the gates will be kept closed, except under extenuating circumstances, to maintain lake conditions. The team deliberated and felt that if the gates were closed on the day of the visit, the model would most likely have been accurate and bank full surface water conditions would have been observed.

Assessment: Field conditions on the day of the visit do not represent model outputs; however, the conditions surrounding Zink Dam releases were different than assumed during model calibration. With the gates open, the area has good connectivity and sand bar presence; however, with the gates closed, surface water within this reach is likely to mimic lake conditions with bank full surface flows.

Figure 14. Model Output from Upstream of Zink Dam to 71st St Bridge (Yellow Stars=Stops; Green Circle= Drone Location)

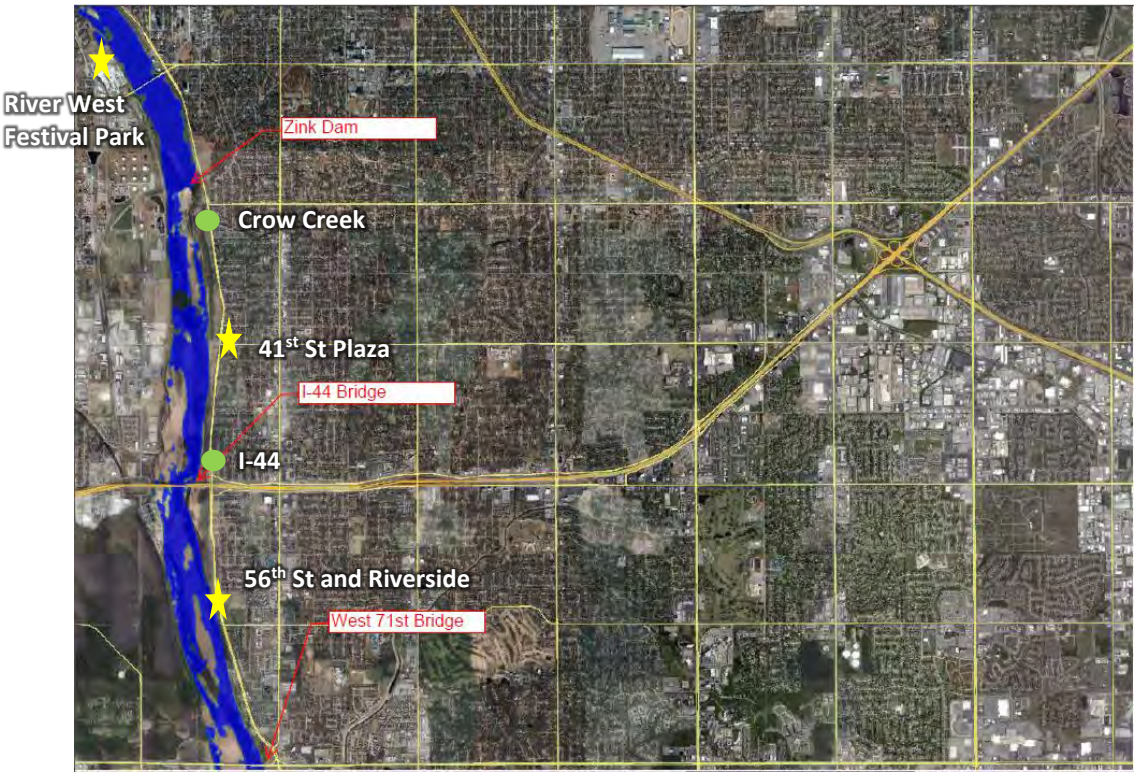


Figure 15. Arkansas River Looking Upstream from Boat Ramp at River West Festival Park

Figure 16. Arkansas River Looking at Cross-Section from Boat Ramp at River West Festival Park

Figure 17. Arkansas River Looking Downstream from Boat Ramp at River West Festival Park

Crow Creek

Drone footage was taken from Crow Creek, which provided valuable data between the River West Festival Park and 41st St Plaza stops. There is more surface water present along the east bank than the model outputs. The model shows the river staying along the west bank, with minimal to no flows along the east bank. However, observed conditions show good surface water presence on both sides of the river up and downstream from Crow Creek. Upstream of the location, a protected sandbar near the center of the river is present, which would benefit least terns in particular. The sandbar was not shown in the modeled outputs. These photographs were not reviewed during the field trip.

Assessment: Model outputs significantly underestimate the amount of surface water along the east bank throughout this stretch of river.

Figure 18. Drone Photograph—Arkansas River Looking Upstream at Crow Creek

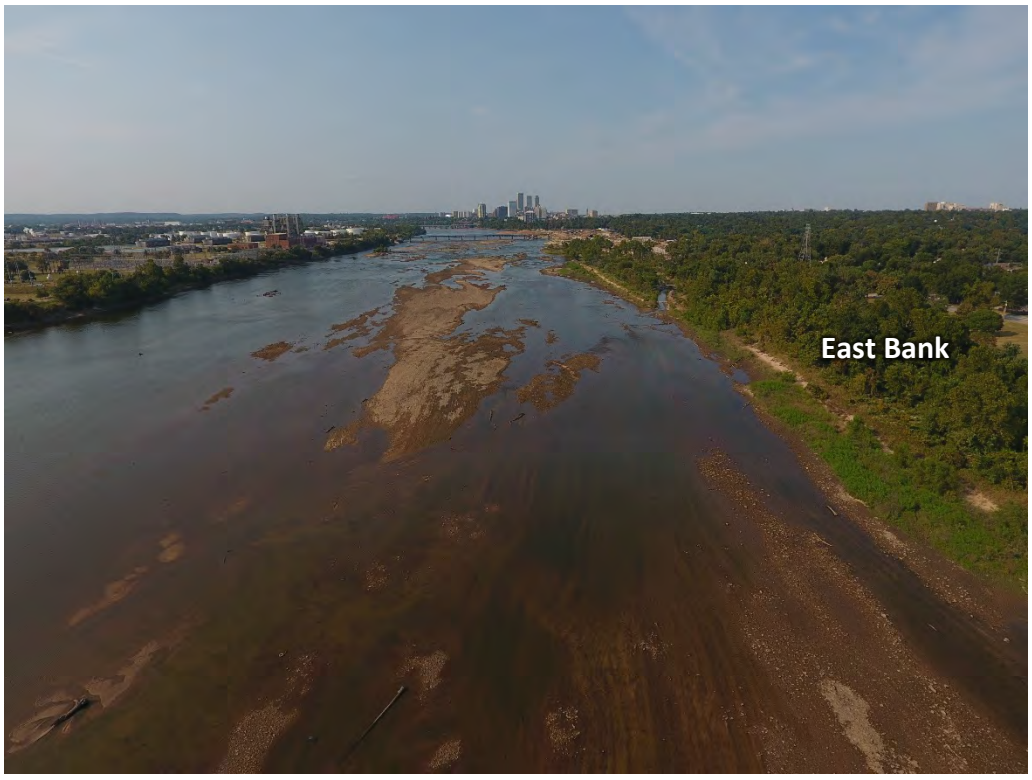


Figure 19. Drone Photograph—Arkansas River Looking at Cross-Section at Crow Creek

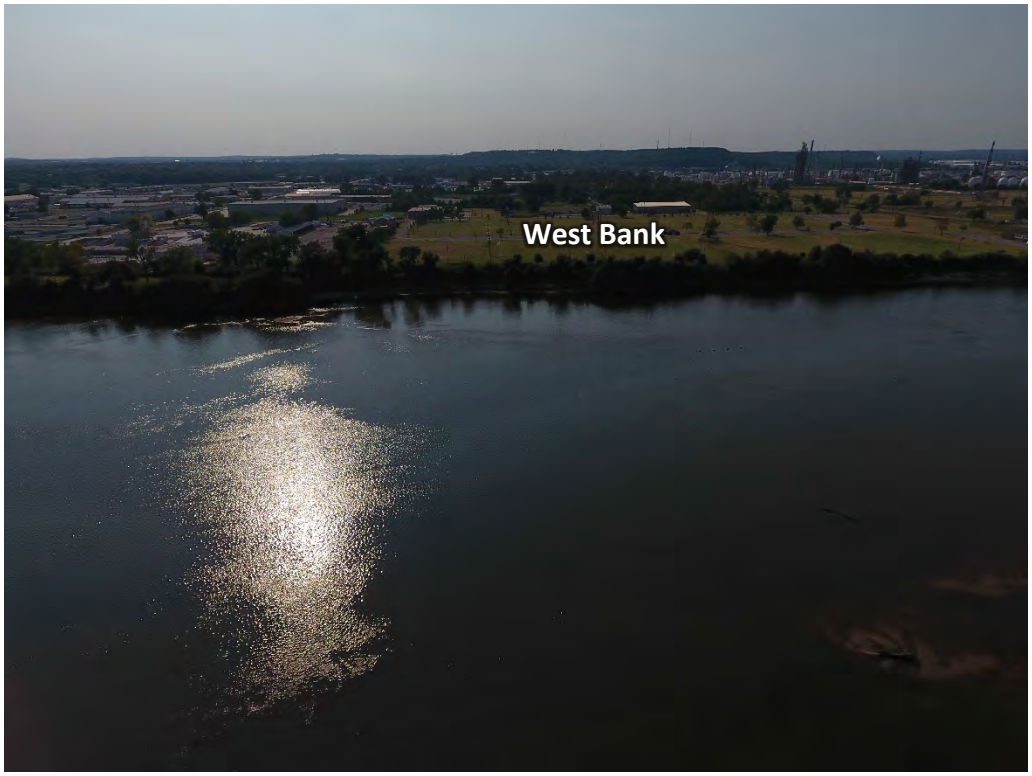


Figure 20. Drone Photograph—Arkansas River Looking Downstream at Crow Creek

41st St Plaza (41st St and Riverside)

The third stop was at the 41st St Plaza (see Figure 14). From the parking lot, we walked to a visible opening in the shoreline vegetation immediately west of the playground. At this location surface water flows very closely resembled modeled outputs. A greater cross-section of water was observed throughout this stretch than was modeled, although it appeared the greater area was fairly shallow. There were some small pools along the east bank upstream of the observation point that were not modeled. As well, the modeled sandbar was larger than the observed sandbar.

Assessment: Model outputs slightly underestimate the amount of surface water upstream of the observation point and at the sandbar in in the center of the river. Resource agencies are satisfied with the amount of flow and say that it is a significant improvement when compared to the no flow conditions.

Figure 21. Arkansas River Looking Upstream at 41st St Plaza

Figure 22. Arkansas River Looking at Cross-Section at 41st St Plaza

Figure 23. Arkansas River Looking at Cross-Section Slightly Downstream from 1st Cross-Section at 41st St Plaza

Figure 24. Arkansas River Looking Downstream at 41st St Plaza

56th St and Riverside

At this location, the ratio of surface water to sandbar very closely mimics the model outputs. From the observation point, there was an obvious channel on the west bank, but its size could not be determined. Drone photographs from the I-44 location were used to further confirm that the ratio of surface water to sandbar closely mimics the model outputs.

Assessment: Model outputs were accurate when compared to field observations.

Figure 25. Arkansas River Looking Upstream at 56st St and Riverside

Figure 26. Arkansas River Looking at Cross-Section at 56st St and Riverside

Figure 27. Arkansas River Looking Downstream at 56st St and Riverside

Figure 28. Drone Photograph—Arkansas River Looking Upstream at I-44

Figure 29. Drone Photograph—Arkansas River Looking at Cross-Section at I-44

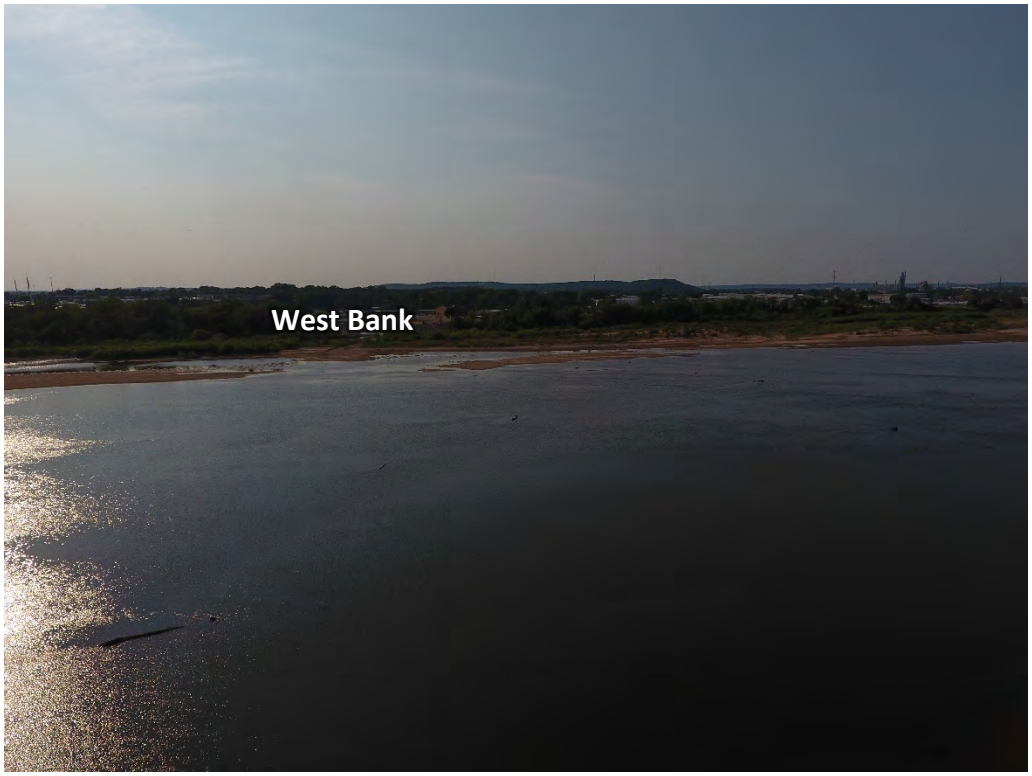
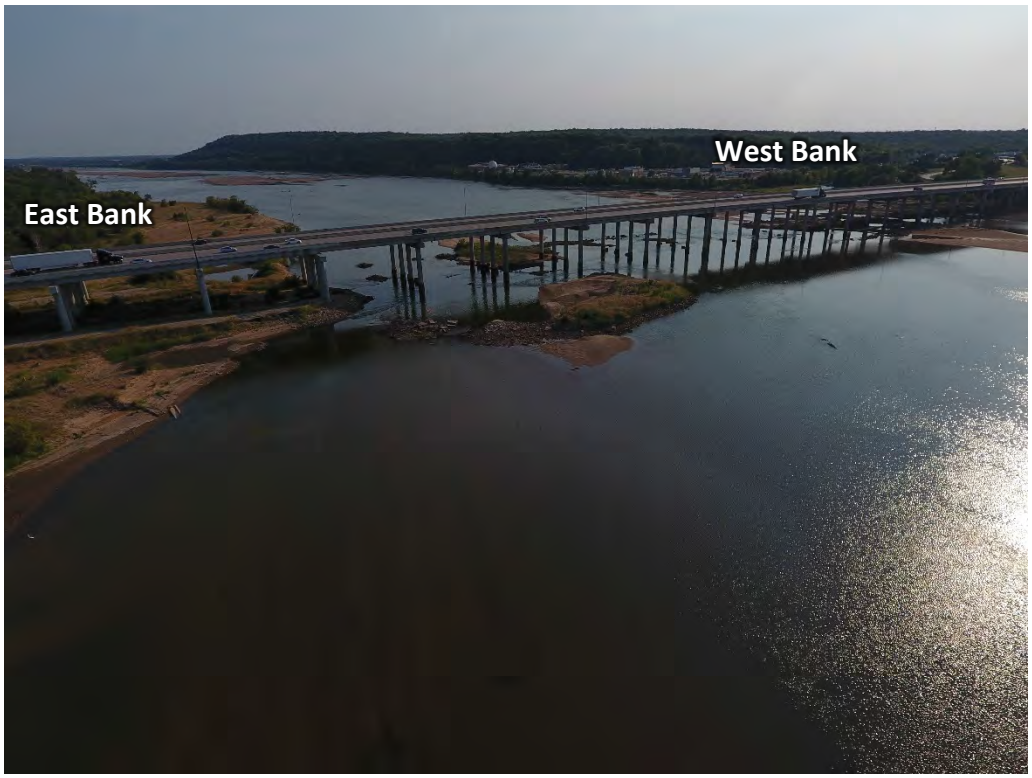


Figure 30. Drone Photograph—Arkansas River Looking Downstream at I-44



Helmerich Park (Between 71st and 81st on Riverside)

At the Helmerich Park observation point, the ratio of surface water to sandbar closely mimics the model outputs. At this location, the amount of water along the east bank is slightly wider and extends further south than the model outputs indicate. From the observation point, there was an obvious channel on the west bank towards the downstream end of the sand bar, but its size could not be determined.

Assessment: Model outputs were accurate when compared to field observations.

Figure 31. Model Output from 71st St Bridge to Creek Turnpike (Yellow Stars=Stops; Green Circle= Drone Location)

Figure 32. Arkansas River Looking Upstream at Helmerich Park

Figure 33. Arkansas River Looking at Cross-Section at Helmerich Park

Figure 34. Arkansas River Looking Downstream at Helmerich Park

From the Helmerich Park location, field observations indicated there was water along the eastern bank, but modeled outputs show the river migrating toward the west bank leaving much of the eastern half of the river channel dry. To verify surface water locations, the team walked from Helmerich Park along the River Parks Trail to the confluence with Joe Creek. From the Joe Creek observation point, the team confirmed surface water presence along the eastern bank. These waters were very shallow but can provide valuable habitat in the riverine system.

Figure 35. Arkansas River Looking Upstream at Confluence with Joe Creek

Figure 36. Arkansas River Looking at Cross-Section at Confluence with Joe Creek

Figure 37. Arkansas River Looking Downstream at Confluence with Joe Creek

Dirt Pullout (Between 118th St and 121st St on Delaware)

Like the last several observation points, the ratio of surface water to sandbar closely matches modeled output mapping. Additional water was observed along the east bank spanning about 100 yards from the bank to the sandbar. The team thought this was slack water; however, drone photographs show a braid in the channel just upstream from the observation point.

Assessment: Model outputs underestimate the amount of surface water along the east bank where an additional “braid” of shallow surface water is present.

Figure 38. Model Output from Creek Turnpike to Hwy 64 Bridge (Yellow Stars=Stops; Green Circle= Drone Location)

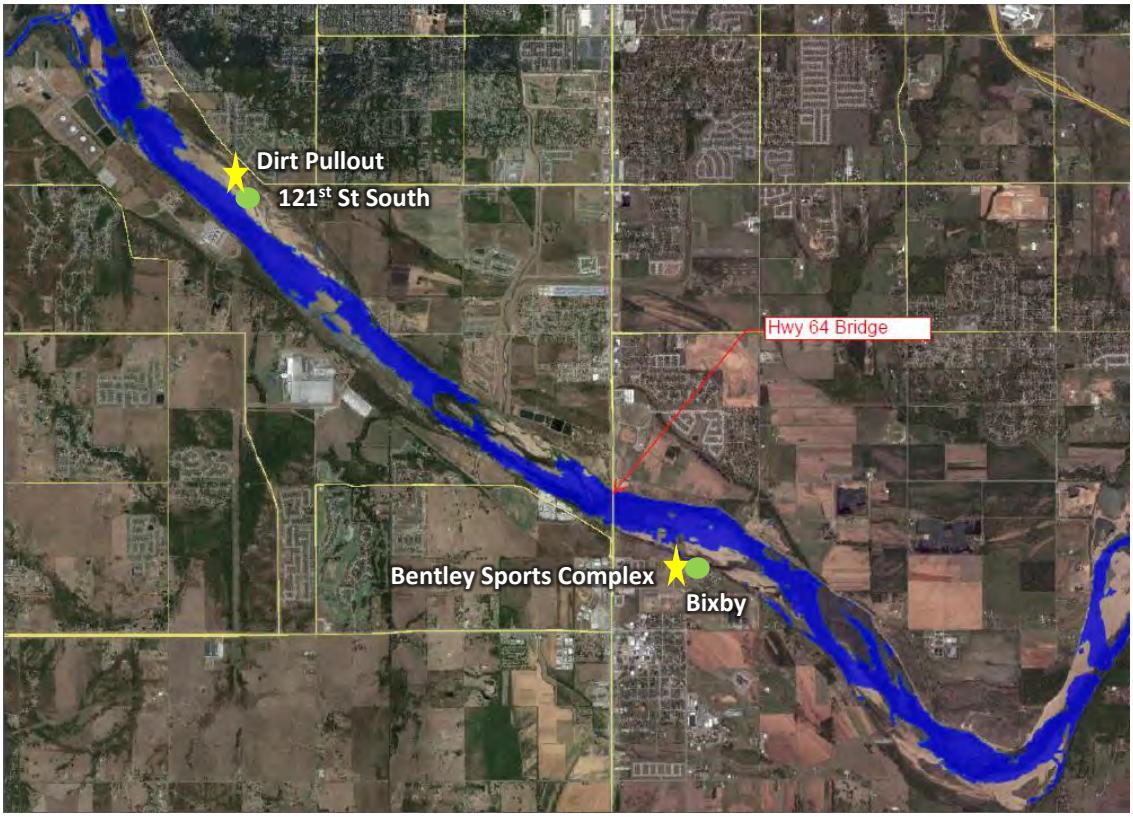


Figure 39. Arkansas River Looking Upstream at Dirt Pullout

Figure 40. Arkansas River Looking at Cross-Section at Dirt Pullout

Figure 41. Arkansas River Looking Downstream at Dirt Pullout

Figure 42. Drone Photograph—Arkansas River Looking Upstream at 121st St South

Figure 43. Drone Photograph—Arkansas River Looking at Cross-Section West Bank at 121st St South

Figure 44. Drone Photograph—Arkansas River Looking at Cross-Section East Bank at 121st St South

Figure 45. Drone Photograph—Arkansas River Looking Downstream at 121st St South

Bentley Sports Complex (Downstream of Highway 64 in Bixby)

To get to the Bentley Sports Complex observation point, the team walked down an old road that leads to a vantage point where the old Highway 64 Bridge use to be. From this location, the ratio of water to sandbar is underestimated. There appears to be more water along the south bank than the model outputs indicate starting at the bridge and progressing downstream to just south of the observation point. It also appears that the width of the sandbar is smaller than in the modeled outputs. The north bank was not visible from the observation point.

Drone photographs were used to compare the field observations to the modeled outputs. From the upstream photograph, the surface flows do not stay in a single channel, rather a braid forms just downstream of the existing Highway 64 Bridge, creating a large sandbar with two channels of flow along the north and south bank. The north bank flows are reduced compared to the model output, but a significant increase in flows along the south bank is seen. Just downstream of the old Highway 64 Bridge, flows return to a single channel flow and appear to be similar to the modeled outputs.

Assessment: The location of surface water during field observations do not agree with the modeled output locations. In general, the model most likely underestimated the ratio of surface water to sandbar. Greater surface flow was observed along the south bank, while reduced flow was seen along the north bank, and a true protected sandbar was created unlike the contiguous land along the south bank in the modeled outputs. Downstream of the old Highway 64 Bridge, surface flows appear to be similar to the modeled outputs.

Figure 46. Arkansas River Looking at Cross-Section at Bentley Sports Complex

Figure 47. Arkansas River Looking at Cross-Section at Bentley Sports Complex

Figure 48. Arkansas River Looking Downstream at Bentley Sports Complex

Figure 49. Drone Photograph—Arkansas River Looking Upstream at Bentley Sports Complex

Figure 50. Drone Photograph—Arkansas River Looking at Cross-Section toward North Bank from South Bank at Bentley Sports Complex

Figure 51. Drone Photograph—Arkansas River Looking at Cross-Section toward South Bank from Center at Bentley Sports Complex

Figure 52. Drone Photograph—Arkansas River Looking at Cross-Section toward North Bank at Bentley Sports Complex

Figure 53. Drone Photograph—Arkansas River Looking Downstream at Bentley Sports Complex

Indian Springs Sports Complex

The last stop was at the Indian Springs Sports Complex just upstream of where the proposed Least Tern Island would be situated. At this location, the ratio and location of surface water to sandbar closely mimics the modeled outputs. During the field visit, the team thought that the location of the actual surface flow was along the opposite bank than what was modeled; however, after reviewing the drone photographs, the observed flows follow the same path as the modeled outputs. The team was thinking they were further downstream than they actually were. Unfortunately, photographs from this observation point where corrupted during file transfer to be able to visually show the changes. However, drone photographs are available and confirm the similarities.

Figure 54. Model Output from Hwy 64 Bridge to Indian Springs Sports Complex (Yellow Star=Stops; Green Circle= Drone)

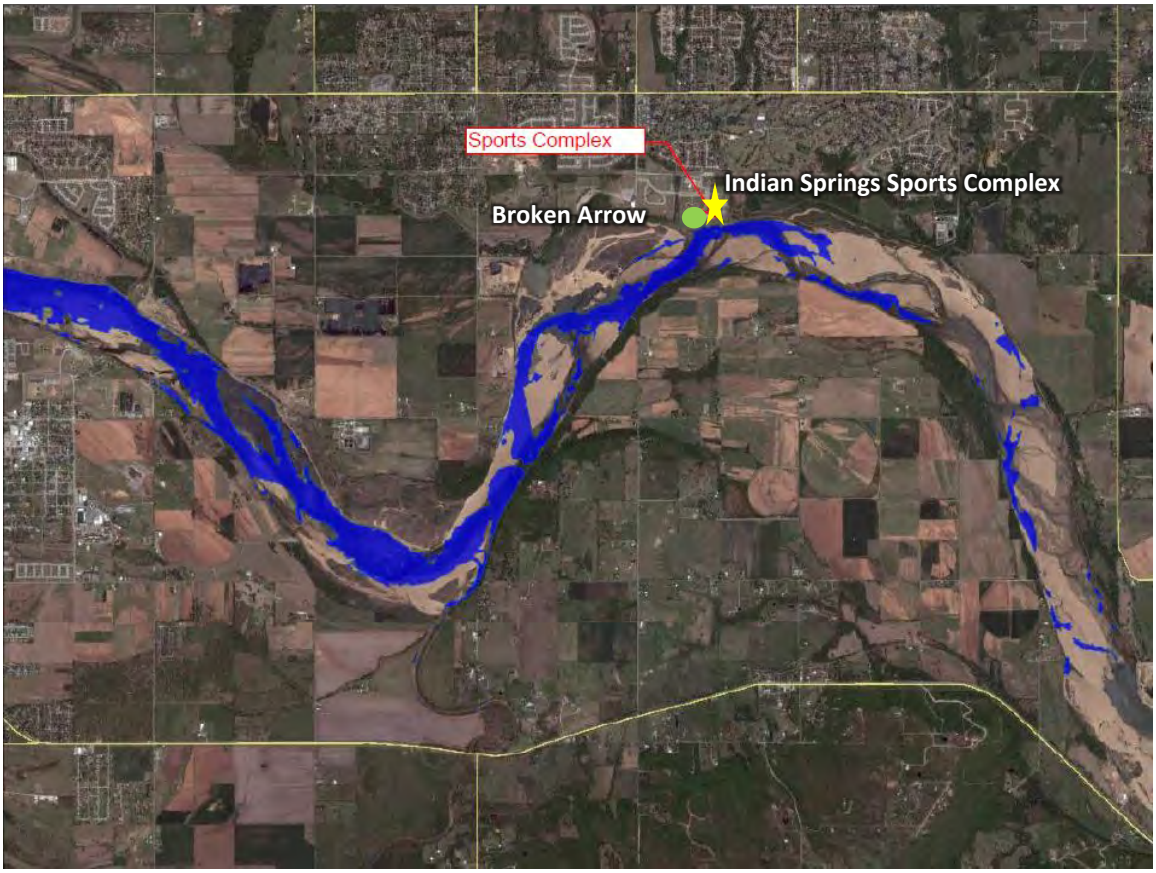


Figure 55. Drone Photograph—Arkansas River Looking Upstream at Indian Springs Sports Complex

Figure 56. Drone Photograph—Arkansas River Looking at Cross-Section at Indian Springs Sports Complex

Figure 57. Drone Photograph—Arkansas River Looking Downstream at Indian Springs Sports Complex