Draft
Supplemental Environmental Assessment

Appendix K: Dredge Material Management Plan

Arkansas River Navigation Study
Arkansas and Oklahoma

January 2024

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McClellan-Kerr Arkansas River Navigation System
Dredge Material Management Plan
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1 Executive Summary

The U.S. Army Corps of Engineers' (USACE) navigation mission is to provide safe, reliable, efficient, and environmentally sustainable waterborne transportation systems (channels, harbors, and waterways) for the movement of commerce, national security needs, and recreation.

The removal or excavation, transport, and placement of dredged sediments are the primary components of the "dredging process." After the sediment has been excavated, it is transported from the dredging site to the designated disposal area. This transport operation is accomplished by the dredge itself or by using additional equipment such as barges, clamshell bucket, or pipelines with booster pumps. The collected and transported dredged material is placed in designated disposal sites such as unconfined onshore (UO); behind bank stabilization and channel alignment structures unconfined structures (US); in confined upland disposal areas Confined Dike (CD); or on designated disposal islands Unconfined Island (UI); as described in this plan.

This Dredged Material Management Plan (DMMP) is intended to provide a brief introduction and overview of the dredging process and problem areas for the McClellan-Kerr Arkansas River Navigation System (MKARNS). The DMMP includes dredging descriptions, transportation systems, and preferred alternative for the placement of dredged material. This DMMP accompanies the Supplemental Environmental Assessment (SEA) being developed by the US Army Corps of Engineers (USACE) Little Rock and Tulsa Districts to assess the potential environmental impacts of the updated recommended plan in the 2005 Arkansas River Navigation Study (ARNS). The SEA is being done in conjunction with the Post Authorization Change Report (PACR) that is intended to address changed conditions along the MKARNS since the completion of the feasibility study and environmental impact statement, also completed in 2005.

The work done for the PACR relies on more evolved hydrographic surveying done by the Little Rock and Tulsa Districts in the wake of the record flooding in 2019. These surveys provide a greater level of detail and less expensive data collection than was available. This data set included single-beam cross sections at approximately 500-foot intervals, multi-beam surveys of all the underwater structures, and multi-beam surveys around each lock and dam. Estimating dredging quantities for an ever-changing river system is challenging. The addition of detailed multi-beam surveys reduces uncertainties in interpolation and triangulations of the previously used survey data and the more detailed picture of the river bottom provides additional visual context of the acting hydrodynamics on the river. Additional technologies in data analysis allow for a faster, more robust analysis of the historic dredging data, which also includes nearly 20 years of additional data points. This DMMP summarizes the methods and assumptions used in the initial feasibility report as well as the methods and assumptions used in the PACR.

2 MKARNS

The MKARNS provides 445 miles of channel improvements to the Arkansas River from its confluence with the White and Mississippi Rivers in Arkansas up to the Port of Catoosa located 15 miles east of Tulsa, Oklahoma. It includes a series of 18 locks and dams (including Montgomery Point Lock & Dam) all having the same usable lock chamber dimensions of 110 feet wide by 600 feet long. Flows on the Arkansas River are controlled primarily by the U.S. Army Corps of Engineers (USACE) operation of 11 reservoirs in Oklahoma. These reservoirs are: Keystone, Oologah, Pensacola, Hudson, Fort Gibson, Tenkiller Ferry, Eufaula, Kaw, Hulah, Copan, and Wister. Project purposes of these reservoirs include navigation, flood control, water supply, hydropower, water quality, recreation, and fish and wildlife habitat. There are 5 major public port facilities on the MKARNS, along with numerous private port facilities.

Water is released from the reservoirs through gated spillways and/or power generating units. The rate of water released from each reservoir depends on many factors including available water storage, power requirements, navigation water requirements, inflow rates, river flow rates downstream, and weather conditions. During flood events, flows are regulated at Van Buren, Arkansas, and Sallisaw, Oklahoma, both located near the Oklahoma-Arkansas state line. The Van Buren site (gage) is the primary regulating station or control point for the lower Arkansas River navigation system from Van Buren to Wilbur D. Mills Dam because it is the most downstream station. The reservoirs are operated to maintain target flows, not to exceed a 22-foot stage, at the Van Buren gage. There is about 7,500 square miles of uncontrolled drainage area between the projects and the Van Buren gage. All upstream reservoir releases are adjusted based on conditions at the Van Buren gage.

The MKARNS navigation channel begins at the confluence of the White and Mississippi Rivers in Desha County in southeastern Arkansas. From that point, the first ten miles upstream are navigated via the White River to the Arkansas Post Canal, which conveys river traffic to the Arkansas River. Continuing upstream, the navigable waterway crosses Arkansas as it proceeds northward into Oklahoma. The system changes from the Arkansas River into the Verdigris River at Muskogee and terminates 50 miles upstream on the Verdigris at Catoosa. The system has eighteen lock and dam projects (5 in Oklahoma and 13 in Arkansas). The two uppermost projects are on the Verdigris River, thirteen projects are on the Arkansas River, two are on the Arkansas Post Canal, and one is on the White River. See Figure 1 for a visual of the McClellan-Kerr Arkansas River Navigation System.

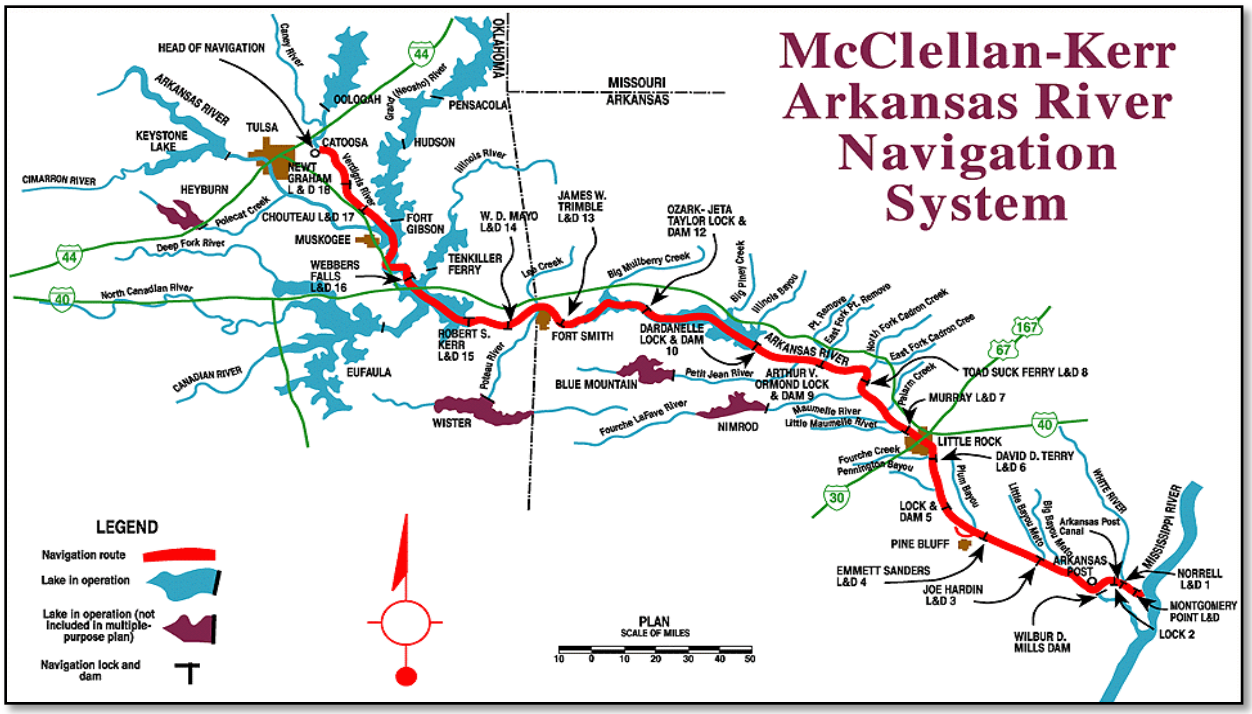

Figure 1: McClellan-Kerr Arkansas River Navigation System

USACE maintains a minimum nine-foot channel depth on the MKARNS. Passage through lock chambers is configured for eight barges, but can accommodate up to 15 barge tows using double lockage. Each of the 18 locks measures 110-feet wide and 600 feet long. Individual locks have lifts ranging from 14 feet to as much as 54 feet. There are 13 “low lift” lock and dam structures that raise or lower river traffic from 14 to 30 feet. Four other structures are “high lift” locks that can raise or lower traffic from 30 to 54 feet. In addition to the minimum nine-foot depth, USACE maintains channel width varying from 300 feet along the White River, Lake Langhofer, and the Arkansas Post Canal to 250 feet on the Arkansas River. Sans Bois Creek is 225-feet wide, and the Verdigris River is 150-feet wide.

3 Authority

The Rivers and Harbors Act of 1946 authorized the development of the Arkansas River and its tributaries for the purposes of navigation, flood control, and hydropower upstream of Little Rock, Arkansas. Downstream of Little Rock, development is authorized for the purpose of navigation and irrigation. Subsequent acts authorized recreation and water supply. Public Law 91-649 stated that the project would be known as the McClellan-Kerr Arkansas River Navigation System (MKARNS) to honor Senators Robert S. Kerr, Oklahoma (OK) and John L. McClellan, Arkansas (AR) who pushed its authorizing legislation through Congress. Later acts authorized water supply, fish and wildlife management, and agricultural water supply. Construction of the project began in 1957, and was opened to navigation in 1971 at a total cost of $1.3 billion.

4 Purpose and Methodology

The purpose of this plan is to publish and anticipate the future needs relevant to dredging operations for

the MKARNS as the system moves towards maintaining a 12-ft channel depth. Historical data, current and past dredging operations, site availability and access, governing regulations and environmental considerations were used to evaluate and determine the federal standard for disposal areas. Dredge disposal sites are to be located as close as possible to areas along the navigation channel currently identified and/or expected to be dredging locations.

The dredging and disposal sites were analyzed using technical guidance presented in the EPA and USACE *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.- Testing Manual* (USEPA, USACE 1998) commonly referred to as the Inland Testing Manual, EPA regulation 40 CFR Part 230, (*Guidelines for Specification of Disposal Sites for Dredge or Fill Material*), and the USACE operation and maintenance regulations 33 CFR Part 335-338. The Inland Testing Manual contains technical guidance for determining the potential for contaminant-related impacts associated with the discharge of dredge material in waters regulated under Section 404 of the CWA through chemical, physical, and biological evaluations. The manual uses a tiered process for analysis of dredge sites. At some sites, sediment sampling and analysis for chemical contaminants has been performed where the guidance indicated the need for such sampling.

Subpart G of the Section 404(b)(1) guideline requires the use of available information to make a preliminary determination concerning the need for testing of the material proposed for dredging. The principle is commonly known as "reason to believe principle". The decision not to perform testing based on prior information must be documented in order to provide a reasonable assurance that the proposed discharge material is not a carrier of contaminants. The reason to believe that no testing is required is based on the type of material to be dredged and/or its potential to be contaminated. As an example, dredge material is most likely to be free of contaminants if the material is composed primarily of sand, gravel, or other such materials and is found in areas of high current or wave action. In addition, knowledge of the proposed dredging sites proximity to sources of contamination, as well as knowledge gained from previous testing or through experience and knowledge of the area to be dredged, may be utilized to conclude that there is no reasonable reason to believe that contaminants are present and, therefore, no need for testing. This general evaluation comprises the procedures found in Tier I of the Inland Testing Manual's tiered-testing process. The tiered testing process allows optimal use of resources by identifying locations that require more extensive investigation and analyzing said areas to adequately determine potential impacts. Evaluation at successive tiers is based on more extensive and specific information about the potential impact of the dredged material that may be more time-consuming and expensive to generate, but that allows more and more comprehensive evaluations of the potential for environmental impacts. It is necessary to proceed through the tiers only until information sufficient to make factual determinations has been obtained. If the available information is sufficient to make a positive factual determination, no further testing is required.

Tier I is a comprehensive analysis of all existing and readily available information on the proposed dredging site, including all previously collected physical, chemical, and biological data for both the proposed dredging and disposal sites. Tier II is concerned with the chemical analysis of the water column assuming total release of the contaminants in the dredged material during the discharge operation, and an evaluation of the potential for benthic impact using calculations of theoretical bioaccumulation potential (TBP). If the numerical model predicts that the concentrations of all contaminants of concern after consideration of mixing are less than the available, applicable state water quality standard (WQS), then the dredged material complies with state WQS.

4.1 Dredging for the 2005 Arkansas River Navigation Study (ARNS) Feasibility Report

Tasso Schmidgall documented the Arkansas River's dredging history from 1969 to 1994 in his 1995 paper titled 'Twenty-Six Years of Dredging on the Arkansas River. The MKARNS dredging records from 1995 to 2002 are also available. The mentioned sources state that dredging volumes averaged 3.5 million cubic yards (MCY) for 1971-1978, 1.3 MCY for 1979-1986, 1.2 MCY for 1987-1994, and 0.3 MCY for 1995-2002. The average flow volumes at Little Rock for these periods were 33.5, 33.0, 40.3, and 35.2 million acre-feet, respectively. These numbers reflected a continued decrease in the amount of sediment that is being transported and deposited in the navigation channel of the MKARNS. Three suspended sediment samples were collected and analyzed by the United States Geological Survey for the feasibility study, and all showed a decrease in the concentration of suspended sediments.

Detailed sedimentation studies were not performed, due to the assumption that the proposed project would have only localized effects on the sediment transport capacity. The 2-D sediment transport model results support this belief as sediment was observed to scour in the channel in both depth and width in the areas of the proposed structures, while the navigation channel downstream of the proposed changes remained relatively stable with indications that additional deposition would occur mostly in the dike fields. Although some deposition was seen in the channel downstream, it was minor and would be expected to self-clean as the system re-adjusts towards a state of equilibrium that presently exists. A comparison of the change in the sediment transport capacity potential for all river reaches was made using the Hydraulic Design module of HEC-RAS. Although this sediment transport capacity potential does not take into account the suspended sediment load, effects can be assessed qualitatively by comparing the percent change. It was noted that once the channel stabilized to the estimated depth and width, only a minor change in the current system's sediment transport capacity was noted. Sediment transport capacity is expected to remain similar to the existing conditions, but it is predicted that there will be minor changes in the location of sediment deposition in the proposed project areas. Sediments will be moved downstream a short distance with most deposition occurring in the dike fields. The potential change in sediment transport capacity was compared to the two-dimensional CCHE2D model. the Sediment Impact Assessment Model (SIAM), and the methods recommended in USACE EM 1110-2-1418, "Channel Stability Analyses for Flood Control Projects" for select pools. An annual average sediment budget analysis showed no significant project impacts. Sensitivity runs were performed and showed no significant increase in project impacts for reasonable modifications of data inputs. The study results suggest that the hydraulic impacts of the navigation project are unlikely to cause long-term channel stability impacts. For the sediment transport model, inflowing suspended sediment concentrations and bedload rate were estimated for the simulations due to lack of data, but the estimated concentrations were similar to three measurements obtained in January and March 2004.

The remaining assumptions from the 2005 feasibility report include:

- The comparisons of water surface elevations between the existing conditions and the plan conditions indicated negligible differences in elevations and was assumed to have no impact to flood heights for the range of flows from the 2-yr to the 100-yr.
- The reduced average maintenance dredging for the period 1995-2002 is due to a reduced sediment load as the system approaches equilibrium.
- Corps of Engineers Marine Terminals will clam the downstream lock approaches to maintain required depth until the maintenance dredge arrives. This work will require three additional dump

barges to expedite excavation and disposal time.

- Large shoals that form during a fast recession in the MKARNS may need to be removed either under an existing contract or under a new contract.
- If the new structures do not adequately scour the channel, then additional dredging will be required.
- Structures may move sediment from one place in the navigation channel to another downstream.
- Montgomery Point Lock and Dam will significantly decrease dredging in the White River Entrance Channel.
- The amount of dredging required may be significant during the first 5 years, decreasing to remain constant for the life of the project.
- Dredging program will be adequately funded.
- No initial modifications will be made to the tow haulage system.
- The computations for the initial dredging quantities in feasibility were based off of a 2003 single-beam hydrographic survey. Some of the methods and assumptions to compute the initial dredging quantities were not clearly defined in the feasibility report. The required dredging depth was documented. In general, reaches in which river training structure modifications were proposed along with the Arkansas Post Canal were computed to an initial dredge depth of 14 feet. The remaining locations were proposed to be dredged to a 15-foot depth. The annual maintenance dredging was estimated as a function of the initial dredging quantity within a given reach. For lock approaches, 100% of the initial dredge amount was assumed twice per year. For areas that did not have any proposed structure modification, 50% of the initial dredge amount was assumed. For areas that had river training structure modification, 10% of the initial dredge amount was assumed. For the Little Rock District, the estimated annual dredging *increase* was about 0.58 MCY. For the Tulsa District the estimated annual dredging *increase* was about 0.24 MCY for a total of 0.82 MCY per year.
- "Twenty-Six Years of Dredging on the Arkansas River" had the average sediment load for 1972 – 1981 as 7.8 MT/Y. A 1999 study for Arkansas-White River Cutoff Project Feasibility Study estimated the load from 4.6-13.3 MT/Y. In the early 2000s some samples were taken that indicated 2.8 MT/Y.

4.2 Dredging for the 2023 PACR Update

4.2.1 Little Rock District

The methods for updating dredging quantities remained unchanged from the 2021 update. Overall, the major reason for change in the quantities can be attributed to simply having more detailed data to compute the quantities from or better context to understand the need of dredging a particular location. The better context either led to reasons to eliminate an area from needing dredging or modification of the design assumption. A variety of influential factors impact dredging trends such as flow conditions, funding levels, District priorities, changes in the sediment load, changes to the river bed. Some years are not necessarily representative of the system as a whole but rather a large, isolated dredging need. Because of the dynamic nature of sediment loads and the non-stationarity due to an initial response in the 1970s as the MKARNS was constructed, water years 2000-2023 were used to develop a baseline economic estimate to maintain the existing 9-ft authority and decadal averages were analyzed by pool to develop new annual dredging estimates. Some noted areas are described below:

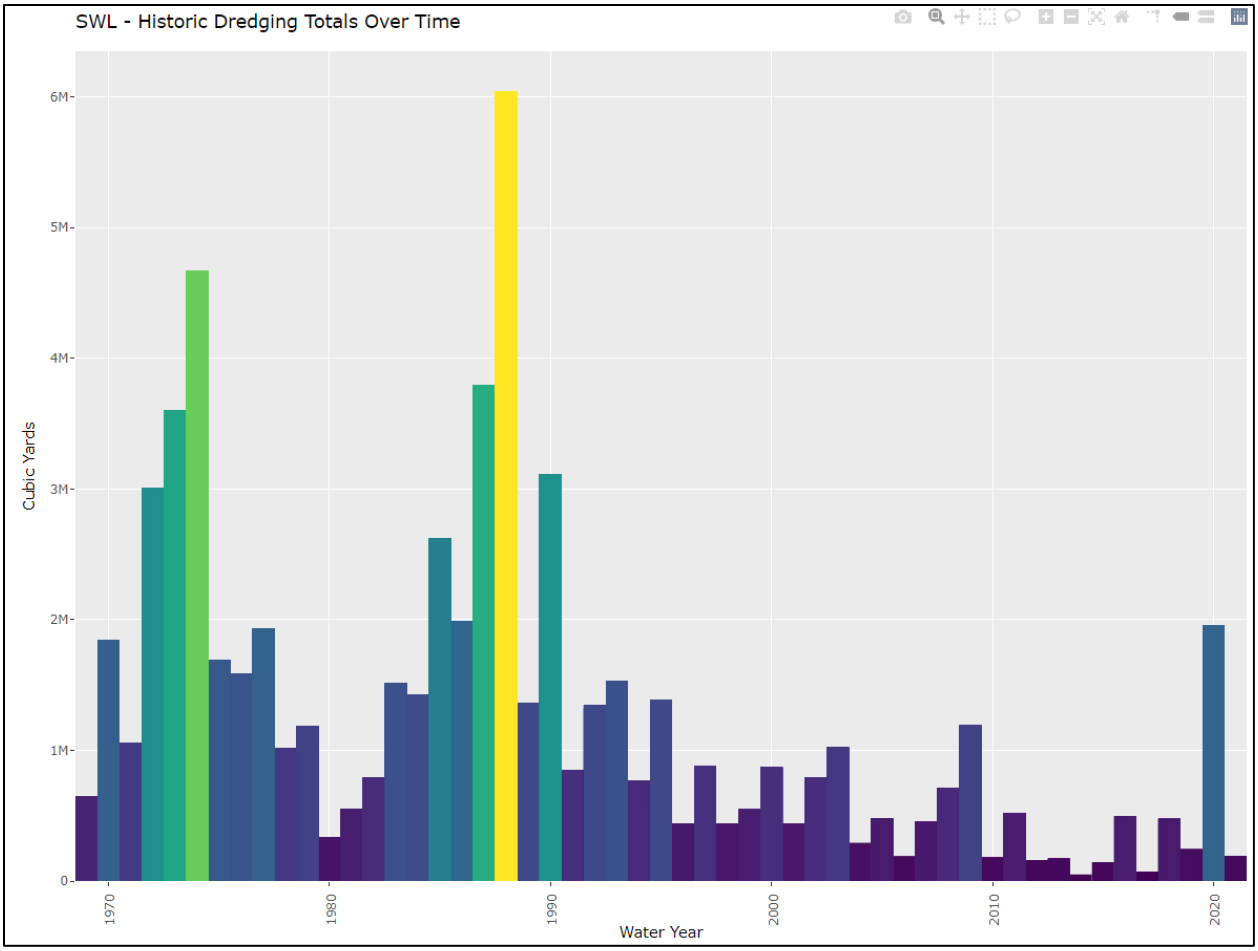

Figure 2. Dredging Totals for Little Rock District by Water Year

- The post-canal dredging assumption was to dredge to a design depth of 13-ft for a bottom width of 250 feet instead of 300 feet as authorized. This width is adequate for passing of tows and much of the canal is already at an adequate depth. Additionally, tow wash on the sides of the navigation canal currently limits the navigation channel to a range of 220 ft – 250 ft wide. The more detailed survey and discussion lessened dredging quantities in the post-canal.
- In Pool 8 at NM 165.9, a portion of an old cutoff structure remains in the navigation channel and will need to be blasted out or excavated Figure 3.

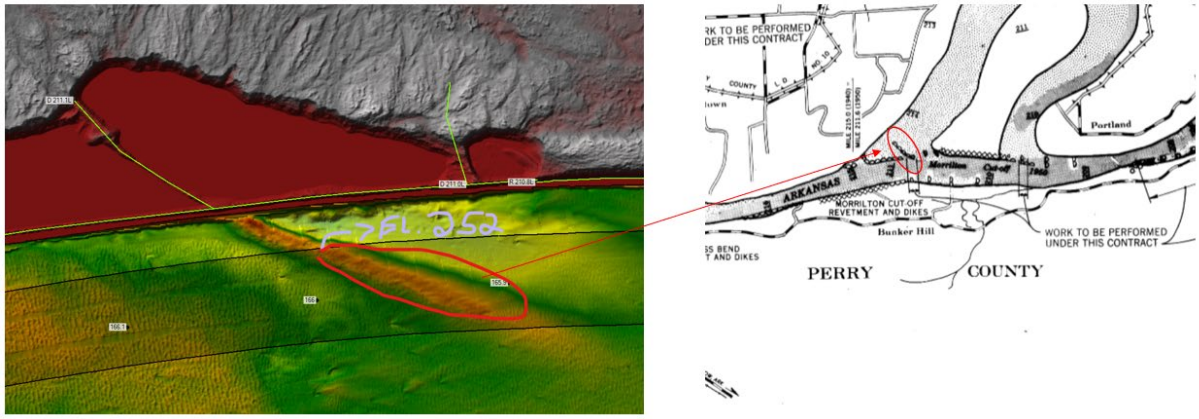

Figure 3. Obstruction of Training Structure Remnant in Pool 8

- In Pool 7 between approximately NM 151 and NM 140, the survey is indicative of either rock, shale, or clay lenses that will need to be blasted or excavated. Quantities in this reach and methods of removal are uncertain until a more detailed resistivity or core sampling method can be obtained (Figure 4). There is some history of excavation and blasting within this reach. In the 1987-1988 timeframe at Hickman Bend (NM 149 -150) some blasting was completed to improve the channel for the 9 foot authority. The material from blasting was largely used as bank paving repairs or dike repairs in the vicinity. In the fall of 2006, some hard-pan clay with boulders was excavated at approximately NM 146 for the 12-ft authority with some earmark funding. Most of the rock excavated was placed in stream in coordination with USFW for habitat creation.

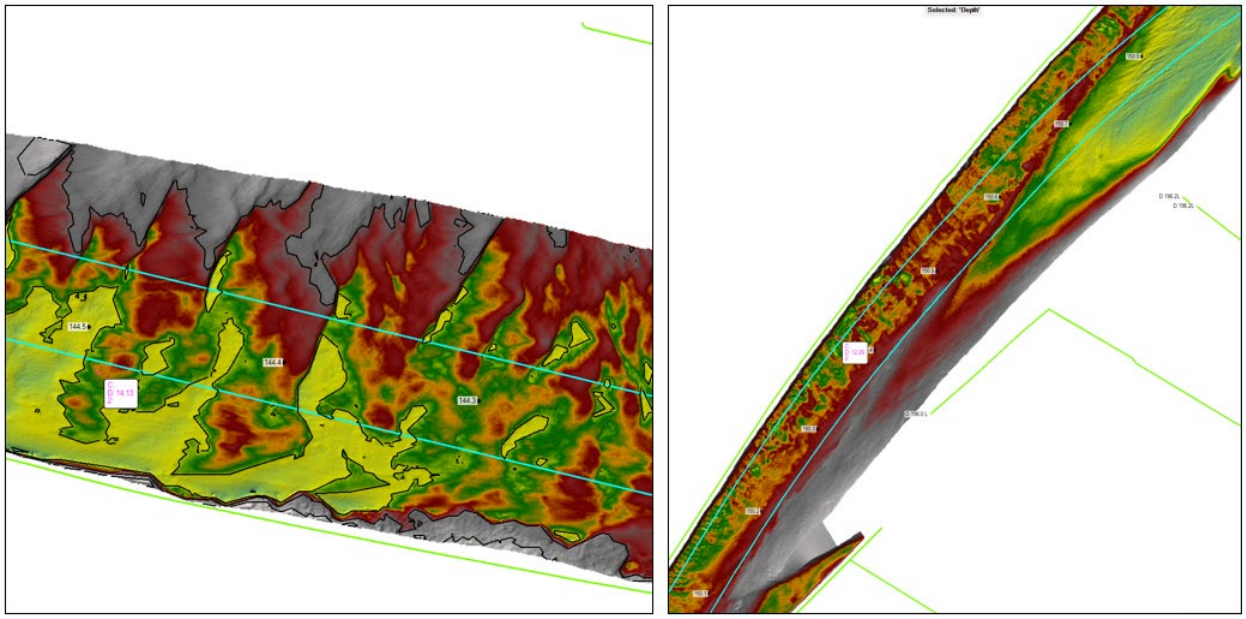

Figure 4. Example of Hard Material to be Excavated or Blasted in Pool 7

- In Pool 7 at NM 149.1, there exists an unnatural obstruction that will need to be investigated to determine proper removal (Figure 5).

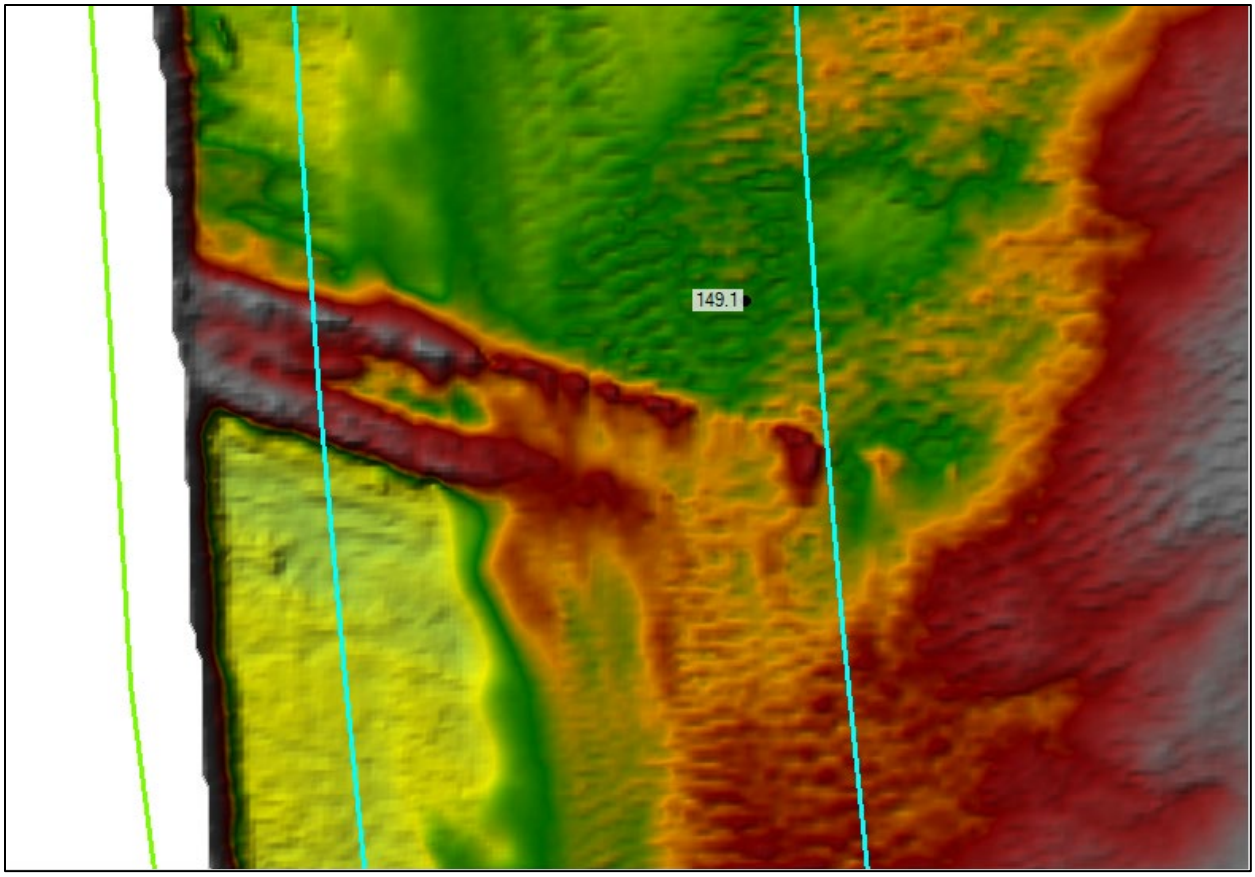

Figure 5. Obstruction in Pool 7 at NM 149.1

4.2.2 Tulsa District

The geological properties and topography of the MKARNS in the Tulsa District are different from the Arkansas River in the Little Rock District. Additionally, most of the sites needed for dredging in Tulsa District require upland disposal sites rather than in-water disposal sites. These factors warranted different assumptions and approaches to developing dredge quantities.

- The presence of bed rock is the Tulsa District reaches generally limits dredge depths such that the construction dredge depth was limited to 13.5 feet for all locations.
- Volumes were calculated from data collected at 500 foot cross section intervals after the 2019 flood event.
- The survey program HYPACK was used to perform the volume calculations.
- Template widths were set to the current authorized navigation widths of 250 feet on the Arkansas, 300 feet on the White, 150 feet on the Verdigris, and 225 feet on the Sans Bois. These widths were tapered appropriately for the lock approaches.

    - Invert elevations for the templates were set based on depths from the minimum regulated pool elevations.
    - Minor dredging volumes identified as a product of nuance in the survey data were screened out section-by-section in a spreadsheet while looking at the depth contours on a map.

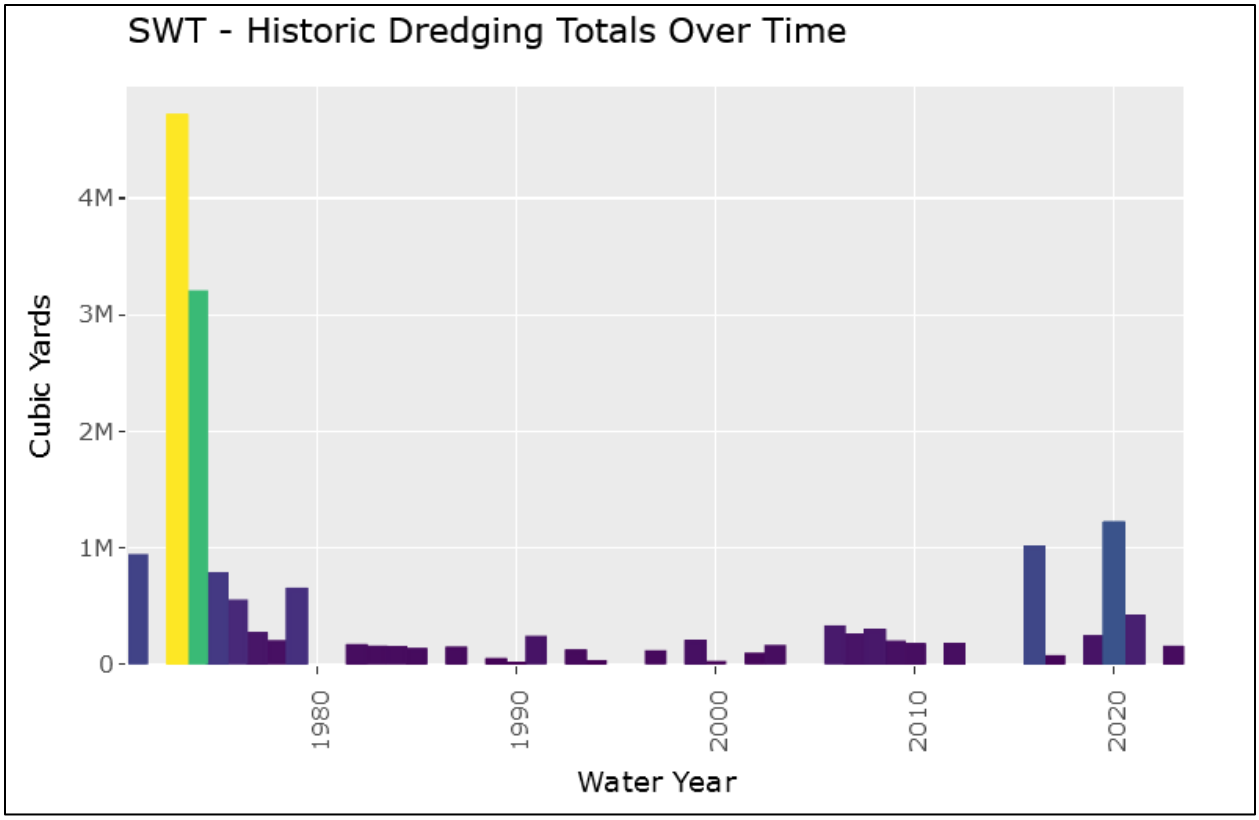

Figure 6. Dredging Totals for Tulsa District by Water Year

4.2.3 Maintenance Dredging History

The Little Rock District has maintained detailed dredging records since the construction of the MKARNS. These records along with the original design assumptions and forecasts can assist in evaluating not only the performance of river training structures, but also the order of construction. Contracted dredging records include the navigation mile of the dredge, the start and finish date of the dredging, and the volume of dredging in cubic yards. To describe priority locations for river training structure designs and to inform design modifications, dredging data was aggregated by the nearest navigation mile and statistically summarized. The two main indicators of potential channel inadequacies were count (the number of times a location has been dredged since construction), and the date of the last time a location was dredged. A scoring system was developed leveraging these two indicators that provided a rating system which helped to define the priorities of the river training structure design updates and provided a reasonable means to rate past performance and provides useful context when modeling and designing structures as well as prioritizing data collection and construction scheduling when supplemented with additional information such as other institutional knowledge of a reach or hydraulic modeling results. The scoring system rates navigation miles as A, B, C, D, or F by natural breaks in the count data and the date of dredge data.

The 2005 feasibility report identified an initial maintenance dredging quantity of 1.5 MCY for the Little Rock District which was updated to 2.3 MCY in 2021. This same quantity was carried forward for the 2023 update. The Tulsa District identified 0.3 MCY of maintenance dredging for the feasibility report which decreased to 0.1 MCY in the 2021 update with this amount being carried forward in the 2023

update. The decrease in dredge quantities is largely attributed to a recommendation of shallower dredge depths and the additional of detailed survey resolution. The following table depicts these maintenance dredging estimates along with totals.

Table 1. Maintenance Dredging by District (MCY)

	SWL	SWT	MKARNS
Feasibility	1,480,910	316,028	1,796,938
2021 Update	2,307,956*	143,105*	2,451,061*

*updated in 2021

4.2.4 Dredging for Deepening

The feasibility report identified 4.5 MCY in initial dredging quantities (dredging to deepen from nine to twelve feet) for the Little Rock District during feasibility. This decreased to 4.3 MCY in the 2021 update and decreased further in the 2023 update to 2.9 MCY. The decrease in initial dredging for Little Rock District is largely a result of recommending shallower initial dredge depths and the addition of detailed survey resolution. The total initial dredge quantities for the Tulsa District during feasibility was 6.3 MCY which was updated to 2.9 million cubic yards in 2021. In the 2023 update, the Tulsa District dredge qualities remained unchanged from the 2021 report. The following table depicts these initial dredging estimates along with totals. These dredging sites are included with SEA material.

Table 2. Initial Dredging by District (MCY)

	SWL	SWT	MKARNS
Feasibility	4,520,273	6,320,552	10,840,825
2021 Update	4,285,537	2,862,100	7,147,637
2023 Update	2,928,999	2,862,100*	5,791,099

*Not updated in 2023

The following table lists the feasibility and 2023 updated deepening dredging quantities organized by navigation mile, navigation pool, and USACE District.

Table 3. Feasibility and Updated Deepening Dredging Quantities by Navigation Mile and Pool

Navigation Miles	Pool	2004 Dredge Quantity (CY)	2023 Dredging Quantity (CY)	Estimated Change from Feasibility (CY)
0 - 0.6	-1		0	0
0.6 - 10.3	0		343,015	343,015
10.3 -13.3	1	501,173	32,612	-468,561
13.3 - 50.2	2	1,525,223	386,478	-1,138,745
50.2 - 66	3	25,744	176,326	150,582
66 -86.3	4	49,881	22,492	-27,389
86.3 - 108.1	5	396,114	22,142	-373,972
108.1 - 125.3	6	13,538	2,299	-11,239
125.3 - 155.9	7	396,000	405,909*	9,909
155.9 - 176.9	8	173,800	255,972	82,172
176.9 - 205.5	9	328,900	95,773	-233,127
205.5 - 256.8	10	427,900	801,205	373,305

Navigation Miles	Pool	2004 Dredge Quantity (CY)	2023 Dredging Quantity (CY)	Estimated Change from Feasibility (CY)
256.8 - 292.8	12	682,000	384,776	-297,224
SWL Total		**4,520,273**	**2,928,999**	**-1,591,274**
292.8 - 319.6	13	945,187	172,296**	-772,891
319.6 - 336.2	14	117,639	70,999	-46,640
336.2 - 366.7	15	2,193,933	1,482,616	-711,317
366.7 - 401.4	16	2,036,135	781,170***	-1,254,965
401.4 - 421.6	17	574,276	216,741	-357,535
421.6 - 445.0	18	453,382	138,278****	-315,104
SWT Total		**6,320,552**	**2,862,100**	**-3,458,452**
Totals		**10,840,825**	**5,791,099**	**-5,049,726**

*394,286 CY of blasting or excavation hard material between NM 151-149 and NM 147-140 and 11,623 CY Sand at downstream lock approach

**D/S approach of 14 is believed to have shale/hard material difficult to get to 9 ft grade

***In Feasibility - NM 397.4 -397.8 was estimated to have 10,860 cy of rock, NM 363.2 - 3636.6 was estimated to have 7,682.4 cy of rock for a total of 18,542 cy of rock removal in Pool 16. We are assuming these numbers are still valid until we have new data.

****In Feasibility - NM 442.2 - 442.4 was estimated to have 5,622.52 cy of rock, NM 441.6 - 442.0 was estimated to have 15,084.92 cy of rock, and NM 433.2 - 433.6 was estimated to have 6,276.66 cy of rock for a total of 26,984 cy of rock removal in Pool 18. We are assuming these numbers are still valid until we have new data.

Totals for both maintenance and initial dredging in Little Rock and Tulsa Districts are depicted in the following table.

Table 4. Maintenance and Initial Dredging by District

	SWL			SWT			MKARNS		
	Maintenance	**Initial**	**Total**	**Maintenance**	**Initial**	**Total**	**Maintenance**	**Initial**	**Total**
Feasibility	1,480,910	4,520,273	6,001,183	316,028	6,320,552	6,636,580	1,796,938	10,840,825	12,637,763
2021 Update	-	4,285,537	-	-	2,862,100	-	-	7,147,637	-
2023 Update	1,765,956	2,928,999	4,694,955	577,528	2,862,100*	3,439,628	2,343,484	5,791,099	8,134,583

*Not updated in 2023

5 Disposal of Dredge

The 2005 feasibility report identified the number of existing disposal sites in both Arkansas and Oklahoma as well as the number of additional dredged material disposal sites required for navigation maintenance and deepening. These numbers are listed in the table below.

Table 5. Existing and Additional Dredged Material Disposal Sites Required for Navigation Maintenance and Deepening

Segment	Number Existing Disposal Sites	Number New Maintenance Disposal Sites	Number of New Joint Use Maintenance and Deepening Disposal Sites (10-12 foot)	Number of New 12 ft Deepening Sites (10-12 foot)
Arkansas				
1-Mouth To Pine Bluff	27	0	0	2
2-Pine Bluff to Little Rock	5	0	0	2
3-Little Rock to Dardanelle	40	0	0	2
4-Dardanelle to Fort Smith	22	0	0	0
Oklahoma				
5-Fort Smith to Muskogee	21	10	9	20
6-Muskogee to Catoosa	27	4	3	15
Total	**142**	**14**	**12**	**41**

Table 5, derived from Table 3-6 of the 2005 EIS, identified the number of existing navigation maintenance and deepening as 142. The current SEA estimates the number of existing disposal sites as 129 (Table 2-6). The current SEA also identified the need for 37 upland disposal sites in Oklahoma and two in Arkansas (Table 2-5). Among the 37 sites in Oklahoma, six would be constructed in Phase 1, nine would be constructed in Phase 2, and eleven each in Phases 3 and 4 (Table 2-7). Forty-one in-water disposal sites would be constructed in Arkansas (Table 2-6).

5.1 Beneficial Uses of Dredge Material

Dredged material can be used in a wide variety of beneficial ways. Ten broad categories, as described in EM 1110-2-5025, of beneficial uses have been identified, based on the functional use of the dredged material or site. They are:

- Habitat restoration/enhancement (wetland, upland, island, and aquatic sites including use by

waterfowl and other birds).
- Beach nourishment.
- Aquaculture.
- Parks and recreation (commercial and noncommercial).
- Agriculture, forestry, and horticulture.
- Strip mine reclamation and landfill cover for solid waste management.
- Shoreline stabilization and erosion control (fills, artificial reefs, submerged berms, etc.).
- Construction and industrial use (including port development, airports, urban, and residential).
- Material transfer (fill, dikes, levees, parking lots, and roads).
- Multiple purpose.

The proposed plan details the beneficial use of dredge material under the following three categories: habitat restoration/enhancement, construction and industrial use, and material transfer.

The selection of dredging equipment and method used to perform the dredging, as described in EM1110-2-5025 "Engineering and Design – Dredging and Dredged Material Disposal", depends on the following factors:

- Physical characteristics of material to be dredged.
- Quantities of material to be dredged.
- Dredging depth.
- Distance to disposal area.
- Physical environment of the dredging and disposal areas.
- Contamination level of sediments.
- Method of disposal.
- Production required.
- Type of dredges available.
- Cost.

Dredging is accomplished basically by two mechanisms:

- Hydraulic dredging--Removal of loosely compacted materials by cutterheads, dustpans, hoppers, hydraulic pipeline plain suction, and sidecasters, usually for maintenance dredging projects.
- Mechanical dredging--Removal of loose or hard, compacted materials by clamshell, dipper, or ladder dredges, either for maintenance or new-work projects.

Hydraulic dredges remove and transport sediment in liquid slurry form. They are usually barge mounted and carry diesel or electric-powered centrifugal pumps with discharge pipes ranging from 6 to 48 inches in diameter. The pump produces a vacuum on its intake side, and atmospheric pressure forces water and sediments through the suction pipe. The slurry is transported by pipeline to a disposal area.

Mechanical dredges remove bottom sediment through the direct application of mechanical force to dislodge and excavate the material at almost in situ densities. Clamshell or draglines are types of mechanical dredges. Sediments excavated with a mechanical dredge are generally placed into a barge for transportation to the disposal site.

5.2 Transportation of Dredged Material

Transportation methods generally used to move dredged material include pipelines or barges. Pipeline transport is the method most commonly associated with cutter head, dustpan, and other hydraulic dredges. Dredged material may be directly transported by hydraulic dredges through pipelines depending on a number of conditions. Longer pipeline pumping distances are feasible with the addition of booster pumps, but the cost of transport greatly increases. Barges are used in conjunction with mechanical dredges for transporting large quantities of dredged material.

5.2.1 Description of Open-Water Disposal

Open water (island creation or enhancement) or onshore disposal is the placement of dredged material at designated sites in rivers, lakes, estuaries, or oceans via pipeline. Such disposal may also involve appropriate management actions. Dredged material can be placed in open-water or onshore sites using direct pipeline discharge, or direct mechanical placement. Pipeline dredges are commonly used for open water disposal adjacent to channels. Material from this dredging operation consists of a slurry with a solids concentration ranging from a few grams per liter to several hundred grams per liter.

Confined disposal is the placement of dredged material within diked nearshore or upland confined disposal facilities (CDFs) via pipeline or other means. CDFs may be constructed as upland sites, nearshore sites with one or more sides in water, as island containment areas. Hydraulic dredging adds several volumes of water for each volume of sediment removed, and this excess water is normally discharged as effluent from the CDF during the filling operation. The amount of water added depends on the design of the dredge, physical characteristics of the sediment, and operational factors such as pumping distance. When the dredged material is initially deposited in the CDF, it may occupy several times its original volume. The settling process is a function of time, but the sediment will eventually consolidate to its *in situ* volume or less if desiccation (drying) occurs. Adequate volume must be provided during the dredging operation to contain both the original volume of sediment to be dredged and any water added during dredging and placement.

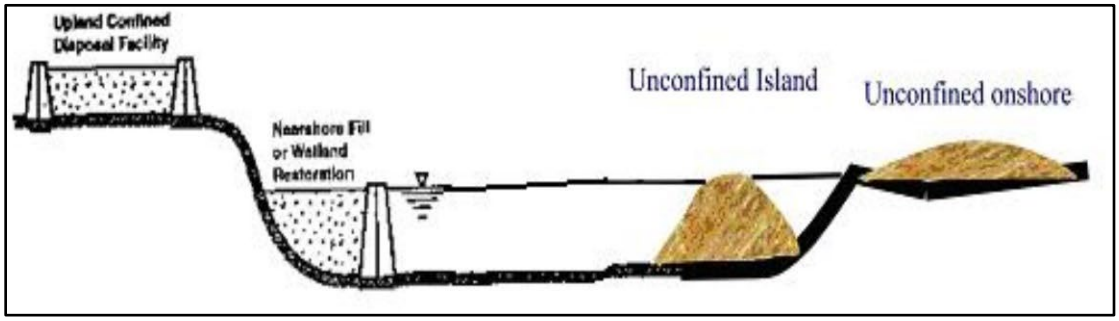

Figure 7. Types of Disposal Facilities

Unconfined disposal takes place either open water or marsh disposal with no confining or outflow control structures. An illustration of confined disposal areas can be found in the figure above. These dredge material disposal sites are depicted in the mapbook included with SEA.

5.3 Dredged Material Disposal Site Capacities, Analyses and Usage

5.3.1 Little Rock District

According to EM-1110-2-5025, upland placement areas must have a minimum of four feet of free board below the top of the containment levee (2 feet for average ponding depth and 2 feet of free board above the basin water surface). The following disposal sites (specified as placement areas or "PAs") were identified in the updated June 2018 30-Year Dredge Material Management Plan for Arkansas portion of the MKARNS in the Little Rock District (pp. 18-19). The Corps repaired PA 9.2 in 1989 after a blowout of the Containment Levee occurred during dredging operations in the summer of 1988. The blowout occurred near the northwest corner of the PA that subsequently flooded adjacent Refuge lands with dredged material. The rehabilitation raised the levee to elevation 180.0 feet, cleaned the exterior ditches, built exterior access ramps, and replaced the outlet flumes. SWL has not rehabilitated any of the PAs since 1994 according to the 2018 DMMP.

PA 9.2: PA 9.2 is 76 acres surrounded by a containment levee. It is located north of the White River, which turns east just before reaching the PA. PA 9.2 is on USFWS Refuge land. USFWS has stated that continued renewal of a special use permit for PA 9.2 to place dredge disposal is not a viable option for them due to the conflict between their mission and the land compatibility, and the Refuge Act of 1997. Several structures on the existing upland disposal site are in need of replacement or repair. The flumes are not working properly. The exterior channels need to be cleared to allow the surrounding Dale Bumpers National Wildlife Refuge lands to drain into the White River. Prior to 1963, the center of current PA 9.2 site was Hoop Pole Bay, an original dredged spoil placement area. The 1974 Operation and Maintenance Environmental Statement for MKARNS displayed the PA 9.2 as west of the Bay. In the 1964 Design Memorandum, the Corps agreed to contain the spoil areas with dikes. However, in 1975, the USFWS required the Corps in the SUP to construct retaining levees around the spoil areas, with ditches along the outside to contain the dredged material with the permit areas. Because PA 9.2 blocked the Refuge's interior drainage to the White River, the exterior ditches provided a drainage outlet. The PA 9.2 levee must be raised and its slope flattened to meet engineering standards. Its flumes, culverts, and exterior ditches require rehabilitation. The majority of the dredging needs are between NMs 9.2 and 8.6. In order to continue using PA 9.2, USACE must obtain permission from USFWS who is requiring that the Corps remove the dredge material and place it in the Mississippi.

PA 8.6: PA 8.6 is approximately 94 acres with a top of levee elevation of 165 feet on Refuge land. The White River runs along the north and northeast comer. USFWS has indicated continued renewal of a SUP for PA 8.6 to place dredge disposal is not a viable option for them due to the conflict between their mission and the land compatibility, and the Refuge Act of 1997. Several structures on the existing upland disposal sites are in need of replacement or repair. The flumes are not working properly, and the exterior ditches require clearing to allow proper draining of the Dale Bumpers National Wildlife Refuge. The levee requires raising and the slope adjusted. As is for PA 9.2, USFWS wants the Corps to remove the dredged material from PA 8.6 and place it in the Mississippi.

PA 7.0: PA 7.0 is approximately 80 acres with a containment dike on all sides. The White River runs along the western edge. USACE has a perpetual easement to place spoil material on the site. The site requires rehabilitation to meet engineering standards. If PA 7.0 is the sole upland PA, an increase in O & M cost would be incurred as the majority of the dredging needs are between NM 9.2 and 8.6. In order to use PA 7.0 for 30 years, its levee would require raising or it would need to be emptied to allow for

continued use. Each of these sites are depicted in Figure 8.

Figure 8. Little Rock District Dredged Material Management Plan Location of Disposal Sites

5.3.2 Tulsa District

The following sites are located in Oklahoma.

Material dredged in maintaining the channel to its authorized dimensions will be placed as part of a disposal plan in the designated disposal sites. A description and analysis of each site is provided below. The dredging and disposal sites were analyzed using technical guidance presented in the EPA and USACE *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.- Testing Manual* commonly referred to as the Inland Testing Manual, EPA regulation 40 CFR Part 230, (*Guidelines for Specification of Disposal Sites for Dredge or Fill Material*), and the USACE operation and maintenance regulations 33CFR Part 335-338. The Inland Testing Manual contains technical guidance for determining the potential for contaminant-related impacts associated with the discharge of dredge material in waters regulated under Section 404 of the CWA through chemical, physical, and biological evaluations. The manual uses a tiered process for analysis of dredge sites. At some sites sediment sampling and analysis for chemical containments has been performed where the guidance indicated the need for such sampling.

Site 18A: Located in Pool 18 on the left descending bank to the navigation channel between miles 444.6 and 445 continuous with the Port of Catoosa. This is an existing disposal site identified in the original project EIS with a constructed confined disposal dike with a minimum anticipated capacity of 300,000 C.Y. and 500,000 C.Y. in design capacity for 20-year plan. It is projected that this site will be used for future disposal activities co-partnered with the Port of Catoosa. Hydraulic dredging with discharge pipes ranging from 18 to 24 inch in diameter will be utilized to remove and transport sediment in liquid slurry

form through pipeline to the confined site. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. These findings were utilized to conclude that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. In 2018, this disposal site was estimated to contain 250,000 C.Y., representing 50 percent of the design capacity. In order to meet future disposal needs, the site will require renovation to regain a minimum capacity of 50,000 C.Y. At this time it is assumed that renovation is the preferred method to regain capacity, in lieu of constructing new disposal sites. Currently the site is moderately to heavily vegetated, and any renovation process would require vegetation removal in addition to the removal of the dredge material. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 18B: Located in Pool 18 on the right descending bank to the navigation channel between miles 444 and 445 continuous with the Port of Catoosa. This is an existing disposal site identified in the original project EIS with a constructed confined disposal dike with a minimum anticipated capacity of 300,000 C.Y. and 500,000 C.Y. in design capacity for 20-year plan. It is projected that this site will be used for future disposal activities co-partnered with the Port of Catoosa. Hydraulic dredging with discharge pipes ranging from 18 to 24 inch in diameter will be utilized to remove and transport sediment in liquid slurry form through pipeline to the confined site. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, there is no need for further testing of the site. In 2018, this site is estimated to contain 250,000 C.Y., representing 50 percent of the design capacity. In order to meet future needs, the site will require renovation to regain a minimum capacity of 50,000 C.Y. The site is heavily vegetated, and any renovation process would require vegetation removal in addition to the removal of the dredge material. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. These findings were utilized to conclude that there is no reason to believe that contaminants are present. No real estate acquisition is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 18C: Located in Pool 18 on the left descending bank to the navigation channel between miles 421.6 and 422.2 above Lock 18. This site is an existing unconfined disposal site identified in the original project EIS. It is projected that this site will be used for future disposal activities, and that mechanical dredging, such as Hydraulic/ Clamshell or Dragline dredging will be utilized to remove debris and sediment and dispose of it in the unconfined disposal site. The estimated quantity of dredged material from the problem area (Wharf area at Lock 18) through the year 2023 to be approximately 100,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition nor vegetation or dredge material removal is needed. Discharge pipes are also not required. Contracting actions are in progress to reevaluate this site's current capacity.

Site 17A: Located in Pool 17 on the left descending bank to the navigation channel between miles 420.8 and 421.6 below Lock 18. This is a disposal site described in the original project EIS consisting of a

confined disposal dike with two outlets and a minimum anticipated capacity and design capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. In 2018, this site is estimated to contain 300,000 C.Y., representing 50 percent of the design capacity. In order to meet future needs the site will require full renovation to the original design capacity of 600,000 C.Y. The site is heavily vegetated, and any renovation process would require vegetation removal in addition to the removal of the dredge material. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 17B: Located in Pool 17 on the right descending bank to the navigation channel between miles 401.6 and 402.6 above Lock 17. This is an existing disposal site identified in the original project EIS with a confined disposal dike with one single outlet and has an anticipated minimum capacity of 300,000 C.Y. and a design capacity of 500,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. In 2018, this site is estimated to contain 500,000 C.Y., representing 100 percent of the design capacity. In order to meet future needs, the site will require renovation to regain a minimum capacity of 300,000 C.Y. At this time the site is heavily vegetated, and any renovation process would require vegetation removal in addition to the removal of the dredge material. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 17B-1: Located in Pool 17 on the right descending bank to the navigation channel between miles 401.6 and 402.6 above Lock 17. This is an existing disposal site described in the original project EIS consisting of a confined disposal dike with one single outlet and has an anticipated minimum and design capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 401.6 to 403.5) through the year 2038 to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. This site is not projected to be expanded. No real

estate acquisition nor vegetation or dredge material removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16A & 16A-1: Both sites are located in Pool 16 on the left descending bank to the navigation channel between miles 400.5 and 401 below Lock 17. These are existing disposal sites identified in the original project EIS consisting of two confined disposal dikes, each with a single outlet and a combined anticipated minimum capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal sites. The estimated dredged material quantity from the problem area (mile 400 to Lock 17) through the year 2038 to be approximately 400,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. These sites are not projected to be expanded. No real estate acquisition nor vegetation or dredge material removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16B: Located in Pool 16 on the right descending bank to the navigation channel between miles 395 and 395.5 in the Three Forks area. This is an existing site described in the original project EIS consisting of a confined disposal dike with a single outlet and an anticipated minimum and design capacity of 400,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal sites. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. In 2018, this site was estimated to contain 225,000 C.Y. of dredged material, representing 56 percent of the design capacity. To meet future needs the site will require full renovation to meet future requirements of 600,000 C.Y. for the next twenty years. Currently the site is sparsely vegetated, and any renovation process would not likely require vegetation to the removal of the dredge material. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16C: Located in Pool 16 on the right descending bank of the Arkansas River at mile 395 in the Three Forks area. This is an existing disposal site described in the original project EIS. It is an unconfined disposal site with an anticipated minimum capacity of 100,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the unconfined disposal site. The estimated quantity of dredged material from the problem area (mile 394 to 395) through the year 2038 to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, there is no need for further testing of the site. Processes to regain capacity may include disposal of

dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16D: Located in Pool 16 on the right descending bank to the navigation channel between miles 394 to 394.7 in the Three Forks area. This is an existing disposal site identified in the original project EIS. It is an unconfined disposal site with an anticipated minimum capacity of 100,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the unconfined disposal site. The estimated quantity of dredged material from the problem area (mile 394 to 394.7) through the year 2038 to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, there is no need for further testing at this site. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16E: Located in Pool 16 on the left descending bank to the navigation channel between miles 393 and 394 in the Three Forks area. This site was constructed as a confined dike disposal site and will handle a capacity of 1,500,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 393 to 394) through the year 2038 to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, there is no need for further testing at this site. In 2018, the site was estimated to contain 25,000 C.Y., representing 15 percent of the design capacity. In order to meet future needs, the site will require renovation to regain a minimum capacity of 25,000 C.Y. The site is sparsely vegetated, and any renovation process would not likely require vegetation removal to renovate the site to full design capacity. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition nor dredge material removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16F: Located in Pool 16 on the right descending bank to the navigation channel between miles 392.8 and 393.3 at the Hwy 62 Bridge. This is a new, yet to be constructed site. The site will be constructed as a confined dike disposal site and will handle a capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities co-partnered with the Port of Muskogee, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 392.8 to 393.3) through the year 2023 to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, additional sampling will not be required for disposal at this site. This site is jointly owned by the Port of Muskogee and the USACE. The total area is approximately 20 acres and Real

estate action may be required to design this site. The Port of Muskogee foresees beneficial use of the dredged material for future expansion of the port. This site is not projected to be expanded. Vegetation or dredge material removal is not required. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16G: Located in Pool 16 on the left descending bank to the navigation channel between miles 393 and 394 in Three forks area. This is an existing disposal site identified in the original project EIS. The site is a confined rock dike disposal site with an anticipated minimum capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 393 to 394) to the year 2038 to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, additional sampling will not be required for disposal at this site. Processes to regain capacity may include disposal of dredged material through the competitive bid process, a disposal contract, or a combination of both. This site is not projected to be expanded. No real estate acquisition nor vegetation or dredge material removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 16X (Spaniard Creek): This area was constructed in Pool 16 on the left descending bank at approximate mile 375 in the vicinity of the Spaniard Creek Public Use Area. This is an existing open water disposal location which used dredged material to construct a migratory bird nesting island. The estimated quantity of dredged material from the problem area (mile 393) to the year 2038 to be approximately 600,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. Therefore, additional sampling will not be required for disposal at this site. This site is not projected to be expanded. No real estate acquisition nor vegetation or dredge material removal is needed. Discharge pipes are also not required. Contracting actions are in progress to reevaluate this site's current capacity.

Site 15A & 15A-1: These sites are located in Pool 15 between miles 353 and 356 Canadian River Confluence and Stoney Point. The two sites were identified in the original project EIS. It is projected that these sites will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing islands**.** Each island is to be an oval or teardrop shape, approximately four acres in area with the length greater than the width, and about 6' above the normal high water mark. Each island will contain approximately 50,000 C.Y. of dredging materials, and be used for migratory bird sandbar island habitats. The estimated quantity of dredged material from the problem area (mile 353 to 356) through the year 2038 to be approximately 100,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. Design of confined islands with silt fences for

sandbar island habitats may be required and hydrographic surveys may be needed. These sites are not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 15B & 15B-1: These sites have been constructed as designated Open Water Dredged Disposal Sites (OWDDS) serving as migratory bird sandbar habitat islands. They are located in Pool 15 between miles 348 and 349.5 at Sandtown Bottom area and have proven highly successful for historical least tern nesting. It is projected that these sites will continue to be used for future disposal activities, and that hydraulic dredging using direct pipeline discharge will be utilized to place dredged material in the designated open water sites. The estimated quantity of dredged material from the problem area (mile 348 to 349.5) through the year 2038 to be approximately 500,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. Data for sediment sampling at this site indicated no contaminants above acceptable levels. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. These sites are not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Discharge pipes are also not required. Contracting actions are in progress to reevaluate this site's current capacity.

Site 15C & 15C1: These sites are located in Pool 15 between miles 6.8SBC and 7.4SBC at Sans Bois Creek Channel. The two existing islands were identified in the original project EIS**.** It is projected that these sites will be expanded (Unconfined Islands) for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing islands. The estimated quantity of dredged material from the problem area (mile 6.9SBC to 7.4SBC) through the year 2038 to be approximately 200,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 15D & 15E &15F: These sites are located in Pool 15 between miles 8SBC and 11SBC upstream of HWY 9 to Turning Basin on Sans Bois Creek Channel. The three existing islands are identified in the original project EIS. It is projected that these sites will be expanded (Unconfined Island) for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing adjacent islands. The estimated quantity of dredged material from the problem area (mile 8BC to 11SBC) to the year 2038 to be approximately 300,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to

believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 13A: This site is located in Pool 13 on the right bank adjacent to the navigation channel between miles 318.3 and 319.1 below Lock 14. This is a new, yet to be constructed site. This site will be constructed as a confined disposal site to handle a minimum capacity of 500,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 317.2 to 319.6) to the year 2038 to be approximately 200,000 C.Y. Analysis of the site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. The dike needs to be designed and constructed. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 13B: The site is located in Pool 13 on the right descending bank to the navigation channel between miles 315 and 317.2 Peno Point below Lock 14**.** This is an existing unconfined disposal site identified in the original project EIS. The dredged materials in this area are heavy sand and gravel and can be disposed of over the bank without use of dikes. The existing contours provide adequate containment. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing unconfined disposal site. The estimated dredged material quantity from the problem area (mile 315 to 317.2) through the year 2038 to be approximately 500,000 C.Y. Analysis of the site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact the that proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 13C: This site is located in Pool 13 on the right descending bank to the navigation channel between miles 311.5 and 313.9 in the Camp Creek area. This is an existing unconfined disposal site identified in the original project EIS. The dredged materials in this area are heavy sand and gravel and can be disposed of over the bank without use of dikes. The existing contours provide adequate containment. It is projected

that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing site over the banks into the existing unconfined disposal site. The estimated quantity of dredged material from the problem area (mile 311.8 to 313.5) to the year 2038 to be approximately 500,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Further, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 13D: The site is located in Pool 13 on the right descending bank to the navigational channel at mile 308.8 to 310 at the confluence of the Poteau River. This is an existing site identified in the original project EIS. This site will handle a minimum capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the adjacent existing disposal site. The estimated quantity of dredged material from the problem area (from the confluence of the Poteau River to the Turning Basin, PR mile 0.0 to 2.0) through the year 2038 to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Therefore, there is no need for further testing of the site. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

Site 13E: The site is located in Pool 13 on the left descending bank to Poteau River Turning Basin PR mile 1.7 to 2.0. This is a new, yet to be constructed site, and would be constructed as a confined disposal site to handle a minimum capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities, and that hydraulic dredging with discharge pipes ranging from 18 to 24 inch diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 1.7 to 2.0) through the year 2038 to be approximately 200,000 C.Y. Analysis of the site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from sediment sampling at this site indicated no elevated contaminants in the sediment. In addition, the Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Therefore, there is no need for further testing of the site. This site is not projected to be expanded. No real estate acquisition nor vegetation removal is needed. Contracting actions are in progress to reevaluate this site's current capacity.

5.3.3 Future Site Development

Future methods of shoal removal and disposal will be investigated in the following areas:

- Investigate a non-dredge alternative known as flushing in the area between Hwy 62 Bridge mile 392.5 and 393 (proposed site 16F)
- Investigate a non-dredge alternative known as flushing in the area between mile 400 to Lock 17 Chouteau (between site 16A and 16A-1).
- Investigate enlarging existing islands, and use maintenance dredged material to create new sandbar islands adjacent to the channel in the Canadian River Confluence mile 353 to 356 and in the Sans Bois Creek channel mile 6.9SBC to 11SBC.
- Utilize a 2017 Memorandum of Understanding (MOU) with the Port of Muskogee (Port) to transfer some dredged material from nearby reaches in the Three Forks area to the Port for beneficial use. Dredged material would be pumped directly to the Port's existing disposal facility, thereby preserving some capacity in USACE-managed disposal areas in the Three Forks area.

Plans to use these methods will be evaluated for implementation in the next couple of years.

6 River Training Structures

River training structures are man-made structures designed and constructed in a river reach to modify the hydraulic flow and sediment response of a river. Some examples of this type of work include dikes, chevrons, bendway weirs, and bank revetments. These engineered structures help to mitigate the cost and impact of dredging as well as ensure a safe, sustainable alignment of the navigation channels. Although approximately 85-90 percent of the Arkansas River is currently at a 12-foot depth or greater, sustaining that depth and alignment for hundreds of miles of an alluvial river system requires construction of river training structures inside and outside of that 10-15% footprint that is not currently at 12-feet of depth.

A nearly 20-year gap between the original feasibility level design and today's economic update in tandem with a number of record floods have altered the river bed of the Arkansas River significantly in many locations. Additionally, 20 more years of channel performance provides additional context and insights into the relative risks and magnitudes of challenging reaches along the system. As such, the expected performance of the original feasibility design would be different from today's perspective. A full conceptual update accounting for recent river conditions and commensurate with the original level of detail in Feasibility with current technology was completed.

While the generally accepted rules of river engineering have not changed radically, the amount, type and detail of data on the river more readily available for use in the design process has drastically changed. Technologies such as multi-beam hydrographic survey for the collection of bathymetry and acoustic Doppler current profilers for measurements of velocity of flow have immensely advanced the ability of river engineering. Additionally, advances in numerical modeling that leverage many of these denser data sets have made a risk-informed, cyclical design approach more attainable in terms of time and cost. Investments in these data collection and modeling efforts increase the confidence in the design and often result in a cheaper construction cost.

A qualitative assessment of the Feasibility designs was performed by comparing available survey data, referencing historical dredging records, investigating the original MKARNS design documents, and eliciting river engineering experience and institutional knowledge. The dike fields for reaches proposed for river training structure modifications in Feasibility were divided into "Tiers" based upon their respective risks, uncertainties, and complexities. Based upon these rankings, data collection, and modeling priorities were developed and executed. After designs were updated or informed with new data and modeling results, the original qualitative assessment and tier assignment were updated by individual structure as part of the Masterplan. The definition of the "Tiers" is described as follows (note that risk of shoaling is a qualitative assessment of existing depths and historical data):

- Tier 0 – Already constructed to 12-ft design, noting for record.
- Tier 1 – Construction in locations of high risk of shoaling, existing depths are 9-12 feet, or required downstream protection feature.
- Tier 2 - Construction in locations of moderate risk of shoaling, existing depths are 12-15, or downstream protection feature.
- Tier 3 - Construction in locations of low risk of shoaling, existing depths are ~15 feet+, or downstream protection feature.
- Tier 4 - Construction in locations of potential risk of shoaling after other Tiers, existing depths are 12-15 feet, or downstream protection feature.
- Tier 5 - Construction in locations of potential risk of shoaling after other Tiers, existing depths are ~15 feet+, or downstream protection feature.

6.1 River Training Structures Assumptions for the 2005 Arkansas River Navigation Study (ARNS) Feasibility Report

The Arkansas River navigation channel consists of dikes and revetments (river training structures) that help constrict the channel and stabilize riverbanks to prevent them from migrating. The original design (PDM 5-3) estimated the equilibrium bed profile for the 250-foot width navigation channel from Arkansas Post to Dardanelle would provide a minimum of 12-feet below the navigation pools, provided all the river training structures were constructed. This original design accounts for the high percentage of the system that currently provides a 12- foot channel depth. The conceptual design criteria for setting the elevations and lengths of the river training structures was based on the original analytical channel studies and physical model studies that were completed in the late 1950's through the early 1970's. These original studies indicated that the channel trace width (channel bank to bank, dike to dike, or dike to bank) on the Arkansas River should typically range from 1000 to 1500 feet to maintain the required navigation depths and widths. However, in some of the upper reaches of the pools, the trace widths had to be reduced to 600 feet to obtain the needed channel depth. Original design had the river training structures sized to contain flows of 70,000 cfs at the trace width, and to contain flows of 100,000 cfs at the location where the river training structures slope back to the channel bank line. Adopting the original design criteria for this study, it was decided to initially raise existing structures so as to contain at least the 70,000 cfs profile and/or to contract the channel by extending existing structures or adding new structures based on the existing reach's trace width.

The 50 percent Annual Exceedance Probability discharge was used as the design flow. This is typical practice to design for in alluvial river systems as a representation of the channel forming discharge. Channel forming discharge is a concept based on the idea that for alluvial channel dimensions - a single

steady flow rate over ample time would produce channel dimensions equivalent to those shaped by a long-term series of flow rates. The 50 percent AEP used in feasibility for Van Buren, Dardanelle, and Little Rock were 150,000 cfs, 190,000 cfs, and 195,000 cfs respectively.

A two-dimensional hydraulic model (CCH2ED) of two miles of river from Navigation Mile 45 to Navigation Mile 43 was developed to determine correlations of design criteria (mainly percent increase in bed shear stress). These criteria were translated as targets in the one-dimensional hydraulic models (HEC-RAS). Once the river training structures input into other reaches within the one-dimensional hydraulic model and the percent increase in bed shear was similar to the percent increase as the two-dimensional model, the design was considered complete. This correlation of bed shear versus bed scour was based on the assumption that the gradations of the materials from the bed sediment samples taken by the USGS in September, October, and November of 2003 were similar. This was the case as the sediment sample analyses showed that the average bed materials were classified as a medium sand for Pools 2, 3, 4, 5, 6 and 7. The D50 particles ranged from about 0.35 mm to 0.50 mm for Pools 2, 3, 4, 5, 6, and 7. Most of the locations upstream from Pool 7 had mixtures of medium and course sand, and thus, the correlation of the 2-D model results may have overestimated the scour. However, since the correlation is based on a percent change from the existing channel bed scour and the current structures are similar to the lower river reaches, the correlation is not unrealistic. For 2D modeling the hydraulic output and results for shear stress is an average shear stress across each face of the cells/nodes then interpolated between faces. For 1D modeling the cross section is broken into user defined slices then average values are computed for each slice. Values are interpolated between cross sections using the cross section interpolation surface. The density of the computation points and underlying data in 2D hydraulic output are greater than in 1D model output allowing a more definitive analysis of the trends can be determined.

The river training structures proposed in feasibility were expected to have minimal impact on the main channel stability and the major tributaries. The river training structures (and corresponding dredging) were projected to lower the channel thalweg in localized reaches as much as three to six feet in order to maintain a 12-foot channel depth. The one-dimensional model indicated negligible impacts to elevations and velocities between the pre- and post-project condition. The lowering of the channel will be localized, several hundred feet from either bank line, and head-cutting will not migrate very far upstream due to already existing deeper thalweg elevations that exist.

6.2 River Training Structures Assumptions for the 2023 PACR Update

The 2023 update sought to comprehensively evaluate and update the original Feasibility design by leveraging a weight of evidence approach. This weight of evidence approach included researching the original design assumptions and forecasts, interviews and discussions with current and retired USACE personnel and subject matter experts, analyzing historical dredging records and channel performance, updating bed sediment samples, collecting more detailed bathymetric surveys, and developing 2D hydraulic models. Each of these elements provides context for any given reach to assist in prudent adjustment and changes to the design. Because the data collection and 2D hydraulic model development can take a considerable amount of time given the 445-mile length of the navigation system, both were prioritized based upon reaches or pools which had large quantities of dredging or rock structures proposed, were uniquely complex, or were likely candidates for initial construction to begin. This strategy allowed the team to update the design with many parallel activities to update the most costly and critical features of the project in the greatest amount of detail with other less costly or critical features updated in

a level of detail commensurate with their overall functionality and impact to project quality and cost. For example, Pools 5 and 8 were identified as locations that initial construction could begin with significant benefits to the navigation channel while minimizing risks should overall project funding cease and were, thus, prioritized first. These risks were considered minimized because the problem areas within Pools 5 and 8 have longer distances between them with little dredging history so it was reasonable to assume that partial construction of river training structure features in those pools would not result in immediate deposition of material in a location that would inhibit navigation. Pools 2, 7, and 10 are complex with rich dredging histories and significant quantities of dredging for the deepening of the channel and were prioritized accordingly. Pools such as 3, 4, and 6 were not highly prioritized for detailed survey or modeling because very little dredging and rock structure designs were required. Pools 17 and 18 are not conducive to a successful implementation of river training structure due to the narrow width and shale bottom.

Other assumptions made for the 2023 update to river training structures were:

- River training structures built after feasibility in the Little Rock District were removed from the quantity computations.
  - Some structures benefit both the 9-foot authority as well as the 12-foot authority, and a few structure designs were constructed after feasibility leveraging the 12 foot channel designs for maintaining a 9 foot depth in problem areas.
- The "Existing Conditions" was assumed to be a fully repaired system of 9-foot river training structures if other data could not be found to invalidate that assumption.
  - Post-flood repairs and priorities are ongoing with flood supplemental funds and O&M funds.
- The relative difference comparison of sediment transport capacity between existing and proposed conditions is an adequate measure of local performance.
- The quantities of rock required could be computed by with basic spreadsheets methods already leveraged for routing O&M
- Comparisons of CAD quantities to the spreadsheets would validate and improve contingency assumptions.
- Assigning contingencies by station along the structure based upon the surveyed data source and date of survey along with the potential dynamic nature of the river in the vicinity better captures the uncertainties in the data while also creating a priority list for future data needs.
- Additional mobile bed analysis will better inform the forecast of future scour and deposition of the proposed designs as well as the cause and effect of different orders of construction.

Appendix E of the 2005 feasibility report lists the number of existing in-water dike and weir structures on the MKARNS in both Arkansas and Oklahoma. The table below is derived from information from that appendix. The number of existing structures totals 1,107 in Arkansas and the number of existing structures in Oklahoma totals 207 for a total along the MKARNS of 1,314. The assumption for this report is that these structures were constructed under the initial 9-foot authorization.

Table 6. Existing Structures on the MKARNS

Arkansas In-Water Structures	
Pool	Number of Structures
2	159
3	92
4	76
5	84
6	94
7	148
8	107
9	111
10	86
12	81
13	69
Arkansas Subtotal	**1,107**
Oklahoma In-Water Structures	
Pool	Number of Structures
13	70
14	93
15	20
16	23
18	1
Oklahoma Subtotal	**207**
Grand Total	**1,314**

The feasibility report listed the following as being necessary for deepening of the channel and represents a seven percent increase in the number of new dikes and weirs and a 0.3 percent increase in the number of new revetments along the MKARNS. These additional and modified structures were identified to address changed conditions relating to maintenance as well as help with deepening of a 12-foot channel. The number of new and modified dikes and weirs are:

- 1-Mouth to Pine Bluff — 4 new and 21 modified dikes and weirs
- 2-Pine Bluff to Little Rock — 30 new and 4 modified dikes and weirs
- 3-Little Rock to Dardanelle — 5 and 34 modified dikes and weirs
- 4-Dardanelle to Fort Smith — 6 and 28 modified dikes and weirs
- 5-Fort Smith to Muskogee — 44 new and 0 modified dikes and weirs
- 6-Muskogee to Catoosa — 0 new or modified dikes and weirs

Total MKARNS — 89 new and 87 modified dikes and weirs

The following table lists the number of existing revetment structures identified in the 2005 EIS. These include 219 in the Little Rock District and 76 in the Tulsa District.

Table 7. Revetments in the Navigation Channel Depth Maintenance on the MKARNS

Segment	Number of Existing Structures
Arkansas	
1-Mouth To Pine Bluff	57
2-Pine Bluff to Little Rock	49
3-Little Rock to Dardanelle	64
4-Dardanelle to Fort Smith	49
Arkansas Total	**219**
Oklahoma	
5-Fort Smith to Muskogee	34
6-Muskogee to Catoosa	42
Oklahoma Total	**76**
MKARNS Total	**295**

The feasibility report identified the following for deepening of the channel. The number of new and modified revetments are:

- 1-Mouth to Pine Bluff 0 new and 9 modified revetments
- 2-Pine Bluff to Little Rock 1 new and 0 modified revetments
- 3-Little Rock to Dardanelle 0 new and 1 modified revetment
- 4-Dardanelle to Fort Smith 0 new and 6 modified revetments
- 5-Fort Smith to Muskogee 0 new or modified revetments
- 6-Muskogee to Catoosa 0 new or modified revetments

Total MKARNS 1 new and 16 modified revetments

The following table lists the number of structures to be raised, extended, or added in both Arkansas and Oklahoma by pool based on the 2023 update. Stated earlier, additional and modified structures address changed conditions relating to maintenance as well as help with deepening of a 12-foot channel. Table 9 lists rock quantities from the 2005 feasibility report and from the 2023 update. These river training structures are depicted in the mapbook included with SEA.

Table 8. Structures to be Raised, Extended, or Added in Arkansas and Oklahoma in 2023 Update

	Structure Type		
Pool	**Dike**	**Revetment**	**Pool Total**
2	29	2	31
3	3		3
5	6		6
7	12		12
8	10	4	14
9	3		3
10	19		19
12	12	2	14
15	5		5
16	5		5

	Structure Type		
Pool	**Dike**	**Revetment**	**Pool Total**
Total	**104**	**8**	**112**

Table 9. Summary of Rock Quantity Changes

Pool	2004 Rock (raw tons)	2023 Rock (tons w/contingency)	Change from Feasibility
-1	0	0	0
0	0	0	0
1	0	0	0
2	722,839	414,191	-308,648
3	105,372	14,741	-90,631
4	86,889	0	-86,889
5	591,573	272,647	-318,926
6	0	0	0
7	509,921	241,532	-268,389
8	107,519	318,696	211,177
9	106,258	61,851	-44,407
10	163,708	230,808	67,100
12	286,639	250,561	-36,078
13	102,803	0	-102,803
14	0	0	0
15	279,174	157,719	-121,455
16	56,043	14,425	-41,618
17	0	0	0
18	0	0	0
Total	**3,118,738**	**1,977,171**	**-1,141,567**

7 References

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