

BCA TECHNICAL MEMORANDUM

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM (MKARNS) MOORING MODERNIZATION PROJECT

MKARNS WATERWAY, OKLAHOMA

EXECUTIVE SUMMARY

The McClellan-Kerr Arkansas River Navigation System (MKARNS) Mooring Modernization Project provides a benefit-cost ratio (BCR) of **3.17** and an **internal rate of return of 10.79 percent**. At this rate, the proposed **total capital project cost of \$26.27 million** (2018\$) will produce a **positive net user benefit of about \$52.85 million (NPV)** over 20 years.

The Benefit Cost Analysis (BCA) identified that the Project will significantly improve safety, reduce operations and maintenance (O&M) costs overtime, and provide economic benefits to the local Project region. The MKARNS Mooring Modernization Project will construct modernized mooring infrastructure at three Port locations the Tulsa Port of Catoosa, Port of Muskogee, and in the Grand River which will serve Oakley's Port 33 located along the waterway system in Oklahoma. Modernized mooring infrastructure will replace obsolete anchors with improved tie down solutions in the waterway that will enable safe harbor for mariners, improved reliability in the event of a flood, and reduce ongoing maintenance costs for each port location. Over the life of the Project, these investments will produce the following benefits:

- **Operations & Maintenance** **\$70,300 net present value (NPV)**
- **Increased Safety** **\$24.4 million (NPV)**
- **Economic Benefits** **\$15,300 (NPV)**
- **Environmental Protection** **\$28.3 million (NPV)**

The Benefit Cost Analysis (BCA) was prepared in accordance with the [2020 FHWA BCA Guidance for Discretionary Grant Programs](#) using total quantifiable project costs and benefits adjusted for inflation, then discounted to reflect the time value of money.

METHODOLOGY

The Benefit Cost Analysis (BCA) for the McClellan-Kerr Arkansas River Navigation System (MKARNS) Mooring Modernization Project was prepared following 2020 FHWA BCA Guidance for Discretionary Grant Programs.

In summary, the BCA was created by:

1. Identifying Project benefits and costs for improvements versus a no-build scenario;
2. Deriving current and forecasted use levels for the baseline and the “build case”;
3. Denominating all benefits and costs in constant 2018 dollars;
4. Assuming an inflation rate of 3 percent annually;
5. Discounting dollar amounts by 7 percent to reflect the time value of money; and
6. Setting an appropriate analysis period of 20 years for the Project’s construction and subsequent operational service.

PROJECT OVERVIEW

The McClellan-Kerr Arkansas River Navigation System (MKARNS) Mooring Modernization Project (the Project) is located in northeast Oklahoma along the McClellan-Kerr Arkansas River Navigation system (MKARNS). The MKARNS is a 445-mile long marine highway which consists of the Verdigris, Arkansas, and White Rivers. This waterway serves a 12-state region and is the most westerly inland ice-free waterway 365 days a year. The two largest public ports on the MKARNS in Oklahoma consist of the Tulsa Port of Catoosa and the Port of Muskogee. In addition, Oakley’s Port 33 is the largest private port in Oklahoma. Together these ports consist of **3,600 acres of industrial park, employ nearly 9,000 workers, and process approximately 5.5 million tons of cargo annually.**¹ These ports are an important economic engine for the State of Oklahoma, and it is vital for infrastructure at these locations to be maintained to ensure Oklahoma can continue to serve as a key player in freight movement by waterway. The Project area is displayed below in **Figure 1**.

¹ [MAKRNS Update \(2018\)](#)

FIGURE 1: OKLAHOMA PORTS - PROJECT AREA



The Project will implement the first of two phases of investment in mooring infrastructure improvements at all three port locations. Moorings are used to provide vessels secure tie down infrastructure to enable safe harbor for mariners, improved reliability in the event of a flood, and reduced ongoing maintenance costs at ports. The three ports have a variety of existing tie down structures including anchor piles, deadman anchors and dolphin moorings. An anchor pile is a vertical piling driven into the bottom of the river with a chain, rope or wire to secure barges. Deadman anchors consist of shore lines connected to buried weights that are installed on dry land. Dolphin moorings in the waterway today consist of a combination of vertical and horizontal piles. All of these structures have been in place since 1971 when the MKARNS opened in Oklahoma, **nearly 50 years ago**. The structures are deteriorating and obsolete as they have reached their intended design life. Because of this, the existing structures create a risk for potential failure which could lead to damages of infrastructure (dams and bridges) and cause the waterway to close while damages are repaired.

In 2019, northeast Oklahoma experienced a damaging flood event that **doubled water flows experienced from the past historical flood in 1986**. The 2019 flood yielded flows of more than **675,000 cubic feet per second (cfs)**, a measurement of the flow rate of water.² During this event, two barges broke loose from the Port of Muskogee and floated downstream where they struck a dam structure at Webbers Falls Lock and Dam before they sank. The dam structure properly maintained its integrity, but without repair to existing

² [National Waterways Conference \(2019\)](#)

infrastructure there is a risk of this occurring again with a worse outcome. For **2.5 months the MKARNS system was closed** because of high water flooding, unsafe water flows and dredging needs. Beyond that time, the system **remained closed for an additional 1.5 months** while the excavation and salvage of the sunk barges occurred. Complete disruption of operations on the MKARNS **costs its beneficiaries \$2 million per day** and **could result in a daily loss of \$20.7 million in Gross Domestic Product** within the State of Oklahoma.³

These ports understand the importance and need to repair existing infrastructure to minimize future damage or safety risks that could occur from the existing obsolete infrastructure. The primary goal of this Project is to ensure safe and efficient freight movement, as well as to provide long-term vitality of the waterway.

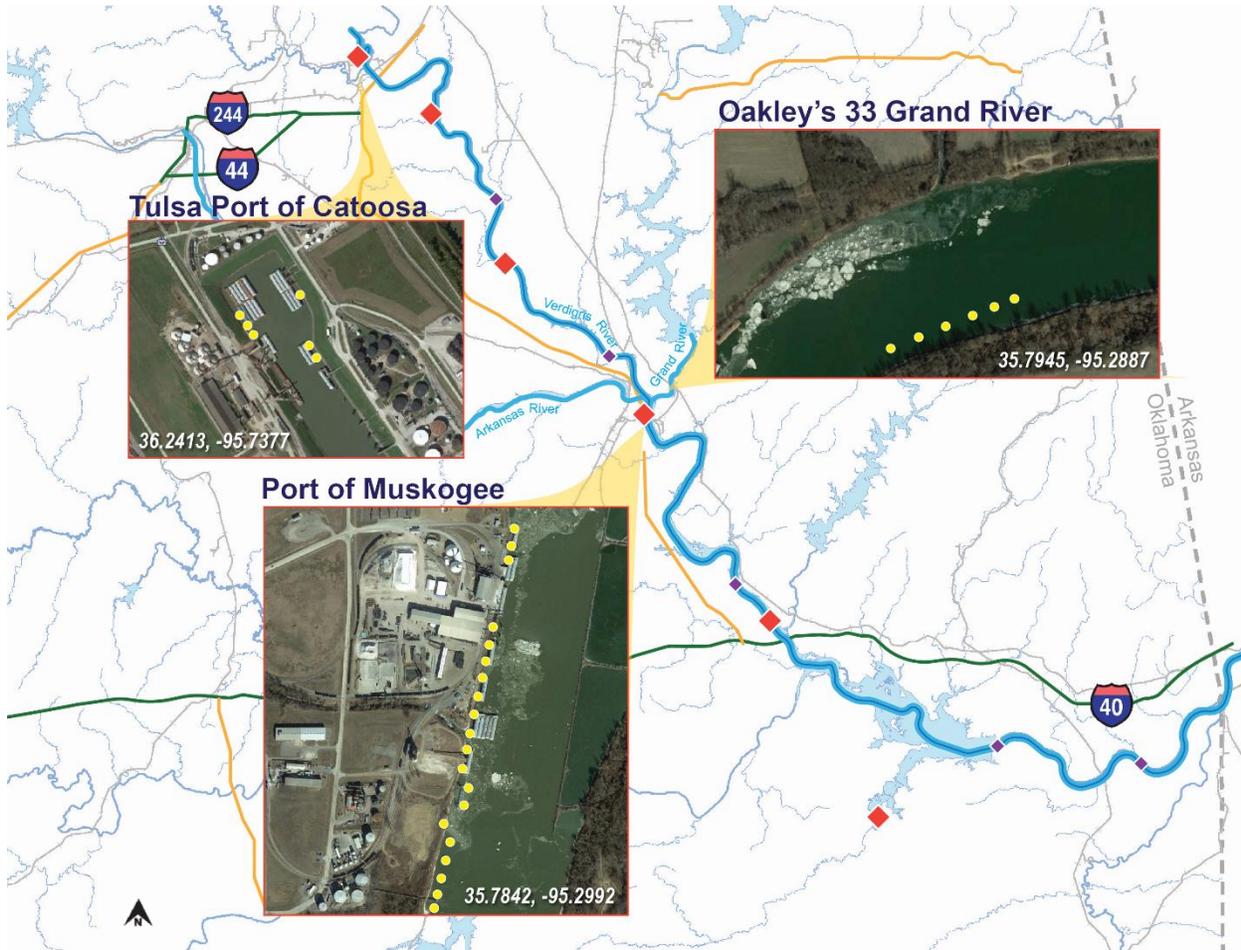
The proposed Project consists of key improvements for each of the three Port locations as follows:

1. Replacing 6 dolphin structures with 6 monopile moorings at the Tulsa Port of Catoosa
2. Replacing 20 dolphin structures with 20 monopile moorings at the Port of Muskogee
3. Replacing 10 dead-man anchors infrastructure with 6 monopile moorings at Oakley's Port 33 along the Grand River

The delegations of mooring construction at each Port location is shown below in **Figure 2**.

³ [MAKARN Update \(2018\)](#)

FIGURE 2: PROPOSED IMPROVEMENTS



PROJECT BENEFICIARIES

The Project will benefit the Tulsa Port of Catoosa, Port of Muskogee, and Oakley's Port 33 as well as local residents, workers and businesses that rely on the MKARNS in Oklahoma to continue to provide jobs and economic growth for the region.

The proposed improvements will increase safety, reduce operations and maintenance (O&M) costs and decrease emissions by encouraging freight movement by the waterway. This is a nationally significant marine highway that serves a 12-state region and at least 42 countries have commercial transactions via the MKARNS. Oklahoma produces and supplies a variety of products including, but not limited to, agriculture, chemical fertilizers, petroleum, and iron and steel throughout the U.S. and internationally. Collectively, the three port locations process nearly 5.5 million tons of cargo annually.⁴ The mooring infrastructure provided by the Project is vital for Oklahoma to remain a key component of the regional and national freight transportation system. The Project will preserve the waterway's economic vitality and prepare for future freight traffic demand.

PROJECT BENEFITS

The Project will provide substantial benefits by improving safety, increased capacity, reduced emissions, operations and maintenance savings and economic vitality for the surrounding area. These benefits are quantified in the following subsections.

Benefits were calculated using data provided by the Oklahoma Department of Transportation (ODOT) and corresponding Port Partners (Tulsa Port of Catoosa, Port of Muskogee, and Oakley's Port 33). Calculations for all figures as well as sources cited can be found within the BCA spreadsheets that are included with the INFRA grant submittal. The benefits are based upon the reduced operating capacity of the ports if the dolphin structure moorings are not replaced as they are nearing their end of life, the monopiles can then replace that capacity lost or prevent that loss.

⁴ [Waterway Fact Sheet \(2019\)](#)

SAFETY BENEFIT

The Project produces **safety savings of \$24.4M (NPV)** by **reducing the crash risk by 34 percent** over the 20-year lifespan of the project. This is calculated by assuming that the cargo which is not shipped on the MKARNS due to the reduced capacity from degraded moorings is reduced by 25% total volume and then 90% of the goods which must change modes are shifted to rail and the remainder is shifted to truck. The capacity is restored with the building of the monopile moorings.



The difference in safety benefits between the No-Build and Build Scenarios projected over a 20-year period are shown in **Tables 1 and 2**.

TABLE 1: SAFETY BENEFITS (NO BUILD)

Year	No-Build Scenario					
	Waterway Ton-Miles	Diverted Rail Ton-Miles	Diverted Truck Ton-Miles	Fatalities	Injuries	Crash Cost
2019	2,620,153,808	0	0	0.06	0.10	\$ -
2020	2,620,153,808	0	0	0.06	0.10	\$ -
2021	2,620,153,808	0	0	0.06	0.10	\$ -
2022	2,620,153,808	0	0	0.06	0.10	\$ -
2023	2,620,153,808	0	0	0.06	0.10	\$ 593,539
2024	2,620,153,808	0	0	0.06	0.10	\$ 593,539
2025	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2026	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2027	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2028	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2029	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2030	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2031	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2032	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2033	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2034	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2035	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2036	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2037	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2038	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2039	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2040	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2041	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
2042	1,728,186,554	602,077,896	66,897,544	0.47	5.67	\$ 5,463,188
						Total \$ 99,524,454

TABLE 2: SAFETY BENEFITS (BUILD)

Year	Build Scenario					
	Waterway Ton-Miles	Diverted Rail Ton-Miles	Diverted Truck Ton-Miles	Fatalities	Injuries	Crash Cost
2019	2620153808	0	0	0.06	0.10	\$ -
2020	2,620,153,808	0	0	0.06	0.10	\$ -
2021	2,620,153,808	0	0	0.06	0.10	\$ -
2022	2,620,153,808	0	0	0.06	0.10	\$ -
2023	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2024	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2025	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2026	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2027	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2028	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2029	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2030	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2031	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2032	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2033	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2034	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2035	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2036	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2037	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2038	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2039	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2040	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2041	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
2042	2,434,327,297	125,432,895	13,936,988	0.14	1.26	\$ 1,608,049
Total				Total	Total	\$ 32,160,983

These projections are based on the planned improvements. The calculations assumed that, based on anecdotal evidence from port directors, 90% of cargo would be diverted to rail, 10% would be diverted to trucks, and that 25% of diverted goods are not moved. They were derived by quantifying 20 years of crash risk to determine the increased crash risk cost that could be improved through the proposed improvements included within this Project. The safety benefits were calculated for each freight mode by getting the national ton-miles and the national number of injuries and fatalities. These numbers were gathered from the Bureau of Transportation Statistics (BTS). The expected annual fatalities and injuries were calculated for both the no-build and build conditions. Safety tables were developed using information contained within the document National Waterways Foundation, Waterways: Working for America, February 2017 and ODOT’s 2018 MKARNS Data”

ECONOMIC COMPETITIVENESS

The Project will **reduce travel time savings with a discounted benefit value of \$15,300 (NPV).**

\$15,300
ECONOMIC BENEFIT (NPV)

Improvements will save approximately \$42,100 by 2042, providing economic competitiveness by decreasing crash risk, reducing diverted rail ton-miles, diverted truck ton-miles, and spillage. Assumptions were based on anecdotal evidence from port directors that 90% of cargo would be diverted to rail, 10% of cargo would be diverted to trucks, and that products weigh the same as water (8.34 lbs). Spillage tables for barge, rail, and truck were sourced from Waterways: Working for America, February 2017 by the National Waterways Foundation.

Table 3 below shows the reduction in lost good value from the Project on an annual basis as a summary of the calculations and the cumulative benefit.

TABLE 3: LOST GOOD VALUE SAVINGS

Year	No Build Scenario						Build Scenario					
	Waterway Ton-Miles	Diverted Rail Ton-Miles	Diverted Truck Ton-Miles	Spillage (Gallons)	Spillage (Tons)	Lost Good Value	Waterway Ton-Miles	Diverted Rail Ton-Miles	Diverted Truck Ton-Miles	Spillage (Gallons)	Spillage (Tons)	Lost Good Value
2019	2,620,153,808	0	0	5,555	23.2	\$ 8,062	2,620,153,808	0	0	5,555	23.2	\$ 8,062
2020	2,620,153,808	0	0	5,555	23.2	\$ 8,062	2,620,153,808	0	0	5,555	23.2	\$ 8,062
2021	2,620,153,808	0	0	5,555	23.2	\$ 8,062	2,620,153,808	0	0	5,555	23.2	\$ 8,062
2022	2,620,153,808	0	0	5,555	23.2	\$ 8,062	2,620,153,808	0	0	5,555	23.2	\$ 8,062
2023	2,620,153,808	0	0	5,555	23.2	\$ 8,062	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2024	2,620,153,808	0	0	5,555	23.2	\$ 8,062	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2025	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2026	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2027	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2028	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2029	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2030	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
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2034	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2035	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2036	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2037	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2038	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2039	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2040	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2041	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
2042	1,728,186,554	602,077,896	66,897,544	7,650	31.9	\$ 11,103	2,434,327,297	125,432,895	13,936,988	5,991	25.0	\$ 8,695
Total						\$ 248,219						Total \$ 206,150

OPERATIONS & MAINTENANCE COST REDUCTION

The Project improvements will create a **total Operations and Maintenance (O&M) cost reduction of \$70,300 NPV** over 20 years. The total O&M savings are based on 2018 dollars, assumes construction begins in 2021 and ends in 2022, and assumes new infrastructure enters in operations in 2023. Annually, the Ports of Muskogee and Catoosa each spend \$200 maintaining their current dolphin structures and Oakley 33 Grand River spends \$455 to maintain its deadman anchors. By providing long-lasting improvements associated with this project, O&M costs will substantially be reduced. **Table 4** shows the O&M cost reduction.



TABLE 4: O&M COST REDUCTION

Year	No Build Scenario		Build Scenario		Operations & Maintenance Savings	Operations & Maintenance Savings
	Infrastructure Condition	Maintenance Cost (\$2018) ³	Infrastructure Condition	Maintenance Cost (\$2018) ³		
<i>(Beg Construction) 2021</i>	Poor	\$ 9,745	N/A	\$ -	\$ -	\$ -
<i>(End Construction) 2022</i>	Poor	\$ 9,745	N/A	\$ -	\$ -	\$ -
2023	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 4,667
2024	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 4,362
2025	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 4,076
2026	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 3,810
2027	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 3,560
2028	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 3,327
2029	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 3,110
2030	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 2,906
2031	Poor	\$ 239,745	Good	\$ 191,382	\$ 48,364	\$ 20,069
2032	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 2,538
2033	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 2,372
2034	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 2,217
2035	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 2,072
2036	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,937
2037	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,810
2038	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,691
2039	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,581
2040	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,477
2041	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,381
2042	Poor	\$ 9,745	Good	\$ 3,200	\$ 6,545	\$ 1,290
Total		\$ 424,909		\$ 252,182	\$ 172,727	\$ 70,254

ENVIRONMENTAL COST SAVINGS

The Project produces emission reductions by preventing cargo from being diverted from waterways to rail and trucks, resulting in **emissions damage savings of \$28,300,000 NPV over 20 years.**

The total environmental damage savings are based on anecdotal evidence from port directors that 90% of cargo would be diverted to rail and 10% would be diverted to trucks. Damage costs for pollutant emissions were based on Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis from the BCA Guidelines 2020, TSD by quantifying carbon dioxide (CO₂), volatile organic compounds (VOCs), nitrogen oxide (NO_x), particulate matter, and sulfur dioxide emission damage costs. Average CO₂ and nitrous oxide emissions for barge, rail, and truck were based on the Waterways: Working for America, February 2017 from the National Waterways Foundation.

Pollutant emission reduction was then converted to emission amounts (in short tons) for each pollutant – CO₂ and NO_x - by its emission production factor (tons per million ton – miles for CO₂ and pounds per thousand ton-miles for NO_x). This is then converted to an environmental damage cost. **Table 5** shows the value of environmental damage reduction savings.



TABLE 5: ENVIRONMENTAL DAMAGE REDUCTION SAVINGS

Year	No-Build Damage Cost	Build Damage Cost	Potential Cost Savings	Potential Cost Savings (NPV)
2023	\$ 6,012,205	\$ 7,187,126	\$ (1,174,921)	\$ (837,702)
2024	\$ 6,012,205	\$ 7,187,126	\$ (1,174,921)	\$ (782,899)
2025	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 2,780,390
2026	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 2,598,495
2027	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 2,428,500
2028	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 2,269,626
2029	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 2,121,146
2030	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 1,982,379
2031	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 1,852,691
2032	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 1,731,487
2033	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 1,618,212
2034	\$ 11,651,824	\$ 7,187,126	\$ 4,464,698	\$ 1,512,348
2035	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 1,415,706
2036	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 1,323,090
2037	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 1,236,533
2038	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 1,155,638
2039	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 1,080,035
2040	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 1,009,379
2041	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 943,345
2042	\$ 11,701,863	\$ 7,229,909	\$ 4,471,954	\$ 881,631
Total	\$ 222,157,556	\$ 144,084,781	\$ 78,072,775	\$ 28,320,030

PROJECT COST

The capital cost is **\$26.27 million** in 2018 dollars per guidance. It covers design and construction based on the moorings being built in 2021-2022. Annual project costs (**Table 6**) include the Net Present Value (NPV) based on a seven-percent discount rate. At the end of the 20-year analysis period, the facility will have a discounted residual value of \$19.3 million. This was calculated using the FHWA-recommended 20-year analysis period, then dividing by the time before the moorings will need to be replaced (75-year lifespan). The number is then multiplied by the project cost in today’s dollars.

TABLE 6: PROJECT COSTS

Year	20 Year Costs		
	Percent Project Cost Paid	Project Cost	Project Cost (NPV)
2021	30%	\$ 7,881,000	\$ 6,433,244
2022	70%	\$ 18,389,000	\$ 14,028,880
2023		\$ -	\$ -
2024		\$ -	\$ -
2025		\$ -	\$ -
2026		\$ -	\$ -
2027		\$ -	\$ -
2028		\$ -	\$ -
2029		\$ -	\$ -
2030		\$ -	\$ -
2031		\$ -	\$ -
2032		\$ -	\$ -
2033		\$ -	\$ -
2034		\$ -	\$ -
2035		\$ -	\$ -
2036		\$ -	\$ -
2037		\$ -	\$ -
2038		\$ -	\$ -
2039		\$ -	\$ -
2040		\$ -	\$ -
2041		\$ -	\$ -
2042		\$ (19,264,667)	\$ (3,797,964)
Total	100%	\$ 7,005,333	\$ 16,664,160

BENEFITS SUMMARY

The McClellan-Kerr Arkansas River Navigation (MKARNS) Project **offers a Benefit-Cost Ratio of 3.17**. This ratio was derived by dividing total discounted benefits by total discounted costs over a 20-year period. It and other figures shown below in **Table 7** and throughout this methodology memo were derived based on FHWA 2020 BCA Guidance.



TABLE 7: BENEFITS SUMMARY

Project	Capital Costs	Project Costs (NPV)	Total Net Benefit	Total Net Benefit (NPV)	Benefit-Cost Ratio
2020 BCA SUMMARY - MKARNS Waterway Project	\$ 26,270,000	\$ 16,664,160	\$ 145,651,042	\$ 52,846,404	3.17