BURNS McDONNELL

2024 PIDP Grant Benefit-Cost Analysis Methodology and Findings

PORT MUSKOGEE

TULSA PORTS

Final Report
April 2024

EXECUTIVE SUMMARY

The McClellan-Kerr Arkansas River Navigation System (MKARNS) Barge Safety & Efficiency Improvement Project (the Project) provides a benefit-cost ratio **(BCR) of 3.6** and a **net present value (NPV) of $42,162,438**. At this rate, the proposed total capital project cost of $16.2 million (2022$) will generate $58,369,882 in discounted benefits over 20 years.

The Project will modernize mooring infrastructure at the Tulsa Port of Catoosa (TPOC) and Port Muskogee (PM), reconstructing 26 mooring dolphins at the ports and constructing two new mooring dolphins at PM, significantly improving state of good repair and safety during both normal operations and in the event of a flood. Together, the Project components will enable safe harbor for mariners, improved reliability, and expanded operations, while avoiding costly and impactful diversion to truck and rail.

The project represents the entire capacity at TPOC to accommodate liquid cargo and all mooring infrastructure at PM. The No-Build scenario assumes 35% of cargo to be served by the project is diverted to other ports, 52% to rail, and 13% to truck. Barge operations in both the Build and No-Build were assumed to travel the full distance of the waterway from each port to the mouth of the Mississippi River; however, as a conservative approach, diversion in the No-Build to truck and rail is assumed to travel a shorter distance from the ports to Little Rock, AR.

Over the 20-year analysis period, these investments will produce the following benefits due to avoided modal diversion from barge to freight rail and truck:

- Emissions reduction: **$26,256,164 NPV**
- Reduced crash costs (fatalities and injuries): **$21,761,509 NPV**
- Avoided highway noise and congestion: **$10,382,706 NPV**
- Reduced cargo spillage: **$4,934 NPV**

The disbenefits of maintenance costs for the mooring infrastructure were accounted for in the analysis.

METHODOLOGY

The Benefit Cost Analysis (BCA) was prepared in accordance with the U.S. Department of Transportation (USDOT) 2024 Benefit-Cost Analysis Guidance using total quantifiable project costs and benefits discounted to reflect the time value of money.

The BCA was created by:

1. Identifying Project benefits and costs for improvements versus a No-Build scenario;
2. Determining current and forecasted use levels for the baseline and the Build scenario;
3. Denominating all benefits and costs in constant 2022 dollars;
4. Discounting dollar amounts by 3.1 percent to reflect the time value of money, except for CO_2 emissions at 2.0 percent; and
5. Setting an appropriate analysis period of 20 years for the Project's construction and subsequent operational service.

PROJECT OVERVIEW

The MKARNS is a 445-mile-long marine highway which consists of the Verdigris, Arkansas, and White Rivers. Freight movements along this system flow from various locations between TPOC in northeast Oklahoma and the Port of New Orleans at the mouth of the Mississippi River. The central location of the two inland waterway ports provides connections to extensive transportation corridors across the nation. Both ports are located in historically disadvantaged, rural areas of Northeast Oklahoma's 2nd Congressional District. The proposed Project consists of key improvements as follows:

1. **Tulsa Port of Catoosa (TPOC)** – The Project will remove and replace 6 dolphin structures with new mooring structures with associated gangway and platforms.
2. **Port of Muskogee (PM)** – The Project will remove and replace 20 dolphin structures with new mooring structures with associated gangway and platforms, as well as construct 2 additional mooring dolphin structures, associated gangway and platforms that can accommodate larger vessels to support an anticipated alternative fueling project.

Together, the Project will benefit the Tulsa Port of Catoosa and Port Muskogee, communities throughout eastern Oklahoma and western Arkansas along truck and rail diversion routes, 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, ensure waterway transportation remains efficient and economically competitive, and decrease emissions by improving state of good repair and encouraging freight movement by the waterway. Oklahoma produces and supplies a variety of products including agriculture, chemical fertilizers, petroleum, and iron and steel throughout the U.S. and internationally. The improvements provided by the Project are 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 each location for future freight traffic demand that is anticipated to grow by 35 percent through 2045.[1]

[1] Oklahoma Transportation 2021 Annual Report.

PROJECT COSTS

Project engineers estimated the total capital costs the Project will require based on the Preliminary Monopile Design Report by Lanier Consultants (2022). Estimated construction costs were provided for the 20 mooring dolphins to be replaced at Port Muskogee and the 6 mooring dolphins to be replaced at TPOC. The original estimates have been updated to accommodate the increased lengths on the monopile structures due to water elevation data and the addition of 2 new mooring dolphins at Port Muskogee.

Cost estimates for the mooring dolphins were developed as part of preliminary design and include a 30 percent contingency. Costs include excavation, concrete work, 60-inch diameter mooring piles and coating, mooring rails and fenders, and turbidity curtain, as shown in Table 1.

TABLE 1. DETAILED ENGINEERING COST ESTIMATE FOR PROJECT COMPONENTS

Capital Construction Costs	Cost (Undiscounted)
Site and Environmental Permitting	$440,000
Engineering Services During Construction	$759,000
Mobilization and Demobilization	$1,480,000
Excavation Overburden	$58,000
Rock Excavation	$1,560,000
Tremie Concrete at Rock Embedment	$212,826
Rebar	$141,809
Mooring Piles	$5,857,789
Mooring Pile Coating	$1,021,128
Mooring Pile Sleeves (2)	$205,851
Mooring Pile Delivery	$420,000
Mooring Rails	$149,952
Fenders	$560,000
Turbidity Curtain	$34,375
Project Design Costs (7%)	$903,051
Contingency (30%)	$4,417,210
Total Project Cost	**$18,220,992**

MODEL SCENARIOS AND ASSUMPTIONS

Tonnage growth at both ports was modeled at a 1 percent cumulative growth rate over the analysis period, offering a reasonable but conservative estimate informed by the Oklahoma Department of Transportation (ODOT) Freight Plan anticipates a 35 percent growth rate over the same 20-year period.[2] The additional capacity created by the 2 new mooring structures at Port Muskogee was not monetized in addition to this growth rate.

Distance in the Build scenario uses the mile-marker for TPOC and PM on the MKARNS, reflecting the total distance the ports are from the waterway terminus at the mouth of the Mississippi River near Montgomery Point. Given the uncertainties around alternate ports in the No-Build scenario, the same distance inputs were used. To take a conservative approach, the No-Build routes for truck and rail only consider the distance from the ports to Little Rock, Arkansas.

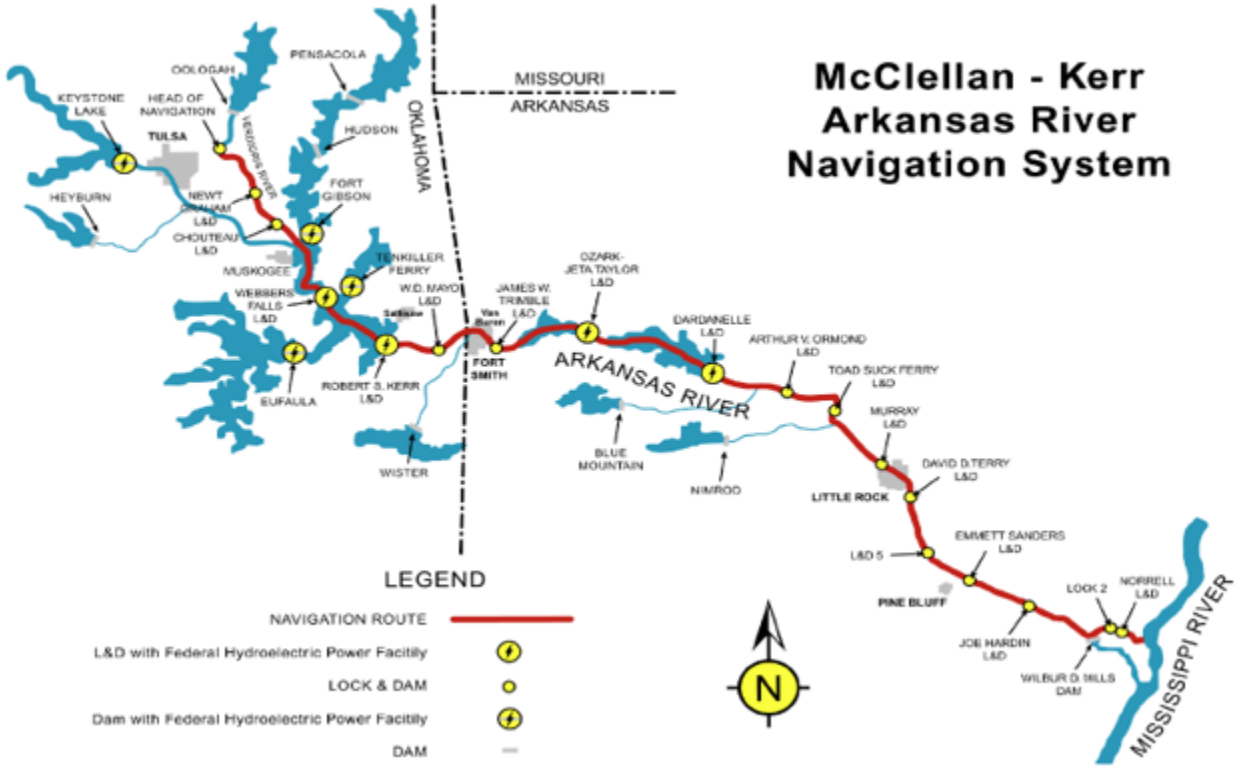

Figure 1 Map of the MKARNS Waterway from the US Army Corps of Engineers.

No-Build Scenario

In the No-Build scenario for the modernized mooring infrastructure, the 26 dolphins to be reconstructed in the Project reach their end of life – as assessed by engineers in infrastructure assessments at each port – in year 2027. Beginning in year 2028, Port Muskogee's overall capacity is reduced by 30 percent, reflective of the loss of 20 dolphins, and the Port of Catoosa's liquid capacity is reduced by 100 percent, as the 6 at-risk dolphins in this Project reflect all infrastructure and pipes to accommodate liquid cargo.

[2] Oklahoma Freight Transportation Plan 2018-2022.

With reduced mooring capacity at the ports, the cargo they currently accommodate will have to be diverted to other ports and other modes, as shown in the list below. The ports have sufficient rail capacity to handle a large volume of cargo. It is important to note in some cases, cargo might be placed on a truck first for a short distance and carried to rail to complete the shipment – however, these effects were not considered within the model to remain conservative given many uncertainties. Considering the multimodal capacity at each port, as well as the other waterway options in geographic proximity, ODOT and the Port Directors developed the following diversion assumptions:

- Slightly over a third (35%) of tonnage would be diverted to other ports, for which no additional benefits were calculated as these locations and their proximity to various producers could vary;
- A majority of tonnage (52%) would be diverted to rail, served by the Burlington Northern Santa Fe Railroad (BNSF) at the Port of Catoosa and Union Pacific Railroad (UP) at Port Muskogee; and
- The remaining tonnage (13%) would be diverted to truck.

NET BENEFIT ASSESSMENT

The Project will provide substantial benefits by improving safety, reducing GHG emissions, and supporting economic vitality for the surrounding area. These benefits are quantified in the following subsections:

- Operations and Maintenance (Disbenefit)
- Emissions Reduction
- Safety Benefits
- Avoided Highway Use Externalities
- Avoided Cargo Spillage

Benefits were calculated using data provided by ODOT, Port Muskogee, Tulsa Ports, and Port Muskogee terminal operator Bruce Oakley, Inc..

OPERATIONS AND MAINTENANCE

Both Tulsa Ports and Port Muskogee currently spend approximately $250/year to operate and maintain each aged mooring dolphin, or $7,000/year for the infrastructure this Project would replace. However, the new infrastructure is designed to have lower operational costs and a proactive 20-year maintenance plan includes annualized costs to keep the dolphins in a state of good repair. The Build scenario uses a cost of $100/year/dolphin, or an annual operations and maintenance cost for the Project of $2,800.

However, it is important to note that although the existing maintenance costs are minimal there is an extreme urgency and need for modernized mooring infrastructure because the existing infrastructure will reach its end of life by 2027: the existing dolphin anchors will be unusable in less than 3 years. The Tulsa Port of Catoosa liquid dolphin line would lose 100 percent of its capacity while the Muskogee dolphin line would lose 30 percent. As such, maintenance costs are not calculated for the No-Build scenario.

The discounted operations and maintenance disbenefit for the life of the Project is -$35,431.

EMISSIONS REDUCTION

By avoiding the modal diversion of the No-Build scenario, this project would result in significant emissions benefits. According to a study from the National Waterways Foundation, barges generate significantly less greenhouse gases, hydrocarbons, carbon monoxide, and nitrous oxide than trucks and rail.[3] In terms of CO_2, barges generate 15.1 tons per million ton-miles, which is 43% less than rail and 832% less than trucks. Barges are much more energy efficient than the other two modes. While trucks and rail can only travel 151 and 472 ton-miles per gallon of fuel respectively, the study found barges are able to travel up to 675 ton-miles per gallon of fuel. This requires barges to use less fuel to move a ton of cargo than the other two modes, which decreases the emissions released.

USDOT BCA methodology was used to calculate truck and rail ton-miles. Approximate distances from Google Maps were used to calculate alternate truck routes (279 miles from TPOC and 232 miles from PM). Input from current rail operations at the ports and Federal Railroad Administration (FRA) data informed the alternate rail routes (255 miles from TPOC and 214 miles from PM). An average hauling speed of 25 miles per hour was assumed based on FRA data, which resulted in approximate hauling times per train of 10.2 hours from TPOC and 8.56 from PM. The analysis accounts for 2 hours of idling time per train, which includes 30 minutes of switching each for loading and unloading, as well as a conservative estimate of 1-hour cumulative switching time for any railyard stops. In the calculation, it is also assumed that one train can accommodate 5,000 tons of cargo, or approximately 50 railcars carrying 100 tons of cargo each.

In the absence of USDOT BCA methodology to quantify emissions for ton-mile or hours traveled by barge, emissions rates from a study by the National Waterways Foundation were used: 0.1526 grams of NO_x and 15.08 grams of CO_2 generated per ton-mile of inland waterway movement.[4] For the purposes of the BCA, these values were converted to metric tons. The project will produce a reduction of non-CO_2 emissions valued at $43,614,490 NPV.

While this methodology shows CO_2 emissions as a project disbenefit, as referenced above, the National Waterways Foundation found barges produce only 15.1 tons of CO_2 per million ton-miles as compared to 21.6 tons for rail and 140.7 tons for trucks. The total discounted (dis)benefit for CO_2 emissions reduction is -$17,358,326. The total discounted benefit for all emissions reductions is $26,256,164.

Please note on the Emissions Reduction tab in the model, the emission costs ($) reflect emissions generated by truck and rail in the No-Build scenario. Emissions in metric tons reflect those generated by barge in both the Build and No-Build scenario. Care was taken to avoid double counting.

[3] Waterways Council Marine Log
[4] A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001-2019

TABLE 2. EMISSIONS SAVINGS COMPARISON (2026)

	Build	No-Build
Non-CO_2 Emissions by Mode		
Truck	$0	$1,408,507
Rail	$0	$69,471,295
Barge	$41,946,634	$14,681,322
Subtotal	*$41,946,634*	*$85,561,124*
CO_2 Emissions by Mode		
Truck	$0	$14,226,932
Rail	$0	$9,897,334
Barge	$63,819,372	$22,336,780
Subtotal	*$63,819,372*	*$46,461,046*
Total Emissions Financial Cost	**$105,766,066**	**$132,022,170**

SAFETY BENEFITS

The project will realize total safety benefits of $21,761,509 NPV. This category calculates how the improvements for this project would reduce the likelihood of fatalities and injuries on the waterway by reducing the number of such crashes and/or their severity. Data from the Bureau of Transportation Statistics[5] and Federal Railroad Administration[6] was used to model the savings per ton-mile for the Build and No-Build scenarios considering truck safety, rail injuries and fatalities, and water injuries and fatalities. As a conservative approach where updated data was not available for inland waterways, the lowest tonnage value from the most recent five-year period was used to produce the highest injury and fatality rates.

[5] Bureau of Transportation Statistics
[6] Federal Railroad Administration

TABLE 3. VALUE OF SAFETY BENEFITS

	Build	No-Build
Truck Safety	$0	$845,104
Rail Injuries	$0	$2,767,962
Rail Fatalities	$0	$20,900,781
Waterway Fatalities	$3,992,246	$1,397,286
Waterway Injuries	$242,119	$84,742
Total Value of Safety Benefits	**$4,234,365**	**$25,995,875**

AVOIDED HIGHWAY USE EXTERNALITIES

This project will reduce congestion and noise on highways and surface transportation facilities from Eastern Oklahoma to Little Rock, Arkansas, and beyond as it will mitigate the need for cargo diversion to trucks. In the No-Build scenario, truck shipments from the ports to Little Rock would likely be routed on I-40, a major transcontinental highway. Additionally, these trucks would travel through tribal land belonging to the Muscogee, Choctaw and Cherokee Nations in Oklahoma. The total discounted benefit for avoided highway externalities (congestion and noise) is $10,382,706. The safety benefits of avoided vehicle-miles-traveled were calculated in the Safety benefits and have not been accounted for here to avoid double counting.

AVOIDED CARGO SPILLAGE

In the No-Build scenario, cargo would be diverted to truck and rail, which have higher rates of spills with 5.5 and 6.6 gallons spilled per million ton-miles respectively, as compared to barge shipments, which only see 2.3 gallons spilled per million ton-miles.[7] An average cargo value per ton across all commodities to be served by the project was calculated using data from ODOT's 2020 Freight and Goods Report.[8]

UNQUANTIFIED BENEFITS

Several anticipated Project benefits were not monetized to maintain a conservative approach. Until the mooring dolphins are removed from service in 2027, barges are at much higher risk of coming loose during flood or high-water events (0.5% chance of coming loose during a 100-year flood, as compared to 0.01% with the improved mooring structures). Infrastructure near the ports – such as bridges (US Route 66 and I-44 near TPOC and US 62 near Port Muskogee) and the Newt Graham, Chouteau, and Webbers Falls Locks and Dams – is at risk of a barge strike. The Webbers Falls dam was struck in 2019 and required repairs worth over $82 million. The economic impacts of these incidents extends beyond infrastructure repair, with repair work requiring public and freight detours for months and environmental damages. Further, as recent

[7] The Waterways Council Marine Log
[8] ODOT Freight and Goods Movement 2020

events have highlighted, vessel collisions with public infrastructure also increase the risk of injuries and fatalities.

This BCA does not account for potential increased congestion and associated vessel dwell at other ports that would accommodate over 300 million additional ton-miles of cargo each year in the No-Build scenario. The value of cargo delay for tonnage diverted by any mode was not considered.

SENSITIVITY POINTS

The new USDOT methodology to calculate rail emissions based on hours idling and hauling inherently results in these inputs having a large impact on the ratio. As such, care was taken to create the most informed assumptions possible at the time of this application. The ports engaged both BNSF and UP to understand the most likely operational scenarios without the project, in addition to analyzing recent operational data. Despite being served by different railroads, rail operations at both ports are relatively similar. As such, the same idling time – which captures switching required for un/loading operations as well as switching at railyards along the route – was used for both ports. The same hauling speed of 25 average miles per hour was used for both ports, accounting only for the increased distance of TPOC from Little Rock as compared to Port Muskogee. Hauling time, which results in more benefits than idling, reflects a conservative estimate as rail speeds would need to slow for a number of at-grade crossings.

BENEFITS SUMMARY

The MKARNS Barge Safety and Efficiency Project delivers a **Benefit-Cost Ratio of 3.60.** This ratio was derived by dividing total discounted benefits for both Project components by total discounted costs over a 20-year period. Table 4 shows a summary of the project costs and benefits along with the NPV.

TABLE 4. PROJECT BENEFITS SUMMARY

	PRESENT VALUE
Discounted Capital Costs	
Capital Costs	$16,207,444
Total Discounted Capital Costs	**$16,207,444**
Discounted Benefits	
Safety	$21,761,509
Non-CO_2 Emissions Reductions	$43,614,490
CO_2 Emissions Reductions *(The Project is anticipated to result in positive CO_2 emissions reductions: for this BCA, actual emissions were calculated for barge movements with conservative assumptions made for other modes)*	($17,358,326)
Avoided Highway Externalities	$10,382,706
Cargo Spillage	$4,934
Maintenance Dis-Benefit	($35,431)
Total Discounted Benefits	**$58,369,882**
Total Benefit-Cost Ratio	**3.60**
Total Net Present Value	**$42,162,438**