# BCA TECHNICAL MEMORANDUM

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

## MKARNS WATERWAY, OKLAHOMA SEGMENT

## EXECUTIVE SUMMARY

The McClellan-Kerr Arkansas River Navigation System (MKARNS) Mooring Modernization Project (The Project) provides a benefit-cost ratio **(BCR) of 11.01** and an **internal rate of return of 36.1 percent**. At this rate, the proposed **total capital project cost of $20.5 million** (2020$) will produce a **positive net user benefit of about $142.7 million net present value (NPV)** over 20 years.

The Benefit Cost Analysis (BCA) identified that the Project will significantly improve safety in the event of a flood, reduce operations and maintenance (O&M) costs over time, and demonstrate the costs associated with loss of use of the waterway if the Project were not constructed. The MKARNS Mooring Modernization Project will construct modernized mooring infrastructure at three Port locations - the Tulsa Port of Catoosa, Port of Muskogee, and Oakley's Terminal Muskogee (an extension of 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** **$214,904 (NPV)**
- **Flood Damage Savings** **$23,055 (NPV)**
- **Loss of Use Savings** **$156.7 million (NPV)**

The Benefit Cost Analysis (BCA) was prepared in accordance with the U.S. Department of Transportation (USDOT) 2022 Benefit-Cost Analysis Guidance (revised version) 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 the 2022 Benefit-Cost Analysis Guidance (revised version) using total quantifiable project costs and benefits adjusted for inflation, then discounted to reflect the time value of money.

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 2020 dollars;
4. Discounting dollar amounts by 7 percent to reflect the time value of money; 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. The MKARNS serves a 12-state region and is the most westerly inland ice-free waterway system in the Country. As such, the waterway provides access to port terminals to transfer freight from barge to either rail or truck. The MKARNS is synonymous with the Arkansas River in Oklahoma from the Port of Muskogee downstream to the State of Arkansas border. Upstream from the Port of Muskogee, MKARNS leaves the Arkansas River to join the Verdigris River and terminates at Tulsa Port of Catoosa.

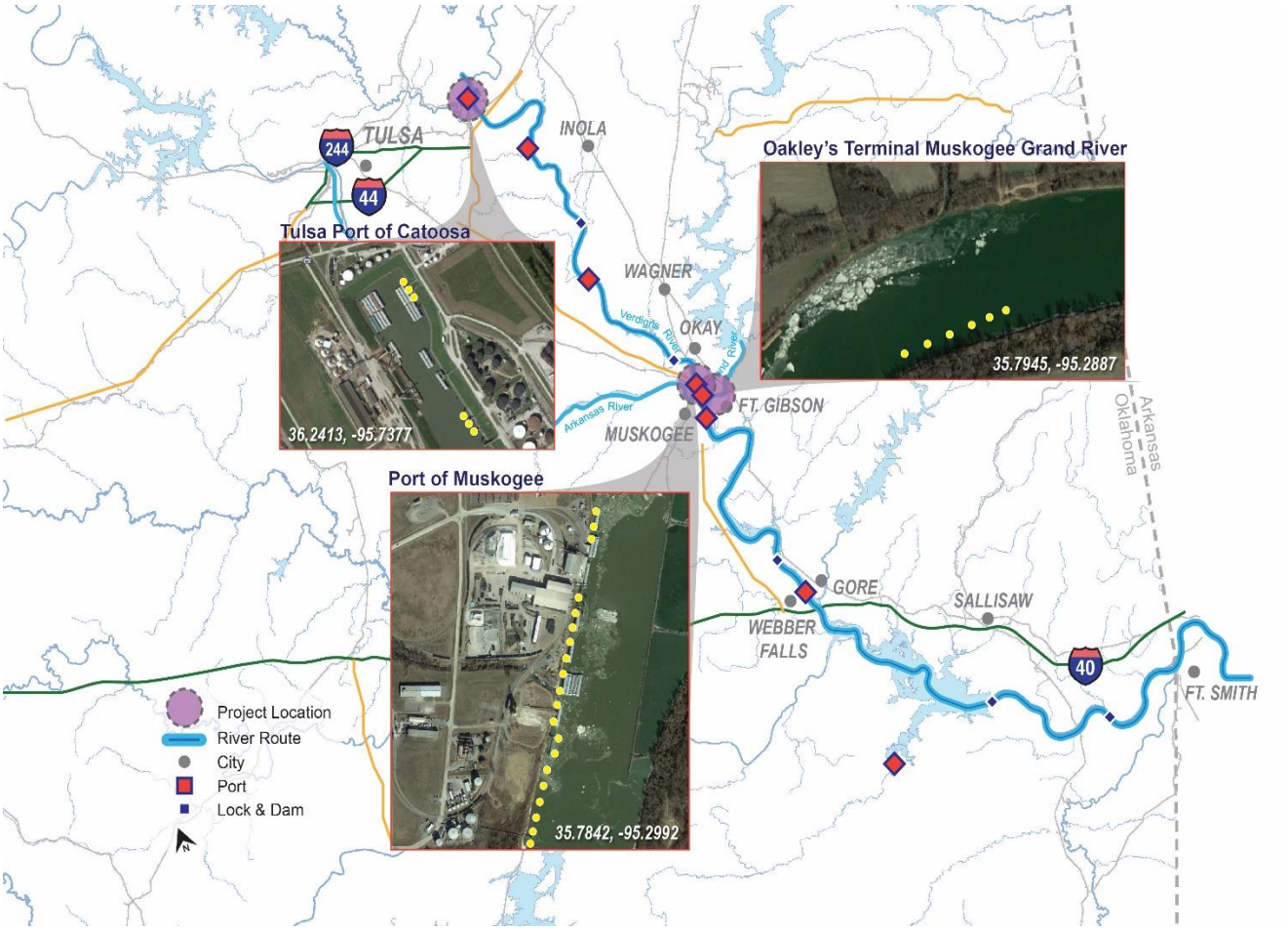
The Project will consist of constructing 32 mooring structures at the Tulsa Port of Catoosa, Port of Muskogee and Oakley's Terminal Muskogee (an extension of Oakley's Port 33), all of which are located in Northeast Oklahoma's 2nd Congressional District. These three ports include the two largest public ports (Tulsa Port of Catoosa and Port of Muskogee) and Oakley's Terminal Muskogee is an extension of the largest private port (Oakley's Port 33) on the MKARNS Oklahoma segment. The specific geospatial coordinates of proposed mooring structures are provided in Figure 1 below.

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

1. Replacing 6 dolphin structures with 6 modernized mooring structures at the Tulsa Port of Catoosa
2. Replacing 20 dolphin structures with 20 modernized mooring structures at the Port of Muskogee
3. Replacing 10 dead-man anchors with 6 modernized mooring structures at Oakley's Terminal Muskogee

The delegations of mooring construction at each Port location is shown below in ***Figure 1***.

## FIGURE 1: PROJECT LOCATION



# PROJECT BENEFICIARIES

The Project will benefit the Tulsa Port of Catoosa, Port of Muskogee, and Oakley's Terminal Muskogee 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 costs and decrease emissions by encouraging freight movement by the waterway. 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 project locations processed approximately 86 percent of the cargo on the Oklahoma Segment of the MKARNS in 2021.**[1] The mooring infrastructure 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.[2]

# PROJECT BENEFIT CATEGORIES

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

- Operations and Maintenance
- Flood Damage Savings
    - Flood Safety
    - Flood Environmental Savings
    - Flood Travel Time Savings
- Loss of Use (Existing infrastructure)
    - Loss of Use Safety Crash Savings
    - Loss of Use Environmental Savings
    - Loss of Use Economic Savings

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 Terminal Muskogee). Calculations for all figures as well as sources cited can be found within the BCA spreadsheets that are included with the RAISE grant submittal. The benefits are based upon the reduced operating capacity of the ports if the dolphin moorings and deadman anchors are not replaced as they are nearing their expected end of life in 2025.

[1] Tonnage information was informed by each Port location associated with this Project.
[2] Oklahoma Transportation 2021 Annual Report

## OPERATIONS AND MAINTENANCE


**The operations and maintenance cost savings** calculated for this Project are **$214,904 (NPV).** Each port location provided their existing annual maintenance costs per existing structure as follows:

- Port of Muskogee = $250 per dolphin mooring over a 20-year period
- Tulsa Port of Catoosa = 250 per dolphin mooring over a 20-year period
- Oakley's Terminal Muskogee = $500 per year per deadman anchor

These costs were each applied to the existing infrastructure at each location to be replaced by this project:

- 20 Dolphin Structures at the Port of Muskogee
- 6 Dolphin Structures at the Tulsa Port of Catoosa
- 6 Deadman Anchors at Oakley's Terminal Muskogee

This equates to approximately $9,500 in maintenance costs per year if no Project is constructed. 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 at these three port locations because the existing infrastructure to be replaced by this Project **will reach their end of life by 2025**. This means that **existing dolphin and deadman anchors will be unusable in less than 3 years.** The Tulsa Port of Catoosa liquid capacity structures would **lose 100 percent of their capacity in 2025** while the Muskogee Dolphin line would **lose 30 percent of its capacity**. Freight movement by waterway is anticipated to grow by 35 percent by year 2045 and without these improvements the remaining infrastructure will become strained and decrease the efficiency of the waterway.[3] The calculated Operations and Maintenance cost savings for the Build and No Build scenarios are show in ***Table 1***.

[3] Oklahoma Freight Transportation Plan 2018-2022

TABLE 1: OPERATIONS AND MAINTENANCE COSTS

| Year | No Build Scenario | | Build Scenario | | Operations & Maintenance Savings | Operations & Maintenance Savings (NPV) |
|---|---|---|---|---|---|---|
| | Infrastructure Condition | Mooring O&M | Infrastructure Condition | Mooring O&M | | |
| 2023 | Poor | $ 9,500 | N/A | $ - | $ - | $ - |
| 2024 | Poor | $ 9,500 | Good | $ - | $ - | $ - |
| 2025 | Poor | $ 239,500 | Good | $ 3,200 | $ 236,300 | $ 168,479 |
| 2026 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 4,198 |
| 2027 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 3,923 |
| 2028 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 3,667 |
| 2029 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 3,427 |
| 2030 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 3,203 |
| 2031 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 2,993 |
| 2032 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 2,797 |
| 2033 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 2,614 |
| 2034 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 2,443 |
| 2035 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 2,283 |
| 2036 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 2,134 |
| 2037 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,994 |
| 2038 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,864 |
| 2039 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,742 |
| 2040 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,628 |
| 2041 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,522 |
| 2042 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,422 |
| 2043 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,329 |
| 2044 | Poor | $ 9,500 | Good | $ 3,200 | $ 6,300 | $ 1,242 |
| **Total** | | **$ 420,000** | | **$ 64,000** | **$ 356,000** | **$ 214,904** |

## FLOOD RISK REDUCTION SAVINGS

**The Project produces $23,055 (NPV) savings for risk reduction in the event of a flood.** This category accounts for the totals of the following sections for flood safety, environmental, and travel time (detour) calculations for the complete risk total for a flood event, which roll up to $23,055 (NPV).


Data from the extreme flood event of 2019 on the MKARNS Oklahoma segment was utilized to calculate the probability of a barge breaking free from existing mooring infrastructure as well as the probability of a barge breaking free once the modernized moorings are provided by the Project.

The reported flood losses from the 2019 flood were approximately $266 million, which encompassed the loss of cargo of two barges that broke free and struck the Webber's Fall Lock and Dam, the cost of repairs to the Lock and Dam, the dredging to recover said barges, closure of the waterway, and any additional damages caused by this incident. The damages assumed for a future loose barge were determined based on the scenario that a barge could hit a pier of the US-62 bridge, which was assumed to be $20 million for this calculation. If the barge did not strike the US-62 bridge the $88.7 million costs of the minor barge strike from 2019 were used as a base for the damage at the Webber Falls Lock and Dam. The flood event of 2019 was determined to be a 100-year flood, so the probability of 1 percent was used for this exercise to pose as the probability for another event of the same magnitude to occur within this timeframe. A probability of 0.01 percent was assumed for the odds that a barge would break loose once improved infrastructure is provided compared to a 0.50 percent chance without improvements. A conservative inflation rate of 2 percent was utilized as costs can vary based on any given year. The values for reduced fatalities and injuries were also informed by the 2022 BCA Guidance, which provides monetized values for non-injury, potential injury, injury, death and number of accidents reported. A per vehicle property damage value also informed by the 2022 BCA guidance was incorporated into this calculation to provide a cost per vehicle. The estimated flood risk reduction savings are displayed in ***Table 2***.

TABLE 2: FLOOD RISK SAVINGS

| Flood Risk Reduction | | | | |
|---|---|---|---|---|
| Year | No Build Cost Potential | Build Cost Potential | Savings | NPV |
| 2025 | $ 2,252 | $ 45 | $ 2,207 | $ 1,574 |
| 2026 | $ 2,308 | $ 46 | $ 2,261 | $ 1,507 |
| 2027 | $ 2,367 | $ 47 | $ 2,320 | $ 1,445 |
| 2028 | $ 2,431 | $ 49 | $ 2,382 | $ 1,386 |
| 2029 | $ 2,500 | $ 50 | $ 2,450 | $ 1,332 |
| 2030 | $ 2,575 | $ 51 | $ 2,523 | $ 1,283 |
| 2031 | $ 2,652 | $ 53 | $ 2,599 | $ 1,235 |
| 2032 | $ 2,736 | $ 55 | $ 2,681 | $ 1,190 |
| 2033 | $ 2,827 | $ 57 | $ 2,770 | $ 1,150 |
| 2034 | $ 2,926 | $ 59 | $ 2,868 | $ 1,112 |
| 2035 | $ 3,036 | $ 61 | $ 2,975 | $ 1,078 |
| 2036 | $ 3,156 | $ 63 | $ 3,093 | $ 1,048 |
| 2037 | $ 3,290 | $ 66 | $ 3,224 | $ 1,021 |
| 2038 | $ 3,439 | $ 69 | $ 3,370 | $ 997 |
| 2039 | $ 3,606 | $ 72 | $ 3,534 | $ 977 |
| 2040 | $ 3,793 | $ 76 | $ 3,718 | $ 961 |
| 2041 | $ 4,006 | $ 80 | $ 3,926 | $ 948 |
| 2042 | $ 4,248 | $ 85 | $ 4,163 | $ 940 |
| 2043 | $ 4,525 | $ 91 | $ 4,435 | $ 935 |
| 2044 | $ 4,845 | $ 97 | $ 4,748 | $ 936 |
| | | Total | $ 62,247 | $ 23,055 |

### *Flood Safety Savings*


**The Flood safety savings** calculated for this Project were **$102,492,920 million (NPV).** The purpose of this category is to calculate how the improvements for this Project would reduce the likelihood of fatalities, injuries, and property damages on the waterway by reducing the number of such crashes and/or their severity. This was calculated for this Project by assuming cargo that is unable to be shipped via the MKARNS due to a flood incident would result in 25 percent of the goods to not be moved, while 75 percent of the remaining tons would be diverted to rail and 25 percent would be diverted to truck. The large percentage diverted to rail versus truck is simply because of the volume of cargo that can be handled via rail. 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. Ultimately, the majority of the tonnage would be placed on rail. Additional assumptions include safety rates per ton-mile for rail, truck, and waterway that report fatalities and injuries per ton-mile for each of these modes of transportation.[4]

The diversion distance assumed was from Mississippi to Muskogee, however, to be conservative Little Rock was used as the starting distance. These assumptions were compiled to determine the total ton-miles diverted from the waterway to rail and truck. These ton-miles were then applied to the fatality and injury factors to calculate the number of fatalities and injuries that occur from the diversion. These factors were compiled using the Bureau of Transportation Statistics. The expected annual fatalities and injuries were calculated for both the no-build and build conditions. **The final value for the increased crash cost as a result of the tonnage diversion** due to waterway closure **produced $102,492,920 million (NPV). The flood waterway diversion increased crash costs are shown in *Tables 3 and 4*.**

[4] Bureau of Transportation Statistics

TABLE 3: WATERWAY DIVERSION INCREASED CRASH COSTS - PART 1

| Year | Flood Waterway Diversion | | | | | |
|---|---|---|---|---|---|---|
| | Waterway Tons Diverted | | | Waterway Ton-Miles Diverted | | |
| | Catoosa | Port 33 | Muskogee | Catoosa | Port 33 | Muskogee |
| 2018 | 320,371 | 342,335 | 112,375 | 142,565,114 | 147,888,720 | 44,163,539 |
| 2019 | 321,973 | 344,047 | 112,937 | 143,277,939 | 148,628,164 | 44,384,356 |
| 2020 | 325,201 | 347,496 | 113,502 | 144,714,300 | 150,118,161 | 44,606,278 |
| 2021 | 330,103 | 352,734 | 114,069 | 146,895,887 | 152,381,211 | 44,829,310 |
| 2022 | 336,755 | 359,842 | 114,640 | 149,855,912 | 155,451,769 | 45,053,456 |
| 2023 | 345,258 | 368,929 | 115,213 | 153,639,962 | 159,377,121 | 45,278,723 |
| 2024 | 355,746 | 380,136 | 115,789 | 158,307,161 | 164,218,601 | 45,505,117 |
| 2025 | 368,386 | 393,642 | 116,368 | 163,931,719 | 170,053,188 | 45,732,643 |
| 2026 | 383,382 | 409,666 | 116,950 | 170,604,895 | 176,975,551 | 45,961,306 |
| 2027 | 400,983 | 428,474 | 117,535 | 178,437,464 | 185,100,601 | 46,191,112 |
| 2028 | 421,489 | 450,386 | 118,122 | 187,562,780 | 194,566,670 | 46,422,068 |
| 2029 | 445,260 | 475,786 | 118,713 | 198,140,539 | 205,539,420 | 46,654,178 |
| 2030 | 472,722 | 505,131 | 119,306 | 210,361,414 | 218,216,641 | 46,887,449 |
| 2031 | 504,388 | 538,968 | 119,903 | 224,452,726 | 232,834,145 | 47,121,886 |
| 2032 | 540,866 | 577,947 | 120,503 | 240,685,401 | 249,672,974 | 47,357,496 |
| 2033 | 582,882 | 622,843 | 121,105 | 259,382,502 | 269,068,254 | 47,594,283 |
| 2034 | 631,303 | 674,583 | 121,711 | 280,929,705 | 291,420,064 | 47,832,255 |
| 2035 | 687,164 | 734,275 | 122,319 | 305,788,193 | 317,206,807 | 48,071,416 |
| 2036 | 751,709 | 803,245 | 122,931 | 334,510,554 | 347,001,706 | 48,311,773 |
| 2037 | 826,428 | 883,086 | 123,545 | 367,760,430 | 381,493,185 | 48,553,332 |
| 2038 | 913,117 | 975,718 | 124,163 | 406,336,872 | 421,510,133 | 48,796,099 |
| 2039 | 1,013,943 | 1,083,457 | 124,784 | 451,204,612 | 468,053,305 | 49,040,079 |
| 2040 | 1,131,532 | 1,209,108 | 125,408 | 503,531,783 | 522,334,455 | 49,285,280 |
| 2041 | 1,269,072 | 1,356,077 | 126,035 | 564,737,087 | 585,825,261 | 49,531,706 |
| 2042 | 1,430,447 | 1,528,515 | 126,665 | 636,548,928 | 660,318,670 | 49,779,364 |
| 2043 | 1,620,404 | 1,731,496 | 127,298 | 721,079,809 | 748,006,068 | 50,028,261 |
| 2044 | 1,844,764 | 1,971,238 | 127,935 | 820,920,197 | 851,574,654 | 50,278,403 |

TABLE 4: WATERWAY DIVERSION INCREASED CRASH COSTS - PART 2

| Year | Flood Waterway Diversion | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Diverted Ton-Miles | | Base | | Diversion | | Increased Crash Cost | NPV |
| | Rail | Truck | Fatalitiies | Inuries | Fatalitiies | Inuries | | |
| 2018 | 100,688,988 | 36,539,313 | 0.00 | 0.00 | 0.24 | 17.61 | | |
| 2019 | 101,192,433 | 36,722,010 | 0.00 | 0.00 | 0.24 | 17.70 | | |
| 2020 | 102,138,573 | 37,065,461 | 0.00 | 0.00 | 0.25 | 17.87 | | |
| 2021 | 103,540,670 | 37,574,483 | 0.00 | 0.00 | 0.25 | 18.11 | | |
| 2022 | 105,419,033 | 38,256,451 | 0.00 | 0.00 | 0.25 | 18.44 | | |
| 2023 | 107,801,533 | 39,121,485 | 0.00 | 0.00 | 0.26 | 18.86 | | |
| 2024 | 110,724,320 | 40,182,712 | 0.00 | 0.00 | 0.27 | 19.37 | | |
| 2025 | 114,232,767 | 41,456,608 | 0.00 | 0.00 | 0.27 | 19.98 | $ 7,371,072 | $ 5,255,472 |
| 2026 | 118,382,668 | 42,963,435 | 0.00 | 0.00 | 0.28 | 20.71 | $ 7,638,974 | $ 5,090,171 |
| 2027 | 123,241,752 | 44,727,786 | 0.00 | 0.00 | 0.30 | 21.56 | $ 7,952,661 | $ 4,952,517 |
| 2028 | 128,891,550 | 46,779,267 | 0.00 | 0.00 | 0.31 | 22.55 | $ 8,317,397 | $ 4,840,801 |
| 2029 | 135,429,700 | 49,153,335 | 0.00 | 0.00 | 0.33 | 23.69 | $ 8,739,486 | $ 4,753,701 |
| 2030 | 142,972,778 | 51,892,320 | 0.00 | 0.00 | 0.34 | 25.01 | $ 9,226,453 | $ 4,690,261 |
| 2031 | 151,659,765 | 55,046,691 | 0.00 | 0.00 | 0.37 | 26.54 | $ 9,787,273 | $ 4,649,863 |
| 2032 | 161,656,303 | 58,676,598 | 0.00 | 0.00 | 0.39 | 28.28 | $ 10,432,638 | $ 4,632,216 |
| 2033 | 173,159,909 | 62,853,764 | 0.00 | 0.00 | 0.42 | 30.30 | $ 11,175,300 | $ 4,637,352 |
| 2034 | 186,406,379 | 67,663,814 | 0.00 | 0.00 | 0.45 | 32.62 | $ 12,030,483 | $ 4,665,629 |
| 2035 | 201,677,675 | 73,209,137 | 0.00 | 0.00 | 0.49 | 35.29 | $ 13,016,391 | $ 4,717,739 |
| 2036 | 219,311,641 | 79,612,413 | 0.00 | 0.00 | 0.53 | 38.38 | $ 14,154,834 | $ 4,794,732 |
| 2037 | 239,714,017 | 87,020,979 | 0.00 | 0.00 | 0.58 | 41.95 | $ 15,472,008 | $ 4,898,042 |
| 2038 | 263,373,333 | 95,612,234 | 0.00 | 0.00 | 0.63 | 46.09 | $ 16,999,453 | $ 5,029,525 |
| 2039 | 290,879,409 | 105,600,358 | 0.00 | 0.00 | 0.70 | 50.90 | $ 18,775,248 | $ 5,191,513 |
| 2040 | 322,946,423 | 117,244,691 | 0.00 | 0.00 | 0.78 | 56.52 | $ 20,845,501 | $ 5,386,874 |
| 2041 | 360,441,746 | 130,860,201 | 0.01 | 0.01 | 0.87 | 63.08 | $ 23,266,210 | $ 5,619,094 |
| 2042 | 404,422,097 | 146,830,612 | 0.01 | 0.01 | 0.97 | 70.78 | $ 26,105,598 | $ 5,892,377 |
| 2043 | 456,179,024 | 165,624,922 | 0.01 | 0.01 | 1.10 | 79.84 | $ 29,447,048 | $ 6,211,763 |
| 2044 | 517,296,295 | 187,818,246 | 0.01 | 0.01 | 1.25 | 90.54 | $ 33,392,810 | $ 6,583,280 |
| | | | | | | Total | $ 304,146,836 | $ 102,492,920 |

## *Environmental Flood Damage Savings*


The total **environmental flood damage savings, $36.3 million (NPV)**, are based on anecdotal evidence from port directors that 75 percent of cargo would be diverted to rail and truck. Of this 75 percent, a total of 75 percent of this value would diverted to rail while the remaining 25 percent would be diverted to truck. Damage costs for pollutant emissions were based on Table A-6 from the 2022 Benefit Cost Analysis Guidance (revised version). Average CO2 and nitrous oxide emissions for barge, rail, and truck were based on the Waterways: Better for the Environment, Better for Communities, January 2022 by the National Waterways Foundation.

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

TABLE 5: ENVIRONMENTAL COST SAVINGS - FLOOD

| Year | Loss of Use Diversion | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Waterway Ton-Miles | Diverted Ton-Miles | | Metric Tons | | | | Cost | | NPV | |
| | | Rail | Truck | Co2 | NoX | So2 | PM2.5 | Polutants | CO2 | Polutants | CO2 |
| 2025 | 379,717,550 | 114,232,767 | 41,456,608 | -1,160 | 195 | 17 | -2 | $ 2,538,709 | $ (64,967) | $ 1,810,064 | $ (56,041) |
| 2026 | 393,541,752 | 118,382,668 | 42,963,435 | -1,203 | 202 | 18 | -2 | $ 2,681,444 | $ (68,556) | $ 1,786,759 | $ (57,414) |
| 2027 | 409,729,178 | 123,241,752 | 44,727,786 | -1,253 | 210 | 19 | -2 | $ 2,843,831 | $ (72,653) | $ 1,770,995 | $ (59,074) |
| 2028 | 428,551,518 | 128,891,550 | 46,779,267 | -1,311 | 220 | 20 | -2 | $ 3,028,250 | $ (78,641) | $ 1,762,469 | $ (62,080) |
| 2029 | 450,334,137 | 135,429,700 | 49,153,335 | -1,378 | 231 | 21 | -2 | $ 3,240,236 | $ (84,050) | $ 1,762,474 | $ (64,417) |
| 2030 | 475,465,504 | 142,972,778 | 51,892,320 | -1,455 | 244 | 22 | -2 | $ 3,506,197 | $ (90,234) | $ 1,782,373 | $ (67,142) |
| 2031 | 504,408,757 | 151,659,765 | 55,046,691 | -1,545 | 259 | 23 | -2 | $ 3,718,481 | $ (97,314) | $ 1,766,624 | $ (70,302) |
| 2032 | 537,715,871 | 161,656,303 | 58,676,598 | -1,647 | 276 | 25 | -3 | $ 3,962,758 | $ (105,435) | $ 1,759,512 | $ (73,950) |
| 2033 | 576,045,039 | 173,159,909 | 62,853,764 | -1,766 | 295 | 27 | -3 | $ 4,243,851 | $ (114,769) | $ 1,761,047 | $ (78,152) |
| 2034 | 620,182,024 | 186,406,379 | 67,663,814 | -1,902 | 318 | 29 | -3 | $ 4,567,521 | $ (125,523) | $ 1,771,363 | $ (82,985) |
| 2035 | 671,066,417 | 201,677,675 | 73,209,137 | -2,059 | 344 | 31 | -3 | $ 4,940,657 | $ (137,944) | $ 1,790,721 | $ (88,541) |
| 2036 | 729,824,034 | 219,311,641 | 79,612,413 | -2,240 | 374 | 34 | -4 | $ 5,371,511 | $ (154,573) | $ 1,819,517 | $ (96,325) |
| 2037 | 797,806,946 | 239,714,017 | 87,020,979 | -2,450 | 409 | 37 | -4 | $ 5,869,996 | $ (171,499) | $ 1,858,290 | $ (103,760) |
| 2038 | 876,643,103 | 263,373,333 | 95,612,234 | -2,693 | 449 | 40 | -4 | $ 6,448,046 | $ (191,223) | $ 1,907,744 | $ (112,323) |
| 2039 | 968,297,996 | 290,879,409 | 105,600,358 | -2,976 | 496 | 44 | -5 | $ 7,120,071 | $ (214,282) | $ 1,968,759 | $ (122,202) |
| 2040 | 1,075,151,518 | 322,946,423 | 117,244,691 | -3,306 | 550 | 49 | -5 | $ 7,903,516 | $ (241,333) | $ 2,042,419 | $ (133,620) |
| 2041 | 1,200,094,054 | 360,441,746 | 130,860,201 | -3,692 | 614 | 55 | -6 | $ 8,819,571 | $ (273,174) | $ 2,130,042 | $ (146,845) |
| 2042 | 1,346,646,963 | 404,422,097 | 146,830,612 | -4,144 | 689 | 62 | -6 | $ 9,894,051 | $ (310,791) | $ 2,233,218 | $ (162,199) |
| 2043 | 1,519,114,138 | 456,179,024 | 165,624,922 | -4,676 | 777 | 70 | -7 | $ 11,158,508 | $ (360,068) | $ 2,353,853 | $ (182,443) |
| 2044 | 1,722,773,254 | 517,296,295 | 187,818,246 | -5,305 | 882 | 79 | -8 | $ 12,651,632 | $ (413,775) | $ 2,494,226 | $ (203,550) |
| | | | | | | | Total | $ 114,508,836 | $ (3,370,803) | $38,332,469 | $(2,023,366) |

## *Flood Event Travel Time Savings*

Travel time savings were calculated to compare whether or not the US-62 bridge over the Arkansas River was open to traffic for trucks and passenger cars. In the event of a barge collision with the bridge, ultimately resulting in a bridge closure, a detour route for traffic would be needed. The assumed distance of this detour route, 14.8 miles, was informed by ODOT and Google Maps. The existing bridge route is 4.4 miles in length which was used as the corridor length assuming the bridge was operable. These calculations provide the total vehicle miles traveled and vehicle hours traveled via the US-62 bridge or the assumed detour route from Fort Gibson to Muskogee.


The 2022 BCA Guidance includes cost factors for the Truck value of time and the Passenger Vehicle Value of Time as well as a per-mile truck and passenger car operating cost. The average daily traffic (ADT) for the US-62 bridge over the Arkansas river for years 2015 and 2019 was used to identify traffic levels on this route. The growth rate and truck percent values for this route were provided by ODOT. The vehicle miles and hours traveled were calculated by applying the truck and vehicle factors to the ADT to determine the split of cars and trucks traveling the route. The vehicle miles and hours traveled were then calculated based on the corridor lengths for the detour route and operable bridge route. The vehicles were then subtracted from one another based on their given route of detour or bridge to determine the overall reduction in vehicle miles traveled. The vehicle miles traveled produced a **negative benefit of $1.7 million (NPV), which highlights how a detour route would negatively impact operations**.

A similar approach was used to determine the vehicle hours traveled based on either the detour or the operable bridge route. The passenger and truck values were subtracted based on either scenario to determine the reduction in vehicle hours traveled. **The vehicle hours traveled calculation produced a negative benefit of $2.4 million**. This identifies the **negative impact to travel time** if a detour route were needed because the bridge was closed. The travel time and operational costs for the detour route and bridge are shown in ***Tables 6 and 7***.


TABLE 6: TRAVEL TIME SAVINGS

| Year | Traffic Volumes | | Vehicle Hours Traveled | | | | Reduction in VHT | | VHT Benefit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Detour | | Bridge | | | | |
| | Passenger Vehicles | Trucks | Passenger Vehicles | Trucks | Passenger Vehicles | Trucks | Passenger Vehicles | Trucks | |
| **2024** | 22,138 | 685 | | | | | | | $ - |
| **2025** | 22,281 | 689 | 5,996 | 185 | 1,783 | 55 | -4,213 | -130 | $ (79,159) |
| **2026** | 22,425 | 694 | 6,034 | 187 | 1,795 | 55 | -4,240 | -132 | $ (79,689) |
| **2027** | 22,570 | 698 | 6,073 | 188 | 1,805 | 56 | -4,268 | -132 | $ (80,190) |
| **2028** | 22,715 | 703 | 6,113 | 189 | 1,817 | 56 | -4,295 | -133 | $ (80,709) |
| **2029** | 22,862 | 707 | 6,152 | 190 | 1,829 | 57 | -4,324 | -133 | $ (81,218) |
| **2030** | 23,010 | 712 | 6,191 | 192 | 1,841 | 57 | -4,351 | -135 | $ (81,761) |
| **2031** | 23,159 | 716 | 6,232 | 193 | 1,853 | 57 | -4,379 | -136 | $ (82,290) |
| **2032** | 23,308 | 721 | 6,272 | 194 | 1,864 | 58 | -4,408 | -136 | $ (82,808) |
| **2033** | 23,458 | 726 | 6,313 | 195 | 1,877 | 58 | -4,436 | -137 | $ (83,344) |
| **2034** | 23,610 | 730 | 6,354 | 196 | 1,889 | 58 | -4,464 | -138 | $ (83,884) |
| **2035** | 23,763 | 735 | 6,394 | 198 | 1,901 | 59 | -4,493 | -139 | $ (84,430) |
| **2036** | 23,916 | 740 | 6,436 | 199 | 1,913 | 59 | -4,522 | -140 | $ (84,976) |
| **2037** | 24,071 | 744 | 6,477 | 200 | 1,925 | 60 | -4,552 | -140 | $ (85,511) |
| **2038** | 24,226 | 749 | 6,519 | 202 | 1,938 | 60 | -4,581 | -142 | $ (86,078) |
| **2039** | 24,383 | 754 | 6,561 | 203 | 1,951 | 60 | -4,610 | -143 | $ (86,637) |
| **2040** | 24,540 | 759 | 6,604 | 204 | 1,963 | 61 | -4,641 | -143 | $ (87,182) |
| **2041** | 24,698 | 764 | 6,646 | 206 | 1,976 | 61 | -4,670 | -145 | $ (87,759) |
| **2042** | 24,858 | 769 | 6,689 | 207 | 1,988 | 62 | -4,701 | -145 | $ (88,315) |
| **2043** | 25,018 | 774 | 6,732 | 208 | 2,001 | 62 | -4,731 | -146 | $ (88,884) |
| **2044** | 25,180 | 779 | 6,775 | 210 | 2,015 | 62 | -4,761 | -148 | $ (89,475) |
| | | | | | | | | **Total** | $ (1,684,299) |

TABLE 7: OPERATIONAL SAVINGS

| Year | Traffic Volumes | | Vehicle Miles Traveled | | | | Reduction in VMT | | VMT Benefit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Detour | | Bridge | | | | |
| | Passenger Vehicles | Trucks | Passenger Vehicles | Trucks | Passenger Vehicles | Trucks | Passenger Vehicles | Trucks | |
| 2024 | 22,138 | 685 | | | | | | | $ - |
| 2025 | 22,281 | 689 | 329,757 | 10,199 | 98,036 | 3,032 | -231,721 | -7,167 | $ (111,011) |
| 2026 | 22,425 | 694 | 331,896 | 10,265 | 98,672 | 3,052 | -233,224 | -7,213 | $ (111,731) |
| 2027 | 22,570 | 698 | 334,035 | 10,331 | 99,308 | 3,071 | -234,728 | -7,260 | $ (112,451) |
| 2028 | 22,715 | 703 | 336,189 | 10,398 | 99,948 | 3,091 | -236,241 | -7,306 | $ (113,176) |
| 2029 | 22,862 | 707 | 338,357 | 10,465 | 100,592 | 3,111 | -237,764 | -7,354 | $ (113,906) |
| 2030 | 23,010 | 712 | 340,553 | 10,533 | 101,245 | 3,131 | -239,308 | -7,401 | $ (114,646) |
| 2031 | 23,159 | 716 | 342,750 | 10,601 | 101,899 | 3,152 | -240,851 | -7,449 | $ (115,385) |
| 2032 | 23,308 | 721 | 344,960 | 10,669 | 102,556 | 3,172 | -242,405 | -7,497 | $ (116,129) |
| 2033 | 23,458 | 726 | 347,186 | 10,738 | 103,217 | 3,192 | -243,968 | -7,545 | $ (116,878) |
| 2034 | 23,610 | 730 | 349,425 | 10,807 | 103,883 | 3,213 | -245,542 | -7,594 | $ (117,632) |
| 2035 | 23,763 | 735 | 351,693 | 10,877 | 104,557 | 3,234 | -247,136 | -7,643 | $ (118,396) |
| 2036 | 23,916 | 740 | 353,962 | 10,947 | 105,232 | 3,255 | -248,730 | -7,693 | $ (119,159) |
| 2037 | 24,071 | 744 | 356,244 | 11,018 | 105,910 | 3,276 | -250,334 | -7,742 | $ (119,928) |
| 2038 | 24,226 | 749 | 358,541 | 11,089 | 106,593 | 3,297 | -251,948 | -7,792 | $ (120,701) |
| 2039 | 24,383 | 754 | 360,867 | 11,161 | 107,285 | 3,318 | -253,582 | -7,843 | $ (121,484) |
| 2040 | 24,540 | 759 | 363,192 | 11,233 | 107,976 | 3,339 | -255,216 | -7,893 | $ (122,267) |
| 2041 | 24,698 | 764 | 365,532 | 11,305 | 108,672 | 3,361 | -256,861 | -7,944 | $ (123,055) |
| 2042 | 24,858 | 769 | 367,901 | 11,378 | 109,376 | 3,383 | -258,525 | -7,996 | $ (123,852) |
| 2043 | 25,018 | 774 | 370,270 | 11,452 | 110,080 | 3,405 | -260,190 | -8,047 | $ (124,650) |
| 2044 | 25,180 | 779 | 372,667 | 11,526 | 110,793 | 3,427 | -261,874 | -8,099 | $ (125,457) |
| | | | | | | | | Total | $ (2,361,896) |

## LOSS OF USE SAVINGS

The loss of use portion of this BCA deals with the end of life of service for existing structures associated with the Tulsa Port of Catoosa liquid dolphins and the Muskogee dolphin line. The structures at the Tulsa Port of Catoosa that support liquid cargo shipment will lose 100 percent of their capacity and the Muskogee dolphin line will lose 30 percent of its capacity at the start of 2025. The benefit calculated for the loss of use section accounts for the environmental, safety, and economic costs that will be discussed in the following sections. The Project will produce **a total benefit of $156.7 million (NPV) in loss of use savings.**


The tons associated with the Tulsa Port of Catoosa and Muskogee dolphin line were informed by each port location. The tonnage values for these existing structures were utilized to determine the value lost when capacity is reduced without improvement in year 2025. The following sections will describe in more detail the assumptions used to determine loss of use benefit for environmental, safety, and the economy.

### *Loss of Use Safety*

The loss of use safety benefits for this BCA were calculated by assuming cargo that is unable to ship via the MKARNS due to lost capacity from deteriorating mooring structures would result in 25 percent of goods not moved, while 75 percent of the remaining tons would be diverted to rail and 25 percent would be diverted to truck. The large percentage diverted to rail versus truck is simply because of the volume of cargo that can be handled via rail. Additional assumptions include safety rates per ton-mile for rail, truck, and waterway that report fatalities and injuries per ton-mile for each of these modes of transportation.[5]

The diversion distance assumed was from Mississippi to Muskogee, however, to be conservative Little Rock was used as the starting distance. These assumptions were compiled to determine the total ton-miles diverted from the waterway to rail and truck associated with the ton-miles supported by the 22 structures that will by unusable by 2025. These ton-miles were then applied to the assumed fatality and injury factors to calculate the number of fatalities and injuries that occur from the diversion. The expected annual fatalities and injuries were calculated for both the no-build and build conditions. **The final value for the increased crash cost as a result of the tonnage diversion** due to waterway closure **produced $134.1 million (NPV). The flood waterway diversion increased crash costs are shown in *Tables 8 and 9*.**

TABLE 8: LOSS OF USE SAFETY SAVINGS – PART 1

| Year | Loss of Use - Safety | | | | | |
|---|---|---|---|---|---|---|
| | Waterway Tons Diverted | | Waterway Ton-Miles Diverted | | Diverted Ton-Miles | |
| | Catoosa | Muskogee | Catoosa | Muskogee | Rail | Truck |
| 2018 | 785,675 | 161,821 | 349,625,499 | 63,595,496 | 132,174,452 | 48,139,834 |
| 2019 | 789,604 | 162,630 | 351,373,626 | 63,913,473 | 132,835,325 | 48,380,533 |
| 2020 | 797,519 | 163,443 | 354,896,147 | 64,233,041 | 134,068,627 | 48,829,999 |
| 2021 | 809,542 | 164,260 | 360,246,251 | 64,554,206 | 135,891,506 | 49,494,486 |
| 2022 | 825,855 | 165,081 | 367,505,393 | 64,876,977 | 138,330,220 | 50,383,569 |
| 2023 | 846,709 | 165,907 | 376,785,365 | 65,201,362 | 141,420,805 | 51,510,393 |
| 2024 | 872,430 | 166,736 | 388,231,166 | 65,527,369 | 145,210,002 | 52,892,002 |
| 2025 | 903,426 | 167,570 | 402,024,785 | 65,855,005 | 149,756,473 | 54,549,792 |
| 2026 | 940,202 | 168,408 | 418,390,025 | 66,184,280 | 155,132,362 | 56,510,074 |
| 2027 | 983,368 | 169,250 | 437,598,554 | 66,515,202 | 161,425,235 | 58,804,784 |
| 2028 | 1,033,657 | 170,096 | 459,977,402 | 66,847,778 | 168,740,509 | 61,472,368 |
| 2029 | 1,091,951 | 170,947 | 485,918,210 | 67,182,017 | 177,204,424 | 64,558,866 |
| 2030 | 1,159,300 | 171,801 | 515,888,582 | 67,517,927 | 186,967,707 | 68,119,249 |
| 2031 | 1,236,957 | 172,660 | 550,445,998 | 67,855,516 | 198,210,052 | 72,219,054 |
| 2032 | 1,326,415 | 173,524 | 590,254,876 | 68,194,794 | 211,145,626 | 76,936,387 |
| 2033 | 1,429,455 | 174,391 | 636,107,491 | 68,535,768 | 226,029,805 | 82,364,387 |
| 2034 | 1,548,202 | 175,263 | 688,949,672 | 68,878,447 | 243,167,465 | 88,614,242 |
| 2035 | 1,685,196 | 176,140 | 749,912,422 | 69,222,839 | 262,923,164 | 95,818,909 |
| 2036 | 1,843,485 | 177,020 | 820,350,901 | 69,568,953 | 285,733,715 | 104,137,698 |
| 2037 | 2,026,725 | 177,905 | 901,892,619 | 69,916,798 | 312,123,720 | 113,761,933 |
| 2038 | 2,239,319 | 178,795 | 996,497,166 | 70,266,382 | 342,724,819 | 124,921,977 |
| 2039 | 2,486,585 | 179,689 | 1,106,530,438 | 70,617,714 | 378,299,616 | 137,895,956 |
| 2040 | 2,774,960 | 180,587 | 1,234,857,157 | 70,970,803 | 419,771,506 | 153,020,637 |
| 2041 | 3,112,262 | 181,490 | 1,384,956,535 | 71,325,657 | 468,261,948 | 170,705,024 |
| 2042 | 3,508,016 | 182,398 | 1,561,067,298 | 71,682,285 | 525,137,222 | 191,447,407 |
| 2043 | 3,973,865 | 183,310 | 1,768,370,127 | 72,040,696 | 592,067,226 | 215,856,807 |
| 2044 | 4,524,085 | 184,226 | 2,013,217,864 | 72,400,900 | 671,099,685 | 244,680,041 |

[5] Bureau of Transportation Statistics

TABLE 9: LOSS OF USE SAFETY SAVINGS – PART 2

| Year | Loss of Use - Safety | | | | | |
|---|---|---|---|---|---|---|
| | Base | | Diversion | | Increased Crash Cost | NPV |
| | Fatalitiies | Inuries | Fatalitiies | Inuries | | |
| 2018 | 0.00 | 0.00 | 0.32 | 23.20 | | |
| 2019 | 0.00 | 0.00 | 0.32 | 23.32 | | |
| 2020 | 0.00 | 0.00 | 0.32 | 23.54 | | |
| 2021 | 0.00 | 0.00 | 0.33 | 23.86 | | |
| 2022 | 0.00 | 0.00 | 0.33 | 24.28 | | |
| 2023 | 0.00 | 0.00 | 0.34 | 24.83 | | |
| 2024 | 0.00 | 0.00 | 0.35 | 25.49 | | |
| 2025 | 0.00 | 0.00 | 0.36 | 26.29 | $ 9,697,136 | $ 6,913,924 |
| 2026 | 0.00 | 0.00 | 0.37 | 27.24 | $ 10,045,578 | $ 6,693,792 |
| 2027 | 0.00 | 0.00 | 0.39 | 28.34 | $ 10,453,463 | $ 6,509,891 |
| 2028 | 0.00 | 0.00 | 0.41 | 29.63 | $ 10,927,627 | $ 6,359,978 |
| 2029 | 0.00 | 0.00 | 0.43 | 31.12 | $ 11,476,251 | $ 6,242,320 |
| 2030 | 0.00 | 0.00 | 0.45 | 32.83 | $ 12,109,108 | $ 6,155,657 |
| 2031 | 0.00 | 0.00 | 0.48 | 34.81 | $ 12,837,846 | $ 6,099,168 |
| 2032 | 0.00 | 0.00 | 0.51 | 37.08 | $ 13,676,349 | $ 6,072,463 |
| 2033 | 0.00 | 0.00 | 0.55 | 39.70 | $ 14,641,172 | $ 6,075,566 |
| 2034 | 0.00 | 0.00 | 0.59 | 42.71 | $ 15,752,077 | $ 6,108,927 |
| 2035 | 0.00 | 0.00 | 0.63 | 46.18 | $ 17,032,700 | $ 6,173,434 |
| 2036 | 0.00 | 0.00 | 0.69 | 50.19 | $ 18,511,355 | $ 6,270,436 |
| 2037 | 0.00 | 0.00 | 0.75 | 54.83 | $ 20,222,051 | $ 6,401,783 |
| 2038 | 0.00 | 0.00 | 0.83 | 60.21 | $ 22,205,734 | $ 6,569,875 |
| 2039 | 0.01 | 0.01 | 0.91 | 66.46 | $ 24,511,841 | $ 6,777,728 |
| 2040 | 0.01 | 0.01 | 1.01 | 73.75 | $ 27,200,232 | $ 7,029,057 |
| 2041 | 0.01 | 0.01 | 1.13 | 82.28 | $ 30,343,605 | $ 7,328,378 |
| 2042 | 0.01 | 0.01 | 1.27 | 92.28 | $ 34,030,533 | $ 7,681,139 |
| 2043 | 0.01 | 0.01 | 1.43 | 104.04 | $ 38,369,265 | $ 8,093,877 |
| 2044 | 0.01 | 0.01 | 1.62 | 117.93 | $ 43,492,550 | $ 8,574,409 |
| | | | | Total | $ 397,536,472 | $ 134,131,804 |

## *Loss of Use Environmental*


The total **environmental benefit produces $56 million (NPV)** for the loss of use in ton-miles associated with the end of life and usabiilty of the 22 structures at the Port of Catoosa and Muskogee by 2025. The calculation is based on anecdotal evidence from port directors that 75 percent of cargo would be diverted to rail and truck. Of this 75 percent, a total of 75 percent of this value would diverted to rail while the remaining 25 percent would be diverted to truck. Damage costs for pollutant emissions were based on Table A-6 from the 2022 Benefit Cost Analysis Guidance (revised version). Average CO2 and nitrous oxide emissions for barge, rail, and truck were based on the Waterways: Better for the Environment, Better for Communities, January 2022 by the National Waterways Foundation.

Pollutant emission reduction was then converted to emission amounts (in metric tons) for each pollutant – CO2 and NOx - by its emission production factor (tons per million ton–miles for CO2 and pounds per thousand ton-miles for NOx). This is then converted to an environmental damage cost. ***Table 10*** shows the value of environmental damage reduction savings.

TABLE 10: LOSS OF USE ENVIRONMENTAL SAVINGS

| | Loss of Use Diversion - Environmental | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diverted Ton-Miles | | Metric Tons | | | | Cost | | NPV | |
| Year | Waterway Ton-Miles | Rail | Truck | Co2 | NoX | So2 | PM2.5 | Polutants | CO2 | Polutants | CO2 |
| 2025 | 467,879,790 | 149,756,473 | 54,549,792 | -984 | 263 | 25 | -2 | $ 3,816,501 | $ (55,124) | $ 2,721,113 | $ (47,551) |
| 2026 | 484,574,306 | 155,132,362 | 56,510,074 | -1,018 | 273 | 25 | -2 | $ 4,030,551 | $ (58,014) | $ 2,685,726 | $ (48,586) |
| 2027 | 504,113,756 | 161,425,235 | 58,804,784 | -1,057 | 284 | 26 | -2 | $ 4,274,281 | $ (61,299) | $ 2,661,808 | $ (49,842) |
| 2028 | 526,825,179 | 168,740,509 | 61,472,368 | -1,102 | 297 | 28 | -2 | $ 4,551,440 | $ (66,136) | $ 2,648,980 | $ (52,208) |
| 2029 | 553,100,227 | 177,204,424 | 64,558,866 | -1,155 | 312 | 29 | -2 | $ 4,870,090 | $ (70,438) | $ 2,649,006 | $ (53,985) |
| 2030 | 583,406,509 | 186,967,707 | 68,119,249 | -1,215 | 329 | 31 | -3 | $ 5,266,429 | $ (75,342) | $ 2,677,185 | $ (56,061) |
| 2031 | 618,301,515 | 198,210,052 | 72,219,054 | -1,285 | 349 | 33 | -3 | $ 5,586,688 | $ (80,941) | $ 2,654,195 | $ (58,473) |
| 2032 | 658,449,670 | 211,145,626 | 76,936,387 | -1,365 | 372 | 35 | -3 | $ 5,955,230 | $ (87,347) | $ 2,644,193 | $ (61,263) |
| 2033 | 704,643,259 | 226,029,805 | 82,364,387 | -1,457 | 398 | 37 | -3 | $ 6,379,336 | $ (94,693) | $ 2,647,197 | $ (64,481) |
| 2034 | 757,828,119 | 243,167,465 | 88,614,242 | -1,563 | 428 | 40 | -3 | $ 6,867,700 | $ (103,140) | $ 2,663,412 | $ (68,188) |
| 2035 | 819,135,261 | 262,923,164 | 95,818,909 | -1,685 | 463 | 43 | -4 | $ 7,430,718 | $ (112,879) | $ 2,693,234 | $ (72,453) |
| 2036 | 889,919,854 | 285,733,715 | 104,137,698 | -1,826 | 504 | 47 | -4 | $ 8,080,846 | $ (125,969) | $ 2,737,262 | $ (78,499) |
| 2037 | 971,809,417 | 312,123,720 | 113,761,933 | -1,989 | 550 | 51 | -4 | $ 8,833,044 | $ (139,199) | $ 2,796,315 | $ (84,217) |
| 2038 | 1,066,763,548 | 342,724,819 | 124,921,977 | -2,177 | 604 | 56 | -5 | $ 9,705,323 | $ (154,597) | $ 2,871,455 | $ (90,809) |
| 2039 | 1,177,148,152 | 378,299,616 | 137,895,956 | -2,397 | 667 | 62 | -5 | $ 10,719,429 | $ (172,579) | $ 2,964,011 | $ (98,419) |
| 2040 | 1,305,827,960 | 419,771,506 | 153,020,637 | -2,653 | 740 | 69 | -6 | $ 11,901,694 | $ (191,000) | $ 3,075,624 | $ (105,752) |
| 2041 | 1,456,282,191 | 468,261,948 | 170,705,024 | -2,952 | 826 | 77 | -6 | $ 13,284,097 | $ (215,487) | $ 3,208,283 | $ (115,835) |
| 2042 | 1,632,749,582 | 525,137,222 | 191,447,407 | -3,303 | 927 | 87 | -7 | $ 14,905,599 | $ (244,395) | $ 3,364,390 | $ (127,548) |
| 2043 | 1,840,410,823 | 592,067,226 | 215,856,807 | -3,715 | 1,045 | 98 | -8 | $ 16,813,819 | $ (278,650) | $ 3,546,823 | $ (141,190) |
| 2044 | 2,085,618,764 | 671,099,685 | 244,680,041 | -4,203 | 1,184 | 111 | -9 | $ 19,067,148 | $ (323,601) | $ 3,759,024 | $ (159,190) |
| | | | | | | | Total | $ 172,339,961 | $ (2,710,829) | $57,669,237 | $(1,634,552) |

## *Loss of Use Economic*

The Project **will save approximately $2,880 (NPV) by 2043**, providing economic competitiveness by decreasing the risk of cargo spillage. This was calculated assuming that the 22 structures mentioned in previous sections were no longer be able to support storage and all associated tonnage would be diverted to truck and rail. Assuming that the cargo weighs the same as water (8.34 pounds), spillage rates associated with barge, truck and rail were utilized to determine the ton spillage that would occur if the cargo was diverted. Spillage tables for barge, rail, and truck were sourced from Waterways: Better for the Environment, Better for Communities, January 2022 by the National Waterways Foundation. The economic savings associated with loss of use are displayed in ***Table 11***.

TABLE 11: LOSS OF USE ECONOMIC SAVINGS

| Year | Diversion Spillage | | | | | | |
|---|---|---|---|---|---|---|---|
| | Waterway Ton-Miles | Diverted Ton-Miles | | Spillage (Gallons) | Spillage (Tons) | Lost Good | |
| | | Rail | Truck | | | Value | NPV |
| 2025 | 467,879,790 | 149,756,473 | 54,549,792 | 108 | 0.4 | $ 202 | $ 144 |
| 2026 | 484,574,306 | 155,132,362 | 56,510,074 | 112 | 0.5 | $ 210 | $ 140 |
| 2027 | 504,113,756 | 161,425,235 | 58,804,784 | 116 | 0.5 | $ 219 | $ 137 |
| 2028 | 526,825,179 | 168,740,509 | 61,472,368 | 122 | 0.5 | $ 230 | $ 134 |
| 2029 | 553,100,227 | 177,204,424 | 64,558,866 | 129 | 0.5 | $ 242 | $ 132 |
| 2030 | 583,406,509 | 186,967,707 | 68,119,249 | 136 | 0.6 | $ 256 | $ 130 |
| 2031 | 618,301,515 | 198,210,052 | 72,219,054 | 145 | 0.6 | $ 272 | $ 129 |
| 2032 | 658,449,670 | 211,145,626 | 76,936,387 | 155 | 0.6 | $ 291 | $ 129 |
| 2033 | 704,643,259 | 226,029,805 | 82,364,387 | 166 | 0.7 | $ 313 | $ 130 |
| 2034 | 757,828,119 | 243,167,465 | 88,614,242 | 179 | 0.7 | $ 337 | $ 131 |
| 2035 | 819,135,261 | 262,923,164 | 95,818,909 | 194 | 0.8 | $ 366 | $ 133 |
| 2036 | 889,919,854 | 285,733,715 | 104,137,698 | 212 | 0.9 | $ 399 | $ 135 |
| 2037 | 971,809,417 | 312,123,720 | 113,761,933 | 232 | 1.0 | $ 437 | $ 138 |
| 2038 | 1,066,763,548 | 342,724,819 | 124,921,977 | 256 | 1.1 | $ 482 | $ 142 |
| 2039 | 1,177,148,152 | 378,299,616 | 137,895,956 | 283 | 1.2 | $ 533 | $ 147 |
| 2040 | 1,305,827,960 | 419,771,506 | 153,020,637 | 315 | 1.3 | $ 593 | $ 153 |
| 2041 | 1,456,282,191 | 468,261,948 | 170,705,024 | 353 | 1.5 | $ 664 | $ 160 |
| 2042 | 1,632,749,582 | 525,137,222 | 191,447,407 | 396 | 1.7 | $ 746 | $ 168 |
| 2043 | 1,840,410,823 | 592,067,226 | 215,856,807 | 448 | 1.9 | $ 843 | $ 178 |
| 2044 | 2,085,618,764 | 671,099,685 | 244,680,041 | 509 | 2.1 | $ 958 | $ 189 |
| | | | | | Total | $ 8,594 | $ 2,880 |

## Project Cost

The total project cost is **$20.5 million** in 2020 dollars per the BCA guidance. It covers design and construction based on the moorings being built in 2023-2024. Annual project costs (***Table 12***) 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 residual value of $14.3 million. This was calculated using the remaining lifespan after the USDOT recommended 20-year analysis period is taken out, then dividing by the time before the moorings will need to be replaced (50-year lifespan). The number is then multiplied by the Project cost in today's dollars.

TABLE 12: PROJECT COSTS

| 20 Year Costs | | | |
|---|---|---|---|
| Year | Percent Project Cost Paid | Project Cost | Project Cost (NPV) |
| 2022 | 10% | $ 2,050,000 | $ 1,790,549 |
| 2023 | 75% | $ 15,375,000 | $12,550,580 |
| 2024 | 15% | $ 3,075,000 | $ 2,345,903 |
| 2025 | | $ - | $ - |
| 2026 | | $ - | $ - |
| 2027 | | $ - | $ - |
| 2028 | | $ - | $ - |
| 2029 | | $ - | $ - |
| 2030 | | $ - | $ - |
| 2031 | | $ - | $ - |
| 2032 | | $ - | $ - |
| 2033 | | $ - | $ - |
| 2034 | | $ - | $ - |
| 2035 | | $ - | $ - |
| 2036 | | $ - | $ - |
| 2037 | | $ - | $ - |
| 2038 | | $ - | $ - |
| 2039 | | $ - | $ - |
| 2040 | | $ - | $ - |
| 2041 | | $ - | $ - |
| 2042 | | $ - | $ - |
| 2043 | | $ - | $ - |
| 2044 | | $(12,300,000) | $ (2,424,903) |
| **Total** | **100%** | **$ 8,200,000** | **$14,262,129** |

## BENEFITS SUMMARY

The McClellan-Kerr Arkansas River Navigation (MKARNS) Project **offers a Benefit-Cost Ratio of 11.01** 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 13*** and throughout this methodology memo were derived based on the 2022 Benefit-Cost Analysis Guidance (revised version).


TABLE 13: BENEFITS SUMMARY TABLE

| Project | Capital Costs | Project Costs (NPV) | Total Net Benefit | Total Net Benefit (NPV) | Benefit-Cost Ratio |
|---|---|---|---|---|---|
| **2022 BCA SUMMARY - MKARNS Mooring Modernization Project** | $ 20,500,000 | $ 14,262,129 | $ 455,982,250 | $ 142,752,869 | 11.01 |