

# BCA TECHNICAL MEMORANDUM

Oklahoma's Marine Highway  
MKARNS  
M-40

## MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM (MKARNS)

### MOORING MODERNIZATION PROJECT - 2022

## 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:

- **O& M Savings**                      **\$214,904 (NPV)**
- **Flood Damage Benefits**        **\$23,055 (NPV)**
- **Loss of Use Benefits**            **\$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 2<sup>nd</sup> 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:

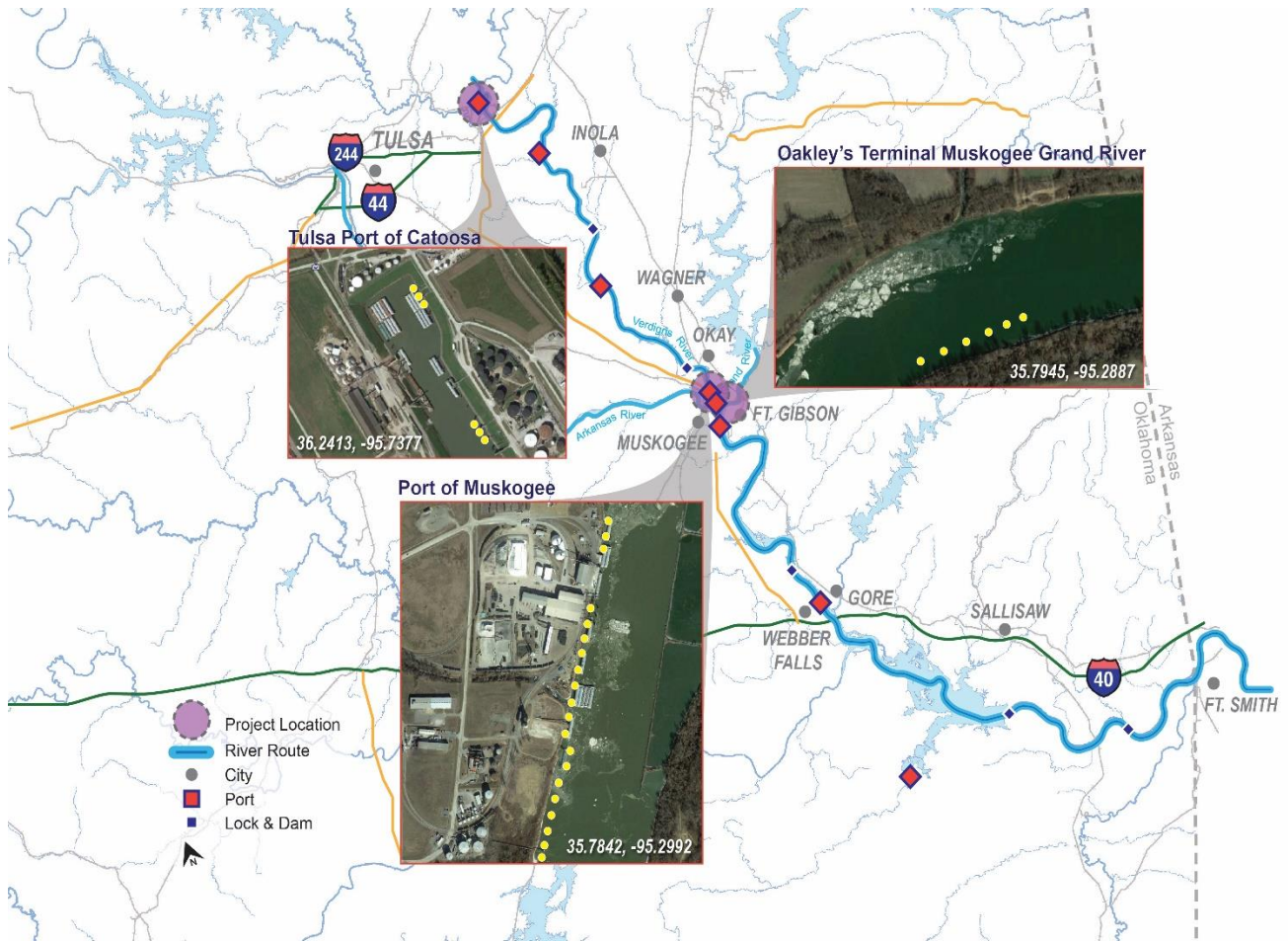
1. Tulsa Port of Catoosa – The Project will remove and replace 6 dolphin structures with new mooring structures with associated gangway<sup>1</sup> and platforms.
2. Port of Muskogee – The Project will remove and replace 20 dolphin structures with new mooring structures with associated gangway and platforms.
3. Oakley’s Terminal Muskogee – The Project will remove and replace 6 deadman anchors with new mooring structures with associated gangway and platforms.

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

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<sup>1</sup> Merriam-Webster defines a gangway as a passageway or walkway.

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.**<sup>2</sup> 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.<sup>3</sup>

## 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 Benefits
  - Flood Safety
  - Flood Environmental Benefits
  - Flood Travel Time Benefits
- Loss of Use (Existing infrastructure)
  - Loss of Use Safety Crash Benefits
  - Loss of Use Environmental Benefits
  - Loss of Use Economic Benefits

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 Port Infrastructure Development Program (PIDP) 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.

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<sup>2</sup> Tonnage information was informed by each Port location associated with this Project.

<sup>3</sup> [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.<sup>4</sup> The calculated Operations and Maintenance cost benefits for the Build and No Build scenarios are show in **Table 1**.

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<sup>4</sup> [Oklahoma Freight Transportation Plan 2018-2022](#)

**TABLE 1: OPERATIONS AND MAINTENANCE COST BENEFITS**

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
<b>Total</b>		<b>\$ 420,000</b>		<b>\$ 64,000</b>	<b>\$ 356,000</b>	<b>\$ 214,904</b>

## FLOOD RISK REDUCTION BENEFITS

**The Project produces \$23,055 (NPV) benefits 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 benefits are displayed in *Table 2*.

TABLE 2: FLOOD RISK BENEFITS

Year	Flood Risk Reduction			NPV
	No Build Cost Potential	Build Cost Potential	Savings	
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
<b>Total</b>		<b>\$ 62,247</b>	<b>\$ 23,055</b>	

### *Flood - Safety Benefits*

The Flood safety benefits 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.<sup>5</sup>



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*.**

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<sup>5</sup> [Bureau of Transportation Statistics](#)



**TABLE 3: WATERWAY DIVERSION INCREASED CRASH COSTS - PART 1**

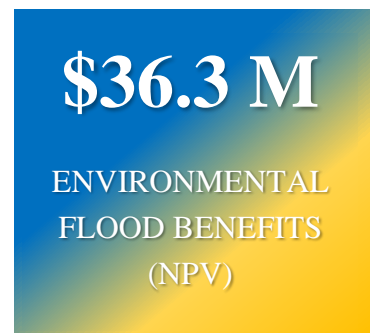
Year	Flood Waterway Diversion					
	Waterway Tons Diverted			Waterway Ton-Miles Diverted		
	Catoosa	Port 33	Muskogee	Catoosa	Port 33	Muskogee
2018	320,371	342,335	112,375	142,565,114	147,888,720	44,163,539
2019	321,973	344,047	112,937	143,277,939	148,628,164	44,384,356
2020	325,201	347,496	113,502	144,714,300	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							Increased Crash Cost	NPV
	Diverted Ton-Miles		Base		Diversion				
	Rail	Truck	Fatalities	Inuries	Fatalities	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	
<b>Total</b>								<b>\$ 304,146,836</b>	<b>\$ 102,492,920</b>

*Environmental - Flood Damage Benefits*

The total **environmental flood damage benefits, \$36.3 million (NPV)**, are based on anecdotal evidence from port directors that 75 percent of cargo would be diverted to rail and truck. The remaining 25 percent was categorized as goods unable to be moved, which would sit as storage until flood conditions subsided. 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 benefits.

TABLE 5: ENVIRONMENTAL COST BENEFITS - 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)
<b>Total</b>								\$ 114,508,836	\$ (3,370,803)	\$38,332,469	\$ (2,023,366)

*Flood Event - Travel Time Benefits*

Travel time benefits 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 BENEFITS

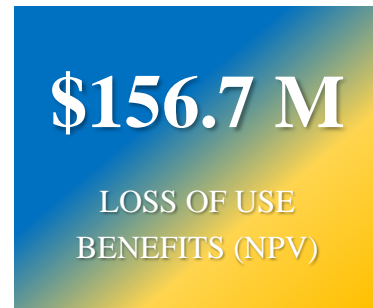
Year	Traffic Volumes		Vehicle Hours Traveled				Reduction in VHT		VHT Benefit
			Detour		Bridge		Passenger Vehicles	Trucks	
	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks			
2024	22,138	685							\$ -
2025	22,281	689	5,996	185	1,783	55	-4,213	-130	\$ (79,159)
2026	22,425	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)
<b>Total</b>									<b>\$ (1,684,299)</b>

TABLE 7: OPERATIONAL BENEFITS

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)
<b>Total</b>									<b>\$ (2,361,896)</b>

LOSS OF USE BENEFITS

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 benefits.**



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.<sup>6</sup>

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 be 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 BENEFITS – 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

<sup>6</sup> Bureau of Transportation Statistics

TABLE 9: LOSS OF USE SAFETY BENEFITS – PART 2

Year	Loss of Use - Safety					Increased Crash Cost	NPV
	Base		Diversion				
	Fatalities	Inuries	Fatalities	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	
					<b>Total</b>	\$ 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 usability 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 be 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 benefits.

TABLE 10: LOSS OF USE ENVIRONMENTAL BENEFITS

Year	Loss of Use Diversion - Environmental										
	Diverted Ton-Miles			Metric Tons			Cost		NPV		
	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)
<b>Total</b>								\$ 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 2044, 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 benefits associated with loss of use are displayed in **Table 11**.

TABLE 11: LOSS OF USE ECONOMIC BENEFITS

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	
<b>Total</b>							\$ 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)
<b>Total</b>	<b>100%</b>	<b>\$ 8,200,000</b>	<b>\$14,262,129</b>

### 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