



The HNTB Companies
Infrastructure Solutions

BCA TECHNICAL MEMORANDUM

Grady County US Highway 81 Realignment
Highway Realignment Project
Oklahoma Department of Transportation

Executive Summary

The Project will create a new, divided, two-lane, controlled-access facility to create better traffic flow for vehicles that currently use the 8.5 mile existing four-lane divided US-81 alignment to pass through downtown Chickasha, Oklahoma. The project includes the construction of an access controlled two-lane divided facility with six grade separated interchanges and two grade separated rail crossings.

The project significantly improves travel time savings due to the realignment, removal of the at grade rail crossing and removal of delay from super loads resulting in the largest positive cash flow for this project.

The **\$250.5 million** total capital project cost of the Program yields:

- **Benefit-cost ratio (BCR) of 1.61**
- **Internal rate of return of 1.94 percent**
- **Positive net user benefit of about \$312.8 million (NPV)** over 30 years, mostly from travel time savings.

Over the life of the **PROJECT**, these investments will produce:

- | | |
|-----------------------------------|----------------------------------------------|
| • Safety Savings | \$8.8 million net present value (NPV) |
| • Environmental Protection | \$3.1 million (NPV) |
| • Travel Time Savings | \$281.3 million (NPV) |
| • Operational Savings | \$11.2 million (NPV) |
| • Maintenance Savings | \$8.4 million (NPV) |

Methodology

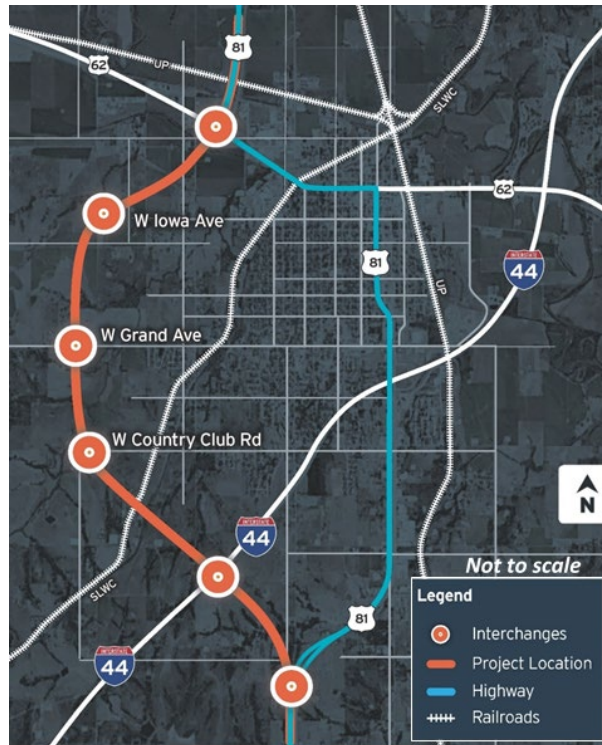
The Benefit Cost Analysis (BCA) was prepared in accordance with the [2022 FHWA BCA Guidance for Discretionary Grant Programs](#) using total quantifiable project costs and benefits that are adjusted for inflation and then discounted to reflect the time value of money. In summary, the BCA was created by:

1. Identifying the Project’s benefits and costs in terms of proposed 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. Assuming inflation based on the Implicit Price Deflators for Gross Domestic Product;
5. Discounting dollar amounts by 7 percent to reflect the time value of money;
6. Emissions discounted at 3 percent rate; and
7. Setting an appropriate analysis period of 30 years for the Project’s development, construction and subsequent operational service.

Project Overview

The project segment of US Highway 81 (US-81) routes along a portion of the old Chisholm Trail, one of the nation’s early freight transportation corridors. The existing route through downtown Chickasha includes more than a dozen signalized intersections and two 90-degree right-angle turns that are difficult for freight to maneuver. Current average speeds on this segment of US-81 through Chickasha are 35 mph, compared to the posted and average speeds of 70 mph and 55 mph north and south of Chickasha. The proposed project includes construction of a new, divided, two-lane, controlled-access facility to create better traffic flow for vehicles that currently use the existing four-lane divided US-81 alignment to pass through downtown Chickasha, Oklahoma. The project includes the construction of an access controlled two-lane divided facility with six grade separated interchanges and two grade separated rail crossings. The Project Area is shown in **Figure 1** on the following page.

Figure 1: Project Area



As mentioned previously, the project will have significant savings in travel time and reduction of collisions. These are just a few of the overall benefits identified from the BCA. **Table 1** outlines all of the proposed improvements that were evaluated by the BCA in a detailed spreadsheet to show the total of all benefits discounted at 7 percent with a 3 percent discount applied to CO₂ emissions.

Table 1: Proposed Improvements

Analysis Year	30 Year BENEFITS									
	Operation and Maintenance Savings	Economic Competitiveness		Environmental		Safety	Total	7% Discount	3% Discount	Total Discount
		Travel Time Savings	Operational Savings	Pollutants (Nox & PM2.5)	Reduced Pollutants (CO2)	Crash Savings				
2011										
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019										
2020										
2021										
2022										
2023										
2024										
2025										
2026										
2027	\$1,174,512	\$8,077,162	\$2,303,983	\$362,694	\$356	\$927,200	\$12,845,906	\$7,999,563	\$289	\$7,999,853
2028	\$2,468,652	\$8,385,131	\$2,227,716	\$369,380	\$322	\$931,100	\$14,382,300	\$8,370,442	\$254	\$8,370,697
2029	\$1,666,052	\$8,716,418	\$2,149,259	\$376,153	\$278	\$840,800	\$13,748,959	\$7,478,372	\$213	\$7,478,585
2030	(\$88,749)	\$9,073,866	\$2,067,772	\$383,634	\$231	\$853,900	\$12,290,655	\$6,247,828	\$172	\$6,248,000
2031	\$381,652	\$9,460,801	\$1,982,763	\$383,992	\$181	\$840,800	\$13,050,189	\$6,199,965	\$131	\$6,200,095
2032	(\$88,749)	\$9,881,148	\$1,895,895	\$384,426	\$128	\$913,400	\$12,986,248	\$5,765,993	\$90	\$5,766,082
2033	(\$2,431,949)	\$10,375,202	\$1,808,539	\$385,001	\$72	\$845,400	\$10,982,265	\$4,557,220	\$49	\$4,557,269
2034	\$2,765,372	\$10,877,704	\$1,715,117	\$385,111	\$12	\$1,387,100	\$17,130,416	\$6,643,466	\$8	\$6,643,474
2035	\$7,085,432	\$11,430,556	\$1,622,710	\$385,813	(\$52)	\$1,391,700	\$21,916,159	\$7,943,443	(\$33)	\$7,943,410
2036	\$4,602,012	\$12,041,904	\$1,522,736	\$385,601	(\$121)	\$1,464,300	\$20,016,431	\$6,780,299	(\$75)	\$6,780,223
2037	(\$88,749)	\$12,721,796	\$1,422,588	\$385,963	(\$193)	\$1,387,100	\$15,828,506	\$5,010,961	(\$117)	\$5,010,844
2038	\$852,052	\$13,482,700	\$1,317,563	\$385,876	(\$269)	\$1,378,600	\$17,416,521	\$5,153,000	(\$158)	\$5,152,842
2039	(\$88,749)	\$14,340,334	\$1,210,863	\$385,916	(\$349)	\$1,382,500	\$17,230,515	\$4,764,477	(\$199)	\$4,764,278
2040	(\$2,431,949)	\$15,314,754	\$1,100,970	\$386,007	(\$434)	\$1,378,600	\$15,747,949	\$4,069,681	(\$240)	\$4,069,441
2041	\$1,274,052	\$16,431,996	\$987,717	\$385,724	(\$522)	\$1,231,400	\$20,310,367	\$4,905,345	(\$281)	\$4,905,065
2042	\$2,468,652	\$17,726,462	\$870,085	\$385,475	(\$616)	\$1,378,600	\$22,828,658	\$5,152,868	(\$321)	\$5,152,546
2043	\$1,666,052	\$19,301,469	\$749,422	\$384,909	(\$722)	\$1,369,400	\$23,470,530	\$4,951,187	(\$366)	\$4,950,822
2044	(\$88,749)	\$21,108,277	\$626,924	\$384,838	(\$826)	\$1,374,000	\$23,404,464	\$4,614,274	(\$406)	\$4,613,868
2045	\$381,652	\$23,294,479	\$499,877	\$384,376	(\$934)	\$1,360,900	\$25,920,349	\$4,775,975	(\$446)	\$4,775,529
2046	(\$88,749)	\$25,994,919	\$367,095	\$383,505	(\$1,048)	\$1,365,500	\$28,021,222	\$4,825,909	(\$486)	\$4,824,823
2047	(\$2,812,049)	\$29,417,002	\$235,182	\$383,220	(\$1,166)	\$1,360,900	\$28,583,089	\$4,600,075	(\$525)	\$4,599,550
2048	\$1,274,052	\$33,896,995	\$94,845	\$382,060	(\$1,290)	\$646,500	\$36,293,161	\$5,458,766	(\$564)	\$5,458,202
2049	\$2,468,652	\$40,018,668	(\$46,998)	\$381,453	(\$1,420)	\$646,500	\$43,466,855	\$6,110,023	(\$603)	\$6,109,420
2050	\$1,666,052	\$48,892,196	(\$193,720)	\$380,397	(\$1,574)	\$569,300	\$51,312,651	\$6,741,002	(\$648)	\$6,740,353
2051	(\$88,749)	\$62,920,324	(\$342,972)	\$379,507	(\$1,716)	\$789,100	\$63,655,494	\$7,815,387	(\$686)	\$7,814,701
2052	\$381,652	\$88,451,822	(\$494,230)	\$378,686	(\$1,863)	\$707,300	\$89,423,367	\$10,260,752	(\$723)	\$10,260,028
2053	(\$88,749)	\$149,608,543	(\$655,075)	\$377,395	(\$2,020)	\$702,700	\$149,942,794	\$16,079,287	(\$762)	\$16,078,525
2054	(\$4,775,149)	\$491,000,149	(\$817,618)	\$375,807	(\$2,180)	\$556,200	\$486,337,210	\$48,740,615	(\$798)	\$48,739,817
2055	\$1,274,052	\$496,518,495	(\$983,488)	\$374,691	(\$2,348)	\$543,100	\$497,724,501	\$46,618,559	(\$834)	\$46,617,725
2056	\$2,468,652	\$502,098,868	(\$1,154,446)	\$373,227	(\$2,522)	\$547,700	\$504,331,478	\$44,147,107	(\$870)	\$44,146,237
Total	\$23,158,165	\$2,220,860,141	\$24,091,073	\$11,440,837	(\$22,605)	\$31,071,600	\$2,310,599,210	\$312,781,241	(\$8,937)	\$312,772,304

Project Beneficiaries

The economic competitiveness category quantifies multiple benefits with its analysis. The benefits quantified represent the difference of the reduced traffic on existing US-81 through Chickasha. Benefits quantified are associated with the build realignment and also account for traffic which will remain on the existing portion of US-81. Today there are approximately two super loads per day that navigate US-81. These loads will be rerouted to the realignment and eliminate traffic delay. In addition, the at-grade rail crossing north of US-62 will receive an overpass allowing for traffic to be unimpeded by trains. Currently four trains per day utilize this crossing with the number of trains per day anticipated to grow to ten by the year 2056. These

two delay contributors along with the reduction of traffic through the city center of Chickasha represent substantial benefits of the realignment project.

Project Benefits

The Project will provide substantial benefit by removing super loads from downtown Chickasha and grade separating all rail crossings along this segment of US-81. The benefits of the change in travel characteristics were quantified including reduced travel time, vehicle operating costs, reduced crash costs, and emissions costs.

The Benefit Cost Analysis was prepared for this project application in accordance with the [BCA Guidance for Discretionary Grant Programs dated March 2022](#). Calculations for all figures as well as the cited sources can be found within the BCA spreadsheets that are included with the INFRA grant submittal.

Travel Time and Vehicle Operating Cost Benefit

The benefit from reduced travel time was calculated by determining the change in travel time for the realigned route and eliminated delays due to super loads and trains compared to the current route. The time difference in vehicle hours traveled was then multiplied by the value of time provided in the BCA guidance (\$17.80 per hour for passenger vehicles and \$33.60 per hour for truck drivers).

It is important to note, that ODOT has incorporated USDOT feedback from the previous BCA submittal, which suggested that 100 percent of traffic likely would not be waiting in the queue. For this BCA submittal, 40 percent of passenger vehicle traffic was allowed to divert and experienced very low delay. The decision that only passenger vehicles would divert was based upon the nature of the alternate paths being narrow and residential in nature. The green time for the US-81 movements is based upon the T-intersection signal timing and was increased to prevent the volume from exceeding capacity but was capped at the moment volume did exceed capacity. Based upon the high-level traffic analysis at this intersection the future traffic volumes become quite high for the main US-81 turning movement in town and the super loads blocking the intersection cause significant problems. This model is sensitive to the capacity of the intersection and any factor adjusting that main movement capacity can have a significant impact on the BCA calculations.

The Project will produce **travel time savings with a discounted benefit value of \$281.3 million (NPV)**.

Tables 2 & 3 below show the improvement in travel time savings from the Project on an annual basis as a summary of the calculations and the cumulative benefit for the No-Build and Build Scenarios.



Table 2: Travel Time Savings No-Build Scenario

Year	No-Build									
	Traffic Volumes		Vehicle Hours Traveled		Super Load Delay (Hours)		Train Delay (Hours)		Total Delay (Hours)	
	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks
2027	13,431	1,660	3,166	391	362,430	47,044	1,228	135	366,824	47,570
2028	13,582	1,679	3,202	396	376,202	48,905	1,245	136	380,648	49,437
2029	13,734	1,698	3,237	400	391,015	50,908	1,261	138	395,514	51,446
2030	13,889	1,717	3,274	405	406,996	53,072	1,278	139	411,548	53,616
2031	14,045	1,736	3,311	409	424,293	55,415	1,295	141	428,898	55,965
2032	14,203	1,755	3,348	414	443,081	57,964	1,312	143	447,741	58,520
2033	14,363	1,775	3,386	418	463,568	60,745	2,991	324	469,944	61,488
2034	14,524	1,795	3,423	423	486,001	63,793	3,031	328	492,456	64,544
2035	14,688	1,815	3,462	428	510,681	67,149	3,072	332	517,215	67,909
2036	14,852	1,836	3,501	433	537,971	70,863	3,113	336	544,585	71,632
2037	15,020	1,866	3,540	438	568,320	74,997	3,154	340	575,014	75,775
2038	15,188	1,877	3,580	442	602,283	79,627	3,197	344	609,059	80,414
2039	15,359	1,898	3,620	447	640,561	84,850	3,240	348	647,421	85,645
2040	15,531	1,920	3,661	452	684,050	90,787	3,284	352	690,995	91,592
2041	15,706	1,941	3,702	458	733,911	97,599	3,328	356	740,942	98,413
2042	15,882	1,963	3,744	463	791,679	105,497	3,374	360	798,797	106,320
2043	16,061	1,985	3,786	468	859,427	114,765	6,079	648	869,292	115,881
2044	16,242	2,007	3,828	473	940,019	125,796	6,162	656	950,009	126,925
2045	16,424	2,030	3,871	478	1,037,537	139,162	6,246	664	1,047,655	140,294
2046	16,608	2,053	3,915	484	1,157,998	155,658	6,332	671	1,168,245	156,813
2047	16,795	2,076	3,959	489	1,310,653	176,585	6,419	679	1,321,031	177,753
2048	16,984	2,099	4,003	495	1,510,506	203,993	6,508	687	1,521,017	205,175
2049	17,175	2,123	4,048	500	1,783,601	241,460	6,598	695	1,794,247	242,656
2050	17,367	2,147	4,094	506	2,179,466	295,787	6,689	704	2,190,249	296,997
2051	17,563	2,171	4,140	512	2,805,299	381,696	6,782	712	2,816,221	382,920
2052	17,761	2,195	4,186	517	3,944,343	538,087	6,876	720	3,955,406	539,325
2053	17,960	2,220	4,233	523	6,669,044	912,244	10,894	1,139	6,684,172	913,906
2054	18,162	2,245	4,281	529	21,899,836	3,003,927	11,047	1,152	21,915,164	3,005,608
2055	18,366	2,270	4,329	535	22,145,959	3,037,687	11,202	1,166	22,161,490	3,039,387
2056	18,573	2,295	4,378	541	22,394,849	3,071,826	11,360	1,179	22,410,587	3,073,547

Table 3: Travel Time Savings Build Scenario with VHT Benefit Total

Year	Build				Reduction in VHT		VHT Benefit	VHT Benefit (NPV)
	Traffic Volumes		Vehicle Hours Traveled		Reduction in VHT			
	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks		
2027	14,477	988	2,521	172	364,303	47,398	\$8,077,162	\$5,030,051
2028	14,712	1,004	2,562	175	378,086	49,262	\$8,385,131	\$4,880,223
2029	14,950	1,020	2,604	178	392,910	51,268	\$8,716,418	\$4,741,154
2030	15,192	1,037	2,646	181	408,902	53,435	\$9,073,866	\$4,612,693
2031	15,438	1,054	2,689	184	426,210	55,782	\$9,460,801	\$4,494,758
2032	15,688	1,071	2,732	187	445,008	58,333	\$9,881,148	\$4,387,348
2033	15,942	1,088	2,777	189	467,168	61,298	\$10,375,202	\$4,305,340
2034	16,200	1,106	2,822	193	489,634	64,352	\$10,877,704	\$4,218,561
2035	16,463	1,123	2,867	196	514,347	67,713	\$11,430,556	\$4,142,960
2036	16,729	1,142	2,914	199	541,671	71,433	\$12,041,904	\$4,079,010
2037	17,001	1,160	2,961	202	572,053	75,573	\$12,721,796	\$4,027,395
2038	17,276	1,179	3,009	205	606,051	80,208	\$13,482,700	\$3,989,044
2039	17,556	1,198	3,058	209	644,364	85,436	\$14,340,334	\$3,965,222
2040	17,841	1,217	3,107	212	687,888	91,380	\$15,314,754	\$3,957,623
2041	18,129	1,237	3,158	215	737,784	98,198	\$16,431,996	\$3,968,542
2042	18,423	1,257	3,209	219	795,588	106,101	\$17,726,462	\$4,001,096
2043	18,721	1,278	3,261	223	866,031	115,658	\$19,301,469	\$4,071,585
2044	19,025	1,298	3,314	226	946,696	126,699	\$21,108,277	\$4,161,426
2045	19,333	1,319	3,367	230	1,044,288	140,064	\$23,294,479	\$4,291,989
2046	19,646	1,341	3,422	234	1,164,823	156,579	\$25,994,919	\$4,476,208
2047	19,964	1,362	3,477	237	1,317,554	177,516	\$29,417,002	\$4,734,089
2048	20,287	1,385	3,533	241	1,517,484	204,934	\$33,896,995	\$5,098,183
2049	20,617	1,407	3,591	245	1,790,656	242,411	\$40,018,668	\$5,625,137
2050	20,950	1,430	3,649	249	2,186,600	296,747	\$48,892,196	\$6,422,827
2051	21,290	1,453	3,708	253	2,812,513	382,667	\$62,920,324	\$7,724,917
2052	21,634	1,476	3,768	257	3,951,638	539,068	\$88,451,822	\$10,149,062
2053	21,986	1,500	3,829	261	6,680,342	913,644	\$149,608,543	\$16,043,227
2054	22,341	1,525	3,891	266	21,911,272	3,005,342	\$491,000,149	\$49,207,713
2055	22,703	1,549	3,954	270	22,157,536	3,039,118	\$496,518,495	\$46,505,381
2056	23,071	1,574	4,018	274	22,406,568	3,073,272	\$502,098,868	\$43,951,454
Total							\$2,220,860,141	\$281,264,216

Vehicle operating costs were calculated by determining the number of miles changed by moving traffic to the realigned US-81. The change in vehicle miles travelled (VMT) were found separately for automobile and truck traffic. The VMTs were multiplied by the operating costs per mile provided in the BCA guidance (\$0.45 per mile for automobiles and \$0.94 per mile for trucks) to determine the additional costs to the user and the year in which they would occur. The Project will produce **vehicle operating costs with a discounted benefit value of \$11.2 million (NPV).**



Table 4 below shows the vehicle operating costs from the Project on an annual basis as a summary of the calculations and the cumulative benefit.

Table 4: Operational Cost Savings

Year	No-Build				Build				Reduction in VMT		VMT Benefit	VMT Benefit (NPV)
	Traffic Volumes		Vehicle Miles Traveled		Traffic Volumes		Vehicle Miles Traveled		Passenger Vehicles	Trucks		
	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks				
2027	13,431	1,660	40,444,069	4,998,705	14,477	988	40,055,576	2,733,640	388,492	2,265,065	\$2,303,983	\$1,434,805
2028	13,582	1,679	40,899,671	5,055,015	14,712	1,004	40,705,809	2,777,911	193,862	2,277,104	\$2,227,716	\$1,296,551
2029	13,734	1,698	41,357,953	5,111,667	14,950	1,020	41,364,287	2,822,179	-6,334	2,289,478	\$2,149,259	\$1,169,055
2030	13,889	1,717	41,824,275	5,169,292	15,192	1,037	42,033,835	2,869,213	-209,560	2,300,079	\$2,067,772	\$1,051,151
2031	14,045	1,736	42,293,277	5,227,259	15,438	1,054	42,714,566	2,916,256	-421,289	2,311,003	\$1,982,763	\$941,997
2032	14,203	1,755	42,767,639	5,285,888	15,688	1,071	43,406,197	2,963,286	-638,557	2,322,602	\$1,895,895	\$841,800
2033	14,363	1,775	43,250,042	5,345,511	15,942	1,088	44,109,010	3,010,325	-858,969	2,335,186	\$1,808,539	\$750,479
2034	14,524	1,795	43,735,124	5,405,465	16,200	1,106	44,822,894	3,060,131	-1,087,770	2,345,334	\$1,715,117	\$665,152
2035	14,688	1,815	44,228,246	5,466,412	16,463	1,123	45,550,444	3,107,158	-1,322,198	2,359,254	\$1,622,710	\$588,145
2036	14,852	1,836	44,724,049	5,527,691	16,729	1,142	46,286,581	3,159,739	-1,562,532	2,367,952	\$1,522,736	\$515,803
2037	15,020	1,856	45,227,891	5,589,964	17,001	1,160	47,039,038	3,209,534	-1,811,147	2,380,430	\$1,422,588	\$450,355
2038	15,188	1,877	45,734,413	5,652,568	17,276	1,179	47,799,911	3,262,103	-2,065,498	2,390,465	\$1,317,563	\$389,819
2039	15,359	1,898	46,248,976	5,716,166	17,556	1,198	48,574,621	3,314,673	-2,325,646	2,401,493	\$1,210,863	\$334,814
2040	15,531	1,920	46,768,898	5,780,426	17,841	1,217	49,363,169	3,367,243	-2,594,270	2,413,183	\$1,100,970	\$284,512
2041	15,706	1,941	47,294,181	5,845,348	18,129	1,237	50,160,132	3,422,587	-2,865,951	2,422,761	\$987,717	\$238,547
2042	15,882	1,963	47,824,823	5,910,933	18,423	1,257	50,973,586	3,477,924	-3,148,763	2,433,009	\$870,085	\$196,390
2043	16,061	1,985	48,363,506	5,977,512	18,721	1,278	51,798,110	3,536,028	-3,434,605	2,441,484	\$749,422	\$158,088
2044	16,242	2,007	48,907,548	6,044,753	19,025	1,298	52,639,239	3,591,366	-3,731,690	2,453,387	\$626,924	\$123,596
2045	16,424	2,030	49,456,951	6,112,657	19,333	1,319	53,491,437	3,649,470	-4,034,486	2,463,187	\$499,877	\$92,102
2046	16,608	2,053	50,011,713	6,181,223	19,646	1,341	54,357,359	3,710,334	-4,345,646	2,470,889	\$367,095	\$63,212
2047	16,795	2,076	50,574,516	6,250,783	19,964	1,362	55,237,231	3,768,439	-4,662,716	2,482,344	\$235,182	\$37,848
2048	16,984	2,099	51,142,679	6,321,005	20,287	1,385	56,130,998	3,832,081	-4,988,320	2,488,924	\$94,845	\$14,265
2049	17,175	2,123	51,718,881	6,392,221	20,617	1,407	57,044,023	3,892,950	-5,325,142	2,499,272	(\$46,998)	(\$6,606)
2050	17,367	2,147	52,297,764	6,463,769	20,950	1,430	57,965,464	3,956,593	-5,667,700	2,507,176	(\$193,720)	(\$25,448)
2051	17,563	2,171	52,887,367	6,536,641	21,290	1,453	58,906,050	4,020,220	-6,018,683	2,516,421	(\$342,972)	(\$42,108)
2052	17,761	2,195	53,482,329	6,610,176	21,634	1,476	59,857,819	4,083,856	-6,375,489	2,526,320	(\$494,230)	(\$56,708)
2053	17,960	2,220	54,082,652	6,684,373	21,986	1,500	60,831,840	4,150,267	-6,749,188	2,534,106	(\$655,075)	(\$70,247)
2054	18,162	2,245	54,691,015	6,759,564	22,341	1,525	61,813,995	4,219,433	-7,122,980	2,540,131	(\$817,618)	(\$81,941)
2055	18,366	2,270	55,304,738	6,835,417	22,703	1,549	62,816,053	4,285,839	-7,511,315	2,549,578	(\$983,488)	(\$92,116)
2056	18,573	2,295	55,926,501	6,912,264	23,071	1,574	63,833,765	4,355,006	-7,907,264	2,557,258	(\$1,154,446)	(\$101,055)
Total											\$24,091,073	\$11,162,253

Safety Benefit

The Project produces **safety savings of \$8.83 million (NPV)**. The reduction in costs associated with crashes along existing US-81 using the existing crash rate will experience less crashes due to lower traffic volumes. The realigned US-81 crashes were then estimated utilizing the Grady County, Oklahoma crash rate to determine the number of crashes on the new facility. These two crash predictions were combined and subtracted from the projected no-build number of crashes to determine crash savings each year. The safety benefits by year are reflected below in **Table 5**.



Table 5: Safety Crash Savings

Safety Crash Savings				
Year	Total Cost		Potential Cost Savings	Potential Cost Savings (NPV)
	No Build	Build		
2027	\$16,650,600	\$15,723,400	\$927,200	\$577,414
2028	\$16,659,100	\$15,728,000	\$931,100	\$541,909
2029	\$16,667,600	\$15,826,800	\$840,800	\$457,339
2030	\$16,685,300	\$15,831,400	\$853,900	\$434,079
2031	\$16,693,800	\$15,853,000	\$840,800	\$399,458
2032	\$16,779,500	\$15,866,100	\$913,400	\$405,561
2033	\$16,797,200	\$15,951,800	\$845,400	\$350,811
2034	\$17,511,600	\$16,124,500	\$1,387,100	\$537,941
2035	\$17,529,300	\$16,137,600	\$1,391,700	\$504,416
2036	\$17,615,000	\$16,150,700	\$1,464,300	\$496,009
2037	\$17,628,100	\$16,241,000	\$1,387,100	\$439,120
2038	\$17,636,600	\$16,258,000	\$1,378,600	\$407,878
2039	\$17,658,200	\$16,275,700	\$1,382,500	\$382,273
2040	\$17,740,000	\$16,361,400	\$1,378,600	\$356,256
2041	\$17,761,600	\$16,530,200	\$1,231,400	\$297,399
2042	\$17,925,800	\$16,547,200	\$1,378,600	\$311,168
2043	\$17,934,300	\$16,564,900	\$1,369,400	\$288,871
2044	\$18,033,100	\$16,659,100	\$1,374,000	\$270,879
2045	\$18,037,700	\$16,676,800	\$1,360,900	\$250,745
2046	\$18,059,300	\$16,693,800	\$1,365,500	\$235,133
2047	\$18,149,600	\$16,788,700	\$1,360,900	\$219,010
2048	\$18,158,100	\$17,511,600	\$646,500	\$97,235
2049	\$18,175,800	\$17,529,300	\$646,500	\$90,874
2050	\$18,192,800	\$17,623,500	\$569,300	\$74,787
2051	\$18,438,800	\$17,649,700	\$789,100	\$96,880
2052	\$18,447,300	\$17,740,000	\$707,300	\$81,156
2053	\$18,464,300	\$17,761,600	\$702,700	\$75,354
2054	\$18,482,000	\$17,925,800	\$566,200	\$55,742
2055	\$18,576,200	\$18,033,100	\$543,100	\$50,868
2056	\$18,593,900	\$18,046,200	\$547,700	\$47,943
Total	\$531,682,500	\$500,610,900	\$31,071,600	\$8,834,510

Environmental Cost Savings

The Project produces an emissions increase from induced demand, resulting in **emissions damage savings of \$3.1 million NPV over 30 years**. The reduction in emission damage from traffic diverted to the realigned US-81 were computed for Volatile Organic Compounds (VOCs), Nitrogen Oxides (NOx), Particulate Matter (PM2.5), and Carbon Dioxide (CO₂). In order to calculate the emission reduction, emission rates were obtained from Federal Transit Administration (FTA), New and Small Starts Evaluation and Rating Process Final Policy Guidance, in addition to Environmental Protection Agency (EPA) source. These rates were used to calculate pollution volumes by mode of travel (Automobile, Trucks, Bus). The reduction in VMT was then converted to the amount of emission (in grams) of each type of pollutant by its emission production factor (grams/VMT). This reduction was then monetized based upon the BCA guidance. **Table 6** on the following page shows the value of the emission improvement.

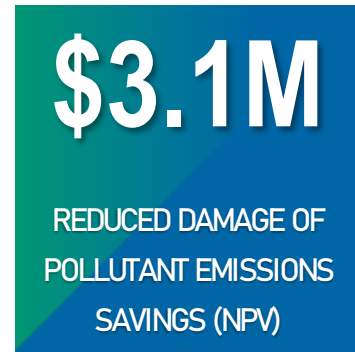


Table 6: Emission Reduction Savings

Year	VMT Savings		Pollutant Emissions Calculations (metric tons)				Benefit of Reduced Damage		
	Passenger Vehicles	Truck	Nitrogen Oxides	Particulate Matter (2.5)	Carbon Dioxide	Nox & PM 2.5	CO2	Environmental Benefit	Environmental Benefit (NPV)
2027	388,492	2,265,065	9.52	0.24	6.14	\$362,694	\$356	\$363,050	\$226,157
2028	193,862	2,277,104	9.53	0.24	5.36	\$369,380	\$322	\$369,702	\$215,237
2029	-6,334	2,289,478	9.54	0.24	4.55	\$376,153	\$278	\$376,431	\$204,815
2030	-209,560	2,300,079	9.55	0.24	3.73	\$383,634	\$231	\$383,865	\$195,192
2031	-421,289	2,311,003	9.55	0.24	2.87	\$383,992	\$181	\$384,173	\$182,563
2032	-638,557	2,322,602	9.56	0.24	1.99	\$384,426	\$128	\$384,554	\$170,780
2033	-858,969	2,335,186	9.57	0.24	1.10	\$385,001	\$72	\$385,073	\$159,811
2034	-1,087,770	2,345,334	9.57	0.24	0.17	\$385,111	\$12	\$385,123	\$149,361
2035	-1,322,198	2,359,254	9.58	0.24	-0.77	\$385,813	(\$52)	\$385,761	\$139,803
2036	-1,562,532	2,367,952	9.57	0.24	-1.75	\$385,601	(\$121)	\$385,480	\$130,541
2037	-1,811,147	2,380,430	9.58	0.25	-2.76	\$385,963	(\$193)	\$385,770	\$122,069
2038	-2,065,498	2,390,465	9.57	0.25	-3.80	\$385,876	(\$269)	\$385,607	\$114,009
2039	-2,325,646	2,401,493	9.57	0.25	-4.85	\$385,916	(\$349)	\$385,567	\$106,510
2040	-2,594,270	2,413,183	9.56	0.25	-5.95	\$386,007	(\$434)	\$385,573	\$99,511
2041	-2,865,951	2,422,761	9.55	0.25	-7.05	\$385,724	(\$522)	\$385,202	\$92,877
2042	-3,148,763	2,433,009	9.54	0.25	-8.21	\$385,475	(\$616)	\$384,859	\$86,685
2043	-3,434,605	2,441,484	9.52	0.25	-9.38	\$384,909	(\$722)	\$384,187	\$80,830
2044	-3,731,690	2,453,387	9.51	0.25	-10.59	\$384,838	(\$826)	\$384,012	\$75,463
2045	-4,034,486	2,463,187	9.49	0.24	-11.82	\$384,376	(\$934)	\$383,442	\$70,375
2046	-4,345,646	2,470,889	9.47	0.24	-13.10	\$383,505	(\$1,048)	\$382,457	\$65,552
2047	-4,662,716	2,482,344	9.45	0.24	-14.39	\$383,220	(\$1,166)	\$382,054	\$61,147
2048	-4,988,320	2,488,924	9.42	0.24	-15.73	\$382,060	(\$1,290)	\$380,770	\$56,899
2049	-5,325,142	2,499,272	9.40	0.24	-17.11	\$381,453	(\$1,420)	\$380,033	\$53,016
2050	-5,667,700	2,507,176	9.36	0.24	-18.52	\$380,397	(\$1,574)	\$378,823	\$49,323
2051	-6,018,693	2,516,421	9.34	0.24	-19.96	\$379,507	(\$1,716)	\$377,791	\$45,907
2052	-6,375,489	2,526,320	9.31	0.24	-21.42	\$378,686	(\$1,863)	\$376,823	\$42,727
2053	-6,749,188	2,534,106	9.27	0.24	-22.95	\$377,395	(\$2,020)	\$375,375	\$39,708
2054	-7,122,980	2,540,131	9.22	0.24	-24.49	\$375,807	(\$2,180)	\$373,627	\$36,865
2055	-7,511,315	2,549,578	9.19	0.24	-26.09	\$374,691	(\$2,348)	\$372,343	\$34,260
2056	-7,907,264	2,557,258	9.14	0.24	-27.72	\$373,227	(\$2,522)	\$370,705	\$31,800
					Total	\$11,440,837	(\$22,605)	\$11,418,232	\$3,139,792

Project Costs

The project has a **total capital cost of \$250,496,353** in 2020 dollars over a four-year construction period from 2022 to December 2026. Numbers shown are in 2020 dollars to provide a uniform base year. All costs by year are shown in **Table 7** which includes its Net Present Value (NPV) based on a discount rate of 7 percent.

At the end of the 30-year analysis period, the corridor will have a **discounted residual value of \$194.4 million** as calculated using the FHWA-recommended residual value calculation for the time before US-81 will need to be replaced (50 years).

Benefits Summary

The Grady County US-81 Realignment has a **Benefit-Cost Ratio of 1.61**. This ratio was derived by dividing total discounted benefits by total discounted costs over a 30-year period. It and other figures shown below in **Table 8** and throughout this methodology memo were derived based on [FHWA 2022 BCA Guidance](#).

Table 7: Summary of Estimated Capital Costs

Project Costs			
Year	Percent Project Cost Paid	Project Cost	Project Cost (NPV)
2011	1%	\$3,062,007	\$3,551,928
2012		\$0	\$0
2013		\$0	\$0
2014		\$0	\$0
2015		\$0	\$0
2016	1%	\$3,305,800	\$3,537,206
2017		\$0	\$0
2018	7%	\$17,792,826	\$18,326,611
2019	9%	\$23,729,318	\$23,966,611
2020	0%	\$741,486	\$741,486
2021		\$0	\$0
2022	3%	\$7,305,745	\$6,381,121
2023	23%	\$57,292,487	\$46,767,735
2024	27%	\$67,141,816	\$51,222,170
2025	16%	\$40,720,111	\$29,032,876
2026	12%	\$29,404,756	\$19,593,631
2027		\$0	\$0
2028		\$0	\$0
2029		\$0	\$0
2030		\$0	\$0
2031		\$0	\$0
2032		\$0	\$0
2033		\$0	\$0
2034		\$0	\$0
2035		\$0	\$0
2036		\$0	\$0
2037		\$0	\$0
2038		\$0	\$0
2039		\$0	\$0
2040		\$0	\$0
2041		\$0	\$0
2042		\$0	\$0
2043		\$0	\$0
2044		\$0	\$0
2045		\$0	\$0
2046		\$0	\$0
2047		\$0	\$0
2048		\$0	\$0
2049		\$0	\$0
2050		\$0	\$0
2051		\$0	\$0
2052		\$0	\$0
2053		\$0	\$0
2054		\$0	\$0
2055		\$0	\$0
2056		(\$100,198,541)	(\$8,770,925)
Total	100%	\$150,297,812	\$194,350,450

Table 8: Summary

Project	Capital Costs	Project Costs (NPV)	Total Net Benefit	Total Net Benefit (NPV)	Benefit-Cost Ratio
2022 BCA SUMMARY - U.S. 81 Realignment	\$250,496,353	\$194,350,450	\$2,310,599,210	\$312,772,304	1.61