

# BCA TECHNICAL MEMORANDUM

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

## Executive Summary

The Project will extend US Highway 81 from the US Highway 81 and State Highway 19 (SH-19) junction to the US Highway 81 and US Highway 62 (US-62) junction, realigning US Highway 81 on the west side of the City of Chickasha. The project includes the construction of an access controlled four-lane divided facility with six grade separated interchanges and two grade separated rail crossings. The Project provides a benefit-cost ratio (BCR) of 1.92 and an internal rate of return of 3.06 percent.

At this rate, the proposed total capital project cost of \$242.8 million will produce a positive net user benefit of about \$300.8 million (NPV) over 30 years.

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. Over the life of the Project, these investments will produce:

- Improved Travel Time \$259.3 million net present value (NPV)
- Improved Operational Savings \$-13.7 million (NPV)
- Safety Crash Savings \$56.7 million (NPV)
- Environmental Savings \$-1.4 million (NPV)

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

## **Methodology**

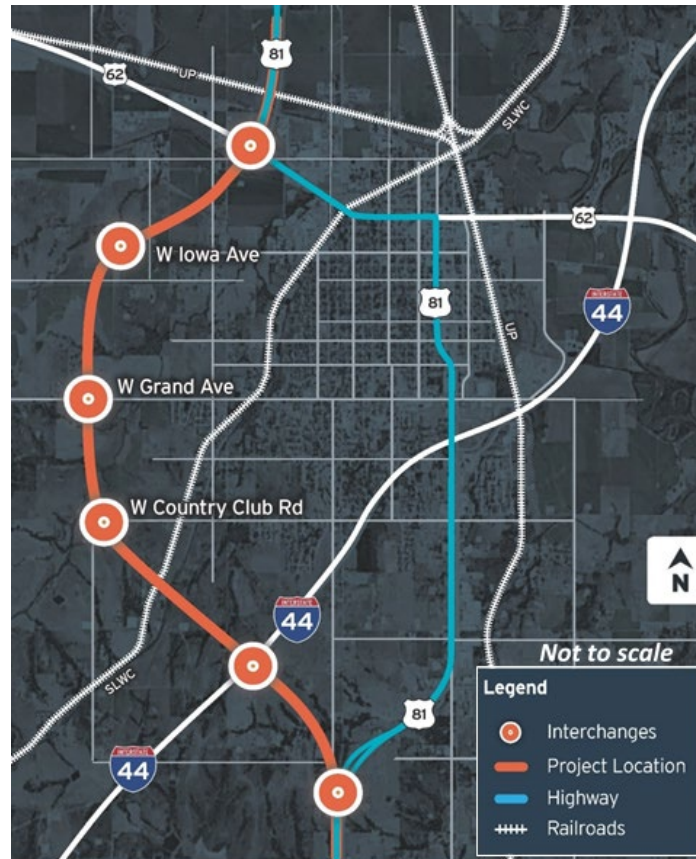
In summary, the BCA was created by:

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 2018 dollars;
4. Discounting dollar amounts by 7 percent to reflect the time value of money; and
5. 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 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 Highway 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 four-lane divided facility with six grade separated interchanges and two grade separated rail crossings. This investment will transform this segment of the corridor and match the existing four-lane divided character of US Highway 81 south of Chickasha. 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.

**Table 1: Proposed Improvements**

30 Year BENEFITS						
Analysis Year	Economic Competitiveness		Environmental	Safety	Total	7% Discount
	Travel Time Savings	Operational Savings	Reduced Pollutants	Crash Savings		
2021						
2022						
2023						
2024						
2025						
2026						
2027	\$11,334,947	(\$1,584,298)	(\$160,826)	\$12,761,200	\$22,351,023	\$12,157,475
2028	\$11,861,831	(\$1,608,828)	(\$163,277)	\$12,572,300	\$22,662,025	\$11,520,225
2029	\$12,434,001	(\$1,634,489)	(\$165,868)	\$3,705,800	\$14,339,444	\$6,812,566
2030	\$13,091,276	(\$1,661,723)	(\$168,685)	\$3,178,400	\$14,439,268	\$6,411,207
2031	\$13,775,107	(\$1,687,340)	(\$171,162)	\$3,132,500	\$15,049,106	\$6,244,844
2032	\$14,527,688	(\$1,714,092)	(\$174,083)	\$3,332,200	\$15,971,712	\$6,194,105
2033	\$15,360,535	(\$1,742,124)	(\$176,850)	\$3,716,600	\$17,158,162	\$6,218,907
2034	\$16,288,003	(\$1,771,132)	(\$179,743)	\$3,855,600	\$18,192,728	\$6,162,506
2035	\$17,328,241	(\$1,797,454)	(\$182,565)	\$3,417,700	\$18,765,922	\$5,940,810
2036	\$18,504,535	(\$1,824,613)	(\$185,144)	\$3,806,500	\$20,301,279	\$6,006,416
2037	\$19,847,354	(\$1,855,497)	(\$188,329)	\$3,809,700	\$21,613,228	\$5,976,238
2038	\$21,397,443	(\$1,886,438)	(\$191,616)	\$3,927,100	\$23,246,490	\$6,007,335
2039	\$23,210,648	(\$1,916,545)	(\$194,523)	\$3,486,400	\$24,585,980	\$5,937,836
2040	\$25,422,095	(\$1,946,710)	(\$197,533)	\$3,817,300	\$27,095,152	\$6,115,733
2041	\$26,831,216	(\$2,170,115)	(\$216,427)	\$13,609,400	\$38,054,074	\$8,027,388
2042	\$28,413,863	(\$2,189,428)	(\$218,431)	\$13,612,600	\$39,618,604	\$7,810,674
2043	\$30,206,040	(\$2,212,274)	(\$220,875)	\$13,612,600	\$41,385,491	\$7,625,243
2044	\$32,255,743	(\$2,230,122)	(\$222,551)	\$13,028,500	\$42,831,570	\$7,375,403
2045	\$34,627,400	(\$2,250,566)	(\$224,693)	\$13,164,300	\$45,316,441	\$7,292,791
2046	\$37,409,805	(\$2,271,504)	(\$226,721)	\$13,691,700	\$48,603,280	\$7,310,041
2047	\$40,729,006	(\$2,291,557)	(\$228,572)	\$13,624,600	\$51,833,477	\$7,285,859
2048	\$44,770,504	(\$2,312,841)	(\$230,778)	\$13,627,800	\$55,854,684	\$7,337,469
2049	\$49,819,602	(\$2,333,394)	(\$232,820)	\$13,627,800	\$60,881,188	\$7,474,567
2050	\$56,420,341	(\$2,353,061)	(\$234,684)	\$13,246,600	\$67,079,195	\$7,696,743
2051	\$65,221,995	(\$2,373,961)	(\$236,904)	\$13,705,700	\$76,316,830	\$8,183,812
2052	\$77,857,988	(\$2,396,717)	(\$239,121)	\$13,841,500	\$89,063,649	\$8,925,901
2053	\$97,748,527	(\$2,415,999)	(\$241,000)	\$13,788,000	\$108,879,528	\$10,197,977
2054	\$134,208,093	(\$2,440,329)	(\$243,445)	\$13,774,000	\$145,298,320	\$12,718,755
2055	\$224,857,320	(\$2,461,324)	(\$245,554)	\$13,788,000	\$235,938,443	\$19,301,850
2056	\$885,636,255	(\$2,485,417)	(\$248,085)	\$13,911,800	\$896,814,552	\$68,567,623
<b>Total</b>	<b>\$2,101,397,400</b>	<b>(\$61,819,891)</b>	<b>(\$6,210,865)</b>	<b>\$286,174,200</b>	<b>\$2,319,540,844</b>	<b>\$300,838,299</b>

**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 Highway 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 Highway 81. Today there are approximately two super loads per day that navigate US Highway 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 Highway 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 January 2020. 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 additional time (122.6 million hours from automobiles and 2.2 million hours from trucks) was then multiplied by the value of time provided in the BCA guidance (\$16.60 per hour for passenger vehicles and \$29.50 per hour for truck drivers).



The Project will produce **travel time savings with a discounted benefit value of \$259.3 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 Travelled		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	12,280	2,515	2,865	587	583,919	54,570	1,145	214	587,930	55,372
2028	12,477	2,555	2,911	596	613,480	55,777	1,166	218	617,558	56,591
2029	12,677	2,596	2,958	606	645,708	57,018	1,188	222	649,854	57,846
2030	12,879	2,638	3,005	616	680,985	58,295	2,723	507	686,713	59,418
2031	13,085	2,680	3,053	625	719,771	59,609	2,774	516	725,599	60,750
2032	13,295	2,723	3,102	635	762,630	60,961	2,827	525	768,558	62,121
2033	13,507	2,767	3,152	646	810,251	62,353	2,880	534	816,282	63,532
2034	13,723	2,811	3,202	656	863,497	63,787	2,934	543	869,633	64,986
2035	13,943	2,856	3,253	666	923,457	65,264	2,990	552	929,700	66,483
2036	14,166	2,902	3,306	677	991,531	66,787	3,047	562	997,883	68,025
2037	14,393	2,948	3,358	688	1,069,552	68,356	3,105	571	1,076,015	69,615
2038	14,623	2,995	3,412	699	1,159,970	69,975	3,164	581	1,166,546	71,255
2039	14,857	3,043	3,467	710	1,266,146	71,645	3,225	591	1,272,837	72,946
2040	15,094	3,092	3,522	721	1,392,827	73,368	3,284	1,069	1,402,193	75,158
2041	15,230	3,120	3,554	728	1,475,885	74,365	3,345	1,079	1,485,346	76,172
2042	15,367	3,148	3,586	734	1,569,334	75,381	3,407	1,089	1,578,891	77,205
2043	15,505	3,176	3,618	741	1,675,371	76,415	3,470	1,100	1,685,025	78,256
2044	15,645	3,205	3,651	748	1,796,885	77,468	3,534	1,111	1,806,638	79,327
2045	15,786	3,233	3,683	754	1,937,759	78,542	3,600	1,121	1,947,611	80,417
2046	15,928	3,262	3,716	761	2,103,340	79,635	3,667	1,132	2,113,293	81,528
2047	16,071	3,292	3,750	768	2,301,219	80,749	3,735	1,143	2,311,274	82,660
2048	16,216	3,321	3,784	775	2,542,572	81,884	3,804	1,154	2,552,730	83,814
2049	16,362	3,351	3,818	782	2,844,583	83,042	3,874	1,166	2,854,846	84,989
2050	16,510	3,381	3,852	789	3,235,184	84,221	3,945	1,177	3,249,217	86,184
2051	16,658	3,412	3,887	796	3,763,118	85,424	4,017	1,188	3,777,298	88,077
2052	16,807	3,443	3,922	803	4,521,992	86,650	4,090	1,199	4,536,321	89,329
2053	16,959	3,474	3,957	811	5,717,841	87,901	4,164	1,210	5,732,321	90,605
2054	17,111	3,505	3,993	818	7,911,779	89,177	4,239	1,221	7,926,412	91,907
2055	17,266	3,536	4,029	825	13,370,106	90,479	4,315	1,232	13,384,893	93,234
2056	17,421	3,568	4,065	833	53,173,547	91,807	4,391	1,243	53,188,491	94,589

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

Year	Build						VHT Benefit	VHT Benefit (NPV)
	Traffic Volumes		Vehicle Hours Travelled		Reduction in VHT			
	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks		
2027	14,118	3,012	2,540	542	585,390	54,830	\$11,334,947	\$6,165,460
2028	14,344	3,060	2,581	550	614,977	56,041	\$11,861,831	\$6,029,953
2029	14,574	3,109	2,622	559	647,232	57,286	\$12,434,001	\$5,907,304
2030	14,807	3,159	2,664	568	684,049	58,499	\$13,091,276	\$5,812,683
2031	15,044	3,209	2,706	577	722,892	60,173	\$13,775,107	\$5,716,180
2032	15,284	3,261	2,750	587	765,809	61,534	\$14,527,688	\$5,634,088
2033	15,529	3,313	2,794	596	813,489	62,936	\$15,360,535	\$5,567,365
2034	15,778	3,366	2,838	606	866,794	64,380	\$16,288,003	\$5,517,310
2035	16,029	3,420	2,884	615	926,816	65,867	\$17,328,241	\$5,485,677
2036	16,286	3,474	2,930	625	994,953	67,400	\$18,504,535	\$5,474,824
2037	16,547	3,530	2,977	635	1,073,038	68,980	\$19,847,354	\$5,487,959
2038	16,811	3,587	3,024	645	1,163,522	70,609	\$21,397,443	\$5,529,506
2039	17,081	3,644	3,073	656	1,269,764	72,290	\$23,210,648	\$5,605,675
2040	17,354	3,702	3,122	666	1,399,071	74,492	\$25,422,095	\$5,738,101
2041	17,632	3,761	3,172	677	1,482,174	75,496	\$26,831,216	\$5,659,961
2042	17,910	3,820	3,222	688	1,575,691	76,522	\$28,413,863	\$5,601,697
2043	18,191	3,880	3,272	699	1,681,796	77,567	\$30,206,040	\$5,565,438
2044	18,474	3,941	3,322	710	1,803,380	78,632	\$32,255,743	\$5,554,294
2045	18,760	4,003	3,372	721	1,944,324	79,716	\$34,627,400	\$5,572,600
2046	19,049	4,066	3,422	732	2,109,976	80,821	\$37,409,805	\$5,626,517
2047	19,341	4,130	3,472	743	2,307,927	81,946	\$40,729,006	\$5,724,984
2048	19,636	4,195	3,522	754	2,549,353	83,093	\$44,770,504	\$5,881,372
2049	19,934	4,261	3,572	765	2,851,438	84,262	\$49,819,602	\$6,116,502
2050	20,234	4,328	3,622	776	3,245,778	86,116	\$56,420,341	\$6,473,734
2051	20,536	4,396	3,672	787	3,773,829	87,337	\$65,221,995	\$6,994,061
2052	20,841	4,465	3,722	798	4,532,820	88,582	\$77,857,988	\$7,802,876
2053	21,148	4,535	3,772	809	5,728,789	89,852	\$97,748,527	\$9,155,414
2054	21,458	4,606	3,822	820	7,922,848	91,146	\$134,208,093	\$11,747,967
2055	21,770	4,678	3,872	831	13,381,297	92,467	\$224,857,320	\$18,395,316
2056	22,084	4,751	3,922	842	53,184,863	93,815	\$885,636,255	\$67,712,966
					<b>Total</b>		<b>\$2,101,397,400</b>	<b>\$259,257,786</b>



Reduced vehicle operating costs were calculated by determining the number of miles saved by moving traffic to the realigned US Highway 81. These reduction in vehicle miles travelled (VMT) were found separately for automobile (-82.5 million) and truck traffic (-29.2 million). The VMTs were multiplied by the operating costs per mile provided in the BCA guidance (\$0.41 per mile for automobiles and \$0.96 per mile for trucks) to determine the additional costs to the user and the year in which they would occur. The Project will also produce **vehicle operating cost savings with a discounted benefit value of \$-13.7 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 Travelled		Traffic Volumes		Vehicle Miles Travelled		Passenger Vehicles	Trucks		
	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks	Passenger Vehicles	Trucks				
2027	12,280	2,515	36,977,698	7,573,745	14,118	3,012	39,062,337	8,333,741	-2,084,639	-759,996	(\$1,584,298)	(\$861,753)
2028	12,477	2,555	37,570,041	7,695,069	14,344	3,060	39,687,627	8,466,546	-2,117,685	-771,477	(\$1,608,828)	(\$817,847)
2029	12,677	2,596	38,172,382	7,818,440	14,574	3,109	40,323,966	8,602,118	-2,151,604	-783,679	(\$1,634,469)	(\$776,534)
2030	12,879	2,638	38,782,220	7,943,346	14,807	3,159	40,968,747	8,740,479	-2,186,527	-797,133	(\$1,661,723)	(\$737,825)
2031	13,085	2,680	39,402,056	8,070,301	15,044	3,209	41,624,428	8,878,808	-2,222,372	-808,508	(\$1,687,340)	(\$700,186)
2032	13,295	2,723	40,034,388	8,199,814	15,284	3,261	42,288,412	9,022,671	-2,254,024	-822,857	(\$1,714,092)	(\$664,755)
2033	13,507	2,767	40,674,218	8,330,864	15,529	3,313	42,966,482	9,166,589	-2,292,263	-835,725	(\$1,742,124)	(\$631,426)
2034	13,723	2,811	41,324,046	8,463,961	15,778	3,366	43,655,372	9,313,220	-2,331,326	-849,259	(\$1,771,132)	(\$599,944)
2035	13,943	2,856	41,986,371	8,599,618	16,029	3,420	44,349,748	9,462,608	-2,363,377	-862,989	(\$1,797,454)	(\$569,028)
2036	14,166	2,902	42,658,692	8,737,323	16,286	3,474	45,060,877	9,612,028	-2,402,184	-874,705	(\$1,824,613)	(\$539,837)
2037	14,393	2,948	43,341,012	8,877,075	16,547	3,530	45,782,976	9,766,961	-2,441,965	-889,887	(\$1,855,497)	(\$513,060)
2038	14,623	2,995	44,033,328	9,018,874	16,811	3,587	46,513,478	9,924,683	-2,480,150	-905,809	(\$1,886,438)	(\$487,491)
2039	14,857	3,043	44,738,141	9,163,234	17,081	3,644	47,260,484	10,082,384	-2,522,343	-919,151	(\$1,916,545)	(\$462,871)
2040	15,094	3,092	45,452,952	9,309,641	17,354	3,702	48,015,893	10,242,874	-2,562,941	-933,233	(\$1,946,710)	(\$439,398)
2041	15,230	3,120	45,862,843	9,393,594	17,632	3,761	48,785,039	10,406,110	-2,602,195	-1,012,516	(\$2,170,115)	(\$457,779)
2042	15,367	3,148	46,275,234	9,478,060	17,910	3,795	49,222,093	10,500,160	-2,646,859	-1,022,100	(\$2,189,428)	(\$431,638)
2043	15,505	3,176	46,690,124	9,563,037	17,950	3,830	49,664,882	10,597,019	-2,694,758	-1,033,982	(\$2,212,274)	(\$407,610)
2044	15,645	3,205	47,112,512	9,649,551	18,112	3,864	50,113,106	10,691,091	-3,000,594	-1,041,540	(\$2,230,122)	(\$384,017)
2045	15,786	3,233	47,534,900	9,736,064	18,274	3,899	50,561,230	10,787,908	-3,026,330	-1,051,844	(\$2,250,566)	(\$362,184)
2046	15,928	3,262	47,962,287	9,823,601	18,439	3,934	51,017,856	10,884,768	-3,055,569	-1,061,167	(\$2,271,504)	(\$341,639)
2047	16,071	3,292	48,394,672	9,912,162	18,606	3,969	51,479,816	10,981,586	-3,085,144	-1,069,424	(\$2,291,557)	(\$322,108)
2048	16,216	3,321	48,829,557	10,001,235	18,773	4,005	51,941,927	11,081,203	-3,112,371	-1,079,968	(\$2,312,841)	(\$303,831)
2049	16,362	3,351	49,269,440	10,091,331	18,942	4,041	52,409,623	11,180,830	-3,140,183	-1,089,499	(\$2,333,394)	(\$286,479)
2050	16,510	3,381	49,714,322	10,182,452	19,113	4,077	52,882,654	11,280,415	-3,168,331	-1,097,964	(\$2,353,061)	(\$269,993)
2051	16,658	3,412	50,161,704	10,274,084	19,284	4,114	53,355,834	11,382,799	-3,194,131	-1,108,715	(\$2,373,961)	(\$254,571)
2052	16,807	3,443	50,611,584	10,366,228	19,458	4,151	53,832,267	11,485,173	-3,225,683	-1,118,945	(\$2,396,717)	(\$240,197)
2053	16,959	3,474	51,068,963	10,459,908	19,633	4,188	54,321,368	11,587,525	-3,252,405	-1,127,617	(\$2,415,999)	(\$226,290)
2054	17,111	3,505	51,526,342	10,553,588	19,810	4,226	54,811,203	11,692,688	-3,284,861	-1,139,100	(\$2,440,329)	(\$213,615)
2055	17,266	3,536	51,991,219	10,648,804	19,988	4,264	55,304,075	11,797,817	-3,312,857	-1,149,013	(\$2,461,324)	(\$201,358)
2056	17,421	3,568	52,458,595	10,744,531	20,168	4,303	55,801,893	11,905,726	-3,343,099	-1,161,195	(\$2,485,417)	(\$190,027)
<b>Total</b>											<b>(\$61,819,891)</b>	<b>(\$13,695,290)</b>

**Safety Benefit**

The Project produces **safety savings of \$56.7 million (NPV).** The reduction in costs associated with crashes along existing US Highway 81 using the existing crash rate will experience less crashes due to lower traffic volumes. The realigned US Highway 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 Grady



County crash facts passenger vehicle occupancy (1.97), FHWA value of truck occupancy (1), and Grady County crash facts number of vehicles per crash (2.01) data was used to determine the benefit to the public of the reduced exposure to crashes. The safety benefits by year are reflected below in **Table 5**.

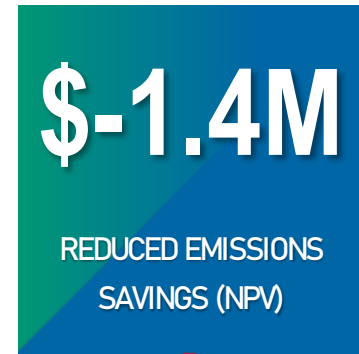
**Table 5: Safety Crash Savings**

Safety Crash Savings				
Year	Total Cost		Potential Cost Savings	Potential Cost Savings (NPV)
	No Build	Build		
2027	\$50,427,000	\$37,665,800	\$12,761,200	\$6,941,247
2028	\$50,523,300	\$37,951,000	\$12,572,300	\$6,391,120
2029	\$51,349,900	\$47,644,100	\$3,705,800	\$1,760,599
2030	\$51,566,800	\$48,388,400	\$3,178,400	\$1,411,248
2031	\$51,742,200	\$48,609,700	\$3,132,500	\$1,299,876
2032	\$52,038,200	\$48,706,000	\$3,332,200	\$1,292,285
2033	\$52,718,600	\$49,002,000	\$3,716,600	\$1,347,067
2034	\$53,017,800	\$49,162,200	\$3,855,600	\$1,306,025
2035	\$53,257,100	\$49,839,400	\$3,417,700	\$1,081,956
2036	\$54,015,400	\$50,208,900	\$3,806,500	\$1,126,206
2037	\$54,236,700	\$50,427,000	\$3,809,700	\$1,053,414
2038	\$54,532,700	\$50,605,600	\$3,927,100	\$1,014,837
2039	\$54,836,300	\$51,349,900	\$3,486,400	\$842,011
2040	\$55,466,400	\$51,649,100	\$3,817,300	\$861,615
2041	\$65,351,600	\$51,742,200	\$13,609,400	\$2,870,861
2042	\$65,572,900	\$51,960,300	\$13,612,600	\$2,683,678
2043	\$65,650,800	\$52,038,200	\$13,612,600	\$2,508,110
2044	\$65,747,100	\$52,718,600	\$13,028,500	\$2,243,449
2045	\$65,965,200	\$52,800,900	\$13,164,300	\$2,118,536
2046	\$66,709,500	\$53,017,800	\$13,691,700	\$2,059,262
2047	\$66,724,700	\$53,100,100	\$13,624,600	\$1,915,112
2048	\$66,884,900	\$53,257,100	\$13,627,800	\$1,790,245
2049	\$67,106,200	\$53,478,400	\$13,627,800	\$1,673,126
2050	\$67,262,000	\$54,015,400	\$13,246,600	\$1,519,930
2051	\$67,942,400	\$54,236,700	\$13,705,700	\$1,469,727
2052	\$68,160,500	\$54,319,000	\$13,841,500	\$1,387,186
2053	\$68,320,700	\$54,532,700	\$13,788,000	\$1,291,425
2054	\$68,403,000	\$54,629,000	\$13,774,000	\$1,205,713
2055	\$68,624,300	\$54,836,300	\$13,788,000	\$1,127,980
2056	\$68,841,200	\$54,929,400	\$13,911,800	\$1,063,653
<b>Total</b>	<b>\$1,812,995,400</b>	<b>\$1,526,821,200</b>	<b>\$286,174,200</b>	<b>\$56,657,497</b>



## Emissions Benefit

The Project produces emission reductions by cutting congestion and travel delays, resulting in **emissions damage savings of \$-1.4 million NPV over 30 years**. The reduction in emission damage from traffic diverted to the realigned US Highway 81 were computed for Volatile Organic Compounds (VOCs), Nitrogen Oxides (NOx) and Particulate Matter (PM2.5). 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		Environmental Protection Cost Savings Pollutant Emissions Calculations (grams)				Benefit of Reduced Damage from Pollutant Emissions	Benefit of Reduced Damage from Pollutant Emissions (NPV)
	Passenger Vehicles	Truck	Carbon Dioxide	Volatile Organic Compounds	Nitrogen Oxides	Particulate Matter (2.5)		
2027	-2,084,639	-759,996	-2,195,822,005	-1,590,502	-8,442,866	-174,366	(\$160,826)	(\$87,479)
2028	-2,117,585	-771,477	-2,229,768,000	-1,615,402	-8,571,737	-177,014	(\$163,277)	(\$83,002)
2029	-2,151,604	-783,679	-2,265,313,718	-1,641,267	-8,707,784	-179,819	(\$165,868)	(\$78,803)
2030	-2,186,527	-797,133	-2,303,132,077	-1,668,234	-8,855,443	-182,886	(\$168,685)	(\$74,898)
2031	-2,222,372	-808,508	-2,338,467,765	-1,694,826	-8,986,034	-185,542	(\$171,162)	(\$71,026)
2032	-2,254,024	-822,857	-2,375,826,120	-1,720,231	-9,138,429	-188,757	(\$174,083)	(\$67,512)
2033	-2,292,263	-835,725	-2,414,570,258	-1,748,927	-9,284,055	-191,739	(\$176,850)	(\$64,099)
2034	-2,331,326	-849,259	-2,454,705,113	-1,778,414	-9,436,171	-194,863	(\$179,743)	(\$60,885)
2035	-2,363,377	-862,989	-2,491,391,479	-1,803,782	-9,583,601	-197,958	(\$182,565)	(\$57,795)
2036	-2,402,184	-874,705	-2,528,790,708	-1,832,304	-9,719,825	-200,712	(\$185,144)	(\$54,777)
2037	-2,441,965	-889,887	-2,571,663,051	-1,862,958	-9,886,781	-204,177	(\$188,329)	(\$52,075)
2038	-2,480,150	-905,809	-2,614,746,353	-1,892,987	-10,058,667	-207,775	(\$191,616)	(\$49,517)
2039	-2,522,343	-919,151	-2,656,271,830	-1,924,266	-10,211,976	-210,892	(\$194,523)	(\$46,980)
2040	-2,562,941	-933,233	-2,698,008,267	-1,954,920	-10,370,215	-214,143	(\$197,533)	(\$44,586)
2041	-2,922,195	-1,012,516	-3,002,505,176	-2,205,912	-11,379,994	-233,750	(\$216,427)	(\$45,655)
2042	-2,946,859	-1,022,100	-3,029,331,792	-2,224,994	-11,484,988	-235,933	(\$218,431)	(\$43,063)
2043	-2,974,758	-1,033,982	-3,061,165,647	-2,247,045	-11,612,717	-238,612	(\$220,875)	(\$40,696)
2044	-3,000,594	-1,041,540	-3,085,718,592	-2,265,925	-11,701,327	-240,397	(\$222,551)	(\$38,322)
2045	-3,026,330	-1,051,844	-3,114,144,926	-2,285,972	-11,813,496	-242,736	(\$224,693)	(\$36,160)
2046	-3,055,569	-1,061,167	-3,143,032,197	-2,307,683	-11,920,403	-244,912	(\$226,721)	(\$34,099)
2047	-3,085,144	-1,069,424	-3,170,573,631	-2,329,119	-12,018,433	-246,875	(\$228,572)	(\$32,129)
2048	-3,112,371	-1,079,968	-3,200,135,773	-2,350,168	-12,134,024	-249,277	(\$230,778)	(\$30,317)
2049	-3,140,183	-1,089,499	-3,228,561,082	-2,371,116	-12,241,423	-251,481	(\$232,820)	(\$28,584)
2050	-3,168,331	-1,097,964	-3,255,640,556	-2,391,789	-12,339,944	-253,472	(\$234,684)	(\$26,928)
2051	-3,194,131	-1,108,715	-3,284,740,738	-2,412,074	-12,456,026	-255,902	(\$236,904)	(\$25,404)
2052	-3,225,683	-1,118,945	-3,316,154,534	-2,435,578	-12,572,844	-258,284	(\$239,121)	(\$23,965)
2053	-3,252,405	-1,127,617	-3,342,772,049	-2,455,488	-12,671,857	-260,303	(\$241,000)	(\$22,573)
2054	-3,284,861	-1,139,100	-3,376,458,484	-2,480,094	-12,800,288	-262,947	(\$243,445)	(\$21,310)
2055	-3,312,857	-1,149,013	-3,405,528,191	-2,501,323	-12,911,148	-265,229	(\$245,554)	(\$20,088)
2056	-3,343,099	-1,161,195	-3,439,037,031	-2,524,913	-13,043,590	-267,992	(\$248,085)	(\$18,968)
<b>Total</b>							<b>(\$6,210,865)</b>	<b>(\$1,381,694)</b>

## Project Costs

The project has a **total capital cost of \$242,800,000** in 2018 dollars over a six-year construction period from 2021 to December 2026. Numbers shown are in 2018 dollars to provide a uniform base year. All costs by year are shown in **Table 7**. The operations and maintenance (O&M) costs shown are the incremental increase over the no-build scenario.

## Benefits Summary

The Grady County US Highway 81 Realignment has a **Benefit-Cost Ratio of 1.92**. 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 2020 BCA Guidance](#).

**Table 7: Summary of Estimated Capital Costs**

Year	30 Year Costs			
	Percent Project Cost Paid	Project Cost	O&M	Project Cost (NPV)
2019		\$0	\$0	\$0
2020		\$0	\$0	\$0
2021	17%	\$40,466,667	\$0	\$33,032,854
2022	17%	\$40,466,667	\$0	\$30,871,826
2023	17%	\$40,466,667	\$0	\$28,852,174
2024	17%	\$40,466,667	\$0	\$26,964,649
2025	17%	\$40,466,667	\$0	\$25,200,606
2026	17%	\$40,466,667	\$0	\$23,551,968
2027		\$0	(\$986,223)	(\$536,440)
2028		\$0	(\$2,379,903)	(\$1,209,822)
2029		\$0	(\$1,577,303)	(\$749,365)
2030		\$0	\$177,497	\$78,811
2031		\$0	(\$292,903)	(\$121,544)
2032		\$0	\$177,497	\$68,836
2033		\$0	\$4,863,897	\$1,762,900
2034		\$0	(\$2,676,623)	(\$906,665)
2035		\$0	(\$6,996,683)	(\$2,214,971)
2036		\$0	(\$4,513,263)	(\$1,335,312)
2037		\$0	\$177,497	\$49,079
2038		\$0	(\$763,303)	(\$197,252)
2039		\$0	\$177,497	\$42,868
2040		\$0	\$4,863,897	\$1,097,846
2041		\$0	(\$1,185,303)	(\$250,036)
2042		\$0	(\$2,379,903)	(\$469,190)
2043		\$0	(\$1,577,303)	(\$290,617)
2044		\$0	\$177,497	\$30,564
2045		\$0	(\$292,903)	(\$47,137)
2046		\$0	\$177,497	\$26,696
2047		\$0	\$5,624,097	\$790,539
2048		\$0	(\$1,185,303)	(\$155,710)
2049		\$0	(\$2,379,903)	(\$292,188)
2050		\$0	(\$1,577,303)	(\$180,982)
2051		\$0	\$177,497	\$19,034
2052		\$0	(\$292,903)	(\$29,355)
2053		\$0	\$177,497	\$16,625
2054		\$0	\$9,550,297	\$835,990
2055		\$0	(\$1,185,303)	(\$96,968)
2056		(\$97,120,000)	(\$2,379,903)	(\$8,709,769)
<b>Total</b>	<b>100%</b>	<b>\$145,680,000</b>	<b>(\$8,300,070)</b>	<b>\$155,500,542</b>

**Table 8: Summary**

Project	Capital Costs	Project Costs (NPV)	Total Net Benefit	Total Net Benefit (NPV)	Benefit-Cost Ratio
2020 BCA SUMMARY - U.S. 81 Realignment	\$242,800,000	\$156,602,863	\$2,319,540,844	\$300,838,299	1.92