Hot Springs Bypass Extension
TIGER 2017 Application

Benefit-Cost Analysis Methodology Summary

Overview

This project proposes to extend the Hot Springs Bypass (US 70/US 270) from US 70 to State Highway 7 in Garland County, Arkansas. The 5.5 mile facility will initially consist of two 12-foot travel lanes and 8-foot shoulders, with an ultimate build out of four travel lanes, 8-foot shoulders and a variable-width grass median. The grant application and analysis described below relate to design, right-of-way acquisition and utility relocation for the ultimate four-lane cross-section; construction of the initial two travel lanes and shoulders; and construction of interchanges and other structures.

The purpose of the proposed project is to provide a continuation of the Hot Springs Bypass as an alternate route to State Highway 7, which passes through Hot Springs National Park and the congested arterial network in central Hot Springs. The matrix of problems, alternatives, impacts and benefits of the project is presented in Table 1.

Table 1. Project Matrix

Problem to be Addressed	*Proposed Solution*	*Types of Impacts*	*Economic Benefit*
Congestion and travel time delay due to lack of freeway connectivity for regional traffic	Provide alternate route for State Highway 7 and other arterials in central Hot Springs	Reduction in travel times	Monetized value of time
Number of crashes on local highway network	Provide alternate route for State Highway 7 and other arterials in central Hot Springs	Reduction in crashes	Monetized value of crash reduction

This document describes the methodology used to estimate the benefits and costs attributable to the project. This analysis was conducted in accordance with the guidelines set forth in *Benefit-Cost Analysis Guidance for TIGER and INFRA Applications* (July 2017).

It should be noted that, for the purposes of this benefit-cost analysis (BCA), it was assumed that the *additional* two lanes for the Hot Springs Bypass Extension would not be constructed until after the horizon year for the *initial* two lanes, and that State Highway 7S would be posted to minimize through traffic. As a result, the traffic inputs that were used for this BCA may differ from the traffic volumes reported in the application, which were based on different assumptions about the Hot Springs Bypass Extension and utilization of State Highway 7S.

Project Benefits and Disbenefits

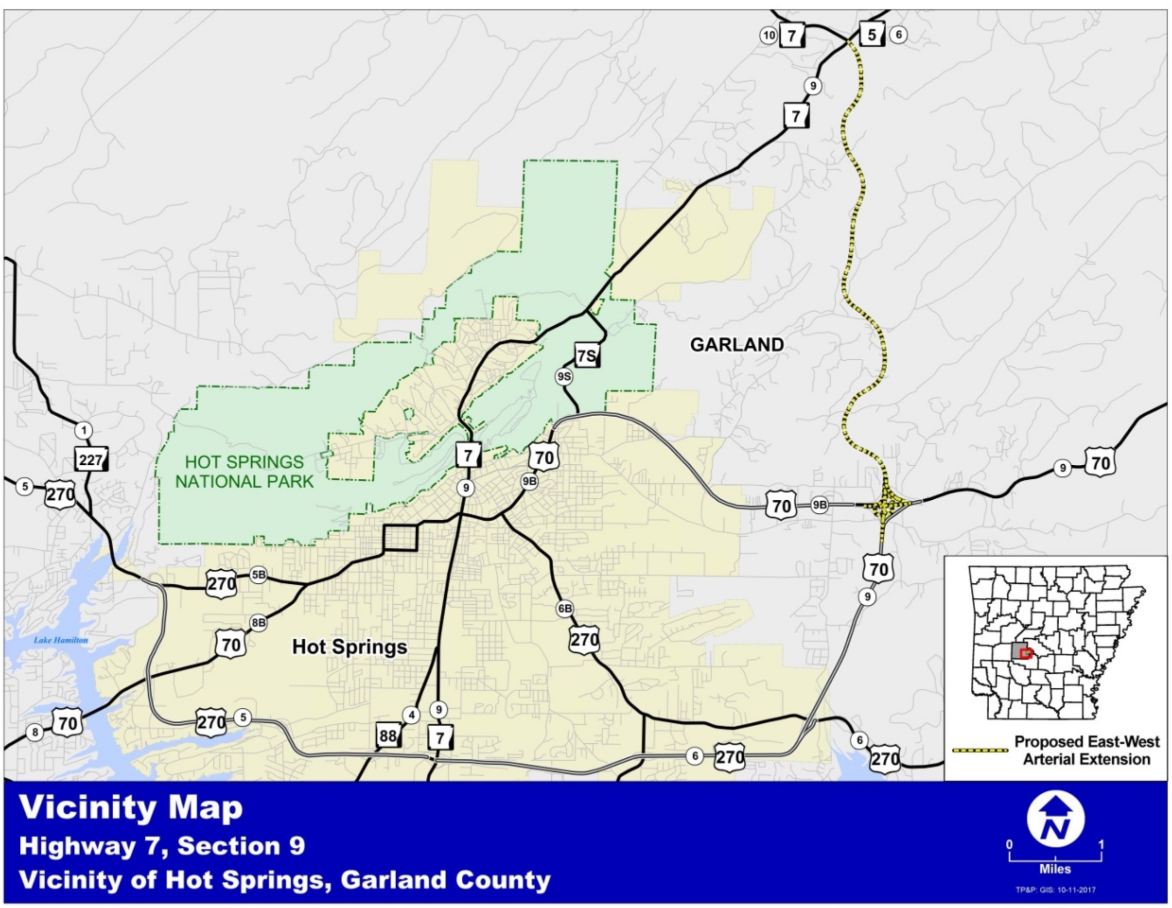
As described below, the benefits of the project are expected to be derived primarily from travel-time savings and improved crash experience. Other potential benefits and disbenefits of the project include changes in vehicle operating costs, maintenance and the residual value of the project.

Traffic Inputs

The traffic network studied for this benefit-cost analysis is illustrated in Figure 1. Traffic inputs were developed for each link using the Arkansas Statewide Travel Demand Model (TDM). Base-year (2010) No-Build volumes from the TDM were compared to ground counts to develop calibration factors, which were applied to the volumes from other TDM scenarios (2040 No-Build, 2010 Build, and 2040 Build). Growth rates were calculated for no-build and build scenarios using model volumes and applied to 2010 traffic counts/estimates to derive opening year (2022) and horizon year (2041) traffic estimates.

Vehicle miles traveled (VMT) was estimated at the link level by taking the product of the actual/estimated traffic volume and the link length. Vehicle hours traveled (VHT) was calculated at the link level by taking the quotient of link length and posted speed and multiplying by the actual/estimated traffic volume. For arterial streets, it was assumed that an additional 35 seconds of delay (equivalent to LOS C/D) would be experienced by each vehicle passing each traffic signal.

Figure 1. Traffic Network



Travel Time Savings

Travel time savings were calculated as follows: Annual VHT was estimated for the opening year and horizon year for the No-Build and Build scenarios. Annual VHT for the interim years was calculated by linear interpolation between the opening year and horizon year. The difference was then taken between annual No-Build VHT and annual Build VHT. Passenger vehicle VHT and truck VHT were separated by assuming that 2 percent of annual VHT is attributable to truck traffic. The annual differential passenger-vehicle and truck VHT were then multiplied by standard occupancy and value-of-time factors for those vehicle classes. Estimated annual travel time savings are reported without discount in Table 2. Positive values represent *decreases* in travel time costs.

Table 2. Undiscounted Travel Time Savings

Year	*Travel Time Savings*
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ 6,551,721
2023	$ 6,566,949
2024	$ 6,582,177
2025	$ 6,597,405
2026	$ 6,612,634
2027	$ 6,627,862
2028	$ 6,643,090
2029	$ 6,658,318
2030	$ 6,673,546
2031	$ 6,688,774
2032	$ 6,704,002
2033	$ 6,719,231
2034	$ 6,734,459
2035	$ 6,749,687
2036	$ 6,764,915
2037	$ 6,780,143
2038	$ 6,795,371
2039	$ 6,810,600
2040	$ 6,825,828
2041	$ 6,841,056
TOTAL	$133,927,768

Safety

Savings related to crash avoidance were calculated as follows: Annual VMT was estimated by facility type and setting (urban or rural) for the opening year and horizon year of the No-Build and Build. Annual VMT for the interim years was calculated by linear interpolation between the opening year and horizon year. The difference was then taken between annual No-Build VMT and annual Build VMT. The annual differential VMT (again, calculated by facility type and setting) was then multiplied by the statewide average crash rates by crash type for that combination of facility type and setting, resulting in an estimate of the number of crashes of each type created or avoided each year. The number of crashes created or avoided each year was then multiplied by standard KABCO monetary values for those injuries. Estimated annual crash savings are reported without discount in Table 3. Positive values represent *decreases* in crash costs.

Table 3. Undiscounted Crash Savings

Year	*Total Safety Benefits*
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ 3,320,541
2023	$ 3,328,842
2024	$ 3,337,142
2025	$ 3,345,442
2026	$ 3,353,742
2027	$ 3,362,042
2028	$ 3,370,342
2029	$ 3,378,642
2030	$ 3,386,942
2031	$ 3,395,243
2032	$ 3,403,543
2033	$ 3,411,843
2034	$ 3,420,143
2035	$ 3,428,443
2036	$ 3,436,743
2037	$ 3,445,043
2038	$ 3,453,344
2039	$ 3,461,644
2040	$ 3,469,944
2041	$ 3,478,244
TOTAL	$ 67,987,854

Vehicle Operating Costs

Vehicle operating costs were estimated as follows: Annual VMT was estimated for the opening year and horizon year for the No-Build and Build scenarios. Annual VMT for the interim years was calculated by linear interpolation between the opening year and horizon year. The difference was then taken between annual No-Build VMT and annual Build VMT. Passenger vehicle VMT and truck VMT were separated by assuming that 2 percent of annual VMT is attributable to truck traffic. The annual differential passenger-vehicle and truck VMT were then multiplied by standard operating cost factors for those vehicle classes. The estimated annual change in vehicle operating costs is reported without discount in Table 4. Negative values represent *increases* in vehicle operating costs.

Table 4. Undiscounted Changes in Vehicle Operating Costs

Year	*Vehicle Operating Costs*
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ (487,331)
2023	$ (508,304)
2024	$ (529,278)
2025	$ (550,252)
2026	$ (571,225)
2027	$ (592,199)
2028	$ (613,172)
2029	$ (634,146)
2030	$ (655,120)
2031	$ (676,093)
2032	$ (697,067)
2033	$ (718,040)
2034	$ (739,014)
2035	$ (759,988)
2036	$ (780,961)
2037	$ (801,935)
2038	$ (822,908)
2039	$ (843,882)
2040	$ (864,856)
2041	$ (885,829)
TOTAL	$ (13,731,600)

Maintenance

The proposed roadway is expected to consist of a jointed plain concrete pavement. Within the 20-year horizon of this analysis, maintenance is expected to consist of joint rehab, patching and grinding, to be performed 15 years after opening. The estimated maintenance costs for the projected are reported without discount in **Table 5**. Negative values represent net *increases* in maintenance costs.

Table 5. Undiscounted Maintenance Costs

Year of Expenditure	*Maintenance Costs*
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ -
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ (2,200,000)
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
TOTAL	$ (2,200,000)

Residual Value

The proposed project will include numerous large structures, at a cost of roughly $15 million. The useful design life of those structures is expected to be 50 years. Because the analysis period for this project is 20 years, the remaining 30 years of useful life of those structures is being captured as residual value. The estimated residual value of the project is reported without discount in **Table 6**.

Table 6. Undiscounted Residual Value

Year of Expenditure	*Residual Value*
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ -
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ 9,000,000
TOTAL	$ 9,000,000

Project Costs

The anticipated schedule of capital costs for the project is presented in Table 7.

Table 7. Schedule of Capital Costs

Year of Expenditure	*Preliminary Engineering*	*Right-of-Way and Utilities*	*Construction Inspection*	*Construction*	*Capital Costs*
2017	$ 2,500,000	$ -	$ -	$ -	$ 2,500,000
2018	$ 2,500,000	$ 4,000,000	$ -	$ -	$ 6,500,000
2019	$ -	$ 8,000,000	$ -	$ -	$ 8,000,000
2020	$ -	$ -	$ 1,500,000	$ 20,000,000	$ 21,500,000
2021	$ -	$ -	$ 1,500,000	$ 20,000,000	$ 21,500,000
2022	$ -	$ -	$ -	$ -	$ -
2023	$ -	$ -	$ -	$ -	$ -
2024	$ -	$ -	$ -	$ -	$ -
2025	$ -	$ -	$ -	$ -	$ -
2026	$ -	$ -	$ -	$ -	$ -
2027	$ -	$ -	$ -	$ -	$ -
2028	$ -	$ -	$ -	$ -	$ -
2029	$ -	$ -	$ -	$ -	$ -
2030	$ -	$ -	$ -	$ -	$ -
2031	$ -	$ -	$ -	$ -	$ -
2032	$ -	$ -	$ -	$ -	$ -
2033	$ -	$ -	$ -	$ -	$ -
2034	$ -	$ -	$ -	$ -	$ -
2035	$ -	$ -	$ -	$ -	$ -
2036	$ -	$ -	$ -	$ -	$ -
2037	$ -	$ -	$ -	$ -	$ -
2038	$ -	$ -	$ -	$ -	$ -
2039	$ -	$ -	$ -	$ -	$ -
2040	$ -	$ -	$ -	$ -	$ -
2041	$ -	$ -	$ -	$ -	$ -
				TOTAL	$ 60,000,000

These values do not include any costs expended to date.

Project Summary

The benefits and costs of the project are summarized in Table 8.

Table 8. Summary of Benefit-Cost Analysis

Benefit/Cost Category	*No Discount*	*Discounted at 7%*	*Discounted at 3%*
Benefits/Disbenefits			
Travel Time Savings	$133,927,768	$50,329,227	$85,746,741
Safety Improvements	$67,987,854	$25,540,020	$43,521,820
Vehicle Operating Costs	($13,731,600)	($4,840,059)	($8,548,174)
Maintenance	($2,200,000)	($568,522)	($1,218,087)
Residual Value	$9,000,000	$1,658,243	$4,298,450
Sum of Benefits/Disbenefits	$194,984,022	$72,118,909	$123,800,750
Costs			
Capital	$60,000,000	$46,275,633	$53,523,752
Sum of Costs	$60,000,000	$46,275,633	$53,523,752
Benefit-Cost Ratio	3.25	1.56	2.31
Net Present Value	$134,984,022	$25,843,275	$70,276,999

Based on the analysis described herein, the project is expected to achieve a benefit-cost ratio of between 1.56 and 3.25, depending upon the discount factor.