Appendix B

Benefit-Cost Technical Memorandum

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MEMORANDUM

TO: Michael Kalnbach
MnDOT District 1 Project Manager

FROM: Graham Johnson, PE

DATE: September 2, 2014

RE: TH 1/US 169 Eagles Nest Lake Area Project Benefit-Cost Analysis
SEH No. MNT01 114996 14.00

PURPOSE

This memorandum documents the methodology and results of the benefit-cost analysis for the five alternative concepts developed as part of the TH 1/US 169 Eagles Nest Lake Area Project Environmental Assessment (EA). The existing 5.42 mile corridor extends from approximately 0.3 miles west of Sixmile Lake Road to Bradach Road in Nest Lake Township, St. Louis County. Under existing conditions, there is little congestion on the corridor. The alternatives would address existing alignment issues in four areas and increase the existing shoulder by 2 feet or more.

The purpose of a benefit-cost analysis is to express the effects of an investment into a common measure, (dollars). This allows for the fact that the benefits of a project are often accrued over a long period of time, while the initial investment is incurred during the initial years of the project.

In this analysis approach, any quantified benefits that are greater than or equal to the quantified costs (benefit-to-cost ratio greater than one) represents an economically viable project.

ALTERNATIVES

This section describes the five alternatives being analyzed as part of this benefit cost analysis. The project termini for all five build alternatives identical.

1. **Existing Route Alternative 1** – Construct under Traffic; total length is 5.46 miles. This Existing Route Alternative shifts the highway slightly off the existing roadbed (up to 110 feet in some locations) in order to allow for construction of the proposed improvement while continuing to allowing traffic to utilize this segment of TH 1/169.

2. **Existing Route Alternative 2** – Close Route and Detour Traffic: total length is 5.41 miles. This Existing Route Alternative follows the current roadway alignment to the greatest extent possible, while correcting the existing clear zone and sight distance design deficiencies (e.g. horizontal and vertical curves). As a result of utilizing the existing alignment to the greatest extent possible this alternative requires the full closure of the roadway during construction and detours traffic onto an alternate route.

3. **Alternative 3 (Southern Route)**; total length is 5.40 miles. The South Route Alternative utilizes a new alignment for the western 2.2 miles of the study area. This allows for construction of the proposed improvement while continuing to allowing traffic to flow along this segment of TH 1/169.

4. **Alternative 2A (Hybrid)**; total length is 5.41 miles. This is a hybrid alternative between the Existing Route Alternative 2 and Alternative 3. This allows for construction of the proposed improvement while continuing to allowing traffic to flow along this segment of TH 1/169.

5. **Alternative 3A (Hybrid)**; total length is 5.40 miles. This is a hybrid alternative between the Existing Route Alternative 1 and Alternative 3. This allows for construction of the proposed improvement while continuing to allowing traffic to flow along this segment of TH 1/169.

BENEFIT-COST METHODOLOGY

The monetary benefit for the project is quantified in terms of reduced vehicle miles traveled (VMT), vehicle hours traveled (VHT), and estimated crashes over the analysis period between the No-Build and the Build options. The costs include construction, bridges and structures, right-of-way, and engineering/project delivery costs. Remaining capital values of these roadway features at the end of the analysis period are subtracted from the total cost of the project.

The results of the analysis provide input for evaluating the overall benefit of the proposed improvements to the corridor. Due to the planning level of detail in the calculations, the magnitude of the value is not as important as the value being greater or less than one.

General Assumptions

- All monetary values are discounted to the 2014 analysis year. Inflation is not included.
- The 20-year benefit period is based on a 2015 day-of-opening through the year 2035.
- Yearly Build and No-Build benefits are calculated based on linear interpolation over the 20-year analysis period.
- Longer travel times and rerouting of trips during construction years are not included.
- Preliminary cost estimates were provided by MnDOT District 1.
- Maintenance Schedule and associated costs were provided by MnDOT District 1.
- The No Build Alternative will require a pavement reclamation project in 2016 based on current pavement conditions.
- The number of days per year used in the analysis was 365. The proposed build alignments slightly change the length of trip for all users and improve safety, every day of the year.

Specific Assumptions

The values in the table below are from the MnDOT Office of Transportation Management. These values are typically adjusted on a yearly basis; however these are the most current values from July 2014.

Table 1. Specific Assumptions (MnDOT)

MnDOT Standard Values	
Crash Costs	
Fatal Type K	$10,300,000
Injury Type A	$550,000
Injury Type B	$160,000
Injury Type C	$81,000
Property Damage Only	$7,400
Operating Costs (Vehicle Miles Traveled)	
Automobile (per mile)	$0.31
Heavy Vehicle (per mile)	$0.96
Time Costs (Vehicle Hours Traveled)	
Automobile (per occupant)	$16.00
Heavy Commercial (per occupant)	$27.30
Vehicle Occupancy Rates	
Automobile (passengers per vehicle)	1.31
Heavy Commercial (passengers per vehicle)	1.02
Capital Cost Estimate – see Preliminary Cost Estimate Table A2	
Component Service Life (years)	
Program Development and Delivery	0
Right-of-way, per acre	100
Major Structure	60
Grading and Drainage	50
Sub-base and Base	40
Surface	25
Analysis Period for Roadway projects (years)	20
Discount Rate (annual)	2.0%

Traffic Assumptions

As part of the EA work, there was limited traffic analysis done on the different alternatives. The existing roadway is not congested and only carries 2,500 vehicles per day (vpd) as of 2011. The 2035 forecasts demand increases by almost 40 percent to 3,600 vpd; however this is still well below the capacity of the roadway. All local street approaches currently operate under two-way stop control for the local roadways and will remain unchanged throughout the study time-frame.

Below are the traffic assumptions used in the VMT, VHT, and crash calculations for both alternatives:

- Daily VMT and VHT in the study area for the four scenarios (2015 & 2035 No-Build, and 2015 & 2035 Builds) were calculated based on forecasts ADT's and posted speed limits. The existing study area corridor is 5.42 miles, posted along the entire length at 55 mph. The Build alternatives vary in length between 5.40 and 5.46 miles long with an assumed posted speed along the entire length at 55 mph.
    - Though the build alternative addresses some alignment issues along some of the winding curves in the corridor, none of the existing curves are posted at less than 55 mph.
- Yearly intersection crashes and crash benefits calculated for the No Build Alternative were based on existing conditions. It was assumed that the No-Build condition would have the same crash rates as the existing conditions for the entire corridor.
- Yearly intersection crashes and crash rates for the alternatives were calculated based on MnDOT Statewide 2012 averages for a rural 2-lane section with and ADT between 1,500 and 4,999 vpd.

Table 2 represents the resulting VMT and VHT values for both the No Build Alternative and the Preferred Alternative for the year of opening and the design year.

Table 2. Yearly VMT and VHT

	No Build (Base)	Existing Route 1	Existing Route 2	Alternative 3	Alternative 2A	Alternative 3A
Length (miles)	5.42	5.46	5.41	5.40	5.41	5.40
2015 ADT	2750	2750	2750	2750	2750	2750
2035 ADT	3600	3600	3600	3600	3600	3600
2015 VMT	5,444,051	5,484,229	5,434,007	5,423,963	5,434,007	5,423,963
2035 VMT	7,126,758	7,179,354	7,113,609	7,100,460	7,113,609	7,100,460
2015 VHT	98,983	99,713	98,800	98,618	98,800	98,618
2035 VHT	129,577	130,534	129,338	129,099	129,338	129,099

BENEFIT-COST ANALYSIS RESULTS

Table 3, below, summarizes the results of the benefit-cost analysis for the TH 1/US169 Eagles Nest Lake Area Project.

Table 3. Summary of Benefit-Cost Analysis

Scenario	Existing Route 1	Existing Route 2	Alternative 3	Alternative 2A	Alternative 3A
VMT & VHT Benefit	($546,227)	$136,600	$273,027	$136,600	$273,027
Crashes Benefit	$15,542,062	$15,622,073	$15,638,075	$15,622,073	$15,638,075
Operating and Maintenance Benefit	$3,639,153	$3,676,452	$3,683,912	$3,676,452	$3,683,912
Total Benefit	**$18,634,987**	**$19,435,125**	**$19,595,013**	**$19,435,125**	**$19,595,013**
Total Costs (Present Value)	$21,802,016	$23,288,259	$26,650,845	$25,385,387	$23,862,472
Remaining Capital Value (RCV)	$5,779,180	$6,248,956	$7,398,174	$7,073,920	$6,526,278
Total Cost – RCV	**$16,022,836**	**$17,039,303**	**$19,252,671**	**$18,311,467**	**$17,336,194**
Benefit-Cost Ratio	**1.16**	**1.14**	**1.02**	**1.06**	**1.13**

The preliminary analysis indicates that all 5 alternatives have a benefit cost ratio greater than 1.0. Meaning, the VMT, VHT and crash reduction benefits of the project are estimated to be greater than the costs associated with the construction of the alternatives.

At this level of analysis, the magnitude of the benefit-cost ratio is not as important as the overall finding that the ratio is greater than one. Further refinements to the VMT and VHT values are possible using different traffic models and methods. However, this basic analysis indicates that all four proposed build alternatives are economically valuable.

See attached Appendix A tables for more detail on the Benefit Cost calculations.

gtj
Tables A1 through A10
c: Chris Hiniker, SEH
Bob Rogers, SEH
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