Martin Memorial Bridge, Rumford ME
Benefit Cost Analysis

A benefit cost analysis was conducted on replacing the Martin Memorial Bridge (MMB) in Rumford, Maine. The analysis looks at the project from the standpoint of society as a whole, and accounts for the net benefits and net costs based on the criteria described in the TIGER Grant NOFA, January 31, 2012. The analysis presented here addresses benefits from travel time savings, user costs, safety, and emissions reduction. Other non-quantified benefits are discussed qualitatively in the applications narrative. These benefits include increased economic competitiveness, and livability enhancement.

Base Case Assumption

This benefit cost analysis focuses on full replacement of MMB, and compares the replacement to the “no build’ scenario, which is the base case assumption. This assumes that the existing bridge would be closed to traffic. Existing and future traffic would be diverted to alternate routes, thereby increasing travel time, mileage, and increased accidents. The benefits that accrue to society from the Martin Memorial Bridge can be estimated by the avoided costs that would occur without the Bridge.

Project Benefits

Travel Costs

The Martin Memorial Bridge is an important crossing on the Androscoggin River. The nearest alternative crossings are in Bethel, 11.9 miles away, and Rumford which is 9.4 miles away. The average annual daily traffic is on the Bridge is 1,720 vehicles, with approximately 16% percent of that being trucks. If the Bridge were closed and taken out of service, travelers would be forced to use these alternate crossings and encounter significant detour routes. The total increase in vehicle-miles-traveled is estimated a 5,580,984 million miles annually. This number was developed using MaineDOT’s Statewide Travel Demand Model, a transportation analysis tool, based on the TRIPS modeling software that can be used to evaluate the impact of major changes in the highway network. The Model relies on population demographics, employment, and economic activity in order to forecast VMT. The Model can be used to evaluate the travel time and distance benefits of a major new bridge or highway facility and can also be used to evaluate the travel costs (disbenefits) of closing a major facility.

For this analysis the Model was run twice, once with the bridge in place and operating and once with the bridge lost or removed from service. The Model run with the bridge in place represents existing conditions. The Model run with the bridge removed represents conditions in which the loss of the bridge forces bridge users to alternate river-crossing routes that longer in distance and time between the start and end points of their trips. Subtracting the existing conditions Model results from the closed conditions provides an estimate of the increases in user costs from closure of the bridge. The increases in travel distances and travel times that are avoided by replacing the bridge, rather than allowing the crossing to be lost, represent the benefits of a replacement bridge. The table below summarizes the calculations.

	User Costs Due to Bridge Closure		
	VMT	VHT	Cost
Per Vehicle Detoured	8.9	0.19	$ 6.45
Year-Round Total	5,580,984	121,733	$ 4,051,655
Note. *AADT =1720.* *Truck Volume =16% .* *Costs: Per Vehicle-Mile-Traveled is $0.37. Per Hourly delay is $16.32. Due to high truck volume.*			

Vehicle Operating Costs

An increase in vehicle operating costs would result from the additional VMT created by closing the bridge. The total annual vehicle operating costs is included in the total user costs presented above. This is based on $0.37 per mile average because of the relatively high truck volume of this route. These operating costs are avoided by bridge replacement. These operating costs will be avoided by a replacement bridge would enhance economic competitiveness in the region served by the project.

Safety

An analysis of the 2008 crash history analysis shows that there four total crashes for the bridge/intersection, two were at the intersection, one was on the bridge, and one was on the curve just to the south of the bridge. The cumulative critical rate factor was 1.95, and 66.7 % of crashes having personal injury. This analysis has assumed that crash reduction factors are due to the reconfiguration of the Route 2/Route 232 intersection at the northerly approach to the bridge. The crash reduction factors are as follows: Replacing the bridge, 45% crash reduction; Re-align intersection from 45 degrees to 90 degrees, 40% crash reduction; Flatten horizontal curve, 40% crash reduction. The safety benefits resulting from the alignment and safety measures in this project result in a savings to society of over $38,000 per year. These calculations can be found in the spreadsheet Crash reduction Benefits.xls, tab Combined Benefits, cells B18:G24.

If the bridge were closed, additional travel would presumably increase crashes on alternate routes in transportation network. These additional crash costs would likely result in significant costs to society; however, these costs have not been quantified for this analysis.

State of Good Repair

The existing bridge was built in 1955. It is 600 feet long with three spans. Estimated annualized maintenance costs are estimated at $14,238. This number was derived from past costs for personnel, repairs, and materials annualized over a 50 year period. If the bridge were closed these costs are avoided. In this BCA the annualized costs are added to user benefits since they are avoided costs to society if a new bridge is constructed. This is shown in spreadsheet MMB Maintenance Costs.xls.

Sustainability

The avoided air emissions are based on avoided VMT from closure of the bridge and the loss of this crossing location. The emission savings have been calculated for nitrogen oxides, volatile organics, and carbon dioxide. The calculations are based on factors that were applied to the avoided VMT resulting from closure of the bridge. Data is not available for sulfur dioxide or particulate emissions. Based on the annual VMT of about 5.6 million miles approximately 3,100 tons of CO_2, 4 tons of VOCs, and 5 tons of NOX are avoided. Based on additional travel time (VHT) of 121, 733 hours, approximately 169 tons of CO_2, 1 ton of VOC, and 1 ton of NO_x are avoided. These emissions amount to a total of over $110,000 annually. The calculations can be found in the spreadsheet, Emission Reduction – Martin Mem Bridge Rumford.xls. The cost of carbon in CO_2 emissions, however has been calculated in the BCA spreadsheet using the social cost of carbon (SCC) assumptions found in "Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866". The reason for this is that the SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change. In conformity with this viewpoint, this analysis escalates the CO_2 portion of the air emissions cost increases estimated on Table 5: "Changes in the Average Annual Growth Rates of SCC Estimates between 2010 and 2050" in the report. The net present value of air emissions costs is $ 4.6 million at 3% discount and $ 15 million at 7 % discount.

Project Costs

Total Construction Costs

Although the present cost of a rehabilitation project is almost 8% lower that the full replacement alternative, the lowest life cycle cost is the full replacement. The life cycle cost analysis (LCCA) indicates that for a 75 year design life, the replacement option is 36% less costly that a bridge rehabilitation, due in part to the likelihood that a bridge replacement would be necessary anyway, 40 years from now. The benefit cost analysis uses the replacement construction costs includes all costs including preliminary engineering, construction engineering, and right-of-way, for total cost of $9.3 million. Construction costs also include a wearing surface replacement after 20 years and full deck replacement after 40 years. Maintenance and operations costs for the replacement structure are considered negligible. The life cycle cost calculations are in the spreadsheet Martin Memorial Bridge Life Cycle Cost Analysis.xls. The cost estimates can be found in the file Life Cycle Two Options- 1b- 6a 3-7-12.xls

Conclusion

The annual benefits and costs values were discounted at 3% and 7% over a 50 year time horizon. Three percent is the most appropriate rate for the analysis because bridge has a very long life, and in addition, the alternate use of funds would be a public expenditure as opposed to a private investment. The full analysis can be found in the spreadsheet attachment to this application. A summary of the results of this analysis are as follows.

- Total NPV Benefits of $ 110.2 million
- Total NPV Costs of $ 10.0 million
- Benefit-Cost ratio of 11.0

When discounted at 7%, the benefits and costs are lower. A larger discount rate implies that time preference for future amounts are preferentially discounted more severely. The amounts are show below.

- Total NPV Benefits of $ 58.9 million
- Total NPV Costs of $ 9.5 million
- Benefit-Cost ratio of 6.2

It is estimated that travel cost savings alone due to avoided VMT amount to $ 104 million over a 50 year period. On an annual basis these costs savings represent 94% of the total annual benefits. These user costs savings are the key driver of the benefit-cost ratio. It must be noted, therefore that the assumptions on the other key criteria have a small influence on these results.