Benefit-Cost Methodology for Moses Wheeler Bridge TIGER Application

The methodology and assumptions underlying the benefit-cost analysis are described herein.

Time Horizon

All benefits and costs were based on a forecast horizon of 35 years, from 2009 through 2043. Bridge construction was assumed to be eight years in duration, beginning in 2009 and completing in 2016. User benefits were assumed to begin in January 2017, immediately after the completion of the bridge, and last through the end of the forecast horizon.

Discount Rate

Consistent with USDOT guidelines, the benefits and costs in this analysis were discounted at a rate of 7 percent.

Project Costs

The bridge was assumed to cost $299 million in 2009 dollars to design and construct. Construction would begin in 2009 and complete in 2016. The annual construction expenditures expected per year is shown in Exhibit A-1.

Exhibit A-1: Breakdown of Contract E Construction Costs by Scenario (Million 2009 Dollars)

2009	2010	2011	2012	2013	2014	2015	2016	TOTAL
$4.1	$23.1	$51.9	$68.3	$68.0	$38.5	$35.0	$10.2	**$299.1**

Source: STV Incorporated, Connecticut Department of Transportation

In the no-build scenario, the following capital expenditures would be needed to keep the bridge at a minimum level of functionality:

Exhibit A-2: Breakdown of Moses Wheeler Bridge No-Build Capital Costs

Year	Capital Cost Description	Estimated Cost (2009 $)
2010	Bridge drainage, fender system repairs	$6.5 million
2020 - 2023	Full deck & bearing replacement, steel repairs, substructure repairs, superstructure painting	$82 million
2035 - 2041	Full bridge replacement	$299 million
Total No-Build Capital Costs		**$387.5 million**

Source: STV Incorporated, Connecticut Department of Transportation

With major repairs scheduled in 2010 and again in 2020, the useful life of the bridge could be extended to 2035, but would need to be completely replaced at that time. Thus, the same annual construction costs in the build scenario from 2009 to 2016 also appear in the no-build scenario from 2035 to 2042.

The total capital costs in the build scenario are estimated to be $230 million in discounted 2009 dollars (using the 7 percent discount rate), and the capital costs in the no-build scenario are estimated to be $77 million in discounted 2009 dollars.

Operations & Maintenance Costs

In the build scenario, the annual bridge operations & maintenance (O & M) costs were estimated to be $115,000 throughout the forecast horizon (see Exhibit A-3 below). No-build operation and maintenance costs were estimated to be $670,000 from 2009 to 2020, and $190,000 from 2021 until the bridge replacement construction begins in 2035. From 2035 to 2045, no-build O & M costs were estimated to be $115,000, equivalent to the O & M costs in the build scenario. When discounted at a 7 percent rate, the total differential O & M costs between the build and no-build scenarios would carry a $4 million benefit to the state throughout the forecast period in the form of lower relative costs.

Exhibit A-3: Breakdown of Moses Wheeler Bridge Operations & Maintenance Costs

O & M Cost Description	Estimated Cost (2009 $)			
	Build Scenario	No-Build Scenario (2010 to 2020)	No-Build Scenario (2021 to 2035)	No-Build Scenario (2036 to 2045)
Drainage	40,000	40,000	40,000	40,000
Crack Sealing	20,000	40,000	20,000	20,000
Bridge Collision Repairs	5,000	10,000	10,000	5,000
Joint Repairs	-	50,000	20,000	-
Added Inspections	-	100,000	-	-
Deck Patching	-	150,000	-	-
Loose Concrete Removal	-	40,000	-	-
Substructure Patching	-	40,000	25,000	-
Minor Steel Repairs	-	100,000	25,000	-
Spot Painting	50,000	100,000	50,000	50,000
Total O & M Costs	**$ 115,000**	**$ 670,000**	**$ 190,000**	**$ 115,000**

Source: STV Incorporated, Connecticut Department of Transportation

Residual Value of Bridge – Negative Cost

The useful life of the replaced Moses Wheeler Bridge is estimated to be 75 years. At the end of the forecast horizon in 2045, the bridge will have approximately 46 years remaining before major rehabilitation and replacement would be necessary. Therefore, the bridge will carry a residual value past the forecast horizon that has been estimated as a negative cost for this analysis.

The residual value has been estimated at $16 million in discounted 2009 dollars. Underlying this estimate is the assumption that the bridge will depreciate on a straight-line basis, with the residual value of the bridge equal to the real value of its construction cost multiplied by the share of its useful life remaining at the end of the forecast period.

User Benefits

Construction-Related Vehicle Travel Time Benefits

The major quantifiable benefit of the bridge replacement project is the elimination of future travel time delays that would occur if the bridge was not replaced today. These delays would be caused by the future capital replacement projects needed just to maintain the Bridge at its current state of good repair rating, which would require lane closures for significant periods of time and cause major delays on I-95 for most of the day.

In particular, the current deck would need to be completely replaced in 2020 if the replacement project was not implemented. Such a replacement would require at least one lane of traffic to be closed in both directions at all times for roughly three years, which would cause severe delays on a daily basis and likely draw heavy opposition from the trucking industry and the residents of Connecticut.

In order to determine the impact of the lane closures during this deck replacement project several methodologies were used to determine the average delay time over the 24 hour period. The peak hourly demand at the bridge has been estimated at 6,600 vehicles in each direction. A lane closure would reduce the capacity to 3,300 veh./hr. in each direction. Based on manual calculations for the daily demand volume across the Moses Wheeler Bridge, the following data was determined:

1) The northbound direction of the bridge would experience a maximum queue of approximately 8,200 vehicles from 2-7 PM, the period when vehicle demand exceeds roadway capacity (total two-lane capacity = 3,330 veh/hr). Given a per vehicle spacing of 30 feet over 3 lanes, the queue length would be approximately 82,000 feet (15.5 miles).
2) The southbound direction of the bridge would experience a maximum queue of approximately 2,730 vehicles from 6:30-9 AM, the period when demand exceeds roadway capacity. Given a per vehicle spacing of 30 feet over 3 lanes, the queue length would be approximately 27,300 feet (5.2 miles).

This information was then analyzed using the Highway Capacity Manual and VISSIM simulation models to develop average delay times over the 24 hour period. The two methods revealed peak period delays ranging from 40 minutes to an hour with average hourly delays over the 24 hour period of 22 minutes in the northbound direction and 15 minutes in the southbound direction. Using weighted averages based on the volumes, an average delay time of 18.3 minutes was estimated over the 24 hour period.

This average delay per vehicle per day on the Moses Wheeler Bridge in the no-build scenario was applied to the forecasted ADT volumes from 2020 to 2022 to arrive at annual travel time savings over the forecast period. Annual ADT projections were based on a study by CTDOT in 2001 that computed historical volumes on the bridge in 1999 and projected volumes in 2025. Applying the compound annual growth rate used in the study to 1999 volumes allowed for an annual ADT forecast to be created from 2009 to 2043.

Applying the projected volumes from 2020 to 2022 to the computed per-vehicle delays during this period led to the computation of total daily vehicle travel time savings. These benefits were then converted to total daily passenger travel time savings (see Exhibit A-4) using a vehicle-occupancy rate of 1.0 for commercial vehicles, estimated to be 13 percent of total ADT, along with a passenger vehicle occupancy rate of 1.424 for the 87 percent passenger share of total ADT[1].

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[1] Source: Connecticut Department of Transportation.

Exhibit A-4: Annual Hours of Passenger Travel Time Savings in Build Scenario, 2009 Dollars

Benefit Description	2020	2021	2022	TOTAL
Passenger Trips	16,185,111	16,290,800	16,397,179	48,873,090
Commercial Trips	1,698,360	1,709,450	1,720,613	5,128,424
TOTAL	**17,883,471**	**18,000,250**	**18,117,792**	**54,001,514**

Source: Parsons Brinckerhoff

The estimated travel time savings in the build scenario were converted into dollar benefits for commercial vehicles, passenger work trips, and passenger non-work trips. Commercial vehicle travel time savings were valued at 100 percent of the hourly truck driver wages plus fringe benefits, according to USDOT guidelines. Truck driver wage data was obtained by inflating the 2008 Bureau of Labor Statistics (BLS) wage data for truck drivers in Connecticut to 2009 dollars, and using a fringe benefits factor of 33 percent of hourly wages. Total hourly 2009 commercial vehicle compensation was estimated to be $32.22.

Passenger work trips, defined by USDOT as non-commute work trips occurring for business purposes, was assumed to represent 5.6 percent of total passenger vehicle travel time savings. This estimate was taken from USDOT estimates of the share of local passenger travel comprising business trips in its 2003 publication "Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis." These trips were valued at 100 percent of hourly passenger wages plus fringe benefits, which was estimated to be $37.50. Passenger wage data was obtained by inflating the 2008 average wage for all Connecticut employees from the BLS to 2009 dollars, and using a fringe benefits factor of 33 percent of hourly wages.

Passenger non-work trips, defined as all "off-the-clock" commute or leisure trips, represent the remainder of total passenger vehicle travel time savings. These trips were valued at 50 percent of hourly passenger wages, which were estimated to be $28.20. Passenger wage data was obtained by inflating the 2008 average wage for all Connecticut employees from the BLS to 2009 dollars.

The total travel time benefits in discounted 2009 dollars are shown in selected years in Exhibit A-5. When discounted at a 7 percent annual rate, such benefits total $73 million for commercial vehicles, $41 million for passenger work trips, and $291 million for passenger non-work trips.

Exhibit A-5: Total Annual Travel Time Benefits, Discounted 2009 Dollars

Benefit Description	2020	2021	2022	TOTAL
Passenger Work Trips	$ 14,419,988	$ 13,564,626	$ 12,760,003	$ 40,744,617
Passenger Non-Work Trips	$ 102,999,911	$ 96,890,187	$ 91,142,879	$ 291,032,977
Commercial Trips	$ 25,997,026	$ 24,454,941	$ 23,004,328	$ 73,456,295
TOTAL	**$ 143,416,924**	**$ 134,909,754**	**$ 126,907,210**	**$ 405,233,889**

Source: Parsons Brinckerhoff

Accident-Related Vehicle Travel Time Benefits

Users of the bridge would also benefit from reduced delays caused by vehicle accidents, since the replaced bridge will have much wider shoulders to efficiently move damaged vehicles. As previously mentioned, the current bridge does not have adequate shoulders, which leads to major backups and travel time delays during accidents due to damaged vehicles remaining in one or more lanes. This problem will be resolved by the new design of the replacement bridge.

To estimate the benefits associated with more efficient accident management on the bridge, historical bridge vehicle accident data from 2003 to 2007 was analyzed and used to derive an annual estimate (65) of accidents. It was assumed that this historical average number of accidents would increase throughout the forecast horizon at the projected annual growth rate of vehicle traffic.

For each projected accident, it was assumed that the accident would create, on average, a 45 minute travel time delay for all vehicles during a two hour window of the day, after which the damaged vehicles would presumably be cleared from the roadway. The costs of this delay were quantified using the same approach and data described in the previous section.

The replaced bridge was assumed to reduce average travel delays from 45 minutes to 15 minutes during accidents, though the bridge is not expected to reduce the overall number of accidents in the future.