Supporting Calculations
Method of Calculating Economic Impact
Using a Discounted Cost-Benefit Analysis

Based off of a cost benefit model developed by NCTCOG staff, the US 175/IH 45 connector project should have a net positive effect on the economy of $145.1 million annually and create 1,577 jobs when completed. During construction there will be a net benefit to the economy of $138.8 million and 754 jobs over each of the two years of the project. This project will have a long-term return on investment of 973 percent and generate 243 percent in taxes as the project cost (assuming a 25 percent capture rate).

\[
W_t = B_t - C_t
\]

\[
J = \frac{W_t}{Y}
\]

\[
B_t = (CO2*Z) + (\text{Hours Saved}^L) + (G_t^M) + (\text{GasSaved}^P) + (\text{Lives}^\beta)
\]

\[
C_t = \frac{PV(1+r)^t}{(1+r)^t - 1}
\]

\[
W_t = \text{Net effect}
\]

\[
B_t = \text{Benefits}
\]

\[
C_t = \text{Costs}
\]

\[
G_t = \text{Government Spending}
\]

\[
M = \text{Multiplier}
\]

\[
r = \text{Interest Rate}
\]

\[
t = \text{time}
\]

\[
Y = \text{Economic output per job.}
\]

\[
J = \text{Total jobs created}
\]

\[
PV = \text{Present Value}
\]

\[
P_g = \text{Price of Gas}
\]

\[
\beta = \text{Economic Value of a human life}
\]

\[
B_t = \text{Benefits will use available data on benefits to core economic activities (excluding real estate). Consideration has been given to the economic benefit of hours saved and pollution reduction. The long-term benefits are $159,988,175 annually.}
\]

\[
\beta = \text{Economic Value of a human life is set at $6 million according to TIGER grant application.}
\]

\[
C_t = \text{Costs are based on just the TIGER funds of the project (PV) or $150 million. These costs have been annualized to match benefits. The annual cost is $14,908,484.}
\]

\[
\text{Gas Saved} = \text{The total amount of gallons of gas saved as a result of the project. This project is predicted to save 14,698 gallons a day in fuel. This number is then multiplied by 250 to get the total saved.}
\]

\[
G_t = \text{Government Spending is the actual amount of construction spending that occurs in any given period. For the US 175/IH 45 connector project it is assumed to be $71 million during each of the two years of construction. The total cost is $185 million with $43 million going towards acquiring land.}
\]
Hours Saved = Total hours saved for the region each year after completion of the project will be 5,364,000 hours according to NCTCOG. This is based on a daily savings of 21,456 hours. No numbers exist for congestion created by the construction. Traffic is assumed to be unaffected by construction.

L= The cost of one-hour spent in traffic. According to the Texas Transportation Institute, the cost of 1 hour is $15.47 per hour for personal transportation and $102.12 for freight traffic. NCTCOG Traffic studies have found that approximately 10 percent of all traffic is freight traffic. The combined numbers are $24.14 per hour saved.

Lives = Number of traffic fatalities prevented as a result of roadway improvements. There have been 245 wrecks in the project area with 14 fatalities. There have not been any studies on the expected reduction. Interviews with engineers involved indicate that removing a sharp-curve known locally as "dead-man's curve" will result in a two-thirds drop in fatalities. This would save 3.6 lives per year or 108 lives over the next 30 years.

M = this is the multiplier applied to construction spending. It is a made up number assumed to be 1.5. The range provided by the Congressional Budget Office for infrastructure projects is 1.0 to 2.5 over the short term.

CO2 = Carbon Dioxide reduced. NCTCOG model found a decrease of 141.53 tons per day. This was multiplied by 250 to get an annual total.

PG = Price of Gas is set at $2.10 per gallon of unleaded.

PV= Total cost of the project in today’s dollars. The total cost is $185 million with $150 million coming from TIGER grant.

r = The interest rate will have a significant effect on the outcome of the model. The lower the rate used the larger the benefits of the project. The model is set at seven percent as required in TIGER grant application.

t = Time is the number of years that will be used to price the project out over. The longer the period used, the larger the benefit of the project. The model is set at 30 years.

Y= Economic output per job is the amount of Gross Domestic Product required to create one job. The White House Council of Economic Advisors set this at $92,000.

Z= the cost of one ton of Carbon Dioxide set at $33. This number is specified in the TIGER application.
Table 1. Economic Impact Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Construction Costs</td>
<td>$142,000,000</td>
</tr>
<tr>
<td>Amount of TIGER Requested</td>
<td>$150,000,000</td>
</tr>
<tr>
<td>Travel Time Savings/Hours Saved per Year</td>
<td>21,456</td>
</tr>
<tr>
<td>CO₂ (tons/day)</td>
<td>141.53</td>
</tr>
<tr>
<td>Fuel Saved (gallons/day)</td>
<td>14,698</td>
</tr>
<tr>
<td>Cost of an Hour</td>
<td>$24.14</td>
</tr>
<tr>
<td>Cost/Ton of CO₂</td>
<td>33</td>
</tr>
<tr>
<td>Cost of Gallon of Fuel</td>
<td>2.1</td>
</tr>
<tr>
<td>Lives Saved</td>
<td>3,603</td>
</tr>
<tr>
<td>Cost of Life Lost</td>
<td>$6,000,000</td>
</tr>
<tr>
<td>Annual Cost</td>
<td>$14,908,485</td>
</tr>
<tr>
<td>Net Benefits (per year)</td>
<td>$159,988,175</td>
</tr>
<tr>
<td>Net Effect</td>
<td>$145,079,175</td>
</tr>
<tr>
<td>Net Benefit of Hours Saved</td>
<td>$129,486,960</td>
</tr>
<tr>
<td>Net Benefit of Pollution</td>
<td>$1,167,623</td>
</tr>
<tr>
<td>Net Benefit of Fuel Saved</td>
<td>$7,716,450</td>
</tr>
<tr>
<td>Net Benefit of Lives Saved</td>
<td>$21,617,143</td>
</tr>
<tr>
<td>Years to Complete</td>
<td>2</td>
</tr>
<tr>
<td>Short-Term Construction Benefit</td>
<td>138,750,000</td>
</tr>
<tr>
<td>Jobs in Short Run</td>
<td>754</td>
</tr>
<tr>
<td>Jobs in Long Run</td>
<td>1,577</td>
</tr>
<tr>
<td>Total Short Run</td>
<td>1,508</td>
</tr>
<tr>
<td>Benefit to Cost Ratio</td>
<td>10.73</td>
</tr>
<tr>
<td>ROI (total economy)</td>
<td>973.14</td>
</tr>
<tr>
<td>Tax Revenue Replaced</td>
<td>243.28%</td>
</tr>
</tbody>
</table>

Sources:

Texas Transportation Institute at Texas A&M Study on Traffic Congestion
http://tti.tamu.edu/inforfor/media/archive.htm?news_id=5206

Texas Commission on Environmental Quality funding methods
Method of Calculating Sustainability Impact

In the build and no-build analysis for this project, vehicle hours of travel (VHT), average loaded speed, congested delay, and traffic delay were analyzed as a performance measure. Fuel consumption and carbon dioxide (CO₂) emissions were estimated from the VHT reduction from the build and no build scenario.

Methodology:
- Fuel Consumption: 0.685 gallons/hour factor was utilized to calculate the Fuel Consumption from Vehicle Hours of Travel. ¹
- CO₂ Emission: 8,788 grams/gallon of gasoline emission factor was used to calculate the CO₂ Emissions from Fuel Consumption.²
- Project Life: 40 years is used as project life for all highway projects.
- Global CO₂ Emission Benefits: $33/Metric Tons of CO₂ emission was used to calculate the Global CO₂ Emission Benefits.³

Performance Analysis:
Table 2 shows the net reduction and percent change from Build case to No Build case.

Table 2. Build minus No Build

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Build – No Build</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Hours of Travel (hours)</td>
<td>-21,456.31</td>
<td>-0.340%</td>
</tr>
<tr>
<td>Speed (mph)</td>
<td>0.21</td>
<td>0.551%</td>
</tr>
<tr>
<td>Congested Delay (hours)</td>
<td>-14,438.68</td>
<td>-1.306%</td>
</tr>
<tr>
<td>Traffic delay (hours)</td>
<td>-6,477.34</td>
<td>-1.065%</td>
</tr>
<tr>
<td>CO₂ Emission (tons/day)</td>
<td>-142.37</td>
<td>-0.340%</td>
</tr>
<tr>
<td>Fuel Consumed (gallons/day)</td>
<td>-14,697.58</td>
<td>-0.340%</td>
</tr>
</tbody>
</table>

Figure 2 graphically represents the percent changes on all the analysis parameters.

Figure 2. Build minus No Build

Percentage Change

Date: 9/15/2009
Summary:
At the regional analysis, this project reduces travel time by 223 million hours, CO\textsubscript{2} emissions by 1.5 million tons and fuel usage by 153 million gallons, with a CO\textsubscript{2} global benefit of 44 million dollars over the project life. Summary of the benefits are shown in Table 3.

Table 3. Performance Summary

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Benefits/day</th>
<th>Benefits/Project-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Hours of Travel (hours)</td>
<td>21,456.31</td>
<td>$223,145,624.00</td>
</tr>
<tr>
<td>CO\textsubscript{2} Emission (tons)</td>
<td>142.37</td>
<td>1,480,696.86</td>
</tr>
<tr>
<td>Fuel Consumed (gallons)</td>
<td>14,697.58</td>
<td>152,854,823.68</td>
</tr>
<tr>
<td>Cost Benefit (dollars)</td>
<td>4,261.42</td>
<td>$44,318,737.69</td>
</tr>
</tbody>
</table>

Fuel consumption and travel time reduction suggests that other criteria pollutants, such as Carbon Monoxides (CO), Volatile Organic Compounds (VOC), Nitrogen Oxides (NO\textsubscript{x}), Particle Matters (PM), will also be reduced.

Sources:
3. Tiger Grant Application requirements.