Appendix B

Detailed Methodology

Appendix B provides the details of the methodology for the *2011 Congested Corridors Report* (*CCR*).

A short roadway segment (less than 1 mile) with congestion for more than 10 hours in a week was the beginning of a congested corridor. ("Congestion" was having a speed less than half of the free-flow speed). Each adjacent, upstream segment of roadway that was congested for four hours per week was included in the corridor. Four hours was chosen as the threshold after reviewing the data which showed that many upstream segments had some congestion nearly every weekday. Since it typically did not constitute every day of the week, choosing four hours allows one day per week to have a different queuing pattern. Researchers combined traffic volume information from the states with the speed data to compute the performance measures.

After the corridor limits were established, the following steps were used to calculate the congestion performance measures for each corridor.

1. Obtain HPMS traffic volume data by road section
2. Match the HPMS road network sections with the traffic speed dataset road sections for each corridor
3. Estimate traffic volumes for each hour time interval from the daily volume data
4. Calculate average travel speed and total delay for each hour interval
5. Establish free-flow (i.e., low volume) travel speed
6. Calculate congestion performance measures

<u>Step 1. Identify Traffic Volume Data</u>

The HPMS dataset from FHWA provided the source for traffic volume data, although the geographic designations in the HPMS dataset are not identical to the private sector speed data. The daily traffic volume data must be divided into the same time interval as the traffic speed data (hour intervals). While there are some detailed traffic counts on major roads, the most widespread and consistent traffic counts available are average daily traffic (ADT) counts. The hourly traffic volumes for each section, therefore, were estimated from these ADT counts using typical time-of-day traffic volume profiles developed from continuous count locations or other data sources. Step 3 shows the average hourly volume profiles used in the measure calculations.

Volume estimates for each day of the week (to match the speed database) were created from the average volume data using the factors in Exhibit B-1. Automated traffic recorders from around the country were reviewed and the factors in Exhibit B-1 are a "best-fit" average for both freeways and major streets. Creating an hourly volume to be used with the traffic speed values, then, is a process of multiplying the annual average by the daily factor and by the hourly factor.

Exhibit B-1. Volume Adjustment Factors

Day of Week	Adjustment Factor (to convert average annual volume into day of week volume)
Monday to Thursday	+5%
Friday	+10%
Saturday	-10%
Sunday	-20%

Step 2. Combine the Road Networks for Traffic Volume and Speed Data

The second step was to combine the road networks for the traffic volume and speed data sources, such that an estimate of traffic speed and traffic volume was available for each corridor. The combination (also known as conflation) of the traffic volume and traffic speed networks was accomplished using Geographic Information Systems (GIS) tools. The INRIX speed network was chosen as the base network; an ADT count from the HPMS network was applied to each segment of roadway in the speed network. The traffic count and speed data for each roadway segment were then combined into areawide performance measures.

Step 3. Estimate Traffic Volumes for Shorter Time Intervals

The third step was to estimate traffic volumes for one-hour time intervals for each day of the week.

Typical time-of-day traffic distribution profiles are needed to estimate hourly traffic flows from average daily traffic volumes. Previous analytical efforts1,2 have developed typical traffic profiles at the hourly level (the roadway traffic and inventory databases are used for a variety of traffic and economic studies). These traffic distribution profiles were developed for the following different scenarios (resulting in 16 unique profiles):

- Functional class: freeway and non-freeway
- Day type: weekday and weekend
- Traffic congestion level: percentage reduction in speed from free-flow (varies for freeways and streets)
- Directionality: peak traffic in the morning (AM), peak traffic in the evening (PM), approximately equal traffic in each peak

The 16 traffic distribution profiles shown in Exhibits B-2 through B-6 are considered to be very comprehensive, as they were developed based upon 713 continuous traffic monitoring locations in urban areas of 37 states.

[1] *Roadway Usage Patterns: Urban Case Studies*. Prepared for Volpe National Transportation Systems Center and Federal Highway Administration, July 22, 1994.

[2] *Development of Diurnal Traffic Distribution and Daily, Peak and Off-peak Vehicle Speed Estimation Procedures for Air Quality Planning*. Final Report, Work Order B-94-06, Prepared for Federal Highway Administration, April 1996.

Exhibit B-2. Weekday Traffic Distribution Profile for No to Low Congestion

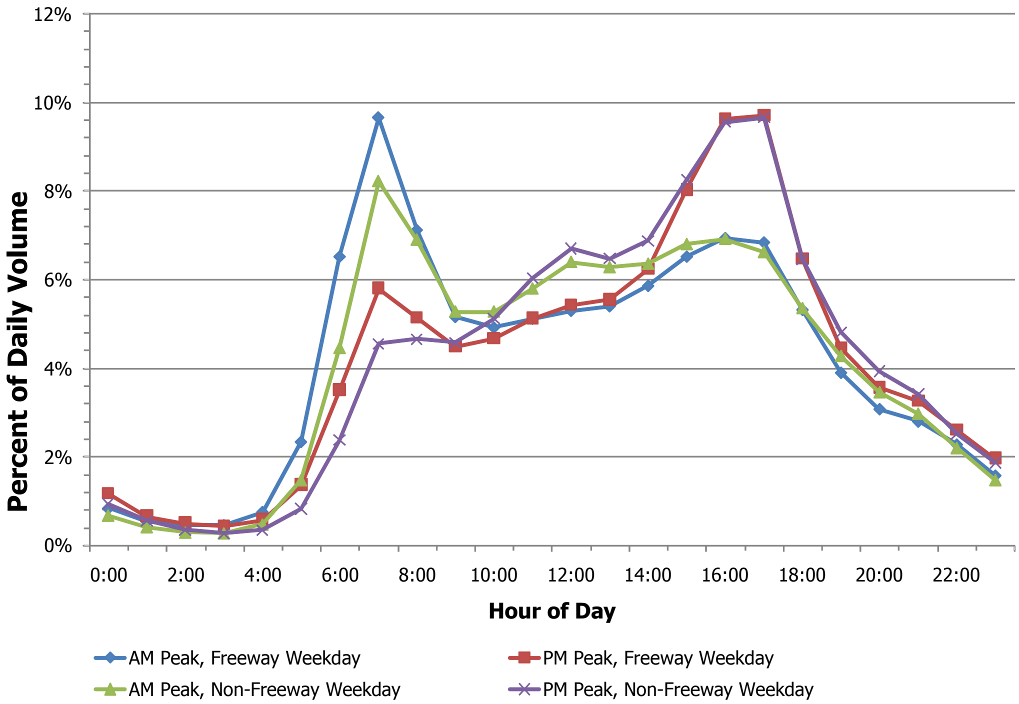


Exhibit B-3. Weekday Traffic Distribution Profile for Moderate Congestion

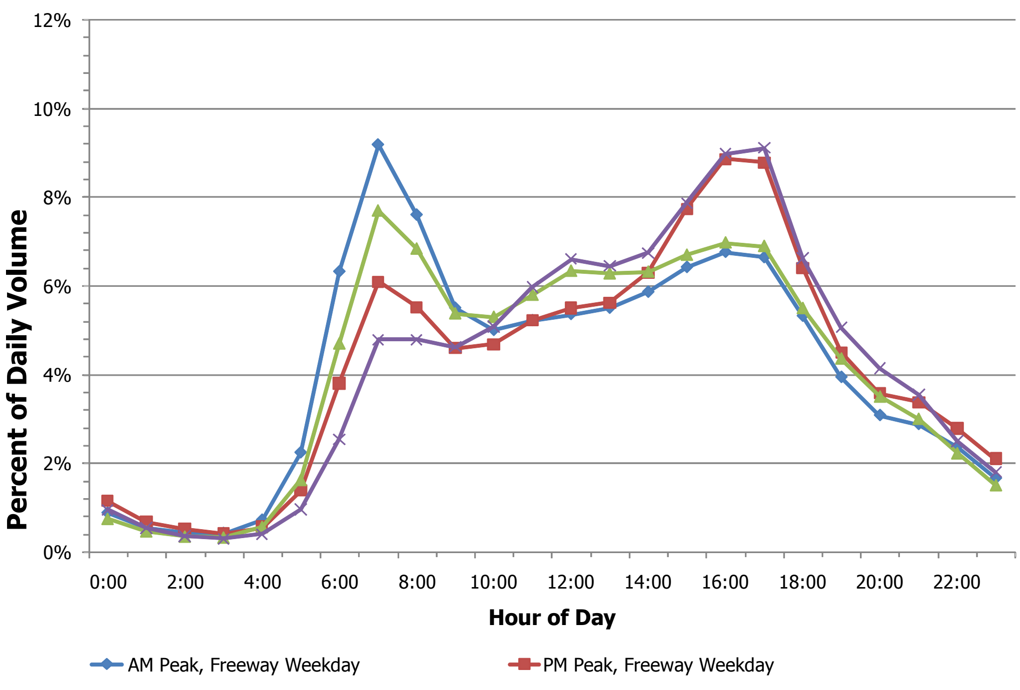


Exhibit B-4. Weekday Traffic Distribution Profile for Severe Congestion

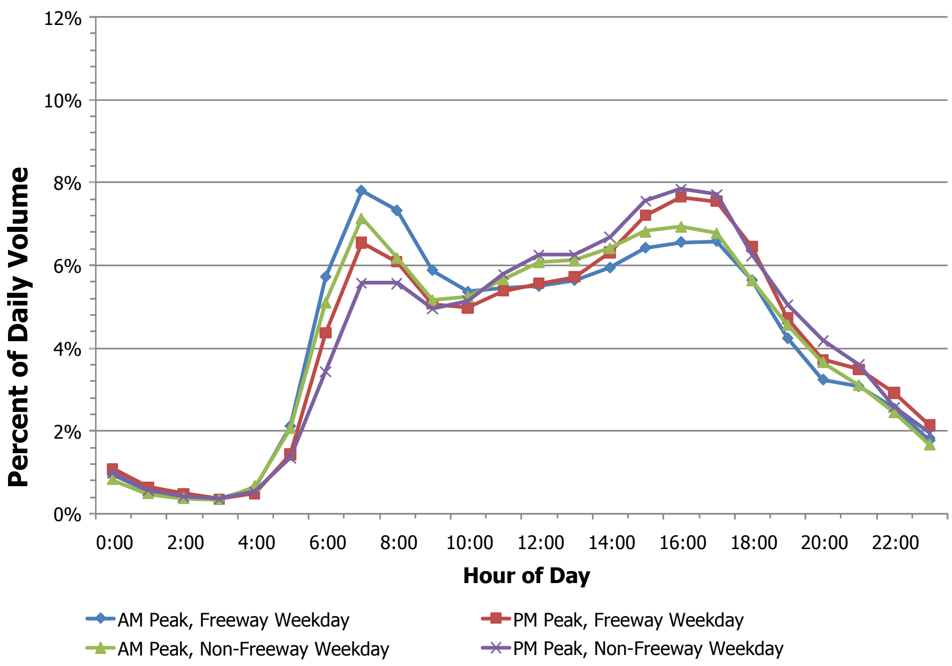


Exhibit B-5. Weekend Traffic Distribution Profile

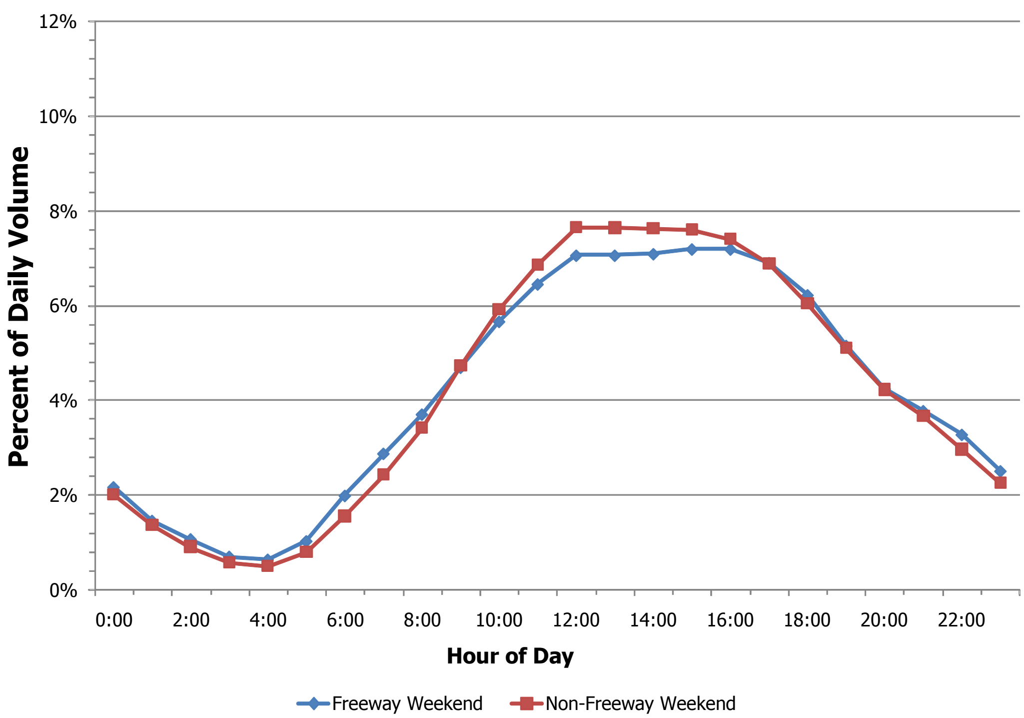
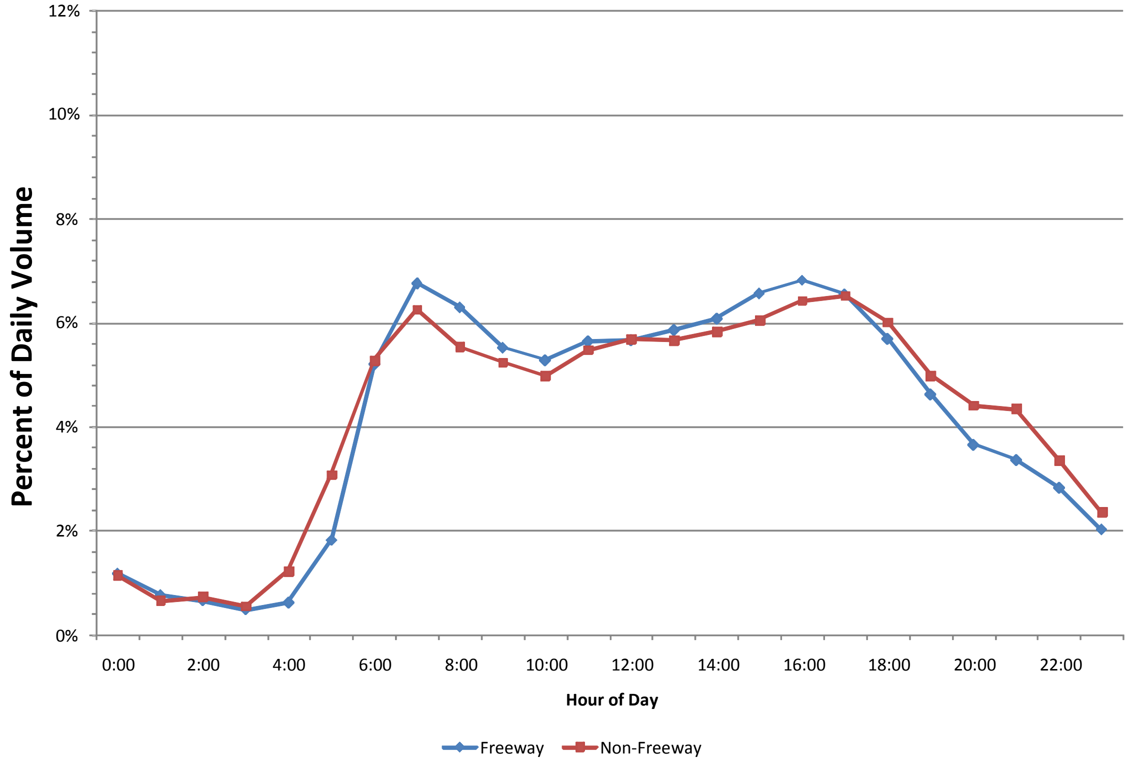


Exhibit A-6. Weekday Traffic Distribution Profile for Severe Congestion and Similar Speeds in Each Peak Period



The next step in the traffic flow assignment process is to determine which of the 16 traffic distribution profiles should be assigned to each Traffic Message Channel (TMC) path (the "geography" used by the private sector data providers), such that the hourly traffic flows can be calculated from traffic count data supplied by HPMS. The assignment should be as follows: Functional class: assign based on HPMS functional road class

- Freeway – access-controlled highways
    - Non-freeway – all other major roads and streets (not used in the *2011 CCR*)

- Day type: assign volume profile based on each day
    - Weekday (Monday through Friday)
    - Weekend (Saturday and Sunday)

- Traffic congestion level: assign based on the peak period speed reduction percentage calculated from the private sector speed data. The peak period speed reduction is calculated as follows:
  1) Calculate a simple average peak period speed (add up all the morning and evening peak period speeds and divide the total by the 8 periods in the eight peak hours) for each TMC path using speed data from 6 a.m. to 10 a.m. (morning peak period) and 3 p.m. to 7 p.m. (evening peak period).
  2) Calculate a free-flow speed during the light traffic hours (e.g., 10 p.m. to 5 a.m.) to be used as the baseline for congestion calculations. Since INRIX provides a free-flow speed in its archived average speed set, this speed was used in the calculations.

3) Calculate the peak period speed reduction by dividing the average combined peak period speed by the free-flow speed.

$$\begin{array}{c}\text{Speed}\\\text{Reduction Factor}\end{array} = \frac{\begin{array}{c}\text{Average Peak}\\\text{Period Speed}\end{array}}{\begin{array}{c}\text{Free-Flow Speed}\\\text{(10 p.m. to 5 a.m.)}\end{array}} \qquad \text{(Eq. B-1)}$$

For Freeways:

- speed reduction factor ranging from 90% to 100% (no to low congestion)
- speed reduction factor ranging from 75% to 90% (moderate congestion)
- speed reduction factor less than 75% (severe congestion)

For Non-Freeways:

- speed reduction factor ranging from 80% to 100% (no to low congestion)
- speed reduction factor ranging from 65% to 80% (moderate congestion)
- speed reduction factor less than 65% (severe congestion)

- Directionality: Assign this factor based on peak period speed differentials in the private sector speed dataset. The peak period speed differential is calculated as follows:
  1) Calculate the average morning peak period speed (6 a.m. to 10 a.m.) and the average evening peak period speed (3 p.m. to 7 p.m.)
  2) Assign the peak period volume curve based on the speed differential. The lowest speed determines the peak direction. Any section where the difference in the morning and evening peak period speeds is 6 mph or less will be assigned the even volume distribution.

<u>Step 4. Calculate Travel and Time</u>
The hourly speed and volume data was combined to calculate the total travel time for each one hour time period. The one hour volume for each segment was multiplied by the corresponding travel time to get a quantity of vehicle-hours; these were summed across the entire corridor.

<u>Step 5. Establish Free-Flow Travel Speed and Time</u>
The calculation of congestion measures required establishing a congestion threshold, such that delay was accumulated for any time period once the speeds are lower than the congestion threshold. There has been considerable debate about the appropriate congestion thresholds, but for the purpose of the *CCR* methodology, the data was used to identify the speed at low volume conditions (for example, 10 p.m. to 5 a.m.). This speed is relatively high, but varies according to the roadway design characteristics. An upper limit of 65 mph was placed on the freeway free-flow speed to maintain a reasonable estimate of delay.

<u>Step 6. Calculate Congestion Performance Measures</u>
The mobility performance measures were calculated using the equations shown in the next section of this methodology once the one-hour dataset of actual speeds, free-flow travel speeds and traffic volumes was prepared.

Calculation of the Congestion Measures

This section summarizes the methodology utilized to calculate many of the statistics shown in the *Congested Corridors Report* and is divided into three main sections containing information on the constant values, variables and calculation steps of the main performance measures of the mobility database.

1. **National Constants**
2. **Urban Area Constants and Inventory Values**
3. **Variable and Performance Measure Calculation Descriptions**
    1) Travel Speed
    2) Travel Delay
    3) Annual Person Delay
    4) Annual Peak Period Travel Time
    5) Travel Time Index
    6) Wasted Fuel
    7) Total Congestion Cost
    8) Buffer Index
    9) Planning Time Index

Generally, the sections are listed in the order that they will be needed to complete all calculations.

National Constants

The congestion calculations utilize the values in Exhibit B-7 as national constants—values used along all corridors to estimate the effect of congestion.

Exhibit B-7. National Congestion Constants for *2011 Congested Corridors Report*

Constant	Value
Vehicle Occupancy	1.25 persons per vehicle
Average Cost of Time ($2010)*	$16.30 per person hour[1]
Commercial Vehicle Operating Cost ($2010)	$88.12 per vehicle hour[1, 2]
Working Days (5x50)	250 days
Total Travel Days (7x52)	364 days

[1] Adjusted annually using the Consumer Price Index.
[2] Adjusted periodically using industry cost and logistics data.
*Source: (Reference *9,10*)

Vehicle Occupancy

The average number of persons in each vehicle during peak period travel is 1.25.

Working Days and Weeks

With the addition of the INRIX speed data in the 2011 *CCR*, the calculations are based on a full year of data that includes all days of the week rather than just the working days. The delay from each day of the week is multiplied by 50 work weeks to annualize the delay. The weekend days are multiplied by 57 to help account for the lighter traffic days on holidays. Total delay for the year is based on 364 total travel days in the year.

Average Cost of Time
The 2010 value of person time used in the report is $16.30 per hour based on the value of time, rather than the average or prevailing wage rate (*9*).

Commercial Vehicle Operating Cost
Truck travel time and operating costs (excluding diesel costs) are valued at $88.12 per hour (*10*).

Corridor Variables
In addition to the national constants, four urbanized area or state specific values were identified and used in the congestion cost estimate calculations.

Daily Vehicle-Miles of Travel
The daily vehicle-miles of travel (DVMT) is the average daily traffic (ADT) of a section of roadway multiplied by the length (in miles) of that section of roadway. This allows the daily volume of all urban facilities to be presented in terms that can be utilized in cost calculations. DVMT was estimated for the freeways corridors located in each urbanized study area. These estimates originate from the HPMS database and other local transportation data sources.

Fuel Costs
Statewide average fuel cost estimates were obtained from daily fuel price data published by the American Automobile Association (AAA) (*11*). Values for gasoline and diesel are reported separately.

Truck Percentage
The percentage of passenger cars and trucks for each corridor was estimated from the Highway Performance Monitoring System dataset (*7*). The values are used to estimate congestion costs and are not used to adjust the roadway capacity.

Variable and Performance Measure Calculation Descriptions
The major calculation products are described in this section. In some cases the process requires the use of variables described elsewhere in this methodology.
Travel Speed
The peak period average travel speeds were obtained from INRIX. Researchers also obtained free-flow travel speeds from INRIX to calculate the delay-based measures in the report.

Travel Delay
Most of the basic performance measures presented in the *Congested Corridors Report* are developed in the process of calculating travel delay—the amount of extra time spent traveling due to congestion. The travel delay calculations have been greatly simplified with the addition of the INRIX speed data. This speed data reflects the effects of both recurring delay (or usual) and incident delay (crashes, vehicle breakdowns, etc.). The delay calculations are performed at the individual roadway section level and for each hour of the week. Depending on the application, the delay can be aggregated into summaries such as weekday peak period, weekend, weekday off-peak period, etc.

$$\begin{matrix}\text{Daily Vehicle-Hours}\\ \text{of Delay}\end{matrix} = \frac{\begin{matrix}\text{DailyVehicle-Miles}\\ \text{of Travel}\end{matrix}}{\text{Speed}} - \frac{\begin{matrix}\text{DailyVehicle-Miles}\\ \text{of Travel}\end{matrix}}{\text{Free-Flow Speed}} \qquad \text{(Eq. B-2)}$$

Annual Person Delay
This calculation is performed to expand the daily vehicle-hours of delay estimates for the freeways to a yearly estimate in each study area. To calculate the annual person-hours of delay, multiply each day-of-the-week delay estimate by the average vehicle occupancy (1.25 persons per vehicle) and by 52 working weeks per year (Equation B-3).

$$\begin{matrix}\text{Annual}\\ \text{Persons-Hours}\\ \text{of Delay}\end{matrix} = \begin{matrix}\text{Daily Vehicle-Hours}\\ \text{of Delay on}\\ \text{Freeways}\end{matrix} \times \begin{matrix}\text{Annual Conversion}\\ \text{Factor}\end{matrix} \times \begin{matrix}\text{1.25 Persons}\\ \text{per Vehicle}\end{matrix} \qquad \text{(Eq. B-3)}$$

The Annual Person-Hours of Delay (Equation B-3) was divided by the congested corridor length to obtain the delay per mile values used for the rankings in the *2011 Congested Corridors Report.*

Annual Peak Period Major Road Travel Time
Total travel time can be used as both a performance measure and as a component in other calculations. The *2011 Congested Corridor Report* used travel time as a component; future reports will incorporate other information and expand on the use of total travel time as a performance measure.

Total travel time is the sum of travel delay and free-flow travel time. Both of the quantities are only calculated for the freeways. Free-flow travel time is the amount of time needed to travel the roadway section length at the free-flow speeds (provided by INRIX for each roadway section) (Equation B-4).

$$\begin{matrix}\text{Annual Free-Flow}\\ \text{Travel Time}\\ \text{(Vehicle-Hours)}\end{matrix} = \frac{1}{\begin{matrix}\text{Free-Flow}\\ \text{Travel Speed}\end{matrix}} \times \begin{matrix}\text{Daily}\\ \text{Vehicle-Miles}\\ \text{of Travel}\end{matrix} \times \begin{matrix}\text{Annual}\\ \text{Conversion}\\ \text{Factor}\end{matrix} \qquad \text{(Eq. B-4)}$$

$$\begin{matrix}\text{Annual}\\ \text{Travel Time}\end{matrix} = \begin{matrix}\text{Freeway}\\ \text{Delay}\\ \scriptstyle\text{Eq. B–3}\end{matrix} + \begin{matrix}\text{Freeway}\\ \text{Free-Flow}\\ \text{Travel Time}\\ \scriptstyle\text{Eq. B–4}\end{matrix} \qquad \text{(Eq. B-5)}$$

Travel Time Index
The Travel Time Index (TTI) compares peak period travel time to free-flow travel time. The Travel Time Index includes both recurring and incident conditions and is, therefore, an estimate of the conditions faced by urban travelers. Equation B-6 illustrates the ratio used to calculate the TTI. The ratio has units of time divided by time and the Index, therefore, has no units. This “unitless” feature allows the Index to be used to compare trips of different lengths to estimate the travel time in excess of that experienced in free-flow conditions.

The free-flow travel time for each functional class is subtracted from the average travel time to estimate delay. The Travel Time Index is calculated by comparing total travel time to the free-flow travel time (Equations B-6 and B-7). The corridor Travel Time Index is calculated by weighting the individual section indices by the vehicle-miles of travel in each section (See Equation B-20).

$$\text{Travel Time Index} = \frac{\text{Peak Travel Time}}{\text{Free-Flow Travel Time}} \qquad \text{(Eq. B-6)}$$

$$\text{Travel Time Index} = \frac{\text{Delay Time} + \text{Free-Flow Travel Time}}{\text{Free-Flow Travel Time}} \qquad \text{(Eq. B-7)}$$

Wasted Fuel

The average fuel economy calculation is used to estimate the difference in fuel consumption of the vehicles operating in congested and uncongested conditions. Equations B-8 and B-9 are the regression equations resulting from fuel efficiency data from EPA/FHWA's MOVES model (*12*).

$$\begin{array}{c}\text{Passenger Car}\\ \text{Fuel Economy}\end{array} = -0.0066 \times (\text{speed})^2 + 0.823 \times (\text{speed}) + 6.1577 \qquad \text{(Eq. B-8)}$$

$$\begin{array}{c}\text{Truck Fuel}\\ \text{Economy}\end{array} = 1.4898 \text{ x} \ln \text{ speed} - 0.2554 \qquad \text{(Eq. B-9)}$$

The *CCR* calculates the wasted fuel due to vehicles moving at speeds slower than free-flow throughout the day. Equation B-10 calculates the fuel wasted in delay conditions from Equation B-3, the average hourly speed, and the average fuel economy associated with the hourly speed (Equation B-8 and B-9).

$$\begin{array}{c}\text{Annual}\\ \text{Fuel Wasted}\end{array} = \begin{array}{c}\text{Travel Time}\\ \text{vehicle hours}\\ \text{Eq. B–4}\end{array} \times \begin{array}{c}\text{Average Hourly}\\ \text{Speed}\\ \text{Eq. B–2}\end{array} \div \begin{array}{c}\text{Average Fuel}\\ \text{Economy}\\ \text{Eq.B–8,9}\end{array} \times \begin{array}{c}\text{Annual}\\ \text{Conversion Factor}\end{array} \qquad \text{(Eq. B-10)}$$

Equation B-11 incorporates the same factors to calculate fuel that would be consumed in free-flow conditions. The fuel that is deemed "wasted due to congestion" is the difference between the amount consumed at peak speeds and free-flow speeds (Equation B-10).

$$\begin{array}{c}\text{Annual Fuel}\\ \text{Consumed in}\\ \text{Free-Flow Conditions}\end{array} = \begin{array}{c}\text{Travel Time}\\ \text{Eq. B-4}\end{array} \times \begin{array}{c}\text{Free-Flow}\\ \text{Speed from}\\ \text{INRIX Data}\end{array} \div \begin{array}{c}\text{Average Fuel}\\ \text{Economy for}\\ \text{Free-Flow Speeds}\\ \text{Eq. B–8,9}\end{array} \times \begin{array}{c}\text{Annual}\\ \text{Conversion}\\ \text{Factor}\end{array} \qquad \text{(Eq. B-11)}$$

$$\begin{array}{c}\text{Annual Fuel}\\ \text{Wasted in Congestion}\end{array} = \begin{array}{c}\text{Annual Fuel}\\ \text{Consumed in}\\ \text{Congestion}\end{array} - \begin{array}{c}\text{Annual Fuel That}\\ \text{Would be Consumed}\\ \text{in Free-flow Conditions}\end{array} \qquad \text{(Eq. B-12)}$$

Total Congestion Cost

Two cost components are associated with congestion: delay cost and fuel cost. These values are directly related to the travel speed calculations. The following sections and Equations B-14 through B-16 show how to calculate the cost of delay and fuel effects of congestion.

Passenger Vehicle Delay Cost. The delay cost is an estimate of the value of lost time in passenger vehicles in congestion. Equation B-13 shows how to calculate the passenger vehicle delay costs that result from lost time.

$$\begin{matrix}\text{Annual Psgr-Veh}\\ \text{Delay Cost}\end{matrix} = \begin{matrix}\text{Daily Psgr Vehicle}\\ \text{Hours of Delay}\\ \text{(Eq. B-3)}\end{matrix} \times \begin{matrix}\text{Value of}\\ \text{Person Time}\\ \text{(\$ / hour)}\end{matrix} \times \begin{matrix}\text{Vehicle}\\ \text{Occupancy}\\ \text{(pers vehicle)}\end{matrix} \times \begin{matrix}\text{Annual}\\ \text{Conversion}\\ \text{Factor}\end{matrix} \quad \text{(Eq. B-13)}$$

Passenger Vehicle Fuel Cost. Fuel cost due to congestion is calculated for passenger vehicles in Equation B-14. This is done by associating the wasted fuel, the percentage of the vehicle mix that is passenger, and the fuel costs.

$$\begin{matrix}\text{Annual}\\ \text{Fuel Cost}\end{matrix} = \begin{matrix}\text{Daily Fuel}\\ \text{Wasted}\\ \text{(Eq. B–12)}\end{matrix} \times \begin{matrix}\text{Percent of}\\ \text{Passenger}\\ \text{Vehicles}\end{matrix} \times \begin{matrix}\text{Gasoline}\\ \text{Cost}\end{matrix} \times \begin{matrix}\text{Annual}\\ \text{Conversion Factor}\end{matrix} \quad \text{(Eq. B-14)}$$

Truck or Commercial Vehicle Delay Cost. The delay cost is an estimate of the value of lost time in commercial vehicles and the increased operating costs of commercial vehicles in congestion. Equation B-15 shows how to calculate the passenger vehicle delay costs that result from lost time.

$$\begin{matrix}\text{Annual Comm-Veh}\\ \text{Delay Cost}\end{matrix} = \begin{matrix}\text{Daily Comm Vehicle}\\ \text{Hours of Delay}\\ \text{(Eq. B-3)}\end{matrix} \times \begin{matrix}\text{Value of}\\ \text{Comm Vehicle Time}\\ \text{(\$ / hour)}\end{matrix} \times \begin{matrix}\text{Annual}\\ \text{Conversion}\\ \text{Factor}\end{matrix} \quad \text{(Eq. B-15)}$$

Truck or Commercial Vehicle Fuel Cost. Fuel cost due to congestion is calculated for commercial vehicles in Equation B-16. This is done by associating the wasted fuel, the percentage of the vehicle mix that is commercial, and the fuel costs.

$$\begin{matrix}\text{Annual}\\ \text{Fuel Cost}\end{matrix} = \begin{matrix}\text{Daily Fuel}\\ \text{Wasted}\\ \text{(Eq. B–12)}\end{matrix} \times \begin{matrix}\text{Percent of}\\ \text{Commercial}\\ \text{Vehicles}\end{matrix} \times \begin{matrix}\text{Diesel}\\ \text{Cost}\end{matrix} \times \begin{matrix}\text{Annual}\\ \text{Conversion Factor}\end{matrix} \quad \text{(Eq. B-16)}$$

Total Congestion Cost. Equation B-17 combines the cost due to travel delay and wasted fuel to determine the annual cost due to congestion resulting from incident and recurring delay.

$$\begin{matrix}\text{Annual Cost}\\ \text{Due to}\\ \text{Congestion}\end{matrix} = \begin{matrix}\text{Annual Passenger}\\ \text{Vehicle Delay Cost}\\ \text{Eq. B-13}\end{matrix} + \begin{matrix}\text{Annual Passenger}\\ \text{Fuel Cost}\\ \text{Eq. B-14}\end{matrix} + \begin{matrix}\text{Annual Comm}\\ \text{Veh Delay Cost}\\ \text{Eq. B-15}\end{matrix} + \begin{matrix}\text{Annual Comm}\\ \text{Veh Fuel Cost}\\ \text{(Eq B-16)}\end{matrix} \quad \text{(Eq. B-17)}$$

Buffer Index. Equation B-18 shows the computation performed to compute the buffer index reliability measure.

$$\begin{matrix}\text{Buffer}\\ \text{Index (\%)}\end{matrix} = 100\% \text{ x} \frac{\begin{matrix}\text{95th Percentile}\\ \text{Travel Time minutes}\end{matrix} - \begin{matrix}\text{Average Travel Time}\\ \text{minutes}\end{matrix}}{\begin{matrix}\text{Average Travel Time}\\ \text{(minutes)}\end{matrix}} \quad \text{(Eq. B-18)}$$

Planning Time Index. Equation B-19 shows the computation performed to compute the planning time index reliability measure.

$$\text{Planning Time Index} = \frac{\substack{\text{95th Percent Travel Time} \\ \text{(minutes)}}}{\substack{\text{Free} - \text{flow Travel Time} \\ \text{(minutes)}}} \qquad \text{(Eq. B-19)}$$

Volume weighting of Indices. Separate travel time indices, buffer indices, and planning time indices were calculated for each segment within a corridor. These indices were weighted together by vehicle-miles of travel from each segment to generate a corridor travel time index, buffer index, and planning time index. Equation B-20 shows how a particular corridor index would be calculated.

$$\substack{\text{Corridor} \\ \text{Index}} = \frac{\substack{\text{Index} \\ \text{Segment 1}} \times \substack{\text{VMT} \\ \text{Segment 1}} + \substack{\text{Index} \\ \text{Segment 2}} \times \substack{\text{VMT} \\ \text{Segment 2}} + \substack{\text{... Index} \\ \text{Segment n}} \times \substack{\text{VMT} \\ \text{Segment n}}}{\substack{\text{VMT} \\ \text{Segment 1}} + \substack{\text{VMT} \\ \text{Segment 2}} + \substack{\text{... VMT} \\ \text{Segment n}}} \qquad \text{(Eq. B-20)}$$

References

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