Federal Highway Administration
Office of Freight Management and
Operations

Freight Benefit/Cost Study:

Highway Freight Logistics Reorganization Benefits Estimation Tool Report and Documentation

FHWA –HOP-08-017

Prepared by:

HDR|HLB Decision Economics Inc.

February, 2008

U.S. Department of Transportation
Federal Highway Administration

Notice

Quality Assurance Statement

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. OVERVIEW

1.1 Overview

The Freight Benefit/Cost Study was a multi-year effort originating in the Federal Highway Administration, Office of Freight Management and Operations, supported by HLB Decision Economics (Subsequently HDR|HLB Decision Economics) and ICF Consulting. The project started as an assessment of previously unaccounted for benefits of infrastructural investment, and it has become a permanent tool for future benefit assessments.

1.1.1 Background

The Freight Benefit/Cost Study project went through three phases of development. The first phase focused on developing the theory and logic. The second phase determined the sensitivity of a firm to infrastructural investment on a national level. The third phase determined sensitivities to infrastructural investment on a regional level and constructed a tool for state and local entities to estimate additional benefits derived though logistics rearrangements from highway performance improvements.

1.1.2 Phase I – Methodological Overview

Phase I constructed the basic economic concepts. In previous attempts by other research papers to capture the benefits of infrastructure investment, long-term benefits had not been calculated primarily because the logistics-exclusive firm had yet to appear as a commonly used method of reducing costs. However, since their adoption as a major service, businesses with efficient economies have seen their costs drop down to 9.5% from the previous 30%. In the new logistics framework, logistics firms are the principle recipients of the benefits from infrastructure work, but their benefits had not been measured. This drop directly relates to the cost of logistics. The lower price for logistics then causes more logistics to be purchased. Hence, this new gap from the old price and consumption is the overall amount of benefit that is netted when highways investments are made.

1.1.3 Phase II – National Estimation of Benefits

Phase II developed an estimate of the relationship between investment and benefits. Phase II was meant to establish the long-term benefits of highway-freight improvements by examining the interaction between freight transportation demand, transportation costs, and the condition of the nation's highway system. These interactions were assessed beyond the traditional travel-time savings model. The method adopted in Phase II allowed the quantification of the effects of transportation system reorganization in relation to the:

- immediate cost reduction to carriers and shippers
- the impact of improved logistics while keeping output fixed
- increased demand
- new products

- improved products

1.1.4 Phase III – Regional Estimation of Benefits

Phase III determined the relationship among various sectors and added an interface for practioners to use. While Phase II provided acceptable results for the national level, Phase III determined the inputs needed for custom use at the regional level. Once the factors for the inputs were determined, the final half of Phase III constructed the Highway Freight Logistics Reorganization Benefits Estimation Tool.

1.2 Economic Logic

1.2.1 Benefits

In economics, every action has a series of consequences that fall into the category of either cost or benefit. Traditionally, an action is undertaken by an individual or firm because there is some form of benefit. The benefit can be as simple as personal fulfillment or as complex as fourth-tier reactions, for example. There are relatively consistent rules regarding what is included in the scope of a Benefit Cost Analysis (BCA).

1.2.2 Traditional Methodology

Traditionally, only first-order reactions to infrastructural investment have been taken into account. For example, when infrastructure is improved, conventional CBAs largely considers the benefits in travel time savings, reduced fuel costs, decreased accident rates, lower environmental impacts, and reduced cost of shipping. This reduced cost of shipping is a first step in a multi-phased series of benefits that occur as firms shift expenditures away from maintaining stock on hand and toward other more productive uses. The Highway Freight Logistics Reorganization Benefits Estimation Tool seeks to measure these second order benefits.

Effects of Improved Freight Transportation	
First-order benefits	Immediate cost reductions to carriers and shippers, including gains to shippers from reduced transit times[1] and increased reliability.
Second-order benefits	Reorganization-effect gains from improvements in logistics.[2] Quantity and quality of firms' outputs do not change.
Third-order benefits	Gains from additional reorganization effects due to changes in product quality or changes in demand for products and output from broader access to suppliers and markets.
Other effects	Effects that are not considered as benefits according to the strict rules of benefit-cost analysis, but may still be of considerable interest to policy makers. These could include increases in regional employment, or growth rate of regional income.

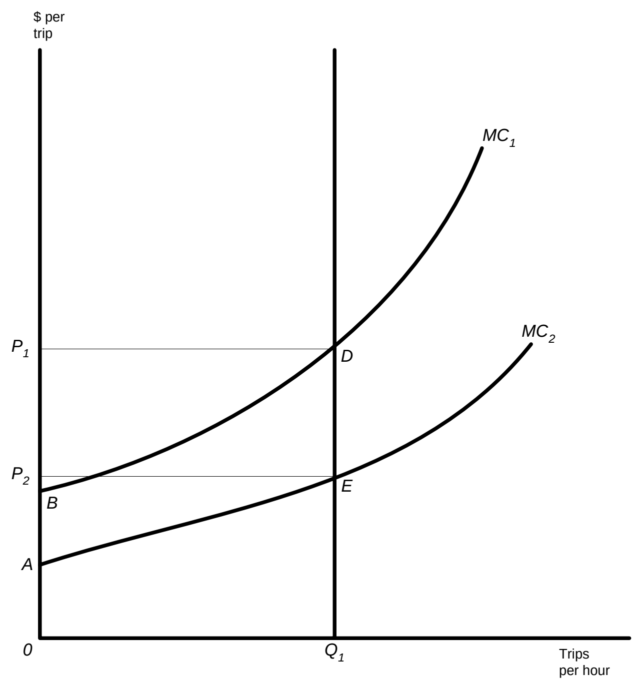
[1] Carrier effects include reduced vehicle operating times and reduced costs through optimal routing and fleet configuration. Transit times may affect shipper in-transit costs, such as for spoilage, and scheduling costs, such as

1.2.3 Conceptualizing Logistics Reorganization Benefits

Logistics has become one of the largest businesses in the world with firms in every sector doing at least some business with logistics providers. Since the inception of these firms, and the growing need for immediacy to deliver lower inventory costs, the benefit from the reduction in logistics costs is more readily capitalized upon by logistics firms. Typically, these savings are passed on to producers who pass them on to consumers and reinvest in their own logistics needs. Logistics includes warehouses, trucks, fuel for trucks, teamsters, drivers, and other things that require a large amount of capital. When it becomes easier to ship via highway across country, fewer warehouses need to be built or maintained. Furthermore, the carrying cost of maintaining production input stock on hand is reduced, as firms can better rely on the shipping system to deliver goods when needed. This is a benefit that the Highway Freight Logistics Reorganization Benefits Estimation Tool seeks to measure.

Figure 1 gives a visual representation of the effects of infrastructure investment. In the very short run, shippers and carriers have a few degrees of freedom in responding to transportation network changes; delivery schedules and routings can be changed, but origins and destinations are fixed. In the longer run, truck-fleet characteristics can be changed while, over the long term, the number, sizes, and locations of factories and warehouses can all be changed.

Figure 1. Direct Very Short Run Benefits of Road Improvements with Marginal-cost Tolls



for inter-modal transfer delays and port clearance. These effects are non-linear and may vary by commodity and mode of transport.

[2] Improvements include rationalized inventory, stock location, network, and service levels for shippers.

Suppose that an additional lane in each direction materializes on the freeway connecting Here and There. On this day, the relevant demand schedule is the vertical line in

Figure 1. Surprised users discover that congestion has diminished sharply and that the full prices of trips — congestion tolls plus travel times—have fallen from OP_1 to OP_2. However, too little time has elapsed for them to adjust their travel behavior to take advantage of this change.

As news of the expressway improvement spreads, price and output levels change in a number of related markets. Increased speeds and reduced prices on the expressway induce additional use that results in increased congestion and tolls. The increased accessibility that the improvement affords may increase the values of neighboring residential, commercial, and industrial sites. The improvement's lower transportation costs apply to goods shipments and person trips. As a result, the delivered price of goods produced "Here" and sold "There" fall. Faster and more reliable travel may induce cost-saving changes in the production, distribution, and inventory practices of Here and There business firms.

1.3 Phase Objectives, Methodology, and Conclusions

1.3.1 Phase I

Phase I developed the theory upon which other phases were constructed. At its conclusion, a White Paper[3] addressed various methodologies that had been previously employed and contrasted these with a proposed new method. The primary objective of Phase I was to ensure that the BCA framework recognized the gains in economic welfare (efficiency) that follow from transportation infrastructure improvements.

The framework employed looks at performance improvements as a sort of subsidy on logistics. The infrastructure input functioned as a reduction to the logistics cost that would later return to the firm. Price sensitivity was a determinant of how much returned to the firm, with less price sensitivity allowing more to return to the firm since there would not be a great benefit to lowering the price. Phase II applied the framework developed under Phase I to determine the data required and construct the benefit estimates.

The Phase I study arrived at the following conclusions:

- First, in a world where marginal-cost prices prevail in all markets including those for transportation facilities, only information on the use made of improved transport facilities is necessary to completely measure the benefits it yields to its users and provider.
- Second, in the absence of marginal-cost pricing on roads and other governmentally provided facilities, benefit measurement becomes much more difficult.
- Third, determining the full benefit of an improvement requires analyzing its use and the use of other facilities that the improvement affects.

Lastly, if elements of a monopoly exist in the markets that the road users participate, sellers' transportation demand schedules understate total benefits. In the simple model used to illustrate the phenomenon, a monopoly hid about one-third of the benefits.

1.3.2 Phase II

The purpose of Phase II was to determine the elasticities (price sensitivities) that exist for highway freight on a national level. The same sensitivities were determined on a more specific, regional basis under Phase IIIA.

Freight demand can be expressed as a function of the demand for goods and services, level of economic activity, general trends, freight charges, and congestion levels. Freight charges, in

[3] Transportation Infrastructure, Freight Services Sector and Economic Growth: A Synopsis Prepared by T. R. Lakshmanan and William P. Anderson Center for Transportation Studies Boston University for FHWA. Available at: http://ops.fhwa.dot.gov/freight.

turn, are a function of freight demand, distance, congestion levels, and factor costs, including fuel and labor costs.

Two types of statistical analyses were undertaken to investigate the effects of highway performance on the demand for trucking and on trucking rates. One was a cross-sectional analysis based on data across 30 corridors for 1998, and the second was a cross-sectional and time-series (panel data) analysis that builds on the cross-sectional database by including historic data on all relevant variables.

The results of the cross-sectional analysis were not usable for the trucking-demand and the trucking-rate equations as they demonstrated that highway performance variables, such as delay and V/C ratio, are positively correlated with freight demand. Numerous alternatives for structuring the analysis were tested, but none provided results that could be used. Three sets of analyses were then conducted based on different approaches to defining corridors. Nevertheless, in every case, the statistical relationships between highway performance and the demand for trucking/trucking rates that the study sought to define were counter-intuitive or insignificant.

However, in the case of the trucking-demand equation, the panel data yielded useful results. The estimated coefficients showed that lowering the volume/capacity ratio would lead to an increase in truck miles; it showed the same result when the volume/capacity ratio was converted to a measure of delay (i.e., as delay goes down, demand for highway freight goes up).

Phase II concluded that the formula's determinations could be replicated at a smaller scope for use at the project level and be incorporated into a tool.

1.3.3 Phase III

Given the results for the national analysis of the reorganization impacts of highway performance improvements, a similar methodology was employed to develop regionalized sensitivities (elasticities). The corridors included in the national analysis were tested to indicate the robustness of results when segregated into regions of various sizes and constitutions. This analysis indicated that the most reliable results could be obtained using a three-region approach consisting of East, Central, and West.

The overall goal of the analysis was to develop regional data points required to estimate additive freight benefits reflecting the added value of specific highway performance improvement efforts at a regional level. In order to develop estimates of the additional reorganization benefit, the methodology required that two types of elasticities be estimated for each region: 1) performance elasticity and 2) price elasticity.

A panel of data on corridor performance, demand for freight movement, freight prices, and regional economic activity was then constructed for these regions. Regression analysis was applied to this panel to develop estimates of performance elasticity of demand. The study successfully estimated the elasticities of demand with respect to performance for each of the three regions using data on performance, volume, and other data for 59 corridors in total. See Table 1.

Table 1. Corridors Included in the Regional Analysis

East Region-18 corridors		Central Region-18 corridors		West Region-23 corridors	
Atlanta-Jacksonville	ATL-JAX	Amarillo-Oklahoma City	AMA-OKL	Barstow-Amarillo	BAR-AMA
Atlanta-Knoxville	ATL-KNX	Billings-Sioux Falls	BIL-SIO	Barstow-Bakersfield	BAR-BAK
Atlanta-Mobile	ATL-MOB	Chicago-Cleveland	CHI-CLE	Barstow-Salt Lake City	BAR-SAL
Birmingham-Nashville	BGH-NSH	Cleveland-Columbus	CLE-COL	Dallas-El Paso	DAL-ELP
Birmingham-Chattanooga	BIR-CHA	Dayton-Detroit	DAY-DET	Dallas-Houston	DAL-HOU
Detroit-Pittsburgh	DET-PIT	Indianapolis-Chicago	IND-CHI	Denver-Kansas City	DEN-KAN
Harrisburg-Philadelphia	HAR-PHI	Indianapolis-Columbus OH	IND-COL	Denver-Salt Lake City	DEN-SAL
Knoxville-Harrisburg	KNX-HAR	Kansas City-St Louis	KNC-STL	Galveston-Dallas	GAL-DAL
Miami-Atlanta	MIA-ATL	Knoxville-Dayton	KNX-DAY	Laredo-San Antonio	LAR-SAN
Miami-Richmond	MIA-RIC	Louisville-Columbus	COL-LOU	Los Angeles-Tucson	LAX-TUC
Mobile-New Orleans	MOB-NOR	Louisville-Indianapolis	IND-LOU	Nogales-Tucson	NOG-TUC
New Orleans-Birmingham	NOR-BIR	Memphis-Dallas	MEM-DAL	Portland-Salt Lake City	POR-SAL
Boston-New York City	NYC-BOS	Memphis-Oklahoma City	MEM-OKL	Portland-Seattle	POR-SEA
New York City-Cleveland	NYC-CLE	Nashville-Louisville	NSH-LOU	San Antonio-Dallas	SAN-DAL
Harrisburg-New York City	NYC-HAR	Nashville-St Louis	NSH-STL	San Diego-Los Angeles	SDG-LAX
Philadelphia-New York City	PHI-NYC	Omaha-Chicago	OMA-CHI	San Francisco-Los Angeles	SFO-LAX
Columbus-Pittsburgh	PIT-COL	St Louis-Oklahoma City	STL-OKL	San Francisco-Portland	SFO-POR
Richmond-Philadelphia	RIC-PHI	St Louis-Indianapolis	STL-IND	San Francisco-Salt Lake City	SFO-SAL
				San Antonio-Houston	SAN-HOU
				Seattle-Billings	SEA-BIL
				Seattle-Blaine	SEA-BLA
				Seattle-Sioux Falls	SEA-SIO
				Tucson-San Antonio	TUC-SAN

The panel data analysis on these corridors indicated that demand for shipping services varied with the expected speed of delivery and that differing levels of variance can be expected in different geographic areas. As highway performance improves, demand for freight movement increases in each region. The impact of improvement is strongest in the Central region. This is possibly due to the greater likelihood of highway freight being chosen over other alternatives (such as the air or water modes) to transport goods between coasts as the cost of shipping declines.

From the regional estimations, the study developed the underlying network of assessment for smaller project use. Using the smaller regional data, the models were custom fitted with relevant data to construct new assessments of future infrastructural improvements. In addition, data on commodities was included as an influencing variable.

Phase III resulted in the construction of a Microsoft Excel ©-based tool that can be used to estimate additive freight benefits resulting from highway performance improving investments. These benefits can be summed with the conventional benefits expressed through CBA to present a more complete picture of the return on highway investment.

The next section describes the Highway Freight Logistics Reorganization Benefits Estimation Tool, its use, and data requirements.

2. USER MANUAL

2.1 Version History

This User Manual refers to release 1, version 2.5 of the Highway Freight Logistics Reorganization Benefits Estimation Tool. It was developed by HDR Decision Economics under the direction of the U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations.

2.2 Tool Purpose

The Highway Freight Logistics Reorganization Benefits Estimation Tool estimates total benefits associated with highway investment by establishing a relationship between elasticity of demand with respect to highway performance, elasticity of demand with respect to price, a set of other region-specific variables, and the conventionally measured freight benefits resulting from travel time savings and other user benefits. The purpose of this manual is to provide users with step-by-step instructions on using the Benefit Estimation Tool, describe the data inputs required, and provide background on the sources and uses of the "default" data provided in the model.

The outputs resulting from the Benefit Estimation tool indicate the additional benefit related to reorganizing logistics that may be expected to occur following from a planned performance improvement. These benefit outputs may be used in (or added to) BCAs that do not independently account for the value of improved freight management.

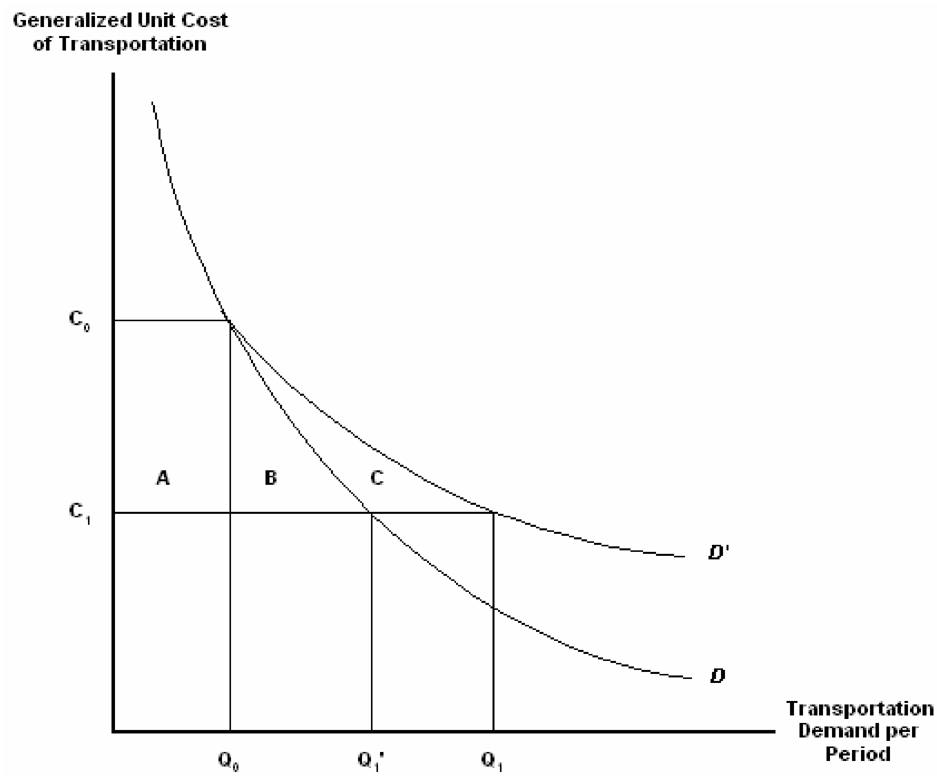
2.3 Additive Freight Benefit Economic Framework and Calculation Approach

2.3.1 Microeconomic Framework

Figure 2 shows the microeconomic framework that identifies the benefits of industrial reorganization. Area A represents the immediate benefits of a highway improvement to existing highway users (mainly user time savings and reduced vehicle operating costs). Area B represents the immediate benefits accruing to users newly attracted to the highway by virtue of the improvement. Areas A and B represent the benefits conventionally measured in a CBA.

Area C represents the value of efficiency gains to the economy due to industrial reorganization precipitated by the highway improvement. Industrial reorganization means the adoption of advanced logistics for a firm depends on the likelihood of a threshold level of reliability in highway performance. Defined as the ratio of area C to the sum of areas A and B (C/[A+B] expressed as a percentage), the "additive freight reorganization benefit" gives the percentage by which to increase the value of conventionally-measured benefits to freight traffic in order to approximate total benefits – that is, benefits inclusive of the reorganization effect.

Figure 2. Change in Consumer Surplus from Changing Demand for Transportation as a Function of Unit Generalized Transportation Cost



To assess the quantitative significance of the additive reorganization benefit, the Additive Freight Benefit Calculation considers:

- Q_0: Initial demand for freight transportation (vehicle-miles);
- Q_1: New demand level as a result of highway improvements or policy change;
- C_0: Initial unit generalized cost of transportation ($/vm);
- C_1: New unit generalized cost of transportation ($/vm) following highway improvement or policy change; and
- β_0 β_1 Immediate and post-reorganization slopes of the transport demand curves (respectively) with respect to the generalized cost of transportation, where generalized cost is the linear sum of vehicle operating expenses, delay-related expenses and unreliability-related expenses.

Using national highway performance data, Phase II of the FHWA Benefit Cost Study found that variable-elasticity in the form of the present and post-reorganization demand curves (indicating constant returns to scale) provides a reasonable description of the available data. Specifically, the elasticity of demand for transport with respect to generalized cost is found to vary proportionately with generalized cost. The elasticity is smaller when generalized cost is relatively low and higher when generalized cost is relatively high. This implies that demand is more sensitive to changes in highway conditions when congestion is high than when congestion is low. The form of the estimated demand curve is:

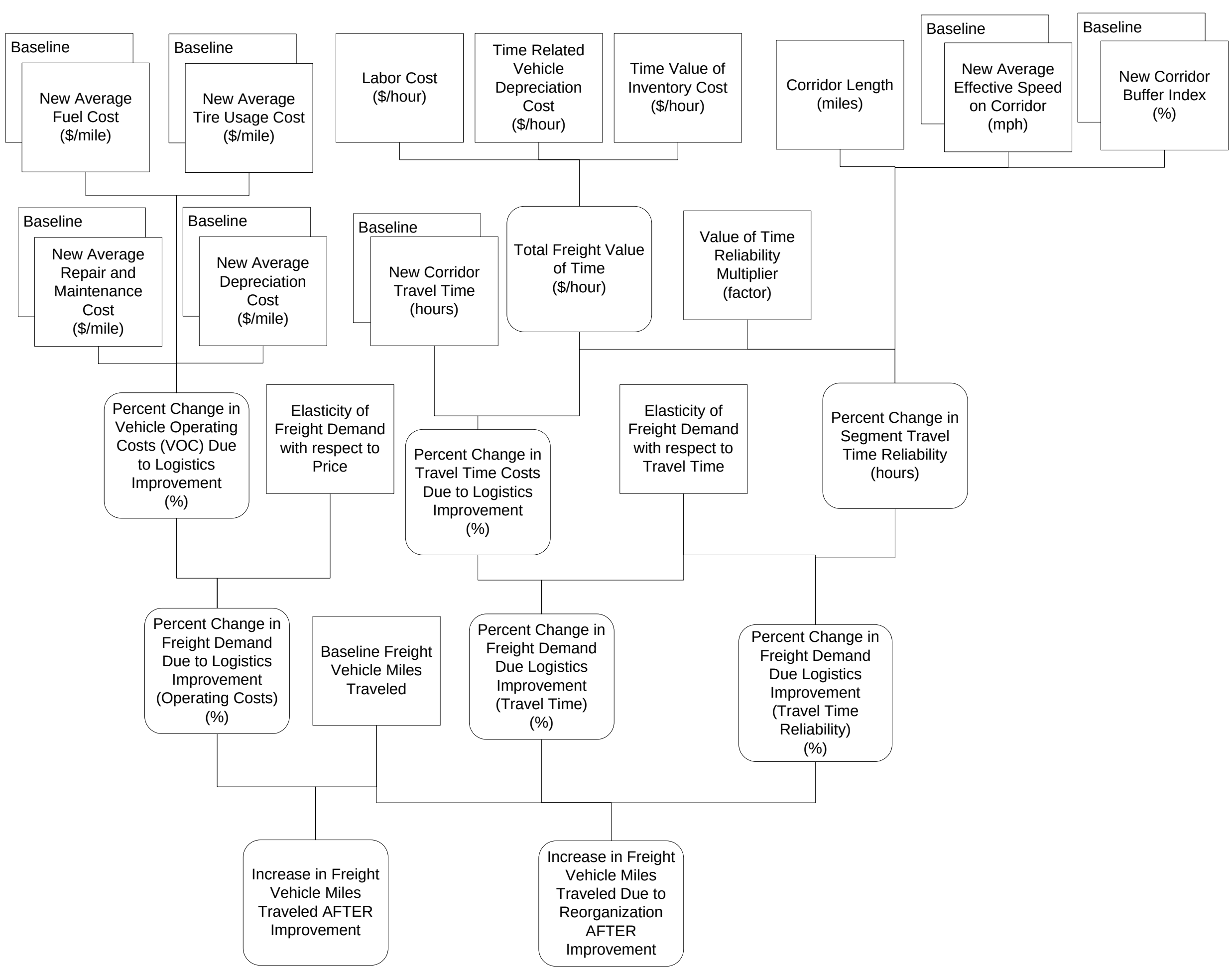
$$\text{Ln } Q = \beta_0 + \beta_1 * C$$

where Q is the quantity of transportation that would be demanded at a generalized cost of C, and where β_0 and β_1 are constants estimates with least-squares in a fixed-effects model that controls for between-corridor variations.

2.3.2 Additive Benefit Calculation Approach

The additive benefit estimation tool has been developed to accommodate outcomes from consumer surplus models where the practitioner explicitly accounts for induced demand using standard transportation demand elasticity estimates and estimates the change in consumer surplus resulting from a candidate highway investment. The tool calculates the additive benefit using the logic laid out in the structure and logic diagram below.

Figure 3. Structure and Logic of Additive Benefit Estimation



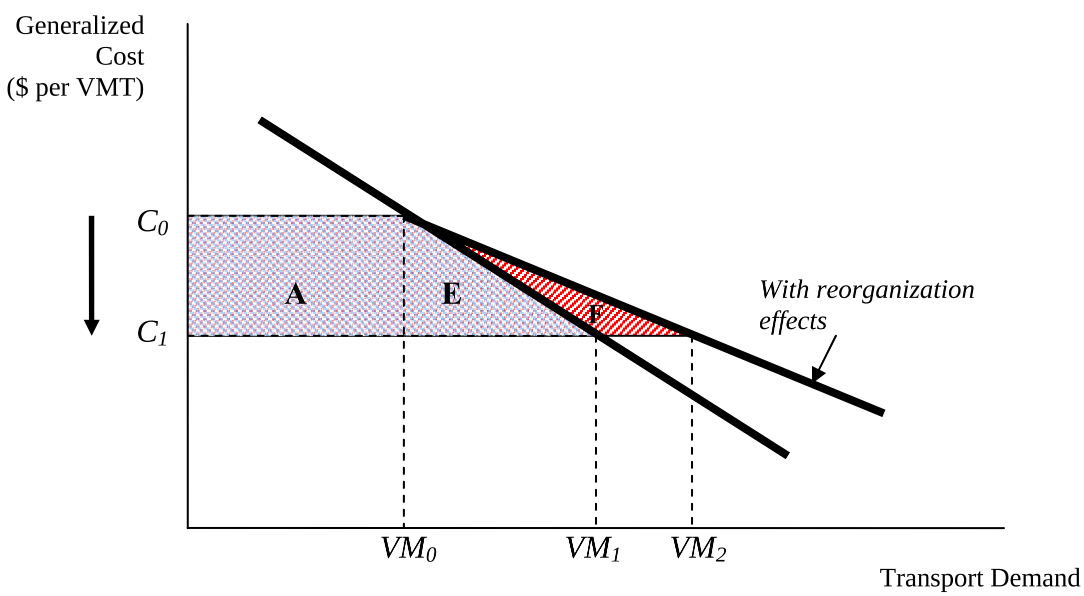
Additive Benefit Estimation with Consumer Surplus Models

In Figure , the additive benefit factor would be calculated as the ratio of area F (the area between the long run transport demand curve "with reorganization effects," the standard short- run demand curve, and the C_1 line) to a standard measure of consumer surplus, represented by area A plus area E.

Additive Benefit Factor = Area F / (Area A + Area E)

In other words, the additive benefit factor is estimated as the percentage change in consumer surplus resulting from incremental transport demand along the long-run demand curve (incremental transport demand is illustrated by the shift from VM_1 to VM_2).

Figure 4. Additive Benefit Estimation with Consumer Surplus Models, *An Illustration*



A numerical example of additive benefit estimation with consumer surplus models is provided in Table 2.

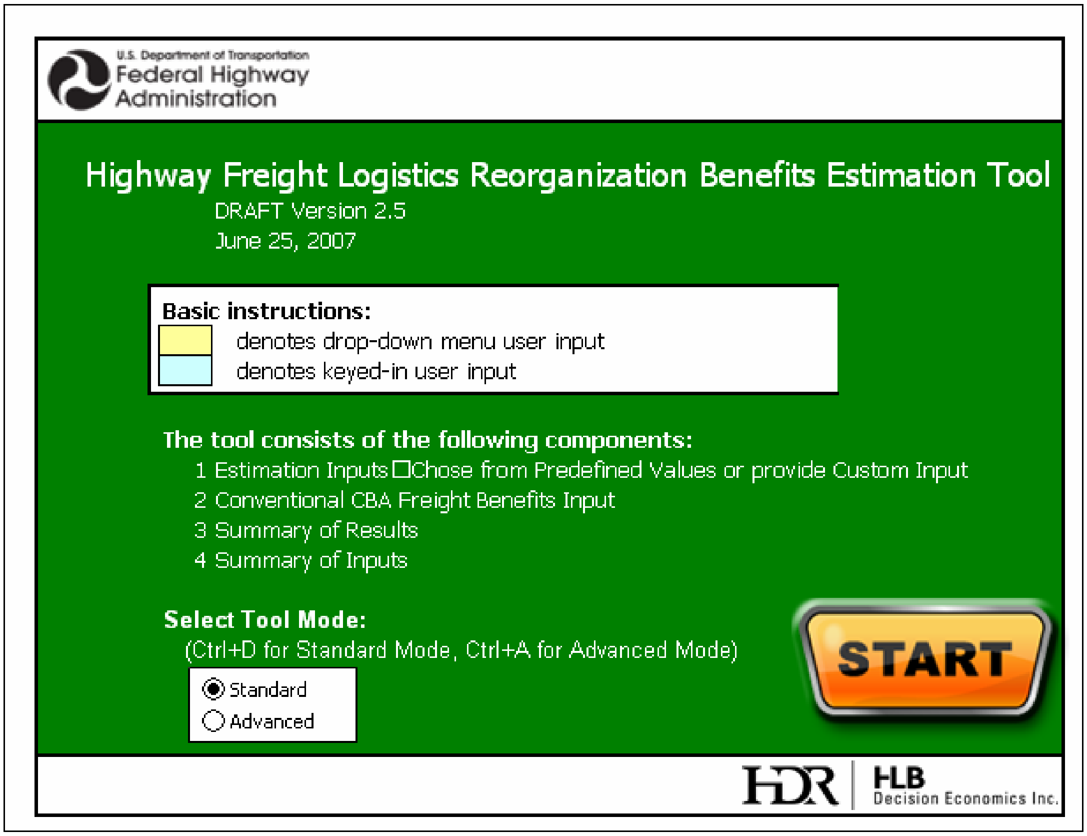
Table 2. Additive Benefit Estimation with Consumer Surplus Models, *A Numerical Example*

#	Parameters	Standard Consumer Surplus Model Output	Augmented Output and Additive Benefit Estimation
	Unit Generalized Costs ($/vehicle mile)		
1	C_0	$3.8100	$3.8100
2	C_1	$3.4351	$3.4351
	Transport Demand (freight vehicle miles)		
3	VM_0	200,000	200,000
4	VM_1	219,400	220,434
	Demand Curve		
5	Constant (a = VM_0*C_0 raised to power b)	54,642	49,879
6	Full Price Elasticity (b)	-0.9700	-1.0382
7	r = 1-(1/b)	2.0309	1.9632
8	a^(1/b)	1.30602E-05	2.98484E-05
9	a^(1/b) * (($VM_{1\ or\ 2}$^r)-(VM_0^r))/r	77,614	81,679
10	Delta VM * C_1	66,641	70,191
11	VM_0 * Delta C	74,988	74,988
12	Direct Benefits (Row 11)	$74,988	$74,988
13	Indirect Benefits (Row 9 minus Row 10)	$10,973	$11,487
14	**Total benefits (Row 12 +Row 13)**	**$85,962**	**$86,476**
15	**% change in “total benefits”**		**0.60%**
16	**% change in “indirect benefits”**		**4.7%**

2.4 Opening Screen

The opening screen of the Highway Freight Logistics Reorganization Benefits Estimation Tool provides the user with some basic information on the tool, such as the tool's name and version, basic user instruction, outline of the tool's components, mode selection, and start button. Figure provides a screenshot of the tool's opening screen.

Figure 5. Screenshot of Opening Screen



Tool Name and Version: The tool name and model version are helpful during user support inquiries.

Basic Instructions: The basic instructions provide the user with an understanding of the color coding applied to user input. Light yellow cells indicate a drop-down menu is available for the user to select. Only values that are contained in the dropdown list will be accepted for input. Light blue cells indicate keyed-in user input. Users must key-in the input for these cells, although certain cells may only accept specific types of keyed-in data.

Tool Composition: Provides an overview of the four main screens of the estimation tool. The user will encounter these screens in sequential order using the model navigation buttons.

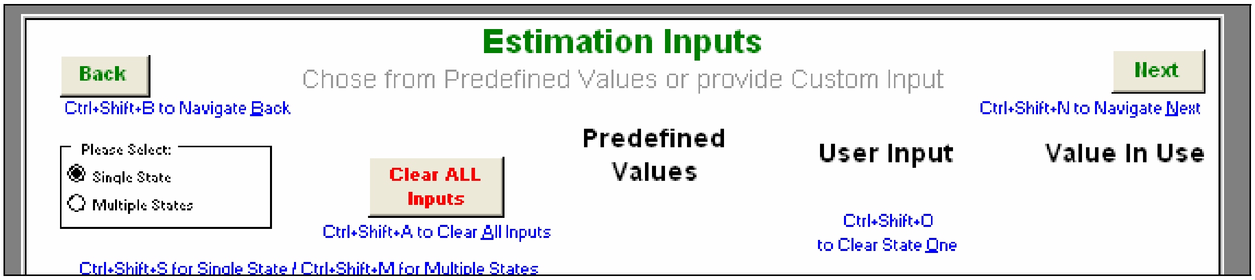
Tool Mode: The tool may be operated in two modes, Standard or Advanced. Standard Mode is recommended for most users. Advanced mode allows the user access to additional inputs, such as price elasticities, which should only be altered if the user has specific knowledge and understanding of these values and their impact on the estimation of benefits.

Start Button: The start button will take the user to the first of the four main model screens, "Estimation Inputs." Click the start button to begin estimation of freight logistic benefits.

2.5 Estimation Inputs Screen

The Estimation Inputs Screen gathers key data from the user regarding the segment data for the specific roadway improvement being analyzed. The header at the top of the Estimation of Inputs Screen contains key navigation and option items for the screen, as well as headings to identify each column. When a state or states are selected, predefined values will populate for all of the key inputs. For specific information, sources and descriptions of the estimation inputs refer to the data dictionary appendix. A screenshot of this header is shown in Figure 6.

Figure 6. Screenshot of the Estimation Inputs Screen Header (Single State)



Navigation Buttons

At each corner of the screen, there are green navigation buttons. The *Back* button can be used to navigate back to the Opening Screen and the *Next* button can be used to navigate forward to the following screen in the tool.

State Mode Selection

The tool is configured to handle one or two states. In the event that a project segment is entirely contained within one state, the *Single State* option button should be selected. In the event that the project segment crosses a state border, and the project encompasses two states, the *Multiple State* option button may be selected. Selecting the *Multiple State* option button will expand the screen to handle two states, and users will be required to input certain values for each state, such as value of time or vehicle mix.

Clear Buttons

The *Clear All Inputs* button will clear all user inputs on the Estimation Inputs screen. When the Multiple States option is enabled, users are also able to clear inputs for a single state with the option buttons: *Clear State 1* and *Clear State 2* appearing under the User Input column heading. Users are prompted to confirm they wish to clear all inputs. *Note: Once the inputs are cleared, they cannot be restored.*

Column Headings

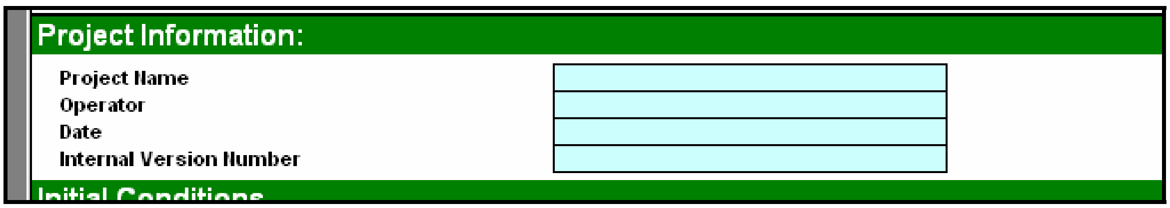
In single state mode, the tool is structured to have three key input columns: Predefined Values, User Input, and Value in Use. When a state is selected, the predefined values will be populated based on research values. These predefined values may be state specific, national averages, or calculated based on other inputs. For specific information, sources and descriptions of the estimation inputs refer to the data dictionary appendix. The User Input column allows users to override the predefined value and input their own values for each of the inputs. The Value in

Use column displays which value the tool uses in its calculations. When the User Input column is blank, the Predefined Values are used. If a User Input value is entered, it will be reflected in the Value in Use column. In the two-state mode, the three columns are duplicated to handle input for multiple states when necessary.

2.5.1 Project Information

The first section on the Estimation Inputs screen is the Project Information section. This section gathers basic information for the project for record keeping. The information contained in this section will be included in the summary output sheets for the user's record.

Figure 7. Screenshot of the Project Information Section



Project Name

Input project name for recordkeeping purposes.

Operator

Input tool operator's name for recordkeeping purposes.

Date

Input today's date for recordkeeping purposes.

Internal Version Number

Input an internal version number for recordkeeping purposes. This will be helpful in keeping track of results if the input data is updated.

2.5.2 Initial Conditions

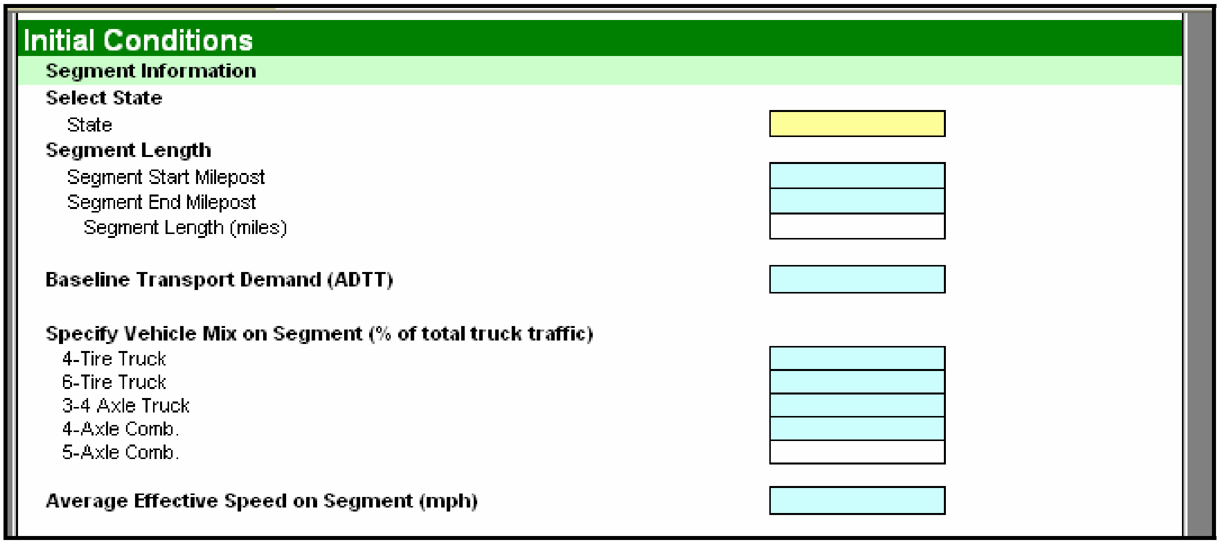
The second section on the Estimation Input screen is for Initial Conditions on the segment. This section establishes the baseline for the estimation of benefits. It is composed for Segment Information, Value of Time, Vehicle Operating Costs and Reliability of Travel Time subsections. All inputs in this section should represent conditions before the planned improvement. This should represent present day information.

2.5.2.1 Segment Information

The segment information section captures key inputs that are specific to the roadway segment being analyzed. Information such as the state in which the project is located, the segment length, baseline truck traffic, truck vehicle mix and average effective speed are collected in this section.

Although the tool offers predefined values for all input data, it is strongly recommended that users input data specific to their segment, as these values vary greatly segment by segment.

Figure 8. Screenshot of the Segment Information Subsection



State

Select a state from the dropdown menu. Selection of a state will population the tool with predefined values based on the state that is selected. *For information on data sources and use, see Section 2.9.1.1.*

Segment Length

Input the start milepost and end milepost. Based on this information, the tool will calculate the segment length. The start milepost must be less than the end milepost. *For information on data sources and use, see Section 2.9.1.2.*

Baseline Transportation Demand (ADTT)

Input baseline transportation demand, in terms of ADTT. *For information on data sources and use, see Section 2.9.1.3.*

Specify Vehicle Mix on Segment

Input the distribution of vehicle types by truck type as a percentage. This represents the share of a specific type of truck as a percentage of total truck traffic (not of total roadway traffic). These values must total to 100% for trucks on the segment. *For information on data sources and use, see Section 2.9.1.4.*

Average Effective Speed on Segment

Input the average effective speed on the segment in miles per hour. *For information on data sources and use, see Section 2.9.1.5.*

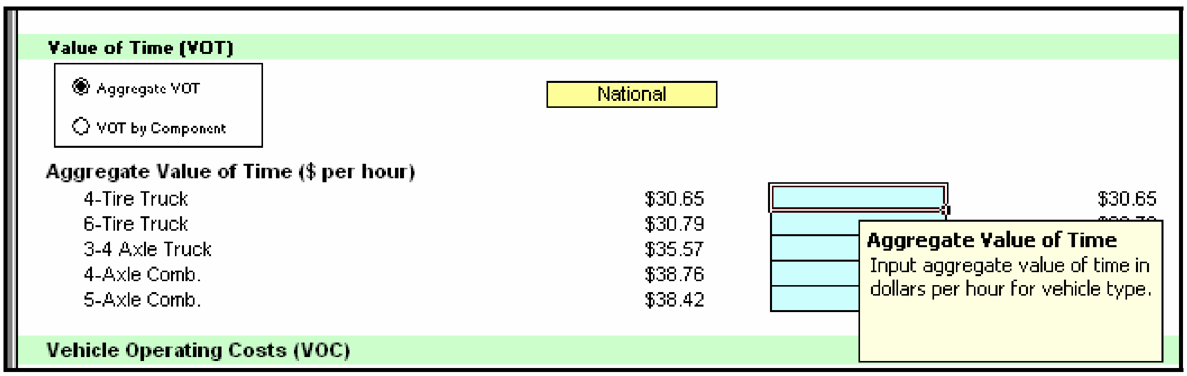
2.5.2.2 Value of Time (VOT)

The VOT subsection gathers baseline information about the average value of time for truck traffic along the segment. These values aggregate to dollars per hour. There are two options when inputting value of time data: aggregate or by component. The user may select the desired option by clicking on the appropriate option button. Additionally, some of the predefined inputs for VOT are available at the state level. Users have the option to select either national or state level (or two-state blend in the two-state tool version) for the predefined values. The national level should be selected if a user believes much of the traffic is from out of state, otherwise the state option should be selected. The tool will default to values based on national averages. *For information on data sources and use, see Section 2.9.2.*

Aggregate VOT

When the Aggregate VOT option button is selected, the user should input the total VOT, by vehicle type, in dollars per hour.

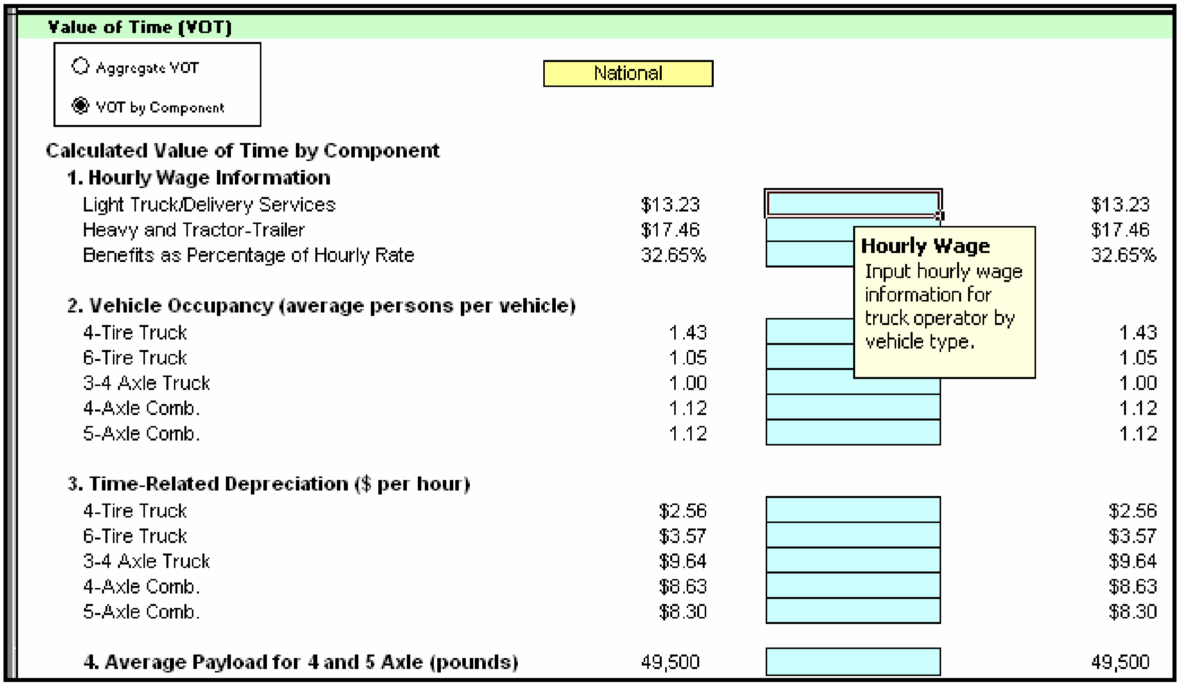
Figure 9. Screenshot of the Aggregate Value of Time Input



VOT by Component

The VOT calculation is made up of the numbered components below. Figure 10 provides a screenshot of VOT by component input area for the first four VOT components.

Figure 10. Screenshot of the Value of Time by Component, Screen 1



1. **Hourly Wage Information**

   Input the wage rate in dollars per hour for light truck/delivery service employees and heavy truck and tractor-trailer employees. Additionally, input an employee's benefits as a percentage of the hourly rate for the freight industry. *For information on data sources and use, see Section 2.9.2.1 and 2.9.2.2.*

2. **Vehicle Occupancy**

   Input the average number of occupants as persons per vehicle by vehicle type. *For information on data sources and use, see Section 2.9.2.3.*

3. **Time-Related Depreciation**

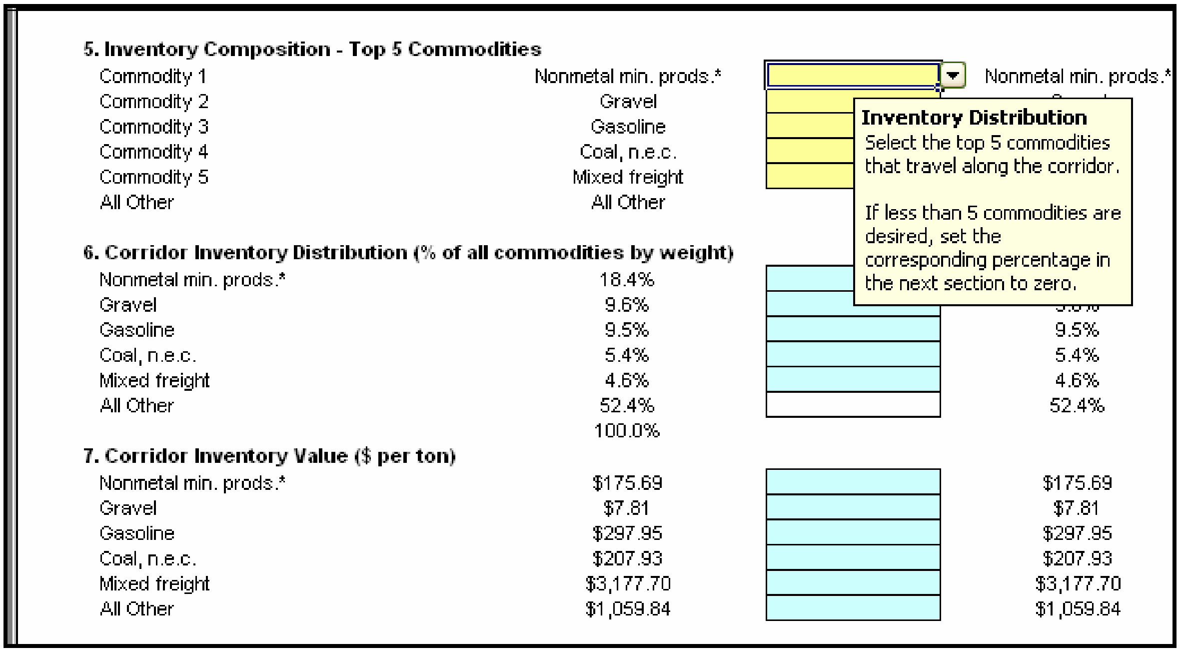
   Input time-related vehicle depreciation by vehicle type in dollars per hour. *For information on data sources and use, see Section 2.9.2.4*

4. **Average Payload**

   Input the average payload weight in pounds for 4- and 5-axle trucks. *For information on data sources and use, see Section 2.9.2.5.*

Figure 11 provides a graphical overview of the inventory component of the VOT calculation.

Figure 11. Screenshot of the Value of Time by Component Screen 2



5. Inventory Composition - Top 5 Commodities		
Commodity 1	Nonmetal min. prods.*	Nonmetal min. prods.*
Commodity 2	Gravel	
Commodity 3	Gasoline	
Commodity 4	Coal, n.e.c.	
Commodity 5	Mixed freight	
All Other	All Other	
6. Corridor Inventory Distribution (% of all commodities by weight)		
Nonmetal min. prods.*	18.4%	
Gravel	9.6%	
Gasoline	9.5%	9.5%
Coal, n.e.c.	5.4%	5.4%
Mixed freight	4.6%	4.6%
All Other	52.4%	52.4%
	100.0%	
7. Corridor Inventory Value ($ per ton)		
Nonmetal min. prods.*	$175.69	$175.69
Gravel	$7.81	$7.81
Gasoline	$297.95	$297.95
Coal, n.e.c.	$207.93	$207.93
Mixed freight	$3,177.70	$3,177.70
All Other	$1,059.84	$1,059.84

5. **Inventory Composition – Top 5 Commodities**

   Select the top five commodities that move through the segment from the drop-down list. *For information on data sources and use, see Section 2.9.2.6.*

6. **Corridor Inventory Distribution**

   Input the corridor inventory distribution by commodity type as a percentage of total commodity movements (by weight) through the segment. *For information on data sources and use, see Section 2.9.2.7.*

7. **Corridor Inventory Value**

   Input the corridor inventory value by commodity in dollars per ton. The "All Other" category should represent an estimate of the weighted average of all other commodities (those not specified in the top five) that move through the segment. *For information on data sources and use, see Section 2.9.2.8.*

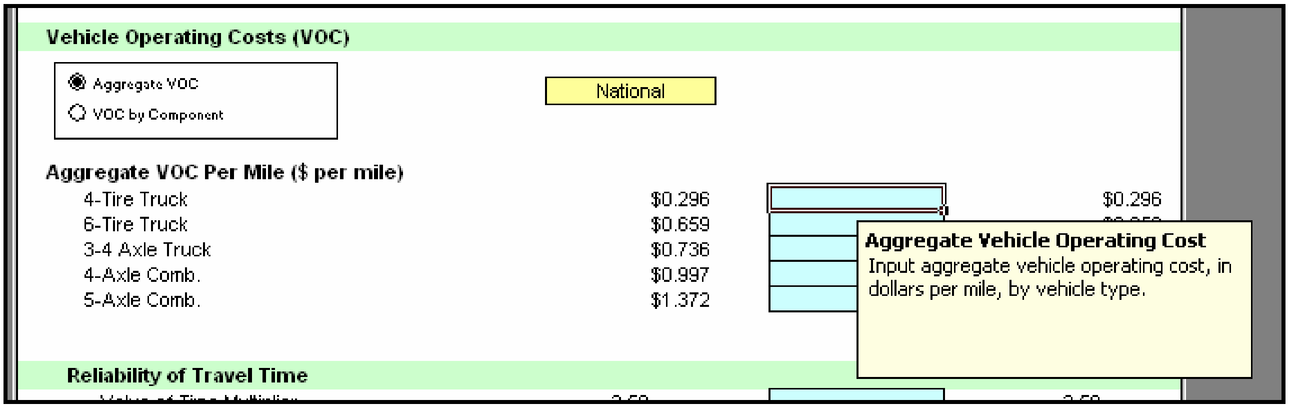
2.5.2.3 Vehicle Operating Costs (VOC)

There are two options when inputting VOC data: Aggregate or by Component. The user may select the desired option by clicking on the appropriate option button. As with the VOT subsection, users have the option to select either national or state level (or two-state blend in the two-state tool version) for the predefined values. The national level should be selected if a user believes much of the traffic is from out of state, otherwise the state option should be selected. The tool will default to values based on national averages. *For information on data sources and use, see Section 2.9.3.*

Aggregate Vehicle Operation Costs

When the Aggregate VOC option button is selected, the user should input the total vehicle operating costs, by vehicle type, in dollars per mile.

Figure 12. Screenshot of the Aggregate Value of Time Input Area



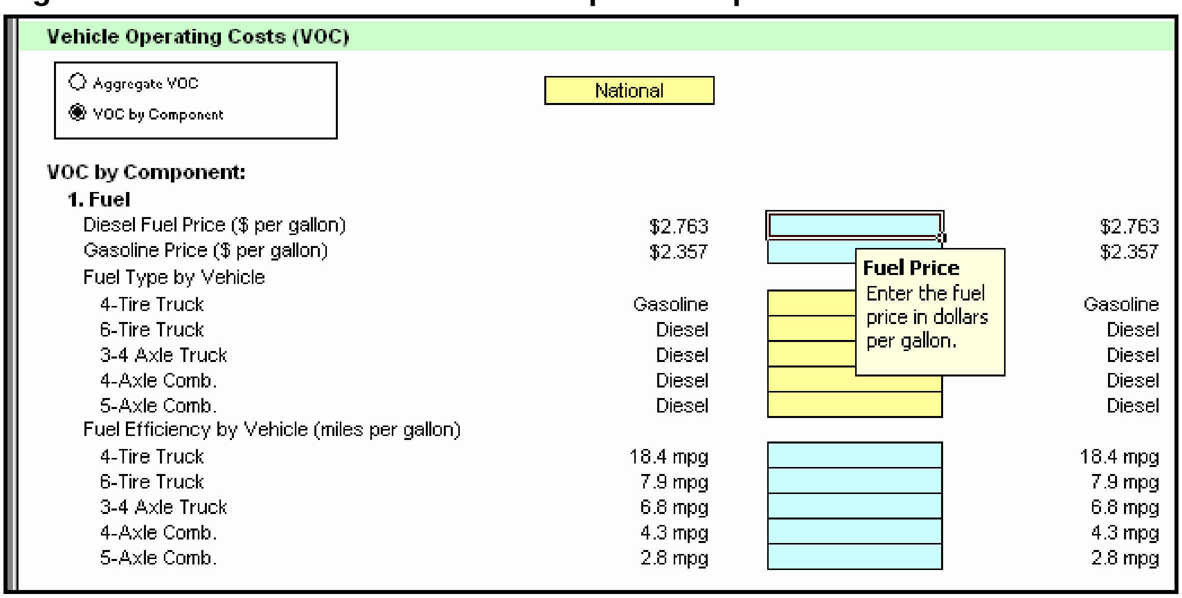
VOC by Component

VOC is made up of the following components.

1. Fuel

The fuel component of VOC is composed of multiple inputs, including fuel price, fuel type by vehicle type, and fuel efficiency by vehicle type. Figure 13 provides a screenshot of the fuel component input area.

Figure 13. Screenshot of the Fuel Component Input Area



Diesel Fuel Price

Input the price for diesel fuel in dollars per gallon. *For information on fuel data sources and use, see Section 2.9.3.1.*

Gasoline Price

Input the price for gasoline in dollars per gallon. *For information on fuel data sources and use, see Section 2.9.3.1.*

Fuel Type by Vehicle Type

Select the fuel type, gasoline or diesel most commonly used by a specific vehicle type for each vehicle type. In the event one fuel type usage does not significantly exceed the others, a gasoline/diesel mix can be specified. *For information on data sources and use, see Section 2.9.3.1.*

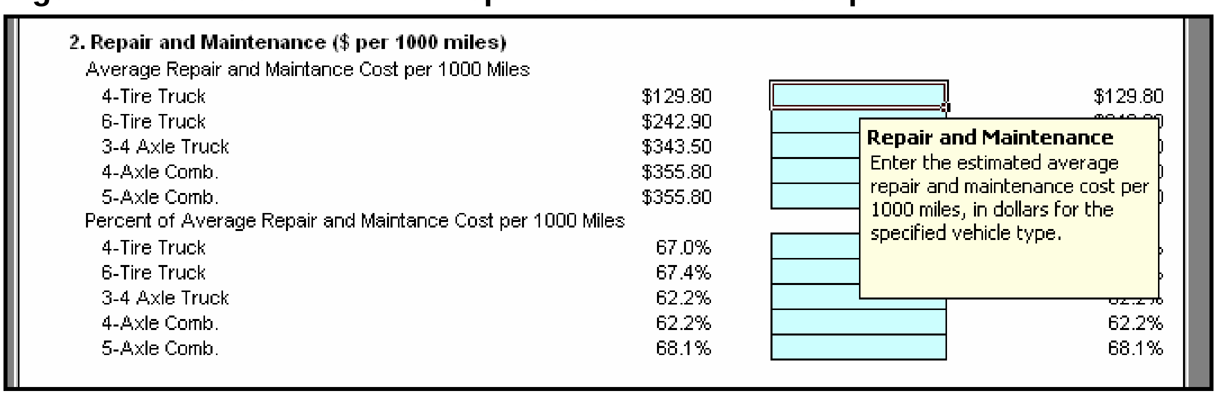
Fuel Efficiency by Vehicle Type

Input the fuel efficiency in miles per gallon by vehicle type for a trip along the segment. *For information on data sources and use, see Section 2.9.3.1.*

2. Repair and Maintenance

The Repair and Maintenance component of VOC is composed of a value component and a usage rate component. The value component is the average repair and maintenance cost per 1,000 miles. The usage rate component is the percentage of average repair and maintenance cost per 1,000 miles. Figure 14 provides a screenshot of the repair and maintenance input area. *For information on data sources and use, see Section 2.9.3.2.*

Figure 14. Screenshot of the Repair and Maintenance Input Area



Average Repair and Maintenance Cost per 1,000 Miles

Input the average cost of repair and maintenance for 1,000 miles of vehicle use, by vehicle type. *For information on data sources and use, see Section 2.9.3.2.*

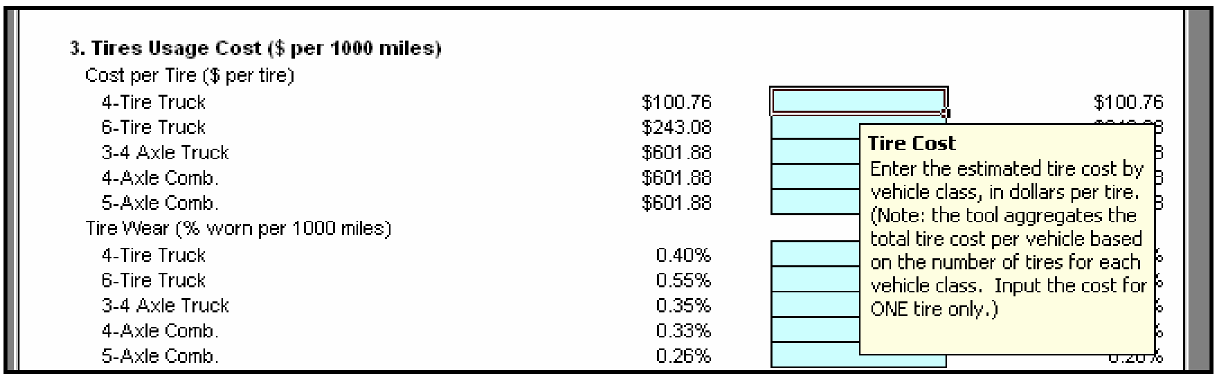
Percent of Average Repair and Maintenance Cost per 1,000 Miles

Input the estimated percentage of the average repair and maintenance cost per 1,000 miles for trips along the given segment. *For information on data sources and use, see Section 2.9.3.2.*

3. Tire Usage Cost

The Tire Usage Cost component of VOC is composed of a value component and a usage rate component. The value component is the price per tire by vehicle type. The usage rate component is the percent of tire worn per 1,000 miles. Figure 15 provides a screenshot of the tire cost component input area. *For information on data sources and use, see Section 2.9.3.3.*

Figure 15. Screenshot of the Tire Usage Cost Component Input Area



Cost per Tire

Input the estimated cost per tire by vehicle class in dollars. *Note: this is the per tire cost, not total tire cost for vehicle type. For information on data sources and use, see Section 2.9.3.3.*

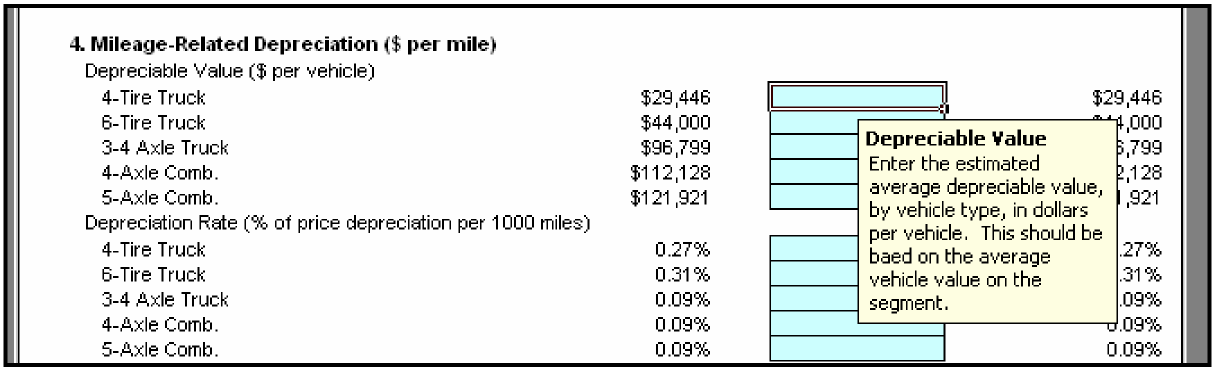
Tire Wear

Input the percent of total tire life used per 1,000 miles for a trip along the segment. *For information on data sources and use, see Section 2.9.3.3.*

4. Mileage-Related Depreciation

The Mileage-Related Depreciation component of VOC is composed of both a value and usage rate component. The value component is the depreciable value of the vehicle by vehicle type. The usage rate component is the percent of price depreciated per 1,000 miles. Figure 16 provides a screenshot of the tire cost component input area. *For information on data sources and use, see Section 2.9.3.4.*

Figure 16. Screenshot of Mileage-Related Depreciation



Depreciable Value

Input the percent depreciable value of a vehicle by vehicle type in dollars. *For information on data sources and use, see Section 2.9.3.4.*

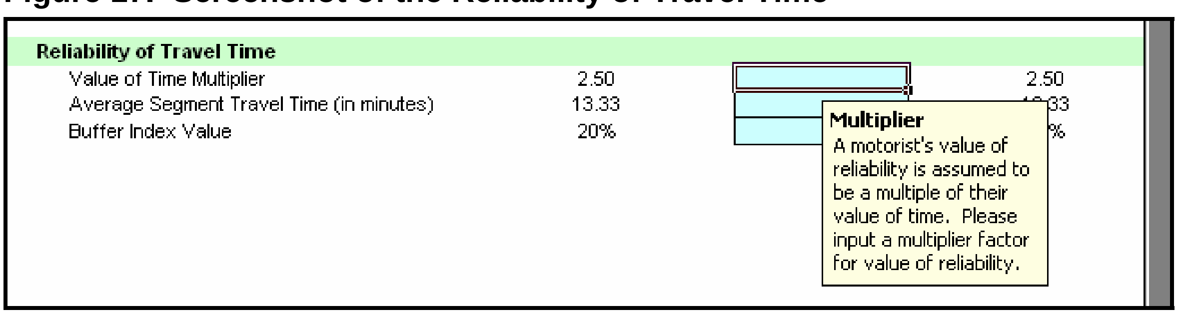
Depreciation Rate

Input the vehicle depreciation rate, by vehicle type, for trips along the segment, as a percentage of depreciation per 1,000 miles. *For information on data sources and use, see Section 2.9.3.4.*

2.5.2.4 Reliability of Travel Time

Reliability of Travel Time is the final, initial-state value component. This accounts for the degree of certainty around a given trip along a segment. Lower variance in travel time results in a greater degree of reliability; whereas greater variance in travel time leads to uncertainty and a low degree of reliability. Reliability of travel time is composed of three components: 1) a value of time multiplier, 2) an average segment travel time, and 3) the buffer index value. The following screenshot provides an overview of the "Reliability of Travel Time" section. *For information on data sources and use, see Section 2.9.4.*

Figure 17. Screenshot of the Reliability of Travel Time



Value of Time Multiplier

Input the value of time multiplier as a multiplicative factor. *For information on data sources and use, see Section 2.9.4.1.*

Average Segment Travel Time

Input the average travel time along the segment in minutes. *For information on data sources and use, see Section 2.9.4.2.*

Buffer Index Value

Input the buffer index value as a percentage. *For information on data sources and use, see Section 2.9.4.3.*

2.5.3 Changes Due to Segment Improvement

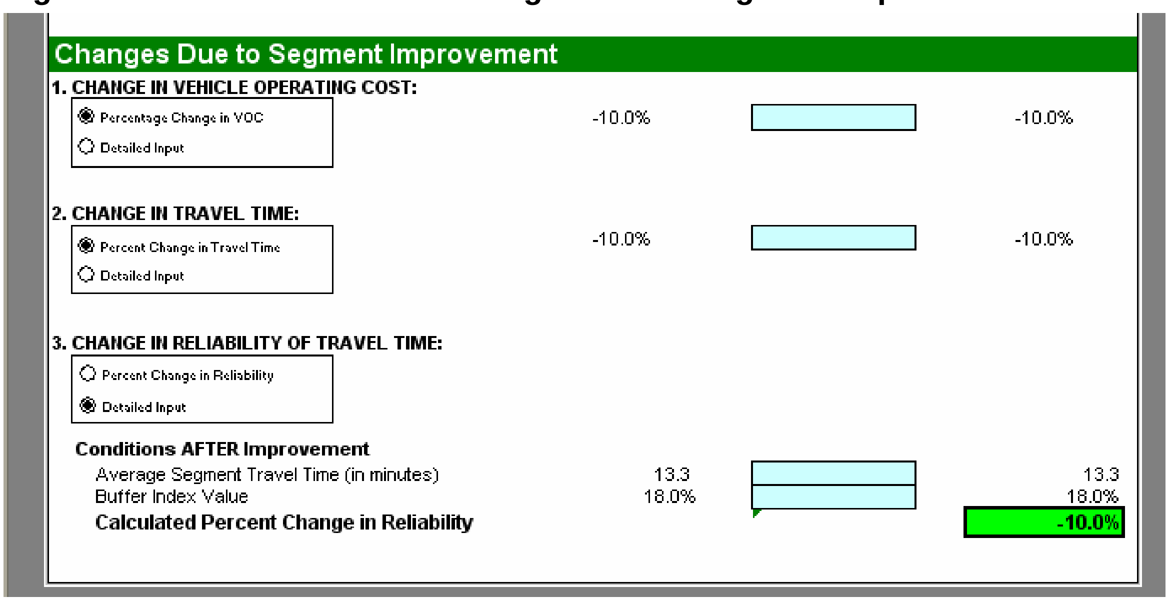
The transportation improvement project is assumed to have a beneficial impact on freight traffic that travels along the segment. In this tool, an improvement can affect any of the three value components identified under the Initial Conditions section: 1) VOT, 2) VOC, and 3) Reliability of Travel Time.

Changes can be entered as either a percentage or as specific changes to detailed input. Option buttons allow the user to select either "Percentage Change" or "Detailed Input." The format of the detailed input is similar to the input under the Initial Conditions section.

2.5.3.1 Changes Represented as a Percentage Change

Figure 18 shows a screenshot of the Change section with all three change types represented as percentages.

Figure 18. Screenshot of the Changes Due to Segment Improvement Section



In the percent change mode, the tool prompts users for inputs to three change categories:

1. Change in VOC,

2. Change in Travel Time, and

3. Change in Reliability of Travel Time.

Changes in the three components should be entered as a negative number to show an improvement along the segment. For example, a negative change in VOC represents a reduction in VOC, i.e. a savings to the vehicle operator when traveling along the segment after the improvement relative to travel before the improvement.

Percentage Change in VOC

Input the Change in VOC represented as a percentage change over the VOC specified under the Initial Conditions section. *Note: A negative value represents an improvement in VOC as this represents a decrease in the per mile vehicle operating cost.*

Percentage Change in Travel Time

Input change in travel time represented as a percentage change over the travel time specified under the Initial Conditions section. *Note: A negative value represents an improvement in travel time and translates into a decrease in the time necessary to travel along the segment.*

Percentage Change in Reliability of Travel Time

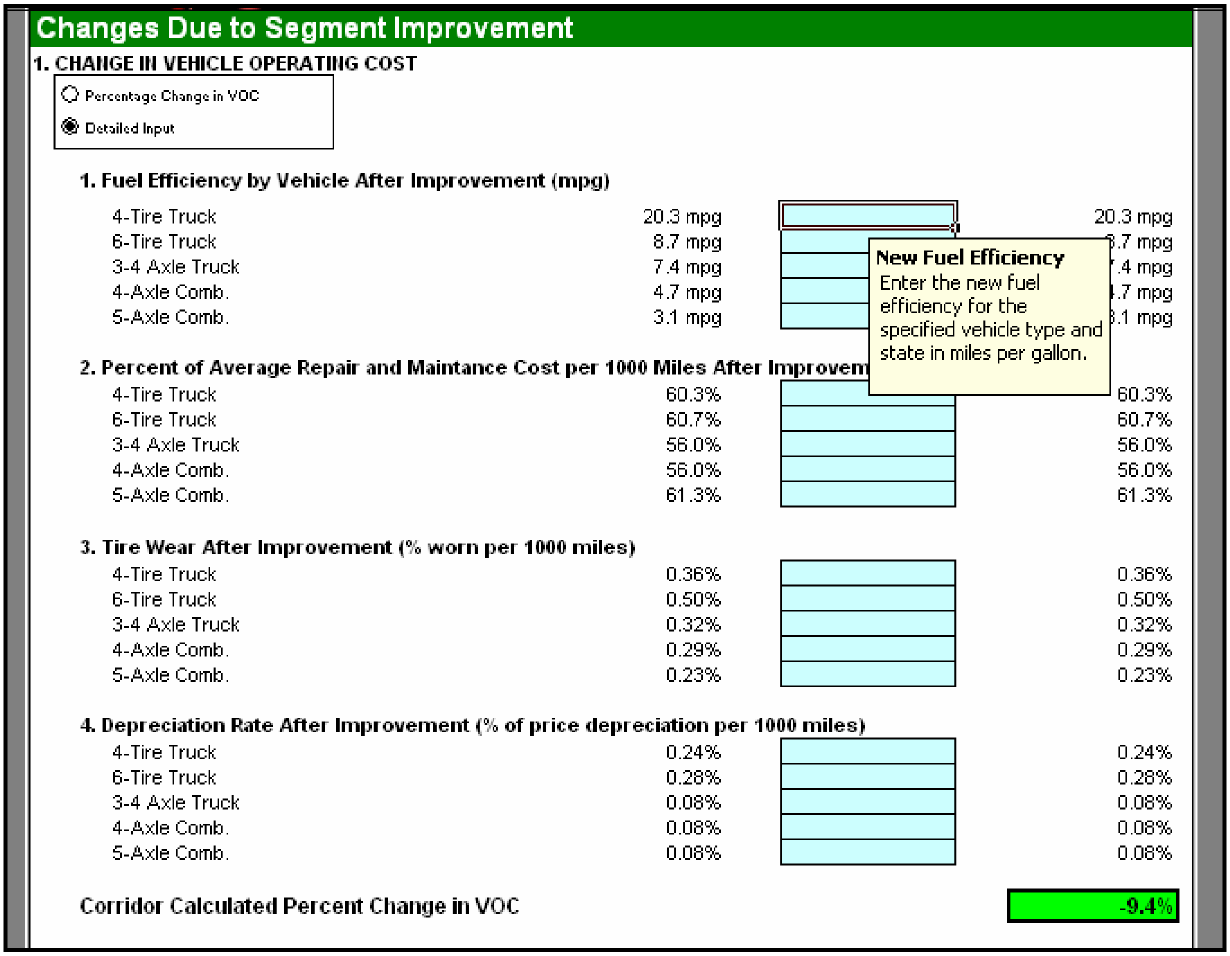
Input change in reliability of travel time is represented as a percentage change over the reliability of travel time specified under the Initial Conditions section. *Note: A negative value represents an improvement in reliability travel time and translates into a decrease in the uncertainty around to travel time along the segment.*

2.5.3.2 Changes Represented as a Detailed Input

Detailed Input Change in VOC

When the “Detailed Input” option button under “Change in Vehicle Operating Cost” is selected, the user will be prompted to input changes to VOC by component. The changes affect the usage rate components for VOC. The value components are held constant in order to isolate the benefits caused by the segment improvement. Figure 19 provides a screenshot of the detailed input change in the VOC section.

Figure 19. Screenshot of Detailed Input Change for Vehicle Operating Costs



1. **Fuel Efficiency by Vehicle After Improvement (mpg)**

   Input the expected fuel efficiency in miles per gallon (mpg) by vehicle type after the proposed improvement is implemented. The predefined values are based on an assumed 10% improvement in fuel efficiency for each vehicle type. *Note: To represent an improvement in VOC, the values for mpg should be greater than those specified under the Initial Conditions section.*

2. **Percent of Average Repair and Maintenance Cost per 1,000 Miles After Improvement**

   Input the expected percent of average repair and maintenance cost per 1,000 miles, by vehicle type after the proposed improvement is implemented. The predefined values represent a 10% reduction in percent of average repair and maintenance cost per 1,000 miles. *Note: To represent an improvement in VOC, the percent of average repair and maintenance cost per 1,000 miles should be lower than those specified under the Initial Conditions section.*

3. **Tire Wear After Improvement (percent worn per 1,000 miles)**

   Input the expected tire wear by vehicle type, after the proposed improvement is implemented and is represented as the percent of tire worn per 1,000 miles of use along the segment. Predefined values represent a 10% improvement in tire wear. *Note: To represent an improvement in VOC, the value of tire wear should be less than those specified under the Initial Conditions section.*

4. **Depreciation Rate After Improvement (percent of price depreciation per 1,000 miles)**

   Input the expected mileage-related depreciation rate, represented as the percentage of price depreciation per 1,000 miles traveled on the segment, by vehicle type after the proposed improvement is implemented. Predefined values represent a 10% improvement in the mileage-related deprecation rate. *Note: To represent an improvement in VOC, the values for mileage-related deprecation rates should be lower than those specified under the Initial Conditions section.*

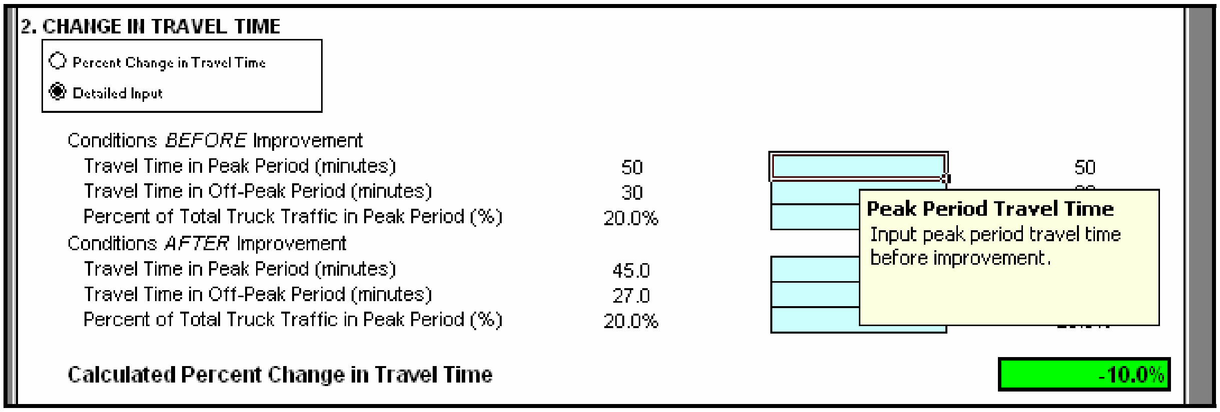
Corridor Calculated Percent Change in VOC

This requires no user input; however, it provides the user with the calculated percentage change in VOC based on user inputs. This value is color coded, where a green background represents a negative change in VOC (per mile vehicle operating costs decrease), a red background represents a positive change in VOC (per mile vehicle operating costs increase), and a light orange background represents zero change. In order for highway users to experience benefits, vehicle operating costs must decrease. *Note: If VOC does not decrease, the tool cannot calculate freight reorganization benefits.*

Detailed Input Change in Travel Time

When the "Detailed Input" option button under "Change in Travel Time" is selected, the user will be prompted to input change in travel time by detailed input. The changes affect the value of time cost across the segment. The change only impacts the travel time component, holding all other elements of value of time constant in order to isolate the benefits from the segment improvement. Figure 20 provides a screenshot of the detailed input change in travel time section.

Figure 20. Screenshot of Detailed Input Change in Travel Time



Conditions Before Improvement

Travel Time in Peak Period

Input the average travel time on the segment, in minutes, during the peak period before improvement. The predefined value is based on segment length and average effective speed, reduced by 20% for peak period travel.

Travel Time in Off-Peak Period

Input the average travel time on the segment, in minutes, during the off-peak period before improvement. The predefined value is based on segment length and average effective speed for off-peak travel.

Percent of Total Truck Traffic in Peak Period

Input the percentage of total daily truck traffic that travels during the peak period before improvement. Predefined value is arbitrary.

Conditions After Improvement

Travel Time in Peak Period

Input the average travel time on the segment, in minutes, during the peak period after improvement. Predefined value is based on a 10% improvement factor.

Travel Time in Off-Peak Period

Input the average travel time on the segment, in minutes, during the off-peak period after improvement. Predefined value is based on a 10% improvement factor.

Percent of Total Truck Traffic in Peak Period

Input the percentage of total daily truck traffic that travels during the peak period after improvement. Predefined value is held constant from pre-improvement state.

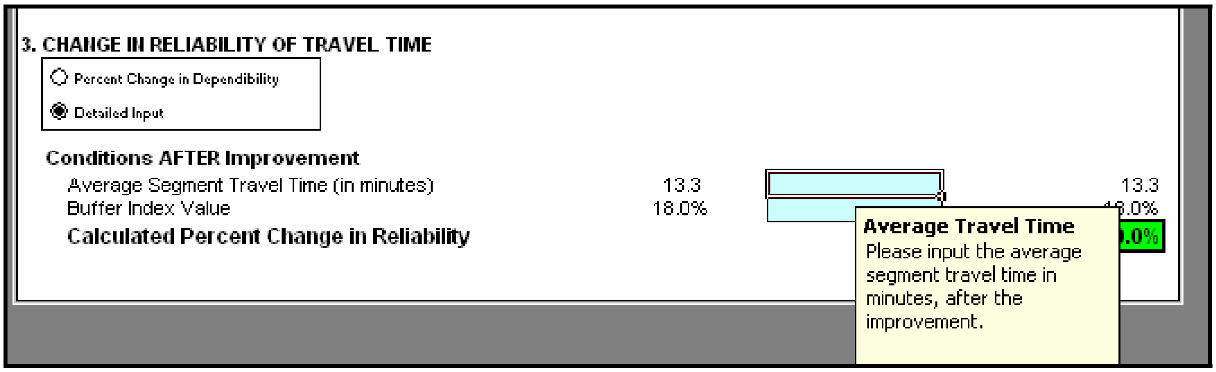
Corridor Calculated Percent Change in VOC

This requires no user input; however, it provides the user with the calculated percentage change in travel time based on user inputs. This value is color coded, where a green background represents a negative change in travel time (per mile vehicle operating costs decrease), a red background represents a positive change in travel time (time to travel along the segment increases), and a light orange background represents zero change. In order for highway users to experience benefits, travel time should decrease.

Detailed Input Change in Reliability of Travel Time

The detailed input Change in Reliability of Travel Time section is similar to the Reliability of Travel Time input section. This section prompts users for conditions after the roadway improvement along the segment. The value of travel time and its multiplier are held constant in order to isolate the impacts of the segment improvement.

Figure 21. Screenshot of Detailed Input Change in Travel Time



Average Segment Travel Time (in minutes)

Input the average segment travel time, in minutes, after the highway improvement. The predefined value assumes a 10% improvement.

Corridor Calculated Percent Change in VOC

Input the buffer index value after the improvement. The predefined value assumes no change from the initial conditions value; all change is reflected in the average travel-time improvement.

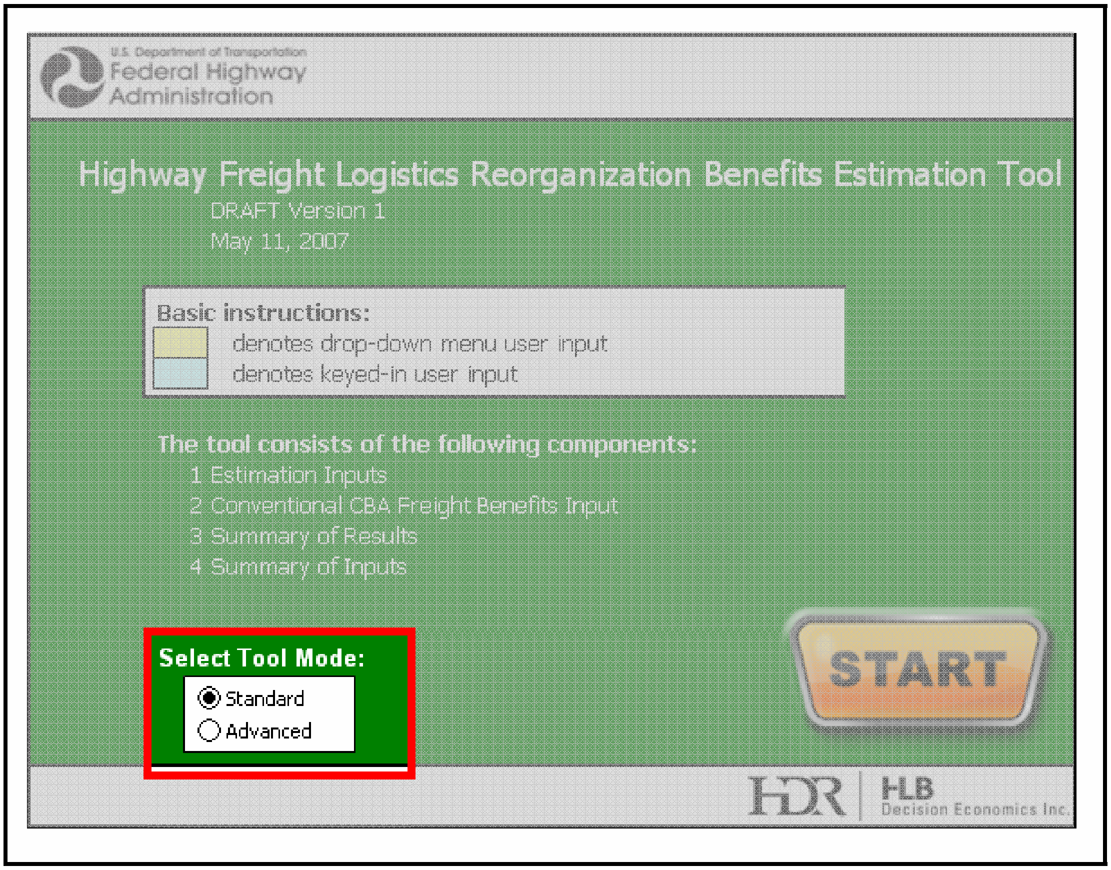
Corridor Calculated Percent Change in VOC

This requires no user input; however, it provides the user with the calculated percent change in reliability for the segment.

2.5.4 Advanced User Inputs

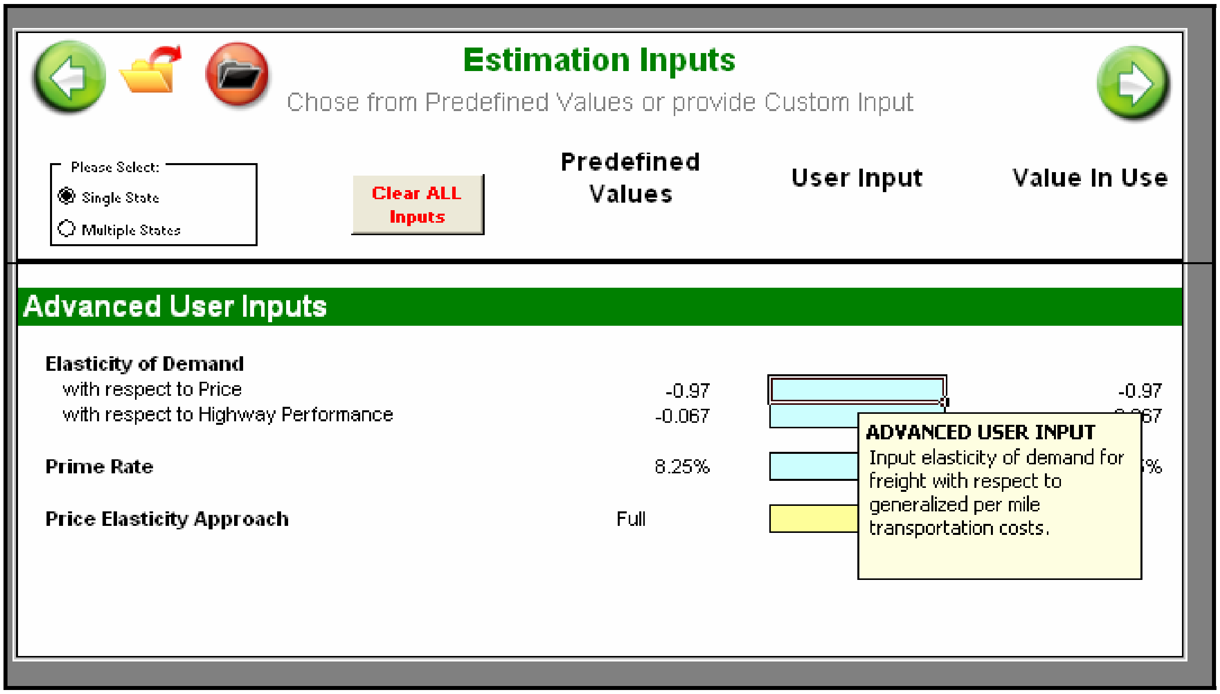
This tool offers the user the option to modify some inputs that have been identified as advanced. In order to enable the Advanced User Input section, the tool mode must be set to Advanced on the Opening Screen. The screenshot in Figure 22 provides a graphical view of the Opening Screen tool mode selection.

Figure 22. Screenshot of Opening Screen Toll Mode Selection



When enabled, the Advanced User Input section is the final input section of the tool. It prompts users for inputs on elasticities of demand, interest rate, and elasticity approach. Figure 23 provides a screenshot of the Advance User Inputs section.

Figure 23. Screenshot of Advanced User Inputs Section



2.5.4.1 Elasticity of Demand

With Respect to Price

Input the elasticity of demand for freight with respect to price. *Note: This input should only be modified if specific, accurate data exists to override the predefined value in the tool. For information on data sources and use, see Section 2.9.5.*

With Respect to Highway Performance

Input the elasticity of demand for freight with respect to highway performance. *Note: This input should only be modified if specific, accurate data exists to override the predefined value in the tool. For information on data sources and use, see Section 2.9.5.*

2.5.4.2 Prime Rate

Input the prime interest rate, expressed as a percentage. *Note: The prime rate is published by the Federal Reserve Bank and may be updated on a periodic basis. For information on data sources and use, see Section 2.9.5.2.*

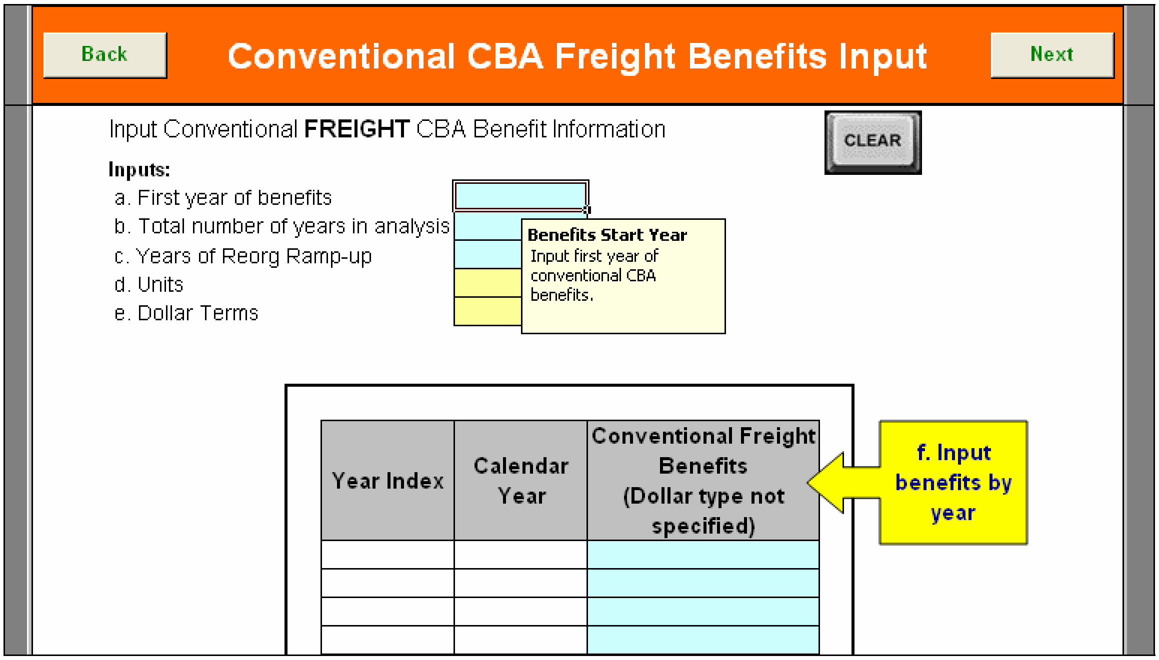
2.5.4.3 Price Elasticity Approach

Select either the "Full" or "Additive" price elasticity approach. *Note: If the user does not have specific knowledge as to the price elasticity approach, the predefined value should not be altered. For information on data sources and use, see Section 2.9.5.3.*

2.6 Conventional CBA Freight Benefits Input Screen

This screen allows for the input of freight benefits from a conventional highway CBA. These benefits would be obtained from an analysis outside this tool that was conducted for the same road segment that is currently being analyzed within this tool. Simple results may be obtained if this screen is skipped; however, it is recommended that the user complete this screen in order to obtain the full functionality of the tool. Figure 24 provides a screenshot of the header area for the "Conventional CBA Freight Benefits Input" screen. *Note: Only benefits that are attributable to freight should be entered on this screen, not total highway-user benefits.*

Figure 24. Screenshot of the Conventional CBA Freight Benefits Input Screen



Navigation Buttons

At each corner of the screen, there are green navigation buttons. The left button can be used to navigate back to the "Estimation Inputs" screen and the right button can be used to navigate forward to the following screen in the tool.

Clear Button

The user may select the "Clear" button in the upper right corner of the screen to clear all inputs on this screen. A warning will prompt the user before clearing all inputs. *Note: Once the inputs are cleared, they cannot be restored.*

Inputs:

A. First year of benefits

Input the first year in which the conventional CBA freight benefits begin to accrue. If a ramp-up profile has been utilized in the conventional CBA, this will be the first year in which any benefits are realized.

B. Total number of years in analysis

Input the total number of years analyzed within the conventional CBA. This will be the total number of years for which the user has conventional CBA freight benefits.

C. Years of reorganization ramp-up

This is an optional input. The user may specify an additional ramp-up for freight reorganization logistic benefits, beyond the increase that may have been implemented in the conventional CBA. This ramp-up is measured in years from the first year of benefits, as entered in (a) above.

D. Units

Select the units in which the conventional CBA freight benefits are displayed. It is common for CBA benefits to be listed in thousands or millions of dollars when summarized. The units specified here should match the units of the benefits that will be entered under (f) below.

E. Dollar terms

Select the dollar terms in which the conventional CBA freight benefits are displayed, either “Real” or “Nominal.” If “Real” is selected, please specify the base year below.

F. Input benefits by year

Input the conventional CBA freight benefits, as calculated in an analysis outside of this tool. The dollar units and dollar terms of theses benefits should match those specified in (d) and (e) above. *Note: If the benefit stream is listed in a column format, they may be pasted into this area.*

2.7 Summary of Results Screen

This screen requires no user input. It provides a summary of the results calculated by the tool based on user inputs from the previous two screens.

Results are presented as three outcomes:

A. Estimation of Consumer Surplus and Reorganization Effects
B. Graph of Reorganization and Conventional Freight Benefits
C. Table of Reorganization and Conventional Freight Benefits

The screen header is similar to the headers in the previous screens. A screenshot of the header is provided in Figure 25.

Figure 25. Screenshot of the Summary of Results Screen Header

Navigation Buttons

At each corner of the screen, there are green navigation buttons. The left button can be used to navigate back to the Conventional CBA Freight Benefits input screen, and the right button can be used to navigate forward to the following screen in the tool.

Print Button

There is a print button to the right of the screen title. Clicking this button will bring up the print dialog box where the user can select the print options and print the results sheet.

Navigation Hyperlinks

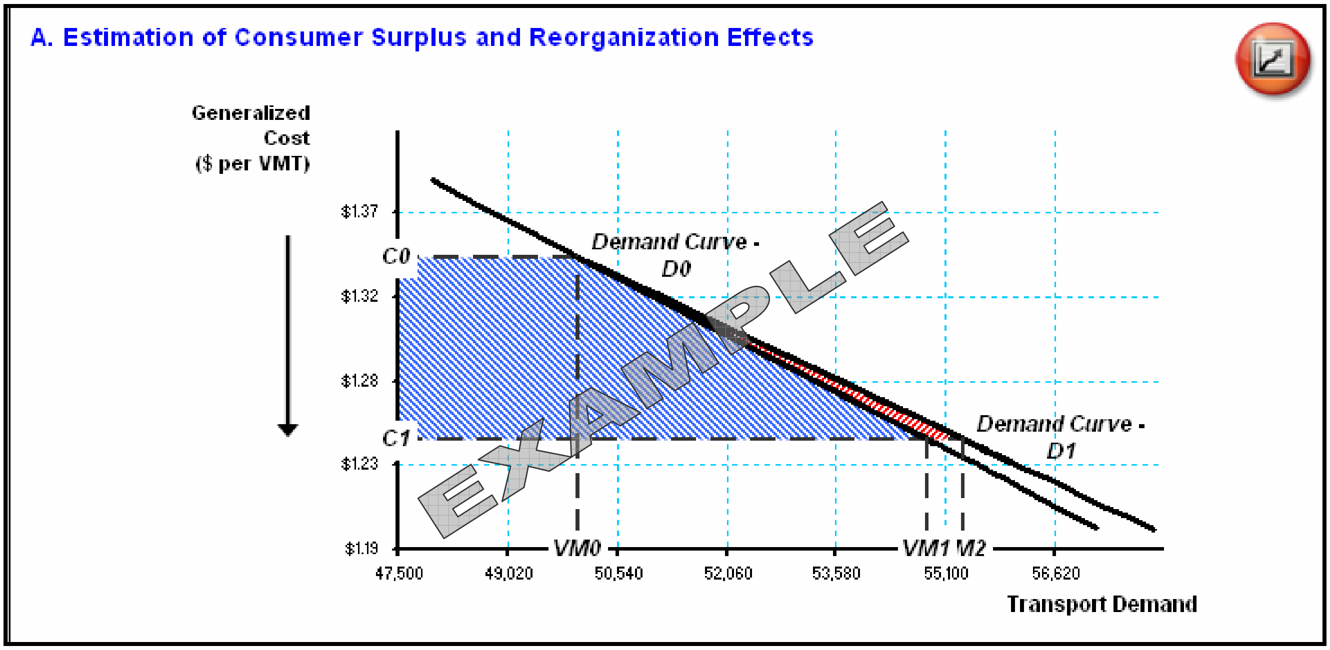
Below the screen title are navigation hyperlinks that allow the user to quickly move to a specific section of the results screen. The three sections are: 1) Consumer Surplus, 2) Benefits Charts, and 3) Benefits Table.

A. Estimation of Consumer Surplus and Reorganization Effects

The first section of the Summary of Results screen provides the user with information on the estimation of demand for freight in both a graphical and tabular format.

This section displays the Estimation of Consumer Surplus and Reorganization Graph. This represents the additive freight benefits that are estimated in this tool. Figure 26 provides an example of the Consumer Surplus Graph.

Figure 26. Screenshot of the Estimation of Consumer Surplus and Reorganization Graph



The area below the graph summarizes the key data points on the graph with their values and an explanation of what each point represents. Following this is a table that summarizes generalized travel costs, transportation demand, and the reorganization benefit factor. A screenshot example of this summary information is provided in Figure 27.

Figure 27. Screenshot of the Estimation of Consumer Surplus and Reorganization Graph Explanation and Summary

Where:

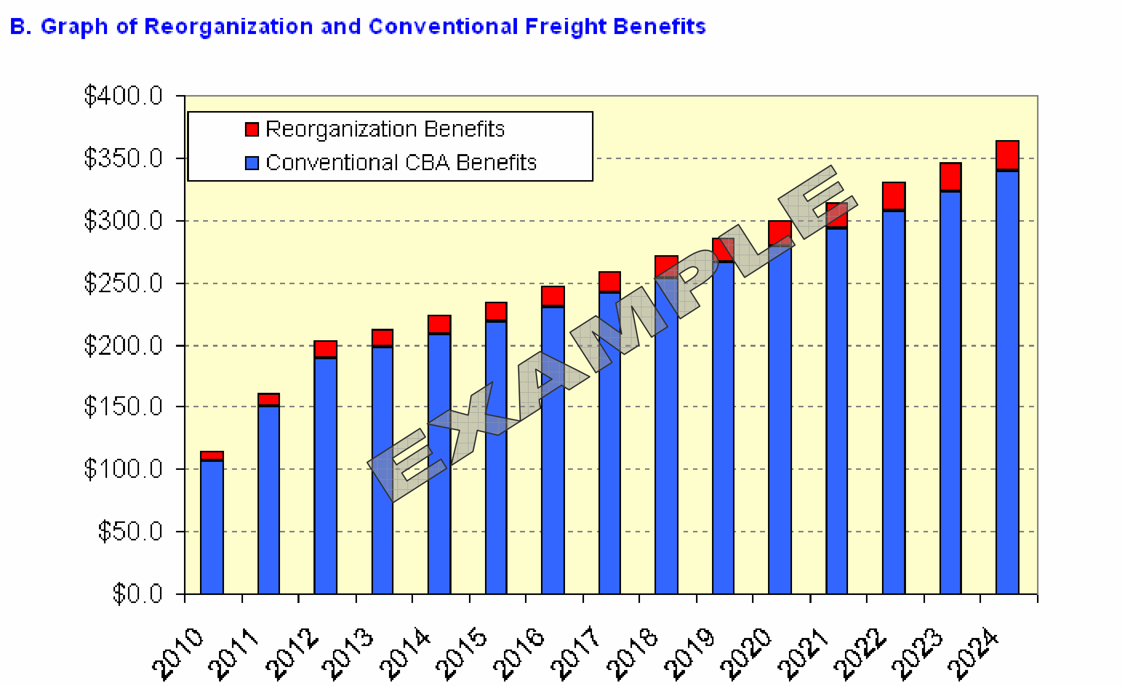
C0 = $1.664 the unit generalized travel cost BEFORE improvement (dollars per vehicle mile)
C1 = $1.505 the unit generalized travel cost AFTER improvement (dollars per vehicle mile)
VM0 = 50,000 the baseline demand for freight
VM1 = 54,850 the demand for freight AFTER improvement
VM2 = 55,287 the demand for freight with reorganization
D0 is the demand curve BEFORE reorganization Shift (below *D1*)
D1 is the demand curve AFTER reorganization Shift (above *D2*)

Item	Before Improvement	After Improvement	After Improvement With Reorganization	Units
Generalized Cost of Truck Travel	$1.66	$1.50	$1.50	$ / vehicle mile
Transport Demand	50,000	54,850	55,287	vehicle miles
Reorg Benefit Factor			**0.9%**	**percentage**

B. Estimation of Consumer Surplus and Reorganization Effects

If conventional CBA benefits are entered on the previous screen, this section will provide a summary table of total benefits, composed of reorganization benefits and conventional CBA benefits. Figure 28 provides an example of this graph.

Figure 28. Screenshot of the Graph of Reorganization and Conventional Freight Benefits



In addition to the graph, a table below the graph provides a summary of conventional CBA benefits, reorganization benefits, and total benefits (conventional + reorganization) by year. Figure 29 below provides an example of this table.

Figure 29. Screenshot of the Table of Reorganization and Conventional Freight Benefits

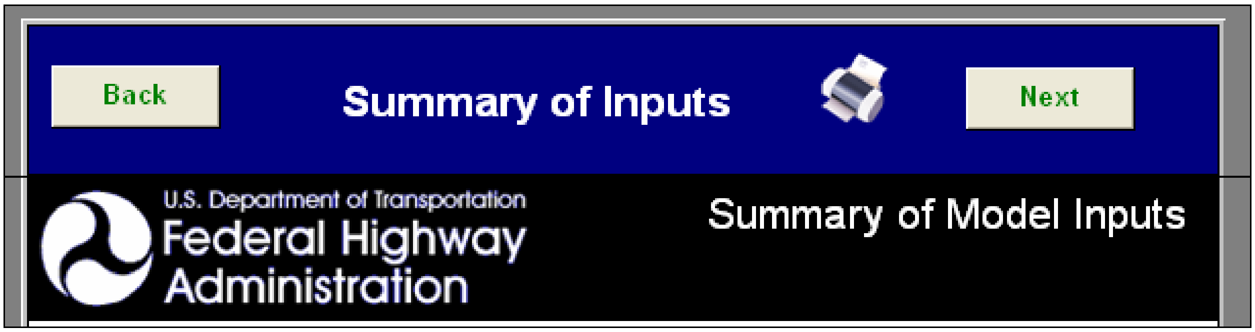
C. Table of Conventional and Reorganization Benefits

Year	Millions of 2006 Dollars		
	Conventional CBA Benefits	Reorganization Benefits	Total Benefits
2010	$107.00	$7.73	$114.73
2011	$150.00	$10.84	$160.84
2012	$189.00	$13.66	$202.66
2013	$198.45	$14.34	$212.79
2014	$208.37	$15.06	$223.43
2015	$218.79	$15.81	$234.60
2016	$229.73	$16.60	$246.33
2017	$241.22	$17.43	$258.65
2018	$253.28	$18.30	$271.58
2019	$265.94	$19.22	$285.16
2020	$279.24	$20.18	$299.42
2021	$293.20	$21.19	$314.39
2022	$307.86	$22.25	$330.11
2023	$323.25	$23.36	$346.61
2024	$339.42	$24.53	$363.94

2.8 Summary of Inputs Screen

A summary of inputs screen is provided as a final screen in the tool. This screen is for summary only and requires no user input. It allows users to keep a record of the inputs used to generate the results. This is helpful if future updates for a specific project are entered into the tool. The screen header is similar to the headers in the previous screens. A screenshot of the header is provided in Figure 30.

Figure 30. Screenshot of the Summary of Inputs Screen



Navigation Buttons

At the left corner of the screen, there is green navigation button. This button can be used to navigate back to the Summary of Results input screen. On the right corner there is a red home button. This button can be used to navigate back to the tool's Opening Screen.

Print Button

There is a print button to the right of the screen title. Clicking this button will bring up the print dialog box where the user can select the print options and print the summary of inputs sheet.

This screen provides a summary of all inputs used in the model. In the single-state model, only one column is shown for the relevant state. In the two-state models, two columns are shown with state specific input for each column. In the event that inputs are entered at the segment level, for example segment length or change in VOC, these items are shown centered across both state columns. The "Summary of Inputs" screen is structured in the same format as the "Estimation Inputs" screen. The key sections are the "Initial Conditions," "Changes," and, if enabled, "Advanced Inputs."

2.9 Data Dictionary

The Data Dictionary contains information regarding the data and its uses in the calculations of the estimation tool. The tool estimates additional freight benefits in the form of generalized freight transportation costs savings due to a roadway improvement project. Generalized transportation costs are categorized into three main groups: 1) Value of Time, 2) Direct Vehicle Operating Costs, and 3) Value of Reliability. This section provides a comprehensive summary of all input data used in the model, definitions, uses, and data sources where applicable.

The section provides a definition of the key input data, as well as its use in the model. Additionally, a description of the tool's predefined data and sources, where applicable, are provided.

2.9.1 Segment Information

This section contains basic information about the highway segment being analyzed.

2.9.1.1 State

Definition: The state in which the project is located.

Use: The state selection list is used to identify the state that the project takes place in and to obtain state specific predefined data values that vary by state or region. In the event of a two-state project, the user must select the 'multiple states' option button, and specify the percentage of the project within each state.

Data: List contains all 50 states in the United States and the District of Columbia.

2.9.1.2 Segment Length

Definition: The total distance covered by the roadway segment being analyzed. This tool elicits segment length by gathering user input on start and end milepost.

Use: Tool requires segment-start milepost and segment-end milepost to calculate total segment length.

Data: The predefined values for segment start and end mileposts are simply placeholders for these values in the estimating tool. These are segment specific values, and it is highly recommended that users update this data with project specific values.

2.9.1.3 Baseline Transport Demand (Average Daily Truck Traffic)

Definition: Average Daily Truck Traffic (ADDT) is the total number of trucks that travel on a given segment in a year, divided by 365.

Use: Baseline transport demand, in ADDT, is used to calculate the baseline from which improvements are measured.

Data: The predefined value for baseline transport demand is simply a placeholder for this value in the estimating tool. This is a segment specific value, and it is highly recommended that users update these data with project specific values.

2.9.1.4 Vehicle Mix

Definition: Vehicle mix for truck traffic represents the average composition of truck traffic by truck type along the segment. It is the percentage of a specific truck type's roadway share relative to total truck traffic within a specific segment. Truck types, as provided by Highway Economic Requirements System (HERS), are listed below:

4-Tire Truck
6-Tire Truck
3-4 Axle Truck
4-Axle Combination
5-Axle Combination

Use: Vehicle mix is used to determine the distribution of vehicles by type within the study corridor, which is used to assign weighting factors to key variables that are vehicle type specific.

Data: The predefined values for vehicle mix is taken from the U.S. Census Bureau's 2002 Economic Census.

Source: For truck types, Highway Economic Requirements System (HERS). For distribution: U.S. Census Bureau, 2002 Economic Census.

Web link: www.census.gov/svsd/www/02vehinv.html

2.9.1.5 Average Effective Speed (miles per hour)

Definition: Average Effective Speed (AES) is the modified unconstrained average speed that exists for a highway section. It is the maximum speed allowed given terrain type, grade, curvature, number of heavy trucks, facility type, number of lanes, speed limit, volume-to-capacity (VC) ratio, pavement roughness, speed limit enforcement, safety concerns, and congestion, as modified by the effects of speed-changes and stop cycles (including idling time associated with these effects).[4]

Use: AES is utilized to convert hourly values, such as value of time, into mileage related values.

Data: The predefined values for average effect speed are simply placeholders for this value in the estimating tool. Average effective speed is highly dependent on roadway specific values. It is highly recommended that users update these data with project specific values.

[4] Definition from: Investment Tradeoffs Using HERS, Analysis for 1999 Oregon Highway Plan Transportation Planning Section Transportation Development Division, Salem, Oregon, July 2000.

2.9.2 Value of Time (VOT)

The VOT calculation is composed of three main categories: labor costs, vehicle depreciation costs, and inventory timeliness cost. The calculations follow those laid out in HERS 2002.

2.9.2.1 Average Hourly Wage

Definition: Average hourly wage represents the average hourly payment received by employees in the truck driver occupation.

Use: A key component in the calculation of hourly value of time. Wages for the "'Truck Drivers, Light or Delivery Services" are applied to the 4-Tire Truck category, and wages for "'Truck Drivers, Heavy and Tractor-Trailer" are applied to the remaining truck categories.

Data: Waged data was collected for 50 states, District of Columbia, and national level for the following occupations:

Occupation: Truck Drivers, Light or Delivery Services (Standard Occupation Classification (SOC) code 533033)

Occupation: Truck Drivers, Heavy and Tractor-Trailer (SOC code 533032)

Source: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment and Wages, May 2007.

Web link: http://www.bls.gov/oes/current/oes_nat.htm

2.9.2.2 Employee Benefits as a Percentage of Hourly Rate

Definition: Employee Benefits as a Percentage of Hourly Rate represents the percentage of an employee's total compensation that accounts for benefits beyond their monetary salary.

Use: Utilized in the calculation of hourly value of time, in conjunction with hourly wage data.

Data: National average value for employee benefits as a percentage of total compensation, for the transportation and warehousing sector.

Source: U.S. Department of Labor, Bureau of Labor Statistics, National Compensation Survey, National Average for Transportation and Warehousing in 2005, Benefits as Percentage of Hourly Rate.

Web link: http://www.bls.gov/ncs/

2.9.2.3 Vehicle Occupancy

Definition: Vehicle Occupancy is the average number of people traveling in a vehicle.

Use: Utilized in the calculation of hourly value of time.

Data: Average vehicle occupancy, measured in average number of persons in a vehicle, by the following vehicle types:

- 4-Tire Truck
- 6-Tire Truck
- 3-4 Axle Truck
- 4-Axle Combination
- 5-Axle Combination

Source: HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, Federal Highway Administration, U.S. Department of Transportation, 2002.

2.9.2.4 Time-Related Depreciation

Definition: Time-related depreciation is the average dollar amount that a vehicle's value declines by for each hour of use. This depreciation value is accounts for deprecation as a result of aging, independent of mileage-related deprecation (which is covered under the Vehicle Operating Costs section).

Use: Utilized in the calculation of hourly value of time.

Data: Average time-related vehicle depreciation, in dollars per hour, by vehicle type:

- 4-Tire Truck
- 6-Tire Truck
- 3-4 Axle Truck
- 4-Axle Combination
- 5-Axle Combination

Source: U.S. Department of Transportation, Federal Highway Administration, HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

2.9.2.5 Average Payload (pounds)

Definition: Average payload in pounds represents the average weight of the inventory carried in 4- and 5-axle vehicles along a highway segment.

Use: It is utilized in the calculation of hourly value of time, specifically in the inventory cost component of value of time. The average payload, measured in pounds, in conjunction with other variables, is used to calculate the average payload value for 4- and 5-axle combination vehicles.

Data: This is the average payload, in pounds, for 4- and 5-axle combination vehicles. In the value of time calculation, inventory costs are only calculated for 4- and 5-axle combination vehicles, in accordance with HERS guidelines.

Source: U.S. Department of Transportation, Comprehensive Truck Size and Weight (CTS&W) Study, August 31, 2000.

Web link: http://www.fhwa.dot.gov/reports/tswstudy/

2.9.2.6 Inventory Composition

Definition: Inventory composition represents the key commodities that account for a majority of the freight movement along the corridor. This tool elicits inputs for the top five commodities, by weight, on the segment, along with a catchall category for all other commodities.

Use: Inventory composition is another factor in the inventory cost component calculation for value of time. It is used in conjunction with inventory value, average payload, and inventory distribution to calculate the inventory cost component of value of time.

Data: Inventory composition comes from the standard commodity types utilized in FHWA's Freight Analysis Framework (FAF).

Source: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework (FAF1 and FAF2) database, Federal Highway Administration, 2002.

Web link: http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm

2.9.2.7 Inventory Distribution

Definition: Inventory distribution represents a commodity's share of total commodity traffic as a percentage, by weight, along the segment.

Use: Inventory distribution is another factor in the inventory cost component calculation for VOT. It is used in conjunction with inventory value, average payload, and inventory composition to calculate the inventory cost component of value of time.

Data: Commodity flow data (type and volume) were collected for 58 distinct corridors from the FAF database. Distribution was determined using a specific commodity's volume relative to total commodity volume within a corridor.

Source: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework (FAF1 and FAF2) database, 2002.

Web link: http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm

2.9.2.8 Corridor Inventory Value ($ per ton)

Definition: This is the average value of commodity shipments by commodity type along a segment, in dollars per ton.

Use: Inventory value is another factor in the inventory cost component calculation for value of time. It is used in conjunction with inventory distribution, average payload, and inventory composition to calculate the inventory cost component of value of time.

Data: Value, tons, and ton-miles of freight shipments within the United States by domestic establishments.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, and U.S. Department of Commerce, Census Bureau, 2002 Commodity Flow Survey: United States (Washington, DC: December 2004), table 5a. Table 1-53: Value, Tons, and Ton-Miles of Freight Shipments within the United States by Domestic Establishments, 2002

Web link: http://www.census.gov/svsd/www/cfsdat/2002cfs.html

2.9.3 Vehicle Operating Costs (VOC)

VOC is composed of fuel costs, repair and maintenance costs, tire usage costs, and mileage related depreciation costs. VOC calculations are based on the guidelines detailed in the 2002 HERS-ST Technical Report.

2.9.3.1 Fuel Costs

Vehicle fuel costs are dependent on a number of factors, including fuel price, fuel type, and fuel efficiency.

Fuel Price

Definition: Fuel price ($ per gallon) is the average price per gallon for either regular unleaded fuel or for highway diesel.

Use: Utilized in conjunction with fuel efficiency and fuel type to calculate the fuel cost portion of vehicle operating costs.

Data: Data has been collected on the price in dollars per gallon for regular unleaded fuel and on highway diesel fuel for all 50 U.S. states, District of Columbia, and national averages.

Source: U.S. Department of Energy, Energy Information Administration, U.S. Retail Gasoline and Diesel Prices.

Web link: http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm

Fuel Type by Vehicle

Definition: This is the type of fuel, either gasoline or diesel, most commonly used by a vehicle class.

Use: Utilized to assign the fuel type prices (either gasoline or diesel) to each of the five truck vehicle types.

Data: Predefined values for fuel type most commonly used by each vehicle type. Options include “Gasoline,” “Diesel,” and “50/50 Mix” (in the event that a vehicle type may not solely use either gasoline or diesel). Fuel type is assigned for each of the HERS truck vehicle types:

4-Tire Truck
6-Tire Truck
3-4 Axle Truck
4-Axle Combination.
5-Axle Combination

Fuel Efficiency by Vehicle

Definition: Fuel efficiency, measured in miles per gallon is the output in the miles traveled that a vehicle gets for one gallon of fuel consumed.

Use: Utilized in conjunction with fuel prices to calculate the fuel cost portion of vehicle operating costs.

Data: Data on fuel efficiency, in mpg, for each of the HERS truck vehicle types:
4-Tire Truck
6-Tire Truck
3-4 Axle Truck
4-Axle Combination
5-Axle Combination

Source: Fuel efficiency based in mpg is calculated in the tool using HERS formulas, by vehicle type, based on average effective speed (all formulas assume zero grade)

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

2.9.3.2 Repair and Maintenance Costs

Repair and maintenance costs are composed of both a value component and a usage rate. The value component is the average repair and maintenance cost per 1,000 miles, in dollars. The usage rate is the percent of the average repair and maintenance cost per 1,000 miles used in 1,000 miles of travel in a given segment.

Average Repair and Maintenance Cost per 1,000 Miles

Definition: This is the average cost per 1,000 miles for truck repair and maintenance expenses, by truck type.

Use: Utilized in the repair and maintenance calculation as part of total per mile vehicle operating costs.

Data: Data on average repair and maintenance cost per 1,000 miles in dollars by truck type.

Source: HERS-ST v2.0, Highway Economic Requirements System–State Version, Technical Report, Federal Highway Administration, U.S. Department of Transportation, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

Percent of Average Repair and Maintenance Cost per 1000 Miles

Definition: This is the percentage of the average cost per 1,000 miles for truck repair and maintenance expenses realized in travel along a given segment by truck type.

Use: Utilized in the repair and maintenance calculation as part of total per mile vehicle operating costs.

Data: This usage rate is calculated in the tool using HERS formulas by vehicle type based on average effective speed (all formulas assume zero grade).

Source: U.S. Department of Transportation, Federal Highway Administration, HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

2.9.3.3 Tire Usage Costs

Tire usage costs are composed of both a value component and a usage rate. The value component is the average cost per tire, by truck type, in dollars. The usage rate is the percent of tire worn in 1,000 miles of travel on a given segment.

Tire Cost

Definition: This is the average cost per tire by truck type.

Use: Utilized for the tire usage cost calculation as part of the total per mile vehicle operating costs.

Data: Tire cost in dollars per miles by truck type.

Source: U.S. Department of Transportation, Federal Highway Administration, HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

Tire Wear Rate

Definition: This is the percent of tire worn in 1,000 miles traveled along a given segment.

Use: Utilized for the tire usage cost calculation as part of the total per mile vehicle operating costs.

Data: The tire usage rate is calculated in the tool using HERS formulas, by vehicle type, based on average effective speed (all formulas assume zero grade).

Source: U.S. Department of Transportation, Federal Highway Administration, HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

2.9.3.4 Mileage-Related Depreciation

Mileage-related depreciation costs are composed of a value component and a usage rate. The value component is the average depreciable truck value by truck type in dollars. The usage rate is the percent of the average value depreciated every 1,000 miles on a given segment.

Depreciable Value

Definition: This is the total depreciable value of a truck, by truck type. It is based on the total cost of a new truck, net of any residual value.

Use: Utilized in the calculation of mileage related depreciation, which is a portion of total per mile vehicle operating costs.

Data: Total depreciable value of a truck by truck type in dollars.

Source: U.S. Department of Transportation, Federal Highway Administration, HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

Depreciation Rate

Definition: This is the rate at which a truck's depreciable value depreciates per 1,000 miles of use on a given segment.

Use: Utilized in the calculation of mileage related depreciation, which is a portion of total per mile vehicle operating costs.

Data: The percent of price depreciation per 1000 miles on a segment, by truck type. This usage rate is calculated in the tool using HERS formulas, by vehicle type, based on average effective speed (all formulas assume zero grade).

Source: U.S. Department of Transportation, Federal Highway Administration, HERS-ST v2.0, Highway Economic Requirements System – State Version, Technical Report, 2002.

Web link: http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf

2.9.4 Value of Reliability ($/hr-sd)

The value of reliability is a proxy for the cost of uncertainty in travel time. The greater the variability in travel time, the higher the cost to the driver. When there is more certainty in travel time, the cost falls since drivers do not have to budget as much time to ensure timely delivery when traveling on a given segment. It is composed of a value component, the average travel time, and the buffer index, which captures uncertainty around travel time.

2.9.4.1 Value of Time Multiplier

Definition: This is the factor by which truck drivers value their time with respect to variability in travel time. It is applied to the value of time.

Use: Utilized in the calculation of the value of reliability, to assign the value component.

Data: This is a multiplier for the value of time. It uses the defined value of time in the tool by truck type to determine the value of reliability.

Source: *NCHRP Report 431*, "Valuation of Travel-Time Savings and Predictability in Congested Conditions for Highway User-Cost Estimation," 1999.

Web link: http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=496

2.9.4.2 Average Segment Travel Time

Definition: This is average amount of time it takes to travel along a given segment.

Use: Utilized in the calculation of the value of reliability as a baseline for the application of the buffer index percentage.

Data: The predefined value is calculated using the average effective speed and the segment length, which are inputs to the tool.

Source: Calculated within the tool.

2.9.4.3 Buffer Index Value

Definition: This is the extra time buffer needed to ensure on-time arrival for most trips along a given segment.

Use: Utilized in the calculation of the value of reliability to determine the amount of uncertainty around travel time.

Data: The predefined value is calculated using the average effective speed and the segment length, both inputs to the tool.

Source: Texas Transportation Institute, Monitoring Urban Freeways in 2003: Current Conditions and Trends from Archived Operations Data, December 2004.

Web link: http://mobility.tamu.edu/mmp/FHWA-HOP-05-018/findings.stm

2.9.5 Advanced User Inputs

2.9.5.1 Elasticity of Demand

Elasticity of Demand with Respect to Price

Definition: This variable represents the change in demand for freight due to a change in the price of freight where the price of freight is represented by the direct vehicle operating costs. An elasticity of -0.97 means that a 10% increase in the price of freight will result in a 9.7% decrease in the demand for freight.

Use: This value is used to calculate the change in freight demand due to a change of the price of freight. When vehicle operating costs fall due to an improvement in freight logistics, this elasticity value is used to calculate the impact on freight demand.

Data: The predefined value is based on findings in the source report.

Source: HLB Decision Economics, Meta-Analysis of Logistics Cost and Transport Demand in Relation to Freight Transportation, Draft Report, July 2001.

Elasticity of Demand with Respect to Highway Performance

Definition: This variable represents the change in demand for freight due to the change in delay. For example, with an elasticity of -0.0076, with other things being equal, a 10% increase in delay per mile reduces freight demand by 0.076%.

Use: This value is used in the calculation of changes in freight demand due to changes in travel time and the reliability of travel time in the estimation tool.

Data: This value was calculated as part of the source analysis for three regions in the United States, using statistical regression techniques where demand for daily truck traffic is specified as a function of delay and real per capita income growth.

Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Analysis of Regional Benefits of Highway-Freight Improvements, Draft Final Report. Prepared by HLB Decision Economics Inc., in association with ICF Consulting, June 2006.

2.9.5.2 Prime Rate

Definition: This is the interest rate charged by banks to their most credit-worthy customers.

Use: This is used as a proxy for the time value of commodities in truck inventory, as part of the VOT inventory component calculation.

Data: The predefined value is calculated using the average effective speed and the segment length, both inputs to the tool.

Source: Board of Governors of the Federal Reserve System, Bank Prime Loan Rate Changes: Historical Dates of Changes and Rates.

Web link: http://research.stlouisfed.org/fred2/data/PRIME.txt

2.9.5.3 Price Elasticity Approach

Definition: This is the approach used in the tool to calculate consumer surplus based on the price elasticities in the tool.

Use: This is used when calculating consumer surplus in the model. The predefined value in the model is additive.

Data: The user may select either an additive or full price elasticity approach.

Source: Implicit to the model.

2.10 Tool Accessibility

In compliance with Section 508 of the Rehabilitation Act of 1973, as amended, the Highway Freight Logistics Reorganization Benefits Estimation Tool is accessibility enabled. Table 3 provides a summary of the keyboard shortcuts that can be used to navigate and use the tool without the use of a mouse.

Table 3. Tool Accessibility Shortcuts

Page	Keyboard Shortcuts		Description
All	Ctrl+Shift+	N	Navigates user forward to Next screen
All	Ctrl+Shift+	B	Navigates user Back to previous screen
Input Page, Conventional Benefit Page	Ctrl+Shift+	C	Clears all user inputs on Estimation Input screen or Conventional CBA Freight Benefits Input screen.
Start Page	Ctrl+Shift+	A	Sets Model to Advanced Mode
Start Page	Ctrl+Shift+	D	Sets Model to Standard Mode
All	Ctrl+	P	Brings up Print dialog box
Input Page	Ctrl+Shift+	O	Clear State One inputs
Input Page	Ctrl+Shift+	T	Clear State Two inputs
Input Page	Ctrl+Shift+	S	Set to Single State mode
Input Page	Ctrl+Shift+	M	Set to Multiple State mode
Input Page	Ctrl+Shift+	E	Select Aggregate VOT Input
Input Page	Ctrl+Shift+	F	Select VOT input by component
Input Page	Ctrl+Shift+	G	Select Aggregate VOC Input
Input Page	Ctrl+Shift+	H	Select VOC input by component
Input Page	Ctrl+Shift+	U	Select percent change in voc
Input Page	Ctrl+Shift+	V	Select detailed input change in voc
Input Page	Ctrl+Shift+	W	Select percent change in VOT
Input Page	Ctrl+Shift+	X	Select detailed input change in VOT
Input Page	Ctrl+Shift+	Y	Select percent change in reliability
Input Page	Ctrl+Shift+	Z	Select detailed input change in reliability

2.11 Additive Benefit Calculation Mathematics

The Highway Freight Logistics Reorganization Benefit Estimation Tool estimates the value of efficiency gains to the economy due to an industrial reorganization precipitated by a highway improvement. This appendix describes the mathematical process for estimating the efficiency gains that are estimated by the tool.

The model calculates the change in demand for truck miles based on a change in price using the elasticity of demand with respect to price in the same manner.

$$Q_1^* - Q_0 = (\varepsilon_p \times \%ChngVOC) \times Q_0$$

The benefit estimation is driven by the estimation of total demand after the reorganization (Q_1) and elasticity of demand (ε_r), which differ for each method.

Benefit Factor

The benefit factor is the percent change in consumer surplus gained by the shift from D to D' (i.e. $\frac{C}{A+B}$).

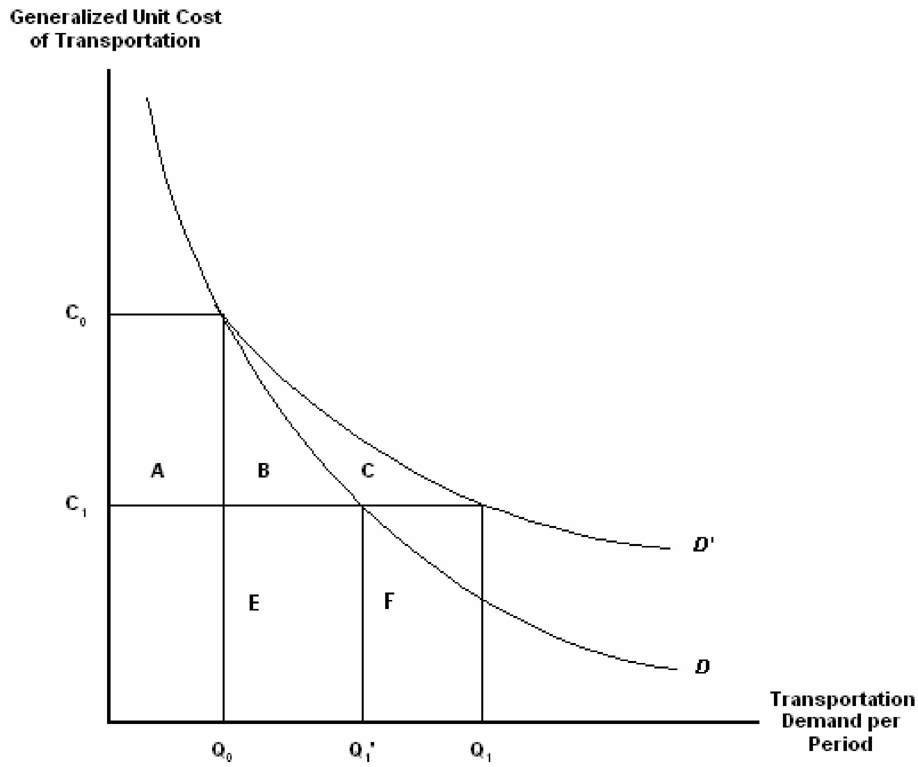


Figure 31. Change in Consumer Surplus from Changing Demand for Transportation as a Function of Unit Generalized Transportation Cost

To assess the quantitative significance of the benefit factor, the tool contains or elicits quantitative evidence of the following:

- Q_0: Initial demand for freight transportation (vehicle-miles);
- Q_1: New demand level as a result of highway improvements or policy change;
- C_0: Initial unit generalized cost of transportation ($/vm);
- C_1: New unit generalized cost of transportation ($/vm) following highway improvement or policy change;

For simplicity, this explanation focuses on how consumer surplus (A + B) is calculated for under demand D.

A = $(C_0 - C_1) \times Q_0$

E = $(Q_1^* - Q_0) \times C_1$

(B + E) = $(Q_0 \times C^{\varepsilon}{}_0)^{(1/\varepsilon)} \times \dfrac{\left[Q_1^* - Q_0\right]^{(1-(1/\varepsilon))}}{1-(1/\varepsilon)} = \int_{Q_0}^{Q_1} \left(\dfrac{Q_0}{Q}\right)^{(1/\varepsilon)} C_0 dQ$

B = (B + E) – E

Using the above equations and changing the Q and ε based on which area under the demand curve we are trying to solve for, we can easily calculate A + B + C. From there the model calculates the additive benefit factor by:

$$BenefitFactor = \frac{A+B+C}{A+B} - 1$$

The difference in benefit factor is determined by both Q_1 and the ε, which are estimated as follows:

The tool calculates the elasticity of demand with respect to the reorganization (ε_r^{FP}) by calculating the linear combination of the elasticity for demand with respect to price (ε_p), transit time (ε_{tt}) and reliability (ε_l) with the average weight being one.

$$\varepsilon_r^{FP} = \alpha_p \varepsilon_p + \alpha_{tt} \varepsilon_{tt} + \alpha_l \varepsilon_l \text{ with } \frac{\alpha_p + \alpha_{tt} + \alpha_l}{3} = 1$$

In order to calculate the change in demand from the reorganization, an estimate for the percent change in demand is calculated by multiplying ε and the percent change of price (i.e. $\frac{C_1 - C_0}{C_0}$), which is then multiplied by the baseline for the estimated change in demand.

$$Q_1 - Q_0 = (\varepsilon_r \times \%Chng\,\mathrm{Pr}) \times Q_0$$

The benefit factor is then calculated by using ε and Q_1.

Technical Report Documentation Page

1. Report No. FHWA-HOP-08-017	**2. Government Accession No.**	**3. Recipient's Catalog No.**	
4. Title and Subtitle Freight Benefit/Cost Study: Highway Freight Logistics Reorganization Benefits Estimation Tool Report and Documentation		**5. Report Date** February 2008 **6. Performing Organization Code**	
7. Authors Neil Pogorelsky, HDR-HLB		**8. Performing Organization Report No.**	
9. Performing Organization Name and Address HDR-HLB Decision Economics 8403 Colesville Rd. Silver Spring, MD 20910		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.**	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Office of Freight Management and Operations 1200 New Jersey Ave., SE Washington, DC 20590		**13. Type of Report and Period Covered** **14. Sponsoring Agency Code**	
15. Supplementary Notes			
16. Abstract The Freight Benefit/Cost Study is a multi-year effort originating in the Federal Highway Administration, Office of Freight Management and Operations. The Freight Benefit/Cost Study project has gone through three phases of development. Phase I focused on developing the theory and logic. Phase II determined the sensitivity of a firm to infrastructural investment on a national level. Phase III established the approach, sensitivities and data inputs required to calculate long-term benefits of highway-freight infrastructural investment on a regional level and constructed a tool for state and local entities to estimate additional benefits derived though logistics rearrangements from highway performance improvements. This Microsoft Excel©-based tool can be used to estimate additive freight benefits resulting from highway performance improving investments. These benefits can be summed with the conventional benefits expressed through CBA to present a more complete picture of the return on highway investment. This report describes the Highway Freight Logistics Reorganization Benefits Estimation Tool, its use, and data requirements.			
Key Words Freight investments, benefit-cost analysis, logistics, highway corridor improvements, freight mobility, productivity		**18. Distribution Statement**	
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21.No of Pages** 59	**22. Price** N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized.

U.S. Department of Transportation
Federal Highway Administration

Office of Freight Management and Operations
1200 New Jersey Avenue, SE
Washington, DC 20590
Phone: 202-366-9210
Fax: 202-366-3302
Web site: http://ops.fhwa.dot.gov/freight

February 2008
Publication # FHWA-HOP-08-017

U.S. Department of Transportation
Federal Highway Administration