Final Report

Surface Transportation Efficiency Analysis Model (STEAM 2.0)

User Manual

Submitted to

Federal Highway Administration
U.S. Department of Transportation

Submitted by

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1.0 Introduction

The Surface Transportation Efficiency Analysis Module (STEAM 2.0) was developed in order to provide an analytical tool for estimating impacts of multi-modal transportation alternatives in a system planning context. Cost-effectiveness evaluation of alternatives is a complex process requiring close interaction among planning professionals, decision-makers, and citizens. Such assessments require an understanding, estimation, and comparison of the wide range of impacts transportation alternatives typically generate. A variety of economic, financial, social, and environmental impacts must be assessed and tradeoffs made to present decision makers with good information.

1.1 Organization of this Manual

This user manual provides the reader with a full understanding of the STEAM 2.0 software and a detailed explanation of each option incorporated in the analysis. It is organized as follows:

Chapter 2: Overview of STEAM 2.0. This chapter provides a general description of the STEAM 2.0 analysis including the model objectives, structure of the software, and analytical procedures that are incorporated in the benefit-cost analysis.

Chapter 3: Input Files. This chapter explains in detail the concept of "market sectors" in relation to the STEAM 2.0 analysis and provides a description and layout of each of the market sector input files required by the model.

Chapter 4: Software User Interface. This chapter covers the user interface of the STEAM 2.0 software. Areas discussed include: installation of the program, defining market sectors, changing parameter values, estimating run time, performing investment analysis, and viewing results.

Chapter 5: Getting Started with STEAM. This chapter provides a step-by-step guide on performing a basic user benefit analysis in STEAM 2.0.

Appendix A: Case Study-Any City, USA. To assist the STEAM 2.0 user in understanding how he or she may use STEAM 2.0 with travel demand output, a case study is provided and explained in this appendix.

Appendix B: Glossary of Terms. This section provides a complete glossary of the parameters specified by the software user in order to perform a benefit-cost analysis.

2.0 Overview of STEAM 2.0

The Surface Transportation Efficiency Analysis Module (STEAM 2.0) is the most recent version of the transportation/economic impact analysis tool developed by the Federal Highway Administration (FHWA). In 1995, the FHWA developed a corridor sketch planning tool called the Sketch Planning Analysis Spreadsheet Model (SPASM) to assist planners in developing economic efficiency and other evaluative information needed for comparing cross-modal and demand management strategies (DeCorla-Souza, Cohen & Bhatt, 1996). In 1997, FHWA introduced the Surface Transportation Efficiency Analysis Module (STEAM) for detailed, system-wide analysis of alternative transportation investments. STEAM was the first FHWA impact analysis product to use input directly from the four-step travel demand modeling process.

STEAM 2.0 retains all of STEAM's functionality and adds two new features: the ability to report mobility and safety benefits by user-defined districts and a new accessibility measure. The district-level reporting feature allows users to compare the impacts of transportation investments to resident trip-makers across aggregations of zones, which may represent neighborhoods, policy areas or political jurisdictions. The accessibility feature produces estimates of employment opportunities within a user-defined travel-time threshold of a district across a base and improvement scenario. Both an index and the percentage change are provided. The district reporting and accessibility features are useful new tools for gauging the social impacts of transportation investments.

STEAM 2.0 post-processes the traffic assignment volumes generated from conventional four-step planning models in order to get more accurate highway travel speeds, especially under congested conditions. It also performs risk analysis to clearly describe the level of uncertainty in the results of the analysis, so that the debate over transportation investments can shift from unproductive technical controversy to compromise and action.

Like STEAM, STEAM 2.0 is based on the principles of economic analysis, and allows development of monetized impact estimates for a wide range of transportation investments and policies, including major capital projects, pricing and travel demand management (TDM). Impact measures are monetized to the extent feasible, but quantitative estimates of natural resource usage (i.e., energy consumption) and environmental impacts (i.e., emissions) are also provided. Net monetary benefits (or costs) of alternatives can then be used to evaluate trade-offs against non-monetizable benefits, including sustainability and community livability.

STEAM 2.0 is highly flexible in terms of transportation modes, trip purposes, and time periods analyzed. It provides default analysis parameters for seven modes (auto, truck, carpool, local bus, express bus, light rail, and heavy rail) and allows the user to deal with special circumstances or new modes by modifying these parameters. Users are allowed to specify different values of time for separate travel markets. The user also provides Base Case and Improvement Case trip tables for different trip purposes, which will be analyzed

separately by the model. Regarding time periods, STEAM 2.0 can be applied to average weekday traffic or to peak and off-peak traffic with different definitions of the peak periods.

2.1 Objectives of the System

The primary objectives of STEAM 2.0 are to provide a framework for estimating impacts of multimodal transportation alternatives and assessing their overall merits.

The STEAM 2.0 analysis provides estimates of the following measures of effectiveness for proposed actions:

- Benefits and costs to transportation users
- Annualized cost to public agencies
- Effect on total transportation cost
- Change in accessibility to jobs for district residents
- Change in emissions for particulates, hydrocarbons, carbon monoxide, and nitrogen oxides
- Change in energy use
- Change in noise and other external costs
- Change in fatal, injury, and property damage only accidents
- Revenue transfers due to toll or fare changes

2.2 Overall Structure of the Software

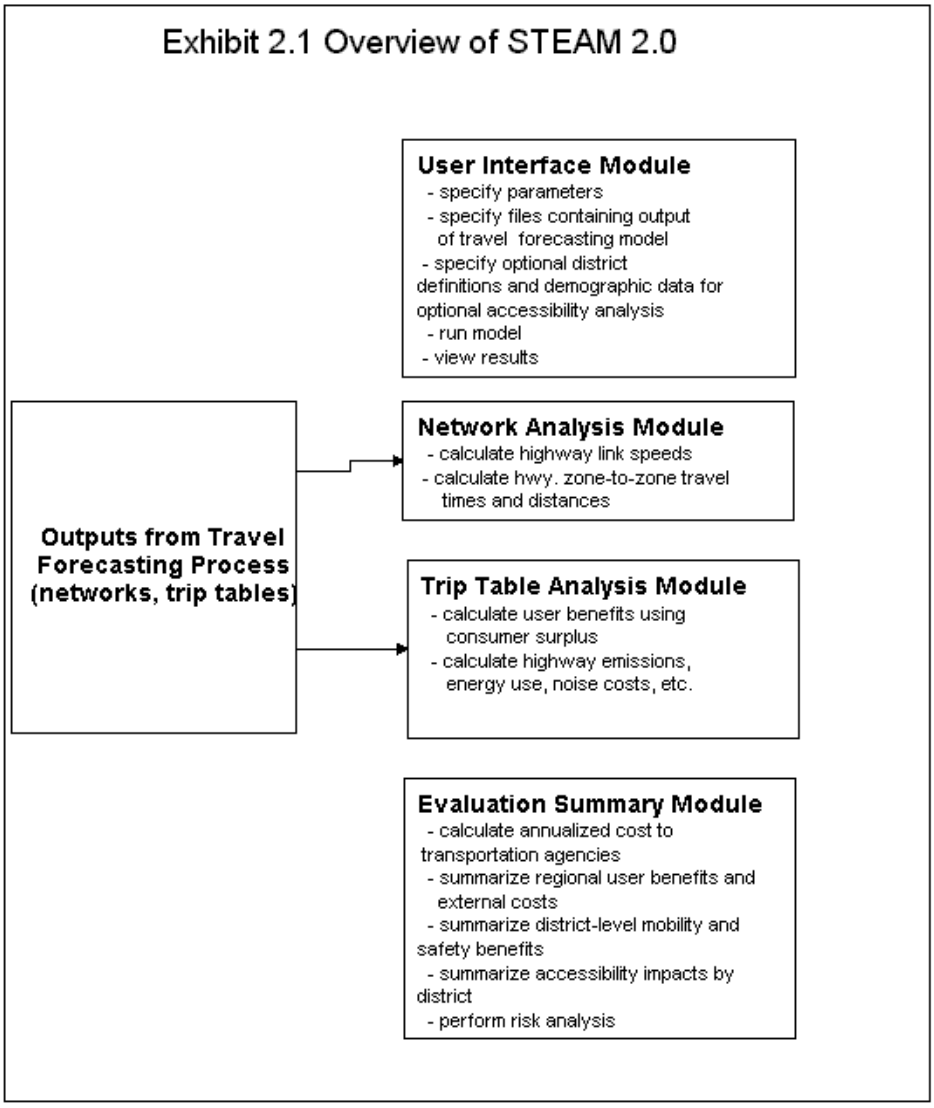
As shown in Exhibit 2.1, STEAM 2.0 consists of four modules:

1. A User Interface Module, which includes on-line help files;

2. A Highway Network Analysis Module, which reads a file containing vehicular traffic volumes, highway segment lengths, highway capacities, and other link data and produces zone-to-zone travel times and distances based on minimum time paths through the network.

3. A Trip Table Analysis Module, which produces estimates of user benefits based on a comparison of Base Case and Improvement Case conditions. It also produces estimates of emissions, noise costs, accident costs, energy consumption, and other external costs associated with highway use.

4. An Evaluation Summary Module, which calculates: 1) mobility and safety and accessibility impacts by district; 2) regional impacts costs and benefits by component; and 3) net present worth, and a benefit-cost ratio for the improvement under consideration. It also provides summary information on individual benefit and cost items.



2.3 Transportation Analysis Analytical Procedures

This section describes the procedures used by STEAM 2.0 for:

- estimating user benefits

- congestion analysis
- analysis of accident costs
- emissions analysis
- fuel consumption analysis
- analysis of other external costs
- analysis of capital costs
- revenue transfers
- accessibility analysis
- risk analysis

Estimation of User Benefits

The analysis of user benefits in STEAM 2.0 focuses on how proposed improvements affect travel conditions for a set of "market sectors" defined by the model user. Market sectors can be defined to represent different modes, trip purposes, and time periods, e.g., peak period auto work trips.

For each market sector to be analyzed, the STEAM 2.0 user provides a Base Case and an Improvement Case trip table, specifying the number of trips from each analysis zone to other zones. User benefits will be calculated for each zone pair and then summed over all zone pairs. Zone-to-zone travel times for the Base Case and Improvement Case for highway modes are estimated by STEAM 2.0's network analysis module, using the speed-volume relationships described below (under Congestion Analysis). Motor vehicle operating costs are calculated as the sum of fuel and non-fuel costs by applying unit (per vehicle mile) fuel consumption rates (as a function of speed) and costs to zone-to-zone distances. As discussed later, user-perceived accident costs are also used in the estimation of user benefits. The STEAM 2.0 user can also specify other changes in zone-to-zone travel times (in-vehicle and walk/wait) and out-of-pocket costs for each zone pair. The difference in the total cost of travel for each zone pair is calculated as the sum of changes in out-of-pocket cost, operating cost, user-perceived accident costs, and the dollar value of changes in travel time. Zone pairs for which a travel time cannot be determined by STEAM are excluded entirely from the analysis. Users may specify different values of travel time for different market sectors. Motor vehicle operating costs and other out-of-pocket costs are assumed to be specified on a per vehicle basis, and are converted to a per person basis by dividing by vehicle occupancy.

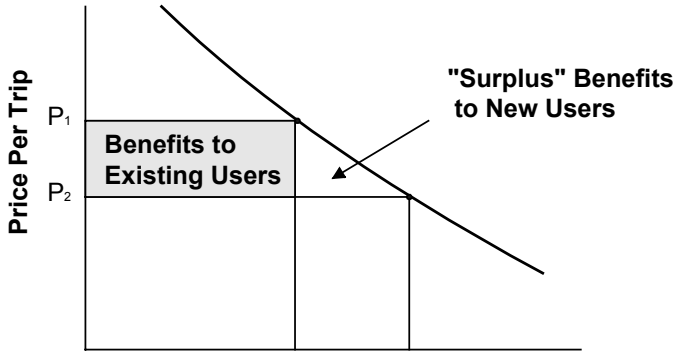
STEAM 2.0 uses the concept of "consumer surplus" to measure user benefits(see Exhibit 2.2). User benefits(B) are calculated using consumer surplus as follows:

$$B = (P_b - P_i)(T_b + T_i) / 2$$

where P_b and P_i are price per trip and T_b and T_i are the number of trips in the Base and Improvement Cases. In Exhibit 1, the rectangular area represents benefits to current users and the triangular area represents benefits to new users.

STEAM 2.0 calculates benefits for a specific analysis year by comparing Base Case and Improvement Case conditions for that year. Capital costs are annualized so that they can be related to analysis year benefits in a benefit-cost ratio. If conditions are expected to vary greatly over the life of the proposed improvements (due to, for example, growth in traffic over time), it may be appropriate to perform several STEAM 2.0 analyses (representing different analysis years) and average the results.

Exhibit 2.2 Consumer Surplus



Congestion Analysis

Cambridge Systematics has developed new speed models for use in STEAM 2.0 (see Exhibit 2.3). The models are designed to be used as part of a post-processor of average weekday traffic assignments. They produce peak, off-peak, and average weekday speeds for freeways and arterials as a function of: 1) free-flow speed; 2) average weekday traffic; and 3) capacity (in vehicles per hour).

The new models were developed by conducting hour-by-hour simulations of traffic volumes and queuing for facilities with different levels of congestion. The simulation program kept track of the growth and dissipation of queues over the course of the day. Queuing was assumed to occur if the volume attempting to use the facility exceeded its capacity, or if there was a standing queue at the end of the preceding hour. The hour-by-hour results were then combined to produce average speeds for a six-hour peak period (7-10 a.m. and 4-7 p.m.), an 18-hour off-peak period, and an average weekday. Finally, sets of curves were fit to simulation outputs, producing the results shown in Exhibit 2.3.

As discussed in the following paragraphs, the new speed models have a number of features that make them especially useful in the evaluation of transportation system improvements.

The models account for delays due to incidents, using data on the frequency, severity, and duration of incidents compiled by Ball Systems Engineering[1]. Incidents account for a large share of total travel delays due to congestion, especially on freeways. For example, Lindley[2] estimates that over 60 percent of the congestion delay experienced on urban freeways is due to incidents rather than recurring congestion. Hence, ignoring incidents could grossly understate actual congestion delays.

The models account for peak spreading that occurs when facilities become more congested. The traffic temporal distributions used in developing the models were based on data from 579 urban automatic traffic recorders (ATRs) across the nation[3]. Separate temporal distributions were developed for freeways and arterials with low, moderate, and high ratios of average daily traffic to capacity.

The models account for day-to-day variations in traffic. The relationship between delays due to congestion and traffic volumes are highly non-linear in nature, especially when the ratio of demand volume to capacity is close to 1.0. Hence, using average volumes, rather than explicitly accounting for day-to-day variations in traffic volumes, can result in a significant overestimate of average speeds. To address this problem, the new speed models were developed using Monte Carlo simulation of traffic volumes, based on estimates of day-to-day variations in traffic compiled from urban ATR counts by SAIC.

[1] Edward Sullivan, Sam Taft, and James Daly; *A Methodology for Measurement and Reporting of Incidents and the Prediction of Incident Impacts on Freeways*; submitted to Federal Highway Administration by Ball Systems Engineering Division; April 1995.

[2] Jeffrey A. Lindley; "Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions"; *ITE Journal*; January 1987.

[3] Science Applications International Corporation and Cambridge Systematics, *Roadway Usage Patterns: Urban Case Studies*; prepared for Volpe National Transportation Systems Center and Federal Highway Administration; June 9, 1994.

Exhibit 2.3 STEAM 2.0 Speed Models

$$S = \frac{1}{\frac{1}{F} + D}$$

$$D = c_1 x^{c_2} e^{c_3 x}$$

for $x <= c_0$

$$D = c_4\left(1 - c_5 x^{c_6} e^{c_7 x}\right)$$

for $x > c_0$

where:

- S is average speed in miles per hour
- F is free-flow speed[4] in miles per hour
- D is congestion delay in hours per vehicle mile
- x is the ratio of average weekday traffic to hourly capacity for the section (AWDT/C)
- c_0 to c_7 are constants, given in the following table

	Freeways			Signalized Arterials		
	Daily	Peak	Off-Peak	Daily	Peak	Off-Peak
C0	1.05E+01	1.21E+01	1.11E+01	9.74E+00	9.62E+00	1.26E+01
C1	2.39E-08	2.35E-07	1.13E-07	5.62E-04	8.44E-04	4.35E-04
C2	3.75E+00	3.29E+00	2.52E+00	8.62E-01	6.15E-01	9.37E-01
C3	2.87E-01	2.35E-01	2.59E-01	7.39E-02	1.24E-01	5.16E-02
C4	5.00E-02	5.00E-02	5.00E-02	1.66E-01	1.66E-01	1.66E-01
C5	1.494E-02	2.865E-04	1.058E-03	1.313E-01	8.591E-03	1.177E-02
C6	3.42E+00	7.00E+00	4.91E+00	1.61E+00	3.80E+00	2.91E+00
C7	-3.72E-01	-7.97E-01	-4.49E-01	-1.73E-01	-4.07E-01	-2.37E-01

[4] Free-flow speed is that which occurs when traffic volumes are very low. On interrupted flow facilities, they include delays due to traffic control devices but exclude any congestion-related delays.

The models account for the decrease in highway capacity that occurs after demand volumes exceed capacity. The 1994 *Highway Capacity Manual* notes that observations of freeway queue departure rates range from 1,500 to 2,000 passenger cars per hour per lane. In contrast, freeway capacities for 12-foot lanes with no lateral obstructions are 2,200 to 2,300 passenger cars per hour per lane. Not accounting for the fact that queue departure rates are generally lower than freeway capacities can result in a large understatement of the delays due to queuing.

Accessibility Analysis

STEAM 2.0's accessibility measure allows users to estimate changes in spatial proximity between workers and jobs resulting from transportation investments. For each user-defined district, STEAM 2.0 reports: 1) the number of jobs within one of up to eight travel time thresholds; and 2) an accessibility index, which provides a single indicator of spatial proximity. Both these measures are reported by district, as well as for the entire region.

The threshold measure uses information on travel times, employment and population. STEAM 2.0 first calculates the total travel time, consisting of in-vehicle, out-of-vehicle and time from the "other changes" file for each origin/destination pair. From each origin zone, STEAM 2.0 identifies all destination zones and the number of jobs within the travel time thresholds specified. STEAM 2.0 aggregates these results by district, weighting by zonal population:

$$A = \sum_{i=1}^{n} \left(\frac{P_i E_{i,m}}{\sum_{i=i}^{n} P_i} \right)$$

where:

Ai is the Accessibility measure for district;
P_i is the population in zone i in the district;
E_i is the total employment within access of threshold m; and
N is the nth zone in each district.

This measure is intended to be used with a production/attraction home-based trip table, so that user benefits can be properly attributed to resident trip-makers. However, users are not prohibited from using any trip table they choose.

To calculate regional job accessibility by travel time threshold, population and employment are summed over all zones in the region, rather than by all zones in the district.

The accessibility index is calculated as a summation of the quantity:

$$\text{AIi} = \sum_{i=1}^{n} \left(E_j \exp^{-\alpha T_{ij}} \right) \forall j$$

where:

AIi is the accessibility index for origin zone I;
Ej is the total employment at destination zone j;
α is a "dispersion" parameter indicating the attractiveness of nearby zones; and
T_{ij} is the total travel time between origin i and destination j.

The district-level accessibility index is a weighted sum of the zonal accessibility values.

To calculate the regional job accessibility index, population and employment are summed over all zones in the region, rather than by all zones in the district.

Analysis of Crash Costs

STEAM 2.0 applies per vehicle mile rates and unit costs for fatal, injury, and property damage only crashes. It includes default rates for limited-access and non-limited-access highways. Alternatively, STEAM 2.0 users can specify crash rates for up to six user-defined highway classes.

STEAM 2.0 allows the specification of "internal" and "external" unit costs for fatal, injury, and property damage only crashes. "Internal" costs are viewed as incident upon and perceived by highway users and are treated in the same way as travel time, operating, and out-of-pocket costs to highway users in the benefit-cost analysis. "External" costs are viewed as incident upon other elements of society and are treated the same way as emissions, noise, and global warming costs in the benefit-cost analysis (i.e., it is assumed that these costs are not taken into account in traveler decisions).

Analysis of Benefits and Travel Demand by User-Defined Districts

STEAM 2.0 produces estimates of user benefits by mode and summarizes travel demand output for each user-defined district. Districts are aggregations of traffic analysis zones. These aggregations may represent neighborhoods, policy areas or political jurisdictions.

With this feature, users can compare user benefits to resident trip-makers across districts that they have defined. The dollar value of in-vehicle travel time, out-of-vehicle travel time, fuel costs, non-fuel operating costs, out-of-pocket costs, and internal accident costs are reported separately, as a total, by mode and by district. Revenue transfers are reported separately as well. Travel demand measures reported by district and mode

include vehicle miles of travel (VMT), person trips, vehicle trips, in-vehicle time, out-of vehicle and total travel time.

The aggregation feature can report user benefits to *resident* trip-makers. For this reason, STEAM 2.0 accepts matrices in *Production-Attraction* format. Trips at the origin end of a daily trip table may contain work to home trips, non-home to non-home trips, shop-to-home trips, and other trips not attributable to residents of a district. However, when trips are provided in production-attraction format, it is possible to determine the district of residence for the trip-maker.

STEAM 2.0 performs an internal conversion of trips from P/A to O/D format. The number of person trips in the production-attraction zone interchange is factored by a user-defined percentage. That percentage is applied to the P/A interchange to create a O/D interchange. The balance (1-the percentage) is assumed to originate at the attraction end and to end at the origin end. This fraction of the trip table is transposed. User benefits for both sets of trips are assigned to districts based on the district code of the production zone.

For example, suppose that 100 home-based work trips are produced in zone 1 and are attracted to zone 2. Home-based work P/A tables typically contain two daily trips for each trip-maker, both of which originate at the production zone. These trips represent the trip from home to work and the trip from work to home. To convert these to O/D format, the user specifies a P/A factor of 50 percent. STEAM 2.0 will assign 50 of the trips to the production/attraction zone interchange, and remaining 50 trips to the attraction/ production zone interchange. User benefits of all 100 trips will be attributed to the user's district of origin.

Users have the option of aggregating results by district of destination. This may be useful if the focus of the analysis is on a group of trip-makers bound for a particular destination, such as a CBD, employment district, or non-work destination.

Emissions Analysis

In STEAM 2.0, emissions for autos, trucks, and carpools are calculated as the sum of: 1) mileage-based emissions on the highway system (calculated under the assumption that vehicles are already warmed up); and 2) added emissions due to cold starts.

Mileage-based emissions are calculated using emission rates as a function of speed. Specifically, emission rates are input for speeds of 5, 10, 15, ..., 60, and 65 miles per hour, and the spreadsheet interpolates to get emission rates at intermediate speeds. The average speeds are trip-based (i.e., calculated as origin to destination distance divided by origin to destination mileage). The added emissions due to cold starts are calculated on a per vehicle trip basis and combined with mileage-based emissions.

Transit emissions are calculated by applying emission rates to changes in transit vehicle miles specified in the inputs to STEAM 2.0.

Analysis of Other External Costs

STEAM 2.0 applies per vehicle mile unit costs for noise, global warming, and other external costs. STEAM 2.0 inputs also include an estimate of external costs incurred during the construction period. These costs are annualized in the same way as capital costs (discussed below).

Revenue Transfers

STEAM 2.0 calculates revenue transfers occurring as a result of changes in fares, tolls, and other out-of-pocket costs paid by transportation system users Increases in fares and tolls implemented as part of a package of transportation system improvements reduce the benefits of the improvements to system users. If the fare and toll increases are very large, the net effect of the package on transportation system users may be negative. However, fare and toll increases do not, in themselves, necessarily result in a loss to society as a whole, since they cause revenues to be transferred from system users to the agencies that collect tolls and fares.

Conversely, decreases in fares and tolls increase benefits to users because revenues are being transferred to them from the collecting agencies. Hence, in calculating the net benefits of a package of actions, revenue transfers to or from collecting agencies must be added to user benefits to capture the full effect of the package of actions on society.

STEAM 2.0 calculates revenue transfers at the zonal interchange level for each market sector. The equation used to calculate revenue transfer (RT) is as follows:

$$RT = (OPTC_i)\ (T_i) - (OPTC_b)\ (T_b)$$

where T_i and T_b are the number of trips in the Improvement and Base Cases and OPTCi and OPTCb are the out-of-pocket costs in the Base and Improvement Cases.

In addition to the revenue transfers which occur as a result of fares and tolls and other out-of-pocket costs paid by users, revenue transfers occur as a result of changes in motor fuel taxes collected. If additional motor fuel is consumed in an improvement case versus a base case, transportation users are paying additional costs for the motor fuel. However, some of the additional cost for fuel is State and Federal tax which is simply a revenue transfer from transportation users to government agencies. The STEAM 2.0 model calculates the amount of revenue transfer resulting from changes in motor fuel consumption based on an average State and Federal motor fuel tax rate. The combined State and Federal tax rates for gasoline is 37.48 c/gal and 42.6 for diesel.

Analysis of Capital Costs

STEAM 2.0 estimates benefits and costs for an analysis year. To determine capital costs for the analysis year, total capital costs are converted into a stream of annual costs starting in the year of opening and extending over the useful life of the project. For simplicity in this conversion, all capital costs are viewed as incurred in the year entered by the spreadsheet user as the midpoint of the construction period. The equation used to annualize capital costs is:

$$a = \frac{(1 - r)}{(1 - r^{L})} \quad \frac{C}{r^{yo-ym+1}}$$

$$r = \frac{1}{1 + d}$$

-

where:

C is capital cost;

y_o is the year of opening;

y_m is the midpoint of the construction period;

L is the useful life of the investment in years;

d is the discount rate expressed as a fraction (e.g., 0.07); and

a is capital cost annualized over the useful life of the investment.

Risk Analysis

Uncertainty is a key attribute of both the physical and economic components of transportation user costs. Risk analysis is useful to reflect both what is known and what is uncertain in the effect of transportation conditions and performance on user costs. Risk analysis allows the planner to evaluate alternative investment options under a variety of scenarios. The result of the risk analysis is a forecast of future outcomes and the probability, or odds, of their occurrence. Risk analysis provides the STEAM 2.0 user with a sense of perspective on the likelihood of future outcomes and a process which is easily understandable and technically robust. This allows planners and decision-makers to select the level of risk within which they are willing to plan and make commitments.

The risk analysis process helps avoid the lack of perspective in "high" and "low" cases used in sensitivity analysis by measuring the probability or "odds" that an outcome will actually materialize. This is accomplished by attaching ranges (probability distributions)

to the forecasts of each input variable. The approach allows all inputs to be varied simultaneously within their distributions, thus avoiding the problems inherent in conventional sensitivity analysis. The approach also recognizes interrelationships between variables and their associated probability distributions.

Probability distributions for the variables in-question are established on the basis of both statistical analysis and subjective probability. In the current version of STEAM 2.0, the variables subject to risk analysis are assumed to follow a log-normal probability distribution. Future versions of STEAM 2.0 will provide more flexibility in selecting probability distributions. Ranges need not be normal or symmetrical – that is, there is no need to assume the bell shaped normal probability curve. The bell curve assumes an equal likelihood of being too low and being too high in forecasting a particular value. It might well be, for example, that if projected inflation rates deviate from expectations, they are more likely to be higher rather than lower. The software places no restrictions on the degree of "skew" in the specified ranges and thus maximizes the extent to which the risk analysis reflects reality.

Although the computer program will transform all ranges into formal "probability density functions", they do not have to be determined or presented in either mathematical or graphical form. All that is required is the entry of upper and lower limits of an 80 percent confidence interval. The software will then use numerical analysis to translate these entries into a uniquely defined statistical probability distribution automatically. This liberates the non-statistician from the need to appreciate the abstract statistical depiction of probability and thus enables administrators, stakeholders and decision-makers to understand and participate in the process whether or not they possess statistical training.

The model uses a monte carlo simulation process to generate the distributions. During the simulation process, the unique probability density function for each variable is sampled, and the resulting numbers populate the mathematical equations making up the model. Values for each result metric are calculated at the end of each simulation. After repeated samplings the model generates a probability distribution for each result metric. For each result there is both a forecast and a quantification of the probability that the forecast will be achieved.

3.0 Input and Output Files

This chapter describes the concept of "market sectors", the basic organizing principle of a STEAM 2.0 analysis. The chapter also describes the inputs necessary for the analysis and the output files produced by STEAM 2.0.

3.1 Explanation of Market Sectors

In conducting a STEAM 2.0 analysis, the software user first divides travel demand into a set of "market sectors". Market sectors describe a specific transportation user segment with unique travel characteristics. Most often, market sectors correspond to specific trip purposes served by particular modes of travel. However, STEAM 2.0 sets no limits on how markets sectors are defined. Unique market sectors can be defined for different trip purposes, geographic submarkets, or time periods. Bus work trips during the off-peak period is an example of a market sector. More aggregate definitions of a market sector can also be used; e.g., all weekday express bus riders.

For each market sector to be analyzed, the STEAM 2.0 user must provide a Base Case and an Improvement Case trip table.[1] If an analysis of benefits to resident trip-makers is desired, a table of trips in P/A format must be provided. The availability of trip tables from the four-step planning process will usually dictate the set of market sectors to be analyzed by STEAM 2.0.

In estimating user benefits, STEAM 2.0 compares travel times and costs under the Base and Improvement Cases for trips from each zone to each other zone. Only zone pairs for which travel times can be determined are included in this calculation. For highway modes (automobile, truck, carpool), STEAM 2.0 includes a network analysis module that can be used to calculate zone-to-zone travel times using special speed-volume relationships developed for STEAM 2.0. Alternatively, the STEAM 2.0 user may wish to provide his or her own matrix of zone to zone travel times and bypass the network analysis module in STEAM 2.0 (if the user provides his own zone-to-zone travel times the user must calculate any external costs and enter them in the non-mileage based external cost variables). For transit modes (local bus, express bus, light rail, and heavy rail), STEAM 2.0 does not have a network analysis capability, so it is assumed the STEAM 2.0 user will provide Base and Improvement Case matrices of zone-to-zone travel times for these modes. For both highway and transit modes, the STEAM 2.0 user can also provide

[1] As noted in Chapter 2, the objective of STEAM 2.0 is to provide an assessment of a package of proposed multi-modal actions. We refer to conditions without the proposed actions as the Base Case and conditions with the proposed actions as the Improvement Case. These are sometimes referred to as the "No-Build" and "Build" alternatives.

Base and Improvement Case matrices of out-of-vehicle (walk, wait) times and out-of-pocket costs (e.g., fares, tolls).

The following exhibit presents a graphic layout of the input files associated with a market sector. As shown in the exhibit, the files are grouped into a "Base Case" and an "Improvement Case" representing conditions before and after the proposed investment.

3.2 Input Files

There are several input files required for a STEAM 2.0 analysis. These include:

- Network Input Files
- Production/Attraction or Trip Table Files
- Zone Information File
- District Definition File
- Other Changes Files (In-Vehicle Time, Out-Vehicle Time, Out-of-Pocket Cost)

The input files are described below:

Network Input File – Contains the road network information that is used in the network analysis module to calculate the minimum travel times and distances for each zone to zone pair. A base and improvement case network file are required for market sectors for which a network analysis is performed.

Network Output File – STEAM 2.0 model stores the minimum travel times and distances for a given network in this file. This information is used later in the benefit-cost estimation. A base and improvement case network output file are necessary for market sectors for which a network analysis is performed.

Zone Information File – Contains zonal-level information needed for the travel time and accessibility analysis and for the aggregation of user benefits by user-defined districts. Each zone number is identified with the corresponding centroid number, and, optionally, its district affiliation, population and employment. Only one centroid file is necessary. This file is used in both the base and improvement cases. All market sectors require this file.

District Definition File - Contains the district number and a qualitative description of the district.

In-Vehicle Travel Time File – One of the three "Other Changes Files" which contains times for in-vehicle travel that are not accounted for in the network analysis. The units are ***hundredths of minutes of travel*** on a zone-to-zone basis. For example, the

entry "135", corresponds to 1.35 minutes. A base and improvement case file is necessary for market sectors for which the user chooses to input other in-vehicle travel time changes.

Out-of-Vehicle Travel Time File – One of the three "Other Changes Files", which contain times for out-of-vehicle or walk and wait travel that are not accounted for in the network analysis. The units are ***hundredths of minutes of travel*** on a zone-to-zone basis. For example, the entry "135", corresponds to 1.35 minutes. A base and improvement case file is necessary for market sectors for which the user chooses to input other out-of-vehicle travel time changes.

Out-of-Pocket Cost File – One of the three "Other Changes Files", which contain out-of-pocket costs that are incurred during a trip. These costs may be items such as tolls or parking charges. The units are cents per trip on a zone-to-zone basis. A base and improvement case file is necessary for market sectors for which the user chooses to input other out-of-pocket cost changes.

Production/Attraction or Trip Table Files – This file contains the market sector trip table that is used to estimate benefits and costs in the analysis. The trip table includes all person trips on a zone-to-zone basis for that market sector during the specified period. A base and improvement case trip table file is required for all market sectors.

Different types of market sectors require different input files depending on what type of analysis is being performed. Generally, the auto, truck, and carpool market sectors use the network analysis to estimate travel times and therefore require network input and output files. Transit market sectors do not have networks to estimate travel times but rely on input travel times through the "Other Changes Files". The following exhibit shows the files used by typical market sectors.

Exhibit 3.1 Typical Market Sector

Input Files	Auto/ Truck	Local Bus/ Exp. Bus	Light Rail/ Heavy Rail
Base Case Network File	X		
Base Case Network Output File	X		
Imp. Case Network File	X		
Imp. Case Network Output File	X		
Zone Information File*	X	X	X
Base Case In-Vehicle Travel Time File		X	X
Imp. Case In-Vehicle Travel Time File		X	X
Base Case Out-of-Vehicle Travel Time File		X	X
Imp. Case Out-of-Vehicle Travel Time File		X	X
Base Case Out-of-Pocket Cost File	**	X	X
Imp. Case Out-of-Pocket Cost File	**	X	X
Base Case Trip Table File*	X	X	X
Imp. Case Trip Table File*	X	X	X
Market Sector Output File*	X	X	X

*Required for all market sectors.
**May be needed if tolls are charged.

3.2.1 Layout of Network Files

Exhibit 3.3 presents the layout of the network files that are used in the network analysis module of STEAM 2.0. The file is a space-delimited ASCII format file with 7 columns, one for each field. No header information is included in the file. Each line represents a link on the network. The fields are described below:

A-Node – The beginning node of a link. The range of permissible values is 1-99,999.

B-Node – The ending node of a link. The range of permissible values is 1-99,999.

Exhibit 3.2 Layout of the Network Files

A-Node	B-Node	Length	FFsp	Capacity	Volume	Class
1	2	0.3	20	350	650	5
1	4	0.4	20	350	735	5
1	5	0.7	50	2100	20323	2
1	7	0.1	40	1000	12235	3
2	1	0.1	20	350	555	5
3	6	1.2	55	3000	22234	1
Continued for the entire network.						

Length – The length in miles from A-Node to B-Node. Length must be greater in value than 0 and less than or equal to 99.

FFSp – The free-flow design speed for a link in mph. Free-flow speed must be greater in value than 0 and less than or equal to 99. *Note that when the "use input free-flow speed option is chosen, this field should contain the loaded highway network speeds from a valid traffic assignment."*

Capacity – The hourly one-way vehicular capacity of a link. Capacity must be a value greater than 0 and less than, or equal to 99,999.

Volume – The 24 hour average weekday traffic (AWDT) on the link. Volume must be a value greater than or equal to 0 and less than or equal to 1,000,000.

Class – The highway class of the link (the model can handle up to six highway classes). (The default assumptions are:

1=Interstates
2=Other freeways and expressways
3=Other principal arterials
4=Minor arterials
5=Collectors
6=local
7=centroid connectors

Class must be coded as a value between 1 and 7. Care must be taken in coding the highway classes, as these are used for assigning the proper speed equation to links in the highway network and for assigning the proper accident rate. Additionally, all links coded with a "7" will not be considered as "through links" in the travel time analysis. ***Non-centroid links coded with 0 capacity will be ignored in the travel time analysis.***

Exhibit 3.3 presents the layout of τηε network files that are used in the network analysis module of STEAM 2.0. The file is an ASCII format file with seven columns, one for each field. No header information is included in the file. Each line represents a link on the network.

3.2.2 Layout of the Zone Information File

Exhibit 3.4 presents the layout of a zone information file which defines the attributes of each zone. Each record contains four columns, each of which is separated by spaces: zone number, and optionally (at a minimum zeros must be provided), district number, population and employment. No header information is included in the file. Each line represents a different zone in the analysis. The fields are described below:

Zone – The zone number used in the analysis.

District – The district number identified with the zone (optional). Districts are used for the zonal aggregation of user benefits and certain demand outputs.

Population - Zonal population for the analysis year (optional). Population is used by the accessibility analysis and to report per-capita user benefits by district.

Employment - Total zonal employment for the analysis year (optional). Employment is used by the accessibility analysis.

If a district-level aggregation of results is not desired, users can simply enter zero in the district field. If no accessibility analysis is desired, zeroes may be entered for the population and employment fields as well.

Exhibit 3.3 Zone Information File Layout

Zone	District	Population	Employment
1	1	345	8
2	1	1558	181
3	16	55	1006
4	16	172	1184
5	2	551	1274
6	2	201	4344
Continued for the entire file			

As is shown in the example above, the zonal information file is sorted by zone.

3.2.3 Layout of District Definition File

The district definition file contains two data items, the district number and the district name, or some other description of the district. A four-zone example is shown below.

Exhibit 3.4 District Definition File Layout

District Number	District Name
2	"District two"
9	"District nine"
12	"District twelve"
11	"District eleven"
14	"District fourteen"

As shown above, the district name should be enclosed in quotes. Comments are allowed in the file; these should appear on a separate line, and be preceded by an exclamation (!) mark.

3.2.4 Layout of Other Changes Files

Exhibit 3.4 presents the layout of the other changes files (in-vehicle travel time file, out-of-vehicle travel time file, and out-of-pocket cost file). Zero value interchanges may be omitted from the file. The files are in ASCII format and are in space-delimited origin/destination/value format. No header information is included in the file. The exhibit below shows the input file for origin zone one and destination zones 1-4. Values for the Other Changes files are expressed in the following units:

- In-vehicle time and out-of-vehicle time are expressed in ***hundredths of a minute***. The value "150" is equal to 1.5 minutes.

- Out-of-pocket costs are expressed in cents. The value "134" is equal to $1.34.

Exhibit 3.5 Layout of Other Changes Files

Origin Zone	Destination Zone	Value
1	2	473
1	3	0
1	4	335
1	5	734

3.2.5 Layout of Production/Attraction or Trip Table Files

Exhibit 3.4 presents the layout of the market sector production/attraction or trip table files. The files are in ASCII format and are in production/attraction/value or origin/destination/value format. Zero value interchanges may be omitted from the file. No header information is included in the file. The exhibit below shows a sample input file for origin zone 1 and destination zones 1-4. Note that STEAM 2.0 evaluates table flows based on person, rather than vehicle trips. Estimates of VMT and VHT are derived from the vehicle occupancy factors entered in the market sector information screen, which is described in Chapter 4.

Exhibit 3.6 Layout of Trip Table Files

Origin Zone	Destination Zone	Value
1	2	553
1	3	300
1	4	34

Note that intrazonal trips are ignored by STEAM 2.0.

3.3 Output files

STEAM 2.0 presents the results of an investment analysis in several different formats organized across different levels of aggregation. These files include:

- Main scenario file (.bsn extension)
- Main scenario Report file (.brp extension)
- Market reports (.mkr, .mkx, mkd extensions)
- District reports (.dkr,.dkx,.mkd extensions)
- Network output files (.ttf extension)
- Excluded zone pairs file (.bsx, .ipx extension)

3.3.1 Main Scenario Report File

The main scenario file (.bsn), is organized around fourteen outcome sections which present improvement case, base case and net results across modes. The report file includes a list of all input parameters, as well as a notification when STEAM 2.0 finds zone pairs that are disconnected or have zero travel times.

The report file is a text file is accessible from the STEAM 2.0 user interface, which invokes the Microsoft program Notepad (or any other compatible text editor program that can be selected under the "Tools/Reporting Options" menu). For best viewing results, the size of the font should be set to eight. For best printing results paper orientation should be set to Landscape. The outcome parameters include:

1. Demand: Person trips, VMT, person trips, IVT, OVT, total travel time;

2. Emissions: Running (HC,CO,NO_x, PM_{10}), Cold Start (HC,CO,NO_x, PM_{10}), Total;

3. Emissions Costs: Running, Cold Start, Total;

4. Greenhouse Gas Emissions: BTU Consumption, CO_2 Emissions, Greenhouse Gas Costs;

5. Accidents: Internal Accidents (Fatalities, Injuries, Property Damage Only, Total) External Accident *Costs*: (Fatalities, Injuries, Property Damage Only, Total);

6. Fuel and Non-fuel Costs: Gallons Consumed, Energy Costs, Non-Fuel Operating Costs;

7. External Costs: Noise Costs, Other Mileage-based External Costs, Non-mileage-Based External Costs, External Costs During Construction;

8. User Benefits: IVT, OVT, Fuel Costs, Non-fuel Operating Costs, Out-of-pocket Costs, Internal Accident Costs, Revenue Transfers;

9. Public Vehicle Operating Costs;

10. Capital Costs: Capital Costs, Salvage Values, Annualized Costs, Other Maintenance Costs, Operating Costs;

11. Summary: User Benefits by Category, Costs to Public Agencies by Category, Net Annual Worth, Benefit-Cost ratio;

12. Scenario Assumptions;

13. Market Sector Definitions; and

14. Risk Analysis Output.

A binary image of the main report file (.brp extension) is created during a STEAM 2.0 analysis. This file is used for secure temporary storage of all input parameters used by STEAM 2.0. This file should not be deleted during a STEAM 2.0 analysis.

3.3.2 Market Report Files

STEAM 2.0 produces three separate reports based on market sectors: 1) spreadsheet-compatible file (.mkx extension); 2) a text-base file (.mkr extension); and 3) database-compatible file (.mkd extension). The market sector files provide results at the regional level organized by market sector.

The spreadsheet-ready market report file (.mkx extension) presents analysis results for each market and mode, and is organized for easy comparison across base and improvement cases. The file may be edited within the spreadsheet application to produce charts, additional summary or cross-tabulation tables. Within each report section, each column presents results for a distinct mode and market sector. Outputs are structured around six sections:

1. Demand: Person trips, VMT, person trips, IVT, OVT, total travel time;

2. Emissions: Running (HC,CO,NO_x, PM_{10}), Cold Start (HC,CO,NO_x, PM_{10}), Total;

3. Benefits: IVT, OVT, non-fuel costs, total benefits, revenue transfers;

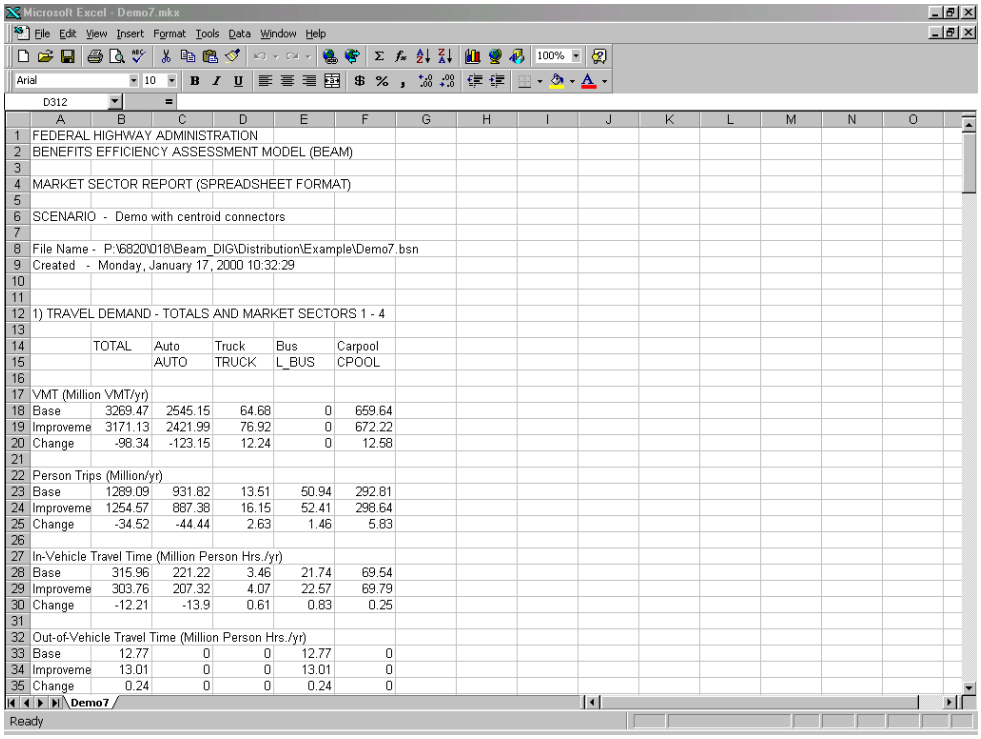
4. Accessibility by travel time intervals: district population to regional jobs and district jobs to regional labor pool;

5. Accessibility by travel time intervals: Percentage of district population to regional jobs and percentage of district jobs to regional labor pool; and

6. Accessibility index: District population to regional jobs and district jobs to regional labor.

Sample output from this file is presented in Exhibit 3.7.

Exhibit 3.7 Spreadsheet-Ready Market Sector Report File



Microsoft Excel - Demo7.mkx

File Edit View Insert Format Tools Data Window Help

	A	B	C	D	E	F
1	FEDERAL HIGHWAY ADMINISTRATION					
2	BENEFITS EFFICIENCY ASSESSMENT MODEL (BEAM)					
3						
4	MARKET SECTOR REPORT (SPREADSHEET FORMAT)					
5						
6	SCENARIO - Demo with centroid connectors					
7						
8	File Name - P:\6820\018\Beam_DIG\Distribution\Example\Demo7.bsn					
9	Created - Monday, January 17, 2000 10:32:29					
10						
11						
12	1) TRAVEL DEMAND - TOTALS AND MARKET SECTORS 1 - 4					
13						
14		TOTAL	Auto	Truck	Bus	Carpool
15			AUTO	TRUCK	L_BUS	CPOOL
16						
17	VMT (Million VMT/yr)					
18	Base	3269.47	2545.15	64.68	0	659.64
19	Improveme	3171.13	2421.99	76.92	0	672.22
20	Change	-98.34	-123.15	12.24	0	12.58
21						
22	Person Trips (Million/yr)					
23	Base	1289.09	931.82	13.51	50.94	292.81
24	Improveme	1254.57	887.38	16.15	52.41	298.64
25	Change	-34.52	-44.44	2.63	1.46	5.83
26						
27	In-Vehicle Travel Time (Million Person Hrs./yr)					
28	Base	315.96	221.22	3.46	21.74	69.54
29	Improveme	303.76	207.32	4.07	22.57	69.79
30	Change	-12.21	-13.9	0.61	0.83	0.25
31						
32	Out-of-Vehicle Travel Time (Million Person Hrs./yr)					
33	Base	12.77	0	0	12.77	0
34	Improveme	13.01	0	0	13.01	0
35	Change	0.24	0	0	0.24	0

Demo7

Ready

The .mkr file is a text file which may be read from any text editor, such as MS Wordpad or MS Notepad. The layout of the file is identical to that of the spreadsheet-ready file. As described in Chapter 4, users may define the number of columns per row of output under the "Tools/Select Text Editor" menu option. Setting the number of columns to fit within the page width will prevent text wrapping. At an eight point font, up to seven columns of output per row can be printed in landscape format without text wrapping.

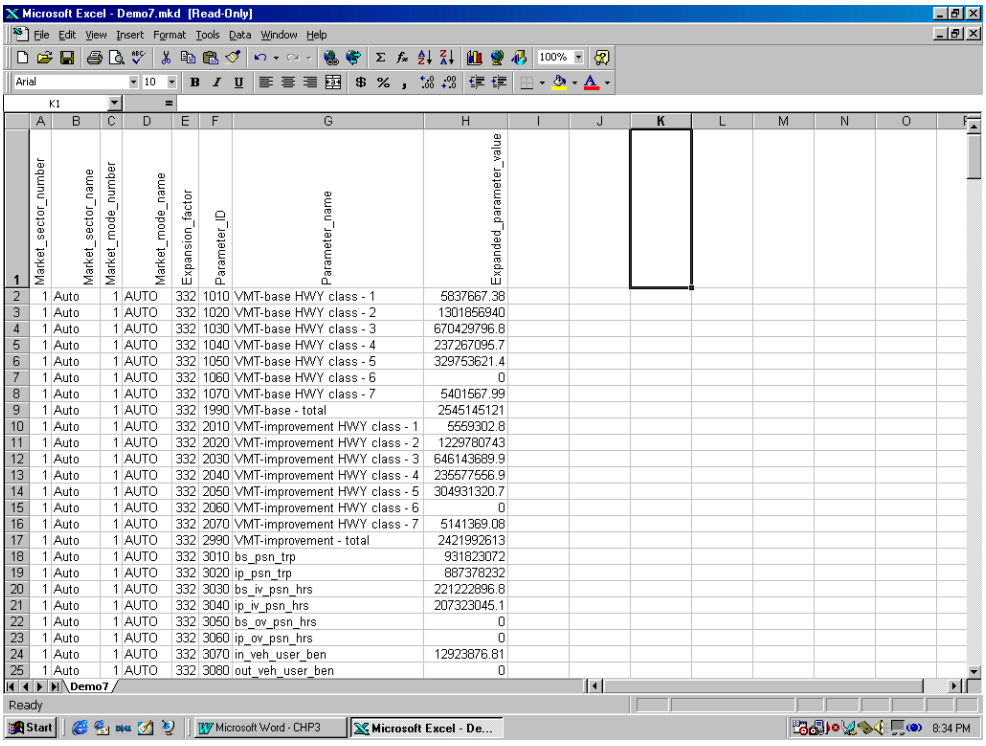
The database-ready market report file (.mkd extension) presents outputs in normalized format, i.e., the rows of each column contain unique information. This allows for easy importation of results into commercial database applications, such as Access, Oracle or FoxPro, and for the development of database queries using the structured query language (SQL). Each output parameter is associated with a market, mode, expansion factor, parameter number, parameter name and parameter value. Exhibit 3.8 presents the output parameters presented in this file.

Exhibit 3.8 Database-Compatible Market Report File Outputs

Demand Outputs	Benefit Outputs	Accessibility Outputs
Productions/Attractions	IVT/OVT	Population to Jobs (by travel time threshold)
Vehicle Miles of Travel	Fuel Cost	Jobs to Labor (by travel time threshold)
Person Miles of Travel	Non-Fuel Costs	Index: Population to Jobs
Person Trips	Total Benefits	Index: Jobs to Labor
IVT/OVT/Total travel time	Revenue Transfers	Total Population
		Total Jobs

Exhibit 3.9 presents a sample of the format of the .mkd file.

Exhibit 3.9 Database-Compatible Market Report File



	A	B	C	D	E	F	G	H
1	Market_sector_number	Market_sector_name	Market_mode_number	Market_mode_name	Expansion_factor	Parameter_ID	Parameter_name	Expanded_parameter_value
2	1	Auto	1	AUTO	332	1010	VMT-base HWY class - 1	5837667.38
3	1	Auto	1	AUTO	332	1020	VMT-base HWY class - 2	1301856940
4	1	Auto	1	AUTO	332	1030	VMT-base HWY class - 3	670429796.8
5	1	Auto	1	AUTO	332	1040	VMT-base HWY class - 4	237267095.7
6	1	Auto	1	AUTO	332	1050	VMT-base HWY class - 5	329753621.4
7	1	Auto	1	AUTO	332	1060	VMT-base HWY class - 6	0
8	1	Auto	1	AUTO	332	1070	VMT-base HWY class - 7	5401567.99
9	1	Auto	1	AUTO	332	1990	VMT-base - total	2545145121
10	1	Auto	1	AUTO	332	2010	VMT-improvement HWY class - 1	5559302.8
11	1	Auto	1	AUTO	332	2020	VMT-improvement HWY class - 2	1229780743
12	1	Auto	1	AUTO	332	2030	VMT-improvement HWY class - 3	646143689.9
13	1	Auto	1	AUTO	332	2040	VMT-improvement HWY class - 4	235577556.9
14	1	Auto	1	AUTO	332	2050	VMT-improvement HWY class - 5	304931320.7
15	1	Auto	1	AUTO	332	2060	VMT-improvement HWY class - 6	0
16	1	Auto	1	AUTO	332	2070	VMT-improvement HWY class - 7	5141369.08
17	1	Auto	1	AUTO	332	2990	VMT-improvement - total	2421992613
18	1	Auto	1	AUTO	332	3010	bs_psn_trp	931823072
19	1	Auto	1	AUTO	332	3020	ip_psn_trp	887378232
20	1	Auto	1	AUTO	332	3030	bs_iv_psn_hrs	221222896.8
21	1	Auto	1	AUTO	332	3040	ip_iv_psn_hrs	207323045.1
22	1	Auto	1	AUTO	332	3050	bs_ov_psn_hrs	0
23	1	Auto	1	AUTO	332	3060	ip_ov_psn_hrs	0
24	1	Auto	1	AUTO	332	3070	in_veh_user_ben	12923876.81
25	1	Auto	1	AUTO	332	3080	out_veh_user_ben	0

3.3.3 District Report Files

A STEAM 2.0 analysis produces three files which organize results by user-defined districts: 1) a text-based file (.dkx extension), 2) a spreadsheet-compatible file (.dkx extension); and 3) a database-compatible file (.dkd extension). Each of these files provide selected results for each district, by market and by mode.

The spreadsheet-ready district report file (.dkx extension) presents analysis results for all districts, markets and modes organized for easy comparison across base and improvement cases. The file may be edited within the spreadsheet application to produce charts or additional summary tables. Within each district section, each column contains results for a distinct mode and market. Outputs are structured around six sections:

1. Demand: Person trips, VMT, person trips, IVT, OVT, total travel time;

2. Benefits: IVT, OVT, non-fuel costs, total benefits, revenue transfers;

3. Accessibility by travel time intervals: district population to regional jobs and district jobs to regional labor pool;

4. Accessibility by travel time intervals: Percentage of district population to regional jobs and percentage district jobs to regional labor pool;

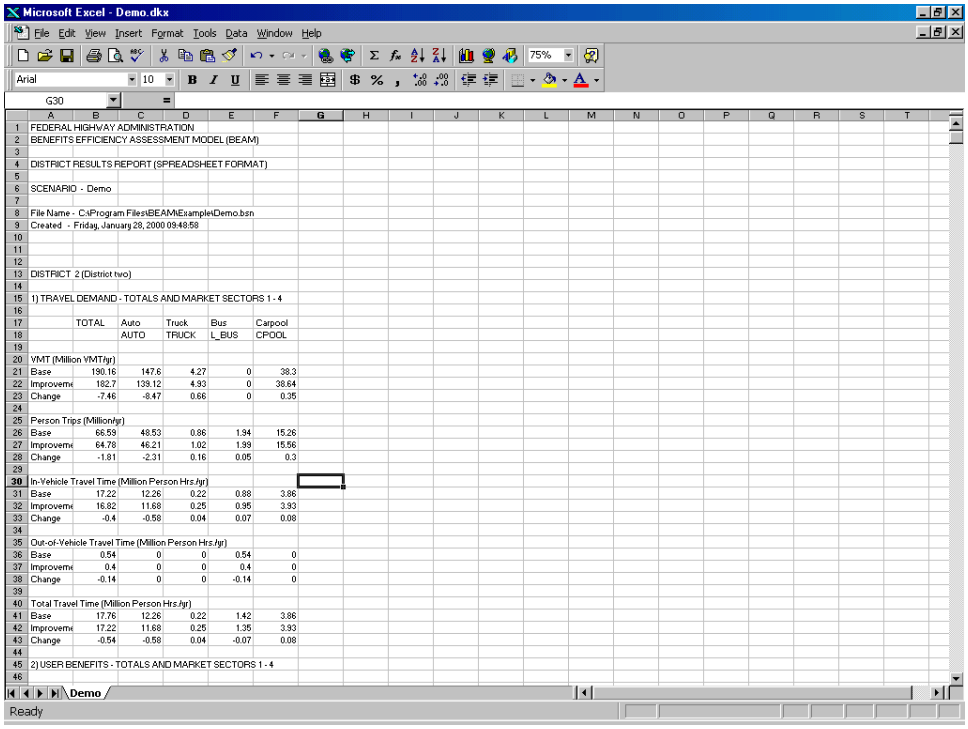
5. Accessibility index: District population to regional jobs and district jobs to regional labor; and

6. Summary: At the end of the file, the summary section reports, for each district, total benefits, percentage of total regional benefits, per capita benefits, change in VMT, VHT, change in PMT (person miles of travel), change in PHT (person hours of travel), change in productions and change in attractions.

Sample output from this file is presented in Exhibit 3.10.

The .dkr file is a textual file which may be read from any text editor, such as MS Wordpad or MS Notepad. The layout of the file is identical to that of the spreadsheet-ready file. When printing output from this file, the text will wrap around to additional rows of output, to accommodate the width of each output row. At an eight point font, up to seven columns of output per row can be printed in landscape format without text wrapping.

Exhibit 3.10 Spreadsheet-Ready District Output File

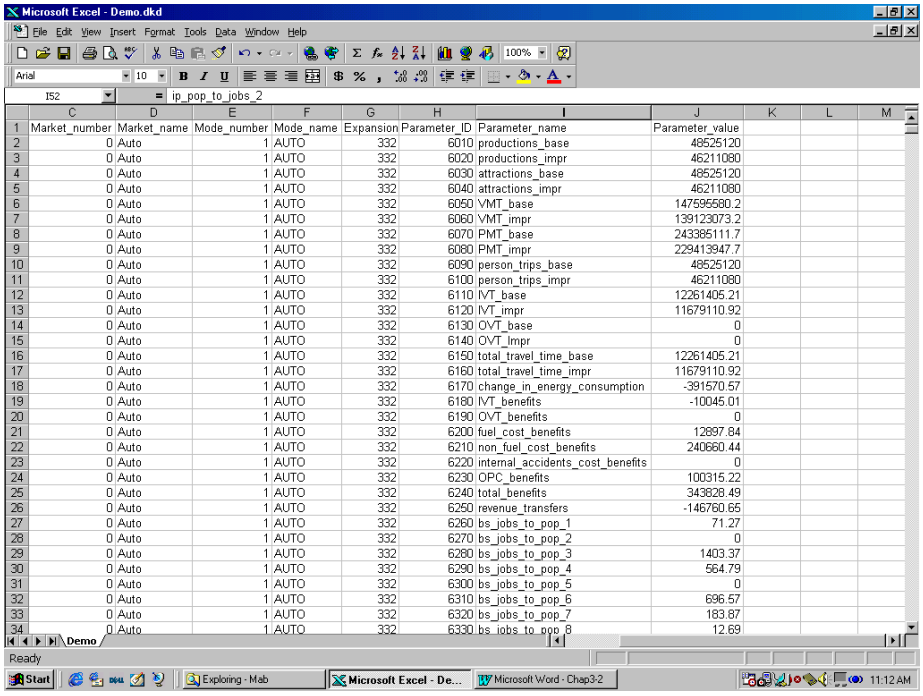


The database-ready district report file (.dkd extension) presents outputs in normalized format, i.e., the columns of each row contain unique information. This allows for easy importation of results into commercial database applications and for the development of database queries using the Structured Query Language (SQL). Each output parameter is associated with a district, market, mode, expansion factor, parameter number, parameter name and parameter value. Exhibit 3.11 below presents the output parameters presented in this file.

Exhibit 3.11 Database-Compatible District Report File Output Parameters

Demand Outputs	Benefit Outputs	Accessibility Outputs
Productions/Attractions	IVT/OVT	Population to Jobs (by travel time threshold)
Vehicle Miles of Travel	Fuel Cost	Jobs to Labor (by travel time threshold)
Person Miles of Travel	Non-Fuel Costs	Index: Population to Jobs
Person Trips	Total Benefits	Index: Jobs to Labor
IVT/OVT/Total travel time	Revenue Transfers	Total Population
		Total Jobs

Exhibit 3.12 Sample of the Format of the .dkd File



Microsoft Excel - Demo.dkd

File Edit View Insert Format Tools Data Window Help

Arial 10 100%

152 = ip_pop_to_jobs_2

	C	D	E	F	G	H	I	J	K	L	M
1	Market_number	Market_name	Mode_number	Mode_name	Expansion	Parameter_ID	Parameter_name	Parameter_value			
2	0	Auto	1	AUTO	332	6010	productions_base	48525120			
3	0	Auto	1	AUTO	332	6020	productions_impr	46211080			
4	0	Auto	1	AUTO	332	6030	attractions_base	48525120			
5	0	Auto	1	AUTO	332	6040	attractions_impr	46211080			
6	0	Auto	1	AUTO	332	6050	VMT_base	147595580.2			
7	0	Auto	1	AUTO	332	6060	VMT_impr	139123073.2			
8	0	Auto	1	AUTO	332	6070	PMT_base	243385111.7			
9	0	Auto	1	AUTO	332	6080	PMT_impr	229413947.7			
10	0	Auto	1	AUTO	332	6090	person_trips_base	48525120			
11	0	Auto	1	AUTO	332	6100	person_trips_impr	46211080			
12	0	Auto	1	AUTO	332	6110	IVT_base	12261405.21			
13	0	Auto	1	AUTO	332	6120	IVT_impr	11679110.92			
14	0	Auto	1	AUTO	332	6130	OVT_base	0			
15	0	Auto	1	AUTO	332	6140	OVT_Impr	0			
16	0	Auto	1	AUTO	332	6150	total_travel_time_base	12261405.21			
17	0	Auto	1	AUTO	332	6160	total_travel_time_impr	11679110.92			
18	0	Auto	1	AUTO	332	6170	change_in_energy_consumption	-391570.57			
19	0	Auto	1	AUTO	332	6180	IVT_benefits	-10045.01			
20	0	Auto	1	AUTO	332	6190	OVT_benefits	0			
21	0	Auto	1	AUTO	332	6200	fuel_cost_benefits	12897.84			
22	0	Auto	1	AUTO	332	6210	non_fuel_cost_benefits	240660.44			
23	0	Auto	1	AUTO	332	6220	internal_accidents_cost_benefits	0			
24	0	Auto	1	AUTO	332	6230	OPC_benefits	100315.22			
25	0	Auto	1	AUTO	332	6240	total_benefits	343828.49			
26	0	Auto	1	AUTO	332	6250	revenue_transfers	-146760.65			
27	0	Auto	1	AUTO	332	6260	bs_jobs_to_pop_1	71.27			
28	0	Auto	1	AUTO	332	6270	bs_jobs_to_pop_2	0			
29	0	Auto	1	AUTO	332	6280	bs_jobs_to_pop_3	1403.37			
30	0	Auto	1	AUTO	332	6290	bs_jobs_to_pop_4	564.79			
31	0	Auto	1	AUTO	332	6300	bs_jobs_to_pop_5	0			
32	0	Auto	1	AUTO	332	6310	bs_jobs_to_pop_6	696.57			
33	0	Auto	1	AUTO	332	6320	bs_jobs_to_pop_7	183.87			
34	0	Auto	1	AUTO	332	6330	bs_jobs_to_pop_8	12.69			

Demo

Ready

Start Exploring - Mab Microsoft Excel - De... Microsoft Word - Chap3-2 11:12 AM

3.4 Network Output Files

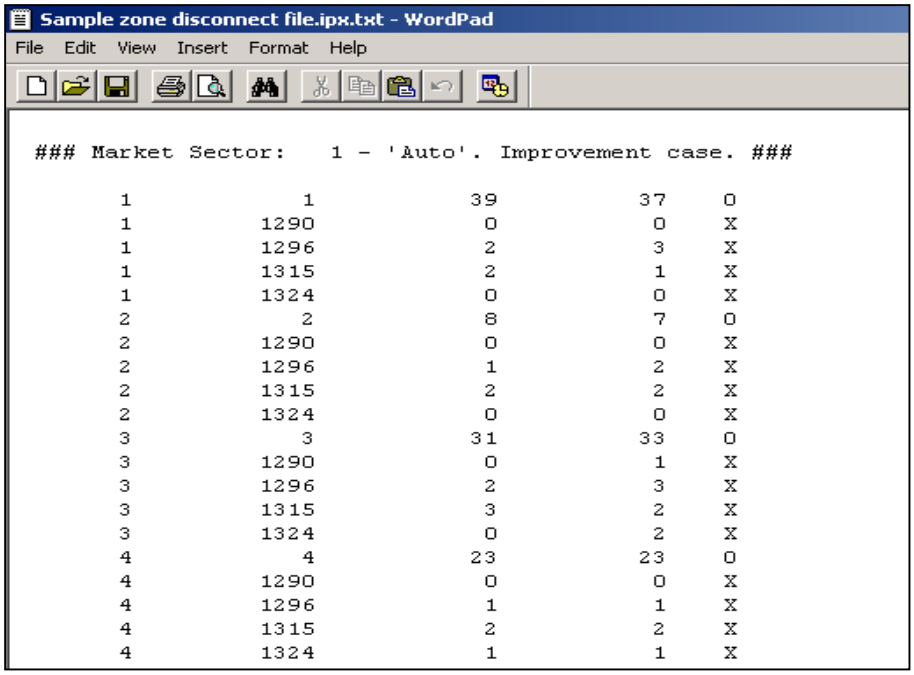
STEAM 2.0 generates network output files (.ttf extension) for storage of zone to zone travel times and distances during a STEAM 2.0 analysis. One each is generated for the base and improvement cases. Once a .ttf file has been generated, it can be used in subsequent analyses by disabling the "Run (base/improvement) Network Analysis" option in the Network and Trip Table File Name screen used to set up a STEAM 2.0 analysis. These files are stored in binary format and cannot be accessed by the user.

3.5 Excluded Zone Pairs File

Zone pairs for which a travel time cannot be determined in either the base case or the improvement case are excluded from the user benefits calculation. For example, STEAM 2.0 cannot calculate shortest time paths between a zone pair on the highway network if all centroid connectors from or to a particular zone are missing. Likewise, STEAM 2.0 will ignore zone pairs for which an in-vehicle time exists only in the base or improvement cases, but not in both cases. This may occur when brand new transit services are being evaluated in the improvement case, for example. User benefits for such cases should be evaluated off-line. STEAM 2.0 produces output files for such off-line evaluation.

Zones excluded from the analysis are reported in the .bsx (base case) and .ipx (improvement case) files. The file contains the origin zone, destination zone, the number of trips in the base and improvement cases and the cause for the exclusion, respectively. The cause for exclusion is denoted by a "0" or an "X", where "0" denotes a zero travel time, while an "X" indicates that no travel time could be determined. This text file can be imported to a spreadsheet application for further analysis. An example of this file format is shown in Figure 3.16 below.

Exhibit 3.13 Sample .ipx/.bsx File Format



4.0 User Interface

This chapter explains the user interface for the STEAM 2.0 software. The program is a windows application that can run under Windows 95, 98, 2000 or NT. The areas covered in this section include:

- Installing STEAM 2.0 software
- STEAM 2.0 program screen
- Creating, loading, and saving scenarios
- Defining market sectors
- Defining districts
- Developing an accessibility analysis
- Changing parameter values
- Specifying improvement costs
- Transit service changes
- Setting Risk Analysis Ranges
- Checking Input Data Files
- Estimating run time
- Performing investment analysis
- Viewing Output results
- Viewing Risk Analysis Results

4.1 Installing STEAM 2.0 Software

STEAM 2.0 has an installation program that installs the proper files on a user's hard drive in order to run the program. The install package is a regular Windows Install-Shield program that is used in the majority of Windows software and is familiar to most Windows users. Close all other programs before beginning the installation process in order to avoid any conflicts with shared files. STEAM 2.0 Release Version 1.0 will only run under Windows 95, 98, 2000 or NT operating systems.

To run the install program, the user executes the "Setup" command from Windows which loads the setup program and prompts the user for specific information. Initially, the setup

program prompts the user to select a directory for the STEAM 2.0 program with a default directory "C:/Program Files/STEAM 2.0 ". Exhibit 4.1 shows the screen displayed for the STEAM 2.0 setup. By selecting the setup button the install package copies the necessary program files into the proper directory and the necessary common files into the Windows (WinNT) directory.

Exhibit 4.1 Install Screen for STEAM 2.0 Setup

To run the STEAM 2.0 program, run the "STEAM 2.0.exe" file from the Windows Explorer.

4.2 STEAM 2.0 Program Screen

Exhibit 4.2 presents the STEAM 2.0 program screen which the user works with to run a benefit/cost analysis. The main screen is divided into two panes: an tree navigation pane (on the left) and a display window (on the right). The user will make a selection from the tree navigator by clicking or double-clicking a specific item which will activate the display window to present information for that selection. The contents of the tree navigator are changed by making a selection from the "Edit Menu" option.

The program screen has six main menu categories: File, Edit, Run, Results, Tools and Help. Exhibit 4.3 shows the full structure of the menu options under the categories. A brief description of each of the options is provided below.

File/New – Creates a new scenario to run the STEAM 2.0 analysis and sets the input parameters to the default values.

Exhibit 4.2 STEAM 2.0 Program Screen

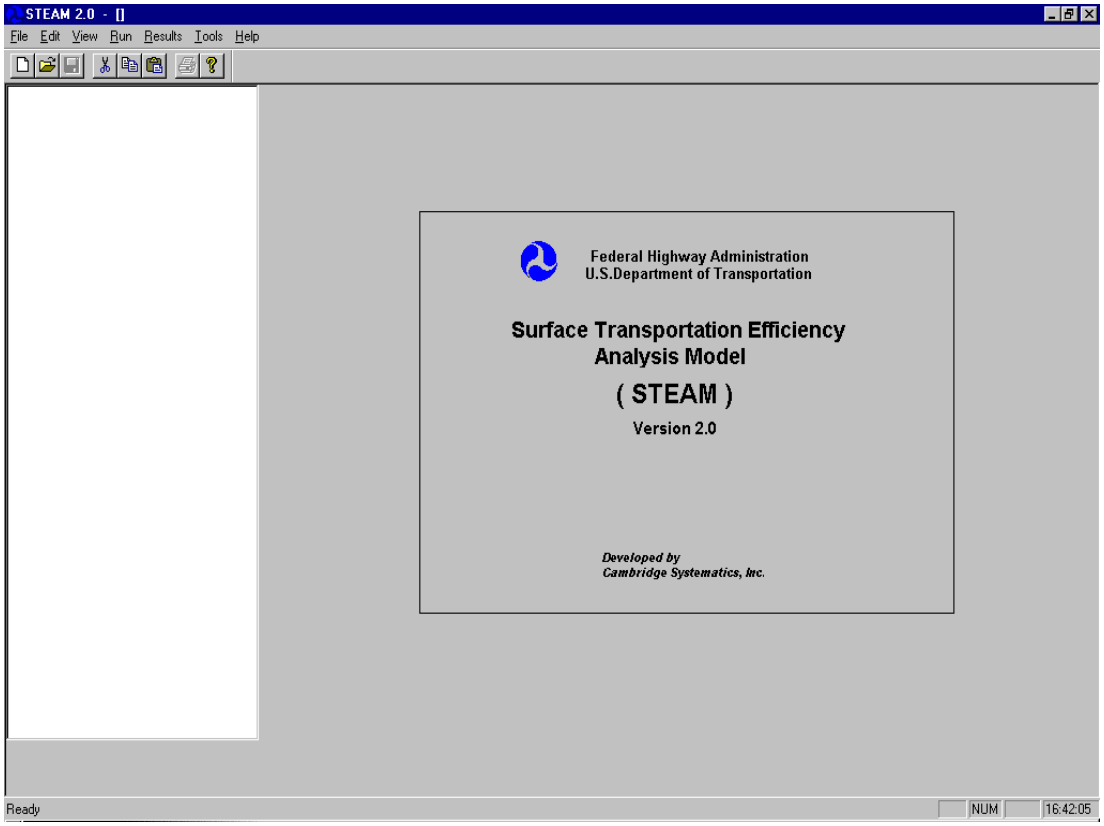
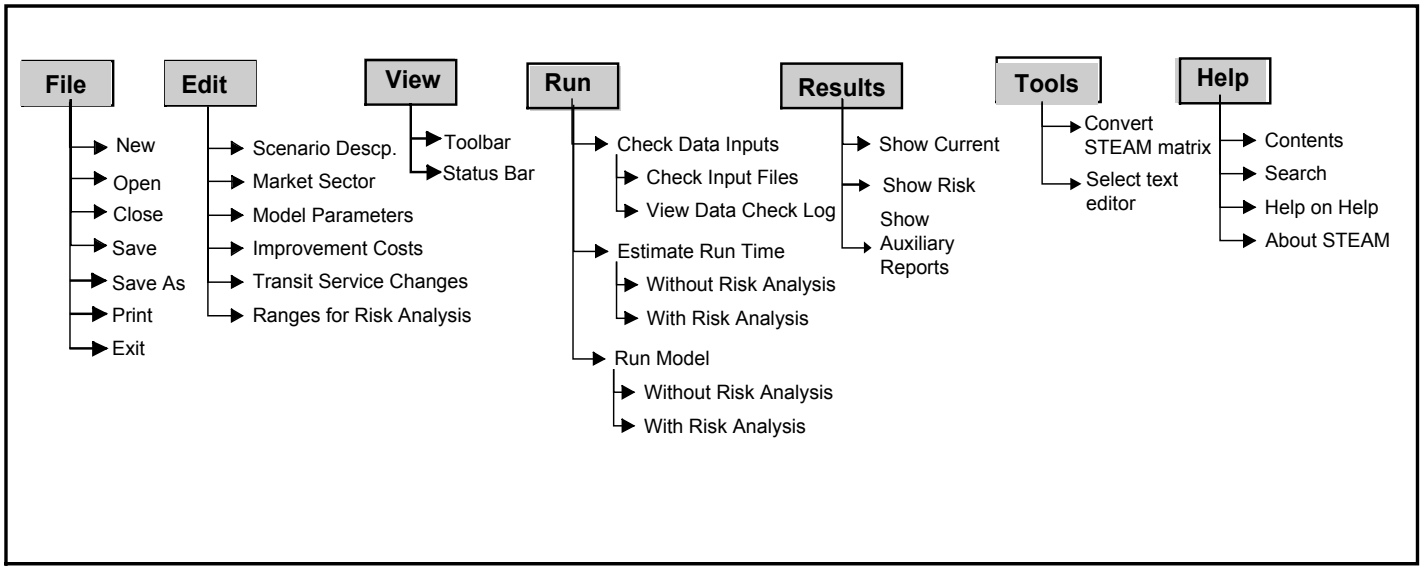


Exhibit 4.3 STEAM 2.0 Menu Structure



File/New – Creates a new workplace, with default parameter settings, from which to create a new transportation analysis.

File/Open – Displays the "File Open" dialog box to load an existing scenario file that was created earlier and allows the user to update information or run the analysis. STEAM 2.0 is backwards-compatible with STEAM scenario (.scn) files. Once loaded, the scenario file must be updated and saved with the updated matrix formats and with the district/accessibility parameter settings correctly specified.

File/Close-- Closes the file.

File/Save – Displays the "File Save" dialog box that saves the current scenario information to a file that can be loaded and used at a later time.

File/Save As – Displays the "File Save As" dialog box and saves the current scenario information under the new file name specified.

File/Print – Prints the scenario report which contains the scenario output, input parameter assumptions, and market sector definitions.

File/Exit – Closes the application.

Edit/Scenario Description and Districts – Displays the screen to input a descriptive title for the current analysis scenario, and prompts user to provide the name of the District definition file.

Edit/Market Sector – Displays a "Market Sector" dialog box which list the existing market sectors in the current scenario and allows the user to add a new market sector, delete a market sector, modify a market sector, or cancel any action.

Edit/Model Parameters – Changes the information displayed in the tree navigator to a list of model parameters that can be selected and changed by the user.

Edit/Improvement Costs – Changes the information displayed in the tree navigator to a list of improvement cost categories that STEAM 2.0 users can select to input the improvement costs being analyzed in the scenario.

Edit/Transit Service Changes – Changes the information displayed in the tree navigator to a list of transit service changes that can be input by the user as a result of the proposed improvements.

Edit/Ranges for Risk Analysis – Changes the information displayed in the tree navigator to a list of variables for which risk analysis ranges can be set by the user.

View/Toolbar – Displays standard Microsoft editing toolbar.

View/Status Bar – Displays standard Microsoft status bar at the bottom of the screen.

Run/Check Data Inputs/Check Input Files – This menu item runs the routine that checks data input files for proper format and valid ranges. The output of the data checking routine is stored in the "Data Check Log" which can be viewed in the menu selection described below.

Run/Check Data Input – This menu item displays the most recent results of the "Check Input Files" routine. Any errors in file formats or in valid ranges will be displayed.

Run/Estimate Run Time/Without Risk Analysis – This menu item estimates the run time necessary to perform the benefit/cost analysis without the risk analysis procedure, based on the market sector information contained in the current scenario. A dialog box is displayed that presents the time estimation. *STEAM 2.0 uses performance benchmarks derived from previous STEAM 2.0 analyses to generate time-to-completion estimates. Therefore the time estimates from the first few STEAM 2.0 analyses are unreliable and should be ignored.*

Run/Estimate Run Time/With Risk Analysis – This menu item estimates the run time necessary to perform the benefit-cost analysis with the risk analysis procedure based on the market sector information contained in the current. A dialog box is displayed that presents the time estimation.

Run/Run Model- Presents a choice of two sub-options: Run Model With Risk Analysis and Run Model Without Risk Analysis.

Run/Run Model/Run Model With Risk Analysis – Runs the risk analysis module with the market sectors and model parameters specified in the current scenario and risk parameters' variation ranges specified by the user.

Run/Run Model/Run Model Without Risk Analysis – Runs the benefit-cost analysis with the market sectors and model parameters specified in the current scenario.

Results/Show Results of Current Scenario – Displays the results contained in the output file specified for the current scenario.

Results/Show Risk Analysis Results – Changes the information displayed in the tree navigator to a list risk analysis output variables that the user can select to view the probability ranges for the scenario.

Results/Show Auxiliary Analysis Results – Presents results of district-level analysis and results by market sector These results are presented in text, spreadsheet-compatible and database-compatible formats.

Tools/Convert STEAM 1.0 Files to STEAM 2.0 – Invokes menu for a utility that converts matrices in STEAM 1.0 "square" format to origin-destination-value format.

Tools/Reporting Options – Invokes menu for users to select a text editor and spreadsheet program for viewing STEAM 2.0 outputs.

Help/Contents – Displays the "Contents" window of the STEAM 2.0 help file.

Help/Search – Displays the "Help Search" window that allows the user to search the STEAM 2.0 help file for specific terms.

Help/Help on Help – Displays the "Using Help" window that provides guidance in using Windows help programs.

Help/About STEAM 2.0 – Displays the information about the program

4.3 Creating, Loading, and Saving Scenarios

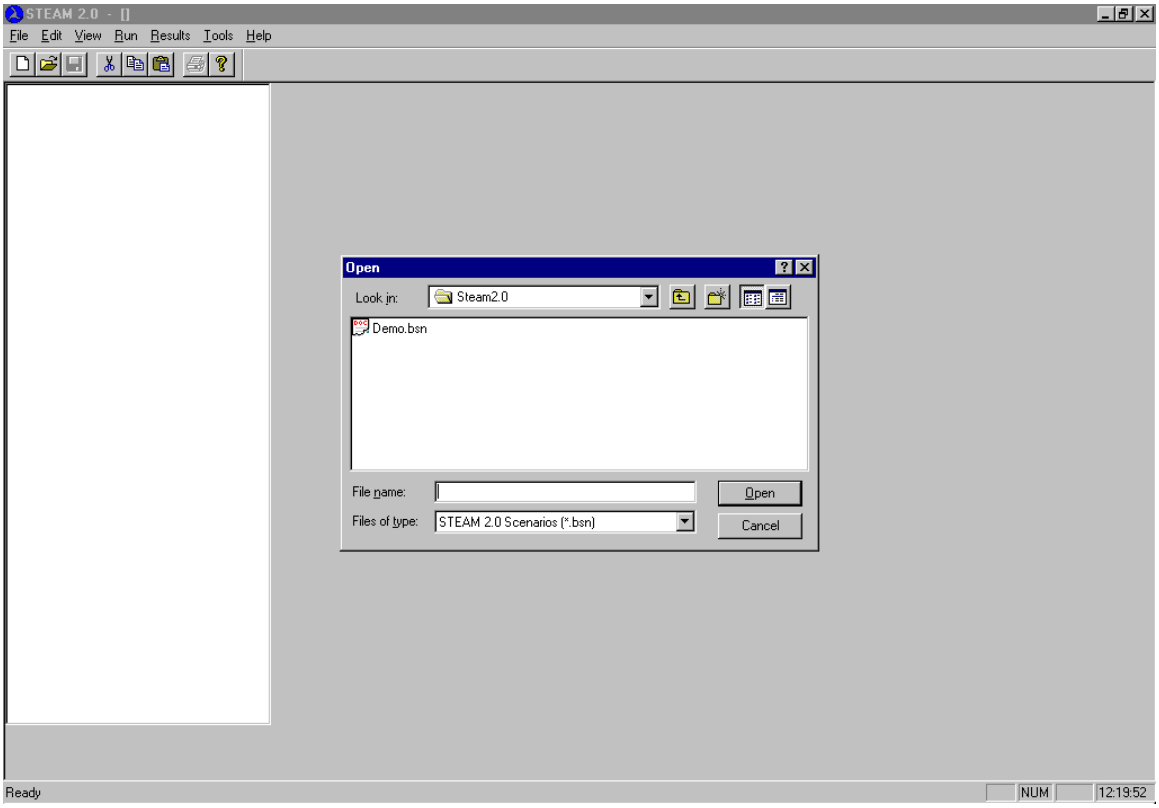
STEAM 2.0 uses the term "scenario" to define the benefit/cost analysis of a given set of transportation system improvements. Users may decide to change specific assumptions and therefore would want to create a different scenario to perform a second analysis. STEAM 2.0 allows users to create multiple scenarios that can be saved, loaded, and run at later times without going through the entire process of defining market sectors and adjusting model parameters.

The assumptions, output, and input file locations for each scenario are stored in a scenario file. Under the "File" menu, the "New", "Open", "Save", and "Save As" options allow the user to create, load, save, and save the scenario under a different file name. These options

work the same as similar options in other Windows programs. Standard Windows "Open File" dialog boxes allow the user to locate files in specific directories. Exhibit 4.4 shows the dialog box that is displayed when one of the options is selected.

The default scenario file extension is ".bsn". However, the file can be saved using any extension that the user chooses.

Exhibit 4.4 STEAM 2.0 File Dialog Box



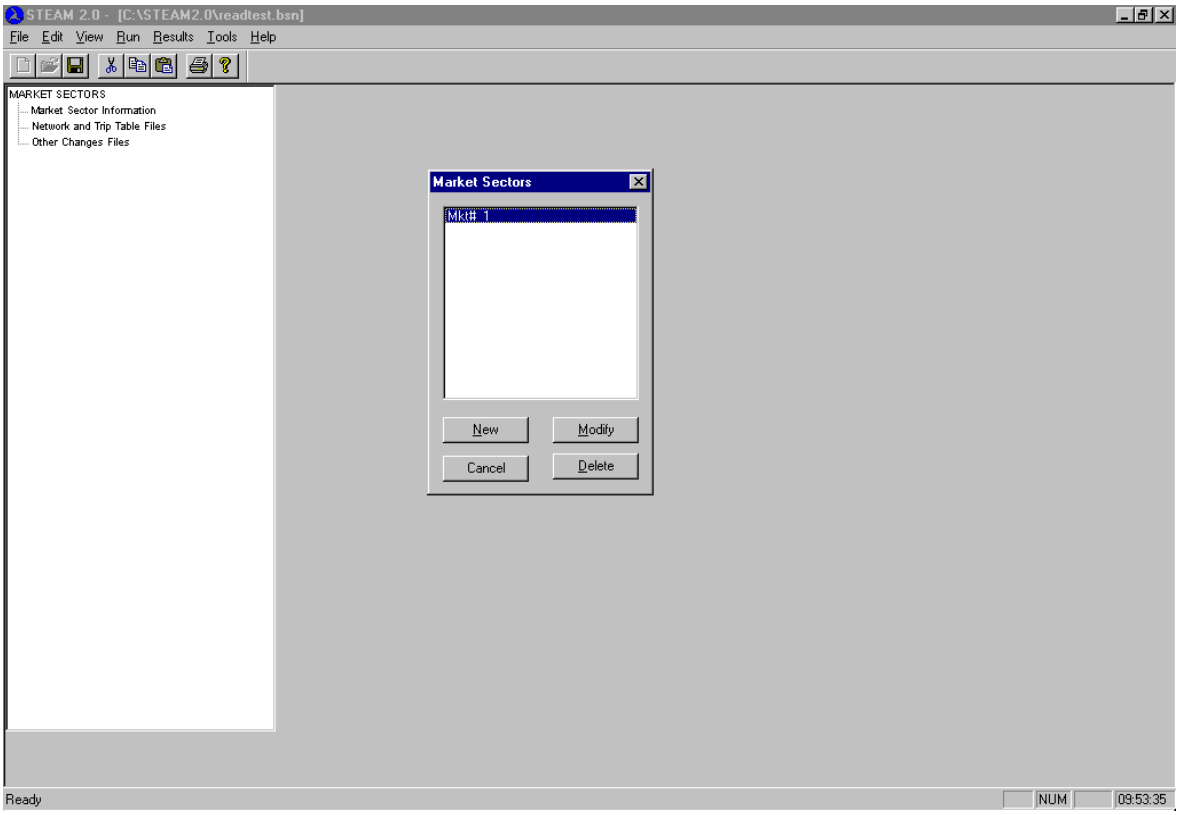
4.4 Defining Market Sectors

STEAM 2.0 analyzes investment decisions by examining individual market sectors that represent portions of the transportation demand on the network. The travel demand can be divided into any number of market sectors and can be divided by mode, trip purpose, or time of day depending on the output of the travel demand model.

Initially, a new market sector is defined by selecting the "Market Sector" option under the "Edit" menu. A market sector dialog box is displayed and lists the existing market sectors in the current scenario. The dialog box allows the user to add a new market sector, delete an existing market sector, modify an existing market sector, or cancel without any action. The maximum number of market sectors that can be used in one scenario is 200.

The market sector dialog box is shown in Exhibit 4.5.

Exhibit 4.5 Market Sector Dialog Box



Once a market sector is added to the scenario, select one of the three branches in the tree navigator: "Market Sector Information", "Market Sector File Names", or "Market Sector Other Changes Files" which will display the market sector input screens displayed in Exhibits 4.6, 4.7, and 4.8. These screens are used to input information about the market sector in order to run the investment analysis.

The "Market Sector Information" screen allows the user to name the market sector, specify vehicle occupancy and expansion factor, and select mode of transportation and speed relationship. Each input variable is defined below:

Market Sector Name. The market sector name is used simply to keep track of individual market sectors and can be up to 28 characters.

Vehicle Occupancy. The vehicle occupancy is the average number of people per vehicle and is used to estimate the number of vehicle trips for a given market sector based on the market sector person trip tables. Separate occupancies can be provided for the Base Case and the Improvement Case.

Expansion Factor. The expansion factor is used to expand the trip tables to an annual value. A market sector that represents daily work trips may have an expansion factor of 250 to represent all work days for a given year.

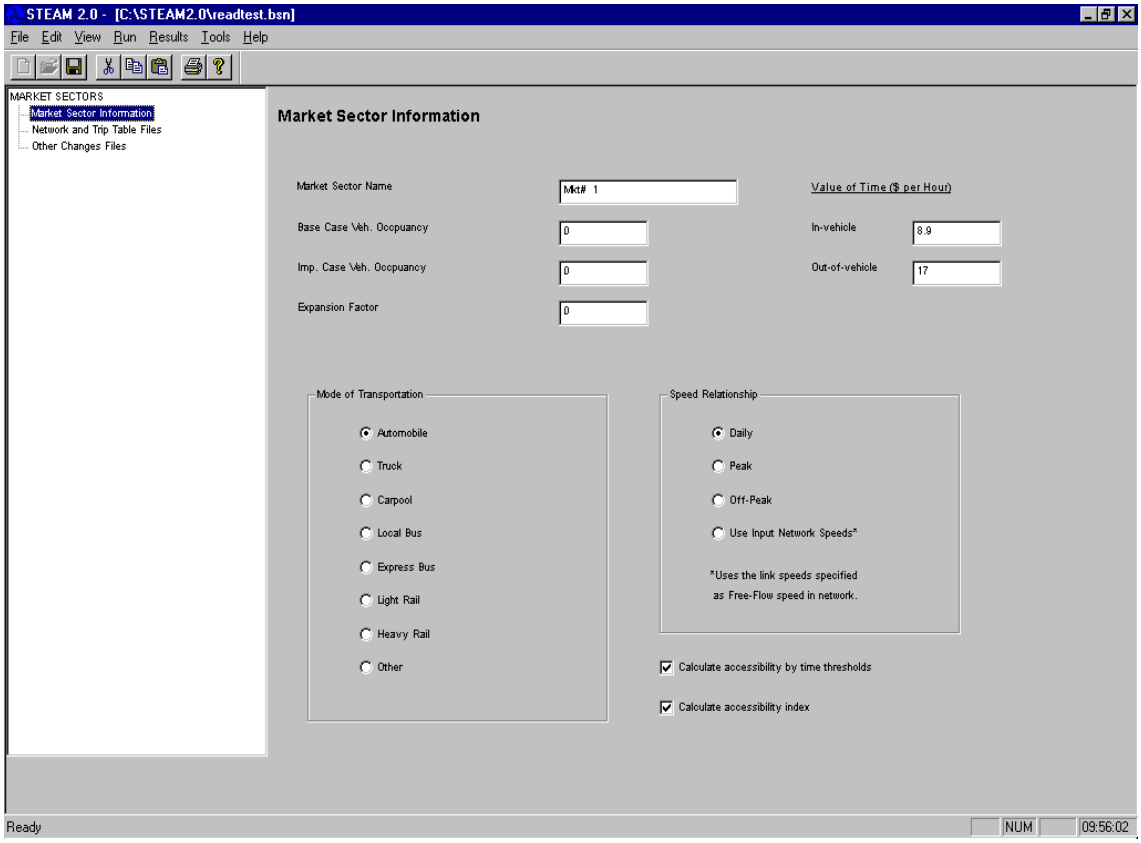
Mode of Transportation. This input option allows the user to select one of eight mode choices that include: auto, truck, carpool, local bus, express bus, light rail, heavy rail, and other. Modes that are not currently defined such as bicycle or walking can be put in the "other" category.

Speed Relationship. Allows the user to select from four speed relationships as a function of AWDT/C (average weekday daily traffic/capacity). The four speed relationship choices are Daily, Peak, Off-peak, and the coded speeds in the free-flow speed field.

Value of time. STEAM 2.0 uses the in-vehicle and out-of-vehicle value of time to calculate user benefits for each market sector. The default values for the mode chosen appear in the text box.

Calculate Accessibility Check Boxes. Selecting the "Calculate Accessibility by Time Thresholds" and/or the "Calculate Accessibility Index" Option enables one or both accessibility analyses. Note that the accessibility thresholds are set in the "model parameters" screen, under "accessibility and aggregation parameters". The dispersion parameter for the accessibility index calculation may be set in this model parameter screen as well.

Exhibit 4.6 Market Sector Information Screen



The "Market Sector File Names" screen allows the user identify the input file locations for the current market sector, determine whether or not to run the network analysis, and whether or not to use travel time estimations. Three check boxes are located at the top of the screen which allow the user to run base or improvement network analysis (if these boxes are not selected the user cannot input file names for the network input files). The "Ignore Network Travel Time Analysis" check box specifies that the market sector will not use any travel time estimation for calculating benefits. This option is generally used for transit market sectors that do not have existing networks to estimate travel times (if this option is selected, the network input and output files become inactive).

Users also may provide a factor to convert trips in production and attraction format to origin/destination format. This feature is used with the district-level reporting feature. Users wishing to report benefits to resident trip-makers should select the aggregation by origin district feature under the model parameters menu. If resident home-based work trips is the market sector chosen for aggregation to districts, then trips should be expressed in P/A format and the appropriate factor applied. Users wishing to aggregate results by destination district should select the aggregation by destination option under the model parameters menu. If the aggregation by destination should consider benefits to non-resident trip makers only, then trips should be expressed in P/A format and the appropriate factor applied as well.

An explanation of each of the files and options is provided below:

Run Network/Don't Run Network Option. This option allows the user to select whether or not to run the network analysis. Once a network analysis has been performed on a particular network, there is no need to re-run it unless changes to the network have been made. STEAM 2.0 will run significantly faster if the network analysis is not re-run for the same network.

Network Input File. This input box provides the location of the network file. The format of the file is described in the "Input File" section of this report. The default name extension for this file is '.nwk'.

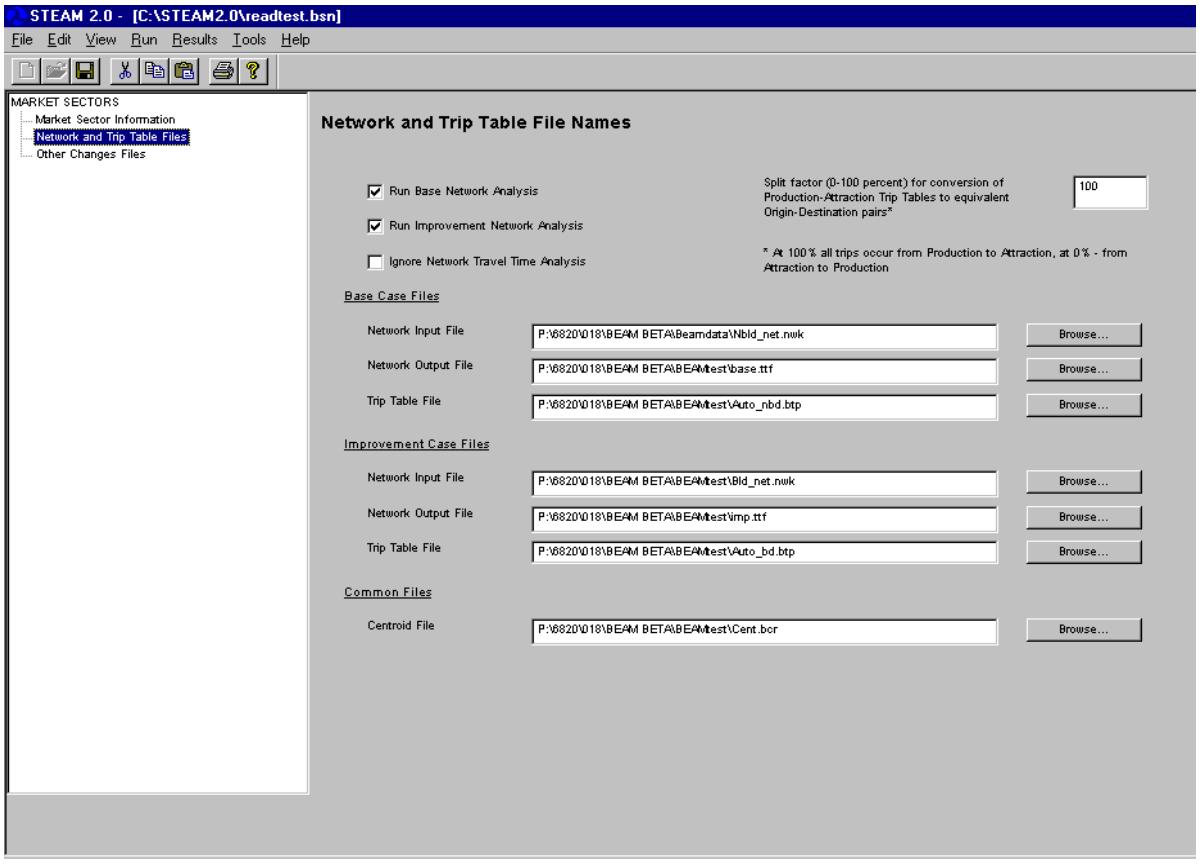
Output File. This input box provides the location of the network output file which is used later in the Trip Table analysis for estimating travel time benefits. This file is an intermediate binary file that is only used by the STEAM 2.0 program. The default name extension for this file is '.ttf'.

Trip Table File. This input box provides the location of the travel demand file. These files are used in estimating benefits and costs occurring on a particular network. The format of the travel demand file is described in the "Input File" section of this report. The default extension for this file is '.btp'.

Zonal Information (Centroid)File. This input box provides the location of the zonal information file which contains information on the zones specified for the travel time analysis. Each zone is identified with the corresponding node location. Optionally, the district number, and population and employment may accompany the centroid number on each record. A zonal information file is necessary for each market sector and it is used in both the base and improvement cases. All market sectors require this file. The default name extension for the centroid file is '.bcr'.

Production/Attraction factor. STEAM 2.0 uses the P/A factor to convert a travel demand file in production/attraction format to origin/destination format. This allows STEAM 2.0 to report district-level results for resident trip makers. STEAM 2.0 applies the percentage entered to the P/A interchange, in order to create an origin/destination interchange. The balance of the P/A interchange (100- the percentage entered) is transposed to create trips from the destination to the origin. Both types of trips are attributed to the district of origin. If the P/A factor is set at 100%, the table is treated as an origin/destination trip table, i.e., no changes to the trip interchanges are made.

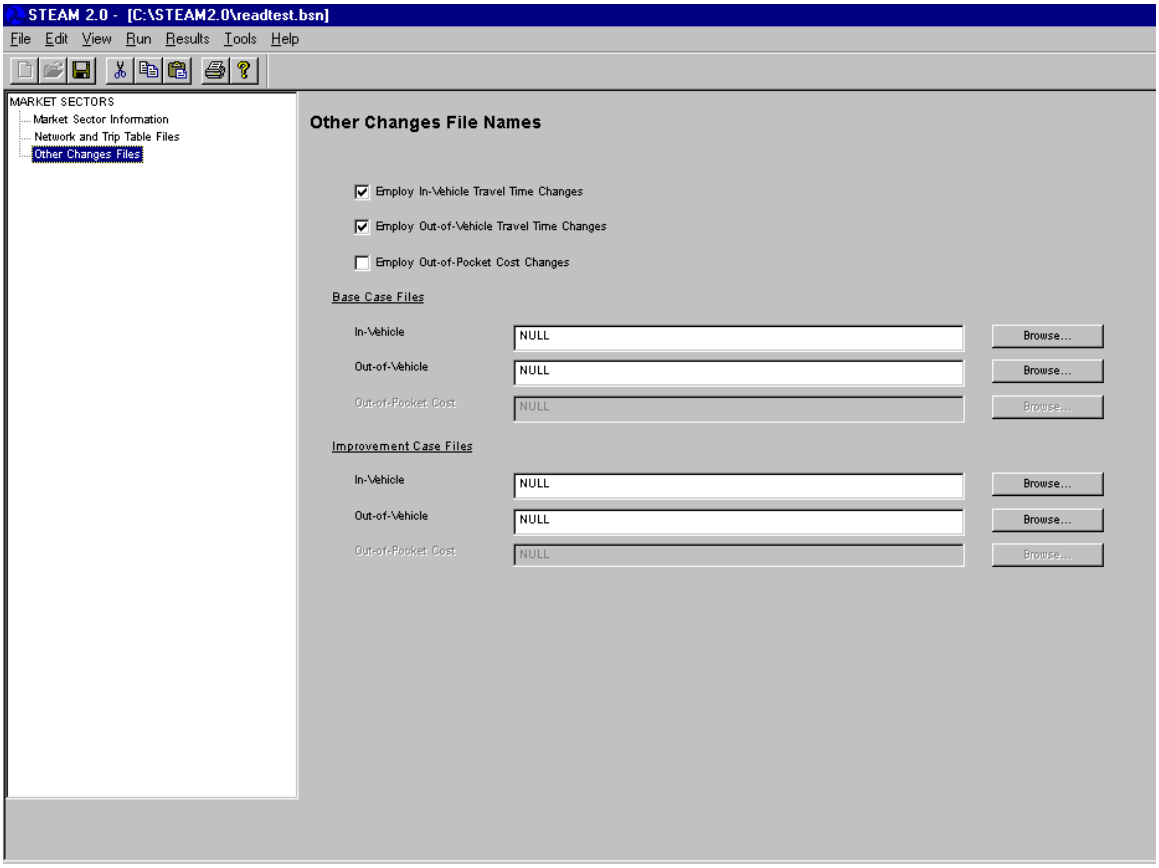
Exhibit 4.7 Market Sector File Locations



The "Other Changes File Names" allows the user identify in-vehicle and out-of-vehicle travel time matrices for transit, or other modes whose travel times cannot be skimmed by STEAM 2.0 from the highway network file. This screen also allows users to input out--of-pocket cost matrices for fares, parking costs and other O/D-based costs. Once the user selects the check box corresponding to the time/cost matrix desired, the Base Case and Improvement Case file dialog boxes are enabled, and the user can identify the name and location of the appropriate input files. The format for these files is described in Chapter 3.

When evaluating transit user benefits (costs), services that provide transit connectivity between zones in the base case and not the improvement case (or vice-versa) should be treated with care. Some analysts prefer to fill zero-value interchanges for time or cost with a value reflecting an average or low level of transit service for the corridor or district in question.

Exhibit 4.8 Market Sector Other Changes Files



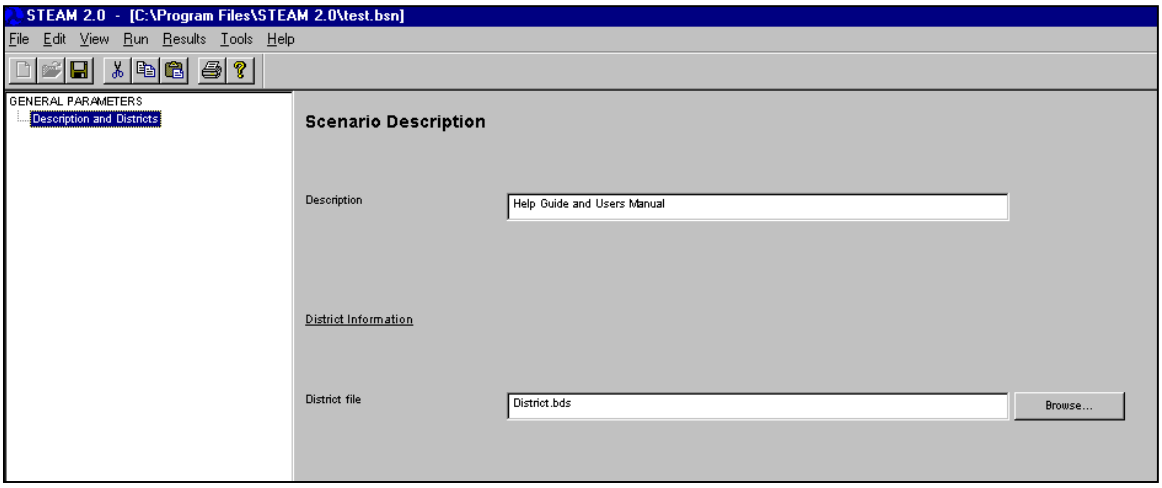
4.5 Defining Districts

STEAM 2.0 reports transportation user impacts for the region and by user-defined districts. These districts are aggregations of traffic zones, and may correspond to county, census tract or other boundaries describing regional sub-markets.

The user-defined districts are defined in two files: the zonal information file and the district file. If the user wishes to report results by district, the zonal information file must contain the district number corresponding to each traffic analysis zone in the second field of each record (See Chapter 3). Each traffic zone can be assigned to at most one district. If no district-level reporting is desired, then only the traffic zone (centroid number) itself is required in the zonal information file. Users also associate a district number with a name (for example, 100 "South County") in the district file. Users assign the district file to the scenario through the "Edit Scenario/Description and Districts" menu option.

Scenario results are reported by district in a district report. This report is accessed through the "Results/Show Current District Results" menu option.

Figure 4.9 Selecting a District File



4.6 Developing an Accessibility Analysis

STEAM 2.0 provides users with the option of evaluating regional accessibility resulting from transportation investments. Accessibility is a measure of proximity between people and places, measured over a transportation system. It can be used in STEAM 2.0 to assess the effectiveness of alternative transportation investments in increasing employment, shopping or other opportunities for geographic (and/or demographic) .submarkets within the region.

An accessibility analysis requires data on population and employment for each zone and a definition of the aggregations of zones, or districts used. The zonal population and employment data are stored in the zonal information file. The districts, which are aggregations of traffic zones such as counties or census tracts, are also defined in the zonal information file. Unique names may be given each district; this information is stored in a separate file, the district file, as described above.

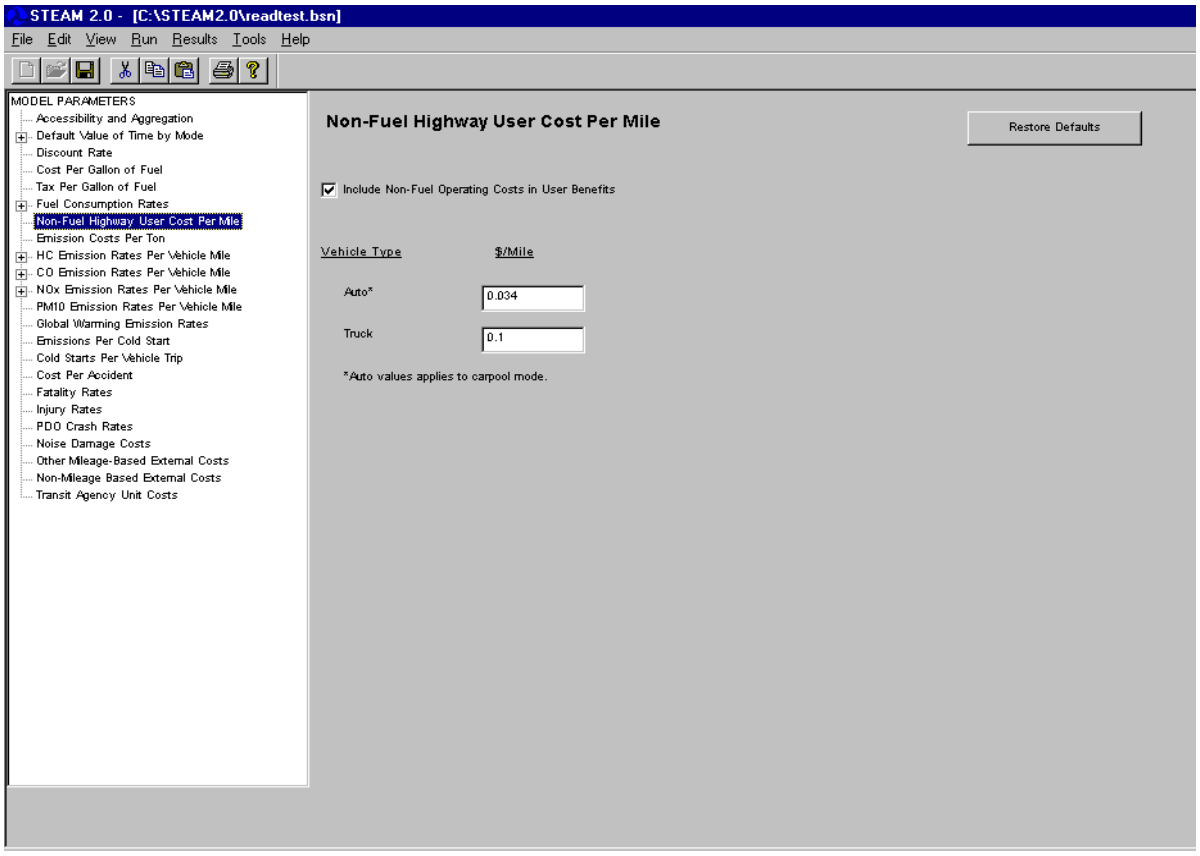
The accessibility analysis reports the number and percentage of regional jobs or persons within a certain time threshold of each district. Users may set up to seven travel time thresholds for the accessibility analysis in the "Edit/Model Parameters" .menu option. Results may be viewed under "Results/Show Current District Results" menu option. STEAM 2.0 also develops an accessibility index, a single figure summarizing results over the entire region.

4.7 Changing Parameter Values

The STEAM 2.0 benefit/cost analysis uses a number of different parameters such as value of time, emission rates, and accident costs to perform the investment analysis. The program has default values for these input parameters; however, users may wish to change the input values to reflect a specific location or situation. All parameter values can be changed by the user, and are saved in the scenario input file.

To change input parameter values, the user must first select the "Model Parameters" option from the "Edit" menu. This changes the information in the tree navigator and displays a list of parameter names as shown in Exhibit 4.10. The user needs to click or double click a particular item from the tree navigator to show the parameter information in the display window. In Exhibit 4.10, the "Non-Fuel Highway Cost" parameter has been selected, displaying the Auto and Truck values. The user can change these values by overwriting the existing value. New values are saved when the scenario file is saved.

Exhibit 4.10 Model Parameters (Non-Fuel Highway Cost)



A restore default button is provided in the top right corner of the display window which will restore the parameters on the current screen to their default values. A list of the

model parameters is provided below. Descriptions of selected parameters and the source for their default values are provided in Appendix A: Glossary of Terms.

Model Parameters

- Accessibility and Aggregation
- Default Value of Time (by transportation mode)
- In-Vehicle (auto, truck, carpool, local bus, express bus, light rail, heavy rail, and other)
- Out-of-Vehicle (auto, truck, carpool, local bus, express bus, light rail, heavy rail, and other)
- Discount Rate
- Cost Per Gallon of Fuel (auto, truck)
- Tax Per Gallon of Fuel (auto, truck, carpool)
- Fuel Consumption Rates
- Auto and Truck Rates (13 MPH categories)
- Transit (local bus, express bus, light rail, heavy rail)
- Non-Fuel Highway User Costs Per Vehicle Mile (auto, truck)
- Emission Costs Per Ton (HC, CO, NOx, PM10)
- HC Emission Rates Per Vehicle Mile
- Auto and Truck Rates (13 MPH categories)
- Transit (bus, rail)
- CO Emission Rates Per Vehicle Mile
- Auto and Truck Rates (13 MPH categories)
- Transit (bus, rail)
- NOx Emission Rates Per Vehicle Mile
- Auto and Truck Rates (13 MPH categories)
- Transit (bus, rail)
- PM10 Emission Rates Per Vehicle Mile
- Auto and Truck Rates (13 MPH categories)
- Transit (bus, rail)
- Cost Per Accident (internal and external fatality, injury, and property-damage-only)
- Emissions Per Cold Start (auto and truck HC, CO, NOx, PM10)

- Cold Start Per Vehicle Trip (auto, truck)
- Fatal Accident Rates (auto and truck by highway class, bus, rail)
- Injury Accident Rates (auto and truck by highway class, bus, rail)
- Property-Damage-Only Accident Rates (auto and truck by highway class, bus, rail)
- Noise Damage Costs (auto and truck by highway class, bus, rail)
- Other Mileage Based External Costs (auto and truck by highway class, bus, rail)
- Non-Mileage Based External Costs
- Transit Agency Unit Costs ($/vehicle mile, $/vehicle hour, $/peak vehicle)

Users may set the value of time in two separate locations within STEAM 2.0: 1) in the market sector information screen and; 2) in the model parameter screen. These settings serve separate functions. The settings in the parameter screen set the market and mode-specific in-vehicle and out-of-vehicle values which appear as defaults in the market sector information screen. The values set in market sector screen are the values actually used by STEAM 2.0 in the analysis.

Users set the accessibility thresholds, dispersion parameter and the orientation of district aggregation through the accessibility and aggregation parameter screen. Up to eight travel time thresholds may be set by the user for the accessibility analysis. The dispersion parameter, used for calculating the accessibility index, specifies the sensitivity of the index to congestion and longer-distance trips. Higher values indicate a greater sensitivity to higher travel times.

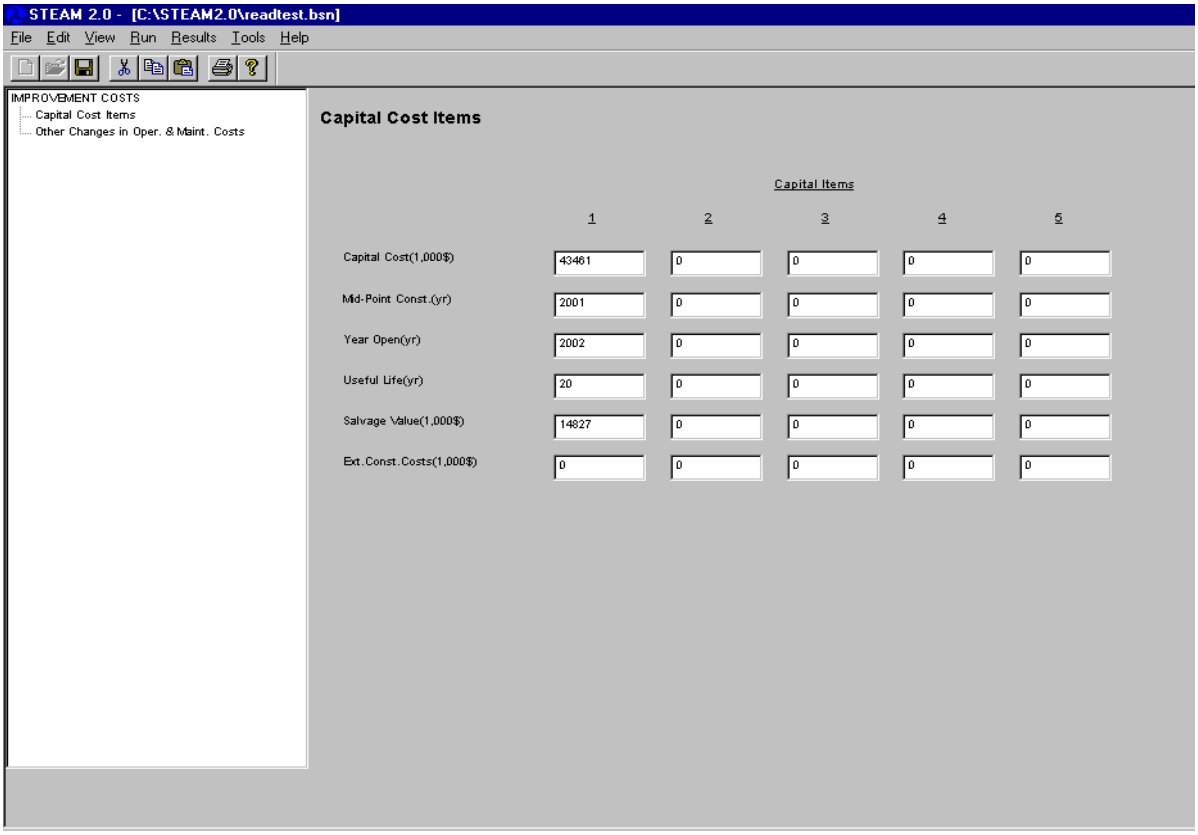
Examples of non-mileage based external costs include noise, travel delay, and fugitive dust during construction. Also, the STEAM 2.0 user can use the parameters for other mileage-based external costs to account other external costs.

4.8 Specifying Improvement Costs

Capital cost values are necessary in calculating a benefit-cost ratio for the proposed improvements. The user enters the capital costs, the midpoint of construction, year of opening, useful life, and salvage value for all improvements being analyzed. ***Net costs, the costs of the improvement case over and above those of the base case, should be entered as capital costs.*** STEAM 2.0 allows each scenario up to 5 different capital investments.

To enter improvement cost information, the user must select the "Improvement Cost" option from the "Edit" menu. The user then selects "Capital Cost Items" from the tree navigator. Exhibit 4.10 shows the Improvement Cost screen which is used to enter the capital cost information.

Exhibit 4.11 Improvement Cost Screen



The following information is entered for up to five items:

Capital Costs. This is the full cost of the capital improvement, which includes any engineering studies, right-of-way acquisition and all construction expenditures. For multiyear projects, capital costs include all expenditures made from start to completion. This variable is in dollars.

Midpoint of Construction. This is the year that falls in the mid point of the construction period. For single year construction projects the midpoint of construction would be the same as the year of opening.

Year of Opening. This is the year that the improvement project is planned to be completed and opened for use.

Useful Life. Useful life is the estimated number of years that a project can be used without requiring major reconstruction of the facility.

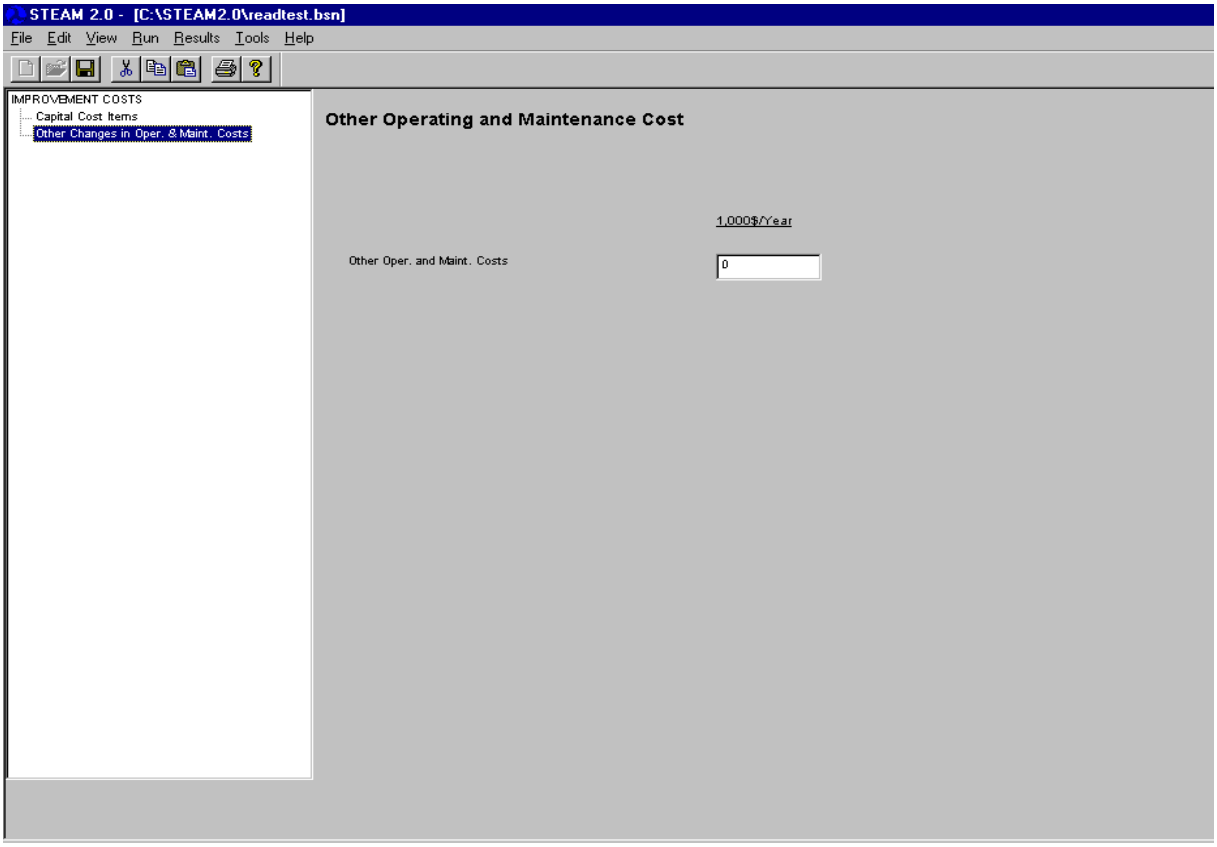
Salvage Value. This is the remaining value of the investment at the end of its useful life.

External Cost of Construction. The external costs to transportation users or non-users that occur as a result of the construction process.

If no capital cost items are specified in the scenario, a benefit analysis is performed that estimates the benefit or costs to highway and transit users.

Other changes in operating and maintenance costs are specified in the second capital cost item screen displayed in Exhibit 4.11. These costs would represent the annual cost of operating and maintaining a new highway if the improvement was to construct a new highway.

Exhibit 4.12 Other Operating and Maintenance Cost Screen



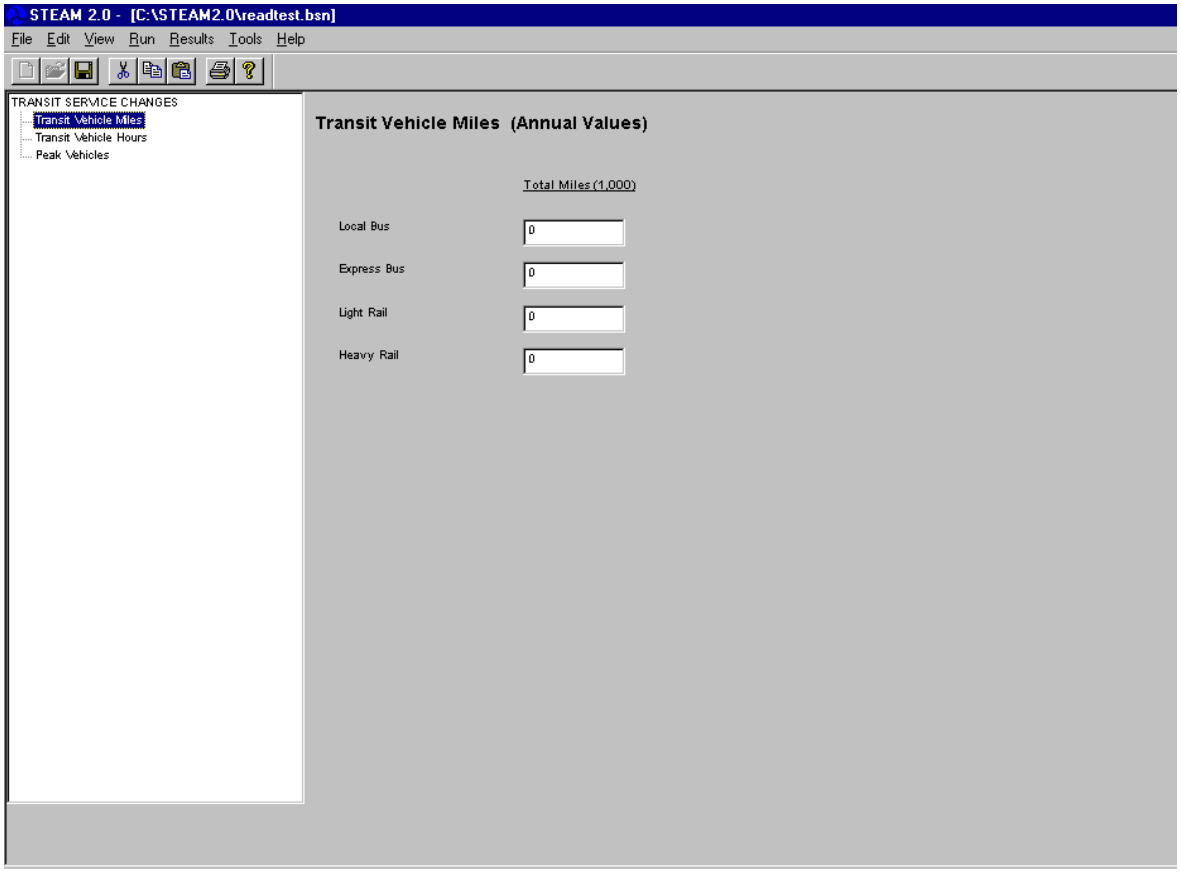
4.9 Transit Service Changes

The STEAM 2.0 benefit-cost analysis allows the user to input transit service changes estimated by the user in order to calculate changes in transit costs. There are three types of transit service changes that can be specified: Transit VMT, Transit Vehicle Hours, and Transit Peak Vehicles. Exhibit 4.12 shows one of the three screens to enter the transit service changes.

To display the transit service changes screens, the user needs to select the "Transit Service Changes" option from the "Edit" menu and then select either "Transit Vehicle Miles", "Transit Vehicle Hours", or "Peak Vehicles" from the tree navigator.

All three transit service changes (vehicle miles, vehicle hours, and peak vehicles) can be specified by the user but the changes and the costs associated with the changes must be additive because all three costs will be included in the analysis.

Exhibit 4.13 Transit Service Changes



Transit service changes are entered in miles, hours, and vehicles. A description of the three service changes is provided below:

Transit Vehicle Miles. The total annual change in transit vehicle miles that occurs as a result of the highway or transit improvement.

Transit Vehicle Hours. The total annual change in transit vehicle hours that occurs as a result of the highway or transit improvement.

Peak Vehicles. The average change in transit peak vehicles that occurs as a result of the highway or transit improvement.

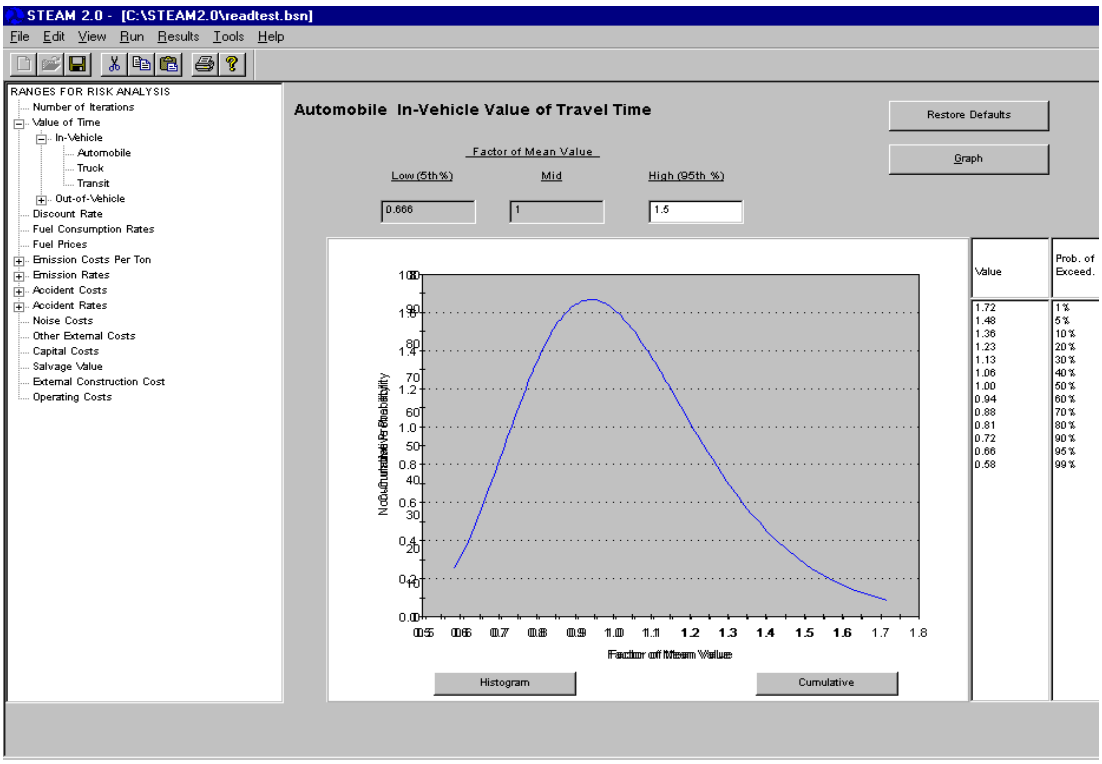
4.10 Defining Risk Analysis Input Ranges

To run the risk analysis procedure on the investment scenario, the user must define ranges for input variables. The input value ranges determine the high and low points for the input variable and the shape of the distribution curve between the high and low points. A log-normal distribution is used to determine the shape of the curve for all input variables.

In order to set the risk analysis input ranges, the user must select "Ranges for Risk Analysis" option under the "Edit" menu. This will display a list of input variables that risk ranges can be specified in the tree navigator. By selecting one of the input variables the risk input screen is created in the display window.

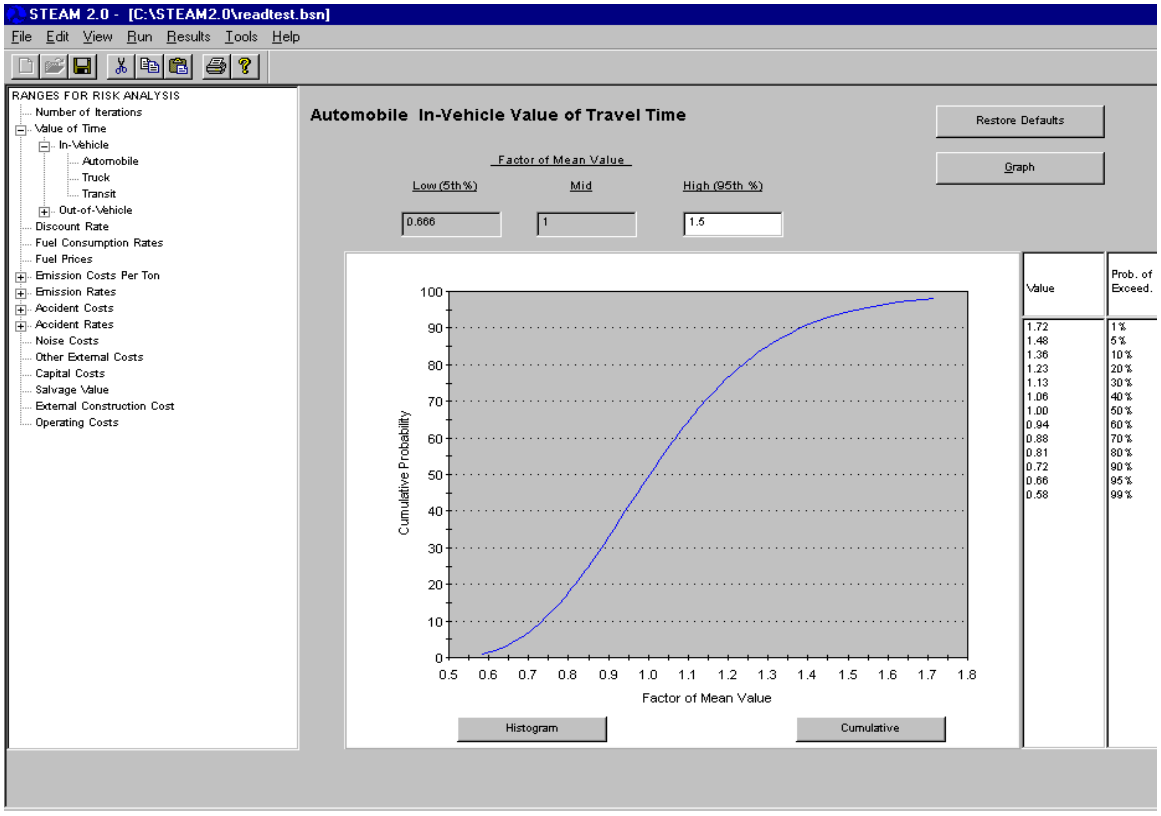
Exhibit 4.13 shows the Input Variable Risk Analysis screen. The user can enter the high value for the input variable. Most of the input variables use a risk factor which is a factor applied to all of the input variables in that category. An example is the HC emission rates. A factor of 2.5 means that the high value for all HC emission rates is 2.5 times the average values specified in the Model Parameter screens. This is applied to all 13 HC emission rates by speed increment. The low value is calculated by the program based on the log-normal distribution and the high and mid points.

Exhibit 4.14 Defining Risk Analysis Ranges



To graph the curve of the distribution of the input values, the user must select the "Graph" button. Similar to other input screens, a "Restore Defaults" button is provided that resets the input variable risk range to the default values. In addition, at the bottom of the screen are "Non-Cumulative" and "Cumulative" buttons which change the graph from a histogram to a cumulative probability distribution curve. The cumulative probability distribution curve is shown in Exhibit 4.14.

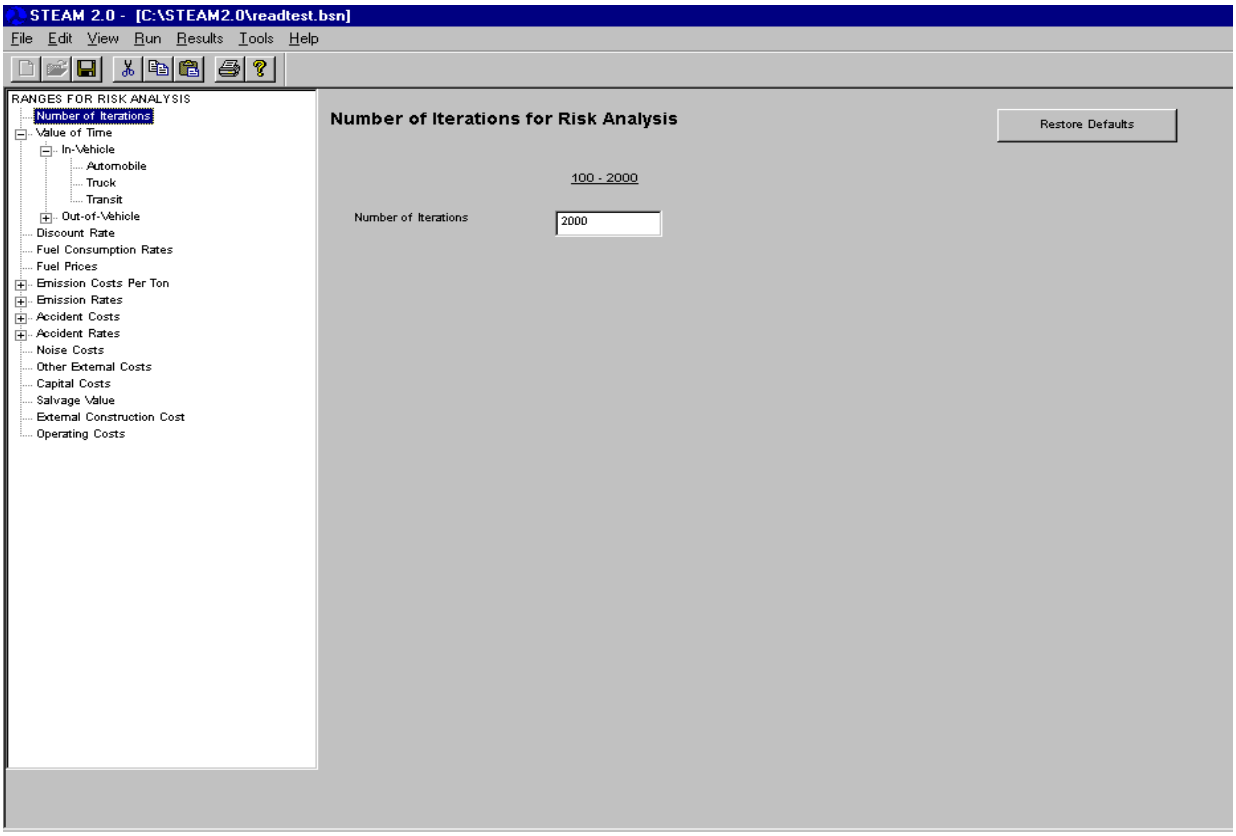
Exhibit 4.15 Cumulative Distribution Curve for Risk Analysis Ranges



Finally, the number of iterations the risk analysis procedure runs must be specified. The "Number of Iterations" is the number of times that the analysis cycles through the benefit cost estimation using different input values determined by the probability curves and a Monte-Carlo simulation.

To set the number of iterations for risk analysis, the user must select "Number of Iterations" in the tree navigator. Exhibit 4.15 shows the screen for changing the iteration value. Risk analysis iterations can be set from 100 - 2000 with the default value at 2000.

Exhibit 4.16 Number of Iterations for Risk Analysis



4.11 Checking Input Data Files

STEAM 2.0's data checking routine identifies out-of-range values and formatting errors that will prevent STEAM 2.0 from executing successfully. In order to run the data checking utility, the user must first create or load the scenario (.bsn) file with the all the market sectors and input files specified. Once the scenario file is completed, the user can run the data checking utility by selecting the "Check Data Input Files" sub-option under "Check Data Input Files" option of the "Run" menu. The data checking utility may take a minute or two depending on the number of market sectors specified.

Once the data checking utility has been run, the result log can be viewed by selecting the "View Data Check Log (for most recent data check)" sub-option under the "Check Data Input Files" option in the "Run" menu. The log is for the most recent run of the data check which will be overwritten when another data check is performed. Exhibit 4.16 shows a sample data check log for a scenario that was specified correctly, with all the input files are in the proper format. Exhibit 4.17 presents a sample data check log showing the error messages that occur when the network file is not in the correct format.

Exhibit 4.17 Viewing Data Check Log

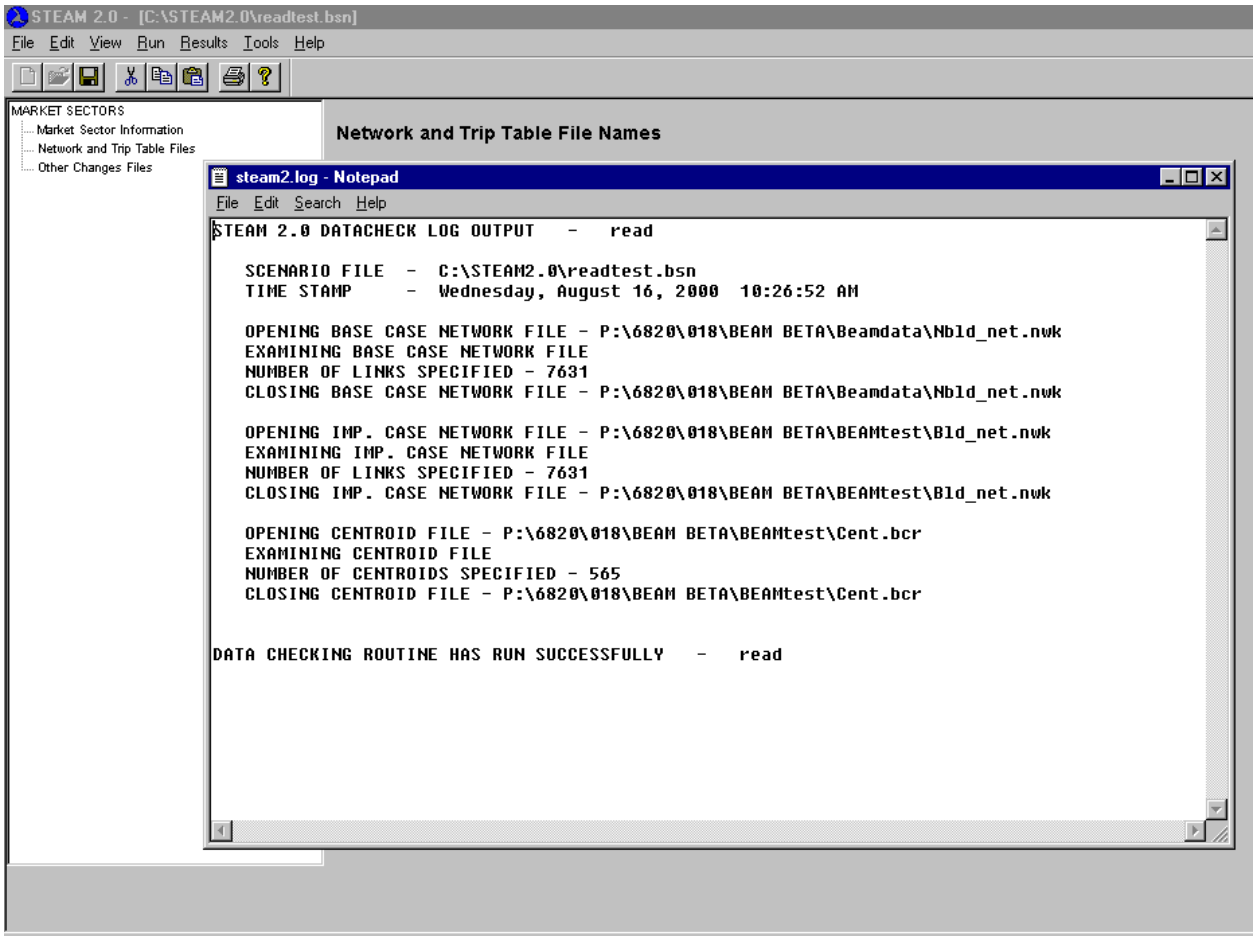
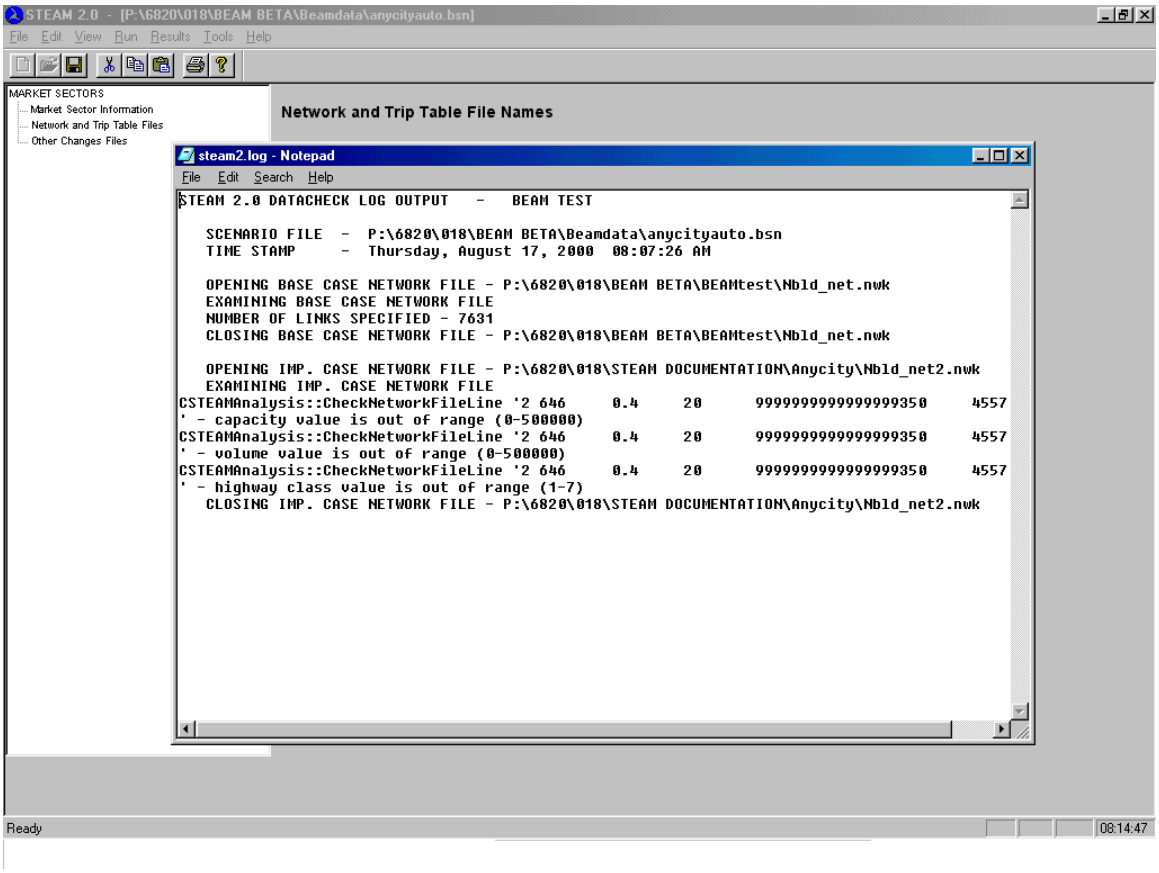


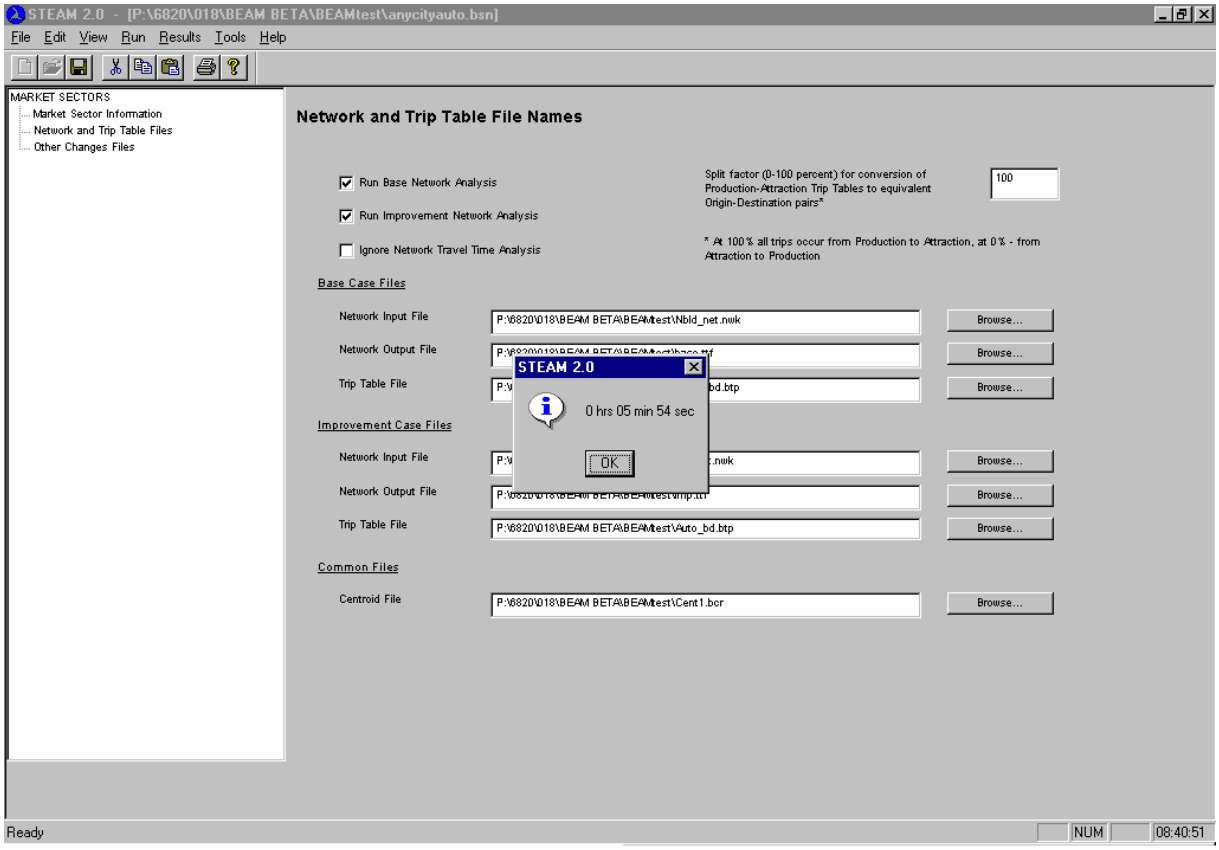
Exhibit 4.18 Viewing Data Check Log with Error Message



4.12 Estimating Run Time

To estimate run time, a scenario must first be defined and saved with all the markets sectors included. Once this has been done, select "Estimate Run Time" from the "Edit" menu. Chose either "Estimate Run Time Without Risk Analysis" or "Estimate Run Time With Risk Analysis" depending on which analysis is desired. STEAM 2.0 calculates run time based on the number of market sectors centroids, links and the speed of the computer. In order to obtain reliable benchmarks of the computer speed the user is advised to run a small demo scenario with the risk analysis option. Computer speed benchmarks will be permanently saved by the system and then applied to all other scenarios that the user will create. Exhibit 4.18 shows the message box reporting the run time estimation.

Exhibit 4.19 Estimating Run Time



Network travel time estimations are the most time consuming process in the benefit-cost analysis. If the user is re-running a scenario that does not change previous travel time estimations or if you have market sectors that use the same networks, there is no need to run the network travel time estimations. Skipping travel time estimation will significantly reduce the model run time.

4.13 Performing An Investment Analysis

To perform an investment analysis, the user must first define the scenario with all the market sectors included and adjust any parameter values that may apply to the run. The scenario file needs to be named prior to running the analysis.

Once the scenario has been properly defined, the user begins the analysis by selecting the "Run Model" option under the "Run" menu item. The user then selects the "Run Model Without Risk Analysis" sub-option, or the "Run Model With Risk Analysis" option. Exhibit 4.19 shows the status screen displayed when the program is running.

Exhibit 4.20 Running STEAM 2.0 Analysis

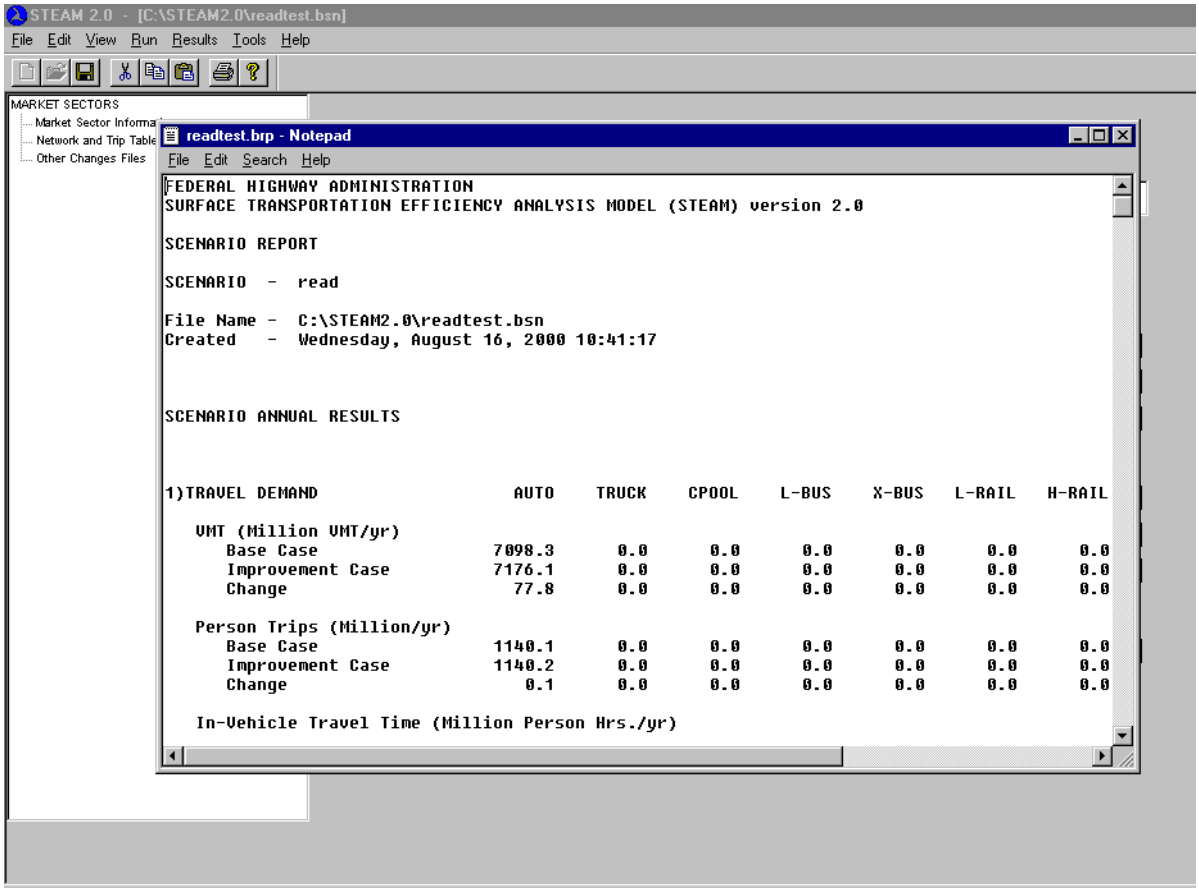
The analysis can be stopped by selecting the "Cancel" button on progress screen. The area on the upper left-hand corner of the screen indicates the status of the analysis, including the stage of the analysis and an estimate of the time remaining.

4.14 Viewing Results

Once the benefit-cost analysis has been performed, STEAM 2.0 allows the user to view the output results of the current scenario and the risk analysis output ranges. As described in Chapter 3, scenario results are stored in binary archive with .bsn extension. In addition to output results, the file contains the input assumptions that were used to produce the results.

To view the main scenario output file, the user must select the "Show Current Scenario Results" option from the "Results" menu item. Exhibit 4.21 shows the screen that displays the output file for a given scenario. Scroll bars allow the user to move vertically and horizontally through the file. The viewer simply displays the contents of the output file but does not allow the user to edit the file.

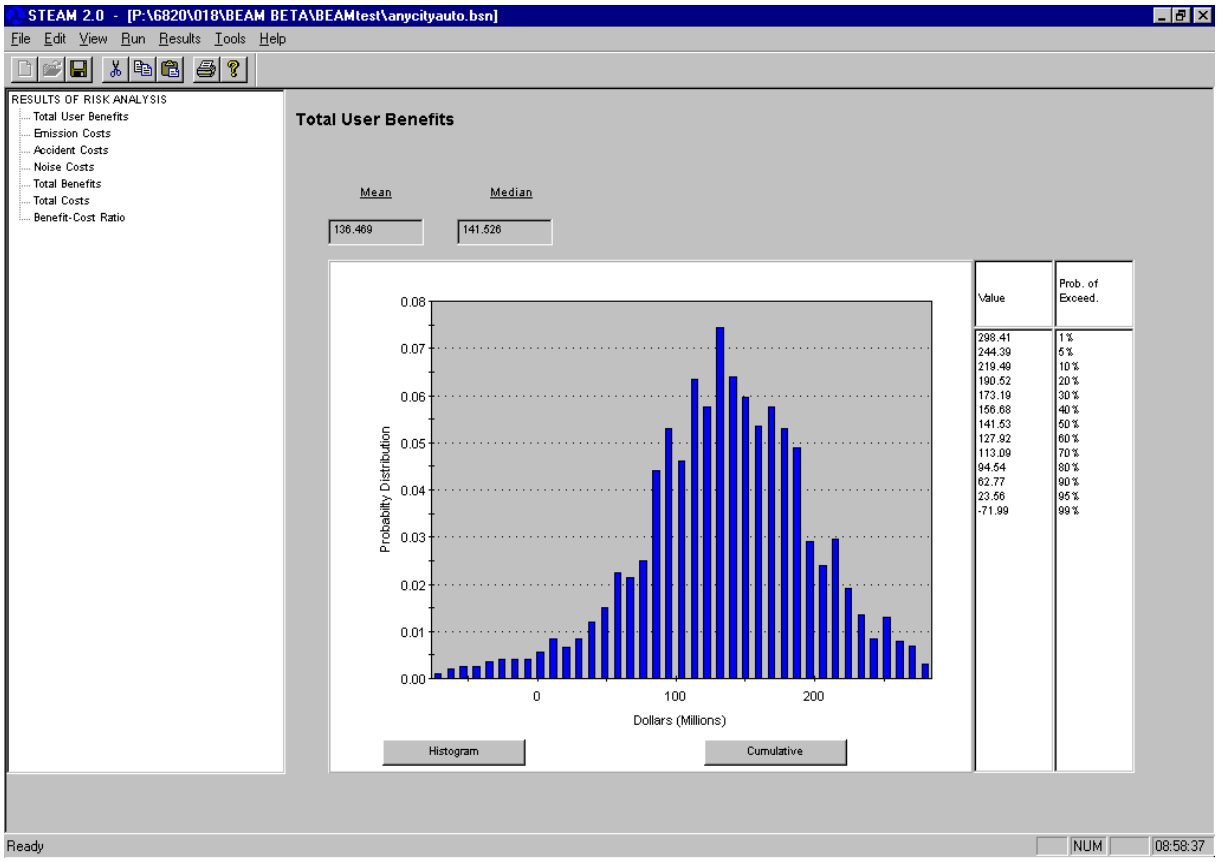
Exhibit 4.21 Viewing Scenario Output File



To view the output for selected variables from the risk analysis, the user must select the "Show Risk Analysis Results" option from the "Results" menu. This action displays a list of output variables in the tree navigator. By selecting one of the output variables in the tree navigator, the range of results for that variable is graphed in the display window.

The top of the screen displays the mean and median values for the output variable. On the right side of the graph presents the probability values. Similar to the input risk range screens, a "Non-Cumulative" and a "Cumulative" button is provided to allow the user to switch between the two types of graphs. Exhibit 4.20 shows the non-cumulative graph for the total user benefit result.

Exhibit 4.22 Non-Cumulative Total User Benefit Risk Analysis Results

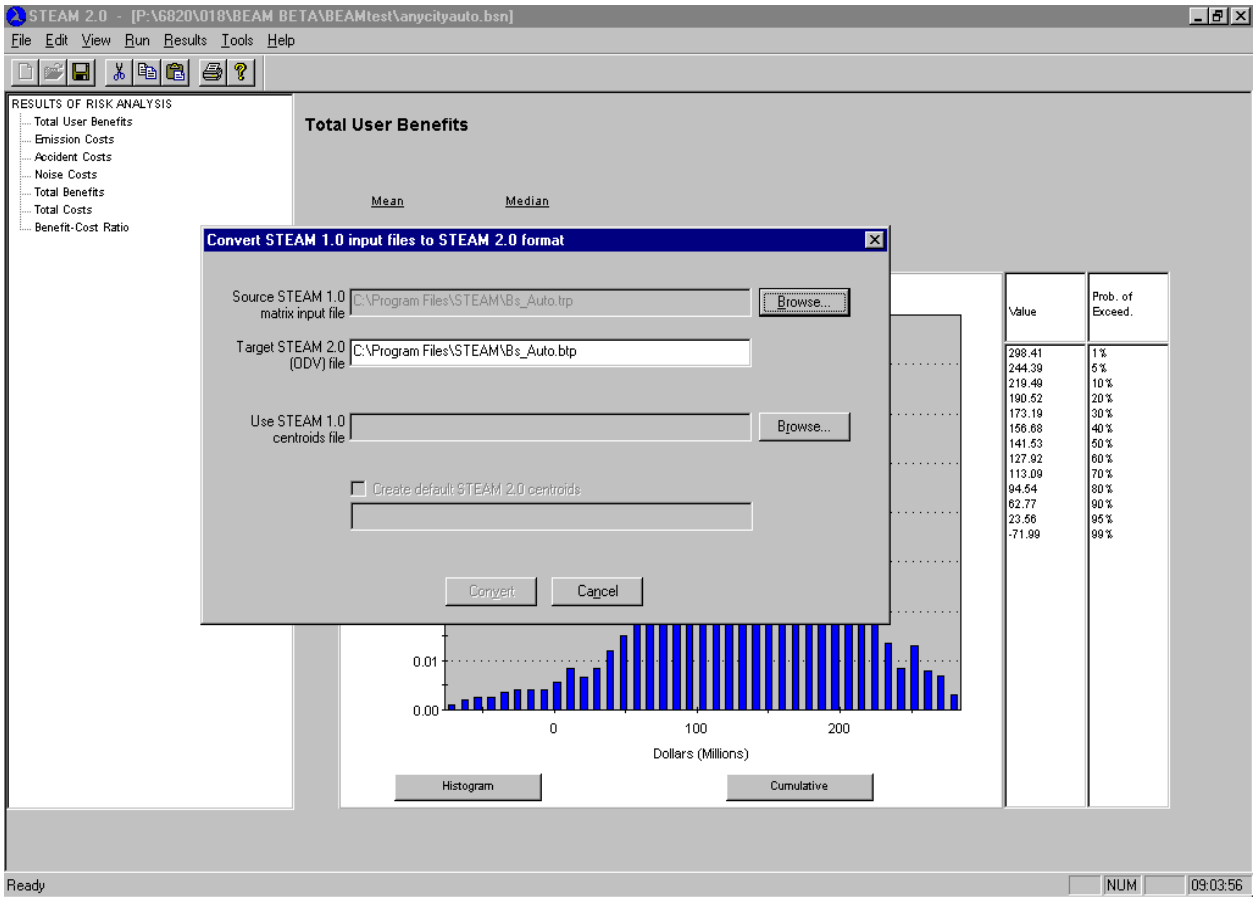


■ 4.15 Using Tools

STEAM 2.0 provides two utilities under the Tools menu: 1) a STEAM 2.0 matrix conversion routine; and 2) a select reporting options.

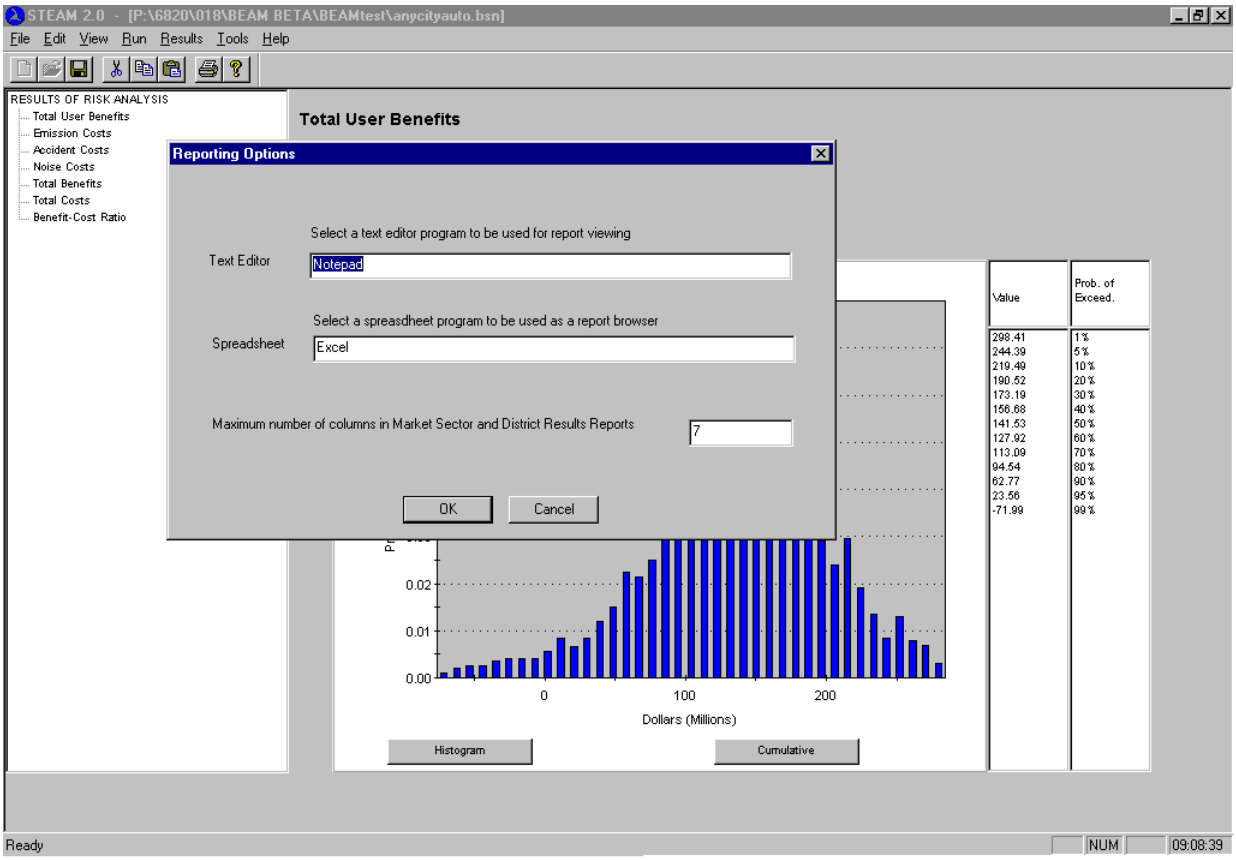
The matrix conversion routine converts files in square matrix format used by STEAM 2.0 to the origin/destination/value format used by STEAM 2.0. The dialog under the "Tools" menu option prompts the user to identify the STEAM 2.0 matrix name and location, and a STEAM-format centroid file. STEAM 2.0 creates a new matrix file, with a .btp extension. STEAM 2.0 also creates a new zone information file, with zeros filled in for columns 2-4, corresponding to the district, population and employment data. Exhibit 4.22 depicts the user interface for this conversion routine.

Exhibit 4.23 Converting STEAM 2.0 Matrices into Origin-Destination-Value Format



The scenario report file, and all of the district and market sector files can be viewed using common text editors and spreadsheet programs accessed from STEAM 2.0. To access these files through STEAM 2.0, users must specify the path and filename for the text editor and spreadsheet application they wish to use. The Windows Explorer "Tools/Find" feature can be used as an aid to find the executable files needed to view the outputs. Also, users can specify the number of columns per row of output to display, in order to configure the text editor-compatible files (.mkr, .dkr) so that the output remains aligned with column headings on a single row of output. Both the spreadsheet-compatible (.dkx,.mkx) and database-compatible (.dkd,.mkd) files may be viewed from the spreadsheet application. Exhibit 4.23 presents the application selection screen.

Exhibit 4.24 Selecting a New Text Editor and Spreadsheet Application for Viewing Scenario Results

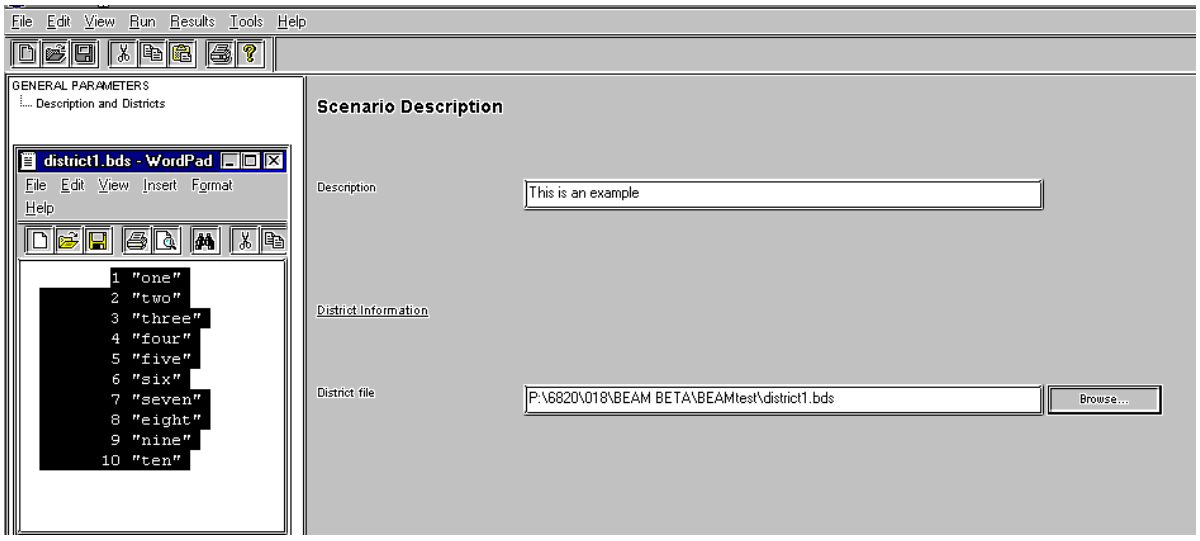


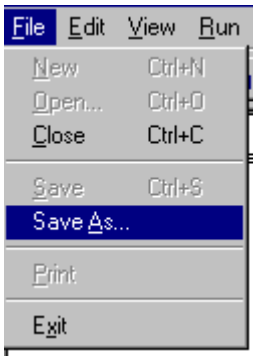
5.0 Getting Started with STEAM 2.0

This section will help you get started with STEAM 2.0, by providing you with a sequence of steps that allows you to do a simple analysis quickly. Let's suppose that you are interested in estimating the user impacts of a highway capacity improvement. You have your highway networks, travel demand matrices and centroid file prepared and ready for use. You're ready to use STEAM 2.0.

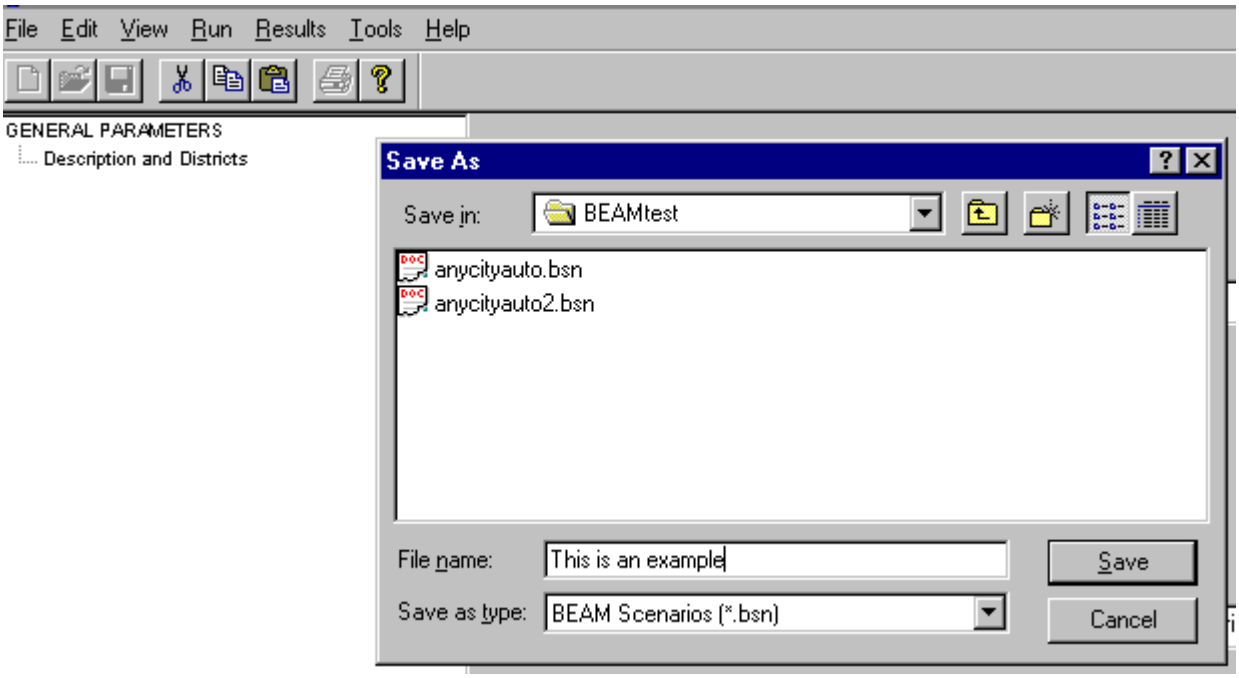
Create a scenario file. Select /File/New from the main menu, and the scenario description window pops open, as shown below.

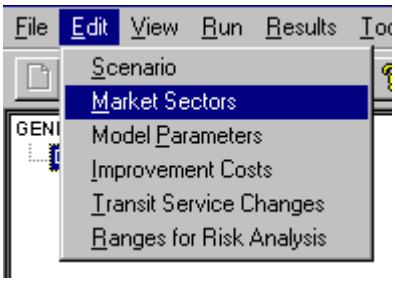
Scenario Description. Type the scenario description, and the location of the district file, if you wish to summarize user impacts by districts. The inset below shows you what a district file looks like. The file contains the number of the district and the name of the district, enclosed in quotes. You can use the "browse" button to identify the district file.



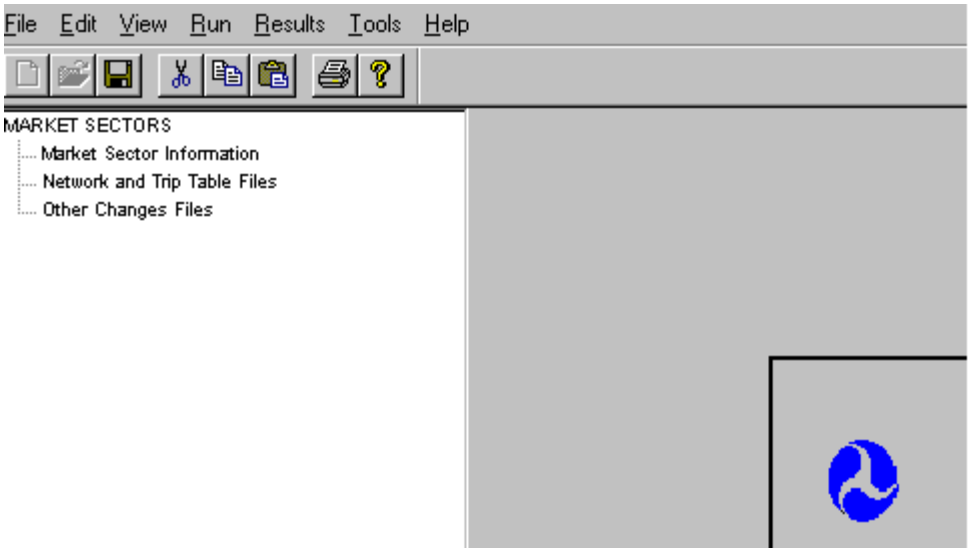


Create the Scenario File. Use the File/Save As menu option to save the scenario file. The interface for saving all files in STEAM 2.0 should be familiar to you if you've used Microsoft Office products before. Type in the name of the new file, or select the name of an existing file, which will overwrite the information in that file. STEAM 2.0 automatically adds the ".bsn" file extension if you don't add any file extension. Using the ".bsn" file extension isn't necessary, but it makes finding scenario files much easier.

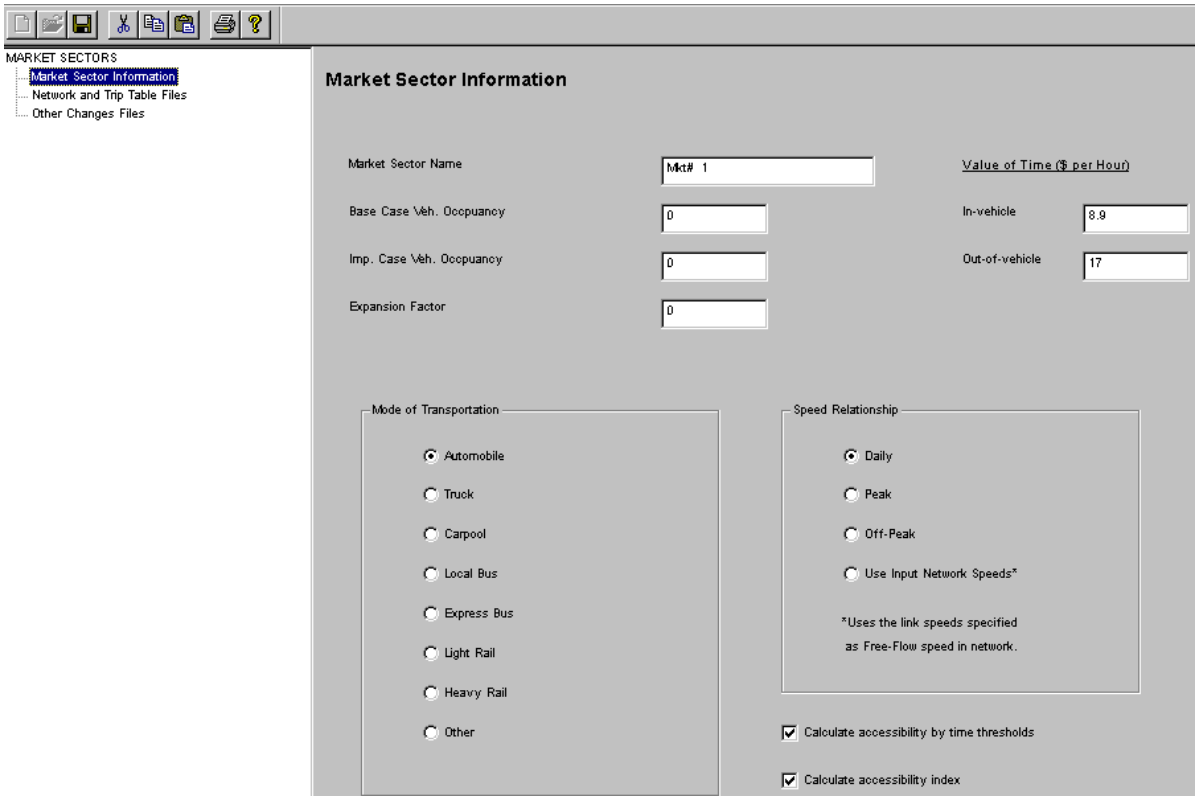




Select Market Sector. Select "Edit/Market Sectors" from the main menu. The Market Sector Screen pops up. Highlight "Mkt #1", then click on the "Modify" button. The Tree Navigator, as shown below, provides three options, "Market Sector Information, Network and Trip Table Files, and Other Changes Files.



Define Market Sector. Select the "Market Sector Information" option from the Tree Navigator and the associated screen appears to the right. Enter a name for the Market Sector (It can be a trip purpose, or a subset of the trip table), ***the base and improvement vehicle occupancy (all trip tables must be in person trips), the expansion factor (which converts daily impacts to annual impacts) and the value of time***. Select the mode of travel and speed relationship (all STEAM 2.0'S speed equations estimate average daily speeds). Note that you can supply your own speeds in the network file, instead of using STEAM 2.0's speed equations. Finally, indicate whether you wish to perform either or both of the accessibility analyses.

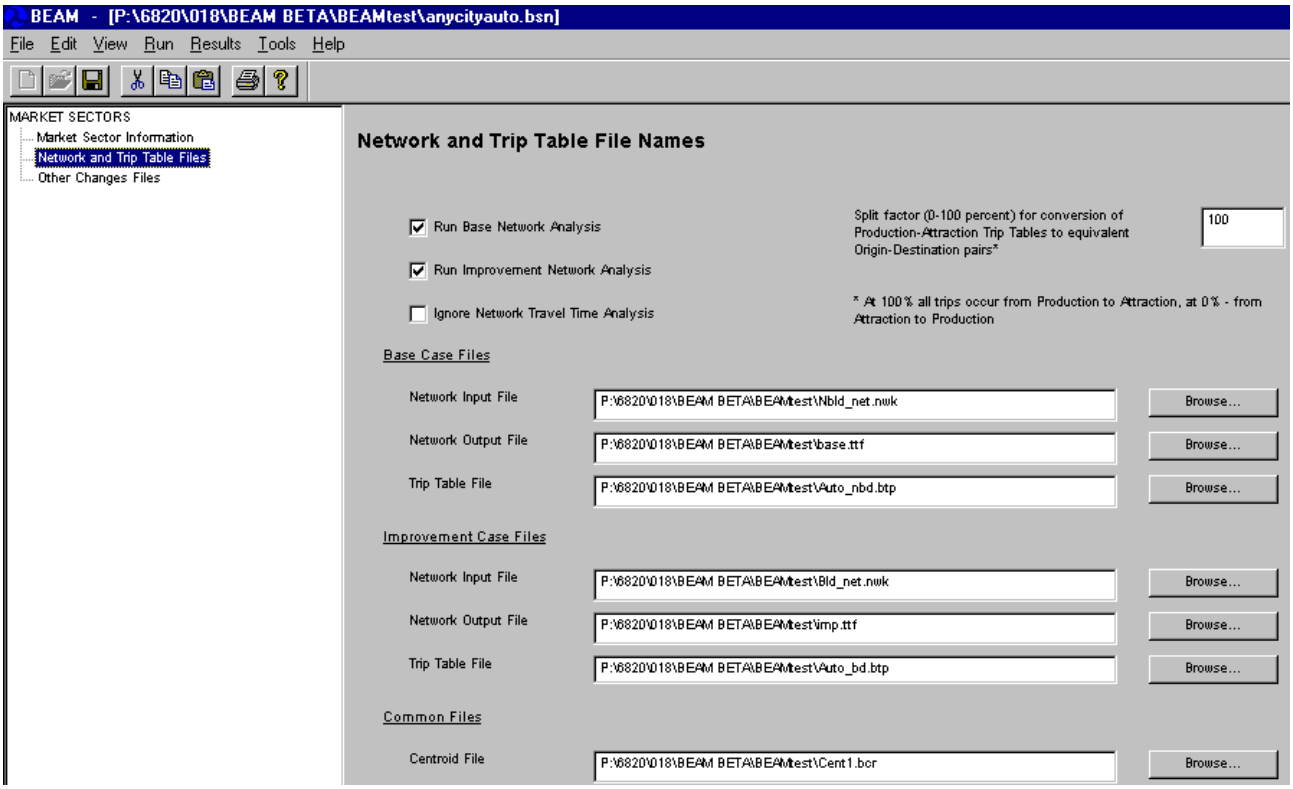


Set Up Analysis. Select "Network and Trip Table Files from the Tree Navigator.

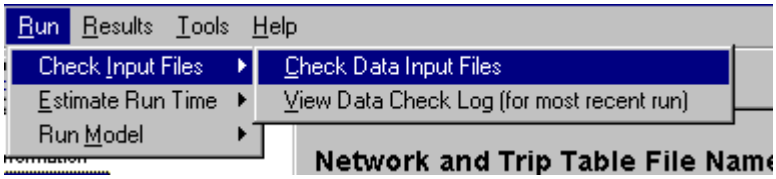
Network Analysis. Select "Run Base/Run Improvement Network Analysis" if you are using STEAM 2.0 to develop O/D travel times. If you have a travel time file already created (this is a large binary file with a ".ttf" extension) and you wish to use it again, the check mark for the base or improvement case may be left blank. Check the "Ignore Travel Time Analysis" option if no travel time analysis is required. Remember that centroids are coded as facility type "7", and that any link coded with a zero capacity will be completely ignored in the analysis.

Base/Improvement Case Files. Select the input files you have prepared and a name for the binary output file (which STEAM 2.0 uses to summarize benefits and costs) using the "Browse" buttons. The formats for the network, matrix and zonal information file are described in Chapter 3.

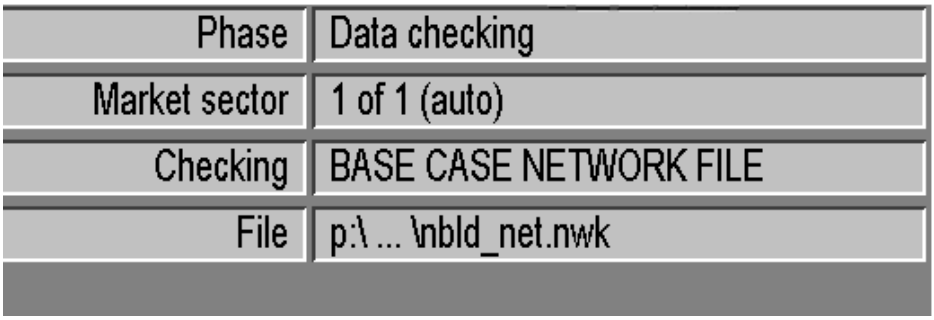
Select Split Factor. If you are reporting results by district, and you wish to report user impacts to **trip-makers who live in the district**, then your matrices must be in P/A format. The split factor allows determines how many resident-trips leave the district and how many enter the district of residence. If you do not have a P/A matrix or wish to ascribe all district benefits to trips leaving the district, leave the P/A factor at the default figure of 100 percent.



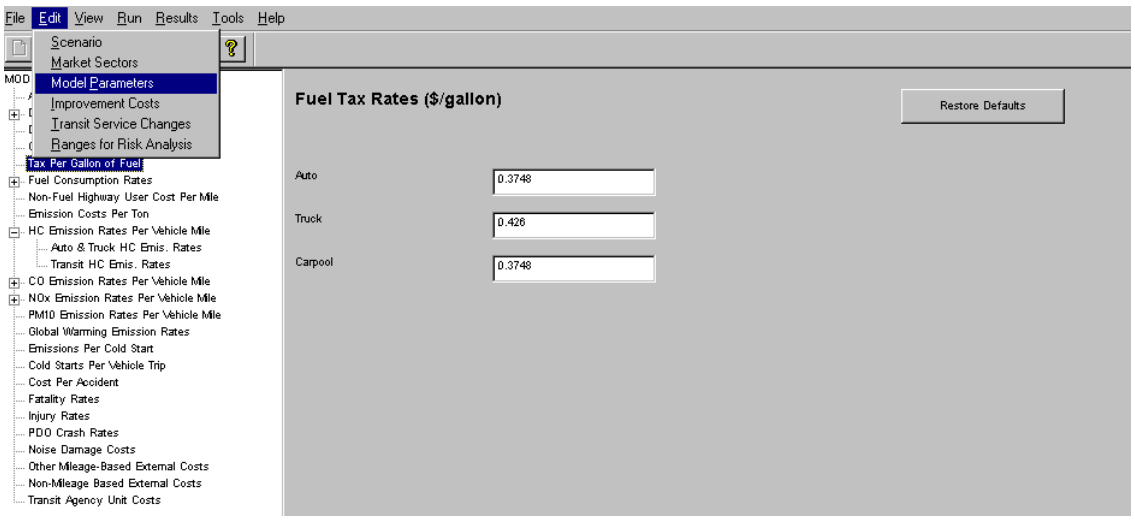
If you have transit skims or parking costs you would like to use for your analysis, select "Other Changes Files" from the Tree Navigator. Base and Improvement, In-vehicle, out-of-vehicle and out-of-pocket costs may be specified. ***Each of these matrices expects values expressed in hundredths, e.g., $1.35 is expressed as "135" in these files.***

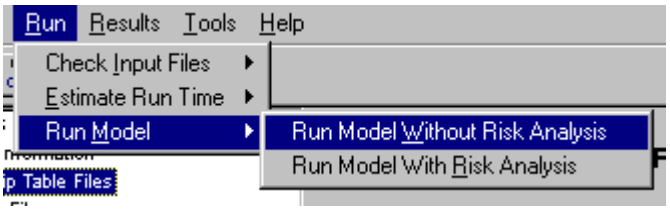


Check Data Files. From the main menu, select "Run/Check Input Files/Check Data Input Files". STEAM 2.0 will check all input files and develop a log file which notes any errors encountered. The check log may be viewed via the "View Data Check Log" menu option.

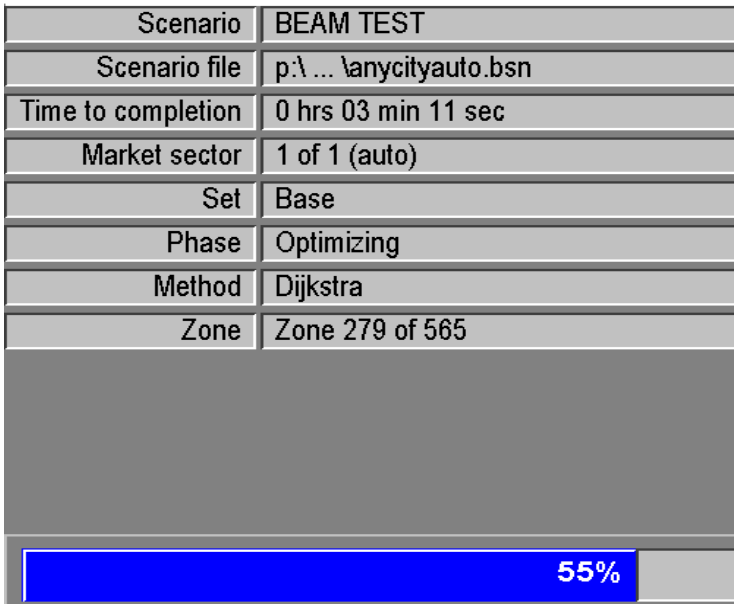


Adjust Parameters and Develop Other Inputs. Use the main menu and the Tree Navigator to adjust various model parameters (such as fuel tax rates, shown below), define improvement costs, define changes in transit service, or to change the distribution of values for the Risk Analysis.

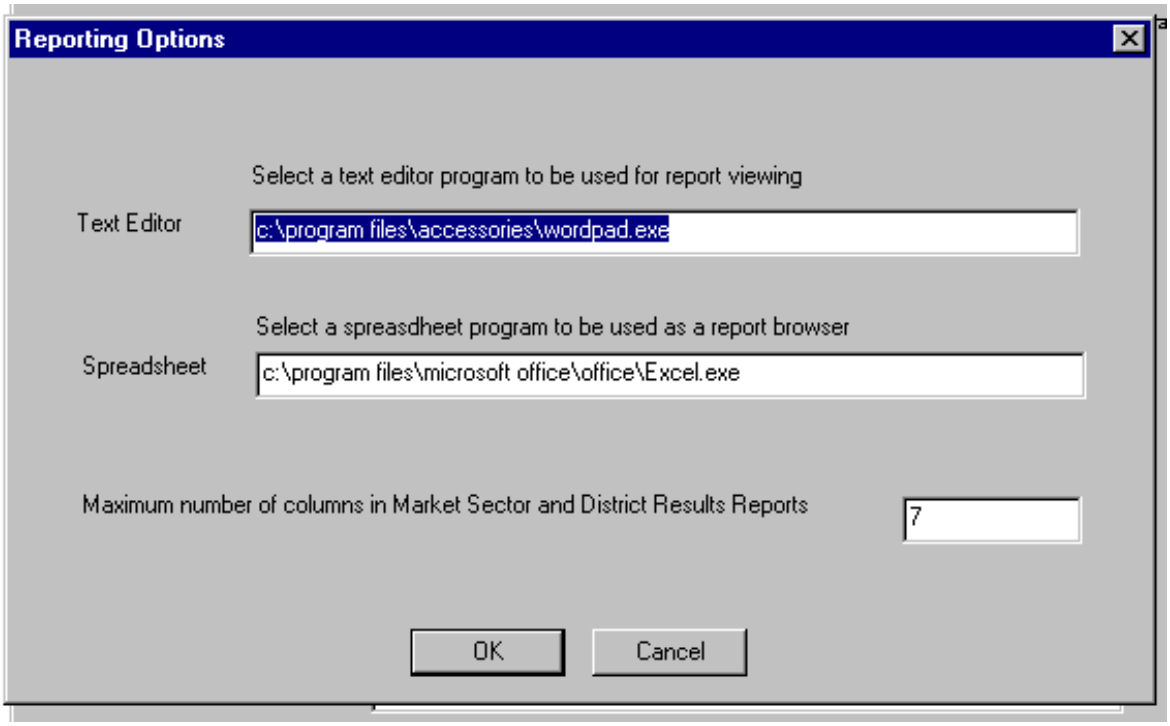




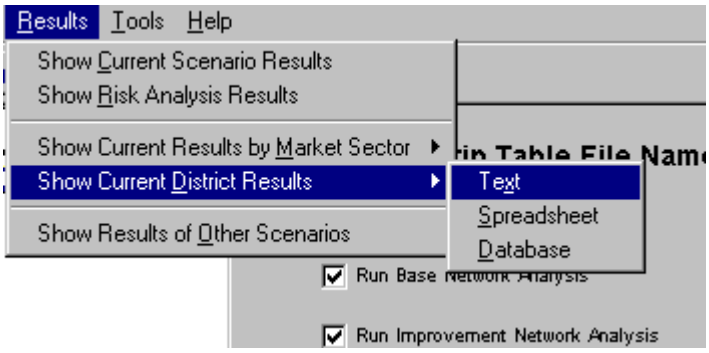
Run the model. Assuming you've adjusted parameters to suit the requirements of your study, entered the proper capital cost data, etc., you are ready to run STEAM 2.0. Select "Run/Run model" from the main menu. Select "With" or "Without Risk Analysis". The STEAM 2.0 status window appears as shown here. You may cancel the process at any time.



Set Reporting Option. STEAM 2.0's various reports are formatted for viewing by a text editor and a spreadsheet program. From the main menu, select "Tools/Reporting Options" and enter the directory path and name of the program you wish to use for the text editor and the spreadsheet program. If you don't know where these programs are located, try using the Microsoft Windows Explorer find option, under Explorer's "Tools" option, or ask your system administrator. You may change the number of columns that appear in each row of your reports as well. Generally, a font setting of eight works well with seven column-output in any text editor.



View Results. From the main menu, select "Results/Show…Results/Text…Spreadsheet…Database" to view results. The contents of each option are described in Chapter 4.



Appendix A Sources of Default Parameter Values

The following is list of sources for the default parameter values used in STEAM 2.0:

Value of Time –

Cost Per Gallon of Fuel -

Fuel Consumption Rates –

Emission Rates:

HC - EPA's, Mobile 5a model results.
CO - EPA's, Mobile 5a model results.
NOx - EPA's, Mobile 5a model results.
PM10 - EPA's, PART5 model results.

Cost Per Ton of Emissions –

Emissions Per Cold Start – HC, CO, and NOx are from EPA's Mobile 5a model results.

Cold Starts Per Trip -

Greenhouse Gas Emissions – FTA, New Starts Criteria Report, 1997.

Cost Per Accident – The Urban Institute, The Cost of Highway Crashes, Final Report.

Accident Rates:

Fatality Rates - FHWA, Highway Safety Performance - 1992, January 1995.
Injury Rates - FHWA, Highway Safety Performance - 1992, January 1995.
PDO Crash Rates - NHTSA, Traffic Safety Facts, 1993.

Noise Costs - FHWA, Federal Highway Cost Allocation Study; Appendix E, 1997.

Discount Rate –

Risk Ranges - Research team judgement.

Federal and State Fuel Tax Rates - FHWA, Highway Statistics - 1995, Table MF-121T.