

# **IMPACTS**

## **SPREADSHEET SOFTWARE DOCUMENTATION**

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# IMPACTS: SPREADSHEET SOFTWARE DOCUMENTATION

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## Introduction

The IMPACTS spreadsheet software was developed for use with the workshop exercises for National Highway Institute course no.15257 "Estimating The Impacts of Urban Transportation Alternatives". During the final workshop exercise, course participants perform sensitivity analysis. The analysis is performed for several multi-modal corridor alternatives for a case study (I-15 corridor in Salt Lake City, Utah), using the IMPACTS spreadsheets, (or alternatively the SPASM software, which can more easily analyze improvements to more than one mode made for a single alternative).

IMPACTS was programmed in EXCEL by Jim Altenstadter of the Pima Association of Governments (PAG) in Tuscon, Arizona. The workshop exercises and the course on which IMPACTS is based were developed by the U.S. Department of Transportation with consultant assistance from K. T. Analytics and Cambridge Systematics, Inc. IMPACTS is an EXCEL spreadsheet which can also be used successfully in Lotus 1-2-3 and Quattro Pro.

Seven spreadsheets are included in IMPACTS, covering the seven alternatives discussed in the course Case Study (see Appendix W of the Participant Notebook for the course). The alternatives include highway expansion, bus system expansion, light rail transit investment, HOV lanes, conversion of the existing facility to a toll facility, employer-based travel demand management, and bicycle lanes. The IMPACTS spreadsheets are based on the "hard copy" manual spreadsheets in the Workshop section (Appendix W) of the Participant Notebook of the course.

The spreadsheets enable estimation of the key impacts of the alternatives. The impacts estimated include:

- ✘ Costs of implementation, including capital, operation and maintenance costs.
- ✘ Benefits (or disbenefits) accruing to previous "base case" users including trip time and out-of-pocket costs such as fares, parking fees and tolls
- ✘ Benefits (or disbenefits) accruing to induced (or discouraged) trips
- ✘ Savings to highway users due to reduced congestion
- ✘ Changes in other highway user costs such as accident costs and costs for parking
- ✘ Revenue transfers due to tolls, fares or parking fees
- ✘ Changes in fuel consumption

## ✧ Changes in emissions

### **Overview of Analysis Procedures**

Seven different spreadsheets were developed, one for each of the seven alternatives. They allow analysis over a single facility, or over a travel corridor comprising several parallel facilities, if the analysis is repeated for each affected corridor facility. The framework underlying the spreadsheets also allows estimates of impacts by particular travel segments or markets and thus helps address some of the key distributional consequences. (For example, see “Using Benefit-Cost Analysis to Evaluate the Distribution of Highway Benefits” by Patrick DeCorla-Souza, presented at the TRB 1997 Annual Meeting (Paper No. 970059) in January, 1997).

There are six principal steps in the spreadsheets, corresponding with individual sections of each workshop alternative W-1 through W-7 in Appendix W (see the Participant Notebook). Multiple mode improvements can be accommodated, but require a separate analysis for each. The analytic procedures in each step are based on corresponding procedures discussed in Modules 5,6,7,8 and 9 of the course (see the Participant Notebook):

- ✧ Step 1: annualization of capital costs, and calculation of annual costs for operation and maintenance (discussed in module 5).
- ✧ Step 2: estimation of user benefits, including (a) direct benefits or disbenefits on improved modes or toll facilities, and (b) analysis of initial congestion effects on roads (effects of VMT change on road delays), estimation of induced (or discouraged) highway travel, and consumer surplus analysis for highway user impacts (discussed in module 6).
- ✧ Step 3: estimation of change in vehicle operation costs, accident costs and parking costs (also discussed in module 6).
- ✧ Step 4: analysis of change in emissions (discussed in module 7).
- ✧ Step 5: analysis of change in fuel consumption (discussed in module 8).
- ✧ Step 6: estimation of B/C ratio and Net Present Value (discussed in module 9).

### **Step 1: Cost Estimation**

Annualized capital costs and annual O & M costs are estimated in this step. Inputs to annualization of capital costs are: capital costs; midpoint of period when these costs are incurred; year of opening to traffic; useful life of investment; and discount rate to be used. Separate analysis can be carried out to trace capital investments by source (e.g. government versus developers/employers).

### **Step 2: User Benefits or Disbenefits**

The spreadsheet first estimates benefits (or disbenefits) to toll road users, and transit,

HOV or bicycle lane users resulting from bike, HOV or transit improvements and from parking price, toll or transit fare changes. Estimates of change in user benefits include benefits or disbenefits to existing “base case” users as to induced (or discouraged) travelers. Benefits or disbenefits from travel time changes (in-vehicle as well as out-of-vehicle) and out-of-pocket cost changes are included.

The spreadsheet then estimates the effect on congestion delay due to changes in VMT resulting from mode shifts. The spreadsheets allow separate analysis for freeways and other roads and highways by repetition of the step for each facility exhibiting a change in VMT. The inputs for the congestion analysis are: delay coefficients and average speeds for various ratios of Average Weekday Daily Traffic to Hourly Capacity (AWDT/HC). Delay coefficients and average speeds for various AWDT/HC ratios are provided in Module VI and Tables Z-1 through Z-2 of Appendix Z in the Participant Notebook for the Course. The spreadsheet then calculates the change in congestion delay (vehicle hours) to existing “base case” vehicles.

Next, the spreadsheet estimates induced (or discouraged) highway traffic due to change in congestion delay resulting from VMT or highway capacity changes. This sub-step starts with estimates of “unequilibrated” highway VMT and speeds estimated on the basis of the previous congestion analysis sub-step (using speeds from AWDT/HC relationships provided in Module VI and Appendix Z of the Participant Notebook). Then, using congestion coefficients (again from Module VI and Appendix Z), the spreadsheet calculates highway travel time elasticity (i.e., percent increase in travel time per VMT percent change). The user provides a demand elasticity (i.e., percent change in demand--VMT--due to a one percent change in travel time) or a default of -0.5 is assumed by the spreadsheet. The spreadsheet then calculates an equilibration factor “F” which, in turn, provides an estimate of induced (or discouraged) VMT under equilibrated travel conditions. Equilibrated VMT and corresponding speed are calculated. Finally, impacts for highway users are estimated in terms of change in consumer surplus.

### **Step 3: Changes in Other Highway User Costs**

In this step, the spreadsheets estimate changes in other highway costs which were not included in the previous calculations in Step 2 because the costs are not usually perceived by users as being *marginal* user costs. These are costs they perceive as being borne by others, e.g., parking costs borne by employers or businesses, or costs they perceive to be of a “fixed” nature because the amount of the cost they actually bear does not usually vary proportionally with the amount they choose to travel, e.g., accident insurance costs.

The spreadsheets treat costs for vehicle operation, accidents and parking as “other highway costs” not considered in the benefits calculations previously done in Step 2.

The spreadsheets compute only the *non-fuel* variable cost for vehicle operation in this step. The fuel cost component for vehicle operation is accounted for later in Step 5, as discussed below. Inputs to Step 3 are: user specified average trip distance; and the estimates of "before improvement" and "equilibrated-after-improvement" estimates of VMT.

#### **Step 4: Change in Emissions**

In this step the spreadsheet calculates changes in emissions for autos, trucks and buses due to changes in VMT, vehicle speeds and the number of cold starts. As a default, an auto trip reduction of one vehicle trip is assumed to produce a reduction of one cold start. If data on the percent of eliminated or induced trips that are cold starts are available, then the number of cold starts can be adjusted by the user.

Inputs are emission coefficients for autos, trucks and buses (coefficients relating the major categories of pollutants to VMT and the number of cold starts); unit costs per ton of emissions; and changes in VMT, speeds and the number of cold starts. Emission coefficients (per VMT at 5 mph intervals, and per cold start) are provided in Appendix Z of the Participant Notebook. For speeds not shown in the table, the user must interpolate between coefficients to get the appropriate coefficient. Outputs are changes in emissions (HC, CO, NO<sub>x</sub>) by autos, trucks and buses, and monetized costs of these changes.

#### **Step 5: Changes in Energy Consumption**

In this step the spreadsheet calculates changes in energy consumption for rail transit and for autos, trucks and buses due to changes in VMT and congestion delay. Inputs are energy consumption coefficients for rail transit and for autos, trucks and buses. The coefficients relate fuel consumption to VMT and vehicle hours of travel delay. The spreadsheet uses fuel consumption rates of 0.04 gals/VMT and 0.42 gals/VHT for autos; 0.16 gals/VMT and 1.87 gals/VHT for trucks; and 0.25gals/VMT for buses. Outputs are changes in gallons of fuel consumed by autos, trucks and buses, and changes in kilowatt hours (KWH) used for rail. Based on unit costs per gallon or KWH, these changes are monetized. Care should be taken not to double count transit energy cost changes when estimating total benefits for an alternative, since these costs are usually included in unit costs for transit O & M used to compute O & M costs in Step 1.

#### **Step 6: Summary**

In this step, a summary of impacts estimated in Steps 1 through 5 is produced. First, total costs are estimated. The user may provide as additional input any other public agency or employer costs not estimated in Step 1.

Next, benefits are tallied. Benefits include: (1) direct benefits (or disbenefits) accruing to

the existing “base case” users including trip time and out-of-pocket cost; direct benefits (or disbenefits) accruing to induced (or discouraged) trips; and savings to highway users due to reduced congestion; (2) changes in other highway costs, including costs for accidents and parking; (3) revenue *transfers* due to tolls, fares or parking fees which were included in user costs estimated in Step 2 – they must be counted as “benefits” to entities receiving the revenues because they are not resource costs, but only a form of payment for resource costs for parking, transit or toll facilities, which have already been accounted for in Step 1 or Step 3; (4) change in energy consumption costs; and (5) change in emissions costs. The user may provide as input any additional benefits or disbenefits not estimated in the previous steps. For example, noise, disbenefits during construction due to traffic delays, and other environmental damage may be monetized by the user and provided as input in the “other benefits” line.

The spreadsheet then compares benefits with cost of implementation to calculate a B/C ratio, net annual benefit and Net Present Value.

### **Software Operation**

✂ Load the file IMPACTS.XLS into your spreadsheet software. The spreadsheet can be used in EXCEL, Lotus 1-2-3 or Quattro Pro.

✂ Input “general”, “alternative specific” and “other” parameters in the first few rows, or use default values included in the spreadsheets. *All cell data which need to be reviewed and modified (as appropriate) by the user are identified by a highlighted bar in column F.*

✂ Input capital and O&M costs of improvements for the alternative and data needed to derive annualized costs, as identified by the highlight in column F.

✂ Provide parameter data (coefficients, unit costs, etc.) For benefits estimation in the rest of the spreadsheet, as identified by the highlight in column F.

✂ The final rows provide a summary of the key impacts derived by the spreadsheets. Provide as input any additional costs or any additional benefits/disbenefits not estimated by the spreadsheet. The estimated B/C ratio and NPV are calculated and shown in the last few rows.