NCHRP

REPORT 525

Surface Transportation Security

Volume 11

Disruption Impact Estimating Tool—Transportation (DIETT): A Tool for Prioritizing High-Value Transportation Choke Points

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 525

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Disruption Impact Estimating Tool—Transportation (DIETT): A Tool for Prioritizing High-Value Transportation Choke Points

David M. Friedman
Michael C. Monteith
Douglas H. Kay
Vivian B. Couts
SAIC
McLean, VA

Jeffrey W. Trombly
SAIC
Oak Ridge, TN

Delma Bratvold
SAIC
Augusta, GA

Ira Hirschman
PB Consult
New, NY

Subject Areas
Planning and Administration • Operations and Safety • Freight Transportation • Security

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Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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FOREWORD

By S. A. Parker
Staff Officer
Transportation Research Board

This eleventh volume of *NCHRP Report 525: Surface Transportation Security* will assist transportation, security, and emergency-preparedness planners as they identify and prioritize potential high-value transportation choke points (TCPs) such as bridges, tunnels, and passes. These high-value TCPs are located predominantly along major transportation routes. A key area of concern is how disruptive events will affect the flow of commercial traffic through TCPs. The Disruption Impact Estimating Tool—Transportation (DIETT) is an electronic analytical tool that calculates direct transportation and economic impacts (costs) of an event that precludes the use of a TCP, and it prioritizes TCPs on the basis of these criteria. DIETT does not calculate replacement costs. Using DIETT's prioritized sets of outputs, along with other risk information, decision makers will be able to better focus their capital resource, security, and emergency-preparedness planning.

Although DIETT is specifically designed to assist state DOTs and other state security and emergency-preparedness organizations, prioritized state results can be readily merged to identify candidate TCPs for use in regional or national prioritization schemes. Localities and metropolitan areas can also work with area-specific data to assess their TCP priorities. DIETT is designed to prioritize based on direct transportation and economic impacts; however, it can be expanded by adding other criteria of interest to the user and thus offers compatibility with numerous applications.

In these pages, readers will find background information on DIETT as well as installation instructions and a user guide. DIETT can be downloaded from the TRB website (www4.trb.org/trb/onlinepubs.nsf). Click on "NCHRP Project Reports," and then click on 525v11—*Disruption Impact Estimating Tool—Transportation (DIETT): A Tool for Prioritizing High-Value Transportation Choke Point*s. This will take users to the report web page, where DIETT is located. DIETT can also be accessed at www.trb.org/SecurityPubs/ under *Disruption Impact Estimating Tool—Transportation (DIETT): A Tool for Prioritizing High-Value Transportation Choke Points*.

Both DIETT and the information herein should be helpful to transportation agencies in creating risk management and emergency response plans, or in evaluating and modifying them, in a manner consistent with the National Incident Management System (NIMS). The importance of NIMS is set out in a September 8, 2004, letter to state governors, from Department of Homeland Security Secretary Tom Ridge: "NIMS provides a consistent nationwide approach for Federal, State, territorial, tribal, and local governments to work effectively and efficiently together to prepare for, prevent, respond to, and recover from domestic incidents, regardless of cause, size, or complexity."

Science Applications International Corporation prepared this volume of *NCHRP Report 525* under NCHRP Project 20-59(9).

Emergencies arising from terrorist threats highlight the need for transportation managers to minimize the vulnerability of travelers, employees, and physical assets through incident prevention, preparedness, mitigation, response, and recovery. Managers seek to reduce the chances that transportation vehicles and facilities will be targets or instruments of terrorist attacks and to be prepared to respond to and recover from such possibilities. By being prepared to respond to terrorism, each transportation agency is simultaneously prepared to respond to natural disasters such as hurricanes, floods, and wildfires, as well as human-caused events such as hazardous materials spills and other incidents.

This is the eleventh volume of *NCHRP Report 525: Surface Transportation Security*, a series in which relevant information is assembled into single, concise volumes—each pertaining to a specific security problem and closely related issues. These volumes focus on the concerns that transportation agencies are addressing when developing programs in response to the terrorist attacks of September 11, 2001, and the anthrax attacks that followed. Future volumes of the reports will be issued as they are completed.

To develop this volume in a comprehensive manner and to ensure inclusion of significant knowledge, available information was assembled from numerous sources, including a number of state departments of transportation. A topic panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data and to review the final document.

This volume was prepared to meet an urgent need for information in this area. It records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. Work in this area is proceeding swiftly, and readers are encouraged to be on the lookout for the most up-to-date information.

Volumes issued under *NCHRP Report 525: Surface Transportation Security* (including the DIETT software described in this report) may be found on the TRB website at http://www.TRB.org/SecurityPubs.

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PART 1

Final Report

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CHAPTER 1

Introduction

This report provides a summary of the research activities conducted under NCHRP Project 20-59(9); a description of the resultant tool, Disruption Impact Estimating Tool—Transportation (DIETT); and a summary discussion of the key algorithms used in DIETT.

1.1 Background

The goal of the research conducted under NCHRP Project 20-59(9) was to develop an analytical tool that would help in the identification and prioritization of state-specific transportation choke points (TCPs) according to their potential economic impact on U.S. commerce. The tool would assist state departments of transportation (DOTs) and other state security organizations in identifying and protecting high-value TCPs. The prioritized state results would be merged to identify candidate national TCPs for use in national security decisionmaking.

The analytical tool developed under NCHRP Project 20-59(9), DIETT, was designed in accordance with structural and operational guidelines specified by the NCHRP 20-59(9) project panel. The guidelines were as follows:

- Identify existing, off-the-shelf tools that can be adopted for use in this application;
- Adapt, modify, and connect these off-the-shelf tools as needed;
- Test, refine, simplify, and otherwise make the analytical tool useful;
- Identify data that can be used by the tool to generate the needed results;
- Develop algorithms that will generate the desired analysis (prioritized estimates);
- Use impact on commercial shipments as the key transportation variable;
- Exclude from consideration the cost of TCP repair, replacement, and collateral damage;
- Consider the effects of conventional explosives only; and
- Select or prioritize TCPs on net national economic impacts criteria.

The final guideline listed above specifically excludes consideration of losses to the local economy (business losses such as fueling stations, repair shops, lodging, etc.). Local economic losses, when considered on a net accounting basis, are predominantly temporary economic transfers, and they generally result in temporary net economic gains elsewhere in the economy. However, there are cases in which local losses translate into permanent economic dislocations and as such result in net national losses. Examples of this type of impact include impacts on unique services or products, severe curtailment of access to "island" economies, loss of cross-border opportunities, and loss of marginally competitive markets to imports. In cases where local losses result in net national economic losses, users of DIETT may want to consider adding these impacts separately.

1.2 System Design

DIETT is composed of two off-the-shelf programs and a set of specified and unspecified optional programs used for generating the prioritized list of TCPs.

The off-the-shelf programs are Microsoft (MS) Access and MS Excel. These were selected for operational desirability and for their simplicity, availability, and popularity. DIETT uses these programs in the following ways:

- **MS Access** is used to select the first-tier candidate TCPs from TCP databases (databases are to be user-supplied) and to connect to MS Excel.
- **MS Excel** is used for modeling the transportation and economic impacts and for generating the input and output presentation module. Interim scenario development and final prioritizations are also performed in MS Excel. All of

the MS Excel modeling and presentation features are preprogrammed for the requirements of this project. The MS Excel part of DIETT is structured to calculate the transportation-related and the economic-related impacts (costs) and to facilitate the development of alternate scenarios. Automatic sort functions were added to allow for ease of prioritization.

The optional programs fine-tune the prioritizations developed in DIETT. One suggested program is ArcGIS (version 9.0), designed to identify detours based on a geographic information system (GIS). These data can replace the detour lengths specified in other sources, such as the National Bridge Inventory (NBI). Other programs may be applied by the users, as deemed appropriate.

It is recommended that DIETT reside in a consequence management package called the Consequences Assessment Tool Set—Joint Assessment of Catastrophic Events (CATS-JACE), which is based on a commercial geographic information system (GIS). CATS-JACE is a configuration of CATS, a disaster analysis system, which is available as an off-the-shelf package. CATS-JACE was developed for the Federal Emergency Management Agency (FEMA) and the Defense Threat Reduction Agency (DTRA) to provide a comprehensive package of hazard prediction models (natural hazards and technological hazards) and casualty and damage assessment tools. CATS-JACE has the capability to overlay event characteristics (e.g., dispersion paths), transportation (e.g., rail and highway networks), population, and business datasets to provide an understanding of the extent, magnitude, duration, and impacts of an event. CATS-JACE also accepts real-time data from local meteorological stations.

It is recommended that DIETT reside in CATS-JACE because CATS-JACE is available to many state transportation and security agencies and because it already contains ArcGIS (version 9.0). When DIETT resides within CATS-JACE, it can interact with resident security-related programs. For more information on CATS, see the appendix to this report or access the "Consequences Assessment Tool Set" at http://cats.saic.com/.

As illustrated in Exhibit 1, the structure of DIETT is relatively simple. Exhibit 1 shows the structure, relationships, and processes of DIETT and the four categories of state-level datasets suggested (mountain pass, tunnel, bridge, and state transportation and commerce).

1.3 Using DIETT

The output of DIETT is a list of state-level TCPs, prioritized by net national economic impact. The output is developed through an interconnected, semi-automatic set of functions implemented by an analyst (who, ideally, will have at least a moderate level of knowledge of MS Access and MS Excel). The general, sequential, steps are as follows:

1. Identify and select the appropriate state-level TCP databases containing relevant data on mountain passes, tunnels, and bridges.
2. Select the specified datasets (e.g., identifiers, bridge span, detour length, and number of vehicles).
3. Direct the database (an automated function) to select the top TCP candidates (500 is the suggested number of candidates) based on preprogrammed initial selection criteria. This list will be automatically exported to the MS Excel spreadsheet.
4. Further prioritize the list in MS Excel by changing transportation cost, performance, and economic impact default values (these are automated functions).
5. Refine the output (optional, but highly recommended) using more specific state transportation and commerce data and other programs. The number of TCPs to be refined and the extent of the refinements are determined by the user's needs, the availability of data, and the desired level of accuracy.
6. Create an output file. Save or print.
7. Compare results with state-level lists of important TCPs to make sure that high-value TCPs were not systematically eliminated. (See "Limitations.")

More detailed installation and operating instructions are provided in Part 2 of this volume, "DIETT Installation Instructions and User Guide." For security reasons, data used to illustrate the use of DIETT were altered NBI data from different U.S. states entered as the data of an imaginary state—Fredonia.

1.4 Limitations

DIETT has some inherent limitations; these are due to scope of work limitations and the generalizations in the algorithms. Generally, the generalizations in the algorithms imply a greater degree of uniformity and precision than really exists. Further limitations are introduced from external sources, predomi-

Security Caution

DIETT is an analytical tool that helps users to prioritize transportation choke points (1) by value to the U.S. transportation system and (2) by value to the national economy. For security reasons, data used to illustrate the use of DIETT were altered. When the tool is used with actual data, the results could not only help users with legitimate purposes, but also those intending to disrupt the U.S. transportation infrastructure. Therefore, DIETT outputs should be guarded, and access should be limited to those with a "need to know."

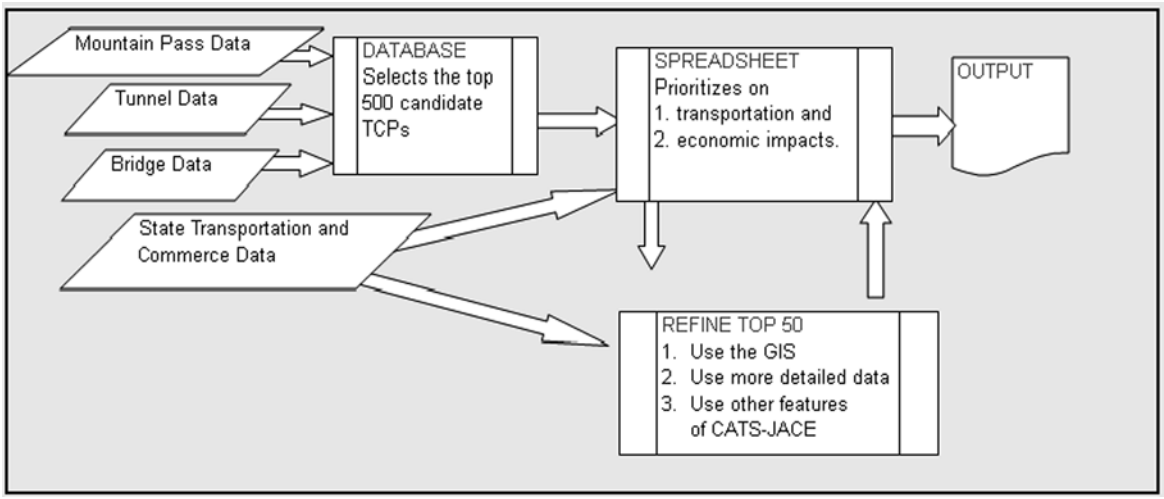

Exhibit 1. The structure and flow of the Disruption Impact Estimating Tool—Transportation (DIETT).

nantly by the limitations of the data. Some key limitations under each of these categories are noted below:

- **Inherent Limitations**—these include but are not limited to the following:
  - **Considering only the commercial-shipment transportation sector limits the scope of the transportation-related impacts that will be reported.** This limitation is pronounced for TCPs in which commercial traffic is only a small fraction of the total traffic. (Note: the non-commercial transportation sector was specifically excluded in the scope.)
  - **Repair or replacement costs for TCPs are not supported by the available data and were not included.** In some cases, this cost element can be a large, or even the largest, component of total losses.
  - **The difference between estimated default values and actual values can be significant.** Even though the user can narrow this difference by changing the default values through the final refinement steps, there may still be a large number of errors, which can result in premature exclusion of certain significant TCPs. The user should compare DIETT results with state-level lists of important TCPs to make sure that high-value TCPs were not eliminated.
  - **The relationships built into the formulas contain simplified estimates of observed or assumed relationships.** The user may change the formulas, as appropriate, and adjust some relationships in the final refinement steps. However, there may still be a large number of errors, which could result in premature exclusion of certain high-value TCPs. The user should compare results with state-level lists of important TCPs to make sure that high-value TCPs were not eliminated.
- **Externally Introduced Limitations**—the dominant externally introduced limitations are the data. Through limited spot validation for the state of Virginia, some critical data from the NBI were found to be suspect. These included length of the detour, number of trucks, and global-positioning-system (GPS) position specifications. This limitation suggests the importance of refining the output of DIETT.
- **Other Limitations**—DIETT may not adequately consider the impact of multiple local or regional events. Similarly, it is not readily applicable to multiple events along a main transportation corridor. In some cases, such as the disablement of a bridge that carries truck and rail traffic, the impacts may be more severe than indicated by the model. The detour data provided in the NBI do not consider the structural capacity of the road to carry the increased traffic.
- **Validation**—DIETT results were not validated.

Other limitations may apply to individual states and TCPs. The user should make application-specific assessment of DIETT and data limitations.

CHAPTER 2

Estimating Methodology—The Algorithms

This chapter presents the summary methodology used in DIETT to estimate the transportation and economic costs of a disruption to a TCP. The methodology is designed to generate net national economic impacts as a function of commercial shipments (used interchangeably with freight movement) by truck, rail, and waterways. These impacts are derived by estimating and then adding the values for the

- Increased cost of freight movement associated with the detours, and
- Increased inventory costs imposed by the relative uncertainty of deliveries through the detour.

Net economic and societal dislocations are not considered. Such dislocations are very important in determining the total impact of a disruption. However, the process of determining the total impact of dislocations is a very complex analytical and modeling exercise that is best performed through complex econometric models. Net total economic and societal dislocations are less important for calculating relative values of direct impact from disruptions to freight movement—the focus of this project.

2.1 Increased Cost of Freight Movement

Increases in the cost of freight movement result from additional vehicle operating costs associated with the added travel distance of a detour. These costs include driver salaries, fuel, operation and maintenance, shipper profit, and other business costs and are implicitly part of DIETT's estimating methodology. There may be other costs associated with the detour, such as tolls, road wear, traffic regulations, etc. These are not considered herein, but they can be included in a DIETT analysis.

The detour distance-related costs are compounded by the capacity limitations of the detour. The initial traffic congestion commonly subsides within about a week. However, long-term freight movement will be redistributed through a wider net (multiple detours) within mode and among modes and will last until the TCP is rebuilt. The degree of redistribution is a function of cost and risk. The cost factor is considered here, and the risk factor is considered in Section 2.2.

The increases in costs of freight movement were calculated using the following:

- **Length of Detour**—the distance traveled to bypass the disabled TCP. This value is provided by the NBI database and expressed in miles of detour, $\mathbf{M_d}$.
- **Level of Congestion**—a factor that indicates the difference in throughput between the original route (the TCP) and the detour. It is expressed as a throughput factor, **T,** where **T** = throughput on detour ($\mathbf{T_d}$) divided by throughput on the TCP ($\mathbf{T_{TCP}}$), or $\mathbf{T = T_d/T_{TCP}}$.
- **Unit Cost of Shipment**—this value is expressed as cost ($) per ton of freight, per mile, **C.** This is a user input (default values are provided).

The formula used for calculating the net cost of freight shipment through the detour ($\mathbf{NCFS_d}$) is

$$\mathbf{NCFS_d = M_d * T * C}$$

Because there are generally multiple options for delivering freight to a point of destination, (alternative routes, different modes, different suppliers, etc.) the net cost of freight shipment through a detour, as expressed by $\mathbf{NCFS_d}$, is the "ceiling" or maximum net cost incurred per unit of shipment. If other options are more costly, they will not be taken.

2.2 Increased Business Inventory Costs

The introduction of a detour into freight shipments dictates additional business costs beyond those considered above. These are due to the following:

- **Increased Time En Route.** An extreme example is maritime shipping, in which delays can be measured in weeks and the inventory costs in millions of dollars. Increased time en route affects surface transportation also, but is less noticeable because the time factor is small and the effect is distributed among many small shipments. However, in the aggregate, the effect can be significant. The cost associated with increased time en route is referred to as the detour time factor.
- **Altered Risk.** This is the real or perceived risk of the revised shipment patterns (route, mode, etc.). The altered risk can be increased risk as well as decreased risk. This impact is most commonly internalized as the probability of making on-time delivery, or reliability. Changing inventory levels is commonly used to hedge the risk effect. Action taken in response to altered risk is referred to as the reliability factor. Both of these effects (factors) are addressed in the methodology. Measuring the impact of these effects required the introduction of three sets of data:
  - **Cargo value**—Default values are provided in three categories for each mode: high ($10,000/ton of cargo), medium ($1,000/ton), and low ($100/ton). These are used to set an estimated value on the rerouted freight. Cargo value is used in the calculation of inventory premiums.
  - **Inventory premium**—This is the inventory cost as a percentage of cargo value. The default value is set at 18% per year. The premium is applied for the duration of the disruption.
  - **Detour reliability factor**—This reflects the reliability of on-time delivery compared with the reliability performance on the original route. Reliability data are not readily available and required the inclusion of estimated values. The best estimates may be generated at the state level. The user can enter state-specific estimates.

The categories and the default values used in determining business inventory costs are shown in Exhibit 2.

Algorithms are constructed within DIETT to calculate all business inventory-related costs using the inventory cost-related parameters to generate separate impact data for transportation-related impacts (costs) and direct economic impacts. The summary results are provided in the 11-column OUTPUTS worksheet of the DIETT application (see Exhibit 3). Of these 11 columns, the first 6 are TCP identifiers and the next 5 are impact results measured in absolute (estimated) value ($) and as defined percentages.

Inventory Cost-related Categories	Default Values
% of Cargo High Value - Truck	60%
% of Cargo Med. Value - Truck	30%
% of Cargo Low Value - Truck	10%
% of Cargo High Value - Rail	20%
% of Cargo Med. Value - Rail	50%
% of Cargo Low Value - Rail	30%
% of Cargo High Value - Barge	5%
% of Cargo Med. Value - Barge	25%
% of Cargo Low Value - Barge	70%
Alternate Route Reliability - Truck	95%
Alternate Route Reliability - Rail	99%
Inventory Cost: % of Cargo/Year	18%

Exhibit 2. Inventory cost-related categories and default values.

2.3 Recommended Use

Recommendations for obtaining the most benefit from DIETT include the following:

- Users (predominantly state DOTs) should consider assigning responsibility for applying this tool to analysts (1) conversant with the recommended datasets (and the limitations of those datasets); (2) with access-controlled workspace and procedures in place to safeguard the data and information generated through use of DIETT; and (3) with clear guidance as to how the information generated through DIETT is to be documented, communicated, and incorporated into agency policy and budget development processes.
- Users should set up DIETT to operate within or in tandem with CATS-JACE to enable interaction with resident security-related programs. One example of the applicability of CATS-JACE is its ability, through ArcGIS (version 9.0), a resident program, to improve on "detour" (distance) data. A feature of ArcGIS (version 9.0) displayed in the toolbar as "Browse Bridges" (see Exhibit 4) can be used to identify alternative detours through the use of GIS information and GIS mapping functions. Other functions of ArcGIS allow users to display the location of candidate TCPs, close off roads (virtually), and develop scenarios for the best detours. A detour can be automatically measured in additional miles traveled—see "Added Distance" in Exhibit 5. The detour can also be visually designated (see Exhibit 6).

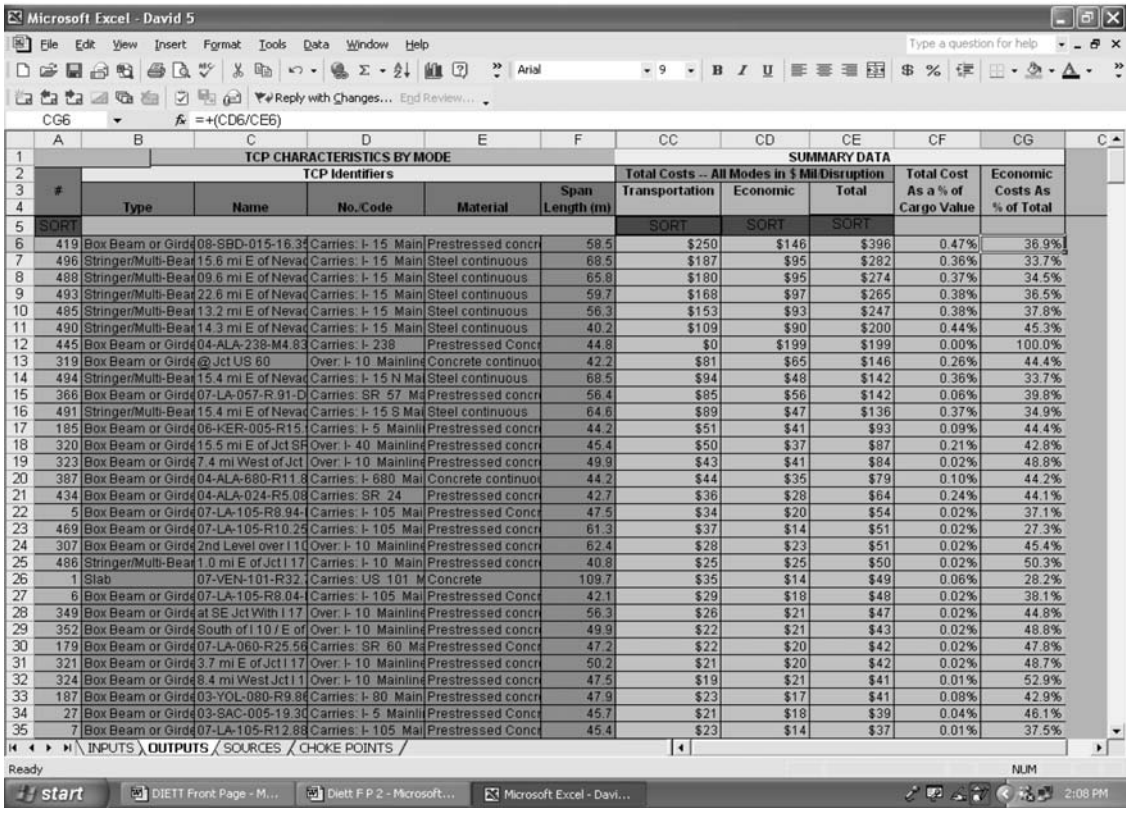

Exhibit 3. The output page of the DIETT spreadsheet application.

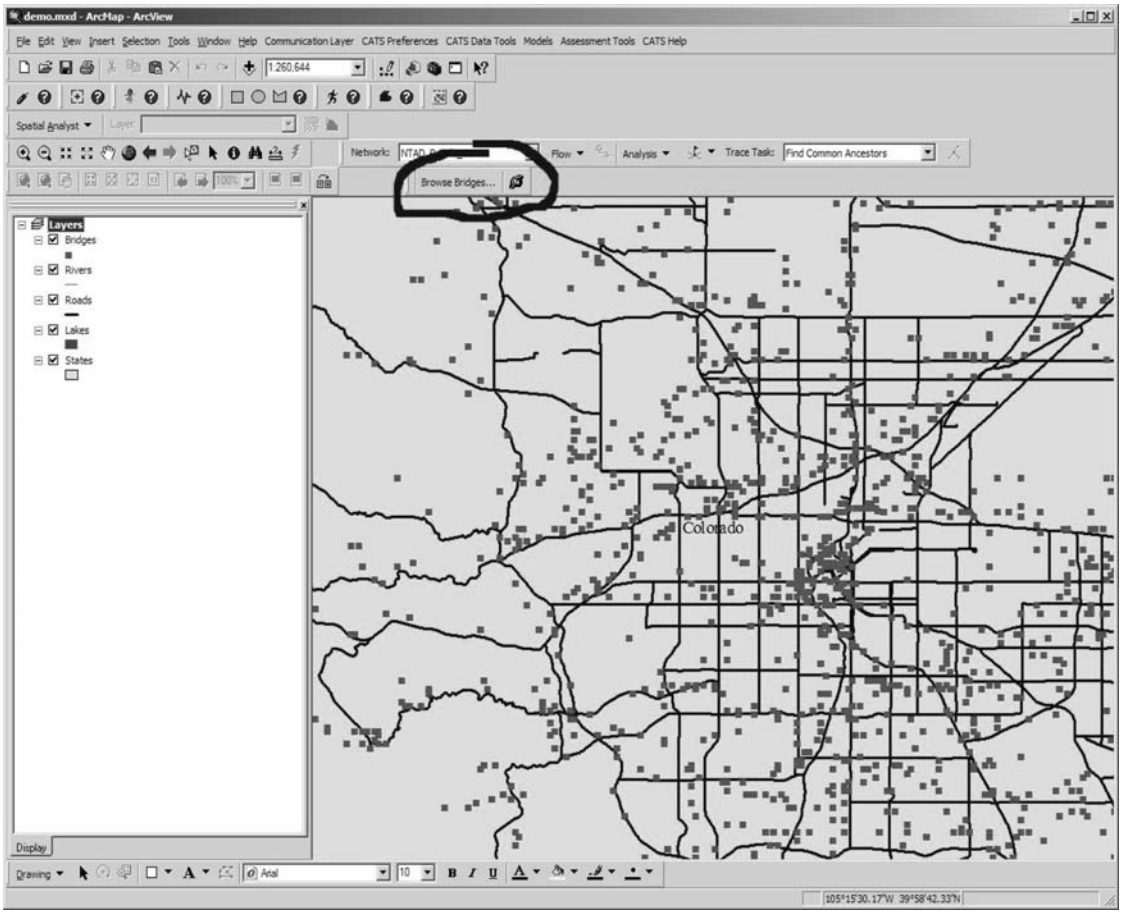

Exhibit 4. ArcGIS (version 9.0) toolbar and data display.

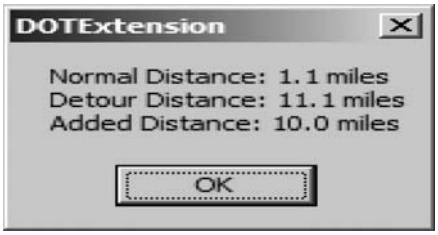

Exhibit 5. ArcGIS (version 9.0) detour result dialog box.

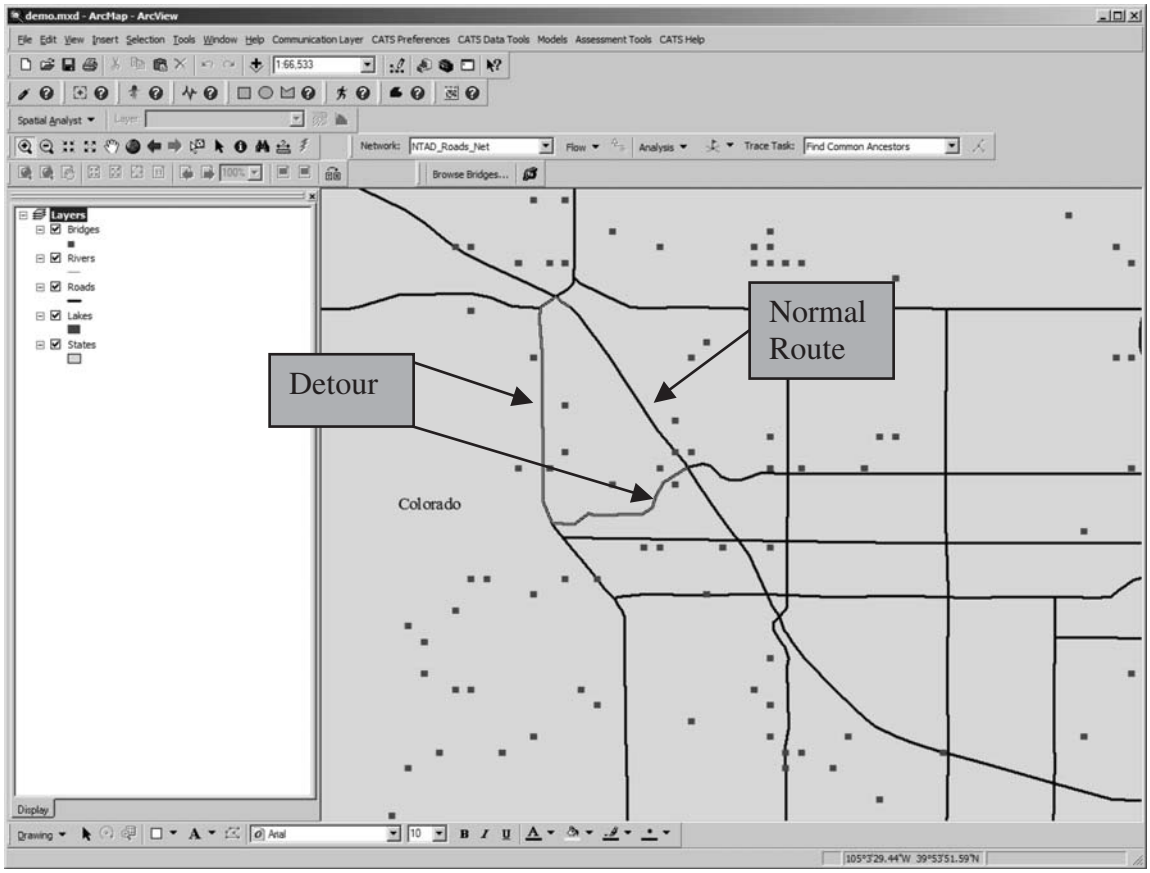

Exhibit 6. ArcGIS (version 9.0) visualization of detour.

APPENDIX

Summary of CATS Features

The Consequences Assessment Tool Set (CATS) is a powerful disaster analysis system for natural and technological hazards. A joint effort between the U.S. Defense Threat Reduction Agency (DTRA) and the U.S. Federal Emergency Management Agency (FEMA) inspired and directed the development of CATS. The Hazards Assessment and Simulation Operation of Science Applications International Corporation (SAIC) (available at www.saic.com) performed the development of CATS under the direction of FEMA and DTRA This appendix presents summary information on CATS. For more detailed information, visit the CATS website at http://cats.saic.com.

CATS Features

CATS provides a comprehensive package of hazard prediction models (natural hazards and technological hazards) and casualty and damage assessment tools. CATS also accepts real-time data from local meteorological stations.

CATS is supplied with over 150 databases and map layers. These include the location of resources to support response to specific hazards, infrastructure objects and facilities (communications, electric power, oil and gas, emergency services, government, transportation, and water supply), a variety of population breakouts and much more. It also offers the user the opportunity to add databases for custom analysis.

Although it was developed for DTRA and FEMA, CATS is now available to federal, state, and local government emergency response organizations nationwide.

Requesting CATS

CATS is available on an annual subscription basis to employees of federal, state, and local government agencies. There is no charge for military or other federal agency users. For all state, county, and local requestors, the charge is $850 per year. See http://cats.saic.com for further information.

States and Other Users of CATS

States

Alabama
California
Colorado
Florida
Hawaii
Iowa
Kansas
Kentucky
Louisiana
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
New Hampshire
New Jersey
New York
North Carolina
Ohio
Oregon
Pennsylvania
South Carolina
Texas
Utah
Washington
Wisconsin

Federal

U.S. Department of Defense (DOD)
U.S. Department of Transportation (DOT)
Federal Emergency Management Agency (FEMA)
National Aeronautics and Space Administration (NASA)
Centers for Disease Control/Agency for Toxic Substances and Disease Registry (CDC/ATSDR)
Federal Bureau of Investigation (FBI)
U.S. Army National Guard

City/County

Arlington, VA
Charleston, SC
New York City
Orange County, CA
San Diego, CA
West Valley City, UT

PART 2

DIETT Installation Instructions and User Guide

CONTENTS

CHAPTER 1

Installation Guide for DIETT

The Disruption Impact Estimating Tool—Transportation (DIETT) is a scenario-enabled estimating tool for identifying and prioritizing transportation choke points (TCPs) according to their potential economic impact on U.S. commerce. The software and hardware requirements, installation instructions, and data importation processes for DIETT are summarized below.

DIETT is configured to operate in two modes: (1) independent of CATS-JACE[1] and (2) within CATS-JACE.[2] However, regardless of the mode of use, independent or within CATS-JACE, the operation and structure of DIETT are the same. For simplicity, in this guide, references to DIETT relate to the independent (non-CATS-JACE) mode. The installation instructions refer to DIETT's use on personal computers (PCs), but an experienced CATS-JACE operator should be able to readily import DIETT into CATS-JACE.

The operation of DIETT requires a user with moderate knowledge of Microsoft Access (MS) Access and MS Excel. The configuration of DIETT requires a set of relatively recent versions of off-the-shelf basic software. For advanced functions, the user will need additional software.

1.1 Software and Hardware Requirements

Software and hardware should meet the minimum requirements listed in Table 1. It is particularly important to have the specified versions of the Microsoft software. DIETT will operate without ArcGIS version 9; however, without it some of the more advanced functions of DIETT will not be available.

1.2 Standard Installation

Installation instructions for loading DIETT onto a PC are provided in Table 2. Installation should proceed in the sequence listed.

1.3 Importing Users' Data

The preloaded data are in the "Geodatabases" folder, labeled "tcp.mdb." New data may be imported to merge with, replace, or augment the preloaded database. The new data or data file may be in MS Access format or in another database format. It is best to import the data from an external source into the database. Doing this ensures that the desired fields are loaded. Exhibit 1 shows the database table structure for data imported from the National Bridge Inventory (NBI) database. This database structure is recommended for imported or created data.

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[1] CATS-JACE is the acronym for Consequences Assessment Tool Set-Joint Assessment of Catastrophic Events, a program based on a commercial geographic imaging system (GIS). CATS-JACE is a configuration of CATS, a disaster analysis system, which is available as an off-the-shelf package. CATS-JACE was developed for the Federal Emergency Management Agency (FEMA), and the Defense Threat Reduction Agency (DTRA) to provide a comprehensive package of hazard prediction models (natural hazards and technological hazards) and a casualty and damage assessment tools. CATS-JACE has the capability to overlay event characteristics (e.g., dispersion paths), transportation (e.g., rail, highway networks), population, and business datasets to provide an understanding of the extent, magnitude, duration, and impacts of an event. CATS-JACE also accepts real-time data from local meteorological stations.

[2] DIETT was designed to operate within CATS-JACE because CATS-JACE is available to many state transportation and security agencies and because it already contains a relevant, specified optional module, ArcGIS (version 9.0), and other (unspecified) features. For more information on CATS-JACE, please access: http://cats.saic.com/.

Table 1. Minimum software and hardware requirements for DIETT.

MINIMUM SOFTWARE AND HARDWARE REQUIREMENTS	
Software	**Hardware**
Microsoft Windows 2000	Pentium III computer or better
Microsoft Office XP	1 GB free disk space
ArcGIS version 9.0 (optional)	256MB memory
	Screen resolution set to 1024 × 768 pixels
HELP	
If you have problems, please check the requirements, make needed adjustments, and try again. If the problems persist, please contact Stephan Parker of TRB's Cooperative Research Programs at SAParker@nas.edu or (202) 334-2554.	

Table 2. DIETT installation instructions for a personal computer.

INSTALLATION	
1	Go to www4.trb.org/trb/onlinepubs.nsf and click on "NCHRP Project Reports."
2	Click on *NCHRP Report 525, Volume 11*.
3	Save "DIETT " ZIP file to your computer.
4	Unzip DIETT files.
5	Install DIETT by double clicking on "install.bat."
6	When prompted, select "Next."
7	Select the default location or another location, and then click on "Next."
8	Click on "Install" on the "Ready To Install" screen.
9	Click on "Finish" and wait a few seconds.
10	Click on "Yes" to install the Microsoft.Net Framework 1.1* Setup.
11	Select "OK." The icon "DIETT" should appear on your desktop.
12	To run DIETT, double click the "DIETT" icon on your desktop.
HELP	
If you have problems, please check the requirements, make needed adjustments, and try again. If the problems persist, please contact Stephan Parker of TRB's Cooperative Research Programs at SAParker@nas.edu or (202) 334-2554.	

*** Microsoft.Net Framework 1.1** is redistributable software. It is a component of the Microsoft Windows operating system used to build and run Windows-based applications. For developers, the .NET Framework makes it easy to rapidly create powerful software that maximizes performance, scalability, opportunities for integration, reliability, security, and the end-user experience, while minimizing the costs of deployment and management. For more information, visit: *http://msdn.microsoft.com/netframework/technologyinfo/default.aspx*

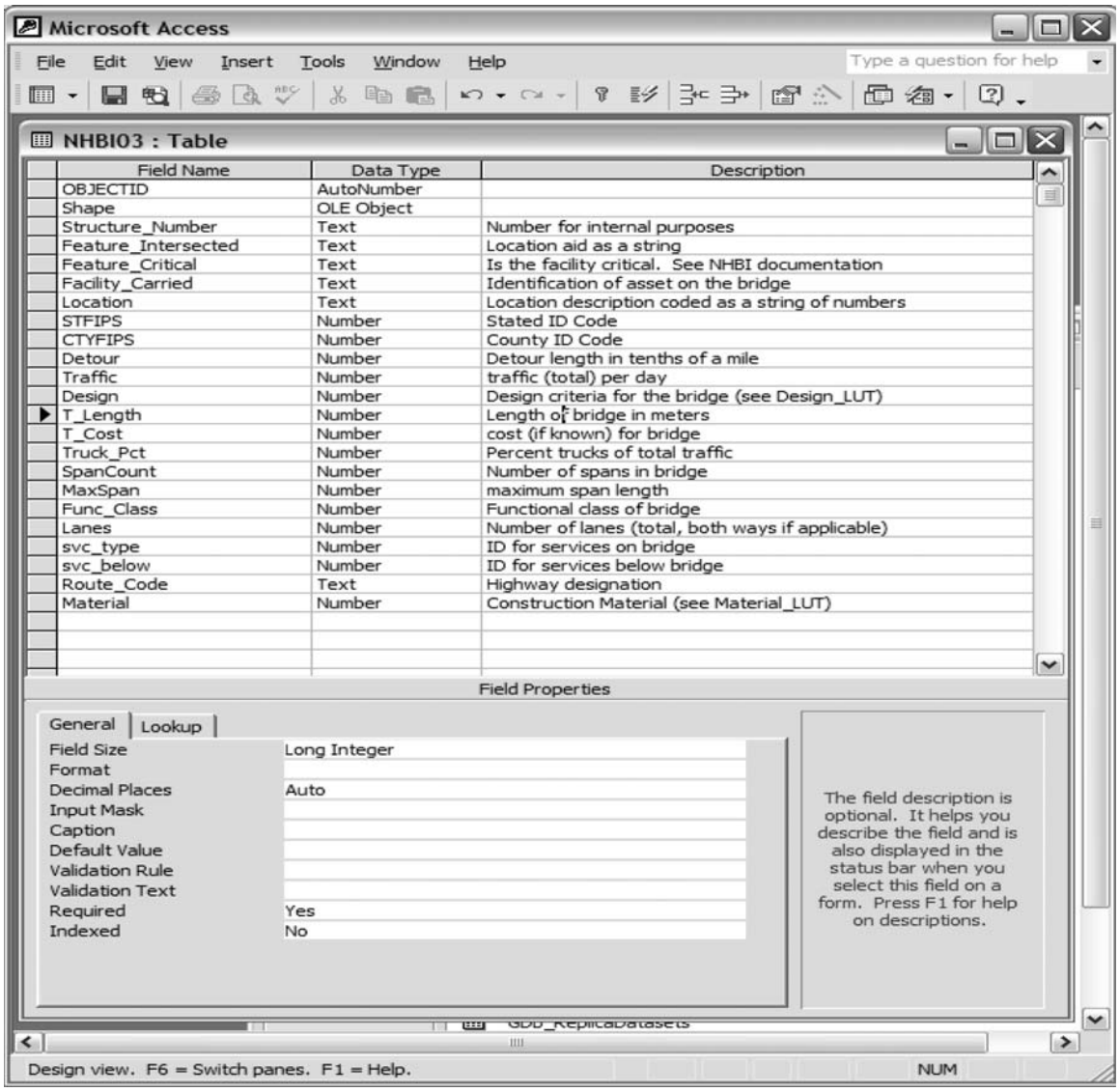

Exhibit 1. Sample recommended database structure—from NBI.

CHAPTER 2

User Guide for DIETT

DIETT consists of three submodules. This chapter provides instructions for each submodule.

2.1 DIETT Query System

The DIETT query system is the first program to trigger when the DIETT icon is clicked on. It is provided primarily to conduct the initial queries and to process the data for the first-order prioritization of candidate transportation choke points (TCPs). The program is set to transfer 500 fields or candidate TCPs. With a click on the "Next" button, the output of the queries is automatically transferred to MS Excel where it will be further analyzed and prioritized.

To start DIETT, click on the DIETT application icon on the desktop. This will launch the application and generate the query page shown in Exhibit 2. To set the parameters for queries, insert the information requested on the query page. At the bottom of the query page, brief instructions are given for using it (see Exhibit 2). A more detailed version of those instructions is given in the seven steps listed below. (Note that circled numbers 1–7 on Exhibit 2 correspond to the step numbers listed below.)

Step 1—State. Insert the name of the state to be modeled (for security reasons, data used to illustrate the use of DIETT were altered and entered as the data of an imaginary state—Fredonia).

Step 2—Trucks Per Day. Insert the desired category for minimum number of trucks using the trucks per day.

Step 3—Span Length (m). Insert the minimum length of the TCP (bridge) span in meters.

Step 4—Records. Track the count of candidate TCPs in the "Records" indicator. If the desired number of records is not reached (500 is recommended), reset the "Trucks Per Day" and "Span Length (m)" parameters. The two parameters should be adjusted in a balanced manner; make adjustments to both the truck and span parameters. Resetting of parameters may be repeated several times to generate the desired number of candidate TCPs.

Step 5—Scoring Method. Select the scoring method by clicking on the "Scoring Method" button and changing the key parameters, as seen in Exhibit 3. The scoring formula is a means of preselecting on the basis of estimated net transportation costs over the detour distance. The net transportation costs over the detour distance are estimated on the basis of average cost per ton-mile and a rough estimate of reconstruction time. Detailed analysis of the cost comes later, in the DIETT spreadsheet tool, after candidate TCPs have been identified and exported.

The score for each asset is determined by the following formula:

$$\textbf{Score} = \text{Days of Outage} \times \text{Detour Distance} \times \text{Cost per Ton} - \text{mile} \times \text{Trucks per Day}$$

$$\textbf{Days of Outage} = 3 \times \text{Span length} \Big/ \text{Meters of Reconstruction per Day}$$

Step 6—Sort on a Desired Category. Most of the column headings on the query page, "Value ($1000)," "Detour," "Traffic," "Span Length," etc. (see Exhibit 2), can be sorted on. The user may want to use the sort function if the number in "Records" (see Exhibit 2, circled number 4) exceeds 500. This will cause the program to work with the top 500 records. It is recommended that the column "Value ($1000)" be used because it utilizes a weighted approximation of value.

Step 7—"Next" and "Quit" buttons. Press the "Next" button to close the query application and open the spreadsheet application. Press the "Quit" button to exit DIETT.

Users should also be aware of the following:

- When the NBI database is used and the selected records indicate that the bridge crosses over a water body, a default for barge traffic is 4 barges per day, with a detour distance of 1 mile. For rail lines using the bridge, a default of 500 rail cars per day is assumed with 100 miles of detour. These

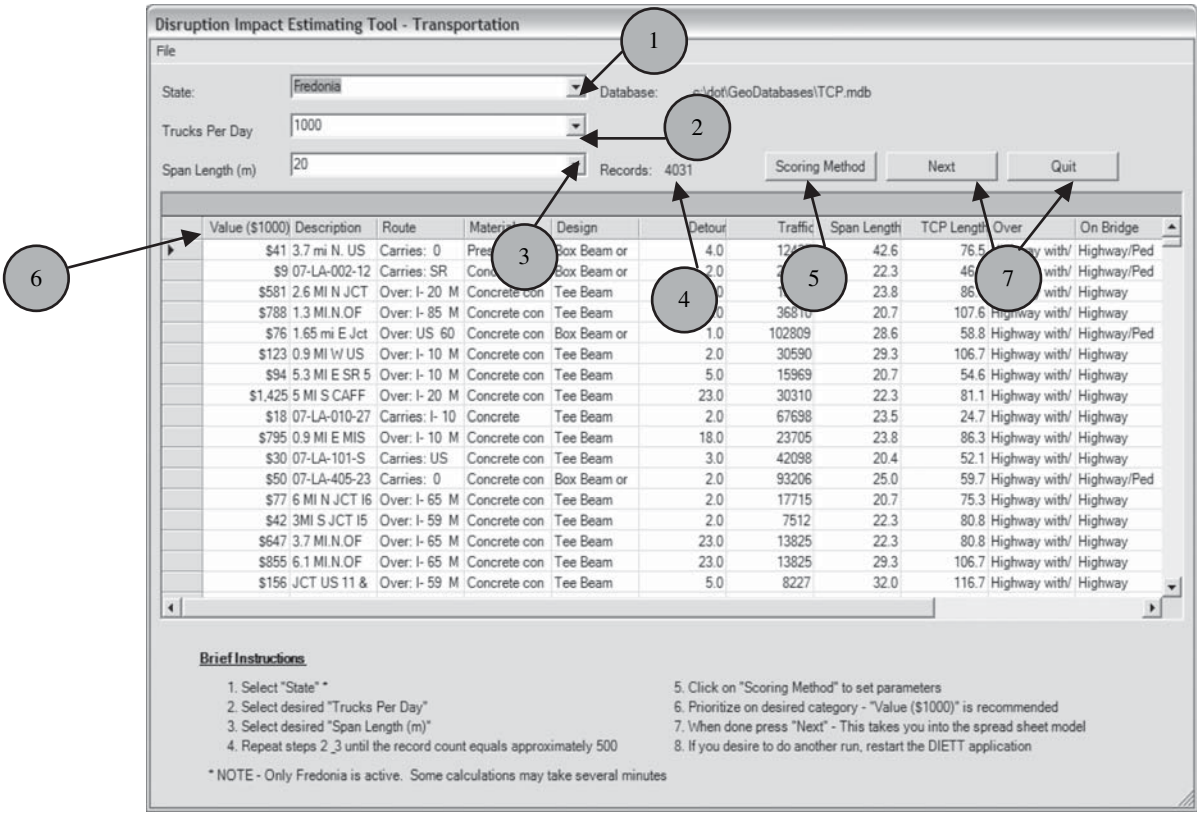

Exhibit 2. DIETT query page.

numbers (4 and 1 for barge, and 500 and 100 for rail) are automatically entered by the program but can and should be modified later to reflect the correct average daily barge and rail traffic. These adjustments can be readily made in the spreadsheet application.[3]

- Some calculations may take several minutes.

2.2 DIETT Spreadsheet—MS Excel

MS Excel is used to do the following:

- Modify default values for key transportation and economic parameters,
- Model and sort on transportation impacts of detours and delays,
- Model and sort on commerce-related economic impacts,
- Accommodate "refinements," and
- Generate the output of DIETT.

2.2.1 The INPUTS Worksheet

MS Excel is activated by pressing the "Next" button (see Exhibit 2) or by double clicking on the filename created in the c:\program files\saic\diett\\spreadsheets directory from Windows Explorer. The INPUTS worksheet shown in Exhibit 4 will appear.

The INPUTS worksheet is designed to generate prioritized lists of TCPs by changing default values for key parameters

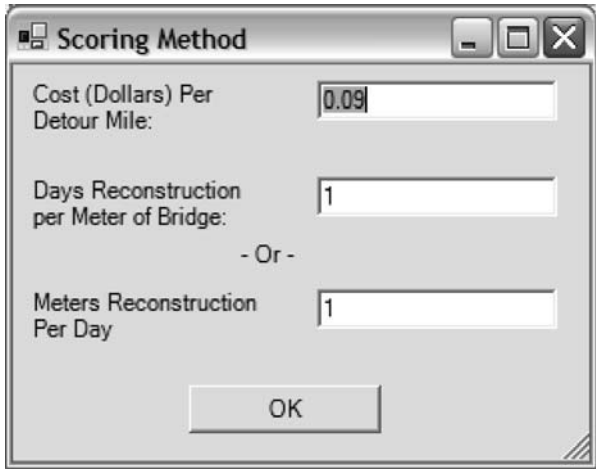

Exhibit 3. Scoring method box in DIETT.

[3] The detour distance for barges, 1 mile, is provided only as a placeholder. When a waterway is obstructed, barge traffic is generally not rerouted; rather, barges wait until the waterway is navigable. For barges, DIETT uses the time delay as the cost variable. In places with good canal networks, rerouting of waterway traffic may be possible. For such places, manual adjustments may be made in the spreadsheet.

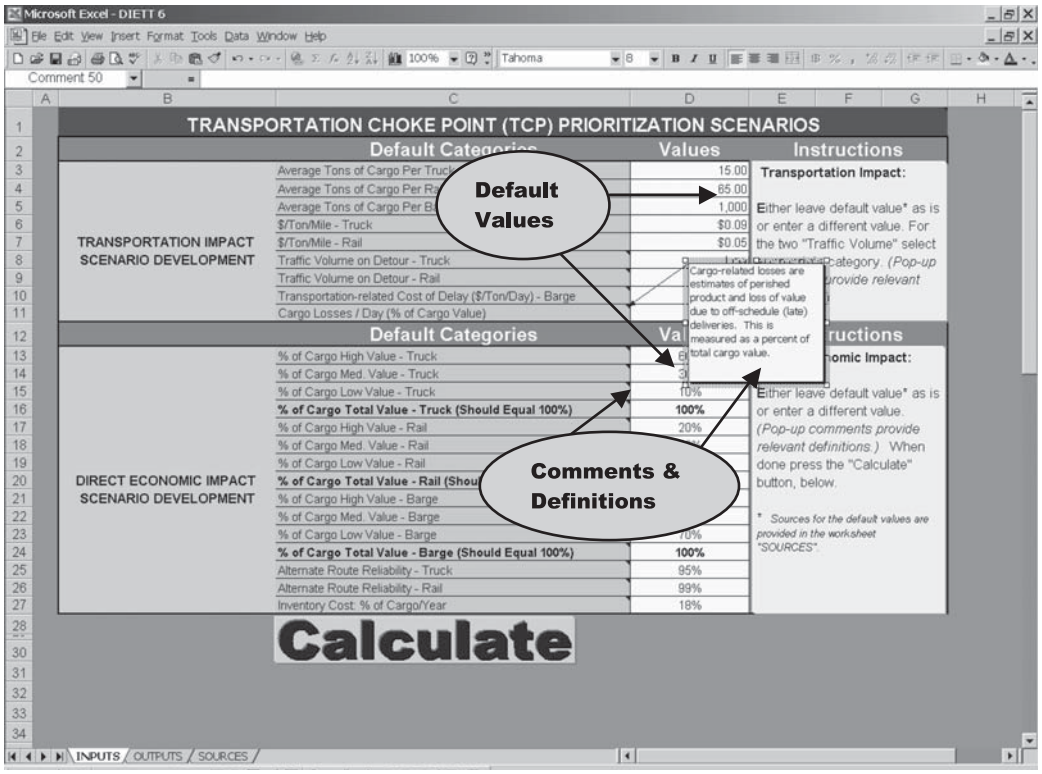

Exhibit 4. The INPUTS worksheet of the DIETT spreadsheet application.

without requiring the user to study the structure of the entire spreadsheet. Adjusting the default values listed on the INPUTS worksheet should be sufficient for the generation of the top-tier TCPs. Changing the values creates list scenarios (prioritized lists). Summary instructions for making the default value adjustments are provided on the screen.

The default values are grouped into those measuring transportation impact and those measuring direct economic impact (Exhibit 4).

Transportation impact measures the direct cost of the disruption to commercial (freight) shipping by measuring the net cost of using less direct routes—detours. For trucks and rail a $/ton/mile cost is used to adjust for the increased distance, and volume categories (low, medium, and high) are used to estimate the time-delay factor. For barges, costs of delay and cargo losses are the principal cost drivers. The default values provided are generalized, national-level estimates. These should be changed to better reflect state averages, and, for the selected top-tier TCPs, further (regional or local) refinements may be appropriate.

Direct economic impact measures the direct economic cost associated with increases in business costs caused by the introduction of a detour into freight shipments. The tool considers the costs associated with the increased time shipments spend en route as well as costs associated with altered risk (real or perceived). The default values reflect generalized approximations developed by the analysts. The default values should be changed to better reflect state averages, and, for the selected top-tier TCPs, further (regional or local) refinements may be appropriate.

After the default values are reset, click on the "Calculate" button, at the bottom of the screen to view results. This will calculate all the fields and take the user to the OUTPUTS worksheet (see Exhibit 5).

2.2.2 The OUTPUTS Worksheet

The OUTPUTS worksheet contains columns A through CG, but only shows columns A through F and CC through CG. Columns G through CB are hidden. The viewable portion of the OUTPUTS worksheet provides the disruption impact estimate. The results are displayed as follows:

- Column CC shows transportation-related impacts,
- Column CD shows direct economic impacts, and
- Column CE shows total impacts.

These columns are can be sorted. Column CE is the recommended sorting method. After sorting, some of the rows may contain "corrupted" data. These data require adjustment in the CHOKE POINTS worksheet.

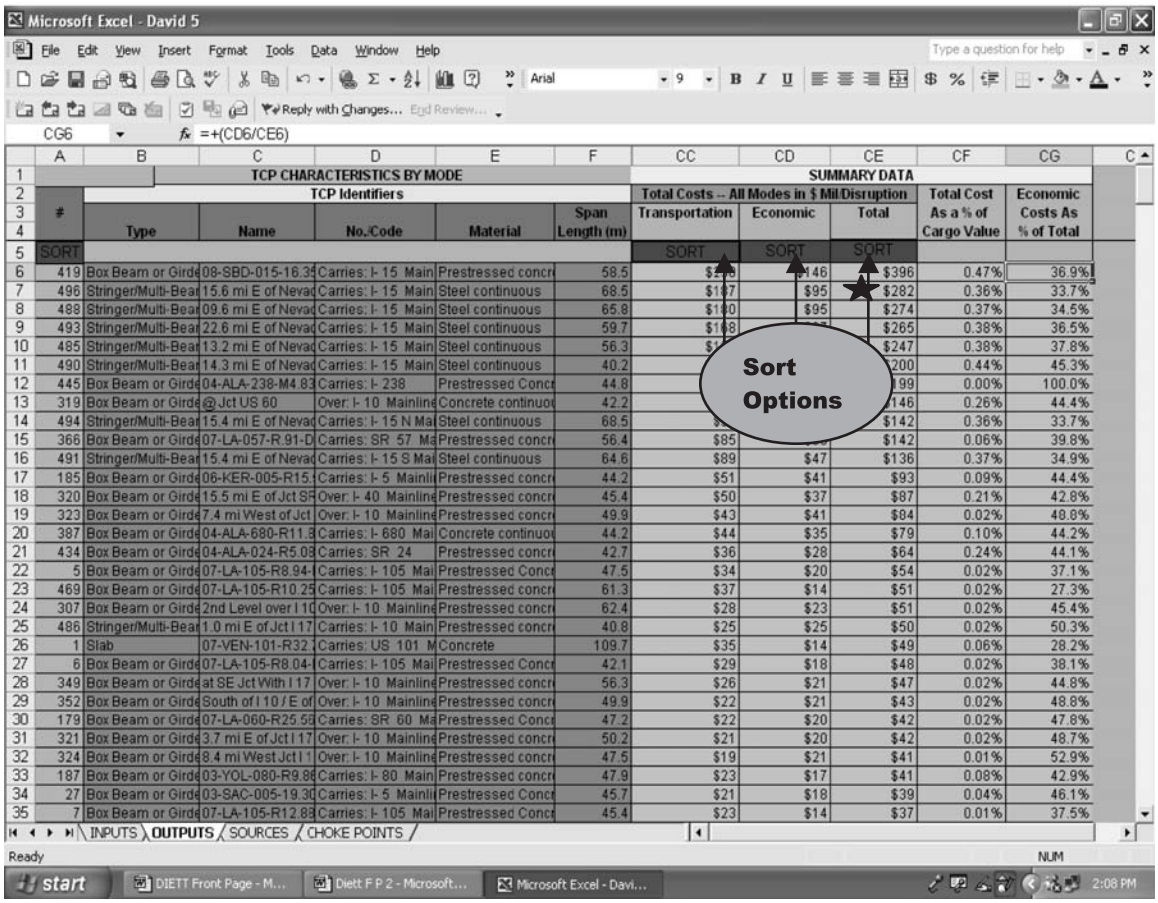

Exhibit 5. The OUTPUTS worksheet of the DIETT spreadsheet application.

2.2.3 The CHOKE POINTS Worksheet

The CHOKE POINTS worksheet contains the data imported from the DIETT Query System (see Section 2.1 and Exhibit 2). The CHOKE POINTS worksheet contains the raw data used by the algorithms in the OUTPUT worksheet. This is where changes to the raw data are to be performed. Suggested activities include the following:

- Review all data for outliers and suspicious numbers—these may be many repeats of large numbers such as 199 or 999 for detour distance, truck traffic that is larger than 30,000 trucks per day, bridge span that is larger than 2000 m, etc.
- Review data for missing information for rail traffic, barge traffic, span length, etc. (Note: span length with a value of "0" is a correct entry indicating that an adjacent TCP can be split to accommodate two-directional traffic.)
- Correct for number and detour distance for rail.
- Correct for number of barges.

After the top-tier TCPs are identified, additional refinements can be made to these candidate TCPs. The number of TCPs in the top tier should be about twice the number sought as the final output. For example, if the final list is to contain the top 25 TCPs for the state, the top tier should contain about 50 candidate TCPs. Refinements to the data should be made to reflect the realistic circumstances associated with the TCP (i.e., refine number of trucks, detour distance, congestion level, etc.).

After the data have been refined, go to the INPUTS worksheet, adjust the default values, and click on the "Calculate" button.

2.2.4 Changes to DIETT

An experienced MS Excel analyst can unhide columns G through CB to examine the detailed algorithms used in DIETT. These algorithms reflect generalized relationships and do not apply equally to all circumstances, TCPs, and states. DIETT can be customized to the needs of a particular state. Changes to the spreadsheet should be made so as to maintain structural functionality—the relationship between the imported data and the spreadsheet should be maintained.

Save all structural and functional changes to DIETT in a different file.

APPENDIX

DIETT Factsheet

What Is DIETT?

The Disruption Impact Estimating Tool—Transportation (DIETT) is an electronic analytical tool designed to assist transportation, security, and emergency-preparedness planners as they identify and prioritize potential high-value transportation choke points (TCPs) such as bridges, tunnels, and passes. These high-value TCPs are predominantly located along major commercial transportation routes, and a key area of concern is how disruptive events may affect the flow of commercial shipments through TCPs. DIETT calculates the direct transportation and economic impacts (costs) of an event that precludes the use of a TCP, and it prioritizes on these transportation assets on the basis of economic criteria. DIETT does not calculate replacement costs. Decision makers can use DIETT's prioritized sets of outputs, along with other risk information, to better focus their capital resources, security, and emergency-preparedness planning.

Who Can Benefit from Using DIETT?

Although DIETT is specifically designed to assist state departments of transportation and other state security and emergency-preparedness organizations, prioritized state results can be readily merged to identify candidate TCPs for use in regional or national prioritization schemes. Localities and metropolitan areas can also work with area-specific data to assess their TCP priorities. Although DIETT is designed to prioritize on the basis of direct transportation and economic impacts, it can be expanded by adding other criteria of interest to the user and thus can be applied in numerous applications. A generalized schematic of DIETT is provided in Exhibit 1.

How Does DIETT Work?

DIETT is an auto-executable program that employs commonly used software and user-supplied data to generate a prioritized list of TCPs. It is composed of two interconnected off-the-shelf programs and a set of specified and unspecified optional programs. The off-the-shelf programs are Microsoft (MS) Access and MS Excel.

- **MS Access** is used to select the first-tier candidate TCPs from user-supplied databases and to connect to MS Excel.
- **MS Excel** is used for modeling transportation and economic impacts and for generating the input and output presentation module. Interim scenario development and final prioritizations are also performed in MS Excel. All of the MS Excel modeling and presentation features are preprogrammed. The MS Excel part of DIETT is structured to calculate the transportation-related and the economic-related impacts (costs) and to facilitate the development of alternate scenarios. Automatic sort functions are included to allow for ease of prioritization.

Although DIETT is packaged on its own and can run on its own, in order to fine-tune the prioritizations developed in DIETT, it is recommended that DIETT reside in the Consequences Assessment Tool Set-Joint Assessment of Catastrophic Events (CATS-JACE). CATS-JACE, a configuration of CATS, is a consequence management package that integrates hazard prediction, consequence assessment, emergency management tools (including the Hazard Prediction and Assessment Capability [HPAC] system) and critical population and infrastructure data within a commercial geographical information system. CATS-JACE is available to state agencies and contains ArcGIS (version 9.0), which can be used to refine the detour lengths specified in the base data (e.g., National

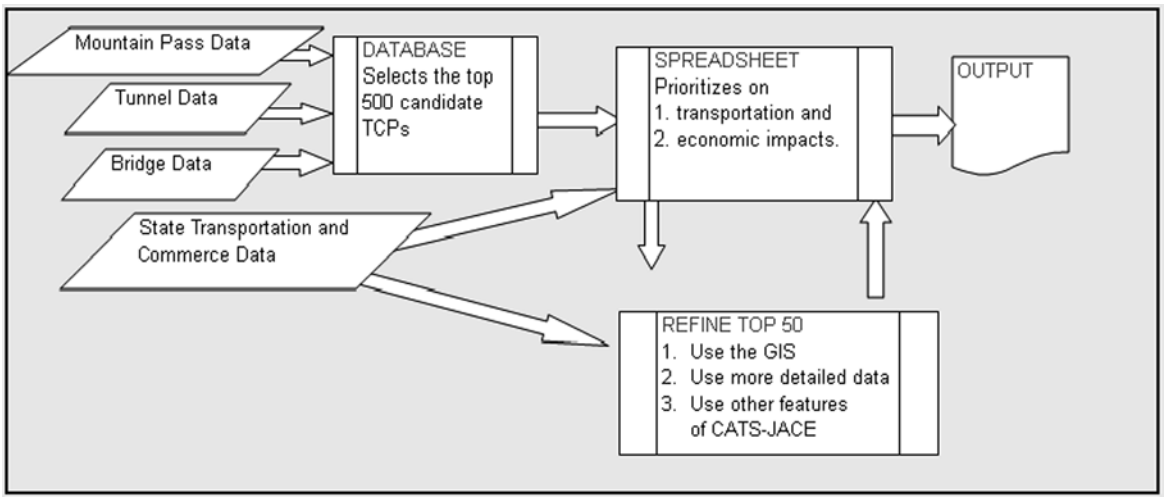

Exhibit 1. Generalized schematic of DIETT.

Bridge Inventory [NBI]). The Defense Threat Reduction Agency (DTRA) and the Federal Emergency Management Agency (FEMA) developed CATS-JACE to support emergency managers' training, exercises, contingency planning, and logistical planning, and to calculate requirements for humanitarian aid and force protection. For more information on CATS-JACE, see http://cats.saic.com/. DTRA provides CATS-JACE software and training; please see http://www.dtra.mil/toolbox/directorates/td/programs/acec/training.cfm.

Detailed installation and operating instructions for DIETT are provided in Part 2 of NCHRP Report 525, Volume 11. For security reasons, data used to illustrate the use of DIETT were altered NBI data from different U.S. states entered as the data of an imaginary state—Fredonia.

SECURITY CAUTION

When DIETT is used with actual data, the results could not only help users with legitimate purposes, but also those intending to disrupt the U.S. transportation infrastructure. Therefore, DIETT outputs should be guarded, and access should be limited to those with a "need to know."

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation