

APPENDIX B

NCDOT REDBOOK WIZARD USER MANUAL

Introduction

In August 2003, the American Association of State Highway and Transportation Officials (AASHTO) produced an updated *User Benefit Analysis for Highways* manual, commonly referred to as the AASHTO Redbook. This manual documents the state-of-practice concerning user benefit methodology for highway construction projects. A Redbook Wizard software tool is included with the manual as a supplement. The Wizard also includes its own User Manual. However, the Redbook Wizard User Manual does not explain the various input parameters. Hence, the research team has developed this *NCDOT Redbook Wizard User Manual* to provide guidance on the input parameters and discuss appropriate default values for construction projects in North Carolina.

The *NCDOT Redbook Wizard User Manual* uses the framework of the original Redbook Wizard User Manual. The original User Manual has been modified to fill the needs and provide examples for the North Carolina Department of Transportation (NCDOT). The AASHTO Redbook is also used throughout this user manual to provide more in-depth discussion.

This *NCDOT Redbook Wizard User Manual* is designed to assist the NCDOT analyst in determining the benefits and benefit/cost ratio of various types of highway construction projects. It is assumed that project costs are available from other NCDOT methods and staff. This manual will describe guidelines and point out potential pitfalls in the Redbook Wizard. North Carolina default values will be discussed where applicable. Steps in this manual generally follow the AASHTO Redbook methodology and help the analyst decide default and input data to use.

This manual goes through each step in the Redbook Wizard that a user would encounter with a single segment project. A project with multiple segments would be very similar except that some steps would be repeated for each additional segment. Detailed explanations of default values for certain input parameters are found in Table 1 and Table 2. Case studies of various projects are located in the Appendix C to give the user examples of how the AASHTO Redbook has been applied to several types of projects.

The NCDOT Redbook Wizard is a customized version of the Redbook Wizard distributed with the AASHTO *User Benefit Analysis for Highways Manual*. Each user of the NCDOT Redbook Wizard should purchase a copy of the AASHTO Redbook and companion Wizard prior to using the NCDOT Redbook Wizard.

Starting the Wizard

1. Open Redbook Wizard.xls
2. If your macro security level is not set to “high”, you will be asked whether you want to enable macros. Press “Enable”.

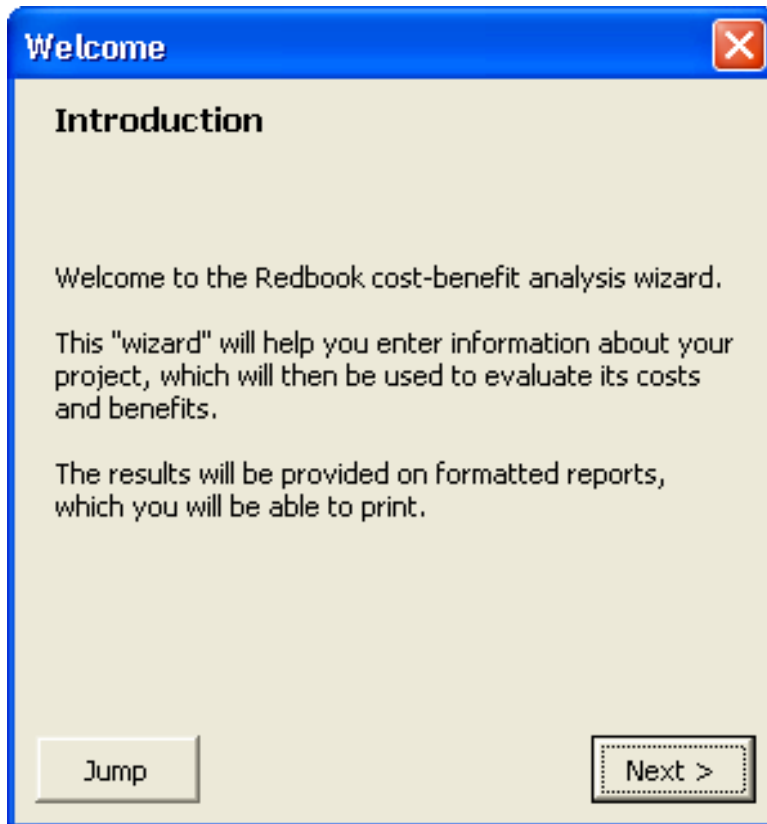
If your security level in Excel is set to “High”, you will be warned that you cannot run macros in this document. To change your security level, go to the “Tools” menu and choose “Options”. Click on the “Security” tab, and then on the “Macro Security” button. Change your macro security level to “medium” (“low” is not a good idea). Close and reopen the Wizard. You will be asked whether to enable macros. Press “Enable”.

3. You will see:


To begin, save a copy of this file under a new name, and then click "Go!"



4. From the “File” menu in Excel, choose “Save As”. In the Save As dialog box, choose an appropriate location for your saved file, and give it a name that identifies it with the project you will be evaluating. This name will show at the top of your results when you print them. Then press “Save”.
5. Press “Go!”. You will see the first dialog box of the Wizard.



6. Press "Next >" to continue. The next screen provides instructions about how to use the wizard. After reading it, press "Next >" to continue.

Welcome 

Navigation


Each screen is formatted similarly.

Some screens (such as this one) simply provide information on what to expect next. Most screens (like the next one) let you enter information.

To go back to the previous screen, click "< Back". To continue to the next screen, click "Next >". To jump to a particular screen, click "Jump" and pick a screen from the list. Asterisks indicate screens you've visited.

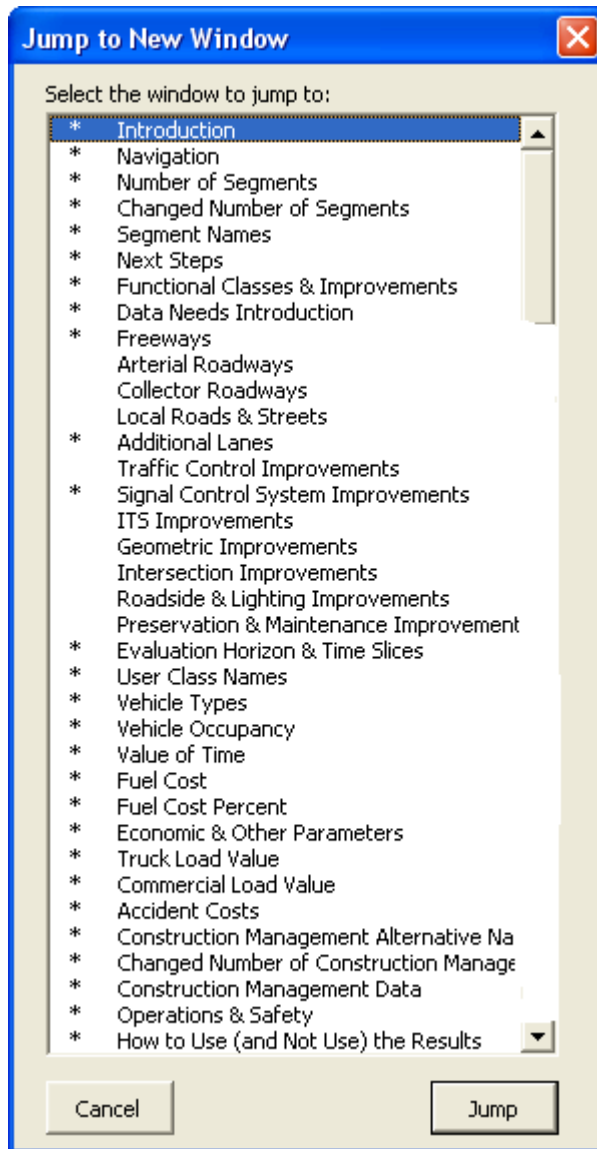
If you need to stop before you finish entering data, close the dialog. Your work up to, but not including, the current screen will be saved. When you start again, click "Jump" and select the last screen with a * by it.

Sometimes, guidance about the information you should provide on a particular screen will be displayed here.

 [Hyperlinks to documents providing more information appear here.](#)

How to Use the “Jump” Tool

The “Jump” tool can be very helpful for the analyst if it is used effectively. The tool allows the user to advance to further steps; this is especially useful when re-evaluating a project or changing a parameter. The “Jump” tool can be difficult to use for an analyst who is just beginning to use the Redbook Wizard. Most of the jump categories are labeled exactly as they are labeled in the Redbook Wizard. The asterisks represent wizard steps that the user has visited.



Two categories in the jump menu contain multiple steps in the wizard: Construction Management Data and Operations & Safety.

Construction Management Data contains:

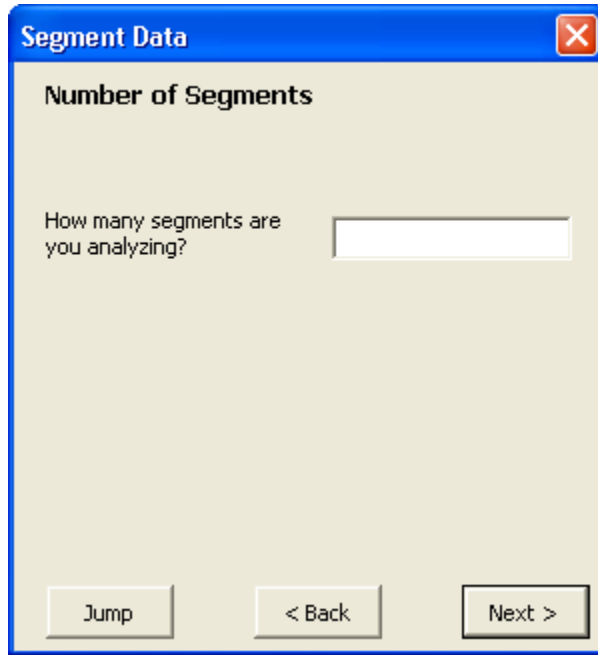
- Project Costs
- Accident Data (During Construction)
- Delay (During Construction)

Operations & Safety contains:

- Base Case Traffic Data (volume, capacity, and free-flow speed)
- Base Case User Class Data
- Base Case Accident Data
- Base Case Operating Costs
- Improved Case Traffic Data (volume, capacity, and free-flow speed)
- Improved Case User Class Data
- Improved Case Accident Data
- Improved Case Operating Costs
- Terminal Value
- Traffic Conversion Factors

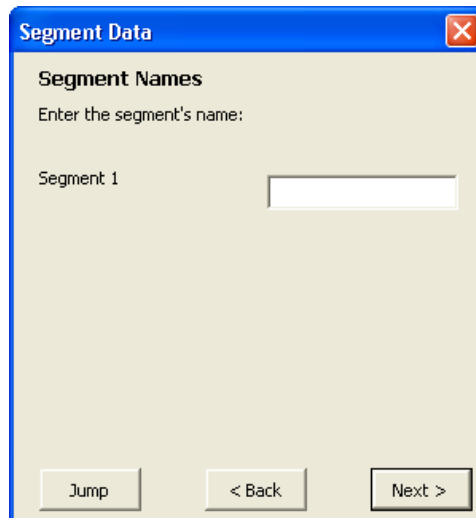
Define Your Project

1. How many segments will you be analyzing? The Wizard examines each segment separately and then combines the results by segment at the end of the analysis. You may want to use a different definition of “segment” in this analysis than you use in your maintenance program or in your traffic model. You can combine small segments if they have the same volume and capacity. You may also want to define a “rest of network” segment to capture changes in delay on unimproved, parallel links. When entering data into the wizard, no alpha characters should be used, including commas or dollar signs.



The screenshot shows a dialog box titled "Segment Data" with a close button (X) in the top right corner. The main heading is "Number of Segments". Below this, the text reads "How many segments are you analyzing?". To the right of this text is an empty text input field. At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

2. Give names to your segments. These should be names that are meaningful to you. The Wizard only uses these names as title place holders.

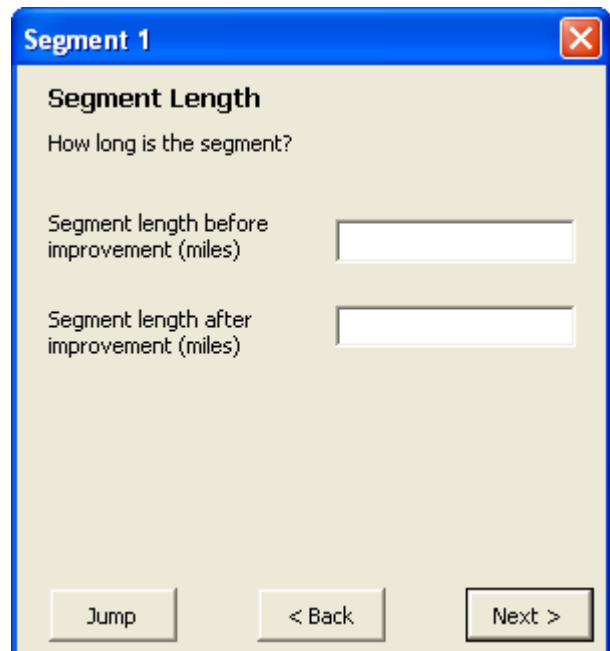
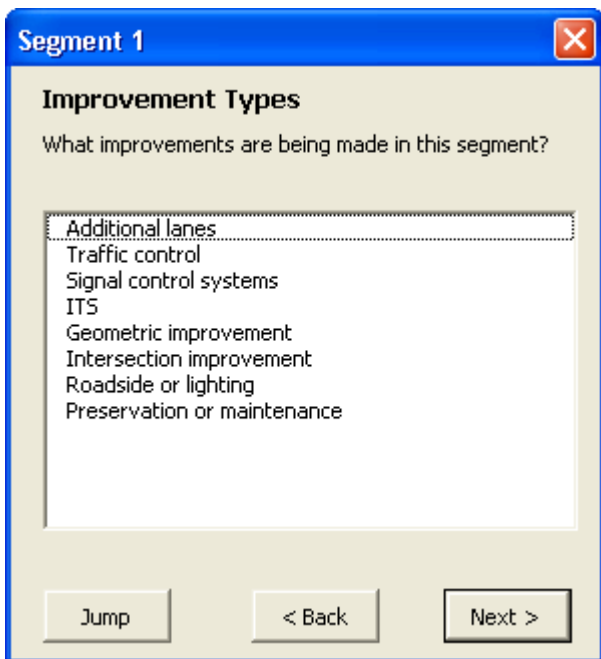
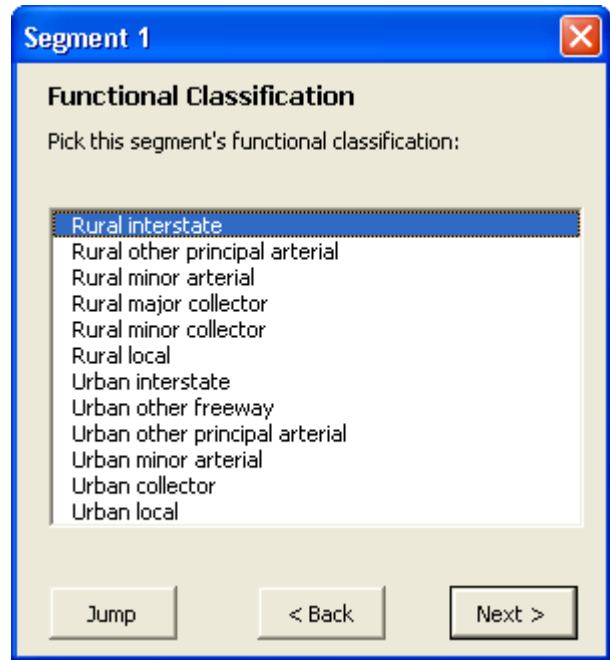
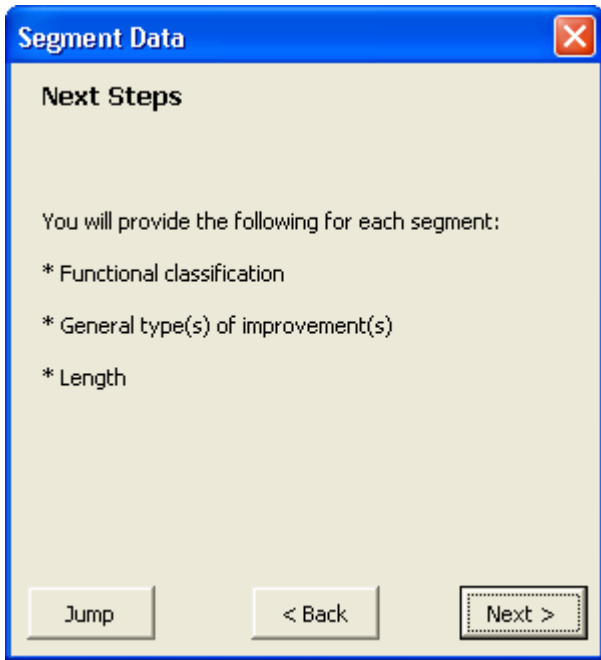


The screenshot shows a dialog box titled "Segment Data" with a close button (X) in the top right corner. The main heading is "Segment Names". Below this, the text reads "Enter the segment's name:". Underneath, there is a label "Segment 1" followed by an empty text input field. At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

- Describe your segments. For each segment, you will be asked to choose a functional classification, the types of improvements on that segment, and the segment's length before and after the improvement in miles.

You may choose more than one improvement type for a given segment. Hold down the control key while clicking on additional improvement types to select more than one.

The name you gave to the segment you are being asked about will show at the very top of the dialog.



Description and Examples of Improvement Types (from the AASHTO Redbook with additions)

Additional Lanes: This is the conventional method of adding capacity, and can take various forms. Additional lanes could actually be referred to as additional capacity. This improvement type should be selected when additional lanes are added. For example, turning a two-lane road into a four-lane road would be considered additional lanes. An example of adding capacity, while not necessarily adding lanes, is converting a four-lane highway into a four-lane freeway with full-access control.

Traffic Control: Signals, signs, ramp metering and roundabouts can be added to existing roads, or incorporated in new roads to enhance effective capacity.

Signal Control Systems: Existing signalization systems can be enhanced to change timing and coordination of traffic flows.

ITS: These are improvements that allow the road or the user to respond to changing conditions on the road. ITS improvements include such things as variable or incident signage, incident management, and on-board navigation aids.

Geometric Improvement: Geometric improvements occur in the curvature and grade of the roadway. Improvements to road geometry are generally targeted at improving safety by reducing curve angles. These improvements are categorized into the following groups: horizontal and vertical curves.

Intersection Improvement: Intersection improvements can sometimes be confused with the other more specific improvements, such as geometric improvement or traffic control. For analysis in the Redbook Wizard, intersection improvements include the alteration of a skew angle, exclusive left-turn and right-turn lanes, and intersection sight distance.

Roadside or Lighting: Roadside or lighting improvements provide safety enhancements to road users. Roadside or lighting projects improve roadside features to reduce the occurrence and severity of accidents should the vehicle leave the road. Some roadside improvements include: roadside topography and drainage features, sign and luminaire supports (and similar structures), roadside barriers, median barriers, bridge railings and transitions, and barrier end treatments and crash cushions.

Preservation or Maintenance: Preservation projects are a road improvement activity involving significant renovation of the existing roadway without adding to the road's effective capacity. Maintenance projects involve the activities needed to keep a highway and its appurtenances in serviceable condition.

Refer to Redbook for more detailed definitions of the project improvement types.

Data Needs

The next screens tell you what data you will need to answer questions about the functional classes and improvements you have chosen. Here are some of the screens you might see:

The image displays three overlapping windows titled "Data Needs".

- Top Window: Data Needs Introduction**

The following screens describe the kinds of information you'll need to provide for each facility and improvement type.
- Middle Window: Freeways**

You'll need to provide the following information for freeway segments:

 - * Peak hour, peak direction traffic volume (PCE/h)
 - * Free flow speed (ft/h)
 - * Peak direction capacity (veh/h)
 - * Number of accidents by type (property damage, injury, fatal)
 - * Number of lanes
 - * Agency operating costs

The following Redbook sections provide more information:
- Bottom Window: Additional Lanes**

You'll need to provide the following information about added lanes:

 - * New peak hour, peak direction traffic volume (PCE/h)
 - * Free flow speed (ft/h)
 - * Peak direction capacity (veh/h)
 - * Number of accidents by type (property damage, injury, fatal)
 - * Change in travel time due to delay
 - * Agency operating costs

The following Redbook sections provide more information:

 - * Equations 5-17 through 5-22
 - * Tables 5-9, 5-10, and 5-11
- Bottom Window: Intersection Improvements**

You'll need to provide the following information about intersection improvements:

 - * New peak hour, peak direction traffic volume (PCE/h)
 - * Free flow speed (mph)
 - * New peak direction capacity (veh/h)
 - * Number of accidents by type (property damage, injury, fatal)
 - * Change in travel time due to delay
 - * Agency operating costs

The following Redbook sections provide more information:

 - * Equations 5-17 through 5-22
 - * Tables 5-9, 5-10, and 5-11

At the bottom of the "Intersection Improvements" window, there are buttons for "Jump", "< Back", "Next >", and an information icon with the text "Open the Redbook".

Analysis Period

You will next be asked questions about the relevant dates for your analysis. NCDOT refers to the “Last year of analysis period” as the Design Year.

Analysis Period

Evaluation Horizon & Time Slices

Enter information about the period of time covered by this analysis:

Year construction begins

Year operation begins

Last year of analysis period
(no more than 50 years from first year of)

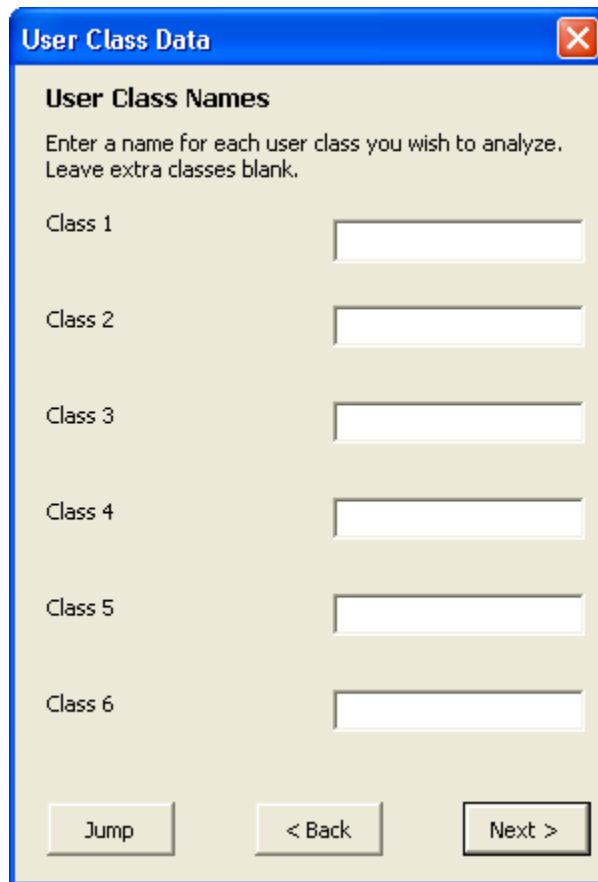
Base year

Jump < Back Next >

User Classes

You can have up to six user classes. User classes might be differentiated by vehicle characteristics or by purpose of trip.

1. First, you will provide names for your user classes. These names should be meaningful to you. The Wizard only uses them as title place holders. The typical user class names are “Autos” for the standard passenger vehicle and “Trucks” for trucks such as duals and TTSTs.



User Class Data

User Class Names

Enter a name for each user class you wish to analyze.
Leave extra classes blank.

Class 1

Class 2

Class 3

Class 4

Class 5

Class 6

Jump < Back Next >

2. You will then pick a vehicle-type category for each user class from the drop-down menu. You may assign a specific type of vehicle, a group of vehicle types (e.g., all cars), or “all vehicles”.

The options for vehicles types in the drop-down menu include: All cars, All commercial vehicles, Small car, Large car, SUV, Van, 2-axle single-unit truck, 3-axle single-unit truck, Tractor/trailer, Transit bus, and All trucks.

User Class Data

Vehicle Types

Assign a vehicle type to each user class:

Autos

Trucks

Jump < Back Next >

3. You will then specify average vehicle occupancies for each user class. Refer to Tables 1 and 2 for information on choosing the vehicle occupancy rates.

User Class Data

Vehicle Occupancy

Enter the average number of vehicle occupants for each user class:

Autos

Trucks

Jump < Back Next >

4. You will then indicate a value of time (in base-year dollars per hour) for each user class. The value you specify should be a weighted average for all occupants. For example, if a class has an average of 1.5 occupants and the driver's time is valued at \$20 per hour and the passenger's time is valued at \$10 per hour, the specified value should be \$16.67 per hour

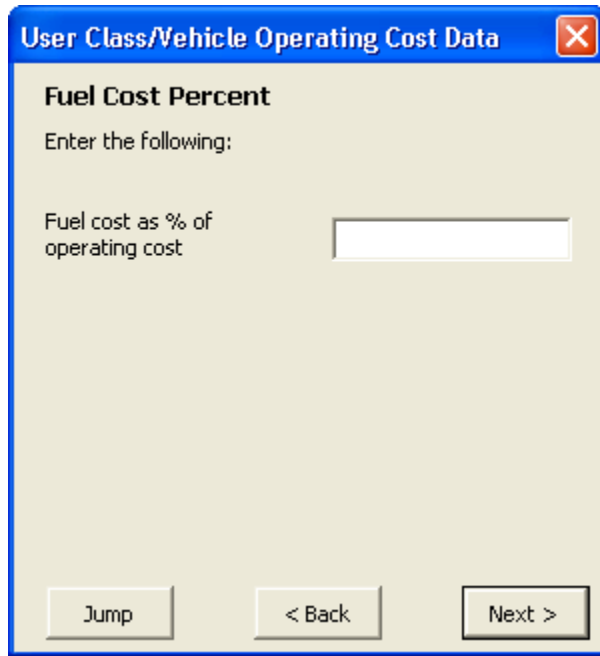
$(\$20 \times 1 + \$10 \times 0.5) / (1 + 0.5) = \16.67 . Refer to Tables 1 and 2 for information on selecting values for Value of Time.

The screenshot shows a dialog box titled "User Class/Economic Data" with a close button (X) in the top right corner. The main heading is "Value of Time". Below the heading, there is a text instruction: "Enter the value of an hour of time for each user class. Enter a number only, with no dollar sign." There are two input fields: "Autos (\$/hour)" and "Trucks (\$/hour)". To the right of these fields, a note states: "Value of time is in base-year dollars per hour." At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

5. You will then specify fuel costs for each user class in base-year dollars per gallon. These are unlikely to vary by much, except in unusual cases. Refer to Tables 1 and 2 for information on selecting values for Fuel Cost.

The screenshot shows a dialog box titled "User Class/Vehicle Operating Cost Data" with a close button (X) in the top right corner. The main heading is "Fuel Cost". Below the heading, there is a text instruction: "Enter the cost per gallon of fuel for each user class. Enter a number only, with no dollar sign." There are two input fields: "Autos (\$/gal)" and "Trucks (\$/gal)". At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

6. You also will be asked to specify the percentage of vehicle operating costs that are fuel costs. Refer to Tables 1 and 2 for information on selecting the fuel cost percent.



The image shows a software dialog box with a blue title bar that reads "User Class/Vehicle Operating Cost Data" and a red close button. The main area has a light beige background. At the top, it says "Fuel Cost Percent" in bold. Below that, it says "Enter the following:". There is a label "Fuel cost as % of operating cost" followed by an empty text input field. At the bottom, there are three buttons: "Jump", "< Back", and "Next >".

Economic and Other Parameters

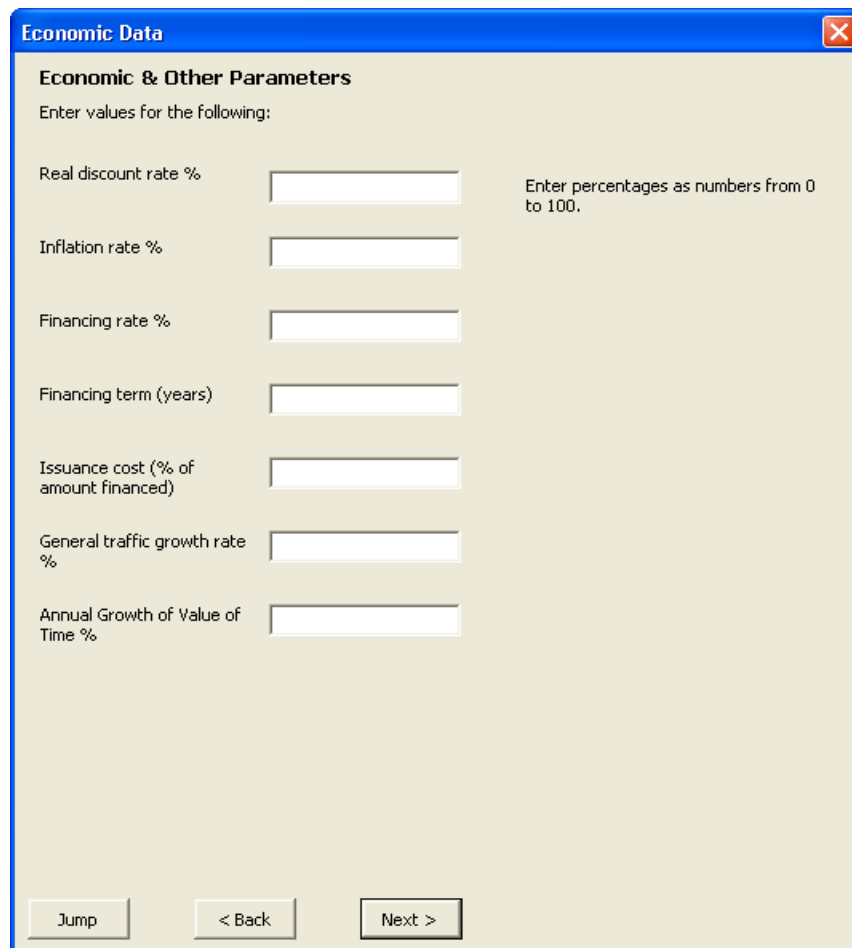
1. You will be asked to specify several economic parameters:

The discount rate is “real”, meaning it does not include inflation. Public investments typically are evaluated using real discount rates in the range of three to four percent. The inflation rate is the average annual rate of inflation expected over the life of the project. The financing rate and financing term are used if money is borrowed to construct the project. For NCDOT projects, these values are zero.

The issuance cost is the cost to the agency of obtaining financing as a percent of the amount financed. It is typically around two percent. For NCDOT projects, this value is zero.

General traffic growth rate is commonly called “background growth rate.” This is the overall growth rate of traffic volumes in the project region. The Traffic Engineering Branch can provide this value for your project. The annual growth in the value of time does not include inflation. It reflects increases in productivity over time. An annual rate of one to two percent is reasonable.

Refer to Tables 1 and 2 for information on selecting economic and other parameters.



The screenshot shows a software window titled "Economic Data" with a sub-header "Economic & Other Parameters". Below the sub-header, it says "Enter values for the following:". There are seven input fields, each with a label to its left and a text box to its right. To the right of the first input field, there is a note: "Enter percentages as numbers from 0 to 100." At the bottom of the window, there are three buttons: "Jump", "< Back", and "Next >".

Parameter	Input Field
Real discount rate %	<input type="text"/>
Inflation rate %	<input type="text"/>
Financing rate %	<input type="text"/>
Financing term (years)	<input type="text"/>
Issuance cost (% of amount financed)	<input type="text"/>
General traffic growth rate %	<input type="text"/>
Annual Growth of Value of Time %	<input type="text"/>

1. If your user classes include trucks or commercial vehicles, you will be asked about the value of cargo on those vehicles. The market interest rate represents the cost to a business of having its inventory delayed. The prime interest rate provides a reasonable value to use here. Refer to Tables 1 and 2 for information on selecting the truck load value and market interest rate.

Economic Data

Accident Costs

Enter the perceived user cost per accident for the following accident types.

Property damage only (\$) Don't use commas or dollar signs.

Injury (\$)

Fatal (\$)

Jump < Back Next >

Vehicle Operating Cost Data

Truck Load Value

Enter the average value of a truck load. Don't use commas or dollar signs.

Average truck load value (\$) Enter percentages as numbers from 0 to 100.

Market interest rate %

Jump < Back Next >

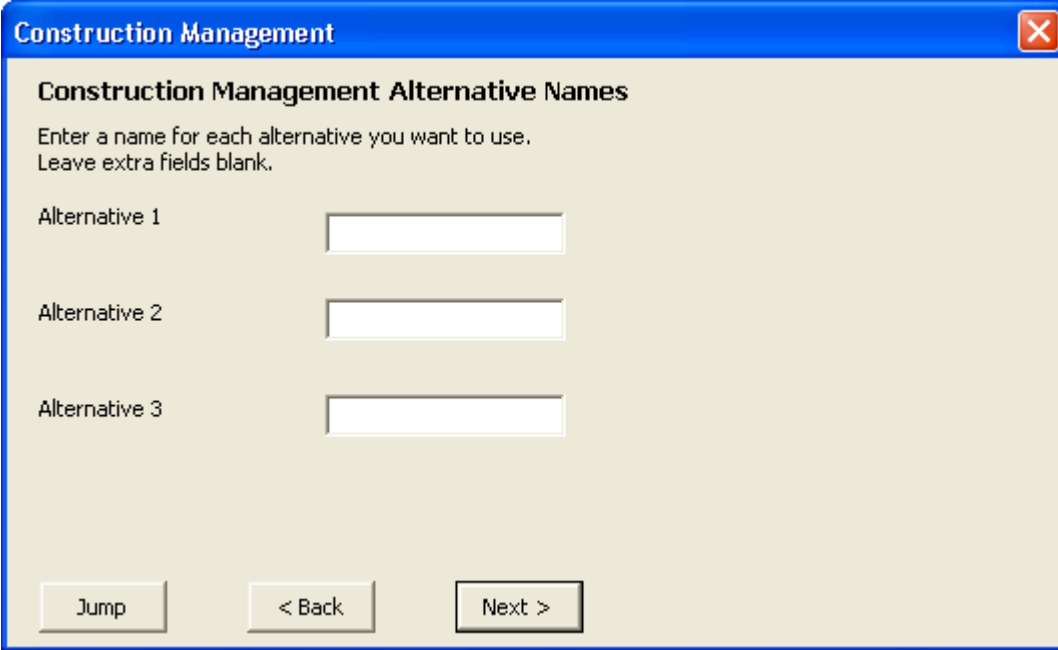
3. You will be asked to provide the perceived user costs of different types of accidents in base-year dollars. These are costs per accident (not per vehicle or per person), net of insurance reimbursement. The NCDOT Traffic Safety Engineer can provide the most up to date values

for the accident costs. Refer to Tables 1 and 2 for information on selecting the accident costs.

Construction Management Alternatives

You must have at least one construction management alternative for each segment. This section is where you will describe the costs of the project and the effects on users of the construction activity. You may define additional alternatives if you wish to evaluate the benefits and costs of alternative construction scenarios, such as working at night, lane rental, or incentive contracting.

1. Name your alternatives. You should choose names that are meaningful to you. If you have only one alternative, you can just call it “Construction”.



The screenshot shows a software window titled "Construction Management" with a close button in the top right corner. The main content area is titled "Construction Management Alternative Names" and contains the instruction: "Enter a name for each alternative you want to use. Leave extra fields blank." Below this instruction are three input fields labeled "Alternative 1", "Alternative 2", and "Alternative 3". At the bottom of the window, there are three buttons: "Jump", "< Back", and "Next >".

2. Specify the project costs in construction-year dollars. If the project requires additional right of way, which has already been obtained, enter what that right of way could be sold for if the project were not built. NCDOT includes Planning & Preliminary Engineering and Management & Construction Engineering with the Construction estimate. Therefore, Planning & Preliminary Engineering and Management & Construction Engineering can be set to zero and the reported amounts can be applied to Right of Way and Construction costs.

Segment 1 ✖

Project Costs: Construction

Enter project costs by category. Don't use commas or dollar signs.

Right-of-way (\$) Project costs are in construction-year dollars.

Planning & Preliminary Engineering (\$)

Management & Construction Engineering (\$)

Construction (\$)

- Specify the number of construction-related accidents expected during the construction period, by type. You can use a value of 0.01 to represent very small, but nonzero probabilities of construction-related accidents. In most cases, the predicted accidents during construction should be zero (0). NCDOT typically reports crash data for a three-year period, which must be divided for a yearly value (in most cases divide by 3) and then further divided for a peak direction value (in most cases divide by 2). In most cases, the overall conversion will require the total three-year crashes to be divided by 6.

Segment 1 ✖

Accident Data: Construction

Enter the number of accidents, by type, expected during construction.

Property damage only

Injury

Fatal

4. Describe the user delay expected from construction. If there will be no detour, answer “0” to the second and third questions.

Segment 1 [Close]

Delay: Construction

Enter the following:

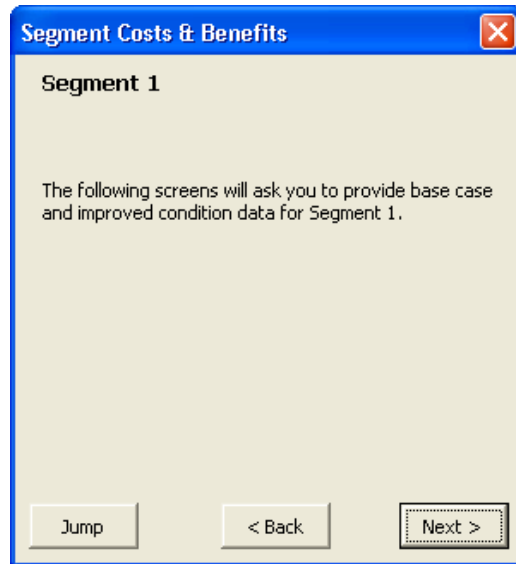
Total travel delay during construction (vehicle-hours)

Total added VMT on detour route (zero if no detour)

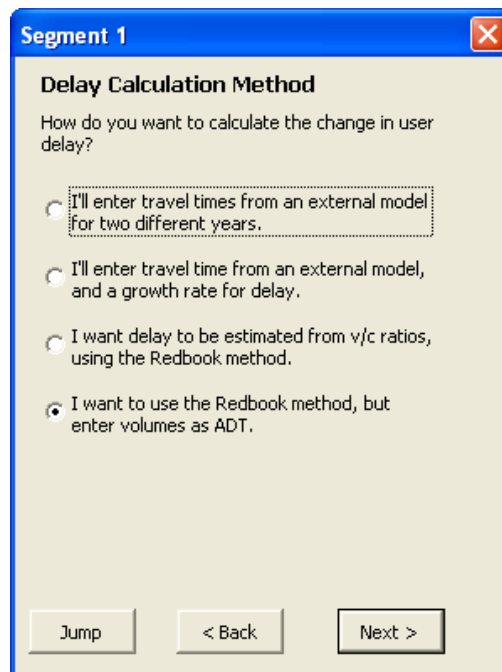
Vehicle speed on detour route (mph) (zero if no detour)

Base Case (Unimproved) Segment User Benefit Data

You will answer questions in a series of dialogs for each segment.



Next, the method for calculating delay must be selected. This is a step that the standard Redbook does not contain. The first two options require the user to calculate delay externally while the last two options use the Redbook method to calculate delay. Option four allows the user to input volumes as ADTs and calculates delay using the Redbook method. For most NCDOT studies, option four should be selected. The following steps in this user manual will guide the user through option four. If the user selects options one, two, or three, the steps will be similar, but require different inputs.



1. Describe traffic on the segment in the base (no improvement) case.

The capacity must be entered in passenger-car equivalents (PCE). The capacity can be found in a planning model or the Highway Capacity Manual. For the full description of concepts of PCE refer to the Highway Capacity Manual (HCM, page 13-7 – 2000 Edition).

Daily two-directional traffic volume must be entered as an ADT in vehicles per day. Traffic volumes can be entered either as one or two-directional volumes. For a one-direction volume, a D factor of 1 should be used in the appropriate slide. A value of less than 1 (Refer to Tables 1 and 2) should be used for two-direction volume.

The screenshot shows a software window titled "Segment 1" with a close button in the top right corner. The main heading is "Base Case Traffic Data". Below this, it says "Enter the following for the base year:". There are three input fields: "Daily two-directional traffic volume (vehicles/day)", "Peak direction capacity (PCE/hour)", and "Free-flow speed (mph)". To the right of these fields is a text box that reads: "Traffic volumes can be either one- or two-directional. Later on, you will enter a 'D' (directional) factor." At the bottom of the window are three buttons: "Jump", "< Back", and "Next >".

2. Specify the percentage of total peak-hour traffic (in PCEs) represented by each user class.

The screenshot shows a software window titled "Segment 1" with a close button in the top right corner. The main heading is "Base Case User Class Data". Below this, it says "Enter the % of traffic volume composed of each user class:". There are two input fields: "Autos" and "Trucks". To the right of these fields is a text box that reads: "Enter percentages as numbers from 0 to 100. The percentages must sum to exactly 100." At the bottom of the window are three buttons: "Jump", "< Back", and "Next >".

3. Specify the annual number of accidents expected on the unimproved segment in the peak direction. Use 0.01 to represent non-zero probabilities of accidents, even if no accidents occurred on that segment in the base year. Using 0.01 will allow the model to function properly and apply a growth rate to the accidents. NCDOT typically reports crash data for a three-year period, which must be divided for a yearly value (in most cases divide by 3) and then further divided for a peak direction value (in most cases divide by 2). In most cases, the overall conversion will require the total three-year crashes to be divided by 6.

The screenshot shows a dialog box titled "Segment 1" with a close button in the top right corner. The main heading is "Base Case Accident Data". Below the heading, it says "Enter the annual number of accidents by type for the base year:". There are three input fields: "Property damage only", "Injury", and "Fatal". At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

4. Specify the annualized, average cost to the agency of maintaining and operating the segment without the improvement, over the life of the project, in base-year dollars.

The screenshot shows a dialog box titled "Segment 1" with a close button in the top right corner. The main heading is "Base Case Operating Costs". Below the heading, it says "Enter the following for the base year:". There is one input field labeled "Annual agency operating costs (\$)". At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

Improved Segment User Benefit Data

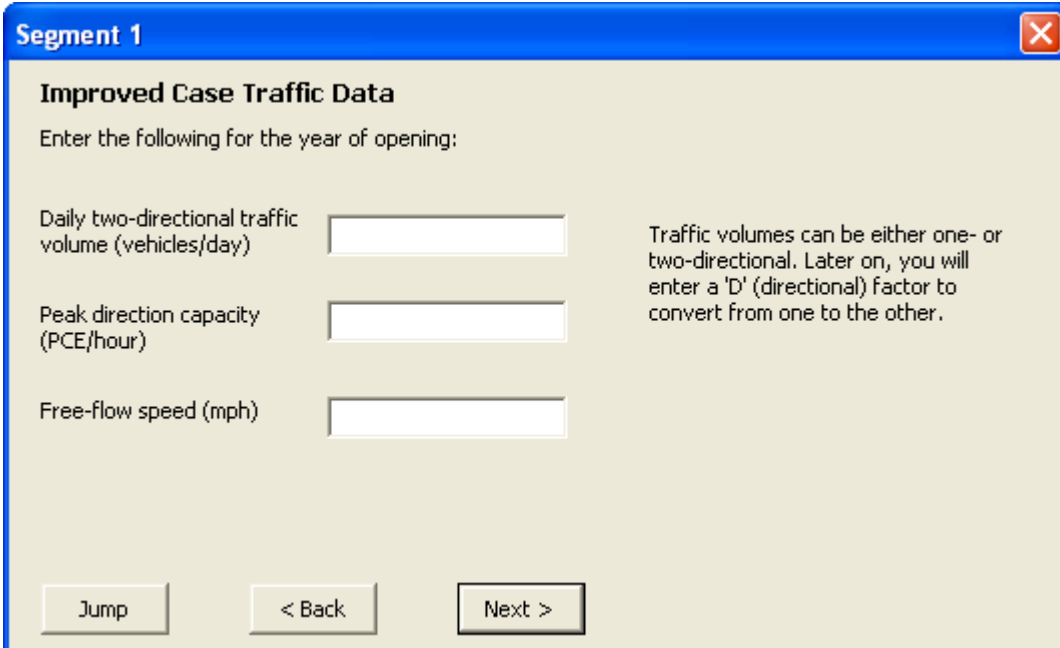
You will answer the same questions again, this time about the improved segment.

5. Describe traffic on the segment in the improved case.

The capacity must be entered in passenger-car equivalents (PCE). The capacity can be found in a planning model or the Highway Capacity Manual. For the full description of concepts of PCE refer to the Highway Capacity Manual (HCM, page 13-7 – 2000 Edition).

Daily two-directional traffic volume must be entered as an ADT in vehicles per day. Traffic volumes can be entered either as one or two-directional volumes. For a one-direction volume, a D factor of 1 should be used in the appropriate slide. A value of less than 1 (Refer to Tables 1 and 2) should be used for two-direction volume.

The last two questions appear only if you have an improvement that may be expected to change user delay through mechanisms other than the volume-delay relationship. In those cases, you enter the additional change in delay, in hours per vehicle, during the peak hour. You also enter the highest exponent on volume in the equation you used to estimate the change in delay. This is used in the extrapolation of peak-hour benefits to annual benefits.



The screenshot shows a software window titled "Segment 1" with a close button in the top right corner. The window contains the following text and input fields:

Improved Case Traffic Data
Enter the following for the year of opening:

Daily two-directional traffic volume (vehicles/day)	<input type="text"/>	Traffic volumes can be either one- or two-directional. Later on, you will enter a 'D' (directional) factor to convert from one to the other.
Peak direction capacity (PCE/hour)	<input type="text"/>	
Free-flow speed (mph)	<input type="text"/>	

At the bottom of the window, there are three buttons: "Jump", "< Back", and "Next >".

- Specify the percentage of total peak-hour traffic (in PCEs) represented by each user class.

The screenshot shows a dialog box titled "Segment 1" with a close button in the top right corner. The main heading is "Improved Case User Class Data". Below the heading, the text reads: "Enter the % of traffic volume composed of each user class:". There are two input fields: "Autos" and "Trucks". To the right of these fields, a note states: "Enter percentages as numbers from 0 to 100. The percentages must sum to exactly 100." At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

- Specify the annual number of accidents expected on the improved segment in the peak direction. Use 0.01 to represent non-zero probabilities of accidents, even if no accidents occurred on that segment in the base year. Using 0.01 will allow the model to function properly and apply a growth rate to the accidents.

The screenshot shows a dialog box titled "Segment 1" with a close button in the top right corner. The main heading is "Improved Case Accident Data". Below the heading, the text reads: "Enter the opening year number of accidents, by type:". There are three input fields: "Property damage only", "Injury", and "Fatal". At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

8. Specify the annualized, average cost to the agency of maintaining and operating the segment with the improvement, over the life of the project, in base-year dollars.

The screenshot shows a dialog box titled "Segment 1" with a blue header bar and a close button (X) in the top right corner. The main content area has a light beige background. The title "Improved Case Operating Costs & Benefits" is displayed in bold. Below the title, the text "Enter the following for the year of opening:" is shown. A label "Annual agency operating costs (\$)" is positioned to the left of a white rectangular input field. At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

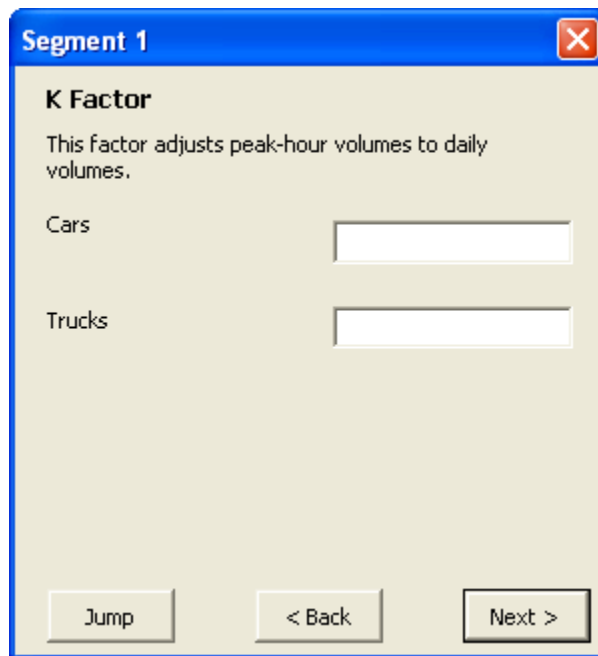
9. Specify the terminal (or salvage) value of the project at the end of the evaluation period you specified earlier. Use base-year dollars (do not add inflation).

The screenshot shows a dialog box titled "Segment 1" with a blue header bar and a close button (X) in the top right corner. The main content area has a light beige background. The title "Terminal Value" is displayed in bold. Below the title, the text "Enter the following without commas or dollar signs:" is shown. A label "Terminal Value (base year \$)" is positioned to the left of a white rectangular input field. At the bottom of the dialog, there are three buttons: "Jump", "< Back", and "Next >".

Traffic Conversion Factors

These are factors that relate the peak-hour, peak-direction volumes you entered earlier to annual average daily traffic. They are used in the extrapolation of benefits. The K factor, D factor, and Weekday-to-Week factor must be entered for each user class. In most cases, the same value should be used for each user class.

Refer to Tables 1 and 2 for information on selecting the traffic conversion factors.



The image shows a software dialog box titled "Segment 1" with a close button in the top right corner. The dialog box has a light beige background and a blue title bar. The main content area is titled "K Factor" and contains the following text: "This factor adjusts peak-hour volumes to daily volumes." Below this text are two input fields. The first input field is labeled "Cars" and the second is labeled "Trucks". At the bottom of the dialog box, there are three buttons: "Jump", "< Back", and "Next >".

Segment 1 ✖

D Factor

This factor adjusts peak-direction volumes to two-directional volumes.

Cars

Trucks

Segment 1 ✖

Weekday-to-Week Factor

This factor converts daily volumes to weekly volumes

Cars

Trucks

Segment 1

Volume Conversion Factors

These factors convert weekly volumes to annual volumes.

Week-to-month expansion factor

Seasonality factor (ratio of peak month to average month)

Jump < Back Next >

Results

Final Thoughts

How to Use (and Not Use) the Results

The output from this Wizard reflects the net benefit of your proposed project based on user benefits, users costs, and project capital and O&M costs. At this point, you may want to consider conducting a sensitivity analysis to determine how the net benefit results may change with variations in the underlying parameters (see Redbook Chapter 6). The results calculated here do not include non-user costs and benefits (such as environmental impacts) and these may be important. Redbook Chapter 2 provides a list of resources that are useful for analyzing these additional factors.

Jump < Back Finish

After you read the information and press “Finish”, you will be taken to your results. All results are in present-value terms, reported in base-year dollars.

User benefits for each segment and for all segments together are reported for Value of Time Benefits, Vehicle Operating Cost Benefits, Accident Reduction Benefits, and Agency Operating Cost Benefits, which are assumed to be passed along to users.

The user costs associated with each construction management alternative are shown for each segment and for all segments together. Since these are separate alternatives, the results may be compared across alternatives, but not combined.

Total user benefits for each alternative are reported for each segment and for all segments together. These are the sum of user benefits from operation and user costs from construction.

The present value of construction costs is reported for each segment and all segments together for each alternative.

The net benefits are the present value of total user benefits minus the present value of construction costs. Positive net benefits indicate that users are better off by paying for the construction.

The benefit/cost ratio is the ratio of the present value of user benefits to the present value of construction costs. A benefit/cost ratio greater than one means the same as positive net benefits. Benefit/cost ratios may be used to rank competing potential projects when funds are limited. Projects with higher benefit-cost ratios provide more user benefits per budget dollar.

Summary Results

Segment	User Benefits from Operation				User Benefits from Construction			Total User Benefits		
	User Value of Time Benefits	User Operating Cost Benefits	User Accident Reduction Benefits	Agency Operating Benefits	Construction			Construction		
All Segments	\$ 7,244,956	\$ 34,248	\$ 665,468	\$ 32,661	\$ (2,571)	\$ -	\$ -	\$ 7,974,762	\$ -	\$ -
A Segment	\$ 7,244,956	\$ 34,248	\$ 665,468	\$ 32,661	\$ (2,571)	\$ -	\$ -	\$ 7,974,762		

Segment	Capital Costs			Net Benefits			Benefit-Cost Ratio		
	Construction			Construction			Construction		
All Segments	\$ 1,633,658	\$ -	\$ -	\$ 6,341,703	\$ -	\$ -	4.883		
A Segment	\$ 1,633,658	\$ -	\$ -	\$ 6,341,703			4.883		

All Results are Present Value Over Life of Project in 2004 Dollars.

Print

References:

American Association of State Highway and Transportation Officials (2003), "User Benefit Analysis For Highways." Washington, DC.

American Association of State Highway and Transportation Officials (2003), "Redbook Wizard User Manual." Washington, DC.

Bureau of Transportation Statistics (2004), "Table 3-14: Average Cost of Owning and Operating an Automobile." Washington, DC.

Federal Highway Administration (December 2004), "Summary of Travel Trends – 2001 National Household Travel Survey." Washington, DC.

Transportation Research Board (2000). "Highway Capacity Manual." Washington, DC.

Table 1: NCDOT Redbook Wizard Default Values

Input	Value or Function	Source
<i>User Class / Economic / Vehicle Operating Cost Data</i>		
Vehicle Occupancy for Automobiles (persons/vehicle)	1.6	Current National Household Travel Survey
Vehicle Occupancy for Trucks (persons/vehicle)	1.08	NCDOT O&D Surveys
Value of Time of Automobiles (\$/hour)	* \$16.00	WEBSARAS
Value of Time of Trucks (\$/hour)	* \$16.00	Bureau of Labor Statistics
Fuel Cost (\$/gallon)	* \$ 3.00	American Automobile Association for NC
Fuel Cost (% of Operating Cost)	52 %	Bureau of Transportation Statistics
Average Truck Load Value	\$ 14,500	Bureau of Transportation Statistics
Market Interest Rate (%/year)	* 6.75 %	United States Federal Reserve
<i>Economic Data</i>		
Real Discount Rate (%/year)	3 %	Redbook Wizard User Manual
Inflation Rate (%/year)	* 3 %	Bureau of Labor Statistics
Financing Rate (%/year)	0 %	Standard Definition
Financing Term (years)	0	Standard Definition (assuming standard payment without bonds)
Issuance Cost (% of amount financed)	0 %	Standard Definition
General Traffic Growth Rate (%/year)	* Varies	Reverse Engineered from the traffic forecast data
Annual Growth of Value of Time (%/year)	2 %	Redbook Wizard User Manual
Property Damage Only Accident Cost (\$/crash)	* \$4,300	NCDOT Traffic Engineering and Safety Systems Branch
Injury Accident Cost (\$/crash)	* \$46,000	NCDOT Traffic Engineering and Safety Systems Branch
Fatal Accident Cost (\$/crash)	* \$3,700,000	NCDOT Traffic Engineering and Safety Systems Branch
<i>Traffic Conversion Factors</i>		
K Factor	0.10-0.15	NCLOS
D Factor	0.55-0.70	NCLOS
Weekday-to-Week Expansion Factor	6.0	Redbook Wizard User Manual
Week-to-Month Expansion Factor	4.35	Redbook Wizard User Manual
Seasonality Factor	1.1	Redbook Wizard User Manual

* = Input value requires regular NCDOT updates

Table 2: Source Information for Default Data

Input	Additional Contact or Source Information
<p>Vehicle Occupancy for Automobiles (persons/vehicle)</p>	<p>Federal Highway Administration <i>Summary of Travel Trends - 2001 National Household Travel Survey:</i> Table 16: Average Vehicle Occupancy for Selected Trip Purposes 1977, 1983, 1990, 1995 NPTS, and 2001 NHTS (person miles per vehicle mile)</p> <p>Use the average vehicle occupancy, unless a detailed study of vehicle occupancy has been conducted. The vehicle occupancy depends on the route and driver classification.</p> <p>From <i>2001 National Household Travel Survey:</i> Trip Purpose: Vehicle Occupancy Rate To or from work: 1.14 Shopping: 1.79 Other Family or Personal Business: 1.83 Social and Recreational: 2.03 Average: 1.63</p> <p>Default Value: Average Vehicle Occupancy for All Purposes = 1.63 \approx 1.6 persons per vehicle</p> <p>http://nhts.ornl.gov/2001/index.shtml</p>
<p>Vehicle Occupancy for Trucks (persons/vehicle)</p>	<p>NCDOT O&D Survey</p> <p>Two O&D studies, Creedmoor and Triangle External, form the dataset for Vehicle Occupancy for Trucks.</p> <p>Creedmoor O&D - A single station one day O&D to evaluate travel patterns in the Creedmoor area. Collected in February 2000. There were 3,999 valid interviews collected of which 199 were trucks. Average truck occupancy was 1.116 persons per vehicle.</p> <p>Triangle External O&D - A multi-station study collected over a few months in 1995 for use in developing the Triangle regional transportation model. There were 81,282 valid interviews of which 5,005 were trucks. Average truck occupancy was 1.073 persons per vehicle.</p> <p>The default value is based on a weighted average by truck volume of the two O&D studies. This value is reasonable with an expected passenger in one of about every thirteen trucks.</p> <p>Default Value: Vehicle Occupancy for Trucks = 1.075 \approx 1.08 persons per vehicle</p>

<p>Value of Time of Automobile (\$/hour)</p>	<p>WEBSARAS <i>Labor Cost Data</i></p> <p>Value of time is a sensitive number and the default value should be used in most cases. A more localized value could be used in a case that is used by a large majority of the local population. This is a North Carolina value because most automobile drivers are from North Carolina or work in North Carolina.</p> <p>Example: North Carolina 2003 Labor Cost Data</p> <p>Average Automobile User, use All Industries: Value of Time (\$) = (\$ 641 / week) / (40 hours/week) Value of Time (\$) = \$ 16.025 / hour \approx \$ 16.00 / hour</p> <p>http://eslmi40.esc.state.nc.us/websaras/</p>
<p>Value of Time of Truck (\$/hour)</p>	<p>Bureau of Labor Statistics <i>Truck Transportation and Warehousing</i></p> <p>A national value is used because truck traffic is based on a more national system of transportation. The average truck driver value of time is around \$ 16.00 / hour.</p> <p>http://www.bls.gov/oco/cg/cgs021.htm</p>
<p>Fuel Cost (\$/gallon)</p>	<p>American Automobile Association (AAA) North Carolina Unleaded Average</p> <p>Current Average Regular Price (10/12/2005) = \$ 3.00 /gallon</p> <p>http://www.fuelgaugereport.com/NCavg.asp</p> <p>For a national value, use: Bureau of Transportation Statistics <i>National Transportation Statistics 2005</i> (or most current edition): Table 3-8: Sales Price of Transportation Fuel to End-Users (Current ¢ / gallon)</p> <p>Example for 2004: Fuel Cost (\$/gallon) = (192.3 ¢ / gallon) / (100 ¢ / \$) = \$ 1.923 \approx \$ 1.92 / gallon</p> <p>http://www.bts.gov/publications/national_transportation_statistics/</p>

<p>Fuel Cost (% of Operating Cost)</p>	<p>Bureau of Transportation Statistics <i>National Transportation Statistics 2005:</i> Table 3-14: Average Cost of Owning and Operating an Automobile</p> <p>Fuel Cost (%) = [Fuel Cost (cents/mile) / (Fuel Cost (cents/mile) + Maintenance (cents/miles) + Tires (cents/mile)) * 100</p> <p>Example for 2004: Fuel Cost (%) = [6.5 (cents/mile) / (6.5 (cents/mile) + 5.4 (cents/miles) + 0.7 (cents/mile))] * 100</p> <p>Fuel Cost (%) = 51.587 % ≈ 52 %</p> <p>http://www.bts.gov/ http://www.bts.gov/publications/national_transportation_statistics/2005/</p>
<p>Average Truck Load Value (\$/load)</p>	<p>Bureau of Transportation Statistics <i>National Transportation Statistics 2005:</i> Table 1-32: US Vehicle-Miles Table 1-35: Average Length of Haul, Domestic Freight and Passenger Modes Table 1-52: Freight Activity in the United States: 1993, 1997, and 2002</p> <p>Average Truck Load Value = Truck Freight Value / (Total Truck Vehicle Miles Traveled / Average Truck Trip Length)</p> <p>Example: Average Truck Trip (Table 1-35) = 485 miles (2001 data)</p> <p>Vehicle Miles (Table 1-32) for Truck, Single-Unit 2-axle 6-tire or more = 72,448 million vehicle-miles (2001 data)</p> <p>Vehicle Miles (Table 1-32) for Truck, combination = 136,584 million vehicle-miles (2001 data)</p> <p>Total Vehicle Miles for Trucks = 209,032 million vehicle-miles</p> <p>Truck Freight Value = \$ 6,200.5 billion (2002 data)</p> <p>Average Truck Load Value = \$ 6,200,500,000,000 / (209,032,000,000 vehicle-mi / 485 miles)</p> <p>Average Truck Load Value = \$ 14,386.52 ≈ \$ 14,500 / load</p> <p>http://www.bts.gov/ http://www.bts.gov/publications/national_transportation_statistics/2005/</p>

<p>Market Interest Rate (%/year)</p>	<p>United States Federal Reserve</p> <p>Use Bank Prime Loan for the Federal Reserve Statistical Release This value should be updated monthly</p> <p>Example for October 2005: Bank Prime Loan = 6.75 % / year</p> <p>http://www.federalreserve.gov/releases/h15/Current/</p>
<p>Real Discount Rate (%/year)</p>	<p>Redbook Wizard User Manual</p> <p>The discount rate is an important value as described by the AASHTO Redbook: “the purpose of discounting is to account for the lost time value of money associated with tying up funds in a project, or failing to deliver valuable benefits.”</p> <p>A value of 3 % to 4 % is suggested. Use Real Discount Rate = 3 % / year unless more detailed data is available</p>
<p>Inflation Rate (%/year)</p>	<p>Bureau of Labor Statistics Consumer Price Index (CPI-U) for U.S. City Average The average inflation rate is around 3 % / year</p> <p>http://www.bls.gov/cpi/home.htm#data</p>
<p>Financing Rate (%/year)</p>	<p>NCDOT does not typically finance projects, therefore Financing Rate = 0 % /year. If a bond is issued to pay for the project, a financing rate should be used.</p>
<p>Financing Term (years)</p>	<p>For a typical NCDOT project, the financing term should be 0 years. If a bond is issued to pay for the project, Financing Term = Design Year- Base Year</p>
<p>Issuance Cost (% of amount financed)</p>	<p>NCDOT does not have issuance costs unless a bond is issued, therefore in most cases, Issuance Cost = 0 %</p>
<p>General Traffic Growth Rate (%/year)</p>	<p>Reverse Engineered from the traffic forecast data</p> <p>Using the following method:</p> <p>$n = \text{Design Year} - \text{Base Year}$ $\text{Volume}_{\text{Design Year}} = \text{Forecasted Volume for the Design Year}$ $\text{Volume}_{\text{Base Year}} = \text{Volume for the Base Year}$ $i = \text{General Traffic Growth Rate}$</p> <p>$\text{Volume}_{\text{Design Year}} = \text{Volume}_{\text{Base Year}} (1 + i)^n$ $\text{Volume}_{\text{Design Year}} / \text{Volume}_{\text{Base Year}} = (1 + i)^n$ $(\text{Volume}_{\text{Design Year}} / \text{Volume}_{\text{Base Year}})^{1/n} = 1 + i$</p> <p>$i = [(\text{Volume}_{\text{Design Year}} / \text{Volume}_{\text{Base Year}})^{1/n} - 1] * 100$</p>

Annual Growth of Value of Time (%/year)	Redbook Wizard User Manual A value of 1 % to 2 % is suggested. Use Annual Growth Rate of Value of Time = 2 % / year unless more detailed data is available
Property Damage Only Accident Cost (\$/crash)	NCDOT Traffic Engineering and Safety Systems Branch http://www.ncdot.org/doh/preconstruct/traffic/safety/ses/costs/costs.html
Injury Accident Cost (\$/crash)	NCDOT Traffic Engineering and Safety Systems Branch http://www.ncdot.org/doh/preconstruct/traffic/safety/ses/costs/costs.html
Fatal Accident Cost (\$/crash)	NCDOT Traffic Engineering and Safety Systems Branch http://www.ncdot.org/doh/preconstruct/traffic/safety/ses/costs/costs.html
K Factor	North Carolina State University Institute of Transportation Research and Education North Carolina Level-of-Service (NCLOS) For Freeways, 2-Lane, and Multilane: Urban = 0.10 Suburban = 0.12 Rural = 0.15 For Arterials (By Design Category – Functional Category – Street Class): High Speed – Principal – I = 0.15 Suburban – Principal – II = 0.15 Suburban – Minor – II = 0.12 Intermediate – Principal – II = 0.12 Intermediate – Minor – III/IV = 0.12 Urban – Principal – III/IV = 0.10 Urban – Minor – IV = 0.10

D Factor	<p>North Carolina State University Institute of Transportation Research and Education North Carolina Level-of-Service (NCLOS)</p> <p>For Freeways, 2-Lane, and Multilane: Urban = 0.55 Suburban = 0.55 (0.60 for Freeways) Rural = 0.60</p> <p>For Arterials (By Design Category – Functional Category – Street Class): High Speed – Principal – I = 0.65 (0.70 for Piedmont Region) Suburban – Principal – II = 0.60 (0.65 for Piedmont Region) Suburban – Minor – II = 0.60 (0.65 for Piedmont Region) Intermediate – Principal – II = 0.55 Intermediate – Minor – III/IV = 0.55 Urban – Principal – III/IV = 0.50 Urban – Minor – IV = 0.50</p>
Weekday-to-Week Expansion Factor	<p>Redbook Wizard User Manual</p> <p>A value of 5 to 7 is suggested. Use Weekday-to-Week Expansion Factor = 6, unless more detailed data is available</p>
Week-to-Month Expansion Factor	<p>Redbook Wizard User Manual</p> <p>A value of 4.35 is suggested. Use Week-to-Month Expansion Factor = 4.35, unless more detailed data is available</p>
Seasonality Factor	<p>Redbook Wizard User Manual</p> <p>A value of close to 1 is suggested. Use Seasonality Factor = 1.1, unless more detailed data is available</p>

APPENDIX C

NCDOT REDBOOK WIZARD CASE STUDIES

Introduction

The following pages contain case studies to demonstrate the NCDOT Redbook Wizard. Each case study listed below contains project descriptions and data to determine the benefit/cost ratios for the several highway project types.

- 1) Boone Trail Road Case Study (U-4761), Fayetteville, Compare Four-Lane Divided Project Versus Five-Lane Undivided Project
- 2) Morgan's Corner Case Study (FS-0101C), Pasquotank County, Convert Intersection to Interchange
- 3) I-74 Case Study (R-3436), Brunswick and Columbus Counties, Convert 4-Lane Facility to Interstate Standards

Case 1

Fayetteville (Cumberland County)

Boone Trail Road: Improve a Two-Lane to Four-Lane Divided or Five-Lane Undivided

The following description of the project is from the NCDOT Feasibility Study of project U-4761. Refer to the Feasibility Study for any further details or information.

Location

Boone Trail Road (SR 1149) from Cumberland Road (SR 1141) to Owen Drive (SR 1007) in the City of Fayetteville, Cumberland County, NCDOT Division 6.

General Description

This study involves the widening of Boone Trail Road (SR 1149) from its current state as a two-lane shoulder facility into either a four or five lane curb and gutter facility. The portion of Boone Trail under consideration extends from Cumberland Road (SR 1141), the southern boundary, to Owen Drive (SR 1007), the northern boundary; a distance of approximately 1.1 miles. There is one intersection (Roxie Avenue/Carlos Street) located between the boundary points however the only existing traffic signals within the project area are located at the intersections with Cumberland Road and Owen Drive.

Boone Trail is designated as a Minor Thoroughfare in the Fayetteville are MPO State Thoroughfare Plan and as an Urban Local in the State Functional Classification system. It is currently a two-lane facility with 29 feet of pavement width along most of the project length. The intersection of Boone Trail and Cumberland currently consists of a shared through/left-lane, a through-lane, and an exclusive right turn lane. The majority of the development along Boone Trail is residential aside from some commercial development located at the Owen Drive intersection.

Need for Project

The purpose of this project is to improve the traffic carrying capacity, to promote a safer driving environment, and to provide improved multi-lane access from Cumberland Road (SR 1141) to the commercial areas located adjacent to Owen Drive (SR 1007).

Boone Trail is currently operating at Level of Service C or higher for the entire project length. If no improvements are made, NCDOT projects that the intersections with Cumberland Road and Owen Drive will operate at LOS F by Design Year 2030 with the remainder of the project length operating at LOS E. The alternative presented in the feasibility study will enable the facility to accommodate a LOS of C or better through the year 2030.

Between the years 2000 and 2003 there were 95 accidents within the project limits; with zero fatalities, 38 injury accidents, and 57 property damage accidents. Approximately 78% of these accidents occurred at the intersection of Boone Trail and Owen Drive. The accident rate for the entire project length is 971.75 accidents per 100 million vehicle miles of travel, which is 43.47% higher than the statewide average for two-lane undivided secondary roadways.

Studied Alternatives

Two different cross sections were considered in the feasibility study for Boone Trail Road with the first being to widen the existing two-lane facility to a four-lane facility and the second being to widen it to a five-lane facility. The cost estimates provided for both alternatives includes the construction of sidewalks on both sides of the roadway as well as the realignment of the intersection of Roxie Avenue and the

addition of a dedicated left-turn lane from Boone Trail onto Cumberland Road. The alternatives are discussed in further detail below:

Alternative 1: Two-Lane to a Four-Lane

This alternative would result in a four-lane divided curb and gutter section 75 feet wide from face-to-face of the curbs with a 23 foot raised grass median and 15 foot berms on 110 feet of right-of-way. With Alternative 1 it is anticipated that there will be zero residential and zero business needing to be relocated. This alternative is estimated to have a cost of \$7,800,000.

Construction	\$5,700,000
Right of Way (110')	\$1,900,000
<u>Sidewalks</u>	<u>\$ 200,000</u>
TOTAL COST (Alt. 1)....	\$7,800,000

Alternative 2: Two-Lane to a Five-Lane

This alternative would result in a five-lane curb and gutter section 64 feet wide from face-to-face of the curbs with 15 foot berms on 100 feet of right-of-way. Under Alternative 2 it is anticipated that there will be zero residential and zero business needing to be relocated. This alternative is estimated to have a cost of \$6,300,000.

Construction	\$4,500,000
Right of Way (100')	\$1,600,000
<u>Sidewalks</u>	<u>\$ 200,000</u>
TOTAL COST (Alt. 2)....	\$6,300,000

Accident Data

The following table summarizes the crash analysis that was conducted by the NCDOT for Boone Trail Rd. from the intersection of Cumberland Rd. to the intersection with Owen Dr. for the period of June 1st, 2000 to May 31st, 2003 and average rates for similar facilities in North Carolina.

	3-Year Crashes	3-Year Crashes per 100 MVM	Alt 1: NC Urban 4 + Lanes Divided with No Control Access Rate per 100 MVM*	Alt 2: NC Urban 4 + Lanes with Continuous Left Turn Lane Rate per 100 MVM*
Fatal	0	0.00	1.28	0.88
Non-Fatal	38	388.70	173.24	120.85
PDO	57	4547.80	107.91	223.75

	1-Year Existing Condition Crashes Peak Direction	Alt 1: 1-Year 4 Lane Divided Crashes in Peak Direction	Alt 2: 1-Year 5 Lane with Continuous Left Turn Crashes Peak Direction
Fatal	0	0	0
Non-Fatal	6.33	2.82	1.97
PDO	9.50	0.23	0.47

* North Carolina Crash Rates can be found at:

<http://www.doh.dot.state.nc.us/preconstruct/traffic/Safety/ses/rates/rates.html>

Traffic Volumes

For simplicity of demonstrating the Redbook Wizard this example will consider the largest volume through the project as the volume, 9,400 vpd. This traffic volume will be used for the base year and the year operation begins.

Study Area

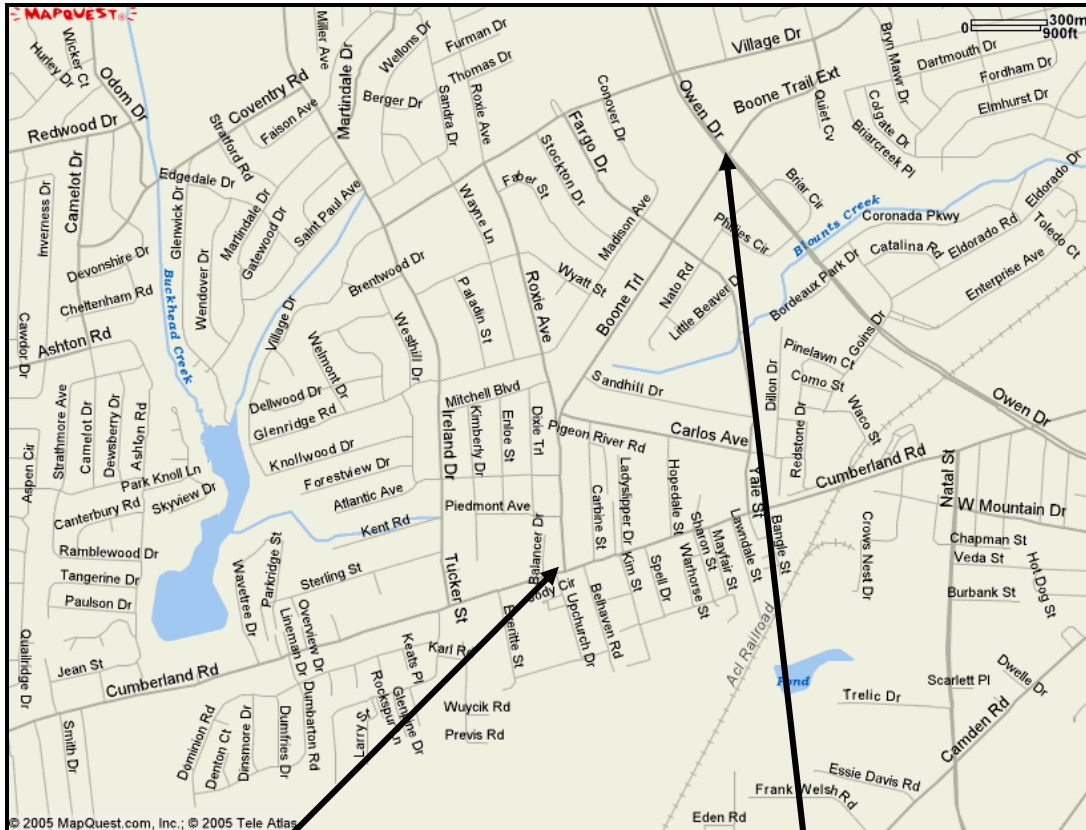


Figure 1: Project Study Area (2005 MapQuest.com, Inc. ©)

Intersection of Boone Trail and Cumberland Rd. – southern end of project length

Intersection of Boone Trail and Owen Dr. – northern end of project length

Benefit Cost Case Study

This Redbook benefit-cost case study will examine each of the alternatives for expanding Boone Trail Road (SR 1149). The objectives of this benefit cost analysis are the following:

1. Determine the benefits and costs of the Boone Trail Road (SR 1149) project.
2. Test the functionality of the Redbook software.

This document serves as a summary of data and information provided by NCDOT for the Redbook analysis. This document contains: study area maps, traffic volumes, project costs, and accident data. The following pages detail the Redbook Wizard input and output.

Redbook Input Data Summary Sheet – Fayetteville Case Study: 4 Lane Divided

Input Item	Value
Number of segments to analyze	1
Year construction begins	2004
Year operation begins	2007
Last year of analysis period	2030
Base year	2004
Name of User Class 1	Cars
Name of User Class 2	Trucks
Vehicle Type for User Class 1	All Cars
Vehicle Type for User Class 2	All Trucks
Vehicle Occupancy for User Class 1 (persons)	1.6
Vehicle Occupancy for User Class 2 (persons)	1.08
Value of Time for User Class 1 (base-year dollars)	16
Value of Time for User Class 2 (base-year dollars)	16
Fuel Cost for User Class 1 (base-year dollars per gallon)	3
Fuel Cost for User Class 2 (base-year dollars per gallon)	3
Percent of Operating Costs that are fuel (percentage points)	52
Real discount rate (percentage points)	3
Inflation rate (percentage points)	3
Financing rate (percentage points)	0
Financing term (years)	0
Issuance cost (% of amount financed) (percentage points)	0
General traffic growth rate (percentage points)	1
Annual Growth of Value of Time (percentage points)	2
Average Truckload Value (base-year dollars)	14,500
Market Interest Rate for truckload value (percentage points)	6.75
Average Commercial Cargo Value (base-year dollars)	N/A
Market Interest Rate for Commercial Cargo Value (percentage points)	N/A
Cost per property damage accident (base-year dollars)	4,300
Cost per injury accident (base-year dollars)	46,000
Cost per fatal accident (base-year dollars)	3,700,000
Name of Construction Management Alternative 1	Construction

Redbook Input Segment Data Summary Sheet – Fayetteville Case Study: 4 Lane Divided

Segment Input Item	Value
Names given to segments	Boone Trail Road
Functional Class of each segment	Urban Minor Arterial
Improvement Type for each segment	Additional Lane
Segment Length without improvement (miles)	1.1
Segment Length with improvement (miles)	1.1
Method for Calculating Change in User Delay	Redbook – ADT
Base both directions (vehicles per day)	9,400
Base peak-direction capacity (PCEs per hour)	1,400
Base Free Flow Speed (miles per hour)	40
Base Property-Damage Only Accidents (with base-year volume) (accidents per year)	9.5
Base Injury Accidents (with base-year volume) (accidents per year)	6.33
Base Fatal Accidents (with base-year volume) (accidents per year)	0.01
Base Operating Cost (base-year dollars)	0
Improved both directions (vehicles per day)	9,400
Improved Capacity (PCEs per hour)	3,800
Improved Free Flow Speed (miles per hour)	40
Improved Property-Damage Only Accidents (with opening-year volume) (accidents per year)	0.23
Improved Injury Accidents (with opening-year volume) (accidents per year)	2.82
Improved Fatal Accidents (with opening-year volume) (accidents per year)	0.01
Improved Operating Cost (opening-year dollars)	0
K Factor for User Class 1 (peak hour volume/daily volume)	0.1
K Factor for User Class 2 (peak hour volume/daily volume)	0.1
D Factor for User Class 1 (peak-direction volume/total volume)	0.5
D Factor for User Class 2 (peak-direction volume/total volume)	0.5
Week Factor for User Class 1 (weekly volume/weekday volume)	6
Week Factor for User Class 2 (weekly volume/weekday volume)	6
Month Factor (monthly volume/weekly volume)	4.35
Seasonal Factor (peak monthly volume/average monthly volume)	1.1
Percent of base peak-hour, peak-direction volume that is in User Class 1 (percentage points)	97
Percent of base peak-hour, peak-direction volume that is in User Class 2 (percentage points)	3
Percent of improved peak-hour, peak-direction volume that is in User Class 1 (percentage points)	95
Percent of improved peak-hour, peak-direction volume that is in User Class 2 (percentage points)	5
Terminal Value (base-year dollars)	0
Construction Management Alternative 1	
Construction Property-Damage Only Accidents (each)	0
Construction Injury Accidents (each)	0
Construction Fatal Accidents (each)	0
Total delay during construction (vehicle hours)	0
Total extra VMT on detour route (vehicle miles)	0
Speed on detour route (miles per hour)	0
Right-of-way acquisition cost (construction-year dollars)	1,900,000
Planning and design cost (construction-year dollars)	0
Construction management cost (construction-year dollars)	0
Construction cost (construction-year dollars)	5,900,000

Redbook Output Data Summary Sheet – Fayetteville Case Study: 4 Lane Divided

	User Benefits from Operation				User Benefits from Construction	Total User Benefits
	User Value of Time Benefits	User Operating Cost Benefits	User Accident Reduction Benefits	Agency Operating Benefits		
Project	\$ 78,948	\$ 2	\$ 3,609,291	\$ -	\$ -	\$ 3,688,241

	Capital Costs	Net Benefits	Benefit-Cost Ratio
Project	\$ 7,138,105	\$ - 3,449,864	0.517

Redbook Input Data Summary Sheet – Fayetteville Case Study: 5 Lane with TWLT

Input Item	Value
Number of segments to analyze	1
Year construction begins	2004
Year operation begins	2007
Last year of analysis period	2030
Base year	2004
Name of User Class 1	Cars
Name of User Class 2	Trucks
Vehicle Type for User Class 1	All Cars
Vehicle Type for User Class 2	All Trucks
Vehicle Occupancy for User Class 1 (persons)	1.6
Vehicle Occupancy for User Class 2 (persons)	1.08
Value of Time for User Class 1 (base-year dollars)	16
Value of Time for User Class 2 (base-year dollars)	16
Fuel Cost for User Class 1 (base-year dollars per gallon)	3
Fuel Cost for User Class 2 (base-year dollars per gallon)	3
Percent of Operating Costs that are fuel (percentage points)	52
Real discount rate (percentage points)	3
Inflation rate (percentage points)	3
Financing rate (percentage points)	0
Financing term (years)	0
Issuance cost (% of amount financed) (percentage points)	0
General traffic growth rate (percentage points)	1
Annual Growth of Value of Time (percentage points)	2
Average Truckload Value (base-year dollars)	14,500
Market Interest Rate for truckload value (percentage points)	6.75
Average Commercial Cargo Value (base-year dollars)	N/A
Market Interest Rate for Commercial Cargo Value (percentage points)	N/A
Cost per property damage accident (base-year dollars)	4,300
Cost per injury accident (base-year dollars)	46,000
Cost per fatal accident (base-year dollars)	3,700,000
Name of Construction Management Alternative 1	Construction

Redbook Input Segment Data Summary Sheet – Fayetteville Case Study: 5 Lane with TWLT

Segment Input Item	Value
Names given to segments	Boone Trail Road
Functional Class of each segment	Urban Minor Arterial
Improvement Type for each segment	Additional Lane
Segment Length without improvement (miles)	1.1
Segment Length with improvement (miles)	1.1
Method for Calculating Change in User Delay	Redbook – ADT
Base both directions (vehicles per day)	9,400
Base peak-direction capacity (PCEs per hour)	1,400
Base Free Flow Speed (miles per hour)	40
Base Property-Damage Only Accidents (with base-year volume) (accidents per year)	9.5
Base Injury Accidents (with base-year volume) (accidents per year)	6.33
Base Fatal Accidents (with base-year volume) (accidents per year)	0.01
Base Operating Cost (base-year dollars)	0
Improved both directions (vehicles per day)	9,400
Improved Capacity (PCEs per hour)	3,800
Improved Free Flow Speed (miles per hour)	40
Improved Property-Damage Only Accidents (with opening-year volume) (accidents per year)	0.47
Improved Injury Accidents (with opening-year volume) (accidents per year)	1.97
Improved Fatal Accidents (with opening-year volume) (accidents per year)	0.01
Improved Operating Cost (opening-year dollars)	0
K Factor for User Class 1 (peak hour volume/daily volume)	0.1
K Factor for User Class 2 (peak hour volume/daily volume)	0.1
D Factor for User Class 1 (peak-direction volume/total volume)	0.5
D Factor for User Class 2 (peak-direction volume/total volume)	0.5
Week Factor for User Class 1 (weekly volume/weekday volume)	6
Week Factor for User Class 2 (weekly volume/weekday volume)	6
Month Factor (monthly volume/weekly volume)	4.35
Seasonal Factor (peak monthly volume/average monthly volume)	1.1
Percent of base peak-hour, peak-direction volume that is in User Class 1 (percentage points)	97
Percent of base peak-hour, peak-direction volume that is in User Class 2 (percentage points)	3
Percent of improved peak-hour, peak-direction volume that is in User Class 1 (percentage points)	95
Percent of improved peak-hour, peak-direction volume that is in User Class 2 (percentage points)	5
Terminal Value (base-year dollars)	0
Construction Management Alternative 1	
Construction Property-Damage Only Accidents (each)	0
Construction Injury Accidents (each)	0
Construction Fatal Accidents (each)	0
Total delay during construction (vehicle hours)	0
Total extra VMT on detour route (vehicle miles)	0
Speed on detour route (miles per hour)	0
Right-of-way acquisition cost (construction-year dollars)	1,600,000
Planning and design cost (construction-year dollars)	0
Construction management cost (construction-year dollars)	0
Construction cost (construction-year dollars)	4,700,000

Redbook Output Data Summary Sheet – Fayetteville Case Study: 5 Lane with TWLT

	User Benefits from Operation				User Benefits from Construction	Total User Benefits
	User Value of Time Benefits	User Operating Cost Benefits	User Accident Reduction Benefits	Agency Operating Benefits		
Project	\$ 78,948	\$ 2	\$ 4,291,776	\$ -	\$ -	\$ 4,370,725

	Capital Costs	Net Benefits	Benefit-Cost Ratio
Project	\$ 5,765,392	\$ - 1,526,766	0.735

Case 2

Morgan's Corner (Pasquotank County)

US 17 / US 158: Convert Existing Intersection into a Grade-Separated Interchange

The following description of the project is from the NCDOT Feasibility Study FS – 0101C. Refer to the Feasibility Study for any further details or information.

Location

Intersection of US 17 and US 158 in Morgan's Corner, Pasquotank County, NCDOT Division 1.

General Description

This study addresses converting the existing “at-grade” intersection of US 17 / US 158 / SR 1416 in Pasquotank County into a “grade-separated” interchange. (See Figure 1 for a vicinity map showing the project's location)

The “grade separation” for the proposed interchange will be accomplished by raising the grade on US 158 / SR 1416 (Northside Road) and constructing dual bridges over existing US 17. Access ramps and loops will be added in three of the four quadrants creating a “full movement” interchange. In order to minimize traffic congestion and increase safety, driveway access will be controlled along US 17 and 1000' beyond the proposed ramp terminals on US 158 / SR 1416. Service roads will also need to be constructed to provide access to several properties.

This study is the initial step in the planning and design process for this project and is not the product of exhaustive environmental or design investigations. The purpose of this study is to describe the proposed project, including costs, and to identify potential problems that may require consideration in the planning and design phases.

Need for Project

The purpose of this project is to increase the traffic carrying capacity and improve safety at the existing “at-grade” intersection of US 17/ US 158 / SR 1416 in Morgan's Corner. In addition, US 17 and US 158 through Pasquotank County is part of the North Carolina Intrastate System, which is designated to support statewide growth and development objectives and to connect to major highways of adjoining states. US 17 is also a STRAHNET route developed by the Department of Defense to provide defense access, continuity, and emergency capabilities. Since the proposed interchange is considered an integral part of the future widening of the US 158 intrastate corridor, it is recommended that these improvements be closely coordinated with TIP project R-2579.

Description of the Project

Existing US 17, in the area of Morgan's Corner, is a four-lane median divided facility with partial control of access. South of the above-referenced intersection, US 158 coincides with US 17. US 158, east and west of the intersection, is a two-lane roadway that runs through a residential and agricultural area. However, TIP projects R-2578 and R-2579 propose to widen US 158 from Morgan's Corner west to US 13 in Gates County. It is anticipated that the future typical section for R-2578 and R-2579 will be a four-lane, divided roadway. A four lane divided section with 12-foot travel lanes, a 16-foot raised grass median, and 10-foot shoulders was used along US 158 / SR 1416 for this study.

This study addresses the raising of the existing grade on US 158 / SR 1416 (Northside Road) and the construction of dual bridges over US 17 in order to create a grade separated interchange at this location. The bridges will be approximately 245 feet in length and will each be 34 feet wide from bridge rail to bridge rail.

The proposed right-of-way width for US 158 / SR 1416 is 200 feet with access being controlled 1000 feet beyond the proposed ramp terminals. Proposed right-of-way for the proposed interchange will generally be 100 feet from the survey line of the ramps. No additional right-of-way will be needed along US 17.

Ramps and loops will be constructed in the northwest and the southeast quadrants of the interchange. In the southwest quadrant, only a ramp will be built. This ramp is needed for the anticipated heavy volume of traffic from Eastbound US 158 to Southbound US 17. No ramps or loops will be built in the northeast quadrant of the interchange because an existing pond is located in this area.

Four service roads will be constructed to properties that would otherwise lose their access after the project is completed.

US 17 through the project limits has partial control of access. It is recommended to close the existing median opening for the driveway on US 17 south of the project and to close the median opening for the access to SR 1417 (Morgan's Corner Road) on US 17 north of the project. Closing these access points will improve the safety and operation of the proposed ramps.

A temporary, on-site, detour will be constructed on the south side of US 158 / SR 1416. This detour will be used to maintain traffic on US 158 / SR 1416 while the new bridge and its approaches are being constructed.

It is anticipated that the above-mentioned improvements will require the relocation of approximately four (4) residences and one (1) business. The total cost, including construction and right-of-way, is estimated to be \$12,700,000.

Construction	\$10,800,000
Right-of-way	\$ 1,900,000
Total Cost	\$12,700,000

Traffic Operations

The estimated base year 2002 Average Daily Traffic (ADT) volume for US 158 / SR 1416 ranges from 1,800 to 5,200 vehicles per day (vpd) and the volume on US 17 / US 158 ranges from 9,200 to 12,200 vpd. The estimated design year 2025 ADT volume for US 158 / SR 1416 ranges from 2,800 to 9,800 vpd and the volume for US 17 / US 158 ranges from 20,200 to 26,800 vpd.

The decision to install new traffic signals at any location will be made by the NCDOT Area Traffic Engineer based on final design plans. This study only makes recommendations based on the projected traffic volumes. For this report it is assumed that the proposed ramp terminal intersections will be signalized.

The level of service (LOS) for the proposed ramp terminal intersections was determined using the "Signalized Intersections Module" of the HCS2000 software package.

The proposed geometry for the eastern ramp terminal intersection includes two westbound through lanes. The eastbound approach includes two through lanes and an exclusive right-turn lane. The northbound approach includes an exclusive left-turn lane and an exclusive right-turn lane. Based on the projected traffic volumes, it is estimated that this intersection will operate at LOS A for both the base year (2002) and the design year (2025).

The proposed geometry for the western ramp terminal intersection includes two westbound through lanes and an exclusive right-turn lane. The eastbound approach includes two through lanes and an exclusive

left-turn lane. The southbound approach includes an exclusive left-turn lane and a shared through/right-turn lane. Based on the project traffic volumes, it is estimated that this intersection will operate at LOS B for both the base year (2002) and the design year (2025).

Warrant Summary

This feasibility study evaluates replacing the existing “at-grade” intersection with an interchange. However, several issues must be addressed before a recommendation is made.

One issue for the interchange warrant is traffic carrying capacity. A capacity analysis was performed for the existing signalized intersection to determine how it would operate in the future. Based on the projected traffic volumes provided by NCDOT and the current lane configuration, it is estimated that the intersection will operate at LOS C for the base year (2002) and LOS D for the design year (2025). Therefore, since the existing intersection will operate at an “acceptable” LOS (LOS D) an interchange is not warranted from strictly a “capacity” standpoint.

Another issue for the interchange warrant is safety. The three-year accident analysis for the intersection indicates no fatalities and a severity index of 9.27, which is above the statewide average (7.65) for this type of intersection. Since the accident history for the intersection indicates an above average severity index it would seem to indicate that an interchange would be needed for safety reasons. Any “at-grade” intersection on a four-lane divided US Route with partial control of access has the potential for severe accidents. Therefore, an interchange at this location with full control of access would greatly enhance the safety for motorists on US 17 and US 158.

Additional Comments

An exhaustive environmental screening was not conducted for this study. However, the following items were identified as needing more detailed analyses during future planning and/or design phases:

- The historical property on SR 1416 needs further investigation. However, the widening of US 158 / SR 1416 will be to the south, which would minimize impacts to the property.
- A more thorough study of proposed service roads should be conducted.
- The design of the interchange should be closely coordinated with TIP projects R-2578 and R-2579.
- Careful study should be done to minimize all wetland impacts.

Benefit Cost Case Study

This Redbook benefit-cost case study will examine part of the proposed improvements to US 17 / US 158 / SR 1416 in Pasquotank County.

The objectives of this benefit cost analysis are the following:

1. Determine the benefits and costs of the Morgan’s Corner Project.
2. Test the functionality of the Redbook software.
3. Obtain comments from NCDOT regarding the Redbook methodology and parameters as they pertain to the Morgan’s Corner case study.

This document serves as a summary of data and information provided by NCDOT for the Redbook analysis. This document contains: study area maps, traffic volumes, accident data, Redbook Wizard input values, and Redbook Wizard output values.

Study Area

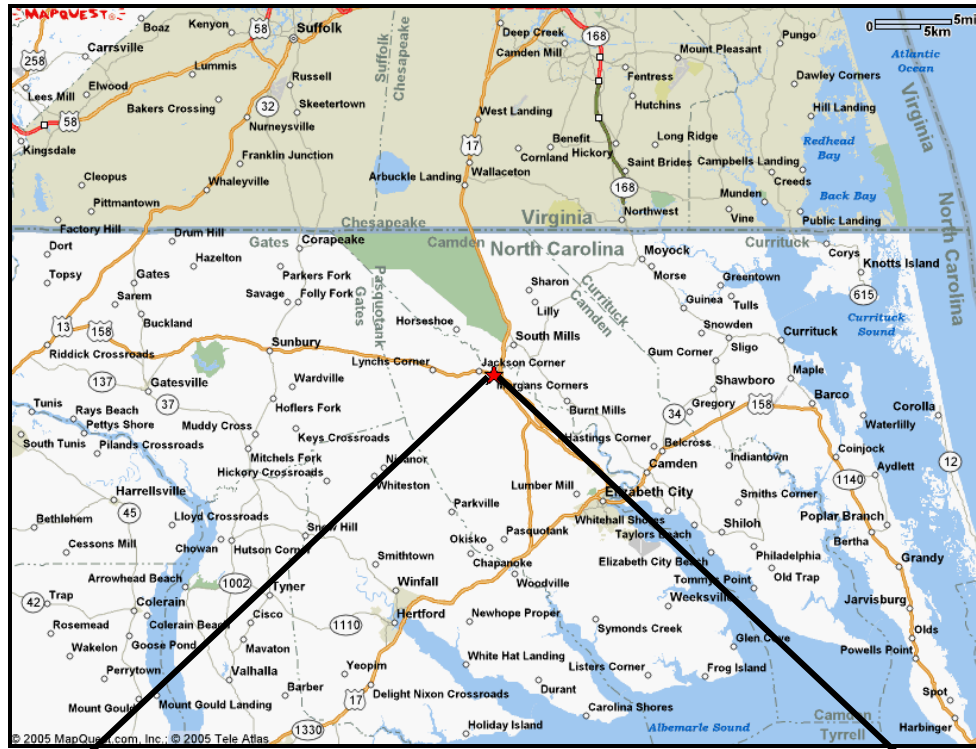


Figure 1: Project Study Area (2005 MapQuest.com, Inc. ©)

Traffic Volumes

For simplicity of demonstrating the Redbook Wizard this example will consider the largest volume through the intersection as the volume, 12,200 vpd. This traffic volume will be used for the base year and the year operation begins.

Accident Data

The following table summarizes the crash analysis that was conducted by the NCDOT for US 17 between April 1, 1999 and March 31, 2002 and average rates for similar facilities in North Carolina.

	3-Year Crashes	Crashes per 100 MVM	NC Rural Interstate Full Control Access Rate*
Fatal	1	5.27	0.24
Non-Fatal	11	58.01	11.86
PDO	7	36.93	16.87

	1-Year Existing Condition Crashes Peak Direction	1-Year Interstate Condition Crashes Peak Direction
Fatal	0.17	0.01
Non-Fatal	1.83	0.37
PDO	1.17	0.53

*North Carolina Crash Rates can be found at:

<http://www.doh.dot.state.nc.us/preconstruct/traffic/Safety/ses/rates/rates.html>

Redbook Wizard Analysis

The following pages detail the Redbook Wizard input and output. Since this is an intersection improvement, the length of the segment is assumed to be 0.1 miles. Other assumptions are previously discussed or are stated in the NCDOT Redbook Wizard User Manual.

Redbook Input Data Summary Sheet: Morgan's Corner

Input Item	Value
Number of segments to analyze	1
Year construction begins	2002
Year operation begins	2005
Last year of analysis period	2025
Base year	2002
Name of User Class 1	Cars
Name of User Class 2	Trucks
Vehicle Type for User Class 1	All Cars
Vehicle Type for User Class 2	All Trucks
Vehicle Occupancy for User Class 1 (persons)	1.6
Vehicle Occupancy for User Class 2 (persons)	1.08
Value of Time for User Class 1 (base-year dollars)	16
Value of Time for User Class 2 (base-year dollars)	16
Fuel Cost for User Class 1 (base-year dollars per gallon)	3
Fuel Cost for User Class 2 (base-year dollars per gallon)	3
Percent of Operating Costs that are fuel (percentage points)	52
Real discount rate (percentage points)	3
Inflation rate (percentage points)	3
Financing rate (percentage points)	0
Financing term (years)	0
Issuance cost (% of amount financed) (percentage points)	0
General traffic growth rate (percentage points)	3.5
Annual Growth of Value of Time (percentage points)	2
Average Truckload Value (base-year dollars)	14,500
Market Interest Rate for truckload value (percentage points)	6.75
Average Commercial Cargo Value (base-year dollars)	N/A
Market Interest Rate for Commercial Cargo Value (percentage points)	N/A
Cost per property damage accident (base-year dollars)	4,300
Cost per injury accident (base-year dollars)	46,000
Cost per fatal accident (base-year dollars)	3,700,000
Name of Construction Management Alternative 1	Construction

Redbook Input Segment Data Summary Sheet: Morgan's Corner

Segment Input Item	Value
Names given to segments	Morgan's Corner
Functional Class of each segment	Rural Interstate
Improvement Type for each segment	Intersection Improvement
Segment Length without improvement (miles)	0.01
Segment Length with improvement (miles)	0.01
Method for Calculating Change in User Delay	Redbook – ADT
Base both directions (vehicles per day)	12,200
Base peak-direction capacity (PCEs per hour)	4,400
Base Free Flow Speed (miles per hour)	55
Base Property-Damage Only Accidents (with base-year volume) (accidents per year)	2.333
Base Injury Accidents (with base-year volume) (accidents per year)	3.666
Base Fatal Accidents (with base-year volume) (accidents per year)	0.333
Base Operating Cost (base-year dollars)	0
Improved both directions (vehicles per day)	12,200
Improved Capacity (PCEs per hour)	4,600
Improved Free Flow Speed (miles per hour)	55
Improved Property-Damage Only Accidents (with opening-year volume) (accidents per year)	1.0657
Improved Injury Accidents (with opening-year volume) (accidents per year)	0.7496
Improved Fatal Accidents (with opening-year volume) (accidents per year)	0.1518
Improved Operating Cost (opening-year dollars)	0
K Factor for User Class 1 (peak hour volume/daily volume)	0.15
K Factor for User Class 2 (peak hour volume/daily volume)	0.15
D Factor for User Class 1 (peak-direction volume/total volume)	0.6
D Factor for User Class 2 (peak-direction volume/total volume)	0.6
Week Factor for User Class 1 (weekly volume/weekday volume)	6
Week Factor for User Class 2 (weekly volume/weekday volume)	6
Month Factor (monthly volume/weekly volume)	4.35
Seasonal Factor (peak monthly volume/average monthly volume)	1.1
Percent of base peak-hour, peak-direction volume that is in User Class 1 (percentage points)	95
Percent of base peak-hour, peak-direction volume that is in User Class 2 (percentage points)	5
Percent of improved peak-hour, peak-direction volume that is in User Class 1 (percentage points)	95
Percent of improved peak-hour, peak-direction volume that is in User Class 2 (percentage points)	5
Terminal Value (base-year dollars)	0
Construction Management Alternative 1	
Construction Property-Damage Only Accidents (each)	0
Construction Injury Accidents (each)	0
Construction Fatal Accidents (each)	0
Total delay during construction (vehicle hours)	0
Total extra VMT on detour route (vehicle miles)	0
Speed on detour route (miles per hour)	0
Right-of-way acquisition cost (construction-year dollars)	1,900,000
Planning and design cost (construction-year dollars)	0
Construction management cost (construction-year dollars)	0
Construction cost (construction-year dollars)	10,800,000

Redbook Output Data Summary Sheet: Morgan's Corner

	User Benefits from Operation				User Benefits from Construction	Total User Benefits
	User Value of Time Benefits	User Operating Cost Benefits	User Accident Reduction Benefits	Agency Operating Benefits		
Project	\$ 19	\$ 0	\$ 12,919,955	\$ -	\$ -	\$ 12,919,974

	Capital Costs	Net Benefits	Benefit-Cost Ratio
Project	\$ 11,622,299	\$ 1,297,675	1.112

Case 3
Interstate 74 (Brunswick and Columbus Counties)
Convert Existing 4-Lane Facility to Interstate Standards

The following description of the project is from the NCDOT Feasibility Study of project R-3436 Re-evaluation. Refer to the Feasibility Study for any further details or information.

Location

From Union Valley Road (SR 1585) in Whiteville to the South Carolina State Line, Brunswick and Columbus Counties, Divisions 3 and 6.

General Description

The study corridor begins west of Whiteville and continues along existing US 74-76 to the west of Bolton. It proceeds southward on a new location to the Columbus/Brunswick county line. The study corridor travels southward alongside existing NC 211 from the county line to US 17 in Supply. The I-74 corridor then turns southwest and travels along the US 17 corridor, utilizing the Shallotte Bypass, and finally terminating at the South Carolina state line. (See Figure 1 for a vicinity map showing the project's location)

Need for Project

Many transportation needs can be satisfied through this study's potential alignment of I-74, including the completion of a vital section of the proposed I-74 interstate from Michigan to South Carolina, as well as the achievement of an important milestone in the Governor's and the North Carolina Department of Transportation's (NCDOT) goals for southeastern North Carolina. The regional goal of the Governor's plan is to provide an economic boost for the area with this new interstate (I-74) in conjunction with other projects. The addition of the proposed I-74 interstate in southeastern North Carolina will be an excellent upgrade to North Carolina's transportation infrastructure and should improve safety and efficiency as well as ignite long-term economic growth in this area of our state.

Benefit Cost Case Study

This Redbook benefit-cost case study will examine part of the proposed improvements to the US 74 corridor. The portion that will be part of this case study is referred to as section 4 by the NCDOT. There are several alternatives for section 4 proposed by the NCDOT, we will examine the scenario that upgrades the existing US 17 facility to interstate standards for I-74. NCDOT includes a section of NC 211 that is approximately two and half miles long in section 4 of the entire I-74 project. The volumes and attributes of NC 211 are drastically different from I-74, therefore, for our analysis we removed the NC 211 segment. The section we analyzed was US 17 at the intersection of NC 904 to the intersection of NC 211. This study addresses this 15.3 mile section of the 65 mile proposed I-74 project.

Study Area



Figure 1: Project Study Area (2005 MapQuest.com, Inc. ©)

Begin Project on US 17
at the Intersection of NC 904

End Project on US 17
at the Intersection of NC 211

Costs and Traffic Volumes

For simplicity of demonstrating the Redbook Wizard this example only considers improving US 17 to Interstate standards. The other options of new parallel alignments are not considered in this example. The original 17.7 mile section 4 was reduced to 15.3 miles when the NCSU team removed the NC 211 segment from consideration in the analysis.

I-74 Project – Section 4A Costs	
Total Construction Cost	\$196,000,000
Total Right-of-Way Cost	\$73,325,000
Adjusted Construction Cost*	\$170,000,000
Adjusted Right-of-Way Cost*	\$63,500,000

*Adjusted to reflect the reduction of the section length from 17.7 miles to 15.3 miles.

I-74 Project – Section 4A Traffic Volumes	
Base Year ADT (2004)	26,800
Design Year ADT – No-Build (2030)	50,900
Design Year ADT – Build (2030)	57,800

Accident Data

The following table summarizes the crash analysis that was conducted by the NCDOT for US 17 between September 1, 2000 and August 31, 2003 and average rates for similar facilities in North Carolina.

	3-Year Crashes	Crashes per 100 MVM	NC Rural Interstate Full Control Access Rate*
Fatal	4	2.06	0.18
Non-Fatal	90	46.33	3.06
PDO	84	43.25	7.02

	1-Year Existing Condition Crashes Peak Direction	1-Year Interstate Condition Crashes Peak Direction
Fatal	0.66	0.058
Non-Fatal	15	0.99
PDO	14	2.27

*North Carolina Crash Rates can be found at:

<http://www.doh.dot.state.nc.us/preconstruct/traffic/Safety/ses/rates/rates.html>

Redbook Input Data Summary Sheet: I-74 Project

Input Item	Value
Number of segments to analyze	1
Year construction begins	2004
Year operation begins	2007
Last year of analysis period	2030
Base year	2004
Name of User Class 1	Cars
Name of User Class 2	Trucks
Vehicle Type for User Class 1	All Cars
Vehicle Type for User Class 2	All Trucks
Vehicle Occupancy for User Class 1 (persons)	1.6
Vehicle Occupancy for User Class 2 (persons)	1.08
Value of Time for User Class 1 (base-year dollars)	16
Value of Time for User Class 2 (base-year dollars)	16
Fuel Cost for User Class 1 (base-year dollars per gallon)	3
Fuel Cost for User Class 2 (base-year dollars per gallon)	3
Percent of Operating Costs that are fuel (percentage points)	52
Real discount rate (percentage points)	3
Inflation rate (percentage points)	3
Financing rate (percentage points)	0
Financing term (years)	0
Issuance cost (% of amount financed) (percentage points)	0
General traffic growth rate (percentage points)	3
Annual Growth of Value of Time (percentage points)	2
Average Truckload Value (base-year dollars)	14,500
Market Interest Rate for truckload value (percentage points)	6.75
Average Commercial Cargo Value (base-year dollars)	N/A
Market Interest Rate for Commercial Cargo Value (percentage points)	N/A
Cost per property damage accident (base-year dollars)	4,300
Cost per injury accident (base-year dollars)	46,000
Cost per fatal accident (base-year dollars)	3,700,000
Name of Construction Management Alternative 1	Construction

Redbook Input Segment Data Summary Sheet: I-74 Project

Segment Input Item	Value
Names given to segments	I-74 Project
Functional Class of each segment	Rural Interstate
Improvement Type for each segment	Additional Lane
Segment Length without improvement (miles)	15.3
Segment Length with improvement (miles)	15.3
Method for Calculating Change in User Delay	Redbook – ADT
Base both direction volume (vehicles per day)	26,800
Base peak-direction capacity (PCEs per hour)	4,400
Base Free Flow Speed (miles per hour)	60
Base Property-Damage Only Accidents (with base-year volume) (accidents per year)	14
Base Injury Accidents (with base-year volume) (accidents per year)	15
Base Fatal Accidents (with base-year volume) (accidents per year)	0.66
Base Operating Cost (base-year dollars)	0
Improved both direction volume (vehicles per day)	26,800
Improved Capacity (PCEs per hour)	4,600
Improved Free Flow Speed (miles per hour)	65
Improved Property-Damage Only Accidents (with opening-year volume) (accidents per year)	2.27
Improved Injury Accidents (with opening-year volume) (accidents per year)	0.99
Improved Fatal Accidents (with opening-year volume) (accidents per year)	0.058
Improved Operating Cost (opening-year dollars)	0
K Factor for User Class 1 (peak hour volume/daily volume)	0.12
K Factor for User Class 2 (peak hour volume/daily volume)	0.12
D Factor for User Class 1 (peak-direction volume/total volume)	0.55
D Factor for User Class 2 (peak-direction volume/total volume)	0.55
Week Factor for User Class 1 (weekly volume/weekday volume)	6
Week Factor for User Class 2 (weekly volume/weekday volume)	6
Month Factor (monthly volume/weekly volume)	4.35
Seasonal Factor (peak monthly volume/average monthly volume)	1.1
Percent of base peak-hour, peak-direction volume that is in User Class 1 (percentage points)	95
Percent of base peak-hour, peak-direction volume that is in User Class 2 (percentage points)	5
Percent of improved peak-hour, peak-direction volume that is in User Class 1 (percentage points)	95
Percent of improved peak-hour, peak-direction volume that is in User Class 2 (percentage points)	5
Terminal Value (base-year dollars)	0
Construction Management Alternative 1	
Construction Property-Damage Only Accidents (each)	0
Construction Injury Accidents (each)	0
Construction Fatal Accidents (each)	0
Total delay during construction (vehicle hours)	0
Total extra VMT on detour route (vehicle miles)	0
Speed on detour route (miles per hour)	0
Right-of-way acquisition cost (construction-year dollars)	63,500,000
Planning and design cost (construction-year dollars)	0
Construction management cost (construction-year dollars)	0
Construction cost (construction-year dollars)	170,000,000

Redbook Output Data Summary Sheet: I-74 Project

	User Benefits from Operation				User Benefits from Construction	Total User Benefits
	User Value of Time Benefits	User Operating Cost Benefits	User Accident Reduction Benefits	Agency Operating Benefits		
Project	\$ 965,814,552	\$ 4,995,838	\$ 51,612,709	\$ -	\$ -	\$ 1,022,423,099

	Capital Costs	Net Benefits	Benefit-Cost Ratio
Project	\$ 213,685,577	\$ 808,737,521	4.785