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Local Road Surfacing Criteria
Study SD2002-10
Automated Software User's Guide

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DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the South Dakota Department of Transportation, the State Transportation Commission, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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15. Supplementary Notes
A final report that provides details on the methodologies used to evaluate road sections is published as SD2002-10-F. A technical brief that provides a summary of the manual procure for evaluating low-volume roads is published as SD2002-10-TB. A spreadsheet analytical tool for applying low-volume road management is also available from the sponsoring agency.

16. Abstract

On a daily basis, local road agencies in South Dakota face the question of how to cost-effectively maintain low-volume roads. Specifically, decision makers are faced with the challenge of determining when it is most economical to maintain, upgrade, or downgrade a road's existing surface.

In order to assist decision makers with these types of decisions, the South Dakota Department of Transportation (SDDOT) initiated a research study in 2002 to investigate surfacing criteria for low-volume roads (LVR). The overall objective of this research study is to create a process that allows the user to compare the costs associated with different types of roads to provide assistance in deciding which surface type (hot-mix asphalt [HMA], blotter, gravel, or stabilized gravel) is most economical under a specific set of circumstances. In addition to incorporating economic factors into the analysis, the process also allows the user to consider other non-economic factors that are more subjective and difficult to quantify, such as political factors, growth rates, housing concentration, mail routes, and industry/truck traffic. The process used during this study is flexible enough to allow users to consider any combination of agency costs incurred by the agency for maintaining its roads, non-agency (user) cost factors such as vehicle operating costs or crash potential, and non-economic factors such as politics and housing densities.

The underlying methodology developed during this project for making road surface type decisions is based upon life-cycle cost analysis (LCCA) techniques that focus on selecting the most cost-effective road surface to meet a specific need. The methodology was created using agency cost and user cost models that were developed based upon specific road section information supplied by various local agencies in South Dakota, average daily traffic (ADT) and crash occurrence information supplied by the SDDOT, information obtained through a literature search, and input from members of the Technical Panel. The primary deliverables for this study include a Technical Brief that summarizes the manual procedure for determining the appropriate surface type for a road section based upon the average conditions, a software tool that allows the user to analyze economic and non-economic factors at specific locations to determine the appropriate surface type.

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1.0 INTRODUCTION

On a daily basis, local road agencies in South Dakota face the challenge of how to cost-effectively maintain low-volume roads. Specifically, decision makers are faced with the challenge of determining when it is most economical to maintain, upgrade, or downgrade a road's existing surface. For example, an agency might need to determine when it is most cost-effective to convert a gravel road to a blotter road.

In order to assist decision makers with these types of questions, the South Dakota Department of Transportation (SDDOT) initiated a research study in 2002 regarding surfacing criteria for low-volume roads. The objective of the research study is to create a process that allows the user to compare the costs associated with different types of roads to provide assistance in deciding which surface type is most economical under a specific set of circumstances. In addition to incorporating the economic factors, the process must also allow the user to consider other non-economic factors that are more subjective and difficult to quantify, such as political factors, growth rates, housing concentration, mail routes, and industry/truck traffic. The process that was developed can be performed using the automated software tool that is outlined in this *User's Guide* or through the use of a manual procedure as outlined in the *Technical Brief* that was also developed under this project.

This *User's Guide* is a hands-on guide that introduces the macro-driven Microsoft® Excel-based analytical tool that was developed to apply the low-volume road management methodologies recommended under the project titled *Local Road Surfacing Criteria* (SD2002-10). Specifically, this spreadsheet tool is used to determine the costs associated with maintaining roads with different surfaces and selecting the most appropriate road surface for a specific set of circumstances.

It is important to note that this *User's Guide* is not intended to answer all questions about the underlying analysis approach; supporting background information for this project is presented in chapter 5 of the final report. This *User's Guide* does, however, focus on providing detailed information organized into the following four areas:

- Analysis tool capabilities—Describes the capabilities and intended use of the decision tool.

- Getting started—General system requirements and step-by-step procedures for getting started using the tool.

- Setting up and conducting an analysis session—This section starts with a discussion of the types of data needed to successfully define all required outputs in the analysis methodology. The second part of this section walks a user through the analysis tool's user interface and the step-by-step procedure for setting up and conducting an analysis session.

- Explanation of output—Explanation of the produced output that summarizes all defined inputs and the analysis output results.

2.0 ANALYSIS TOOL CAPABILITIES

The primary purpose of this analysis tool is to provide the users with the ability to determine the appropriate surface type for a specific roadway section based upon data relating to that section. The tool provides a step-by-step procedure in the form of screen-by-screen progression for making road surface type decisions between different surface materials (hot-mix asphalt [HMA], blotter, gravel, and stabilized gravel) on low volume roadways.

The methodology incorporated into the tool is flexible enough to allow users to consider only those costs actually incurred by the agency for maintaining their roads, to include non-agency cost factors such as vehicle operating costs or crash potential, or to include non-economic factors. Whatever considerations are included in the analysis, the software tool provides a practical tool to assist agencies with decisions about the most cost-effective road surface type to be used in various situations.

The output of an analysis includes the following:

- Agency and user cost information summarized for the specified analysis period in a tabular format.

- Plot of a comparison of cumulative costs for the different surface types over the analysis period.

- Summary output of all input information (project description, analysis setup, agency cost details, user cost details, and advanced user inputs).

- Scoring table for economic and non-economic factors included in the analysis.

- Surface type selection for a given roadway section based either upon economic factors or a combination of economic and non-economic factors.

3.0 GETTING STARTED

System Requirements and Recommendations

To effectively use this analysis tool, an IBM-compatible industry-standard personal computer with the following minimum characteristics is required:

- Intel Pentium Pro, Pentium, or 486 PC.

- Microsoft® Windows 98, Windows 95, Windows NT 4.0, or newer operating system.

- Minimum of 32 Mb of RAM.

- Pointing device.

- CD-ROM drive.

- Super video graphics adapter with at least 800 x 600 resolution with 256 colors (Note: for best viewing, set the display resolution to 1024 x 768 with High [16 bit] color selected).

- Microsoft® Excel. Note: this analysis tool was developed under Microsoft® Excel 2002.

Copying the Analytical Tool to Your Computer

To use this analysis tool, first copy the *SD_LowVolumeSurface.xls* Excel workbook to your computer's hard drive. Note: you must have administrative privileges on your computer to accomplish this task. To copy the file, complete the following steps:

1. Use *Windows Explorer* to create a new working directory on the computer's hard drive that will store the analysis tool workbook.

2. Copy the *SD_LowVolumeSurface.xls* file to the newly created directory.

To effectively use this analysis tool, continued administrative privileges are needed for the created directory, so that files can be saved to that directory as necessary.

Preparing the Microsoft® Excel Environment

The SDDOT low-volume road surface selection analysis tool is a Visual Basic Application (VBA) driven Microsoft® Excel workbook. To facilitate the entry of data, a user-friendly dialog-box driven user interface has been incorporated to give the feel of a stand-alone software program. However, this tool differs from stand-alone software in that it must be opened within Microsoft® Excel. Because this analysis tool is driven by many macros (a series of commands and functions stored in a Microsoft® Visual Basic code module), Microsoft® Excel must be set up to allow these macros to run. To set security to an acceptable level, complete one of the following sets of steps:

<u>From the "Tools" menu:</u>

1. Under the **Tools** menu, click **Macro**.
2. Click **Security** from the **Macro** submenu.
3. Under the **Security Level** tab, set the macro security level to **Medium**.
4. Click **OK** to close the **Security** dialog box.

<u>From the "Options" menu:</u>

1. On the **Tools** menu, click **Options**.
2. Click the **Security** tab.
3. Click on the **Macro Security** button.
4. Click the **Security Level** tab, and then set the macro security level to **Medium**.
5. Click **OK** to close the **Security** dialog box.
6. Click **OK** to close the **Options** dialog box.

If these instructions do not appear to be valid for Excel, click on the "Help" menu and conduct a search for "macro security." Follow the subsequent instructions to set the macro security to "medium."

Starting the Analysis Tool

To start the analysis tool, simply open the *SD_LowVolumeSurface.xls* file like any other Microsoft® Excel workbook. Specifically, this file may be opened by either double clicking on the file name after using *Windows Explorer* to locate the file, or by opening the file using the File => Open menu commands within Microsoft® Excel.

Upon opening the file, the standard Excel pop-up dialog box should appear that contains the following warning about macros:

Macros may contain viruses. It is always safe to disable macros, but if the macros are legitimate, you might lose some functionality.

Click the **Enable Macros** button to allow Excel to run the macros and open the analysis tool. Upon opening the *SD_LowVolumeSurface.xls* file, the macro-driven user interface will automatically present the *Introduction* dialog box.

4.0 SETTING UP AND CONDUCTING AN ANALYSIS SESSION

Introduction

This section provides the user with all of the information that is required to set up and conduct a typical analysis session. The user interface of this analytical tool differs from a typical Microsoft Excel spreadsheet in that a series of dialog boxes (windows) are presented to the user to collect needed inputs for the analysis process. That is, you will enter inputs using typical Windows controls (i.e., typing values in input boxes, selecting values from drop down list boxes, clicking check boxes, etc.) rather than entering values into cells in a traditional spreadsheet. The intention of this dialog box-driven user interface is to facilitate the gathering of required inputs and to make the analysis process more user friendly.

Specifically, the user interface of the analysis tool is organized into a series of required and optional steps that are completed to conduct an analysis. An overall flow chart showing the general structure of the user interface is presented in figure 1. Each step of the setup process is discussed in more detail in the separate sections below.
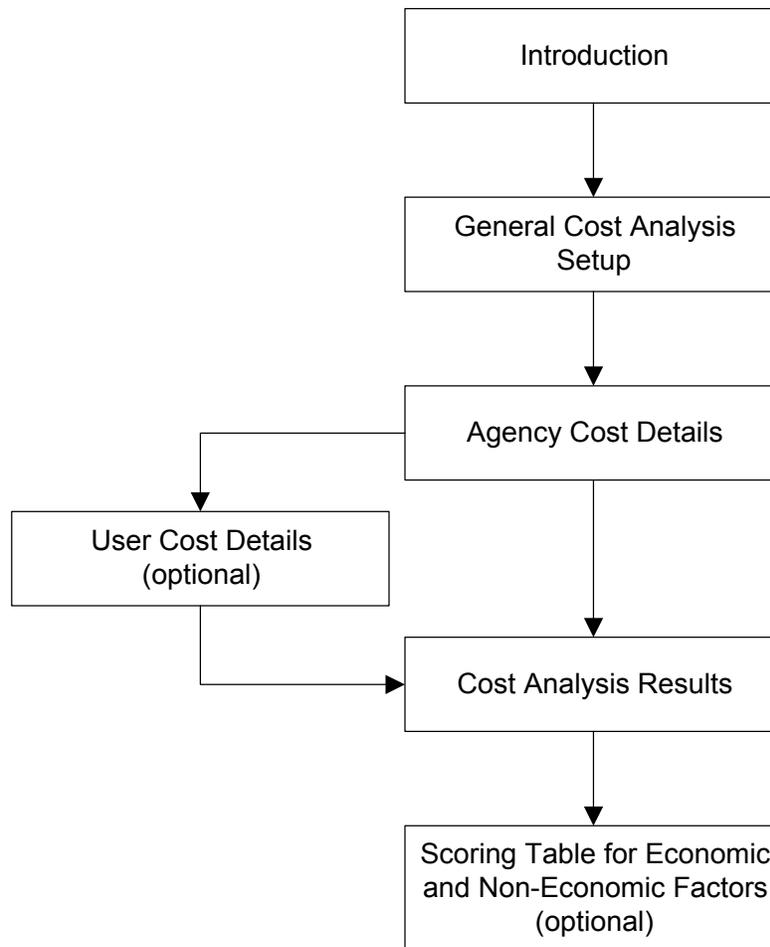
Figure 1. General structure of the analysis tool's user interface.

Introduction Dialog Box

When you first open the start the *SD_LowVolumeSurface.xls* workbook, you will be presented with the *Introduction* dialog box displayed in figure 2. This dialog box introduces the user to the analytical tool, provides controls where the user can enter some general project description information, and determines the level of analysis complexity that the user will be subjected to throughout the remainder of the analysis setup process. More details on the specific areas and controls included on this dialog box are described below.

Figure 2. *Introduction* dialog box.

Project Description Information Area

The *Project Description Information* area of this dialog allows you to define some identifying information about the current project for which you are analyzing potential surface types. The following input boxes allow you to enter project-specific information that helps identify the project:

- *Road name*—Use the *Road name* to store an identifying road name, highway number, or project ID associated with a given project (e.g., *County Road A*). To change the current defined road name, simply type a new name in the *Road name* input box.

- Location—The Location input box is intended to store more detailed identifying information that can be used to identify the specific location associated with a given project (e.g., *5 mile section from Grant Road to SD Highway 7).*

- County—The *County* drop-down list box contains an alphabetical list of counties in the State of South Dakota. As another piece of project identifying information, select the appropriate county from the *County* list box.

Advanced User Inputs Area

The *Advanced User Inputs* area contains a check box that, if checked, will allow a more advanced user access to some of the underlying defaults associated with the cost analysis. When conducting a typical surface selection comparison, it is strongly recommended that you leave the *Enable "Advanced User" Inputs* check box unchecked. In general, the default values that are made available to advanced users do not need to be changed as they are values recommended by the research team and Technical Panel associated with this project. The more detailed cost analysis variables made available to "advanced users" should only be changed when conducting more complex "what if-type" analysis sessions.

Development Information Area

The *Development Information* area of this dialog simply provides the user with contact information relevant to this analysis tool.

Next Button

As mentioned above, the user interface for this workbook is laid out as a sequential series of dialog boxes that are used to gather the required inputs for an analysis. Clicking on the [Next] button will display the next dialog box in the series (i.e., General Cost Analysis Setup).

Help Buttons

If at any point during the setup of the analysis session more detailed information associated with a dialog box's purpose, controls, or inputs is needed, click on the provided [?] button to view specific help text.

Closing the Workbook Without Saving

If you would like to close (exit) the workbook without saving any of your changes, you may do this by clicking the close window box (i.e., [X]) in the upper right corner of any primary dialog box in the user interface. Clicking this button will bring up the *Exiting the Program* dialog box shown in figure 3. The [OK] and [Cancel] buttons provided on this dialog box are described below.
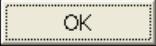
- The [OK] button closes the analysis tool workbook <u>without</u> saving any changes made to the current session. Inputs are only saved as part of the new workbook that is created as a result of conducting an analysis session.

- The [Cancel] button returns the user to the user interface. The analysis tool workbook will not be closed, and therefore any input changes will not be lost.
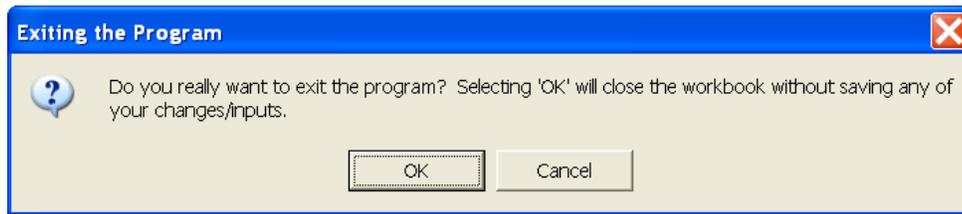

Figure 3. *Exiting the Program* dialog box.

General Cost Analysis Setup Dialog Box

The *General Cost Analysis Setup* dialog box (shown in figure 4) provides controls used to collect some of the more general required cost analysis-related inputs. The dialog box is divided into four different areas titled *Analysis Type*, *Selection of Alternative Surface Types*, *Analysis Setup Inputs*, and *Inclusion of User Costs*. Each of these different input areas is described in more detail below.
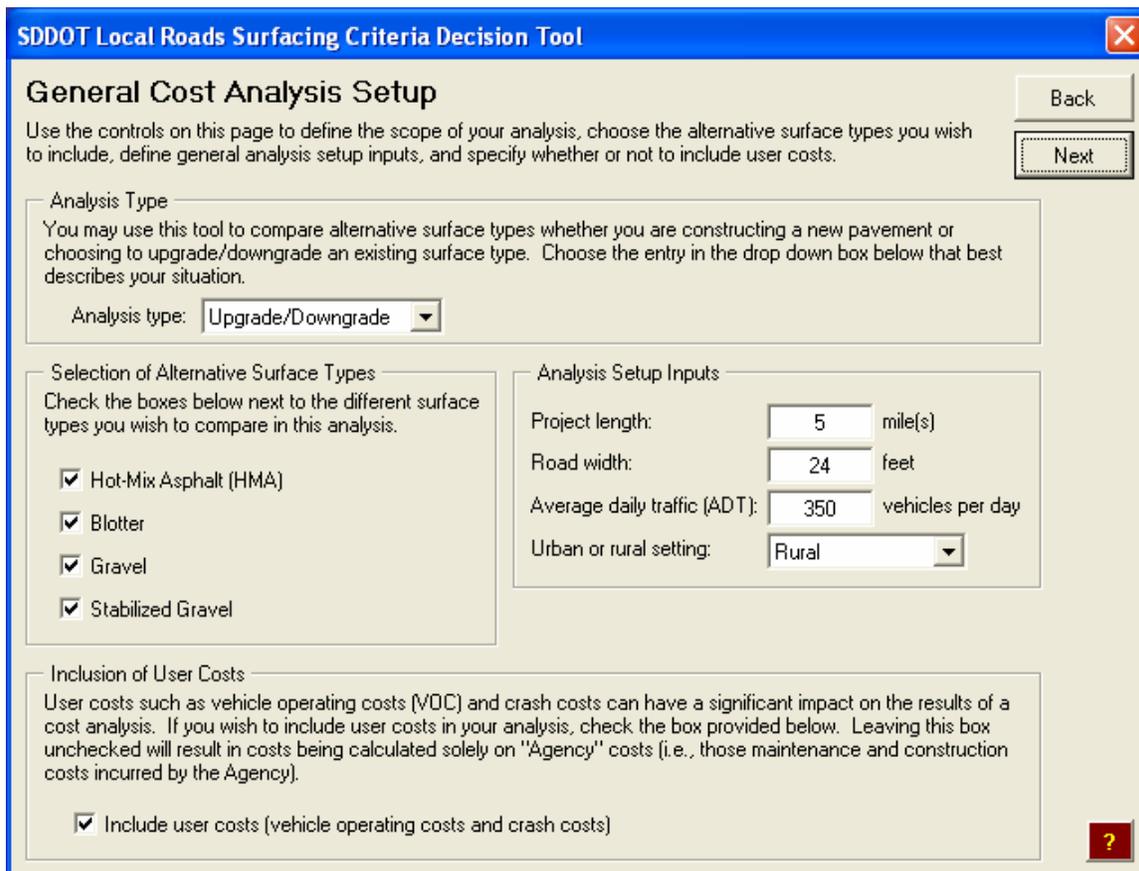

Figure 4. *General Cost Analysis Setup* dialog box.

Setting the Analysis Type

As explained in the introductory text in the *Analysis Type* area of this dialog box, this analytical tool may be used to help select a surface type for either a new construction project or a project in

which the current surface is being upgraded or downgraded. Choose the appropriate analysis type from the *Analysis type* drop down list box.

Selecting the Surface Types to be Considered in the Analysis

For a given analysis, the user has the option to choose which of the four available surface types (Hot-Mix Asphalt [HMA], Blotter, Gravel, and Stabilized Gravel) are to be considered for a given project. The controls in the *Selection of Alternative Surface Types* area of the General Cost Analysis Setup dialog box are used to define the surface types to be included in the analysis session. To include a particular surface type in the analysis, click on the surface type name or its associated check box to enable it. To disable a previously selected surface type, click again on the surface type name or check box.

Defining General Cost-Related Analysis Setup Inputs

The four inputs contained in the *Analysis Setup Inputs* area of the *General Cost Analysis Setup* dialog box are grouped together as they are project-related inputs that directly influence the cost analysis. Brief descriptions of each of these inputs are presented below.
- *Project length*—Use this input box to enter the length of the project that you are investigating. The primary importance of this input is that it is used to translate any costs entered as total project costs, to a unit cost per mile. For example, if the user defined a project that was 5 miles in length, and entered an annual total project maintenance cost of $5,000, the cost analysis would translate this total cost into a unit cost of $1,000 per mile (i.e., $5,000/5 miles = $1,000 per mile). All cost-related results from the cost analysis are presented in standard units of dollars per mile.
- *Road width*—The width of the road is used to convert the cost of a treatment that is provided on a square foot basis to a unit cost per mile.
- *Average daily traffic (ADT)*—The average daily traffic is important for two reasons. First, all treatment frequency and cost information collected from South Dakota personnel as part of this project was specific to a given ADT. That is, the typical maintenance treatment schedules for gravel surfaces with ADTs of 100 and 1000, respectively, are most likely different. Therefore, if you are interested in using default treatment timing, frequency, and cost data collected in the state of South Dakota under this project, the analytical tool needs to know the ADT associated with your current project. Second, if you choose to include user costs in the analysis, the number of vehicles using that road directly influences these costs. The optional use of user costs is described in more detail below.
- *Urban or Rural setting*—Use this drop down list box to select whether your project is located in an urban or rural setting.

Inclusion of User Costs

User costs typically refer to the vehicle operating, crash, and delay costs incurred by the users of a facility. During a life-cycle cost analysis, some or the entire user cost portions may be used in the analysis depending upon the desires of the agency. For this study, a decision was made to only include the vehicle operating and crash components of the user costs in the life-cycle cost analysis. Brief descriptions of each of these cost types are as follows:

- Vehicle operating costs (VOC)—In the analytical tool, vehicle operating costs are computed as a function of surface type, number of vehicles (by vehicle type), vehicle speed, and road grade. The vehicle operating cost data used as the basis of these calculations are based on industry averages for the cost of operating vehicles on paved surfaces that are converted based upon the different factors.

- Crash costs—Crash costs refer to the costs to society as a whole associated with roadway crashes. As is typically done, the crash costs computed in the analytical tool are categorized into costs associated with fatalities, non-fatal injuries, and property damage.

Including user costs in your analysis session is completely optional. If you wish to include user costs, click the check box in the Inclusion of User Costs area to enable it. If you wish to exclude user costs from your analysis session, make sure that this check box is not selected when proceeding to the next dialog box. If you choose to include user costs, you will be asked to enter more specific user cost-related inputs at a later stage of the analysis setup procedure. If you choose not to include user costs, all user cost-related inputs will be hidden throughout the analysis setup process.

Agency Cost Details Dialog Box

The *Agency Cost Details* dialog box (shown in figure 5) provides controls that are used to define all of the maintenance treatment timing, frequency, and costs associated with the different surface types included in the analysis. Note that a separate tab is displayed for each of the surface types previously selected on the *General Cost Analysis Setup* dialog box. While the maintenance treatments differ between the surface types, the controls and general layout of the different surface-related tabs use the same format. The details associated with defining the maintenance treatment-related inputs are discussed below.

Defining Initial Costs

The first input at the top of each surface-specific tab is the initial cost of placing the surface treatment. This initial cost is either the total project cost or unit cost (cost per mile) associated with a particular surface type. If you previously selected the analysis type to be *New Construction*, the initial cost is the total or unit cost associated with placing that new surface. If you selected an analysis type of *Upgrade/Downgrade*, this initial cost typically represents the cost of the last major rehabilitation on an HMA surface, last seal coat on a blotter surface, or last regraveling on both gravel and stabilized gravel surfaces. You may also add any costs associated with upgrading a road from one surface type to another to meet existing road standards.

To define the initial cost for a given surface type, simply type the representative cost in the appropriate input box and select the units (either total cost, cost per mile, or cost per square foot) from the associated unit drop down list box. Those users wishing to include the cost of curb and gutter for urban roads should include that cost within the initial construction/last major rehabilitation cost.

Figure 5. *Agency Cost Details* dialog box (showing controls associated with an HMA-surfaced pavement).

Defining Maintenance Treatment Timing and Cost Details

The controls in the *Maintenance Treatment Timing and Cost Details* area of the *Agency Cost Details* dialog box allow you to define which maintenance treatments are to be applied to a given surface type, when they are to be applied, and how much they are going to cost.

Selecting the Maintenance Treatments to Apply

The first step in setting up a maintenance strategy is determining which maintenance treatments are to be used on each included surface type. Table 1 summarizes the different maintenance treatments that are commonly used on low volume roads in South Dakota.

To include a particular maintenance treatment as part of a particular maintenance strategy, click on the maintenance treatment name or the check box next to the treatment name to check the box. To deselect a particular maintenance treatment that is checked, simply click on the name or associated check box again to uncheck the box. Note, if you choose to include the *Overlay* maintenance treatment for the HMA surface type, you are asked to enter an overlay thickness (in inches) into the input box provided to the right of the *Overlay* name.

Table 1. Available maintenance treatments for HMA, blotter, gravel and stabilized gravel surfaced roads.

Surface Type	Available Maintenance Treatments
Hot-mix asphalt (HMA)	▪ Crack sealing ▪ Seal coat ▪ Overlay ▪ Striping and marking ▪ Patching/maintenance
Blotter	▪ Seal coat ▪ Striping and marking ▪ Patching/maintenance ▪ Process in place, add aggregate, and reblot
Gravel	▪ Blading ▪ Regravel ▪ Reshape cross section ▪ Spot gravel/maintenance
Stabilized Gravel	▪ Dust control ▪ Blading ▪ Regravel ▪ Reshape cross section ▪ Spot gravel/maintenance

To include one of the user definable *Other* fields, first click the associated check box to enable the *Other* maintenance treatment field, and then enter a descriptive maintenance treatment name in the text box directly to the right of the associated check box.

Defining the Timing and Frequency of the Included Maintenance Treatments

The second set of inputs in the *Maintenance Treatment Timing and Cost Details* area of the *Agency Cost Details* dialog box allow you to define the timing and frequency of each included maintenance treatment for a given surface type. The inputs are organized so that you can read the description of timing and frequency from left to right after you define values in the input boxes associated with the number of times a year the particular treatment is applied, how often the treatment(s) is to be applied (in terms of years), and the year at which the first application is to be applied. For example, if you wanted to schedule one seal coat every 4 years, starting in year 7, you would set the *Seal Coat* treatment line to read "*Applied* 1 *time(s)/yr* every 4 years *starting in year* 7." As another example, if you wanted to reblade a gravel road 4 times a year, every year, starting in year 1, you would set the Blading line to read "*Applied* 4 *time(s)/yr* every year *starting in year* 1."

Defining Maintenance Treatment Unit Costs

The final set of inputs in the *Maintenance Treatment Timing and Cost Details* area of the *Agency Cost Details* dialog box are used to define the cost associated with applying one application of a particular maintenance treatment. To define the cost of a particular treatment application, type the cost in the input box and set the corresponding cost units to either dollars per application ($/app), dollars per mile ($/mile) or dollars per square foot ($/sq ft). Note that when choosing

units of "$/app," the cost that is expected is the total cost of applying one application of the maintenance treatment over the entire project length. For example, assume that a seal coat costs $5,000 per mile and is applied on a 4 mile long project. Such a cost could be entered as "$20,000 per app" or as "$5,000 per mile." Both cost descriptions would be equivalent in the cost analysis. Also note that for maintenance treatments that are typically applied more than one time in a year (e.g., blading), the cost that should be entered is the cost associated with <u>one</u> application of that maintenance treatment (i.e., the cost associated with one blading).

Applying South Dakota Default Treatment Timing and Cost Information

If a user does not have the data necessary to populate all initial construction/last major rehabilitation cost and maintenance costs and frequencies for the various surface types they wish to analyze, the tool can provide sample default costs and timings. These default values are summarized in tables 2 through 5 and were determined primarily by averaging the data supplied by the counties that participated in the study; however, some modifications to the data were made using the expert opinion of the Technical Panel as a reasonableness check. Data were averaged using 100-point ADT ranges starting at a zero ADT value. The data were supplemented with expert opinion from the Technical Panel in order to provide reasonable values for all ADT ranges. Again, it should be noted that the default values provided for initial construction/major rehabilitation cost do not include the cost of upgrading a road from one surface type to another. Therefore, if the user wishes to consider upgrade costs in the analysis, the default cost values must be increased by the appropriate amount.

Table 2. Default construction and maintenance costs for HMA roadways in South Dakota based upon ADT levels.

ADT	Initial Construction or Major Rehab. Cost ($/mile)	Crack Seal		Seal Coat		Overlay		Striping and Marking		Patching/ Annual Maint. Cost ($/mile)
		Years Between App.	Cost ($/ mile)	Years Between App.	Cost ($/ mile)	Years Between App.	Cost ($/ mile)	Years Between App.	Cost ($/ mile)	
0-99	35,000	3	900	5	6,500	21	35,000	5	210	500
100-199	35,000	3	900	5	6,500	17	35,000	4	250	500
200-299	37,000	3	1,200	4	7,000	20	37,000	4	280	500
300-399	37,000	3	1,200	4	7,000	20	37,000	4	280	500
400-499	39,000	5	1,600	4	7,300	20	39,000	4	310	500
500-599	40,000	6	1,600	4	7,300	20	40,000	4	320	500
600-699	43,000	6	1,600	4	7,300	20	50,000	4	360	500
≥ 700	43,000	6	1,600	4	7,300	20	50,000	4	360	500

* All costs are costs per mile.

Table 3. Default construction and maintenance costs for blotter roadways in South Dakota based upon ADT levels.

| ADT | Initial Construction or Major Rehabilitation Cost ($/mile) | Seal Coat | | Striping and Marking | | Patching/ Annual Maintenance Cost ($/mile) |
		Years Between App.	Cost ($/ mile)	Years Between App.	Cost ($/ mile)	
0-99	7,000	5	7,000	5	250	530
100-199	7,000	5	7,000	5	250	920
200-299	7,170	4	7,170	4	280	1,250
300-399	7,850	4	7,850	4	370	1,260
400-499	9,180	5	9,180	5	440	1,430
≥ 500	9,540	4	9,540	3	450	3,150

   * All costs are costs per mile.

Table 4. Default construction and maintenance costs for gravel roadways in South Dakota based upon ADT levels.

| ADT | Initial Construction or Major Rehabilitation Cost ($/mile) | Blading | | Regravel | | Patching/ Annual Maintenance Cost ($/mile) |
		Times Per Year	Cost ($/mile)	Years Between App.	Cost ($/mile)	
0-99	3,700	17	45	8	3,700	350
100-199	3,700	20	45	8	3,700	800
200-299	4,500	30	50	6	4,500	1,070
≥ 300	7,036	50	65	6	7,036	2,420

   * All costs are costs per mile.

Table 5. Default construction and maintenance costs for stabilized gravel roadways in South Dakota based upon ADT levels.

| ADT | Initial Construction or Major Rehab. Cost ($/mile) | Dust Control | | Blading | | Regravel | | Reshape Cross Section | | Spot Gravel/ Annual Maint. Cost ($/mile) |
		Years Between App.	Cost ($/ mile)	Times Per Year	Cost ($/ mile)	Years Between App.	Cost ($/ mile)	Years Between App.	Cost ($/ mile)	
0-99	5,000	1	2,700	4	40	12	2,300	--	--	500
100-199	8,154	1	3,300	4	40	5	4,854	--	--	333
200-299	8,154	1	3,300	4	40	5	4,854	--	--	333
≥ 300	19,716	1	2,300	6	380	10	17,416	10	3,400	3,635

   * All costs are costs per mile.

To apply the average default treatment timing and cost information for a given surface type, simply click on the button at the bottom of each tab. For example, for the HMA surface type, click on the [Apply Default "HMA" Strategy] button. After clicking one of the surface-specific buttons to apply default values, a confirmation pop-up dialog box will appear (see figure 6). The purpose of this dialog box is to confirm that you want to apply the default values as most of the currently defined values will be replaced by the default values.
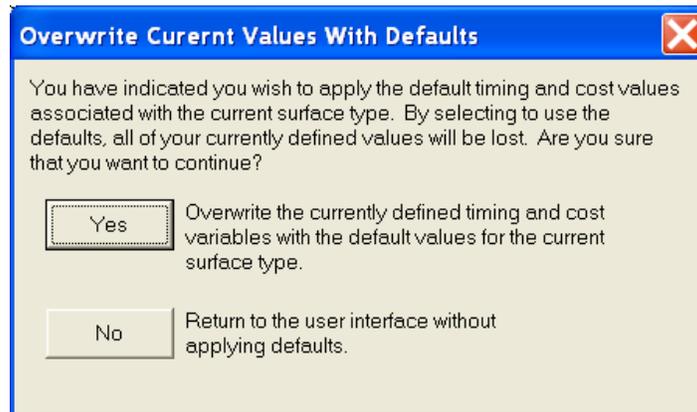
Figure 6. Confirmation dialog box that appears when choosing to apply default maintenance treatment timing and cost information.

Upon applying the default values, all controls on the current tab that reflect the applied defaults are shaded yellow (see figure 7). Also, as the default values are ADT-specific, a text box at the bottom of the tab reminds you what ADT was defined when you chose to apply defaults. Note that if you return to the *General Cost Analysis Setup* dialog and change the ADT value, you will have to click the button again to apply the default values associated with the new ADT value.

After default values are applied, any input value that is changed from the applied default value will be displayed with a white background. For example, figure 8 shows the same information as shown in figure 7 except the crack sealing frequency has been changed from "every 3 years" to "every 4 years," the start year has changed from 3 to 4 years, and the cost value changed from $1,200 to $1,300. Note that these changes resulted in the background of those input controls being changed from yellow to white. Also, note that the background color of the other crack sealing-related input controls did not change as those values were not changed.

Be aware that when you change your ADT value after you have applied default values for a different ADT, you will most likely observe a large number of input controls changing background color. For example, figure 8 shows the HMA tab after ADT was changed from 350 (the defaults shown in figure 6) to 100. The inputs shown in white reflect those current values that do not match the default values associated with the newly defined ADT of 100. Likewise, the inputs with yellow backgrounds indicate those current inputs that still match with the defaults applied for the ADT of 350. Therefore, once you have chosen to apply default values for a given surface type, it is recommended that you always reapply the default values if you make a change to the ADT value.

Figure 7. Example of the *Agency Cost Details* dialog box after default values have been applied (showing controls associated with an HMA-surfaced pavement).

Accessing Advanced General Cost Inputs

If the *Enable "Advanced User" Inputs* check box is checked on the *Introduction* dialog box, the [Advanced Inputs] button will be visible on the *Agency Cost Details* dialog box. If the *Enable "Advanced User" Inputs* check box is left unchecked on the *Introduction* screen, this button will not be visible during an analysis session.

When enabled, clicking on the [Advanced Inputs] button provides the user with access to some of the underlying defaults associated with the life-cycle cost analysis. Specifically, clicking this button will display the *Advanced General Cost Inputs* dialog box shown in figure 10. On this dialog box, the screen is divided into two areas. The first area, the *General Life-Cycle Cost Defaults*, displays the default values utilized for three of the general values associated with the life-cycle cost analysis. The second area of the screen allows you to include or exclude salvage value. Details associated with these cost-related inputs are described in more detail below.

Figure 8. Example of the *Agency Cost Details* dialog box illustrating how inputs that differ from the applied default values are distinguished with white backgrounds.

Figure 9. Illustration of the numerous differences in current values and applied default values that may result if the ADT value is changed after defaults have been applied.
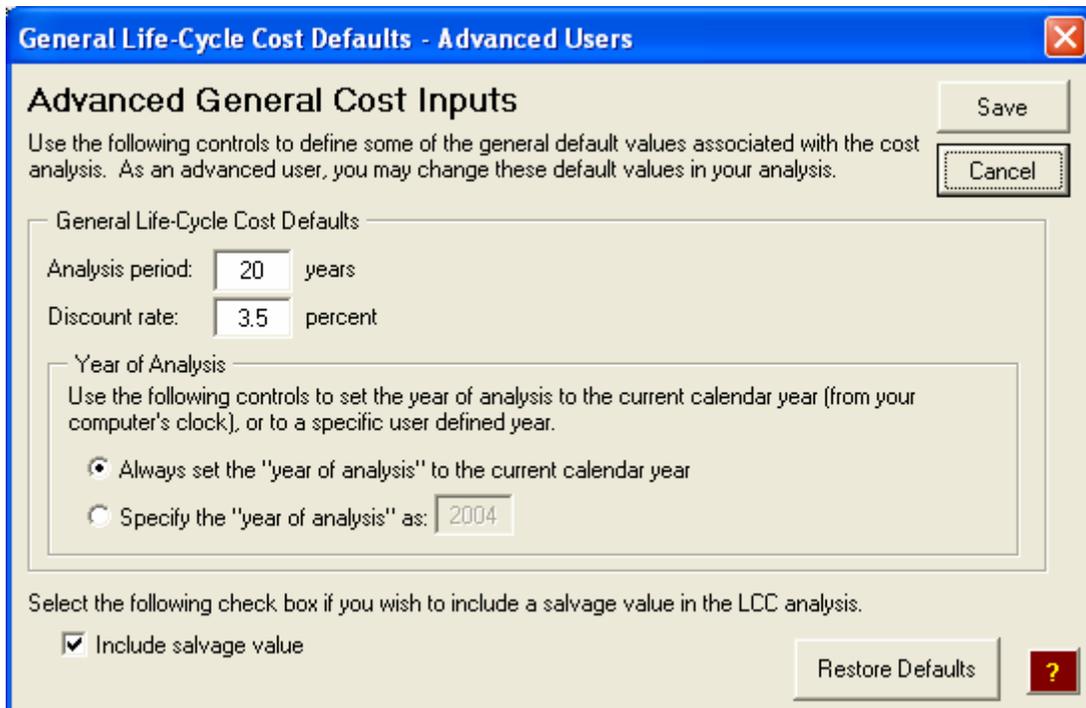
Figure 10. *Advanced General Cost Inputs* dialog that stores general life-cycle cost default values accessible to advanced users (default values shown).

Setting General Life-Cycle Cost Defaults

The *General Life-Cycle Cost Defaults* area of the *Advanced General Cost Inputs* dialog box provides input boxes so you can alter the following three life-cycle cost-related default values:

- *Analysis period*—The *Analysis period* specifies the time period over which the cost analysis is evaluated. Based upon input from the Technical Panel, the default analysis period was set to 20 years. You can change this value by deleting the current value and entering a new value in terms of years. Note: A 20-year analysis period is often considered the minimal range for a life-cycle cost analysis. Analysis periods less than 20 years should not be used without specific reasoning. It should also be noted that the analysis period is limited to 50 years on the upper end.

- *Discount rate*—By definition, the discount rate is the estimated difference between the interest and inflation rates over a long period of time, therefore, representing the true time value of money. The interest rate (or *market* interest rate) is described as the cost of borrowing money. The inflation rate is typically defined as the rate of increase in the prices of goods and services (e.g., construction of highways) over time. In the analysis tool, the discount rate is used to adjust all user-provided cost values to present worth dollars. The default value of 3.5 percent, which falls in the commonly quoted acceptable industry-wide range of 2 to 4 percent, is based upon the recommendations of the research team and Technical Panel.

- *Year of analysis*—The *Year of analysis* reflects the base year used in conducting the analysis. Since the tool was initially developed in 2003, the default costs in the tool are based upon this date. Documentation of the current *Year of analysis* is needed so costs

can be converted to that base date. The tool allows the user to set the year of analysis to the current calendar year (from the computer's internal clock) or to a specific user identified year. If the first radial button is selected, the year of analysis will be determined based upon the computer's clock. For example, if the user conducts an analysis in December of 2004 and the user opened the tool in January of 2005, the analysis year would be automatically updated to 2005. However, if the user wishes to keep the analysis year at 2004, the second radial button can be selected and 2004 can be entered into the *Year of analysis* input box.

Including Salvage Value

Simply put, a salvage value may be defined as the estimated value of an asset at the end of its useful life. Within the analysis approach, a salvage value is computed for each included maintenance treatment used in the analysis. Specifically, a salvage value is computed for a given maintenance treatment by determining the estimated remaining life of a maintenance treatment at the end of the defined analysis period, and then "giving back" the cost of the unused life of the treatment (to accomplish this computation, a linear depreciation approach is used).

For example, let's assume a $5,000 seal coat is expected to last 5 years, and is applied the year before the end of the analysis period used in the analysis. Therefore, in practice, the roadway has only used one of the five years of "benefit" provided with the application of the seal coat. Therefore, if the user chooses to include a salvage value in the computations, a salvage value of (4/5) * $5,000 = $4,000 would be applied as a *negative* cost at the end of the chosen analysis period. Conversely, if the user had chosen to not include a salvage value, the seal coat would be assumed to have no value after only one year in place (i.e., at the end of the analysis period).

The default setting is to include salvage value in the analysis. Therefore, by default, the *Include salvage value* check box on the Advanced General Cost Inputs dialog box is checked. If you wish to exclude the salvage value from the cost analysis, simply click the check box to remove deselect it.

User Cost Details Dialog Box (Optional)

The *User Cost Details* dialog box (shown in figure 11) provides controls that are used to define the general inputs required to include user costs (vehicle operating costs and the crash costs) in an analysis session. Note that this dialog box will only be displayed if you check the *Include user costs (vehicle operating costs and crash costs)* check box on the *General Cost Analysis Setup* dialog box. The *User Cost Details* dialog box is divided into two areas: the *Vehicle Operating Costs* portion and the C*rash Costs* portion. Also included in the dialog box is the ability to access the *Advanced Inputs*. The details associated with defining these user cost inputs are discussed below.
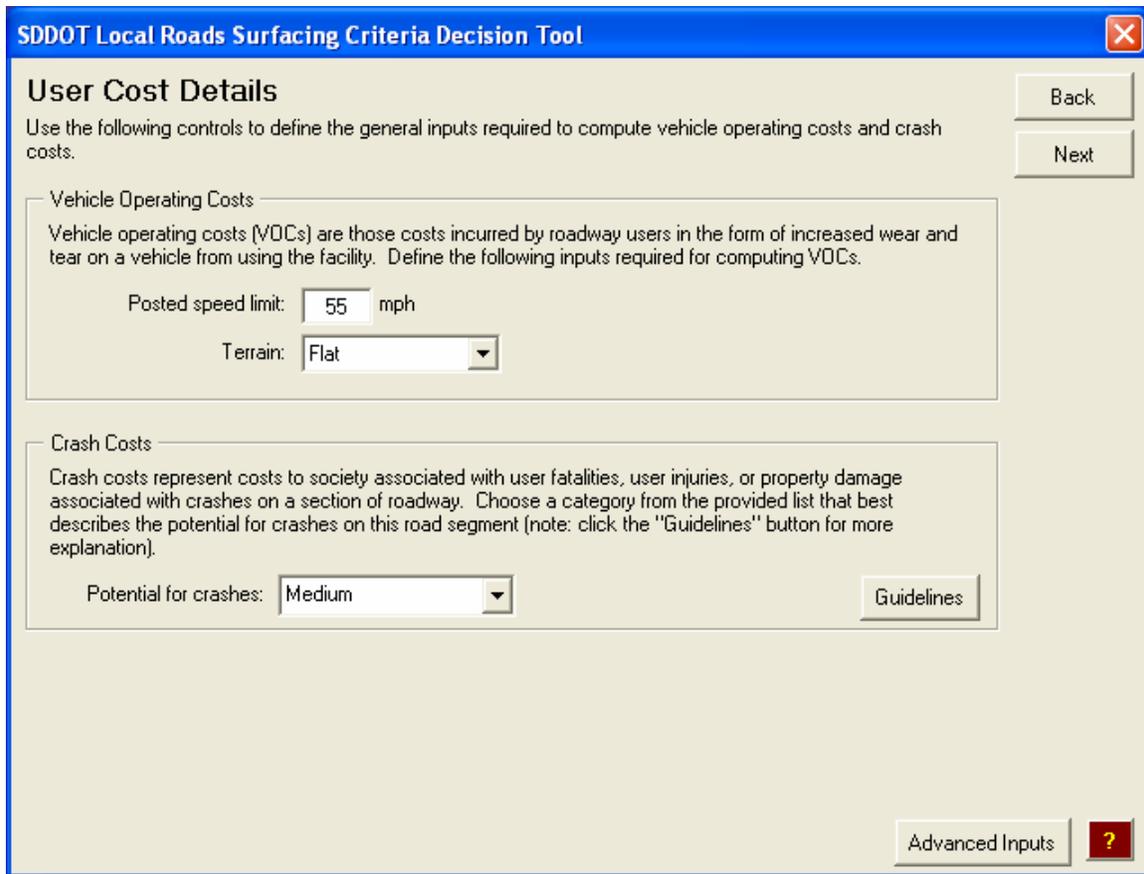
Figure 11. *User Cost Details* dialog box.

Defining Vehicle Operating Cost Attributes

The *Vehicle Operating Costs* area of the *User Cost Details* dialog box includes inputs for both the *Posted speed limit* and *Terrain* associated with the project being analyzed. These inputs are both required to compute the vehicle operating costs associated with the project (i.e., the costs incurred by roadway users in the form of increased wear and tear on a vehicle from using the facility). More detailed descriptions of both of these inputs are the following:

- *Posted speed limit*—The posted speed limit represents the maximum allowed legal speed at which traffic may travel on the roadway section being analyzed. This information is needed when computing running costs associated with different vehicle types on a given roadway section. The units of the speed limit are miles per hour (mph). To change this default value, simply enter a new value into the provided input box.

- *Terrain*—The *Terrain* input describes the topography of the land surrounding the given roadway section. Within the analysis tool, terrain is classified as *flat*, *rolling*, or *mountainous*. These three terrain descriptions are associated with grades of 0, 2, and 5 percent, respectively. Similar to the *Posted speed limit*, the *Terrain* type is needed to compute running costs associated with different vehicle types on a given roadway section. To select the appropriate terrain for a given project, select the appropriate value from the *Terrain* drop down list box.

Defining Crash Cost Attributes

The *Crash Costs* area of the *User Cost Details* dialog box requires the specification of the potential for crash occurrence. This information is needed to compute the total crash cost expected for a given roadway section. Specifically, the total crash cost represents the costs to society associated with user fatalities, user injuries, or property damage crashes on a particular section of roadway. You are provided with four categories of crash potential from which to choose: *None*, *Low*, *Medium*, and *High*. To select the appropriate crash cost potential for a given project, choose the proper crash potential from the *Potential for crashes* drop down list box.

When choosing the appropriate crash potential for a given project, it is important to understand the specific characteristics that are used to differentiate between the different levels of crash potential. To access more detailed crash cost-related information, click on the [Guidelines] button. Clicking the [Guidelines] button will display a pop up dialog box containing a table of crash potential guidelines (see figure 12). This table describes the expected number of crashes by type associated with the different crash potential levels. The guidelines for the number of crashes are based upon a ten-year time period assuming a 1-mile section of road. The values presented are based on averages of South Dakota crash data analyzed as part of this project. Crash potential is provided for a 10-year period even though the analysis period may be different. The crash potential rates were provided for a 10-year period because it is easier to estimate crash potential over a shorter time period such as 10 years versus a longer time period such as the 20 years that might be used as the analysis timeframe. The costs associated with the crash potential selected will be automatically converted to the appropriate analysis period in the software tool.

Figure 12. Guidelines for crash potential selection.

Accessing Advanced User Cost Inputs

If the *Enable "Advanced User" Inputs* check box is checked on the *Introduction* dialog box, the
[Advanced Inputs] button will be visible on the *User Cost Details* dialog box. If the *Enable*
"Advanced User" Inputs check box is left unchecked on the *Introduction* screen, this button will
not be visible during an analysis session.

When enabled, clicking on the [Advanced Inputs] button provides the user with access to some of the
underlying user cost-related defaults associated with the life-cycle cost analysis. Specifically,
clicking this button will display the *Advanced User Cost Inputs* dialog box shown in figure 13.
On this dialog box, the screen is divided into three areas: *Traffic Growth*, *Traffic Breakdown by
Vehicle Type*, and *Detailed Crash Location Information*. Each of these areas is described in
more detail below.

Figure 13. *Advanced User Cost Inputs* dialog that stores user cost-related default values
accessible to advanced users (default values shown).

Defining the Traffic Growth Rate

As the vehicle operating costs are directly related to the number of vehicles that travel on a
roadway in a given year, it is important to take the expected annual growth in traffic into
account. Based on feedback obtained from the Technical Panel associated with this project, the

traffic was expected to grow linearly at a rate of 1.2 percent per year. For example, if a pavement section were expected to receive 100,000 vehicles in the first year, using a growth rate of 1.2 percent would result in 101,200 vehicles expected in the second year (i.e., 100,000 * [1.012] = 101,200). To change the growth rate to something different that the default value, simply enter a new value in the provided input box.

Defining the Traffic Breakdown by Vehicle Type

Different vehicle types have different operating costs associated with them. Therefore, to get a more accurate estimate of the total vehicle operating costs expected for a given roadway segment, it is important to analyze different vehicle types separately. Within the analysis tool, traffic is divided into five different vehicle types: *passenger cars*, *commercial delivery trucks*, *single unit trucks*, 2-axle tractor-semitrailer combination trucks *(2-S2 trucks)*, and 3-axle tractor-semitrailer trucks *(3-S2 diesel trucks)*. Based on guidance by the Technical Panel for this project, the following default percentages of the annual ADT were assigned to each of the five included vehicle types.

- Passenger cars (97 percent).
- Commercial delivery vehicle (1 percent).
- Single unit truck (1 percent).
- 2-S2 (2-axle tractor-semitrailer) trucks (0.5 percent).
- 3-S2 (3-axle tractor-semitrailer) trucks (0.5 percent).

Also, note that if tractor-trailer farm equipment is part of the traffic mix they are best included as 2-S2 (2-axle tractor-semitrailer) trucks. To change any of the five default values, simply enter a new percent of traffic value in the appropriate input box.

Detailed Crash Location Information

As discussed previously, the user may classify the crash potential for a given roadway segment in terms of *None*, *Low*, *Medium*, or *High*. The default procedure is to assign the same crash potential (i.e., that defined on the *User Cost Details* dialog box) to all four surface types available for comparison. However, if you feel that the crash potential would differ depending on the particular surface type, the advanced user inputs contained in the *Detailed Crash Location Information* area of the *Advanced User Cost Inputs* dialog box allow you to make those designations.

To assign surface-specific crash potentials, start by selecting the *Select surface-specific crash potentials* check box (note: making this selection will override the global crash potential defined previously on the *User Cost Details* dialog box). Next, use the provided surface-specific drop down list boxes to select the crash potential level associated with each. As with the Guidelines button in the *Crash Costs* area of the User Cost Details dialog box, clicking on the Guidelines button provided on the *Advanced User Cost Inputs* dialog box will display a table of crash potential guidelines (see figure 12).

Restoring User Cost-Related Default Values

At any time, if you wish to restore the original default values to all of the controls on the *Advanced User Cost Inputs* dialog box, simply click on the [Restore Defaults] button. However, note that you will lose any changes that you have made to this screen up to that point.

Cost Analysis Results Dialog Box

The general results of the cost analysis are displayed on the *Cost Analysis Results* dialog box. This screen is divided into three general areas: *Summary of Cost Analysis Inputs*, *Cost Results Summary*, and *Additional Selection Criteria*. Each of these areas, along with other general controls on this page, is described in more detail below.

Summary of Cost Analysis Inputs

In an effort to provide some general feedback to the user on this summary page, a number of cost analysis-related inputs are displayed in the *Summary of Cost Analysis Inputs* area. Specifically, the inputs that are displayed here include the entered road name, road location, ADT, analysis period, and discount rate. Note, if you did not make any changes to analysis period or the discount rate under the *Advanced General Cost Inputs* dialog box (only available to advanced users) then these two values will be set to the default values of 20 years and 3.5 percent, respectively.

Because the magnitude of user costs can become very large in comparison to agency costs, the inclusion of user costs in a cost analysis remains a controversial practice. Therefore, the one user input included in this *Summary of Cost Analysis Inputs* area allows you to define how much of the computed user cost value is included in the cost analysis. If the *Include user costs (vehicle operating costs and crash costs)* check box was checked on the *General Cost Analysis Setup* dialog box, you will be able to input a desired weighting factor in the provided *User cost weighting factor* input box. If that check box was not selected, the *User cost weighting factor* input box will be grayed and the user cost weighting factors in the summary table below will show up as "n/a" (i.e., not applicable).

When activated, to enter an appropriate user cost weighting factor into the provided input box, first determine what percentage of the total user costs you want to include in your analysis. The defined weighting factor represents the chosen user cost percentage expressed as a decimal. For example, if you would like to include 50 percent of the total computed user costs, you would enter "0.50" into the *User cost weighting factor* input box. Entering a value of "0.03" would only use 3 percent of the computed user costs in the analysis. Clicking on the [Weighting Factor Guidelines] button will display a table displaying some general guidelines for choosing a level of user costs to include (see figure 15). It is important to note that these guidelines are intended as general industry "rules-of-thumb" guidelines as they are not based on scientific data.
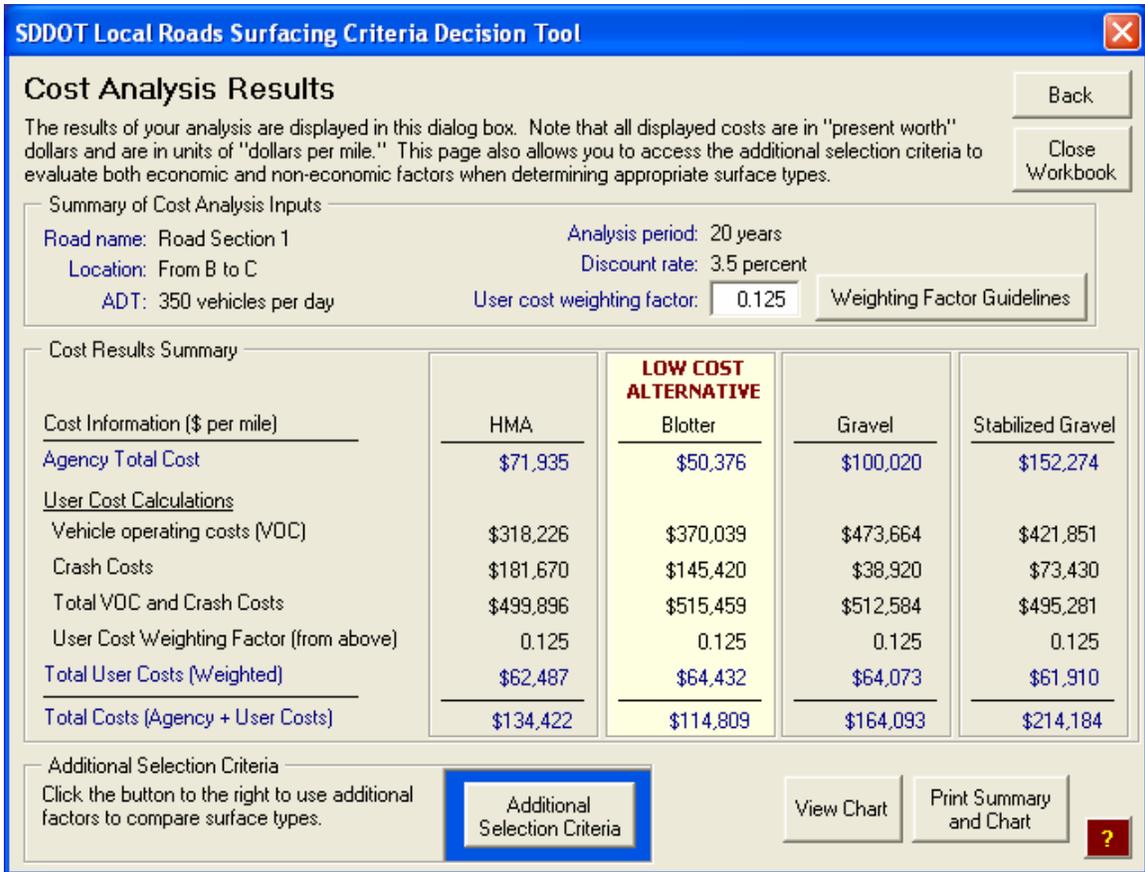
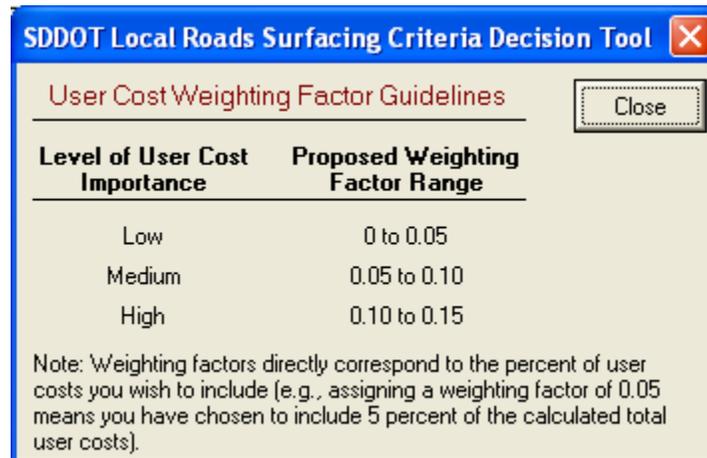Figure 14. Example of the *Cost Analysis Results* dialog box.

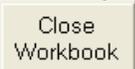Figure 15. General guidelines for selecting user cost weighting factors.

Cost Results Summary Table

The *Cost Results Summary* area of the *Cost Analysis Results* dialog box presents all of the detailed cost information computed for each surface type included in the analysis. From top to bottom the following describe the presented cost-related information (note: all costs are presented in units of dollars per mile):

- *Line 1: Agency Total Cost*—The total cost (in present worth dollars) of all maintenance treatments scheduled to be applied during the chosen analysis period.

- *Line 2: Vehicle Operating Costs (VOC)*—The total operating costs associated with all vehicles expected to use the roadway segment over the chosen analysis period. As mentioned previously, VOCs are based on ADT, surface type, speed, vehicle type, and road grade. If user costs are not included in the analysis, this value will be zero.

- *Line 3: Crash Costs*—The total cumulative crash costs expected on the roadway segment over the chosen analysis period. The total crash costs are computed as a function of surface type and the chosen crash potential level. If user costs are not included in the analysis, this value will be zero.

- *Line 4: Total VOC and Crash Costs*—This line is simply the sum of the values presented in lines 2 and 3 of the table (i.e., the total VOC and crash costs, respectively).

- *Line 5: User Cost Weighting Factor (from above)*—This line in the summary table redisplays the user-defined user cost weighting factor that is defined in the *Summary of User Cost Inputs* area of the dialog box.

- *Line 6: Total User Costs (Weighted)*—This line in the table displays the total adjusted user cost value (i.e., the value from line 4 times the value from line 5). For example, if the *Total VOC and Crash Costs* value in the table is $500,000, and the user entered a user cost weighting factor of 0.20, the total displayed on the *Total User Costs (Weighted)* line in the table would be "$100,000" (i.e., $500,000 * 0.20 = $100,000).

- *Line 7: Total Costs (Agency + User Costs)*—This value represents the total present worth life-cycle costs associated with a given surface type. This is computed as the sum of the total computed agency cost (line 1) and the adjusted total user costs (line 6).

The most economic surface type for a given project is that which has the lowest total cost in the summary table (i.e., the lowest cost value presented in line 7). To make the selection of the most economic surface type more clear, the lowest-cost surface alternative is highlighted in the summary table. For example, in figure 14, the Blotter surface type is clearly identified as the low cost alternative for that project.

Closing the Workbook

You may close the workbook from the *Cost Analysis Results* dialog box by clicking on the
Close Workbook button. Clicking this button will bring up the *Closing the Analysis Workbook* dialog box shown in figure 16. The function of the three buttons provided on this dialog box are described below.

- The Save As button saves any changes that you have made during the current analysis session and then closes the analysis tool workbook.

- The Quit button closes the analysis tool workbook <u>without</u> saving any changes made to the current session.

- The Return button returns the user to the user interface. The analysis tool workbook will not be closed, and therefore any input changes will not be lost.
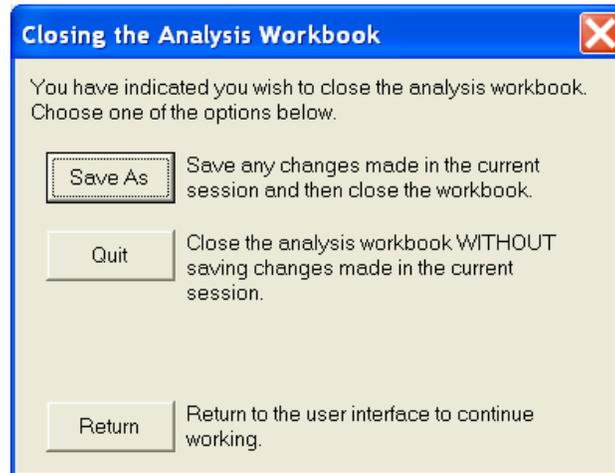
Figure 16. *Closing the Analysis Workbook* dialog box.

Viewing the Cumulative Costs Chart

Another method of visualizing the cost differences between the different included surface types is to view the cumulative costs (total of agency and included user costs) over the selected analysis period. To view a chart showing a comparison of the cumulative costs, click on the
View Chart button at the bottom of the *Cost Analysis Results* dialog box. An example of a cumulative cost chart is presented in figure 17.

Comparison of Cumulative Costs Associated with Different Surface Types
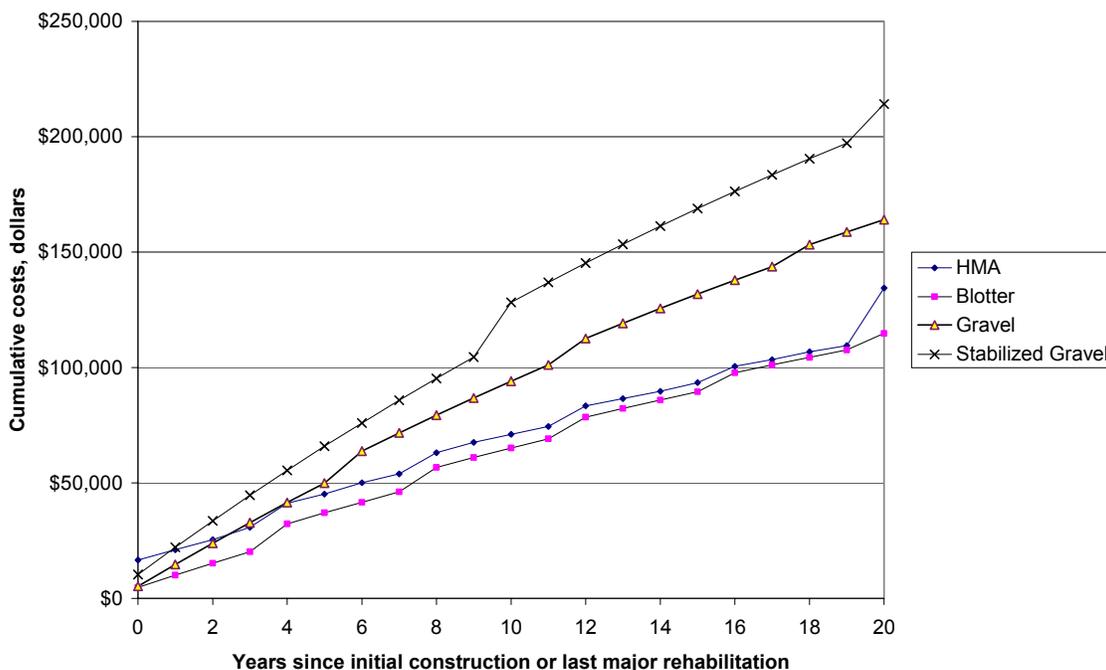
Figure 17. Example of a cumulative cost chart comparing the life-cycle costs associated with each included surface type.

After viewing the chart click on the provided [Return to Program] button to return to the *Cost Analysis Results* dialog box.

Printing the Summary Table and the Cumulative Cost Chart

To print an output report that contains specified inputs, cost analysis tabular output, and the created cumulative cost comparison summary chart, click the [Print Summary and Chart] button. The specifics of the created output report are described in more detail in the *Output* section of this *User's Guide*.

Accessing the Additional Selection Criteria

If you want to compare surface types solely on an economic basis, you may stop your analysis session at this point. However, if you are interested in making the surface type selection based on a combination of economic and non-economic factors, it is recommended that you click on the [Additional Selection Criteria] button in the *Additional Selection Criteria* area on the Cost Analysis Results dialog box. Clicking this button will display the *Scoring Table for Economic and Non-Economic Factors* dialog box that is discussed in the following section (see figure 18).

Scoring Table for Economic and Non-Economic Factors Dialog Box

In some cases, an agency may select a local road surface based solely on economic factors. However, in most cases, there are other issues besides total costs that come into play when deciding on a roadway surface. These issues include political factors, growth rates, housing concentration/dust control needs, mail routes, and industry/truck traffic. This section includes more detailed descriptions of the six different factor categories, describes the use of rating factors, describes the assignment of scoring factors, and finally, describes the computation of the total score used to compare different surface type alternatives.

SDDOT Local Roads Surfacing Criteria Decision Tool

Scoring Table for Economic and Non-Economic Factors

Use these controls to enter category rating factors and scoring factors. Rating factors represent the relative importance of each category in the final surface type decision. Scoring factors are used to compare how well each surface type addresses the six categories being considered. Note: Rating factors are entered as percentages and must sum to 100. Scoring factors are integers from 1 to 4 (4 and 1 are the highest and lowest ratings possible, respectively).

Factor Categories	Rating Factor (RF), %	HMA Scoring Factor (SF)	HMA Total Score (RF * SF)	BLOTTER Scoring Factor (SF)	BLOTTER Total Score (RF * SF)	GRAVEL Scoring Factor (SF)	GRAVEL Total Score (RF * SF)	STABILIZED GRAVEL Scoring Factor (SF)	STABILIZED GRAVEL Total Score (RF * SF)
Total Cost	55	3	1.65	4	2.20	2	1.10	1	0.55
Political Issues	25	4	1.00	3	0.75	1	0.25	2	0.50
Growth Rates	0	4	0.00	3	0.00	1	0.00	2	0.00
Housing Concentration/ Dust Control	10	4	0.40	3	0.30	1	0.10	2	0.20
Mail Routes	5	4	0.20	3	0.15	1	0.05	2	0.10
Industry/Truck Traffic	5	4	0.20	3	0.15	1	0.05	2	0.10
TOTALS	**100**		**3.45**		**3.55**		**1.55**		**1.45**

Buttons: Back | Close Workbook | Rating Factor Guidelines | Print Scoring Table Results | ?

Figure 18. *Scoring Table for Economic and Non-Economic Factors* dialog box.

Definition of Different Factor Categories

Based on discussions with the Technical Panel associated with this project, six different factor categories were identified as being influential when selecting the appropriate surface type for a given alternative. These categories include:

- Total Cost.

- Political Issues.

- Growth Rates.

- Housing Concentration/Dust Control.

- ▪ Mail Route.

- ▪ Industry/Truck Traffic.

When evaluating these categories for your given roadway section, you should plan on using only those factors that apply to your roadway. If for instance, you have a substantial growth in population for the area surrounding the given roadway you would include *Growth Rates* as a factor in your analysis.   Likewise, if you have, or are expecting, an increase in industry and truck traffic in the area of your roadway section, you would consider the *Industry/Truck Traffic* factor as a non-economic factor in the analysis. However, if there are no *Political Issues* relating to your roadway section you might decide to exclude the factor from your analysis.

<u>Assigning of Rating Factors</u>

The first step in evaluating both non-economic and economic factors simultaneously is to assign rating factors associated with each of the six different factor categories. These rating factors represent the relative (weighted) importance of the six factors considered in the selection process. That is, those factors that are more important in an agency's decision process should have a higher rating factor. All assigned rating factors must add up to 100 percent.

If the user desires more guidance on selecting rating factor, they may click on the
[Rating Factor Guidelines] button and a table displaying some general guidelines for choosing a rating factor will be provided (see figure 19). It is important to note that these values are intended as general guidelines to aid the user and are not based on scientific data.
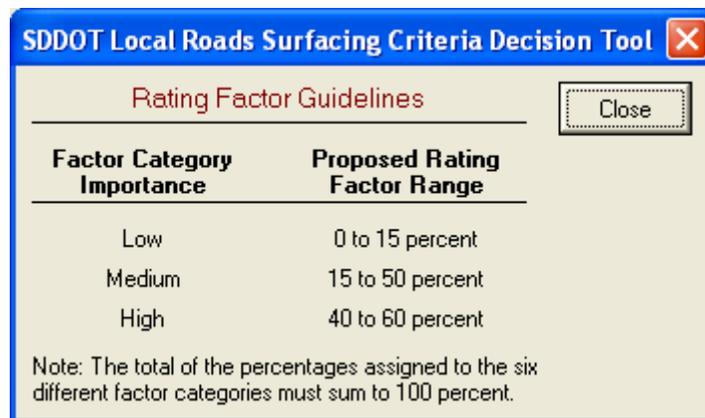
Figure 19. General guidelines for selecting rating factors.

In the example shown in figure 18, the user has identified the *Total Cost* factor category as the most important of the six categories as the largest single weight (55 percent) was assigned to this category. The least important categories were *Mail Routes* and *Industry/Truck Traffic* as they all were assigned the same weigh of 5 percent with *Growth Rates* receiving no rating.

Assigning Scoring Factors

The second step in the evaluation is to assign scoring factors associated with each factor category/surface alternative combination. For each rating factor, the scoring factor identifies how well the treatment alternative addresses that rating. Scoring factors are assigned on a 1 to 4 point scale. Within a given factor category, the higher the assigned scoring factor, the more appropriate that surface type would be if only that factor category were being considered.

For example, let us assume that you are conducting an analysis in which you are considering three different surface types: HMA, blotter, and gravel. In the process of assigning scoring factors, you would start with the *Total Cost* category. For the given project, you would ask yourself "how do the costs of the three considered surface alternatives compare?" Let's assume that your cost analysis showed that blotter was expected to have the least cost. HMA was the next least expensive of the three alternatives, although its cost was very close to the cost of the blotter alternative. Finally, let's assume that the gravel surface type was found to be nearly twice as expensive as the blotter alternative. Therefore, in the *Total Cost* row of the scoring table you might assign a scoring factor of 4 for blotter as it was found to the least expensive. Since the cost of more expensive a value of 3 may be the most appropriate score for HMA. Finally, since gravel was found to be nearly twice as expensive as both the blotter and gravel alternatives, a scoring factor of 2 might be the most appropriate value for the gravel surface type and stabilized gravel would receive a scoring factor of 1 because it was over nearly four times as expensive as the blotter surface. Note that the same scoring factors can be assigned within a given factor category (e.g., in the previously described example, the HMA and gravel alternatives could both be assigned a scoring factor of 2 if their costs were very close). To complete the scoring table, continue assigning scoring factors for each of the six different factor categories.

Comparing Surface Types Using the Computed Total Score

After rating and scoring factors have been assigned, the final step of the evaluation is to calculate the total scores associated with each surface type. For each factor category/surface type combination, a score is computed by multiplying the assigned scoring factor times the associated rating factor. For this calculation, the rating factor, which previously was given as a percentage, is now expressed as a decimal (e.g. 10 percent = 0.10). For example, in the *Total Cost* row shown in figure 18, the cost component to the total score of 1.65 for an HMA surface is computed by multiplying the 55 percent rating factor for total cost by the assigned scoring rating of 3 (i.e., 0.55 * 3 = 1.65).

A total score is computed for each surface type by summing the individual contributions to the total score determined for each factor category. The surface type with the highest overall total score is then identified as the most appropriate surface type when both non-economic and economic factors are considered together. In the example shown in figure 18, the blotter surface type was determined to be the most appropriate surface type since it had the highest total score of 3.55. Note that the surface type with the highest overall score is highlighted in the *Scoring Table for Economic and Non-Economic Analysis* dialog box to clearly indicate the most appropriate surface type based on the user-defined ratings and scoring factors.

<u>Printing the Scoring Table Results</u>

To print an output report that contains results of the scoring table, click the button. The specifics of the created output report are described in more detail in the *Output* section of this *User's Guide*.

5.0 OUTPUT

As indicated in previous sections, two different output reports may be printed from the analysis tool. Specifically, these two output reports include the primary output report and the *Scoring Table for Different Factor Categories*. Both of these outputs are described separately in more detail below.

Primary Output Report

The primary output report summarizes all general cost-related inputs, a table of cost summary results, and the chart showing the cumulative costs over time for each of the included surface type alternatives. As indicated previously, this output report is printed by clicking on the

 button in the *Cost Analysis Results* dialog box. Each of the different parts of this output report is briefly described below.

Input Table

The first part of the output report is a table that summarizes all of the important cost-related inputs defined by the user during the analysis setup steps. Specifically, all of the inputs associated with the project description, general analysis setup, maintenance treatment timing and costs, and user costs are summarized. If the advanced user options were enabled during the analysis session, a summary of all advanced user inputs will also be displayed.

Cost Summary Results Table and Chart

The second part of the primary output report is a table that summarizes all of the cost calculations (see table 6) for the analysis. The *Cost Summary Results* table is divided into agency cost and user cost details and shows all of the computed costs associated with the various surface types included in the analysis. All costs in the table are summarized in present worth dollars per mile of roadway based upon the analysis period and discount rate specified in the analysis setup. In addition to the table of cost summary results, this page of the primary output report also contains a chart that compares the cumulative costs for the various surface types in the analysis (see the example chart previously shown in figure 17). Based solely on costs, the most cost-effective surface type is that surface that provides the lowest total cost over the chosen analysis period.

Scoring Table for Different Factor Categories

If a user decides to consider non-economic factors, rating and scoring factors will be assigned to all surface types and final scores will be calculated and provided in tabular format in the software tool. As indicated previously, this scoring table may be printed by clicking on the

 button in the *Scoring Table for Economic and Non-Economic* dialog box. An example of this tabular output is shown in table 7. The surface with the highest overall score is considered the appropriate surface type for the given set of circumstances for the road section.

Table 6. Example cost summary results contained in the primary output report.

COST SUMMARY RESULTS

AGENCY COST SUMMARY				
	Unit Costs ($/mile) for Different Surface Types			
Cost Type	**HMA**	**Blotter**	**Gravel**	**Stabilized Gravel**
Initial Cost	$37,000	$7,850	$7,036	$19,716
Maintenance Costs	$55,344	$45,625	$94,752	$141,973
Salvage Value	$20,409	$3,098	$1,768	$9,415
TOTAL AGENCY COSTS	**$71,935**	**$50,376**	**$100,020**	**$152,274**
USER COST SUMMARY				
	Unit Costs ($/mile) for Different Surface Types			
Cost Type	**HMA**	**Blotter**	**Gravel**	**Stabilized Gravel**
Vehicle Operating Costs (VOC)	$318,226	$370,039	$473,664	$421,851
Crash Costs	$181,670	$145,420	$38,920	$73,430
Total VOC & Crash Costs	$499,896	$515,459	$512,584	$495,281
User Cost Weighting Factor	0.125	0.125	0.125	0.125
TOTAL USER COSTS (Weighted)	**$ 62,487**	**$ 64,432**	**$ 64,073**	**$ 61,910**
TOTAL COST SUMMARY				
TOTAL COST (Agency + User)	**$134,422**	**$114,809**	**$164,093**	**$214,184**

Table 7. Example scoring table for the simultaneous comparison of both economic and non-economic factor categories.

		Score Calculations for Different Surface Types							
		HMA		Blotter		Gravel		Stabilized Gravel	
Factor Categories	Rating Factor (%)	Scoring Factor	Computed Total Score	Scoring Factor	Computed Total Score	Scoring Factor	Computed Total Score	Scoring Factor	Computed Total Score
Total Cost	55	3	3 x 55/100 = 1.65	4	4 x 55/100 = 2.20	2	2 x 55/100 = 1.10	1	1 x 55/100 = 0.55
Political Issues	25	4	4 x 25/100 = 1.00	3	3 x 25/100 = 0.75	1	1 x 25/100 = 0.25	2	2 x 25/100 = 0.50
Growth Rates	0	4	4 x 0/100 = 0.00	3	3 x 0/100 = 0.00	1	1 x 0/100 = 0.00	2	2 x 0/100 = 0.00
Housing Concentration/ Dust Control	10	4	4 x 10/100 = 0.40	3	3 x 10/100 = 0.30	1	1 x 10/100 = 0.10	2	2 x 10/100 = 0.20
Mail Routes	5	4	4 x 5/100 = 0.20	3	3 x 5/100 = 0.15	1	1 x 5/100 = 0.05	2	2 x 5/100 = 0.10
Industry/Truck	5	4	4 x 5/100 = 0.20	3	3 x 5/100 = 0.15	1	1 x 5/100 = 0.05	2	2 x 5/100 = 0.10
TOTALS	100		3.45		3.55		1.55		1.45

Scoring Table for Different Factor Categories