DRAFT

HERS-ST v2.0

Highway Economic Requirements System-State Version

USER'S GUIDE

U.S. Department of Transportation
Federal Highway Administration

2002

Highway Economic Requirements System - State Version

User's Guide

U.S. Department of Transportation
Federal Highway Administration

August 2002

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 - INTRODUCTION

1.1 Scope

This *User's Guide* describes the usage and capability of the Highway Economic Requirements System – State Version (HERS-ST). HERS-ST was designed to perform highway engineering/economic analyses that reflect both the current condition of the highway system and the estimated costs and benefits of potential improvements to the system.

The system enables the user to better examine the costs, benefits, and economic implications associated with highway options. It can be used to develop estimates of needs for pavement, capacity, and alignment improvements to highways.

The purpose of this guide is to provide the user with the information needed to use the system efficiently and effectively. The remainder of this chapter consists of a brief overview of the contents of this document. A general introduction to the HERS-ST model is also provided, followed by a description of the HERS-ST software and its application.

1.2 Applicable Documents

The following documents are companion pieces to this user guide:

HERS-ST Technical Report	August 2002
HERS-ST Overview	August 2002
HERS-ST Induced Demand and Elasticity	August 2002
HPMS Field Manual	December 2000

1.3 Overview

The HERS-ST software is designed to analyze the effects of alternative funding levels on highway performance. To achieve this end, HERS-ST uses data describing a highway system in the 2000 Highway Performance Monitoring System (HPMS) format as the basis for analyses of the benefits and costs of alternative improvements.

Capabilities of HERS-ST 2.0 include:

- Application of user-specified deficiency criteria to identify potential pavement, capacity, and alignment improvements for individual sections;
- Estimation of the costs of these improvements;
- Estimation of the effect of each of these improvements on use of the improved section (but not the effect on use of other highway sections);
- Estimation of the benefits of these improvements and other exogenously specified improvements;
- Use of benefit-cost analysis to evaluate and prioritize the improvements to be implemented in each "funding period"; and
- A facility allowing users to modify or override improvement decisions made by the system.

1.4 THE HERS-ST SYSTEM

The HERS-ST software is comprised of a graphical user interface that overlays an analysis engine consisting of two executable programs. The expression “analysis engine” is used throughout the remainder of this document when referring to the executable programs collectively. The expression “perform analysis” is used throughout the remainder of this document when referring to running the analysis engine.

In HERS-ST, you organize your work in one or more “projects.” A typical project addresses one or more problems you are using HERS-ST to explore. Each project provides places for all the information you need to generate the analysis, and for the results of the analysis. Put another way, projects are similar to the drawers of a file cabinet. Following this analogy, HERS-ST divides the drawer into three parts named Settings, Results, and Reports. You will put the information needed to conduct the HERS-ST analysis in the Settings area. After HERS-ST executes the analysis, it will place a copy of the settings used in the analysis, and the outputs of the analysis, in the Results area. HERS-ST calls this combination of settings and outputs a “configuration.” HERS-ST also calls the outputs of the analysis an “iteration.” (In a special case, a configuration can contain more than one iteration.)

HERS-ST provides a set of tools you can use to transform the Results into the formats that best serve your needs. Using these tools, you select outputs and build customized charts, maps, reports, and tables. HERS-ST places your customized displays in the Reports area.

HERS-ST uses five types of input data, the first four of which are referred to as models *within* the software and documentation:

Highway Includes base-year descriptions of a set of highway sections to be analyzed. This must be in a comma-delimited ASCII file in the 2000 HPMS format.[1] This data format is described in Appendix A.

Improvement data Includes optional information describing user-specified improvements to highway sections that the user wants HERS-ST to implement, effectively overriding the HERS-ST analysis for these sections. This data is also described in Appendix A.

Parameter data Contains a variety of engineering standards, cost information, and other parameters, which are used by the analysis engine. This data is described in Appendix B.

Control data Contains information used to govern the operation of the analysis engine. This data is described in Appendix C.

Map data Contains optional information used in creating maps. This data must be in the form of a shape file, and is described in Chapter 11.

HERS-ST analyzes changes in traffic volume and road conditions over time, and recommends improvements to be made to the highway sections analyzed. The analysis occurs over discrete, user-defined funding periods. Three major sets of output are produced:

Section conditions Contains a description of the condition of each section at the beginning and end of each funding period, along with information about all improvements that have been selected and the effects of these improvements.

Tabular output Describes the state of the highway system analyzed at the beginning of the run; the simulated state of the system at the end of each funding period under the assumption that all recommended improvements are implemented; and several sets of statistics describing the costs and effects of the recommended improvements.

System conditions Contains a subset of the information from the tabular output and is used internally by HERS-ST as input into reports, tables, charts, and maps. These files include *system conditions* (SS1) and *improvement types* (SS2).

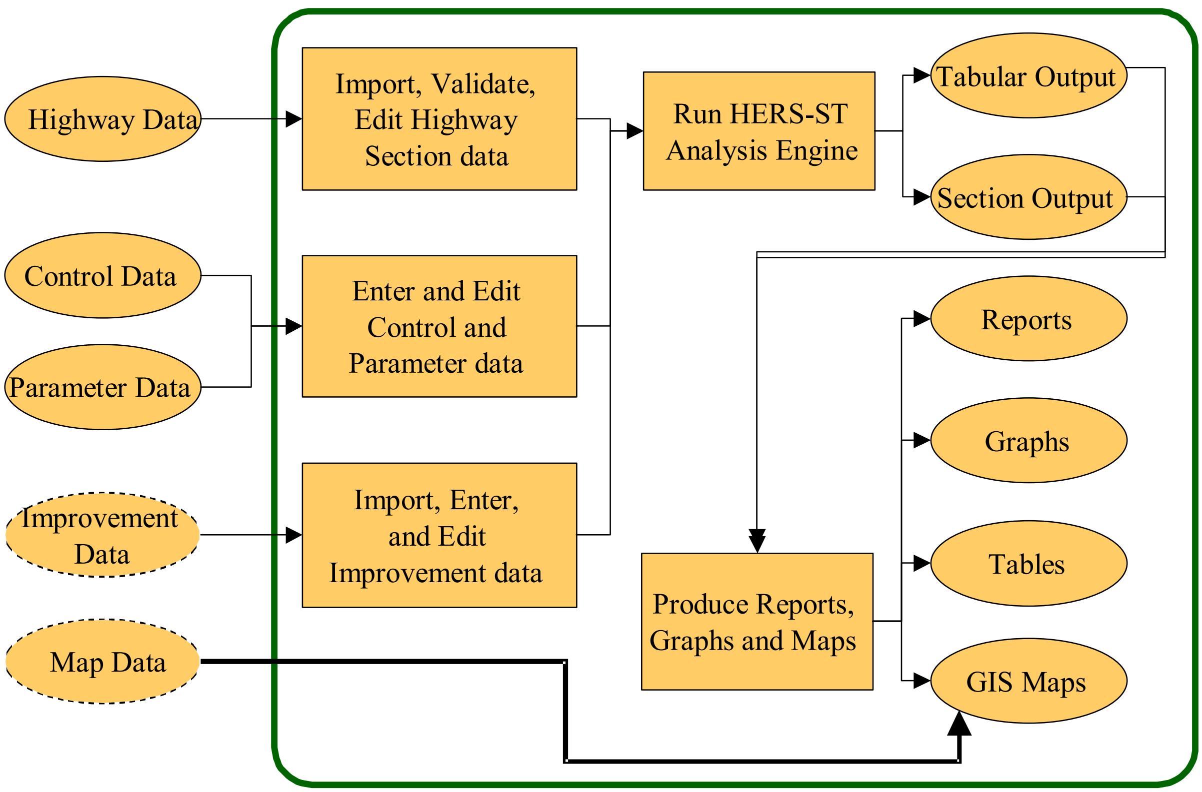
---

1 FHWA, *Highway Performance Monitoring System Field Manual,* December 1999.

The software provides a series of windows to allow the user to view and edit the control, parameter, improvement, and highway data. HERS-ST also provides the ability to execute the analysis engine, view outputs, and produce reports. Figure 1.4-1 is a simplified diagram of the HERS-ST analysis software showing the relationship between the input data, analysis engine, and output data.

SPECIAL NOTE: There are two fields in addition to those outlined in the HPMS field manual appended to the end of the highway data. They are single digit integers required by HERS-ST. If the highway data file does not contain these fields, they will be added by HERS-ST when the data is imported.

HERS-ST stores both the input data and settings along with the analysis results together in a Microsoft® Access database and can optionally store a copy of the data in a user specified archive directory. The information stored in the database can be reused to produce multiple sets of results for comparison, or the application can automatically execute multiple runs using the same set of data. For additional information on the inner workings of HERS-ST, please see Chapter 11 and Appendices F through J.



Note: The system output is not shown since it is used internally by HERS-ST for creating reports, graphs, tables, and GIS maps.

Figure 1.4-1 HERS-ST Flow Diagram

CHAPTER 2 - GETTING STARTED

2.1 SYSTEM REQUIREMENTS

- Personal Computer with Pentium III 400 Mhz (or equivalent) minimum
- Any of the Microsoft Windows family of operating systems including 95/98/ME/NT/4.0/2000 or XP with the latest Service Pack (Windows 2000 SP2 or higher recommended)
- 128 MB of RAM (256 MB or higher recommended)
- 100 MB of Free Disk Space
- Adobe Acrobat Reader 4.0 or higher (to view documentation)
- CD-ROM drive
- SVGA (800x600) or higher-resolution monitor

Note: This is the recommended configuration when using a highway data set of approximately 20,000 sections. Additional 128 MB blocks of RAM should be considered for each 20,000 section increase in highway data size.

2.2 INSTALLING THE HERS-ST SOFTWARE

a. Ensure that the current user has local administrative privileges on the computer on which HERS-ST v2.0 is to be installed.

b. Insert the HERS-ST v2.0 CD into the CD drive on the computer.

c. The HERS-ST Installation Main Window should be displayed. If not, browse to the drive where the HERS-ST CD is located and double-click on the file **setup.exe**.

d. From the Main Window, select **Install Software**.

e. A series of windows will prompt for different information during the installation process. It is recommended that the default directory locations be used.

f. Depending on the configuration of the computer on which the HERS-ST software is being installed, the system may require a reboot after installing a portion of the software, after which the installation will be complete.

g. Upon completion of the installation, a new Start Menu group, HERS-ST will be created.

h. The application may be started by selecting **Start / Programs / HERS-ST / HERS-ST v2.0**.

2.3 A QUICK TOUR OF HERS-ST

2.3.1 Starting the Software and Logging In

a. Start the HERS-ST v2.0 software by selecting **Start / Programs / HERS-ST / HERS-ST v2.0**.

b. At the Logon screen, type your last name and click **OK**.

> NOTE: The name entered at the login window will identify the individual who created or edited the different models within the software.

2.3.2 Creating a New Project

a. In the Project Browser, Figure 2.3-1, which should now be displayed, select the **New** tab to start the process for creating a new project. A default project name of "New Project" is provided. This default name can be edited by the user.

b. On this same window, select the 'Import from a highway file' button.

c. Click the **Browse** button to display a standard File Open dialog window.

d. Browse to "c:\Program Files\HERS-ST\Samples" and select the file "ODOT_TXT.csv" and then click the **Open** button to select a sample set of highway data in the 2000 HPMS format. The HERS-ST analysis process uses this highway data. For more information regarding the highway data, refer to Chapter 4 in this *User's Guide*.

e. Click the **OK** button to complete the Project creation process using the defaults for the remaining models. This will close the Project Browser and start the data import and validation process.

f. When the Import Highway Data popup message is displayed, select **Yes** to perform validation.

g. Select **Yes** again at the next popup message to complete the import process.

h. Select **Yes** to mark only the "good" highway records.

i. Select **No** at the prompt for displaying the error file. At this point, the import process is completed.

j. The Project Tree, located on the left side of the main application window, will now include four items under the Project. See Figure 2.3-2. These four items are the input models used by the HERS analysis process. They may be renamed by the user to provide a more descriptive name.

k. Expand the tree items to show the imported Highway Data and the default Control and Parameter Models.

l. Verify that the button for each is selected (3 places). These are the models that will be input to the analysis process. For more details on each of these models, review Chapters 4, 6, and 7.

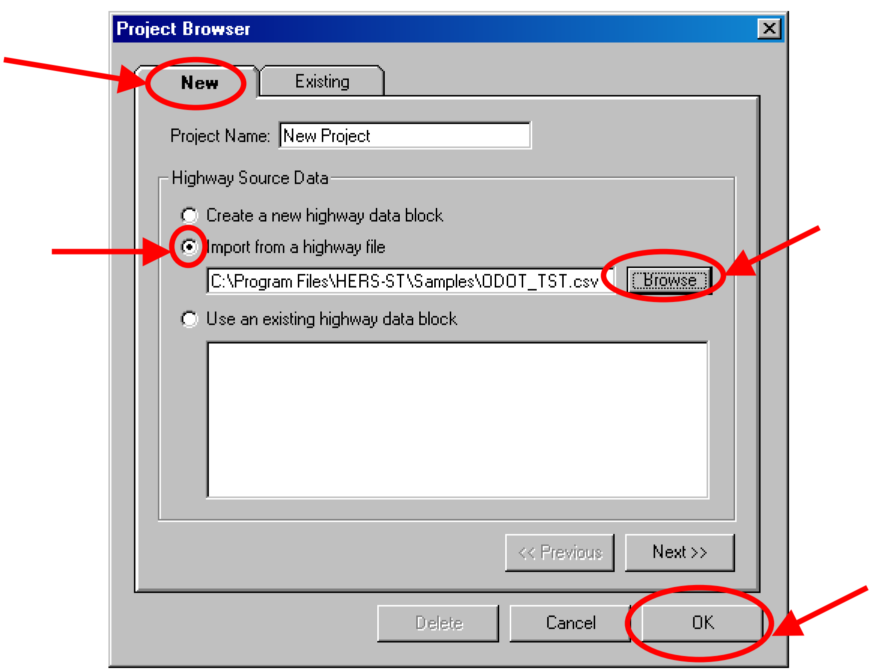


Figure 2.3-1 Project Browser

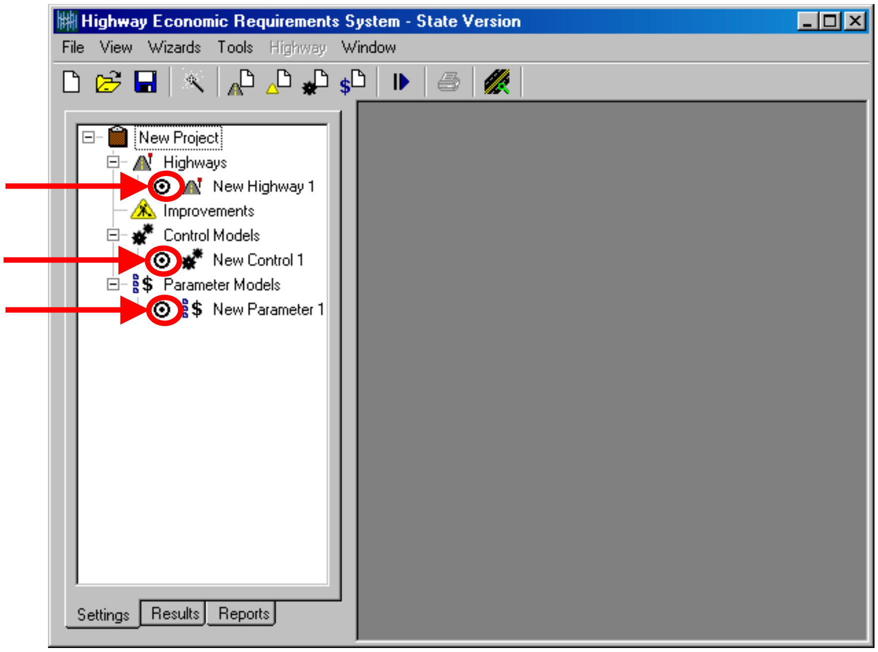


Figure 2.3-2 Project Tree

2.3.3 Viewing the Highway Data

a. In the Project Tree, right-click on **New Highway 1** and from the popup menu, select **Display**.

b. The Highway Data Window will be displayed in the application's workspace area on the right portion of the screen.

c. In the Highway Data Window, select the **Sections** branch of the tree. A grid view, similar to that shown in Figure 2.3-3 will be displayed, with one row for each section. Rows that have a reddish background are those sections that were found to violate the validation rules. You should also notice that they are not checked. Only those rows that are checked will be analyzed.

d. Close the Highway Data Window by clicking the **X** in the upper corner of the window.

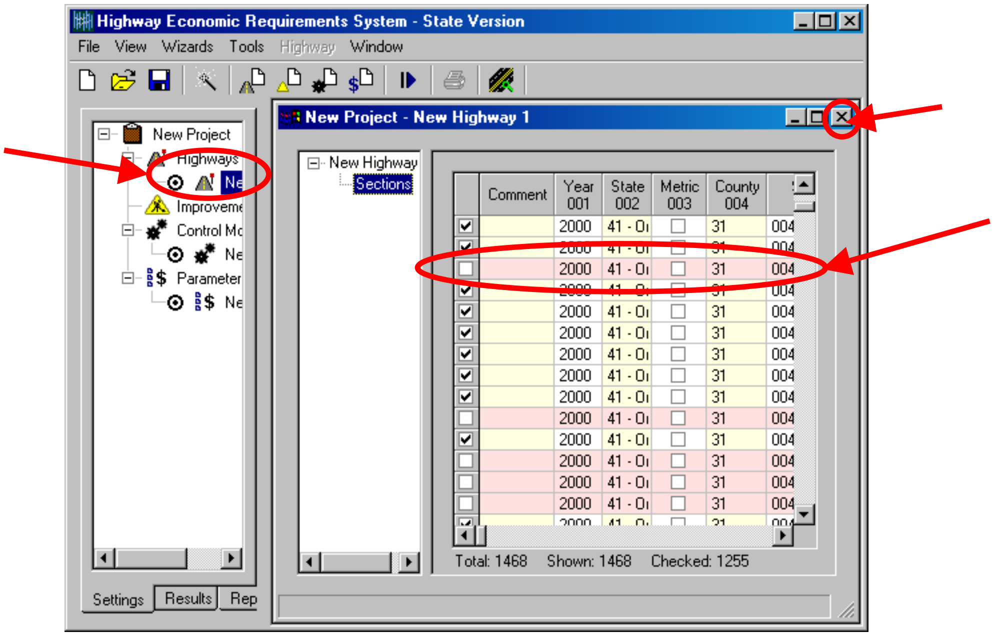


Figure 2.3-3 – Highway Data Window

2.3.4 Performing the Analysis

a. Select the **Run** icon  from the main toolbar to start the analysis process.

b. The Run HERS-ST Window is displayed.

c. Verify that the settings are as shown in Figure 2.3-4 below.

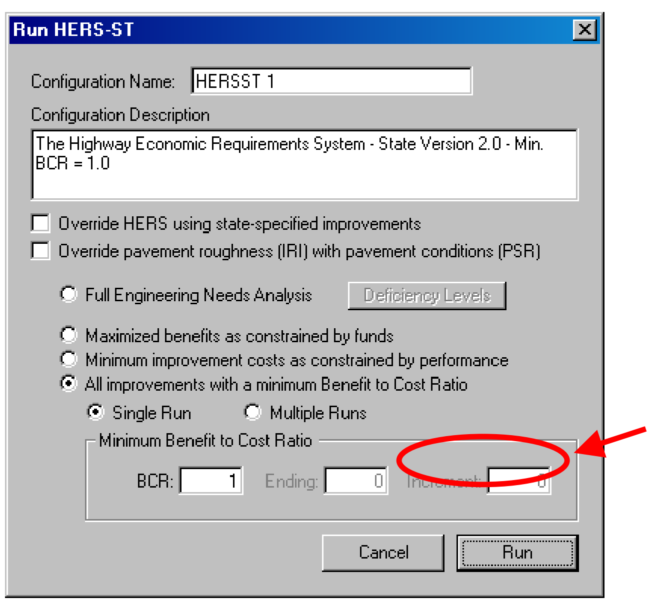
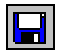


Figure 2.3-4 Run HERS-ST Window

d. Click the **Run** button to start the analysis.

e. After a short pause, a series of MS-DOS command windows will be displayed as the data is pre-processed and then analyzed by the HERS-ST model. For more details on the HERS-ST analysis types, refer to Chapter 8 in this *User's Guide*.

f. Upon completion of the analysis, control will be returned to the user and the project view will move to the **Results** tab. Refer to Figure 2.3-5. For more information on the results, refer to Chapter 9, in this *User's Guide*.

g. At this time, click the **Save** icon  in the main toolbar to save the Project, including the results. Results must be saved before reports can be created.

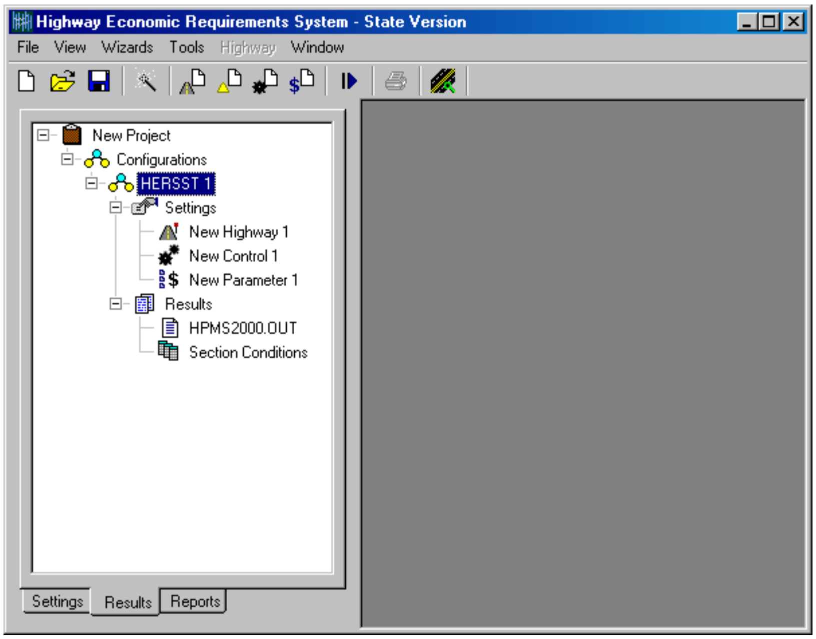


Figure 2.3-5 Results Tab of Project Viewer

2.3.5 Viewing the Results of the Analysis

a. To view the results of the HERS Analysis, ensure that the **Results** tab of the Project Tree is selected and expand the tree until it appears similar to Figure 2.3-5, showing two items under the **Results** branch.

b. Double-click on the **Section Conditions** item to display the Section Conditions Window.

c. Within this window, select a **Funding Period** to display the results of the analysis and recommended improvements on a per each highway section basis. Refer to Figure 2.3-6.

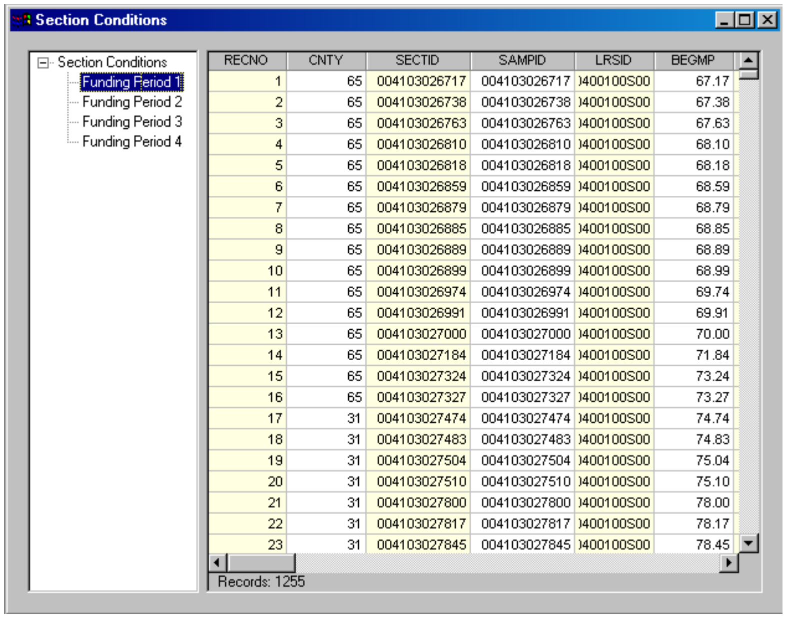


Figure 2.3-6 Section Conditions Window

d. Close the Section Conditions Window

e. Next, double-click on the **HPMS2000.OUT** item in the tree to display the Tabular Output Window.

f. Selecting any item in the tree will display the data page associated with that data. Refer to Figure 2.3-7.

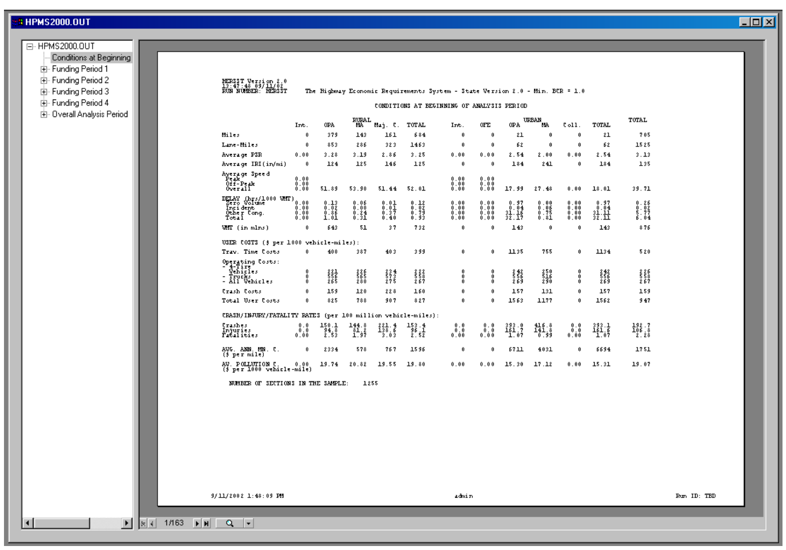


Figure 2.3-7 Tabular Output Window

g. Close the Tabular Output Window.

2.3.6 Creating a Chart from the Analysis Data

a. In the Project Tree, select the **Reports** tab.

b. Right-click on **Charts** and from the popup menu, select **New Item**. **New Chart 1** is added to the Project Tree. Refer to Figure 2.3-8.

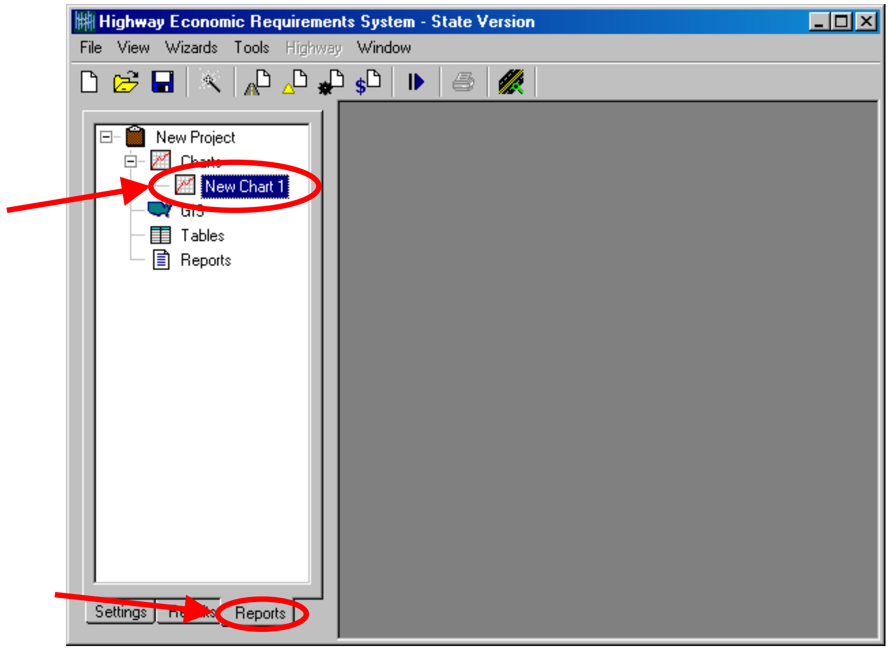


Figure 2.3-8 Reports Tab of Project Tree

c. Double-click **New Chart 1** to display the Chart Window.

d. Select the **Design View** tab in the Chart Window.

e. Right-click in the dark gray area at the lower portion of the chart to access the popup menu, which will show a list of the chart options, including predefined charts. From this popup menu, select **Single Iteration Charts** then **Funding Level per Improvement Type**. Refer to Figure 2.3-9.

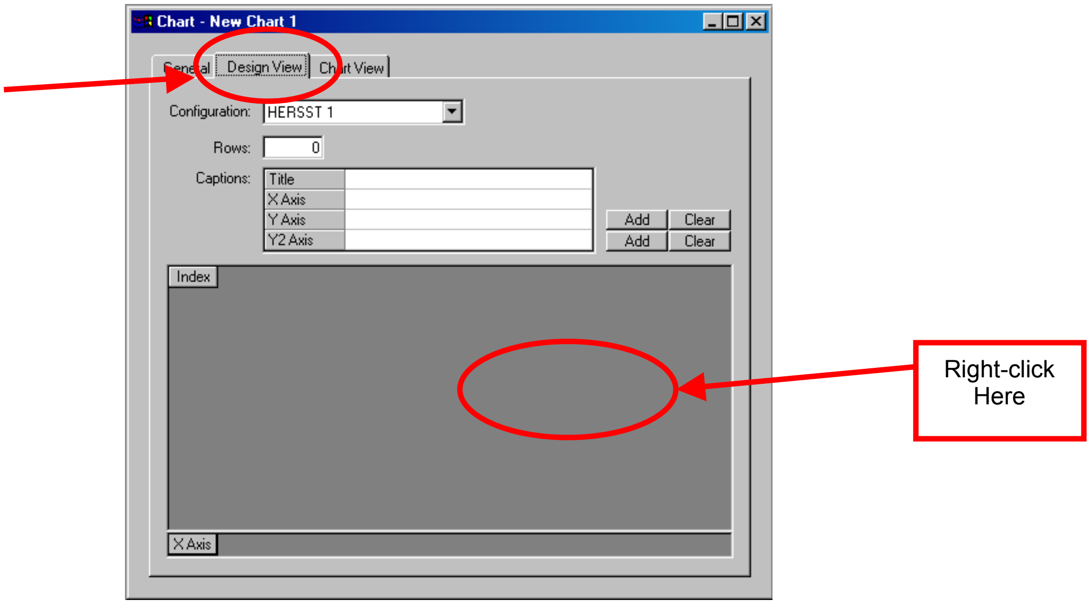


Figure 2.3-9 Chart Window

f. The predefined chart will populate the data for the titles and both the X and Y-axes. Refer to Figure 2.3-10.

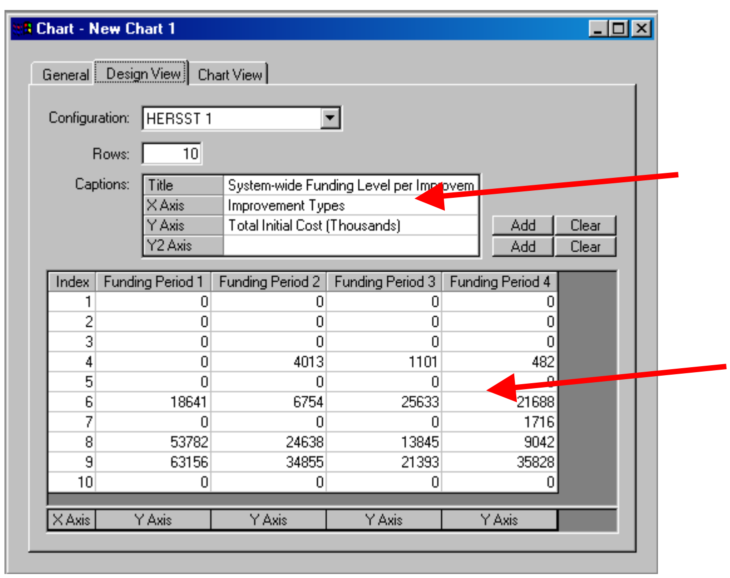


Figure 2.3-10 Chart Window after Built-In Query Selected

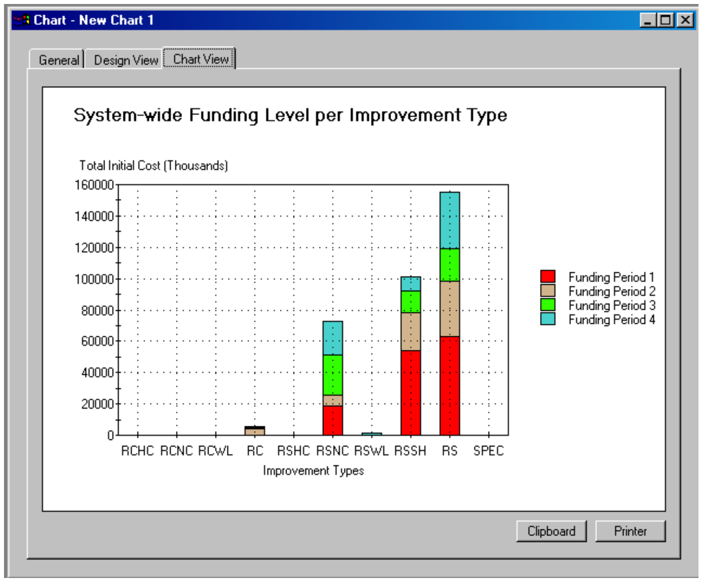


Figure 2.3-11 Chart View with Chart Displayed

g. Select the **Chart View** tab to view the resulting chart. Refer to Figure 2.3-11.

h. Close the Chart View Window.

i. For more details on Chart creation, refer to Chapter 10.

2.3.7 Creating a Map from the Analysis Data

a. Remaining in the **Reports** tab, right-click on GIS and select **New Item** to add a new GIS Map to the Project Tree.

b. Double-click **New GIS 1** to display the GIS Map Window

c. Click on the **Settings** tab.

d. In each of the three drop-down windows, select an item from the list.

e. In the file path field, click the **Browse** button and locate "c:\Program Files\HERS-ST\Samples\odot_tst.shp".

f. Refer to Figure 2.3-12 for a completed example of the window.

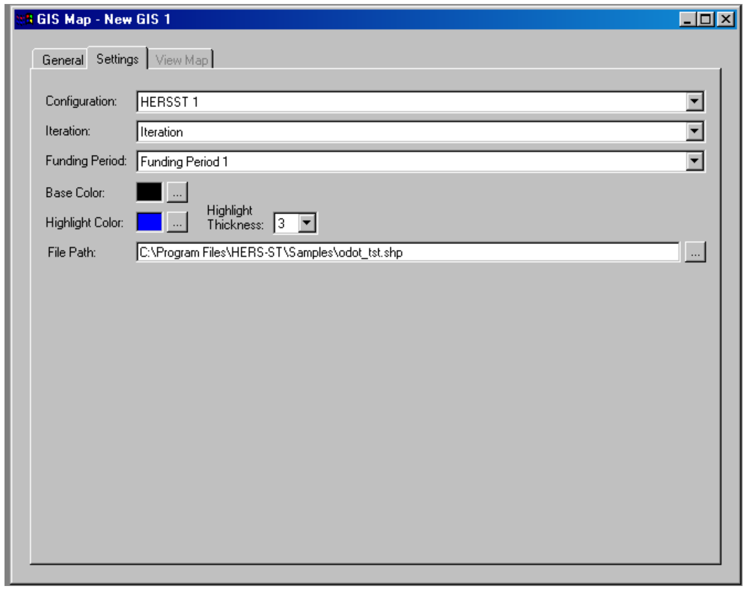


Figure 2.3-12 GIS Map Settings Tab

g. Select the **View Map** tab to start the map rendering process.

h. Click **OK** to accept the two information messages displayed.

i. The resultant chart should appear similar to that shown in Figure 2.3-13. All highway sections selected for improvement are shown in blue.

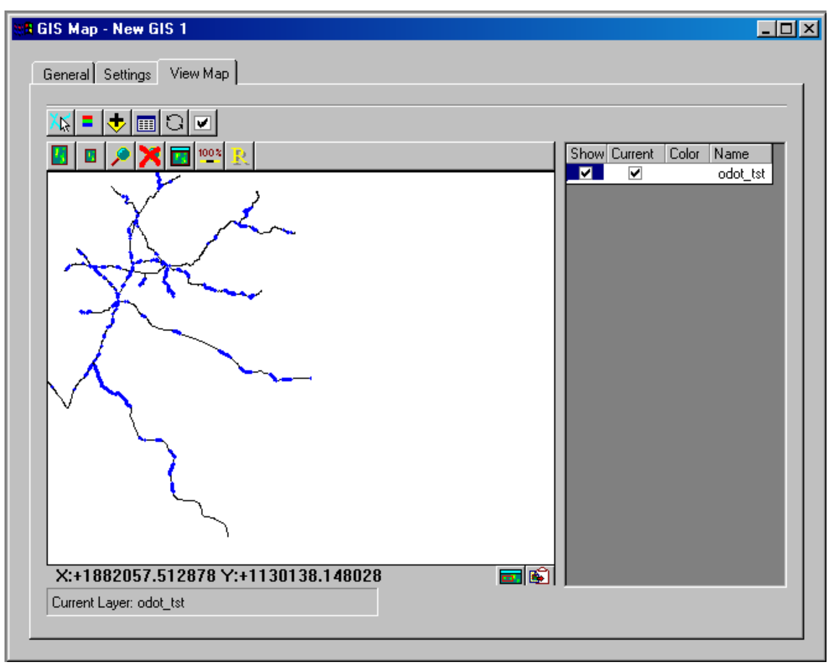


Figure 2.3-13 GIS Map View

j. Close the GIS Map Window.

2.2.8 Creating an *Ad-Hoc* Report from the Analysis Data

a. Remaining in the Project Tree **Reports** tab, right-click on **Reports** in the Project Tree and select **New Item** to add a new *Ad-Hoc* Report to the Project Tree.

b. Double-click **New Report 1** to display the Report Window.

c. Click on the **Query Designer** tab.

d. Click on the **Wizard** button to access the Query Wizard.

e. In the Query Wizard, accept the default query by clicking the **OK** button.

f. The three-panes of the Query Designer will be populated with the pre-defined query. Refer to Figure 2.3-14 for an example of the window.

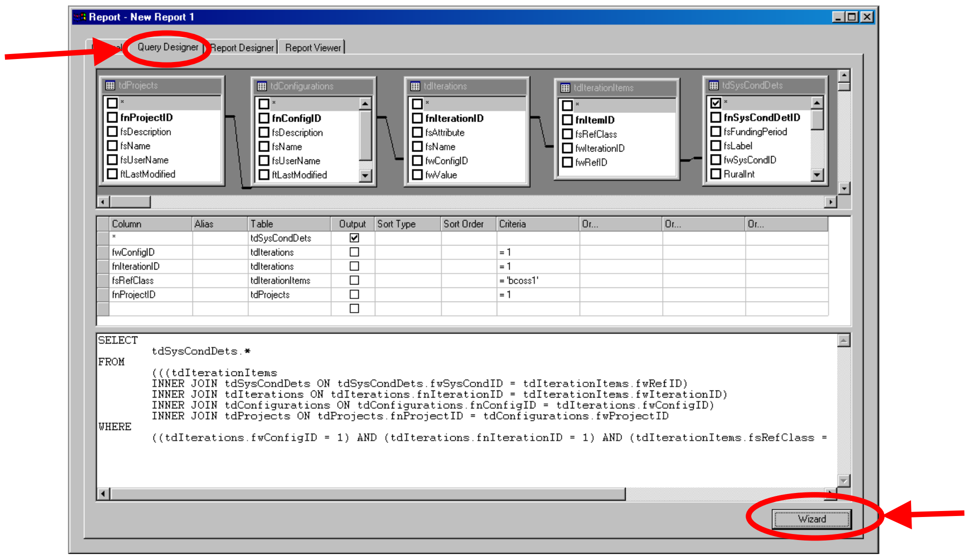


Figure 2.3-14 Report Window Query Designer

g. Click the **Report Designer** tab to access the layout tool.

h. Click the **Report Templates** button to access the pre-defined templates.

i. From the Select Report Templates Window, select **System Conditions (SS1).rpx** and then click **OK.**

j. The pre-defined report template will be displayed in the window. Refer to Figure 2.3-15. This window allows the user to design the layout of the report including fields of data, labels, graphics, etc.

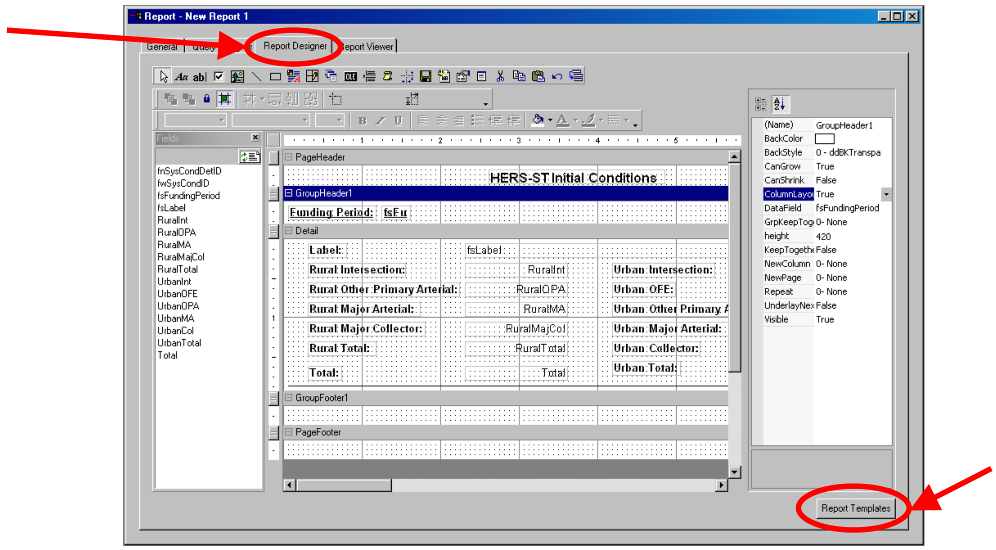


Figure 2.3-15 Report Window Report Designer

k. Lastly, click the **Report Viewer** tab to view the results of merging the data query with the report template. Refer to Figure 2.3-16.

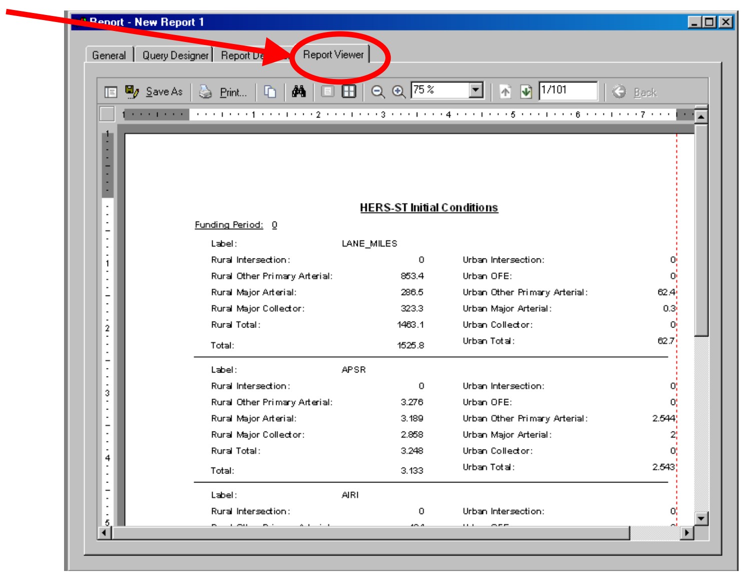


Figure 2.3-16 Report Window Report Viewer

This completes a quick walk-through of the HERS-ST software, including the generation of user-defined reports. For details on each of the steps discussed in this section, refer to the remainder of this *User's Guide*.

CHAPTER 3 – THE HERS-ST APPLICATION

3.1 APPLICATION ENVIRONMENT

The main application environment is made up of a Multi-Document Interface (MDI) window that, in turn, contains the individual windows to display the highway and state-improvement data, control and parameter settings, analysis results and user defined reports. The environment workspace contains two main areas, the project area and the workspace area. The project area is on the left side of the window and displays a project tree that presents the items that make up the project on three tabs. Right click on the branches of the tree to display a popup menu that will allow the user to add, remove, clone, import, export and display individual items. The workspace area is where the project items are displayed. Figure 3.1-2 shows the flow of data through HERS-ST.

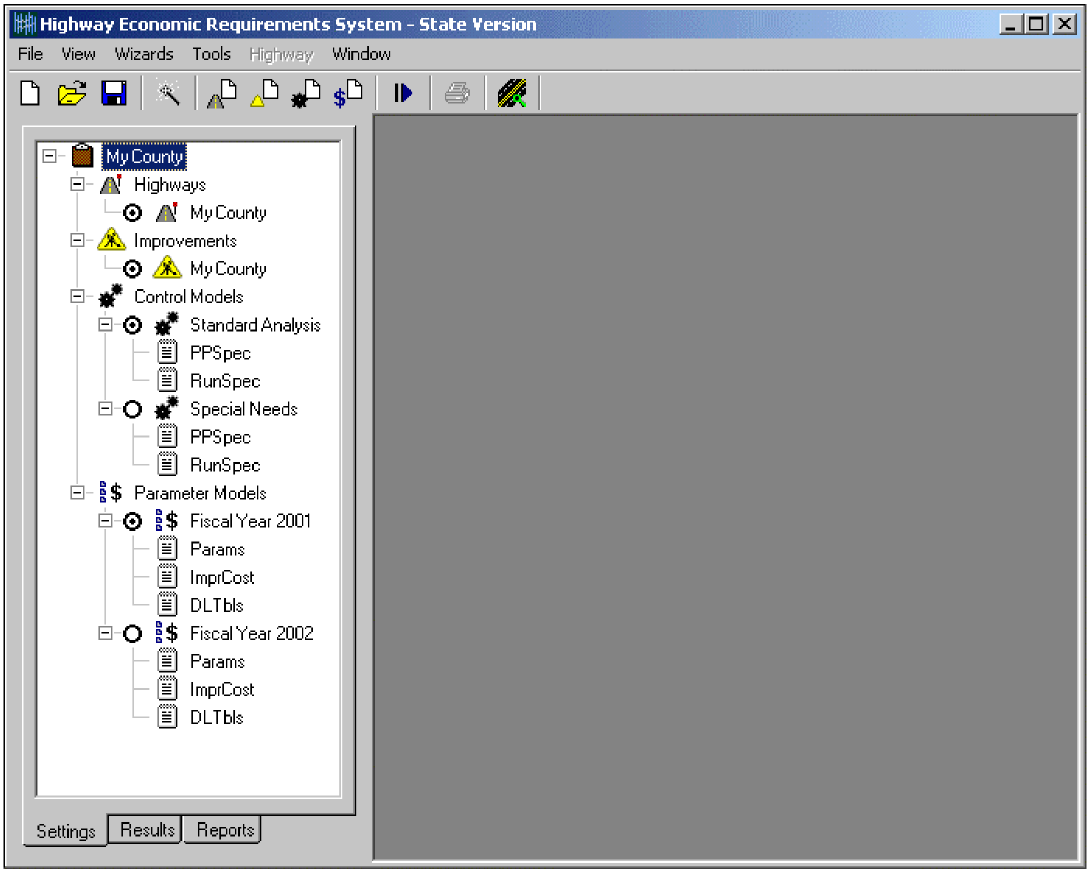


Figure 3.1-1 Main Application Window

The first tab (shown) displays the items that make up the current project settings. A project may have any number of highway, state-improvements, control or parameter models, however only one of each may be selected at a time. When the HERS-ST analysis is initiated, the selected highway, improvement, control and parameter model is used to conduct the analysis.

SPECIAL NOTE: A highway model and a control and parameter model is required for the HERS-ST basic analysis. When conducting a HERS-ST analysis in its override mode (see Section 8.2.2), an improvement model must also be included to provide the state specified improvements.

The second tab displays the analysis results and the complete configuration that was used by the HERS-ST analyzer for a single or minimum BCR run. A project may contain any number of configurations with each containing a copy of the settings and a set of results that it produced.

The third tab displays any user created GIS maps, charts and graphs and add-hoc reports created from the HERS-ST analysis data.

SPECIAL NOTE: The data generated by the HERS-ST analysis is contained in the configuration results. However, this information cannot be used to generate any reports until it is saved to the database.

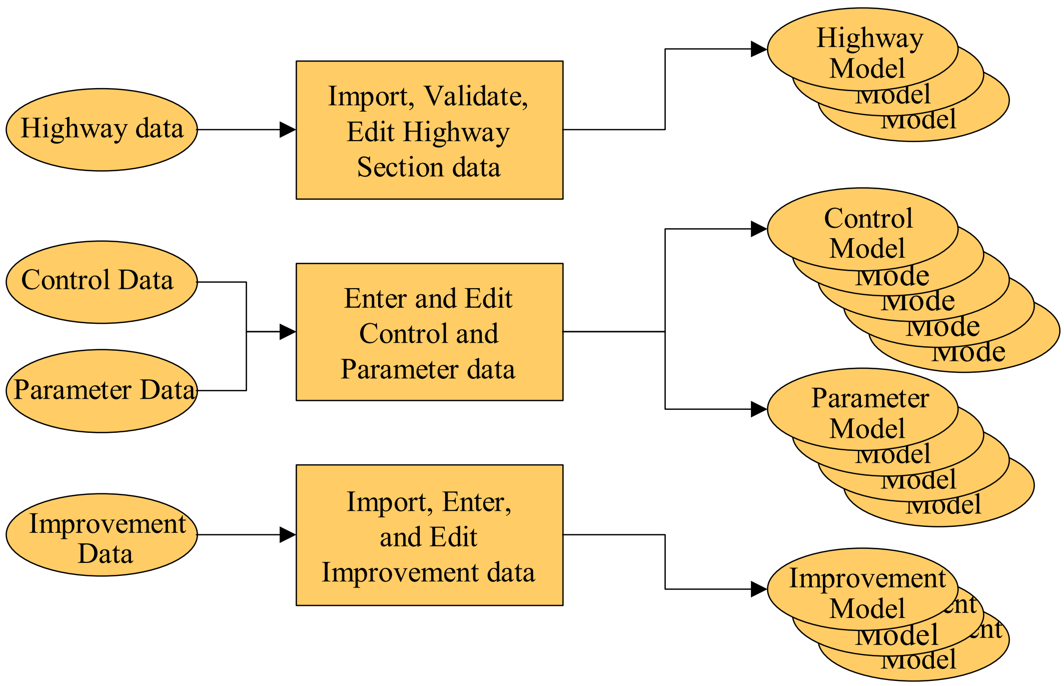


Figure 3.1-2 Flow of Data within HERS-ST

3.2 Logon

When the GUI application is started the user is presented with a logon window required to access to the applications database. This window allows the user to select the database file that the application is to work with and enter their username and password. The database selected must contain the HERS-ST tables or it will not function correctly.

Figure 3.2-1 Logon Window

SPECIAL NOTE: The logon window will currently support any user name.

3.3 PROJECT BROWSER

Normally, the project browser is displayed on project startup, however this behavior can be changed in the application's option settings. Clicking the **New** or **Open** buttons on the main application's toolbar or selecting the corresponding items in the **File** menu will also activate the project browser.

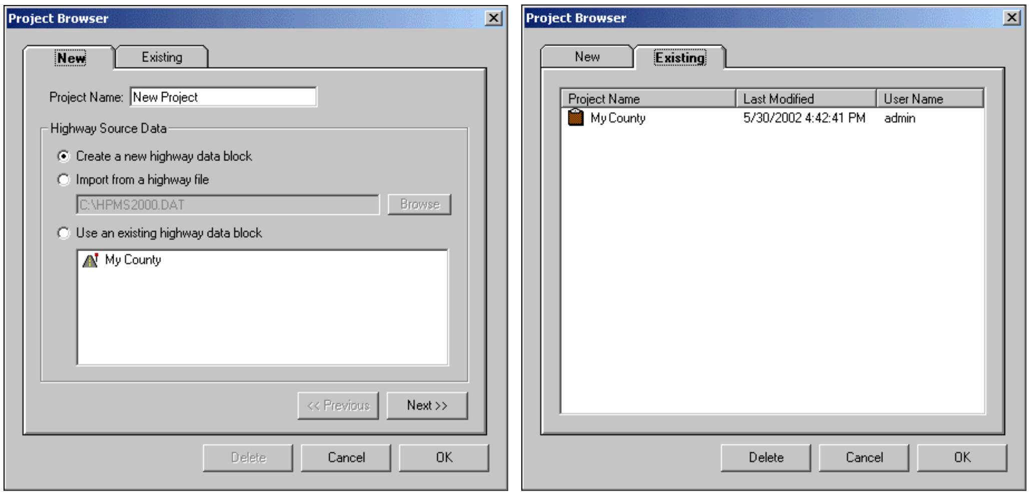


Figure 3.3-1 Project Browser

> SPECIAL NOTE: If this is the first time the GUI application is being run, you should close the project browser and proceed to the application options window to ensure that the application settings are correct before creating your first project.

The **Existing** tab allows the user to select an existing project from the database. The user may also delete existing projects from the database from here. To delete a project that is no longer wanted, select it in the list and click the **Delete** button. Note that deleting a project is permanent and once deleted, it cannot be recovered.

The **New** tab provides an interview that allows the user to name the project and select the source of the highway data, state-improvements, control and parameter models. In each case the user has the option to create a new model, import it from an existing file set or use an existing item already stored in the database. The **Next** and **Previous** buttons will move through the interview process. The project interview presented here is identical to that of the *Project Wizard* described in paragraph 3.5.

3.4 ENVIRONMENT OPTIONS

There are various behavioral options that can be selected by the user. The environment options window is displayed by selecting **View/Options** from the application's menu and is arranged on seven tabs as follows.

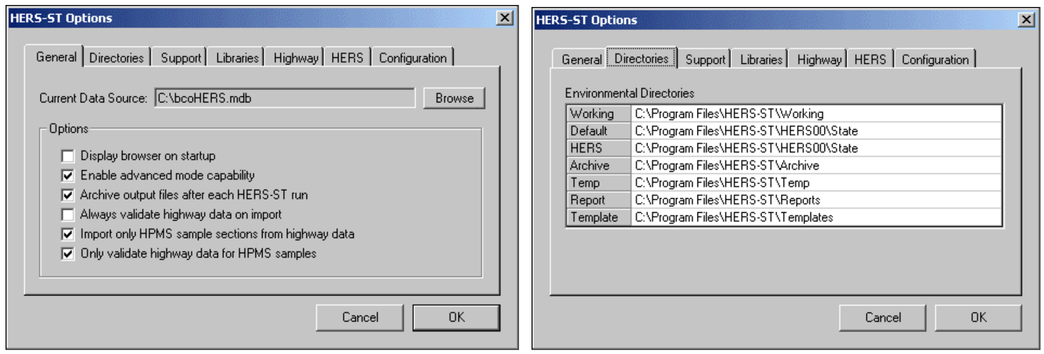


Figure 3.4-1 HERS-ST General and Directories Options

The **General** options tab allows the user to set the following options:

Current Data Source Permits the selection of the Microsoft Access 2000 database file currently in use by the application.

Display Browser Causes the project browser to be displayed when the application starts.

Advanced Mode Permits the user to access the advanced features of the application, which includes the ability to edit all portions of the HERS-ST control and parameter files.

Archive Output Files Copies all files generated by a HERS-ST run into a specified location as determined by the **Archive** directory location entry on the **Directories** tab. If this option is not enabled, no archive will be created however all the file information will still be saved in the database.

Validate Highway Data Automatically runs the data validation routine when importing a highway data file. If disabled, the user will be prompted to run the validation.

Import Flagged Samples Restricts the importing of a highway data file to only those records that are flagged as valid standard samples.

Only Validate Samples Restricts enforcement of the highway validation rules to only those sections that are flagged as valid standard samples.

The **Directories** options tab allows the user to specify the location of the various files required and generated by the software as follows.

Working Location where all data files are exported and the pre-processing and analysis takes place each time a HERS-ST run is performed. This directory is cleared before each run and must not correspond to any other directory.

Default Location where HERS-ST data files used by the application for its default values are located. These files include the runspec.dat, ppspec.dat, etc.

HERS Location where HERS-ST Preprocessor (hstpp.exe), and analysis engine (hersst.exe) are located.

Archive Location where archive files are stored. The software will create a sub-directory for each run of HERS-ST.

Temp Location for miscellaneous use.

Report Location where ad hoc reports are stored. The database maintains a reference pointing to these files.

Template Location where predefined report templates are stored.

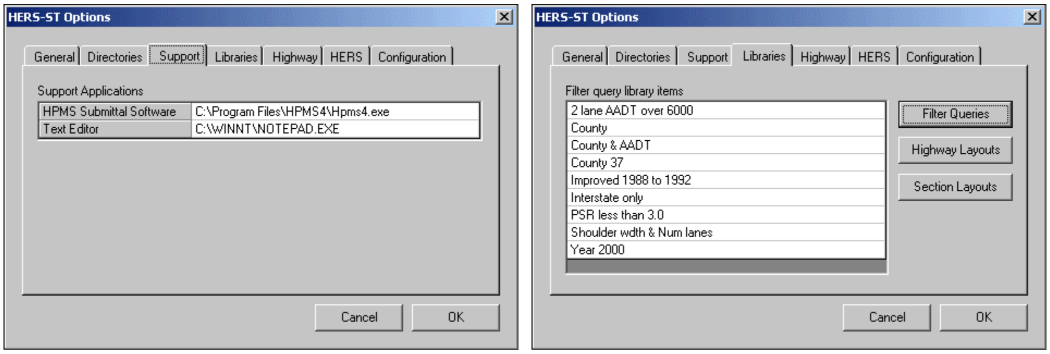


Figure 3.4-2 HERS-ST Support and Libraries Options

The **Support** options tab allows the user to specify of the location of third-party applications that may be invoked from within the HERS-ST software as follows.

HPMS Analyzer This option specifies the location of the Highway Performance Monitoring System (HPMS) software. This software is commonly known as the *Submittal Software*. When this option is set to point to the HPMS software, the HPMS button on the main application toolbar will become enabled.

Text Editor This option specifies the path and executable file name for a third-party text editor that may be invoked from within the HERS-ST application. By default, HERS-ST will utilize the Windows Notepad application

The **Libraries** options tab allows the user to view and delete items that have been created in the applications libraries. The application libraries store items such as highway query filters and grid layouts for the highway and section conditions windows. To delete an item from a library, select it and press the **Delete** button on the keyboard.

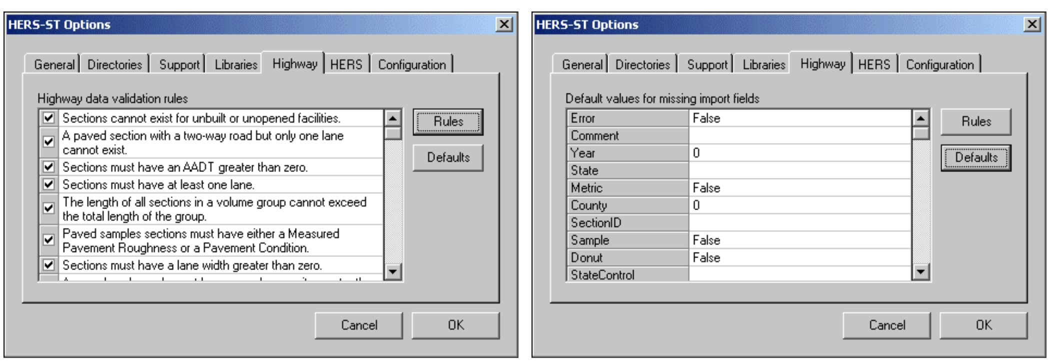


Figure 3.4-3 HERS-ST Highway Options

The **Highway** options tab allows the user to specify which HPMS validation rules are to be enforced on the highway data and the default values for each field of the highway data to be used during import if the field value is missing from the import file. When viewing the validation rules, the text for each rule is displayed along with a checkbox to enable or disable it. If a rule is checked, it is enabled and will be enforced when highway data is either imported or edited.

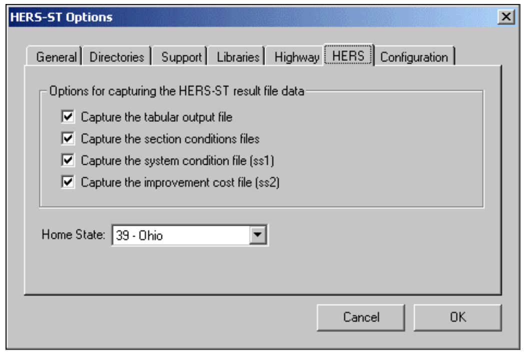


Figure 3.4-4 HERS-ST Options

The **HERS-ST** tab allows the user to select which result files created by HERS-ST are to be captured by the environment. HERS-ST generates four types of data as described in Chapter 9. If a type of result data is not checked, its data capture is disabled and it will not be available. If the user does not desire a particular type of result data, disabling its data capture will improve the overall performance of the application.

This tab also allows the user to set the home state option. This setting identifies which state cost factor is displayed on the *Improvement Costs* page of the parameter model wizard.

SPECIAL NOTE: If the archiving option is enabled, all result files are still copied to the archive directory even if its data capture option is disabled.

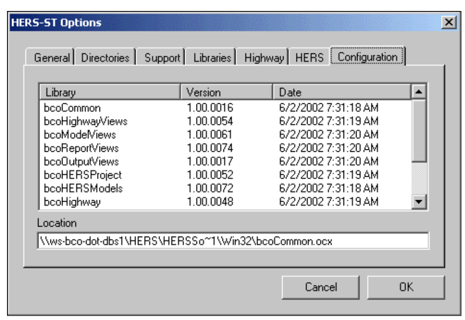


Figure 3.4-5 HERS-ST Application Configuration

The **Configuration** tab allows the user to view the version numbers and compile date of each component of the HERS-ST GUI application. This information is useful to the system administrator to ensure matching application configurations on multiple computers.

3.5 PROJECT WIZARD

The simplest way to create a HERS-ST project and run the analysis is to use the interview of the built-in project wizard. The user can start the project wizard by selecting **Project Wizard** from the application's **Wizards** menu or clicking the project wizard button on the toolbar. The project wizard interview is organized onto six pages as follows.

The first page of the project interview allows the user to specify to either use an existing project or to create a new project. If the user selects an existing project, the wizard will then skip to the final page where the user will start the HERS-ST analysis. When creating a new project, the wizard will proceed as described in the following paragraphs.

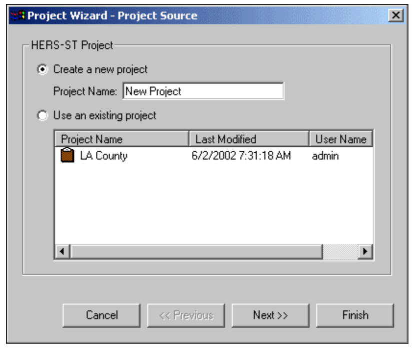


Figure 3.5-1 Project Interview

SPECIAL NOTE: The user may click the **Finish** button at any point in the interview process. The project wizard stores the settings made by the user and restores them each time it is invoked. Therefore, any pages not displayed will reuse the last user settings.

The next two pages of the project interview allow the user to specify the highway data and the state-improvements data (if any) to be used by the project. In each case the user has the option to create a new model, import it from an existing file or use an existing item already stored in the database. A highway model must be specified, however a state-improvements model need only be specified if the HERS-ST analysis is to be conducted in *Override* mode.

When importing a highway data file, the user will be asked if they wish to validate the highway data fields during the import. If so directed, a log file will be created to record any errors encountered, which can be viewed after the import process is complete. If an error is encountered, the user will be given the option to either continue or terminate the import and to mark only records that do not contain any errors as selected.

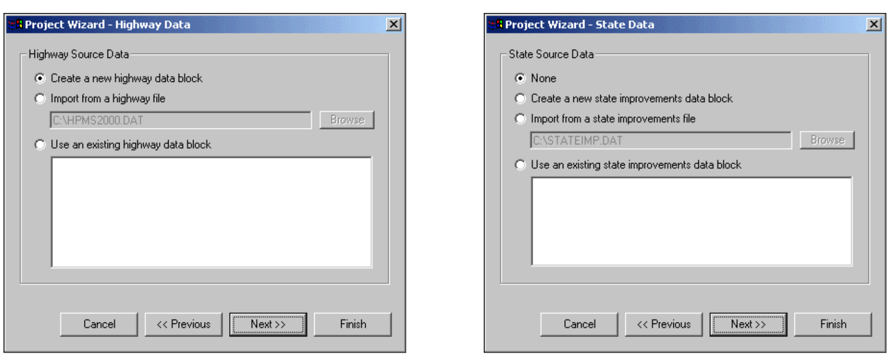


Figure 3.5-2 Highway and State-Improvements Data

SPECIAL NOTE: The import process will either read all the records from the source file or read only those flagged as HPMS standard samples and ignore the rest. This behavior is controlled in the application's environmental option settings.

The next two pages of the project interview allow the user to specify the control and parameter models to be used by the project. Like before, the user has the option to create a default model, import it from an existing file set or use an existing item already stored in the database. Both a control and parameter model must be specified.

When creating a default control or parameter model, the new model will be initialized based on the default files located in the default directory specified in the environmental options. Changing the contents of the default files will, therefore, change what a default model is initialized to. If the default files are not found, the new model will prompt the user to select files to be used.

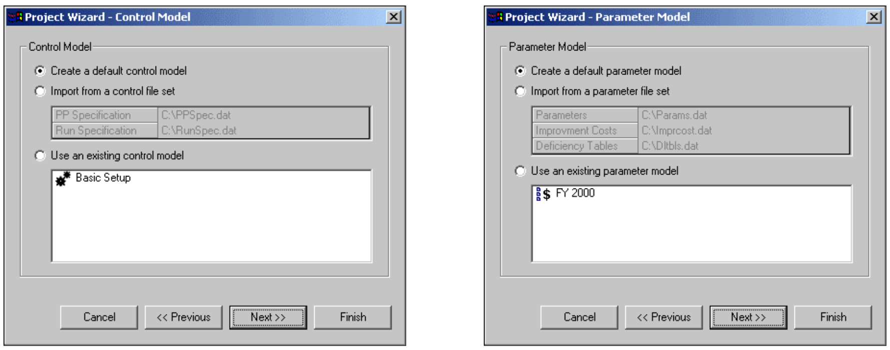


Figure 3.5-3 Control and Parameter Models

The last page of the project interview allows the user to select various run options for the HERS-ST analysis engine. These options are identical to those of the HERS-ST run dialog described in Chapter 8, Figure 8-1.

When the user clicks the **Finish** button, the wizard will create and populate the project and run the HERS-ST analysis. Upon the completion of the HERS-ST analysis, a run configuration will be created and added to the project. The resulting project will be displayed in the project tree on the HERS-ST GUI main window.

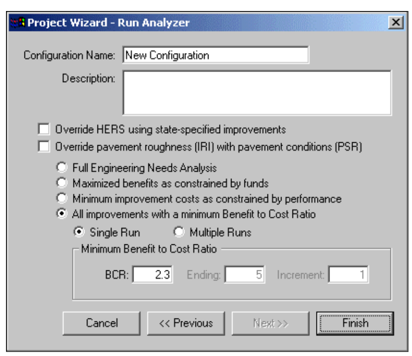


Figure 3.5-4 HERS-ST Analysis Options

CHAPTER 4 - HIGHWAY DATA

The HPMS file contains ASCII descriptions of each highway section to be analyzed, one record per highway section, in the standard HPMS comma-delimited format. Each record contains 98 fields. Table A-3 provides a brief listing of the contents of the record. This table skips over item numbers and positions that are not by HERS-ST. Please note that all of the HPMS data items need to be included, they are just not all initially displayed in the highway data window. The variable names shown in the table are the internal HERS-ST variable names.

HERS-ST is not designed to handle rural minor collectors or sections on the two local functional systems. To allow states to analyze sections on these three systems, HERS-ST treats all sections on these systems as if they were rural major collectors or urban collectors, as appropriate. Accordingly, statistics printed by HERS-ST for rural major collectors actually include information for any rural minor collectors and rural local roads analyzed; and statistics for urban collectors similarly include information for any urban streets analyzed.

Also, in HERS-ST, the user may specify separate widening feasibility overrides for each functional system, which is described in Appendix B.

4.1 Highway Data Window

The highway data window is the primary user interface to enter and edit the highway section information that will be processed by HERS-ST. It is displayed by double clicking a highway data branch in the project tree or by selecting the **Display** item in its popup menu. The interface is displayed in two panes. The left pane shows a hierarchal tree displaying the structure of the highway data and the right pane shows the specific details for the selected portion of the structure.

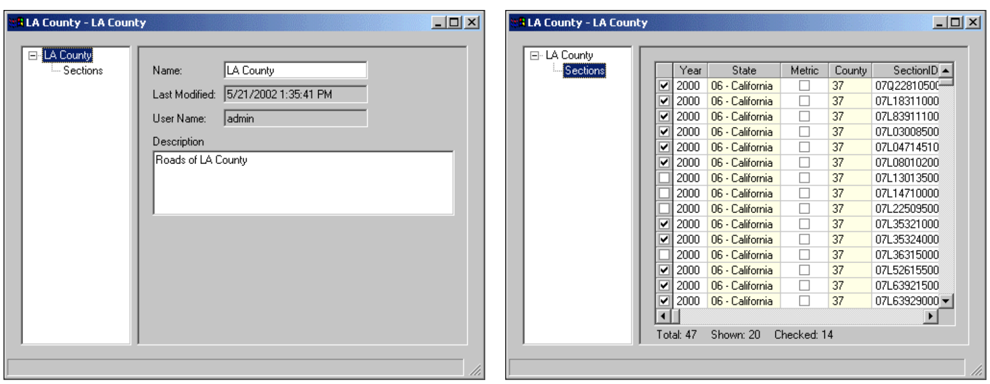


Figure 4.1-1 Highway Data Window

Selecting the root of the tree will display the general information about the highway data object including its name and description. It also displays the name of the last user to modify the data and a timestamp of when the modification occurred.

Selecting the **Sections** branch of the tree will display a grid containing all of the information about each section of highway data. The grid provides layout formatting and editing capability through a number of popup menus that are activated by right clicking in the grid area or the column headers. In addition, a secondary edit window is available for editing a single highway data section in a more readily readable format. The section editor window is activated by double clicking a record in the grid or by selecting **Edit** in the popup menu. This window will float above all other windows and will track with the active row selected in the sections grid.

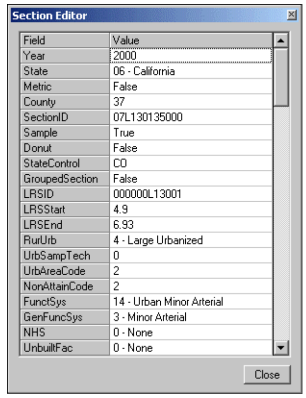


Figure 4.1-2 Section Editor Window

All the values in an entire column can be modified at once using the **Set** or **Replace** items in the header popup menu. The **Set** option will set all the values of the column to the value of the currently selected cell and the **Replace** option will set the column values that match the currently selected cell with a new value.

4.2 GRID LAYOUT

To reorder the columns of the sections grid, drag the column to the desired position and drop it. To resize a column, drag the column divider in the header to the desired width. Selecting the **Hide** option on the header popup menu will hide unwanted columns. All columns that have been so hidden can be re-displayed by selecting the **Show** or **Show All** options on the same menu.

The layout of the sections grid can be configured by the user to present the information in any way that is convenient. This may involve re-arranging the column order, hiding unwanted columns and adjusting column widths. Once a desired layout is created, it can be saved to a library for future use by selecting the **Table/Save Layout** option in the popup menu. The user will be asked to give the layout a name to refer to it by. If an existing layout already has the same name, the user will be asked if he wishes to overwrite it. To restore a previously saved layout, select it by its name from the **Table/Restore Layout** option in the popup menu.

Not all of the highway data fields are required by HERS-ST. The unused highway data fields can be automatically hidden from view by activating the **HERS-ST Layout** option on the highway grid popup menu. Although the unused fields are hidden from the user, their data is still preserved, saved and exported as usual. To return to full view of the highway data, deactivate the HERS-ST layout mode by un-checking it in the menu.

4.3 RECORD SORTING

The records in the sections grid can be sorted by column by clicking on the header of the column which the user wishes to sort by. Repeat clicking of a column header will toggle the sort between ascending and descending order. Sorting can also be initiated by selecting the **Sort/Ascending** or **Sort/Descending** options in the header popup menu. To sort multiple columns, select a column group by clicking on the column headers while pressing the SHIFT key. Then, select an ascending or descending sort from the menu.

4.4 RECORD VALIDATION

When a highway data file is imported the user has the option to perform validation checking on the data it contains. Records that fail the validation test are displayed with a red tinted background in the highway data grid. Validation of individual records or the complete highway data set can also be conducted by selecting the **Validate** or the **Table/Validate** items available on the highway grid popup menu. Validating the complete data set will produce a log file containing a list of all the errors found.

When editing a data field of a section, the new value is verified against the appropriate validation rules. If an error is detected, the user is given the option to either ignore the violation on that occasion or to return to the field's previous value. The complete record will then be validated to determine its error status. Records with errors will be displayed with a red tinted background.

SPECIAL NOTE:	The user can disable individual highway validation rules in the environmental option settings. Validation rules can also be disabled for sections that are not an HMPS standard sample.

4.5 RECORD SELECTING

Records that are selected for use are designated with a checkmark in the fixed column at the left of the grid. Only records that are checked will be used when executing the HERS-ST analysis, exporting the highway data to a file or creating a clone. The user can choose to view only the checked records by selecting the **Table/Show Checked** option from the popup menu. To return to viewing all records select the **Table/Show All** option.

There are many ways to mark a record as checked or unchecked, the most simple of which is clicking the checkbox with the mouse cursor. The record must be highlighted for it to respond to the mouse click. The following paragraphs describe other means of selecting records with increasing complexity.

The entire set of records in the grid can be marked from a special header popup menu that appears only for the fixed (checkbox) column. This menu will allow the user to either check, uncheck or toggle the checked state of all the records in the grid. If the highway data contains records with errors, this menu also provides the ability to check only the valid or errant records.

Individual rows and groups of rows may be highlighted collectively from the grid by clicking them with the mouse while holding down the CTRL or SHIFT key respectively. Selecting the **Table/Select All** option of the popup menu highlights the entire grid at once. Once a group of rows is highlighted they can be marked together as checked or unchecked by selecting the **Check** or **Uncheck** options in the popup menu.

The most full featured means of marking records as checked is by using the query dialog. This window appears when the user selects the **Table/Query** option on the popup menu.

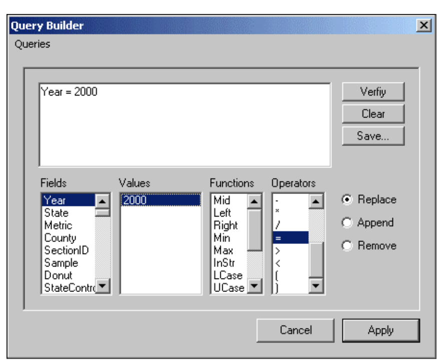


Figure 4.5-1 Query Builder Window

The query builder window allows the user to build complex criteria conditions by which to select the records with. The syntax of the query text represents the **WHERE** clause of a Structured Query Language (SQL) statement and must comply with all SQL syntax rules. The user may type the desired selection criteria directly into the query textbox or may build it using the Fields, Values, Functions and Operators listed. Double click an item in any of these lists to copy that item to the SQL query textbox.

The list of fields contains all of the field names of the highway data. The list of values contains all unique values that the selected field has. The list of operators and functions contains a list of commonly used SQL logical and comparison operators and built-in functions that can be used. This is not meant to be a complete list of all SQL capabilities and the user is referred to SQL documentation for more advanced features.

Once the query text is complete, the user must decide which of three actions is to be carried out on the records. The **Replace** option will clear any existing selected records and then select only those records that meet the criteria. The **Append** option will not affect any existing selected records and will add any additional records that meet the criteria to be included in the set. The **Remove** option will unselect any records that meet the criteria while leaving other records unaffected.

The query text that the user creates can be saved to a library for future use by clicking the **Save** button. The user will be asked to give the query a name to refer to it by. If an existing query already has the same name, the user will be asked if he wishes to overwrite it. To reload a previously saved query, select it by its name from the **Queries/Load** menu.

4.6 RECORD ADDING AND DELETING

To add a record to the highway section list, select the **Add Record** option from the popup menu. The new record is added to the end of the list and is a copy of the record that was selected when the adding operation was initiated. Focus will be set to the new record. The unique fields **SectionID**, **LRSID**, **SampID**, **LRSStart** and **LRSEnd** of the original record are not copied.

To delete a record or set of records, highlight the rows that are to be deleted and then select the **Remove Record** option from the popup menu.

SPECIAL NOTE: Deleting a section record is permanent and once deleted, it cannot be recovered.

CHAPTER 5 - STATE IMPROVEMENTS

The state improvements data window is the primary user interface for entering and editing the state specified improvements that are used by HERS-ST when operating in its *Override* mode. This information supplements the highway data and serves to override the HERS-ST improvements on any given highway section with the state specified ones. It is displayed by double clicking a state improvements branch in the project tree or by selecting the **Display** item in its popup menu.

Like the highway data window, this interface is displayed in two panes. The left pane shows a hierarchal tree displaying the structure of the state-improvements data and the right pane shows the specific details for the selected portion of the structure.

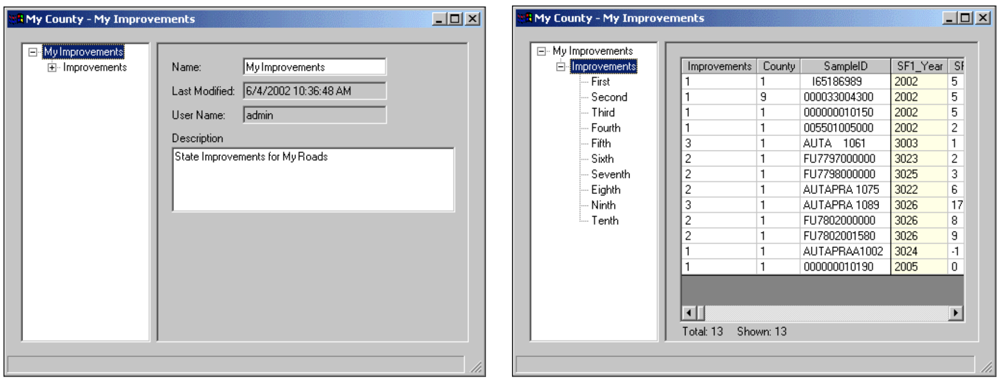


Figure 5-1 State Improvements Data Window

Selecting the root of the tree will display the general information about the state-improvements data object including its name and description. It also displays the name of the last user to modify the data and a timestamp of when the modification occurred.

Selecting the **Improvements** branch of the tree will display a grid containing all of the information about each section that has a state specified improvement. Up to ten improvements can be specified for each section. The number of improvements specified for a given section is displayed in the first column and is followed by the county code and highway section identification number.

Next, each of the ten improvements for the section is described in a set of six columns each. When the main improvements branch is selected, all 60 columns are displayed. Select one of the specific improvement braches from the tree to display just the six columns for that improvement. If the user selects a specific improvement branch that is greater than the number of improvements for a section, then its six columns will be blank and will not be editable. The user can hide these sections by selecting the **Table/Show Improvements** item from the grid popup menu.

All the values in an entire column can be modified at once using the **Set** or **Replace** items in the header popup menu. The **Set** option will set all the values of the column to the value of the currently selected cell and the **Replace** option will set the column values that match the currently selected cell with a new value.

The records in the state-improvements grid can be synchronized with those of the highway data by checking the **Synchronize** option on the popup menu. When synchronized, the selected record of the state data will track with the corresponding record of the highway data as determined by the county code and sample ID fields. Only the current state model that is selected by the option button in the project tree will be in synchronization with the highway data.

5.1 RECORD SORTING

The records in the sections grid can be sorted by column by clicking on the header of the column which the user wishes to sort by. Repeat clicking of a column header will toggle the sort between ascending and descending order. Sorting can also be initiated by selecting the **Sort/Ascending** or **Sort/Descending** options in the header popup menu. To sort multiple columns, select a column group by clicking on the column headers while pressing the **SHIFT** key. Then, select an ascending or descending sort from the menu.

5.2 ENCODING STATE IMPROVEMENTS

HERS-ST requires that state specified improvements not involving resurfacing, reconstruction, widening, or improved alignment be assigned a code that is divisible by 20. In addition, this code can be combined with HERS-ST improvement codes for pavement, widening and alignment improvements. To simplify this for the user, the interface provides a dialog box for editing the improvement-type columns.

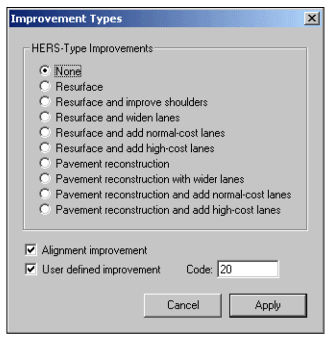


Figure 5.2-1 Improvement Type Dialog

5.3 RECORD ADDING AND DELETING

To add a record to the state-improvement list, select the **Add Record** option from the popup menu. The new record is added to the end of the list and is a copy of the record that was selected when the adding operation was initiated. Focus will be set to the new record. The unique field **SectionID** of the original record is not copied.

Records can also be created directly from highway data by selecting the **Create from (highway)** item in the popup menu. A new record is created for each checked record in the source highway data set. The **County** and **SectionID** field is copied to the new state-improvement record. If a record with the county and section ID already exists, it will not be duplicated.

To delete a record or set of records, highlight the rows that are to be deleted and then select the **Remove Record** option from the popup menu.

SPECIAL NOTE: Deleting a section record is permanent and once deleted, it cannot be recovered.

5.4 USER-SPECIFIED IMPROVEMENTS

Each State Improvement record describes one or more improvements for a single highway section in chronological order, using a comma-delimited format. Each record contains *6*n+3 fields, where *n* *i*s the number of improvements described. The contents of the first 9 fields of this file are shown in Table 5.1.

Table 5.1 Format of State Improvements

Field	Format
1. Number of improvements	Integer
2. County Code	Integer
3. Sample Identifier	Alphanumeric
4. Year of First Improvement (four digits)	Integer
5. Type of improvement	Integer
6. Override Flag	Integer
7. Cost of Improvement	Floating Point
8. Lanes Added	Integer
9. Increase in Capacity	Integer

Fields 4 – 9 continue for up to a total of 10 improvements.

The first field of each record specifies the number of improvements described. A maximum of 10 improvements can be described in any record.

The next two fields contain the county code and the Sample Identifier (from HPMS Field 47). These fields are used to match the State Improvement record with the corresponding HPMS record describing the section in question.[2]

User-specified improvements are entered in chronological order in sets of six fields (Fields 4-9, 10-15, etc.). A more thorough discussion of State Improvements along with the table showing the Improvement type codes can be found in Appendix A.

[2] The match will be unique if all HPMS records are from a single state. If data from multiple states are used in a single run, there is a small probability that the same County/Sample-ID pair will be used to identify sections in more than one state. In this case HERS-ST 2.0 will arbitrarily match the StateImps record to the first HPMS record that it finds.

CHAPTER 6 - PARAMETER MODEL

The parameter model provides a wide variety of parameters for the HERS-ST analysis. There are two ways that a parameter model can be edited. The standard interview provides a logical organization of pages to enter the most common information on. The advanced interface provides access to all of the parameter information. The following sections describe each mode.

6.1 STANDARD PARAMETER INTERVIEW

The parameter model interview is provided to edit the HERS-ST parameter model and is always available. The parameter interview is displayed by double-clicking the parameter model branch in the project tree or selecting the **Display** item in its popup menu. Only the most commonly modified items are presented here. Use the advanced parameter model interface to view all the items of the parameter model.

Figure 6.1-1 shows the flow through the pages of the parameter model interview. A general description of each page is presented here, please referred to Appendix B for further information pertaining to the data entered on these pages.

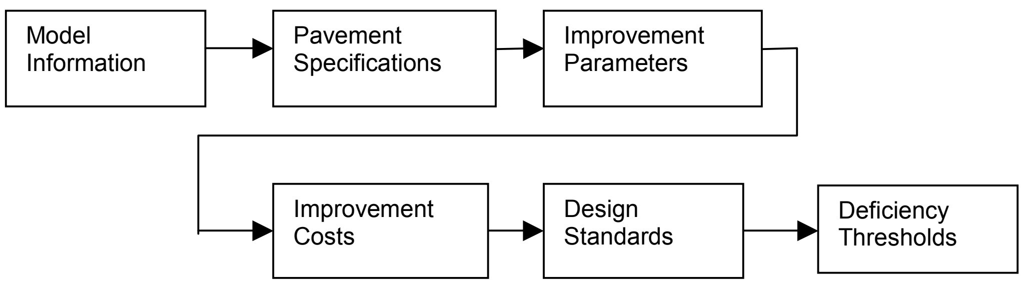


Figure 6.1-1 Parameter Model Interview

The first page of the parameter interview allows the user to enter a name and description for the model. The name of the last user to modify the model and a corresponding timestamp are also displayed.

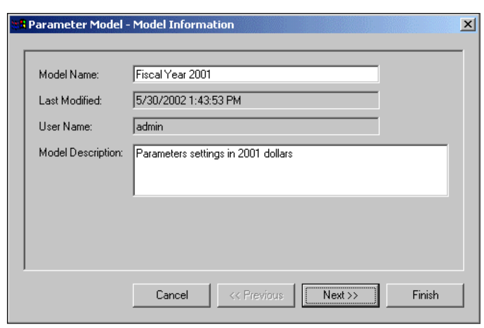


Figure 6.1-2 Parameter Model Information

SPECIAL NOTE: The new parameter model settings are not applied until the interview is finished. The user may click the **Finish** button at any point in the interview process. If the name of the parameter model is changed, the user will be asked if they wish to create a new model or apply the changes to the existing model.

The next two pages of the interview collect various pavement specifications and improvement parameters. These parameters specify items such as the pavement life expectancy, the effects of improvements on a sections pavement condition that result in an improvement in the pavements present serviceability rating (PSR), the maximum pavement deterioration rate, widening feasibility override, and maximum number of lanes.

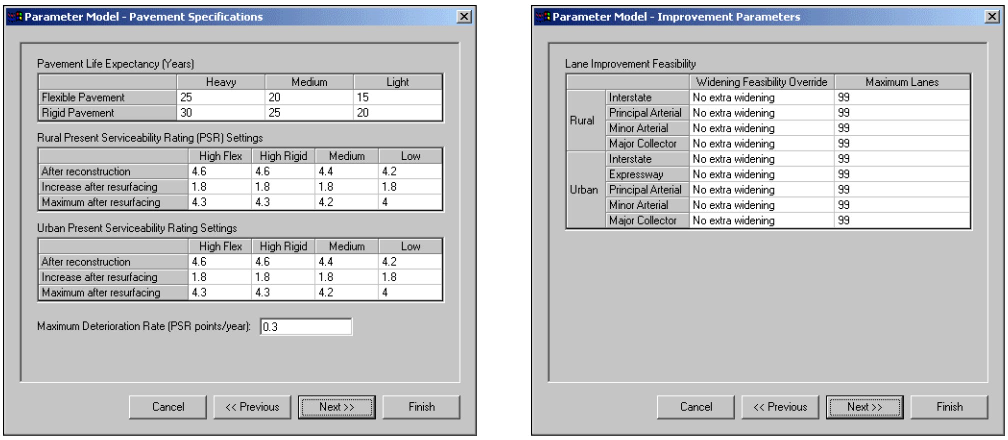
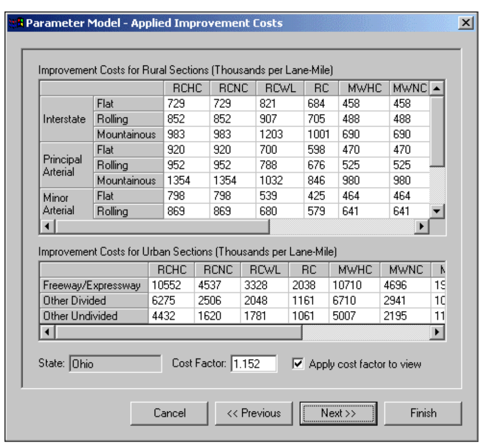


Figure 6.1-3 Pavement Specifications

The next page of the interview collects improvement cost information. The improvement costs are organized by functional class and improvement type. The abbreviations for the improvement types are shown below. The improvement costs can be viewed either as raw data or as modified by the state cost factor for the home state specified in the environment options. The improvement cost data cannot be edited when it is viewed with the state cost factor applied, however any changes to the cost factor itself will be reflected in the values seen in the grid.



RCHC Reconstruction with lanes added at high cost.

RCNC Reconstruction with lanes added at normal cost.

RCWL Reconstruction with wider lanes.

RC Pavement reconstruction

MWHC Major widening with lanes added at high cost.

MWNC Major widening with lanes added at normal cost.

MinW Minor widening with resurfacing.

RsSh Resurfacing with shoulder improvements

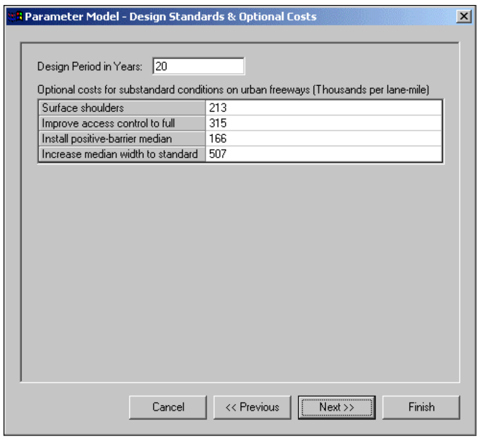
Rs Resurfacing

Figure 6.1-4 Improvement Costs

As a default, the screen presents the cost factor used for the selected state for the *2002 Conditions and Performance (C&P) Report*. The state must be selected under the HERS tab of the Options screen (which is accessed from the View drop-down menu as discussed in paragraph 3.4). Entering a new cost factor will change the cost factor for the selected State. Note also that the section's State field determines the cost factor used in calculating improvement costs on a section.

SPECIAL NOTE: Applying the state cost factor only affects how the improvement costs are viewed in the interface. The raw data is not affected by this feature and can only be changed by editing it directly when the cost factor is not applied to the view.

The last two pages of the interview collects design standards, optional costs and deficiency thresholds. The thresholds for each deficiency level category are organized by functional classification. Deficiency Levels (DLs) and the first User Specified Threshold (UST1), which are described in Section 9.1.1, are selected via the option buttons below the table.



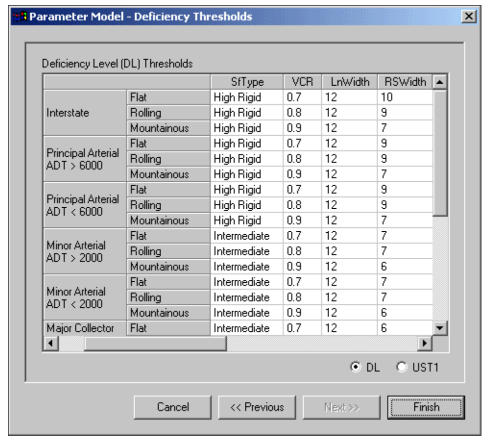


Figure 6.1-5 Design Standards and Deficiency Thresholds

SPECIAL NOTE: Only the Deficiency Levels (DL) and the first User Specified Threshold (UST1) are available in the standard interview. Use the advanced parameter interface for the deficiency level tables to edit other deficiency levels.

6.2 Advanced Parameter Model

When the application is placed in advanced mode, additional detailed information about the parameter model is available. The parameter model is made up of three components that appear as branches beneath the parameter model branch in the project tree. Each component has its own file and is editable in its own window as follows:

- Parameter Tables Params.DAT
- Improvement Cost Tables ImprCost.DAT
- Deficiency Level Tables DLTabls.DAT

The window for editing the parameter data is shown in Figure 6.2-1. Double-clicking on the component branch in the project tree or selecting the **Display** item in its popup menu will display the component. The interface for each component is virtually identical with the left pane showing a hierarchal tree of the items that make up each component and the right pane showing the details of the selected item in the tree. The only difference between the components is the attributes, lists and tables shown in the tree. A definition for each attribute, list and table item for each component is listed in Appendix A.

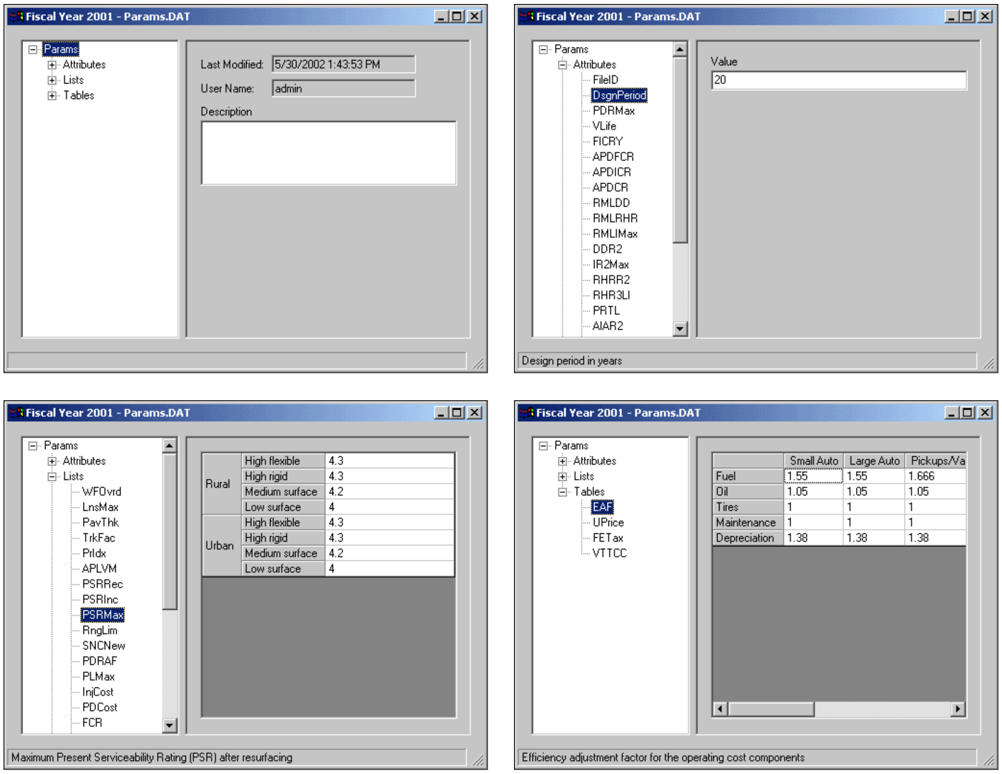


Figure 6.2-1 Advanced Parameter Model Interface

The contents of each component can be imported and exported from HERS-ST to a text file by selecting the **Import** or **Export** options on the project tree popup menu. The text file format is specified in the Appendix B.

6.2.1 Costs

All default cost data used by HERS-ST provided as national averages. These include unit costs for highway improvements, vehicle operation, travel time, injuries, and property damage, as well as fuel excise taxes and the value of life. The costs are supplied in dollars of various years and converted to 2000 dollars using price index values. Estimates can be produced in any other year dollars by appropriately adjusting these price indexes. The price index values currently in this file have been obtained from the following sources:

- Fuel cost – Consumer price index (CPI) for motor fuel (SETB);[3]
- Oil – CPI for motor oil, coolant, etc. (SS47021);
- Tires – CPI for tires (SETC01);
- Maintenance and repair – CPI for motor vehicle maintenance and repair (SETD);
- Vehicle costs – Average expenditure per new car;[4]

[3] U.S. Department of Labor, Bureau of Labor Statistics, CPI Database.
[4] Ralph W. Morris, "Motor Vehicles, 2000," *Survey of Current Business,* U.S. Department of Commerce, Bureau of Economic Analysis, February 2001. (This data series is preferred to the CPI series because the CPI incorporates adjustments for changes in quality; i.e., the CPI is adjusted downward to exclude the value of new features being purchased.)

- Value of time and crash delay costs – Total compensation of all civilian workers (Series ECU10001I);[5]
- Value of life and injury costs – Implicit price deflator for gross domestic product;[6]
- Inventory – Implicit price deflator for durable goods;
- Property damage – CPI for motor vehicle body work (SETD01); and
- Highway improvement costs, highway maintenance costs, and alignment-related costs – the FHWA's composite price index for federal-aid highway construction.[7]

The FHWA's estimates of national unit costs for highway improvements (contained in IMPRCOST.DAT) have been adjusted to 2000 dollars (using the FHWA's composite price index for federal-aid highway construction). The system then adjusts these costs to state values using a set of State Cost Factors contained in the Parameter Model. State users may wish to incorporate their own estimates of pavement and widening costs into the system. The remainder of this section discusses how to incorporate these estimates.

For rural areas, the costs are specified separately by functional system and terrain (flat, rolling, or mountainous). For urban areas, they are specified separately by facility type (freeways and expressways, other divided roads, and undivided roads). There are 135 unit costs in this part of the file. With a few exceptions, the costs are specified in thousands of 2000 dollars per lane mile. The exceptions are resurfacing or reconstruction with additional high-cost lanes and also, for urban sections, resurfacing with additional normal-cost lanes; for these improvement types the costs are specified in thousands of 2000 dollars per *added* lane mile.

States that wish to use their own cost data are likely to have information for some of the 135 unit costs in this part of the file, but not for all of them. However, it is important that reasonable relationships be maintained between the various unit costs. Thus, if significant changes are made to any of the unit costs, all of the costs will require some adjustment. These adjustments may be made either judgmentally or by scaling the remaining costs (or appropriate subsets of these costs) uniformly. States that use their own cost estimates should change the State Cost Factor for their state to 1.0.

When changing the unit costs for pavement and widening improvements, it is not necessary to continue to express these costs in 2000 dollars. However, if dollars of another year are used, it is important to replace the price indexes (available in advanced mode only) with values that will result in converting the costs to 2000 dollars. Values for converting rural and urban improvement costs expressed in dollars of any year between 1995 and 2001 to 2000 dollars are shown in Table 6.1.

Table 6.1 Price Index Values for Converting Improvement Costs to 2000 Dollars

Convert From	Rural	Urban
1995	123.8	118.5
1996	115.7	130.2
1997	113.7	111.0
1998	111.2	117.1
1999	105.7	108.9
2000	100.0	100.0
2001	102.4	96.8

Source: Derived from FHWA, "Price Trends for Federal-Aid Highway Construction," quarterly.

[5] U.S. Department of Labor, Bureau of Labor Statistics, Employment Cost Index.
[6] U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts Tables, Table 7.1.
[7] FHWA, "Price Trends for Federal-Aid Highway Construction," quarterly.

CHAPTER 7 - CONTROL MODEL

The control model provides the control settings for the HERS-ST analysis. Like the parameter model, there are two ways that a control model can be edited. The standard interview provides a logical organization of pages to enter the most common settings on. The advanced interface provides access to all of the control settings. The following paragraphs describe each mode.

7.1 STANDARD CONTROL INTERVIEW

The control model interview is provided to edit the HERS-ST control model and is always available. The control interview is displayed by double-clicking the control model branch in the project tree or selecting the **Display** item in its popup menu. Only the most commonly modified items are presented here. Use the advanced control model interface to view all the items of the control model.

Figure 7.1-1 shows the flow through the pages of the control model interview. The interview will direct the user to enter only information required for the selected run options while skipping unnecessary pages. A general description of each page is presented here, however the user is referred to Appendix C for further information pertaining to the data entered on these pages.

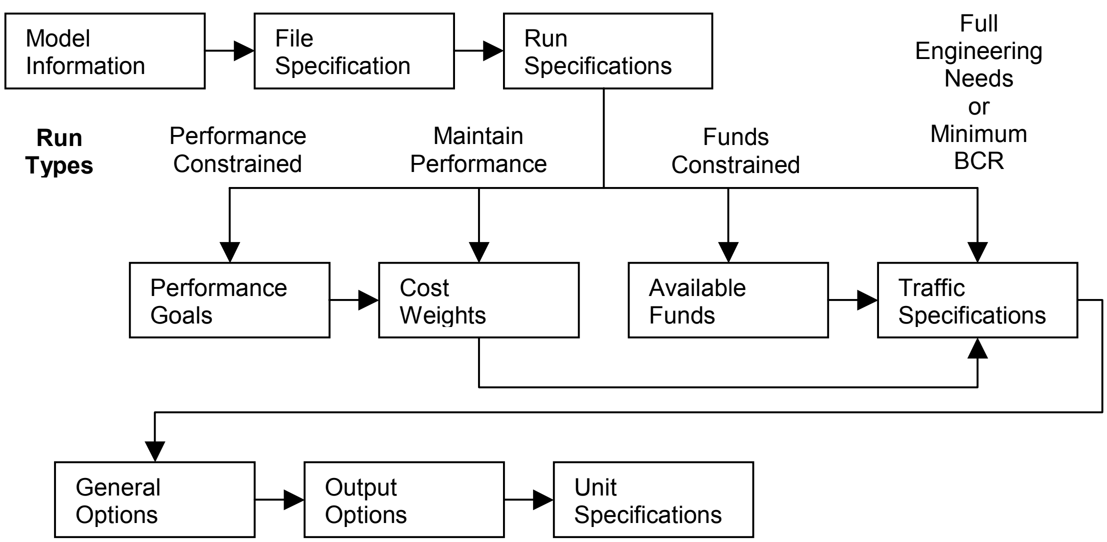


Figure 7.1-1 Control Model Interview

The first page of the parameter interview allows the user to enter a name and description for the model. The name of the last user to modify the model and a corresponding timestamp are also displayed.

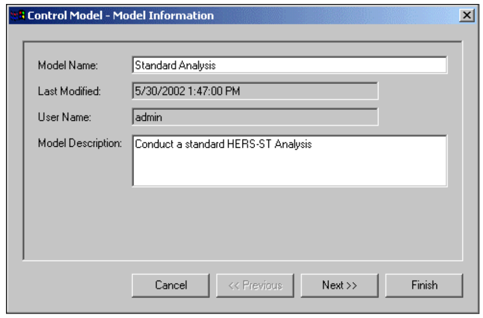


Figure 7.1-2 Control Model Information

SPECIAL NOTE: The new control model settings are not applied until the interview is finished. The user may click the **Finish** button at any point in the interview process. If the name of the control model is changed, the user will be asked if they wish to create a new model or apply the changes to the existing model.

The next two pages collect file names and run specifications. The file names must be provided, however the names themselves are arbitrary and the default names shown usually need not be changed. The objective selected in the run specification will direct the interview down one of the flow paths shown in figure 7.1-1.

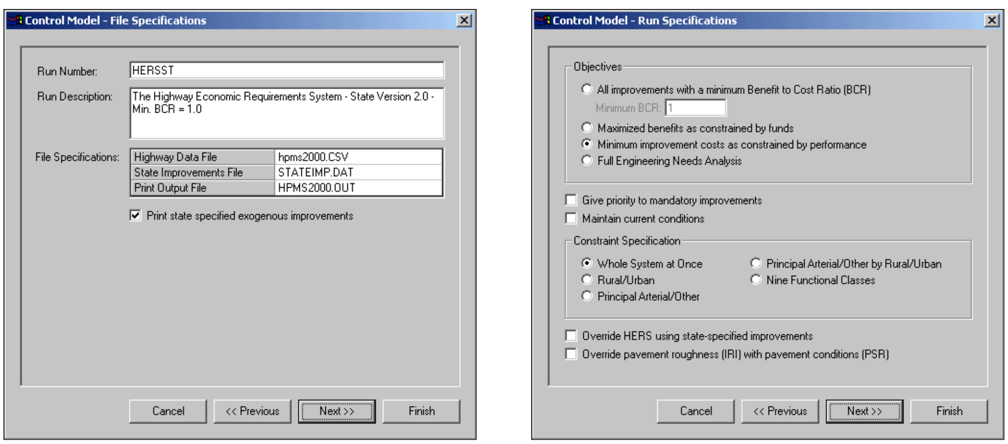


Figure 7.1-3 File names and Run Specifications

If the user selects a full engineering needs analysis objective, a message will be displayed to remind the user to review the deficiency levels of the parameter model that this type of analysis is dependent on. If the project has a selected parameter model then the user will be given the option to open and view it at this point.

Depending on which objective the user selected for the run specification, one of these two pages may appear. Selecting the objective to maximize benefits as constrained by funds will cause the **Available Funds** page to be shown. The table for the portion of funds reserved for mandatory improvements is only displayed if the user chose to give priority to mandatory improvements (see Section 8.3.6) in the run specification. Selecting the objective to minimize improvement costs as constrained by performance will cause the **Performance Goals** page to be shown.

In either case, the information is organized by functional classification for up to four funding periods. The functional classifications shown are those appropriate for the constraint specification selected on the run specifications page.

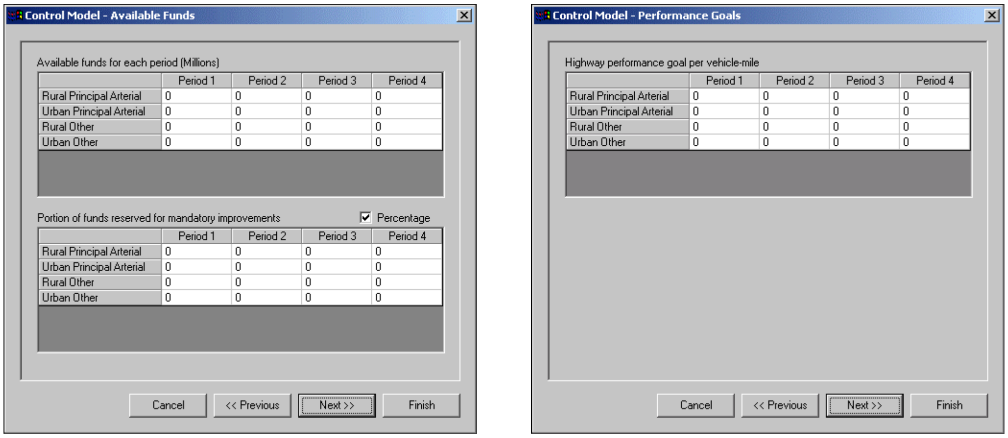


Figure 7.1-4 Funds Available or Performance Goals

SPECIAL NOTE: Leaving a field set to zero for the second, third or fourth funding period will imply the reuse of the entry for the previous funding period.

The next two pages collect cost weight information and traffic specifications. The cost weights are used to establish a performance goal and are organized by functional classification. The cost weights page is only shown when a performance constrained run is specified.

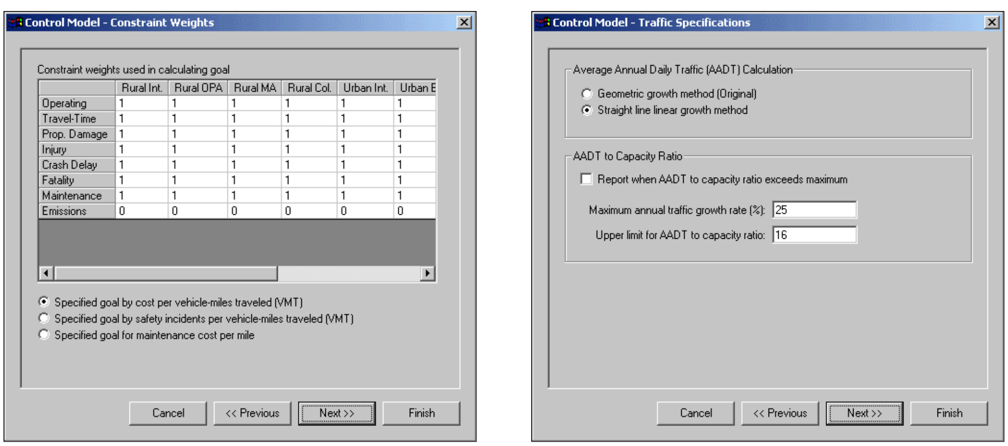


Figure 7.1-5 Cost Weights and Traffic Specifications

The next two pages allow the user to select various general options and output options. The output options shown here determine which pages will be printed to the tabular output file described in paragraph 9.1.1.

The value for the **Long Run Share of Elasticity** in the general options is not directly editable by the user. Rather, it is calculated from the funding period and the long and short run elasticity values using the following formula. Changing any of these three factors will cause a new long run share value to be calculated. The value of the long and short run elasticity is always negative; however, the long run elasticity must always be more negative than the short run elasticity.

Long Run Share Elasticity

$$\mathbf{LRS} = (0.158667\mathbf{FP} - 0.0085\mathbf{FP}^2 + 0.0001533\mathbf{FP}^3)(\mathbf{LRE} - \mathbf{SRE})$$

Where: **FP** = Length of Funding Period
SRE = Short Run Elasticity
LRE = Long Run Elasticity
LRS = Long Run Share of Elasticity

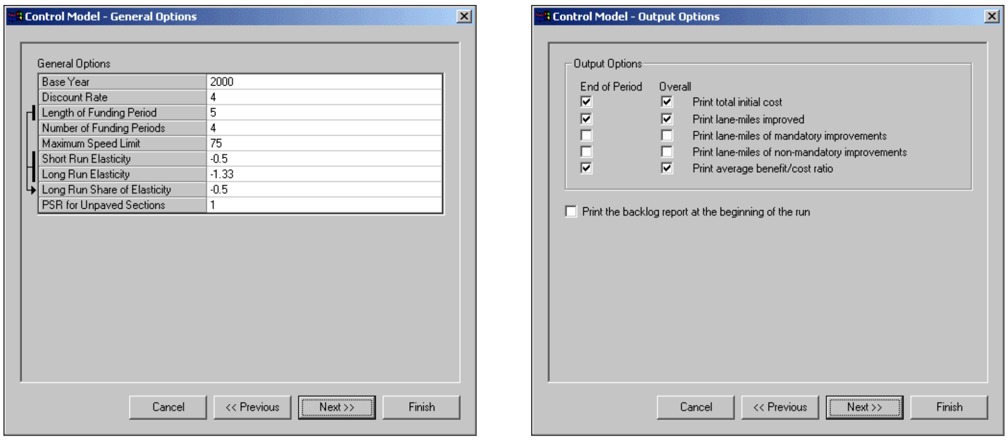


Figure 7.1-6 General and Output Options

The last page collects settings for the units of measurement used in the analysis. The units of cost entries allow the user to scale output cost data and the units of VMT allow the user to scale the calculated vehicle miles traveled.

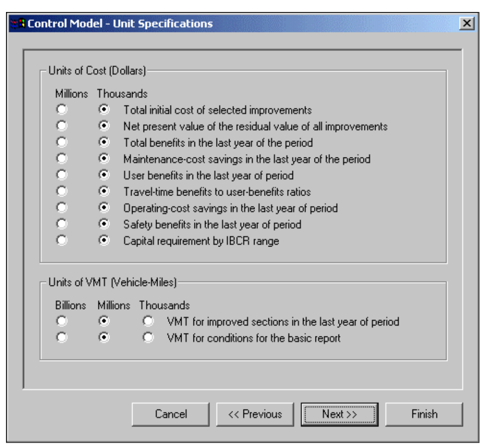


Figure 7.1-7 Units of Measurement

7.2 ADVANCED CONTROL MODEL

When the application is placed in advanced mode, additional detailed information about the control model is available. The control model is made up of two components that appear as branches beneath the control model branch in the project tree. Each component has its own file and is editable in its own window as follows:

- Preprocessor Specification PPSpec.DAT
- Run Specification RunSpec.DAT

The window for editing the run specification data is shown in Figure 7.2-1. Double-clicking on the component branch in the project tree or selecting the **Display** item in its popup menu will display the component. The interface for each component is virtually identical with the left pane showing a hierarchal tree of the items that make up each component and the right pane showing the details of the selected item in the tree. The only difference between the components is the attributes, lists and tables shown in the tree. A definition for each attribute, list and table item for each component is listed in Appendix C.

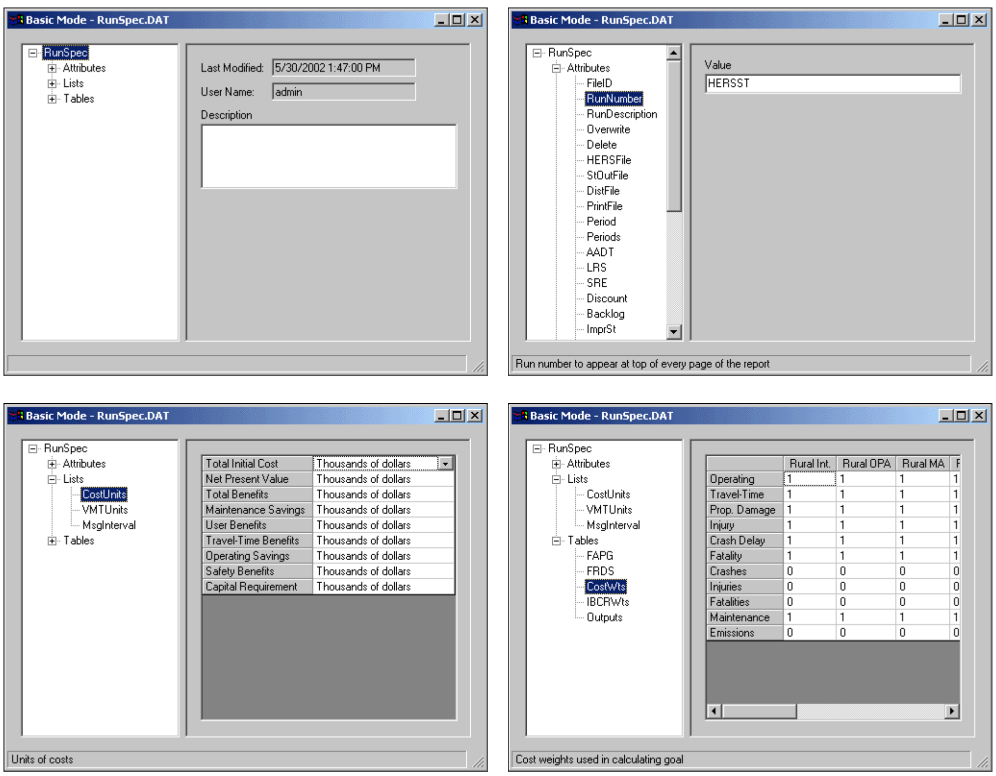


Figure 7.2-1 Advanced Control Model Window

The contents of each component can be imported and exported from HERS-ST to a text file by selecting the **Import** or **Export** options on the project tree popup menu. The text file format is specified in Appendix C.

CHAPTER 8 - RUNNING HERS-ST

To run the HERS-ST analyzer the user must first select a highway data model, a state-improvements model (if needed) and a control and parameter model. Individual models are selected by clicking them in the project tree so that the option button next to each item is marked. To start HERS-ST, select the **File/Run HERS-ST** menu option or click the run button on the toolbar. The run HERS-ST dialog will appear.

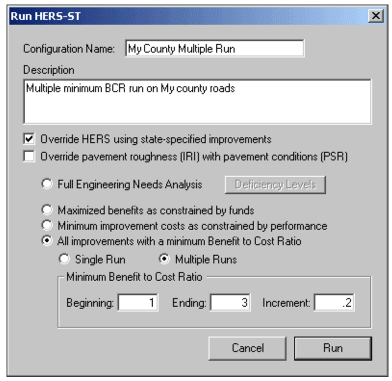


Figure 8-1 Run Dialog Window

The name of the run configuration is assigned the value of the run number attribute of the run specification and its description is assigned the value of the run description attribute. These are the default assignments and can be changed by the user.

The other options presented here are from the run specification described in the control model. They are displayed here to allow a short cut means to change these setting without the need to reopen the control model each time. Changes made to the settings are applied to the copy of the control model used in the HERS-ST configuration and not to the original control model selected in the settings tab of the project tree.

When a full engineering needs analysis is selected, the button that allows access to the deficiency levels that affect this type of analysis is enabled. This button will display the parameter model interview page shown in figure 6.1-1.

There are two modes of running available. The first mode is the *Basic Mode* where HERS-ST identifies only HERS-ST type improvements. The other mode is the *Override Mode* where the HERS-ST type improvements can be overridden by user specified state-improvements. In basic mode only a highway data model and a control and parameter model are required. However, in override mode a state improvements model is also required.

The user can elect to run a single HERS-ST analysis or multiple analysis iterations. The multiple run option will conduct one or more runs of the HERS-ST analyzer while incrementing the value of the minimum BCR value between each run. When selecting multiple runs, the user must specify the starting, ending and increment value to be assigned at the minimum BCR for each run. The number of iterations conducted by the HERS-ST analyzer will depend upon the size of the minimum BCR range and the value of the increment.

> SPECIAL NOTE: The user can monitor the progress of the pre-processor and the HERS-ST engine in the DOS windows that appear on the screen during the execution. During the HERS-ST execution, the application is locked and will not responded to the mouse or keyboard.

If the user has enabled archives in the options window then a complete copy of the input files and output files will be copied to an archive sub-directory named after the configuration. If running multiple iterations of the HERS-ST analysis, an archive will be created for each run using the configuration name appended with a run index as the archive directory name.

8.1 HERS-ST Error and Warning Messages

The HERS-ST analysis consists of two parts, the Preprocessor and the HERS-ST analyzer. The Preprocessor is executed prior to the analyzer and is ran only once even when the analysis is conducted multiple times for a multiple minimum BCR run. If the Preprocessor generates any error or warning messages, the analysis execution is halted to inform the user. From this point the user can make one of two choices.

- Terminate the analysis execution and review the messages.
- Ignore the messages and continue with the analysis execution.

Likewise, if the HERS-ST analyzer produces any errors or warning messages, the user is given the same two choices. It is recommended that the first time the user encounters this situation that the analysis execution be terminated and the error and warning messages reviewed. If they are found to be insignificant, then restart the analysis execution and chose to ignore the messages when asked. If the errors or warnings are not insignificant, then make the necessary corrections before restarting the analysis.

8.2 HERS-ST Run Types

8.2.1 Basic Runs

In basic runs, HERS-ST performs its own evaluations of the estimated costs and benefits of all potential pavement, widening, and alignment improvements and determines which improvements best meet the criteria provided by the user. Information about the state of the highway system in the base year and forecast traffic volumes for some specified future year are provided in the HPMS file.

The starting point for a run of the HERS-ST system is an HPMS data file containing an ASCII description of a set of highway sections (e.g., all sections of the State Highway System or some subset of these sections) for some base year. The HSTPP program is used to perform some preliminary processing of this file and to convert it to two files, including one containing binary descriptions of the individual highway sections. The HERSST program is then used to perform a more detailed analysis of the specified highway sections, starting with the description contained in the binary file.

Each run of HERSST analyzes the specified set of highway sections over an overall analysis period consisting of one or more “funding periods” (FPs) starting in the base year specified. The length of each FP and the number of FPs are specified by the user. A maximum of 25 FPs can be analyzed in a single run of HERSST.

In basic runs, in each FP, the HERSST program applies user-specified criteria to identify and select pavement, widening, and alignment improvements to be implemented on the highway sections being analyzed. The objective functions available for controlling this selection process are described in Appendix C.

8.2.2 Override Runs

In override runs, the HERS-ST user has the ability to override some (or all) of the decisions HERS-ST makes regarding the selection of improvements, the initial cost of these improvements, and their effects on capacity. In particular, for any section, the user can specify:

- That a particular type of improvement is to be made in a particular FP;
- The initial cost of such an improvement;
- Its effect on capacity; or
- That improvements are to be made only in specified FPs.

Override runs make it possible to override HERS-ST decisions on the basis of specific knowledge of the feasibility of particular improvements selected by HERS-ST or knowledge of unusual costs (e.g., for replacing bridges) that would be incurred in implementing these projects. These runs also make it possible to require that several related improvements (such as widening a given highway) be scheduled for the same FP or in consecutive FPs. (Because HERS-ST analyzes individual sections in isolation, it is not currently capable of recognizing the relationship between such improvements.)

Override runs also make it possible for HERS-ST users to specify improvements not selected by HERS. These improvements can be either HERS-type improvements (pavement, widening, or alignment improvements) or other types of projects (such as intersection modification or grade separation). In the latter case, the user must specify both the initial cost of the project and its effect on capacity. For HERS-type improvements, the user has the choice of providing cost and/or capacity specifications or allowing HERS-ST to estimate these quantities.

Appendix A describes how users can specify improvements that should or should not be made and, optionally, specify the initial costs of these improvements and/or their effects on capacity. Also provided in Appendix A are details about how HERS-ST estimates the costs and benefits of user-specified improvements as well as the incremental costs and incremental benefits of substituting a more aggressive improvement for a user-specified improvement.

8.3 HERS-ST Analysis Types

HERS-ST is designed to perform three types of analyses:

- Minimum Benefit/Cost Ratio;
- Constraint by Funds; and
- Constraint by Performance.

Additionally, there are two special case analyses performed by HERS:

- Full Needs Analysis; and
- Maintain Performance Analysis.

These analysis types differ in the methods used by HERS-ST to select which improvements are implemented. HERS-ST also includes an option to have the model correct sections with unacceptable deficiencies (see Appendix B) regardless of the economic desirability of the improvement. The following paragraphs provide an overview of these types of analyses.

8.3.1 Minimum BCR

Minimum BCR analysis may be described as follows: Implement all improvements with incremental benefit/cost ratios greater than some threshold value.

When you select minimum BCR analysis you must specify the minimum acceptable benefit/cost ratio for any implemented improvement. The questions you are asking are:

What are those improvements that exceed a specified minimum benefit/cost ratio?

How much can be invested at this level of return?

What will be the condition and performance of the highway system after investing at this level?

This is the essential HERS-ST analysis. The FHWA uses this type of analysis, with the minimum BCR set to 1.0, in the Maximum Economic Investment scenario for the *C&P Report*. FHWA also uses a minimum BCR approach for the Maintain User Costs scenario in the *C&P report*. For each funding period, the model examines each section, identifying and calculating BCRs for all potential improvements. Then, for each section, the model implements the economically most attractive improvement with a BCR above the user-specified threshold.

8.3.2 Full Engineering Needs Analysis

The full engineering needs analysis is a special form of the Minimum BCR analysis, where the minimum BCR is automatically set to -9999. When you select a full engineering needs analysis, you are asking for solutions to these questions:

How much will it cost to correct all highway deficiencies for each funding period?

What will the system condition and performance be?

This form of analysis essentially ignores all of the economic analysis capabilities that have been built into HERS. While it includes calculation of a BCR for each improvement, it effectively disregards the BCR when selecting improvements for implementation. Instead, it improves all sections on which HERS-ST identifies a deficiency, and implements the most aggressive improvement in order to ensure that all deficiencies are corrected. Thus, the standards for improvement are determined by user-specified engineering criteria, instead of economic analysis. This type of analysis is similar to that performed by the HPMS Analytical Process.

8.3.3 Constraint by Funds

Constraint by Funds (or fund constrained) analysis may be described as follows: Maximize the net present value of the benefits of improvements subject to specified constraints on funds available during each funding period.

When you select fund constrained analysis, you must specify the funding level the model may allocate for improvements. The questions you are asking are:

What level of system condition and performance can be obtained when the improvements are limited by the funds you specify?

Funds can be specified by functional class (or combinations of functional class) for each of the first four funding periods. (The values for the fourth funding period are utilized for subsequent funding periods.) During each funding period, the model identifies potential improvements, and ranks them by BCR. After all sections are examined, the model selects the most economically attractive improvements in order until the available funds are expended, or no economically justifiable candidate improvements remain. (That is, the system sets the minimum BCR threshold at 1.0.)

HERS-ST is not able to exactly meet the funding constraint levels set by the user. This is because, as successive improvements are implemented and the available funding is exhausted, the model will inevitably reach the point where it has some funds available, but not enough to fully implement the next improvement. The national model solves this problem by splitting the last section in order to implement the selected improvement. When the funding constraints are not severe, the state version typically overspends by two to five percent per funding period. When the funding constraints are severe, the amount of over-spending may exceed fifty percent.

8.3.4 Constraint by Performance

Performance constrained analysis may be described as follows: Minimize the cost of improvements necessary to achieve specified goals for the performance of the highway system at the end of each funding period.

When you select constraint by performance, you must specify the level at which you want the highway to perform. The question you are asking is:

How much will it cost to achieve a specified level of system performance?

Performance goals can be specified by functional class (or combinations of functional class) for each of the four initial funding periods. (The values for the fourth funding period are utilized for subsequent funding periods.) The goals may be specified in cost per vehicle mile (vehicle operating cost, highway maintenance cost, injury cost, etc.), number of safety incidents (crashes, injuries, and fatalities), or maintenance costs per mile. Goal components can be weighted relative to each other and also by functional class. As with the Constraint by Funds analysis, during each funding period the model identifies potential improvements, and ranks them by BCR. After all sections are examined, the model selects the most economically attractive improvements in order until the performance goal is attained, or no economically justifiable candidate improvements remain. (Once again, the system sets the minimum BCR threshold at 1.0.)

8.3.5 Maintain Performance Analysis

The Maintain Performance analysis is a special form of the Constraint by Performance analysis, where the current level of system performance is used as the performance goal. The questions answered by this type of analysis are:

How much will it cost to maintain the current level of system performance?

As in Constraint by Performance analysis, the goal may be specified in cost per vehicle mile (vehicle operating cost, highway maintenance cost, injury cost, etc.), number of safety incidents (crashes, injuries, and fatalities), or maintenance costs per mile. Goal components can be weighted relative to each other and also by functional class. The model determines the performance level during its first pass through the system, and per mile. Goal components can be weighted relative to each other and also by functional class. As with the Constraint by Performance analysis, during each funding period the model identifies potential improvements, and ranks them by BCR. After all sections are examined, the model selects the most economically attractive improvements in order until the performance goal is attained.

8.3.6 Mandatory Improvements

With this analytical option, the user can instruct the model to implement corrective improvements on sections which meet a distinct set of deficiency criteria even though the improvements do not meet the economic criteria for implementation. The user enables this option in the Control model wizard. The user specifies “unacceptability levels” (ULs) in the DLTbls table in the Parameter Model (advanced mode only) for the same eight section characteristics used in specifying DLs. Generally, the ULs would be set to specify worse conditions than the DLs. The model will identify the least aggressive improvement that corrects the unacceptable conditions on any such section. These improvements are termed “mandatory” improvements on the output pages.

The HERS-ST handling of mandatory improvements differs depending upon the type of analysis. In all cases, the model first examines all sections to identify those in unacceptable condition, selects improvements to correct those conditions, and then, if not bound by a constraint, reexamines all sections again to identify deficient sections and economically attractive improvements for the deficiencies. Mandatory improvements are the lowest cost improvements that will correct the unacceptable condition. HERS-ST may replace a mandatory improvement with a more aggressive and economically more attractive improvement the second time through the database.

8.3.6.1 Mandatory Improvements and Constraint by Funds

For constrained fund analysis, the user specifies (1) the total funds available for improvements, all of which may be used to correct unacceptable conditions; and (2) the amount of the total funds which will not be used to correct unacceptable conditions, but reserved for the most economically attractive improvements. If, after implementing improvements for all unacceptable sections, funds remain (whether not needed to correct unacceptable conditions, or reserved for additional improvements), the model proceeds to identify and implement improvements for sections which are merely deficient until all the funds allocated for that funding period have been exhausted. If there are insufficient funds to implement all improvements to correct deficiencies, then the benefit-cost analysis (BCA) process uses the improvements' BCRs to select the best of the potential improvements for implementation.

If the cost of the mandatory improvements exceeds the available funds, HERS-ST uses the BCA process to select the best of the mandatory improvements for implementation. The model then applies the reserved funds to the correction of deficient sections. Sections with unacceptable conditions not corrected with mandatory improvements remain eligible for improvement, however they must satisfy the economic criteria.

8.3.6.2 Mandatory Improvements and Constraint by Performance

For performance constrained analysis, the model first identifies the mandatory improvements. If implementing all the mandatory improvements achieves or exceeds the performance goal, no additional improvements are identified, and all the mandatory improvements are implemented. Unlike constrained fund analysis, HERS-ST does not use the BCA process to select only enough of the best improvements to exactly meet the constraint. Under this type of analysis, HERS-ST will implement all mandatory improvements.

If implementing all the mandatory improvements does not meet the performance goal, additional improvements addressing merely deficient conditions are identified, ranked by BCR, and selected using the BCA process until the performance goal is attained.

8.3.6.3 Mandatory Improvements and Minimum BCR

For minimum BCR analysis, the model implements mandatory improvements to correct all unacceptable conditions regardless of the BCR of the improvement. It then implements the most aggressive improvement for each section that has a BCR above the minimum BCR. As with the other types of analysis, mandatory improvements may be replaced with a more aggressive improvement which meets the economic criteria.

CHAPTER 9 - HERS-ST ANALYSIS RESULTS

Each time the user conducts a run of the HERS-ST analyzer a new run configuration is created and added to the project. The run configurations are displayed in the project tree on the **Results** tab. Each configuration contains a *Settings* and *Results* section. If the configuration was for multiple minimum BCR runs then it will show multiple result iterations in the tree. Each iteration will be named for the value of the BCR by default, but can be renamed by the user.

> SPECIAL NOTE: Only one copy of the setting components are kept in a multiple minimum BCR run even though the control model is automatically changed for each iteration. It is understood that the only control value to changed between the iterations is the minimum BCR whose value is documented by the name and description of each iteration.

The settings branch contains an exact copy of the selected highway model, state-improvement model and the control and parameter models that were used during the run. The configuration settings are read only, however selecting the **Clone** option in the popup menu can copy them. The new copy is displayed in the project tree back on the **Settings** tab.

The result iterations branch contains the results of the HERS-ST analysis. There are four types of result data created by the analysis that are displayed here as shown below. Detailed descriptions of each type of result data are provided in the following paragraphs.

- Tabular Output Data
- Section Conditions Data
- System Conditions Data (SS1)
- Improvement Cost Data (SS2)

The HERS-ST tabular output data and the sections conditions data contain information that can be directly viewed by the user. To view the contents of these result items double click on an item or select the **Display** option from the popup menu. The system conditions (SS1) and improvements costs (SS2) data are only visible when the application is placed in advanced mode. These items do not contain data that is directly viewable by the user. The contents of all four types of result data can be export to its original text file format by selecting the menu **Export** option.

> SPECIAL NOTE: The user can disable the capture of any of the four types of result data in the environmental options settings. The performance of the application will improve if it does not need to capture result information that is of no interest to the user.

9.1 TABULAR OUTPUT

9.1.1 Description

Separate columns of output are produced by HERS-ST for the highway system as a whole, for the rural and urban systems, and for nine of the 12 functional systems. In HERS-ST, tabular output for any urban local streets is combined with that for urban collectors, and output for any rural minor collectors and local roads are combined with that for rural major collectors.

The first summarizes the conditions of the highway system at the beginning of the analysis period. The date and time of the run are shown on the second line of this page. Similar pages (without the date and time) are also produced showing the condition of the system at the end of each FP.

The system conditions page is described in Appendix D. The HERS-ST 2.0 system conditions page contains more information than was available in previous versions. The additional information includes lane-miles and a substantial increase in information about speed and delay. The new speed and delay information is described in the following paragraphs.

For the three freeway systems, the system conditions page now shows separate estimates of average speed for peak and off-peak periods.

For all functional systems, total delay is shown along with separate estimates of three components of delay. The first of these, zero-volume delay, represents the delay that would be caused by traffic signals and stop signs in the absence of any congestion; i.e., it reflects the minimum amount of extra travel time that results from slowing and stopping for signals and stop signs. This component of delay is independent of congestion. The other two components represent delay caused by incidents and all other congestion-related delay.

At the user's request, HERS-ST will follow each system conditions page with one or two "deficiency" pages, which present information about the relative extent of various shortcomings in the highway system. These pages replace a few lines of such information that were previously printed at the bottom of the system conditions page.

The top portion of the deficiency page shows the percent of road miles that have IRIs that exceed various user-specified thresholds. Up to five sets of thresholds (UST1, …, UST5) may be specified by the user in the deficiency table (DLTbls.DAT file in advanced mode only). Each set of thresholds may have values that vary by functional system and (for rural systems) by terrain. A potential use of these thresholds would be to produce information about the percent of pavement that meets or fails one or more sets of state-specified standards for pavement condition.

Pavement condition thresholds can also be specified on the basis of PSR, and the system also produces deficiency information for volume/capacity ratio, lane width, shoulder width, shoulder type, surface type, horizontal alignment, and vertical alignment.

There is a difference between the "user-specified thresholds" (UST1, …, UST5) and the various "levels" (UL, RL, DL, etc.) that are specified in this file. The USTs are used only for generating the deficiency page and have no effect on any other HERS-ST results. The "levels," on the other hand, play various roles in HERS' selection of recommended improvements. For example, the DLs are used by HERS-ST to identify roadway deficiencies and potential corrective actions to be analyzed by HERS. The DLs are referred to as "deficiency levels" in HERS-ST documentation. (It should be noted that, in HERS-ST documentation, "deficiency" has a very specific meaning when used in the phrase "deficiency level" and a more general meaning when used in other contexts.)

9.1.2 Tabular Output Window

The tabular output file created by HERS-ST is displayed in a two-pane window. Each section of the output file is listed in a hierarchal tree on the left pane. When the user selects and item in the tree, its corresponding section is displayed in the document viewer on the right pane. The document view can be zoomed in as desired by the user or the whole document can be viewed as thumbnails. To print the document, select the **Print** option in the popup menu or click the **Print** button on the main toolbar.

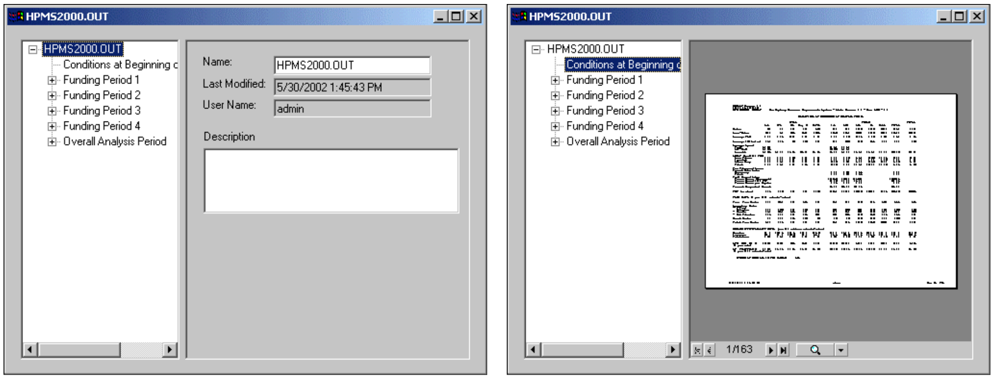


Figure 9.1-1 Tabular Output Window

> SPECIAL NOTE: The content of the tabular output file is user specified in the control model via the **Output** table of the run specification. When all options are enabled, this data will be 164 pages in length.

9.2 SECTION CONDITIONS

9.2.1 Description

For each FP, the HERS-ST program produces a comma-delimited ASCII file describing the condition of each section at the end of the FP along with information about all improvements that have been selected and the effects of these improvements. The file describing conditions at the end of FP nn is called SECNSnn.OUT. The first record of the file contains the final year of the FP. The second contains the user's description of the run. The third record contains a set of column headings shown in Appendix D; and the remaining records contain descriptions of all sections, in comma-delimited format, as listed in and described in Appendix D.

9.2.2 Section Conditions Window

The section condition files are displayed in a two-pane window. Each funding period analysis conducted by HERS-ST is displayed separately in a tree in the left pane. When a funding period is selected in the tree, all of its section conditions information is display in the left pane. The number of funding periods that are displayed is user specified via the **Periods** attribute of the run specification in the control model.

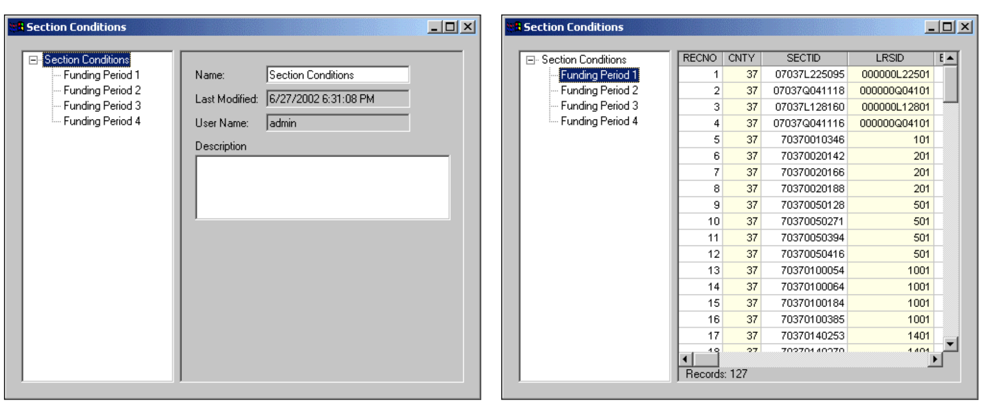


Figure 9.2-1 Section Conditions Window

The columns of the section conditions grid can be hidden, resized and reordered as desired by the user. Once a desired layout is created, it can be saved to a library for future use by selecting the **Table/Save Layout** option in the popup menu. The user will be asked to give the layout a name to refer to it by. If an existing layout already has the same name, the user will be asked if he wishes to overwrite it. To restore a previously saved layout, select it by its name from the **Table/Restore Layout** option in the popup menu.

When printed, the column layout created by the user will be preserved. To print the section conditions of a funding period, select the funding period in the tree and select the **Print** option in the popup menu or click the **Print** button on the main toolbar.

9.3 SYSTEM CONDITIONS

In addition to the tabular output and section conditions, there are two other items contained in the system condition iteration result. These are the System Conditions item (SS1) and Improvements Costs item (SS2). The information in these items is not directly viewable by the user. Rather they provide the source data for the user to create charts, tables, maps and reports from. Although they cannot be display like the other result items, they can still be exported to a text file and be viewed as an external file.

The SS1 and SS2 result items are only displayed in the project tree when the application is placed in the *Advanced* mode in the environmental options otherwise they are hidden.

SPECIAL NOTE: The information contained in the SS1 and SS2 result items is not available to create tables, charts or reports until the configuration is saved to the database.

9.3.1 The SS1 File

The SS1 file contains the initial conditions page, and a page for the state of the system at the end of each funding period. The file opens with the *runnumber* identifier and the identification of the initial block of data as being the initial conditions data. Each line begins with a cryptic acronym, interpreted in Table D-2, "SS1 File Acronyms," identifying the contents of the line. This is followed by a dozen fields, representing the functional classes and the rural, urban, and overall totals. The order of the columns are the same as in the printed output: rural interstate, rural other principal arterials, rural major arterials, etc. The lines are also presented in the same order as in the printed output. The two lines which are not included in the SS1 file are the line listing the number of miles in each functional class, and the line indicating the number of sections in the sample. For constrained runs, the lines identifying performance goals specified and achieved, and the last selected BCR, are also not included. After the initial conditions data, a line is inserted identifying the following data as being generated at the end of the first funding period. Additional blocks of data are included for each subsequent funding period.

The second of the comma-delimited files is named *runnumbe*rSS2, and contains data from the functional class by improvement format.

9.3.2 The SS2 File

Like the SS1 file, the SS2 file opens with the *runnumber* identifier. This is followed by a line identifying the first block of data as being the initial cost of improvements for the first funding period. As with the SS1 file, the first entry on each data line is an acronym: in this case, for the various HERS-ST improvement types (and a last line for totals across all improvement types). The acronyms correspond, in order, to the improvements as shown in Appendix A, table A-5. The fields on each line are arranged by functional class in the same manner as in the SS1 file.

The SS2 file contains only data for all improvements selected: unlike the printed output, it does not contain data for only those sections receiving alignment modifications.

Following the block of cost data is a line which identifies the next data block as containing average BCR data for the first funding period. This is followed by the data, arranged identically to the cost data.

Additional paired blocks of data are included for each subsequent funding period.

CHAPTER 10 - CREATING REPORTS

Once the HERS-ST analysis is complete, a great deal of information exists that can be used to create reports that depict the information in a useful way. There are four different types of reports that can be created as follows.

Table	Use the table to build ad hoc queries to retrieve and present information
Chart	Use the chart style report to create a wide variety of charts and graphs
Report	Use this type of report to build ad hoc documents
GIS Map	Use the GIS map report to create graphical representations of the road sections

The project reports are displayed on the **Reports** tab of the project tree. To create a new report, select the **New Item** menu option from the popup menu that appears when you right-click one of the four report-type branches. All of the reports in any of the four report-type branches can be deleted from the popup menu by selecting the **Remove All** item. Deleting a report is permanent and once delete it cannot be recovered.

The following paragraphs describe each report type in detail.

> SPECIAL NOTE: After a HERS-ST analysis is complete, the information it created is available in the application, but is not yet stored in the database. The user must save the run configuration to the database before it is available to be used to create any reports.

10.1 TABLES

A table report is used to build ad hoc queries of the information in the database. The table view is displayed when the user either double-clicks its branch in the project tree or selects the **Display** item from its popup menu.   The popup menu also allows the user to rename or create a copy of the existing table using the **Rename** and **Clone** items respectively.

The interface of a table report is presented on four tabs. The first tab collects general information about the table including the table name and description. The name of the last user to modify the table as well as a timestamp of when it was modified is also displayed.

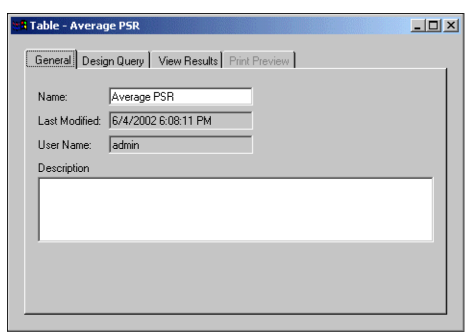


Figure 10.1-1 Table General Tab

The next two tabs provide the user a graphical means to design and test a SQL query. The design tab has three panes that can be resized as needed. The view results tab displays the results of the query in a table.

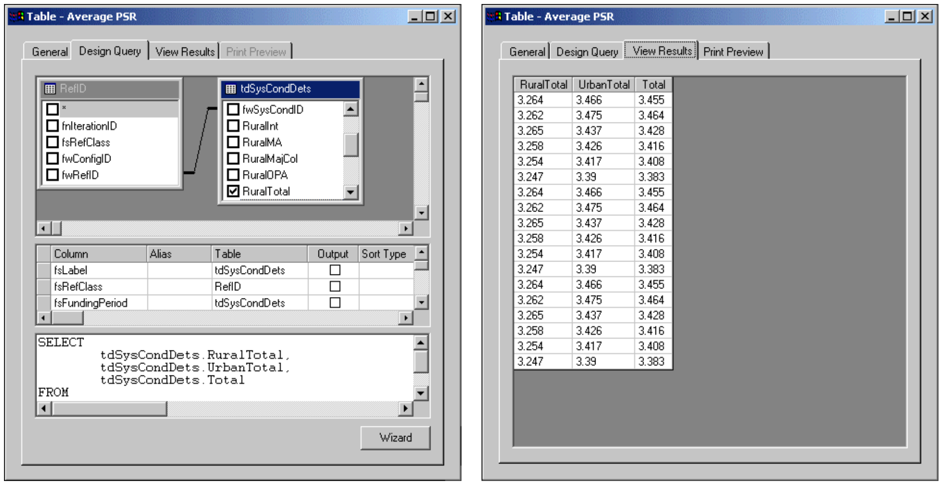


Figure 10.1-2 Table Design and View Tabs

The top pane of the design tab provides a graphical diagram of the database tables and relational links between them. Right-click in the field of the top pane to display a list of the tables in the database that can be added to the view. To create a relationship between two tables, drag the desired field from one table and drop it on the desired field of the second table. To delete an existing relationship, highlight it and press the DELETE key. Add any desired field to the output of the query by selecting its checkbox.

The center pane provides a view of the query that will allow the user to create features such as sorting, name aliases and filter criteria. The bottom pane displays the actual SQL query text and allows an experienced user to modify or manually enter any SQL statement. Manually entered SQL statements will not be reflected in the other panes until the user closes the table report window and then displays it again. A query wizard is available when the user clicks the **Wizard** button. This wizard is identical to the one shown in figure 10.2-3.

The fourth tab is not enabled unless a table has been created and is displayed on the results tab. It displays a printing preview window that will allow the user to see how the generated table will appear when printed. The page setup can be switched between landscape and portrait and the table can be zoomed, scrolled and printed from here.

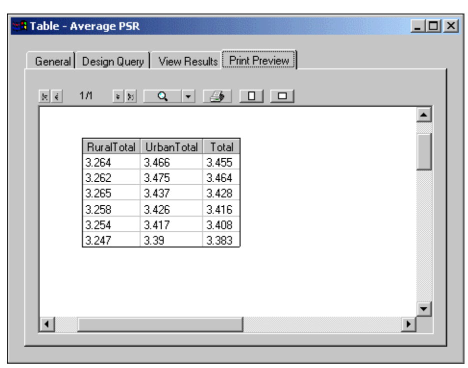


Figure 10.1-3 Table Print Preview Tab

10.2 CHARTS

A chart report is used to create complex charts and graphs to compare information from the database. The chart view is displayed when the user either double-clicks its branch in the project tree or selects the **Display** item from its popup menu. The popup menu also allows the user to rename or create a copy of the existing chart using the **Rename** and **Clone** items respectively.

The interface for a chart is organized onto three tabs. The first tab collects general information about the chart including the chart name and description. The name of the last user to modify the chart as well as a timestamp of when it was modified is also displayed.

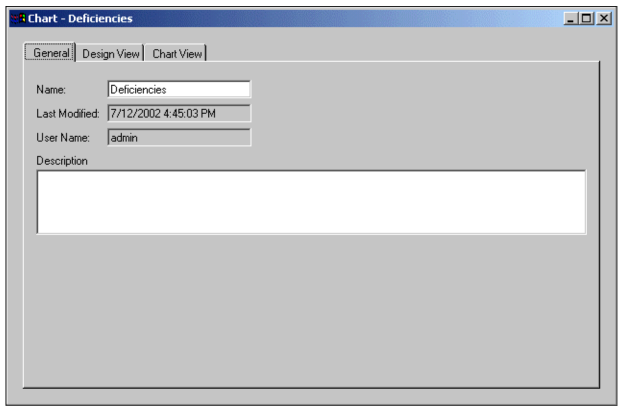


Figure 10.2-1 Chart General Tab

The second tab displays the chart designer. A chart is normally based off of the data of a specific HERS-ST analysis configuration. A list of saved configurations that have been created for the project are displayed in a drop-down list at the top of the window. Select a configuration from the list for the chart to be based on.

The user may enter a title for the chart as well as captions for the X, Y and Y1 axis. The number of rows in the chart designer grid is also displayed and can be modified by the user if needed.

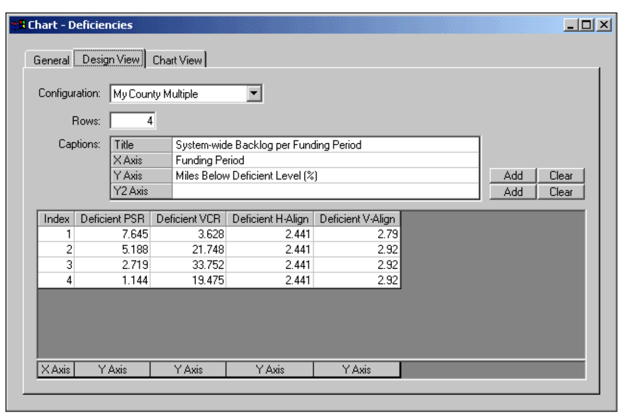


Figure 10.2-2 Chart Design Tab

The chart designer grid itself is where the information that is to be charted is displayed. A chart will always have an X-Axis column that is displayed in the left most position. The data in the X-Axis column will be plotted on the X-Axis of the chart.

There are two types of Y-Axis columns available designated as the Y-Axis and Y2-Axis. Any number of columns of data can be added to the table with each column corresponding to a separate plot on the chart. Each plot column is designated as a Y-Axis or a Y2-Axis plot or can be designated as OFF in which case its data will still be saved but it will not appear in the chart. The column designation is selected from a dropdown list at the bottom of each column.

When the chart is displayed, the Y-Axis is drawn on the left and the Y2-Axis on the right. The chart will always display a Y-Axis, however if no columns are designated for the Y2-Axis then it will not appear on the chart. Plot columns are added by clicking the **Add** button for either the Y or Y2 axis. All existing plot columns for either the Y or Y2 axis can be deleted by clicking the corresponding **Clear** button.

Every row of the X-Axis column must be provided with a value. However, the other plot columns may skip rows if no data corresponding to the X-Axis is available. To skip a row in a plot column, leave the unwanted field blank.

There is a variety of ways to add data to the chart designer columns. The simplest way to add data is to just manually type desired values into the cells. This allows the user to add data to the chart that was not created by the HERS-ST analysis or is not otherwise in the database. The other ways is to automatically generate data from the information in the database. This capability is available through a popup menu that appears when the user right-clicks any one of the column headers.

The most flexible means of getting information from the database is to use the ad hoc query builder that is selected by clicking the **Query/Query** item in the menu. A dialog box appears where the user can build and test a SQL syntax query. This window functions identically to the query designer tab of the Table report described in section 10.1.

> SPECIAL NOTE: If the SQL query has more than one output field, only the first field will be used to fill the selected column in the chart designer grid and the remaining fields will be ignored.

Any data stored in the System Conditions item (SS1) or the Improvement Costs item (SS2) can be easily accessed by using the query wizard. The query wizard appears when the user clicks the **Query/Wizard** item in the popup menu. A configuration must be selected for the query wizard to be enabled.

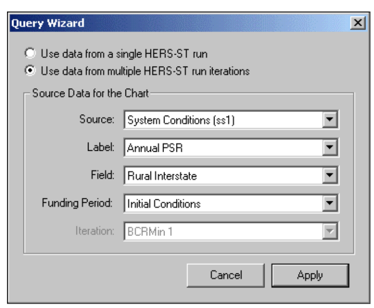


Figure 10.2-3 SS1 and SS2 Query Wizard

The wizard can return a list of data either from a single HERS-ST analysis or for a multiple minimum BCR analysis. The multiple iteration model will not be enabled if the selected configuration has only one iteration. The values that comprise the list of data for each mode are as follows:

Single The values returned will be from each funding period of a selected iteration. The number of items in the list will equal the number of funding periods that was specified for the analysis

Multiple The values returned will be from the selected funding period of each iteration. The number of items in the list will equal the number of iterations conducted during the analysis.

The source for the data is either System Conditions (SS1) or Improvement Costs (SS2) and is selected from a drop-down list. The valid labels for the selected source are shown in the next drop-down list and finally the valid fields are displayed in the third drop down list. By selecting a source, label and field, the user can pick any value contained in either data source.

There are a number of predefined charts and queries available to make it easy to quickly derive commonly used data to crate the chart with. The predefined charts are selected by right clicking in the neutral area of the chart. They are segregated into charts for multiple iterations and charts for a single iteration. The predefined queries are selected from the **Query/Predefined** item in the popup menu. A configuration must be selected for the predefined charts and queries to be available.

> SPECIAL NOTE: If a multiple iteration chart is selected for a configuration with only a single iteration, the resulting plot will have only one point. If a single iteration chart is selected for a configuration with multiple iterations, the user will be asked to pick the iteration whose data is to be used to create the chart.

The following predefined charts and queries are provided. Additional information about each is provided in Appendix E.

Predefined Charts	**Predefined Queries**
Annual Investment vs. Pavement Conditions	Average Annual Funding
Annual Investment vs. Effective Speed	Average PSR
Annual Investment vs. Congestion Delay	Average Effective Speed
Annual Investment vs. Crash Rate	Congestion Delay
Annual Investment vs. User Costs	Average Crash Rate
Annual Investment vs. User Benefits	Average Annual User Costs
Annual Investment vs. Volume/Capacity Ratio	User Benefits
Annual Investment vs. System Wide Backlog	Volume/Capacity Ratio
Total Initial Costs vs. Minimum BCR	Total Initial Costs
Funding Level per Improvement Type	Minimum Benefit/Cost Ratio
Backlog per Funding Period	

When a predefined chart is selected, all previously existing information for the chart is lost and replaced with the information for the new chart. Likewise, when a predefined query is select, all previously entered data for the selected plot column is lost and replaced with information from the query.

The third tab displays the chart of the data entered into the designer grid. This tab also provides a means to print the to chart or copy it, as a bitmap, to the Windows clipboard to be pasted into other applications.

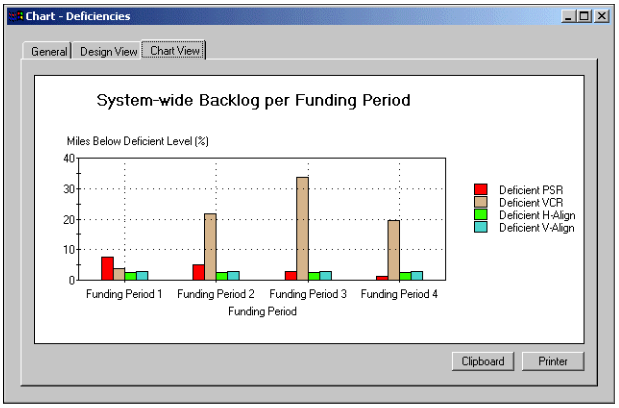


Figure 10.2-4 Chart View Tab

There is a great deal of properties that can be set by the user to customize the appearance of the chart. Right click on the chart area to display a dialog box that will allow chart customizing. The user is referred to the online help available from the chart-customizing dialog for detailed information on the available features of the chart viewer.

10.3 Reports

A report is used to create document style ad hoc reports using database information, manually written text and advanced formatting and graphics. The report view is displayed when the user either double-clicks its branch in the project tree or selects the **Display** item from its popup menu. The popup menu also allows the user to rename or create a copy of the existing report using the **Rename** and **Clone** items respectively.

The interface for a report is organized onto four tabs. The first tab collects general information about the report including the report name and description. The name of the last user to modify the report as well as a timestamp of when it was modified is also displayed.

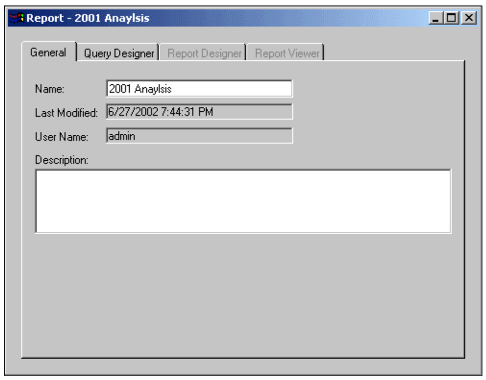


Figure 10.3-1 Report General Tab

The second tab displays the query designer. A report is usually based on a query of data from the database. The fields of the query are available to be used in the report. This tab functions identically to the query designer tab of the Table report described in section 10.1.

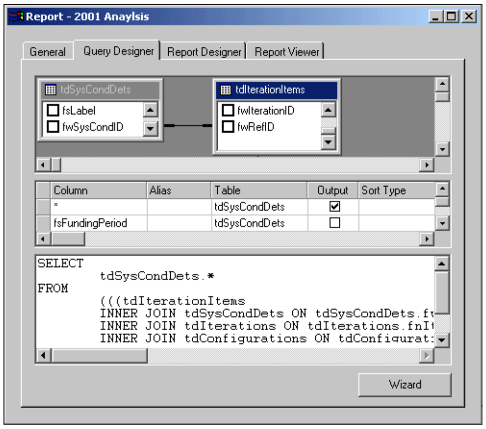


Figure 10.3-2 Query Designer Tab

The data used to create reports generally resides in one of three tables that correspond to the section conditions, system conditions (SS1) or improvement costs (SS2) results data produced for a particular HERS-ST analysis. To simplify the creation of a query to retrieve the data for any of these three tables, a query wizard is provided. Click the **Wizard** button to display the query wizard dialog.

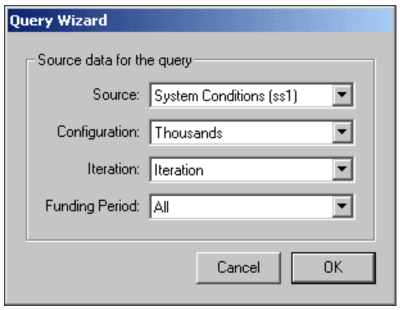


Figure 10.3-3 Query Wizard

The query wizard allows the user to select the data source table for the query, the saved HERS-ST analysis configuration and iteration and the specific funding period of interest. It will then generate the complete SQL statement required to retrieve the information from the database and display it in the query designer tab. The query is ready to be used as is, but can still be modified further by the user if additional criteria are desired.

The third tab displays the report designer. It provides a great deal of tools to create complex report formats through a series of toolbars. The report design is assembled using three panes.

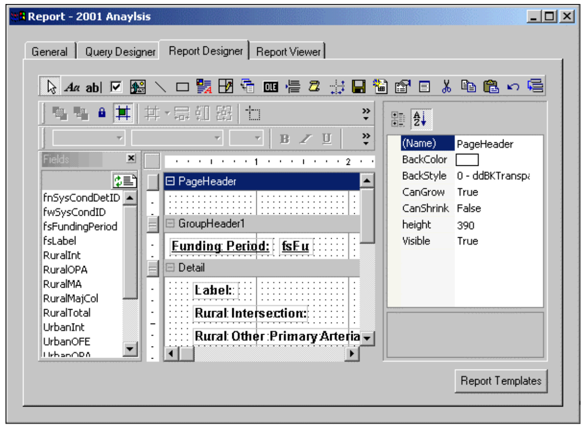


Figure 10.3-4 Report Designer Tab

The leftmost pane displays a list of database fields that are made available to the report by the query created on the query designer tab. Only fields returned by the query can be used in creating the report. The rightmost pane displays the properties of the various components of the report and allows the user to directly edit them.

The middle pane displays the report itself. A report usually contains a page header section, a detail section and a footer section. Additionally, the detail section may contain one or more group headers and footers to partition the report into additional sections.

> SPECIAL NOTE: After the user has customized the content or format of the report it is important to click the **Save** button on the toolbar to ensure that the new report is saved before closing the window.

Predefined report templates are available to quickly produce reports that use the data from any of the tree tables. Click the **Report Templates** to display the template selection dialog.

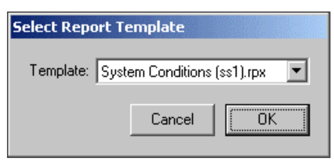


Figure 10.3-5 Report Template Dialog

The predefined report templates are stored in the directory specified in the **Directories** tab of the environmental options. The user may define their own report templates and store them in this directory along with the predefined reports.

> SPECIAL NOTE: The name of the template file must identify the table source it is built around by including its identifier enclosed in parenthesis. The identifiers for the three table types are:
>
> **(secns)** Sections Conditions Table
> **(SS1)** System Conditions Table
> **(SS2)** Improvements Cost Table

When a report template is selected it is displayed in the report designer and uses the query specified in the query designer. If the query is retrieving data from a table that is different than the table that the report template is expecting, then the some or all of the data fields of the report will not function. The application attempts to ensure that the report template is compatible with the query, however this is ultimately the users responsibility.

The final tab displays the report in a page formatted view that will allow the user to see how the generated report will appear when printed. The report can also be saved to an external file from the viewer tab. When saving to a file the user has a number of different options for the file format for it to be saved in. Saving the report to an external file allows the user to export the report to a desired file format, however it is not necessary for the report to be exported in this way for it to be saved as part of the project in the HERS-ST application.

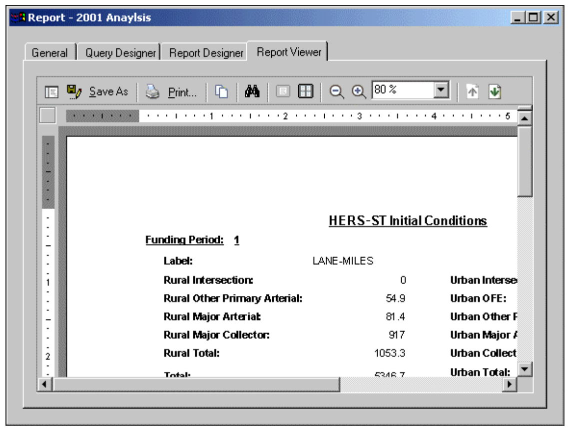


Figure 10.3-6 Report Viewer Tab

10.4 GIS MAPS

A GIS map is used to create maps of the highway sections that need to be improved using database information. The GIS map view is displayed when the user either double-clicks its branch in the project tree or selects the **Display** item from its popup menu. The popup menu also allows the user to rename or create a copy of the existing GIS map using the **Rename** and **Clone** items respectively.

The interface for a GIS map is organized onto three tabs. The first tab collects general information about the GIS map including the GIS map name and description. The name of the last user to modify the GIS map as well as a timestamp of when it was modified is also displayed.

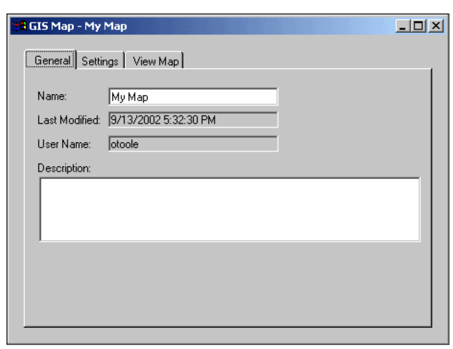


Figure 10.4-1 GIS Map General Tab

The second tab allows the user to set the various settings used to create the map. These settings include selecting the HERS-ST analysis configuration, run iteration and specific funding period to be used for the source data. The base color of the map is black by default but can be modified by the user. The highlight color and line thickness is also available to be set by the user. A highway shape file must be specified before the map can be generated. The map viewer tab will not be enabled until all these settings are set.

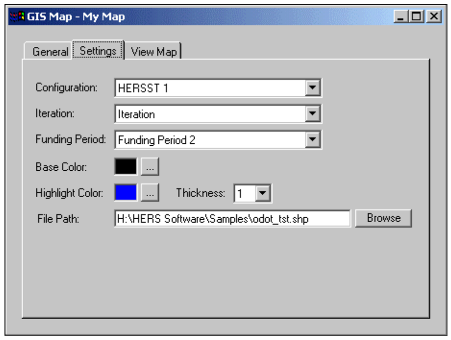


Figure 10.4-2 GIS Map Settings Tab

SPECIAL NOTE: The GIS shape file database must contain the following two fields for the GIS map to be created.

Section_ID	12 Character String	Unique identification number
COUNTY	Integer	Unique county code

The third tab displays the map described in the GIS shape file with the sections that are recommended for improvements highlighted. The GIS map is presented in two panes. The map itself is displayed in the right pane. The user can zoom in and out on the map area using the buttons in the toolbar.

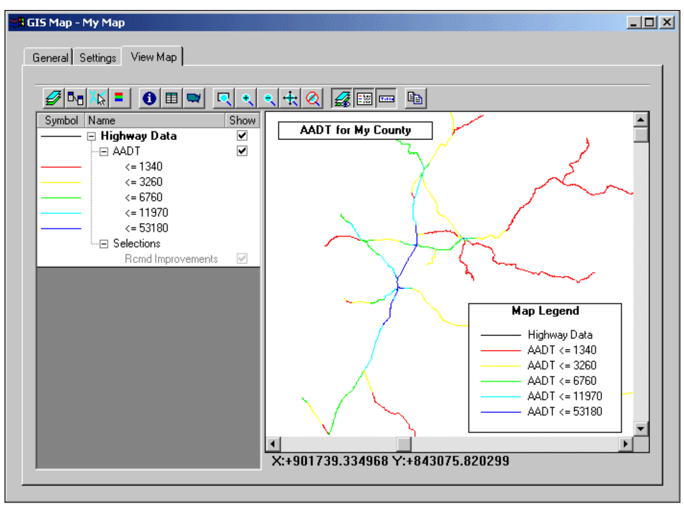


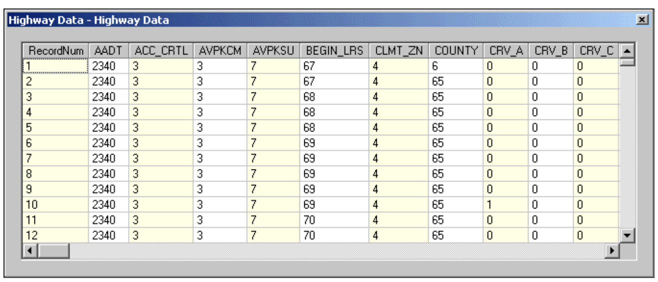
Figure 10.4-3 GIS Map View Map Tab

The left pane displays a hierarchal view of shape layers. Each layer can have a theme applied to it or display any number of user-defined selections, however the user-defined selections are not available while a theme is applied. A layers theme, selections or even the entire layer itself can be hidden by unselecting its **Show** checkbox in the layer pane. Any item that is not shown will appear grayed out. The symbol color, width and style for any item can be modified from the symbol edit window that appear when the users clicks the ellipsis button in the **Symbol** column.

SPECIAL NOTE: Each item of a theme uses the same line style and width but different colors. Therefore changing the line style or width of any item of the theme will affect all of the themes items.

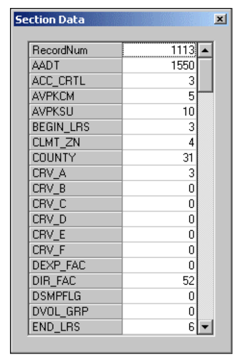
When multiple layers are displayed they are drawn in the order they appear in the hierarchal layer windowpane. That is, the layer at the top of the list is above all other layers in the map and so forth. The order of the layers can be changed using the up and down arrow keys while pressing the **CTRL** key.

The map provides two floating windows that can be used to annotate the image. The title window and legend window are activated from the maps toolbar. When displayed both windows can be resized and position as desired. The legend window contains a list of all items in the layer windowpane that are shown in the map. The title window is directly editable by the user. The copy button on the toolbar creates a screen capture of the map windowpane including the floating windows and places it in the windows clipboard.



Highway Data - Highway Data

RecordNum	AADT	ACC_CRTL	AVPKCM	AVPKSU	BEGIN_LRS	CLMT_ZN	COUNTY	CRV_A	CRV_B	CRV_C
1	2340	3	3	7	67	4	6	0	0	0
2	2340	3	3	7	67	4	65	0	0	0
3	2340	3	3	7	68	4	65	0	0	0
4	2340	3	3	7	68	4	65	0	0	0
5	2340	3	3	7	68	4	65	0	0	0
6	2340	3	3	7	69	4	65	0	0	0
7	2340	3	3	7	69	4	65	0	0	0
8	2340	3	3	7	69	4	65	0	0	0
9	2340	3	3	7	69	4	65	0	0	0
10	2340	3	3	7	69	4	65	1	0	0
11	2340	3	3	7	70	4	65	0	0	0
12	2340	3	3	7	70	4	65	0	0	0



Section Data

RecordNum	1113
AADT	1550
ACC_CRTL	3
AVPKCM	5
AVPKSU	10
BEGIN_LRS	3
CLMT_ZN	4
COUNTY	31
CRV_A	3
CRV_B	0
CRV_C	0
CRV_D	0
CRV_E	0
CRV_F	0
DEXP_FAC	0
DIR_FAC	52
DSMPFLG	0
DVOL_GRP	0
END_LRS	6

Figure 10.4-4 Data View Windows

Selecting the **Data View** button on the toolbar allows the user to see the underlying information for the map sections. The data for an individual section can be viewed in an easier-to-read vertical format by double-clicking on the desired section of the data view window. Selecting the **Get Info** button on the toolbar and then clicking the desired section directly on the map can also display the information for an individual section.

These windows will float on top of all other windows until they are closed.

Additional information from external data sources can be joined into the existing data using the data-joining feature. Select the **Create Join** button on the toolbar to display the join wizard.

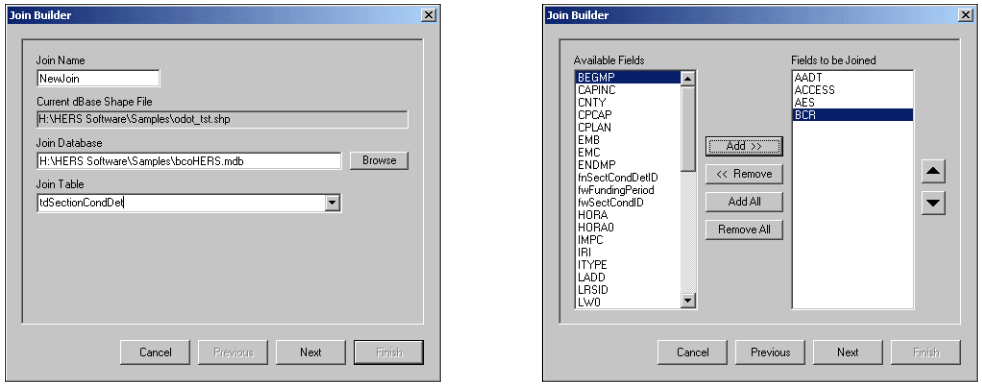


Figure 10.4-5 Data Source and Join Fields

The first page of the wizard identifies the shape file associated with the current layer and allows the user to name the Join and specify the data source. The second page displays a list of field names from the data source and allows the user to select the fields to be joined. At least one field must be selected for joining.

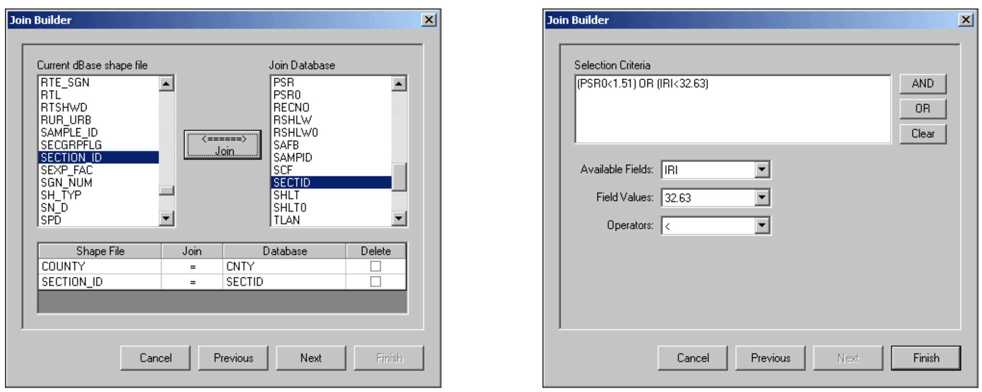


Figure 10.4-6 Join Clause and Selection Criteria

The next page of the join wizard displays a list of fields in both the external data source and the existing section data to allow the user to create an association between the two databases. The settings entered here are used to relate the new data to the existing data. At least one relationship between the two databases must be specified.

The last page of the wizard allows the user to build selection criteria to limit the information that is to be joined. No selection criteria need be entered if all the data is to be joined. When writing selection criteria, each condition of the criteria must be enclosed in parentheses as shown above.

SPECIAL NOTE: The information created by the HERS-ST analysis is joined into the layer data automatically when the map is loaded.

The user can create themes for any attribute of the highway section or any data joined to it. The selected property can be subdivided into up to thirteen partitions with each partition having its own color. Themes are created for the map by selecting the **Create Theme** tool from the toolbar. The theme builder window is displayed.

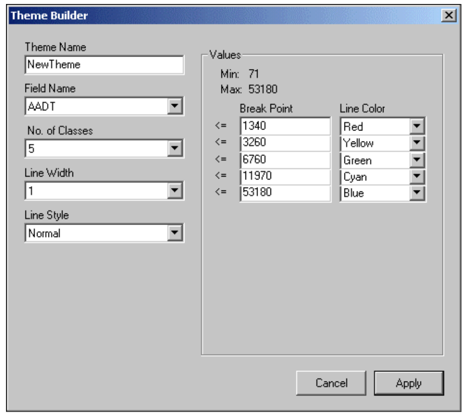


Figure 10.4-7 Theme Builder

The theme builder window provides the user the ability to give the theme a descriptive name and to select the data field that it is to be based on. A list of all the available data fields including any data fields that have been joined into the layer data is provided.

Next the number of subdivide classes is selected. A theme may be partitioned into up to thirteen subdivisions. All sections of the map will be included into one of the partitions. A breakpoint for each division is calculated and displayed. The values shown for the breakpoints are only suggestions and can be edited and refined by the user. The line width and style attributes are the same for the entire theme, however the line color is selectable for each partition.

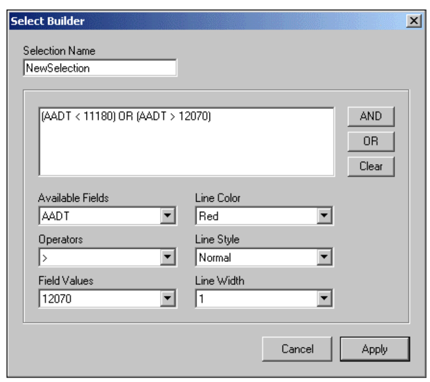


Figure 10.4-8 Select Dialog

Specific sections can be highlighted from the map by selecting the **Create Selection** tool from the toolbar. Sections can be selected by any attribute of the highway section or any data joined to it. The user selects the desired field name, the type of comparison and the value to be delimited. Multiple conditions can be specified and combined using AND/OR logic. When writing selection criteria, each condition of the criteria must be enclosed in parentheses as shown above.

10.4.1 GIS Shape Files

The HERS-ST GIS window uses a shape file (.shp), which is a spatial data format developed by Environmental Systems Research Institute, Inc.(ESRI). A shape file stores non-topological geometry and attribute information for the spatial features in a data set. These spatial features can be a line (highway), point (city), and area (county boundaries) features. Shape files that are created with measures (exported from ArcInfo route event theme) cannot be used by the HERS-ST GIS window. Measures must be removed prior to using the shape file within the HERS-ST GIS environment.

Shape files can be created by exporting any data source to a shape file using ARC/INFO ® , PC ARC/INFO ® , Spatial Database Engine (tm) (SDE (tm)), ArcView ® GIS, or BusinessMAP (tm) software. Shape files can be created directly by digitizing shapes using ArcView GIS feature creation tools. A number of other third party GIS softwares can also be used to create shape files. These are TransCAD, Geomedia, MapInfo, Maptitude, ATLAS, and ArcCADGIS software.

An ESRI shape file consists of a main file, an index file, and a dBASE table. The main file is a direct access, variable-record-length file in which each record describes a shape with a list of its vertices. In the index file, each record contains the offset of the corresponding main file record from the beginning of the main file. The dBASE table contains feature attributes with one record per feature. The one-to-one relationship between geometry and attributes is based on record number. Attribute records in the dBASE file must be in the same order as records in the main file.

Examples:

- Main file: counties.shp
- Index file: counties.shx
- dBASE table: counties.dbf

CHAPTER 11 - HERS-ST GUI TECHNICAL SPECIFICATIONS

11.1 DEFINITIONS

The following terms are used throughout this document to describe both the interface (i.e., objects, names on tabs, and items in the "project tree"), as well as the underlying hierarchical structure of the HERS-ST software. Figures 3-1 shows the HERS-ST hierarchy. Figure 3-2 shows the flow of data through HERS-ST.

11.1.1 Project

A project is the highest level of organization used within HERS-ST. In simple language, the project is the technical problem or analytical task that you are using HERS-ST to solve. The project grouping is used to include the input data, results of multiple analyses and user-defined reports associated with the analytical task. When a run is performed, one of each input data model type contained within the current project, with the exception of the optional State Improvement data, is selected and the results of the analysis are grouped into a configuration (see below). Any reports (charts, maps, tables or ad-hoc reports) which are created based on the data referenced by the open project are also stored as part of the project.

11.1.2 Configuration

A configuration is grouping mechanism used within a project to organize the data associated with a specific run of the HERS-ST analysis. Every time the analysis is performed, a configuration is created and added to the current project. This configuration will contain a read only copy of all of the input setting models (Highway, Control, Parameter and optionally, State Improvements) used to perform the analysis as well as one or many Iteration result sets, depending on whether a single or multiple minimum benefit-cost ratio (BCR) run was performed. When a project is saved, all configurations are saved with this project. Configurations may also be deleted from a project if the information contained in it is no longer needed.

11.1.3 Iteration

An iteration is a grouping mechanism used within a configuration to organize the resultant output data associated with a specific run of the HERS-ST analysis. Every time an analysis is performed and a configuration is created, one or many iterations are added to the configuration depending on the run type. A single run will create a single iteration, identified as ‘Results’ in the Project Tree, as a direct child of the new configuration. In a multiple run, an iteration will be created for each Min. BCR value and sub grouped under the ‘Results’ branch as ‘BCRMin X’ (where X is the value of Min BCR for the particular analysis run). An Iteration may contain a copy of the Tabular Output, Section Conditions, System Conditions (SS1) and Improvement Costs By Functional Class (SS2) as determined by the Output setting in the Options window.

11.1.4 Settings

Settings, which are displayed in the first tab in the Project Viewer, refer to the input data stored in the underlying database and used as inputs to the HERS-ST analysis. Settings include the Highway Model(s), State Improvements Model(s), Configuration Model(s) and Parameter Model(s).

11.1.5 Results

Results, which are displayed in the second tab in the Project Viewer, refer to the data generated by the analysis process and stored in the HERS-ST's underlying database. Results include Tabular Outputs, Section Conditions, System Conditions and Improvement Cost by Functional Class.

11.1.6 Reports

Reports, which are displayed in the third tab in the Project Viewer, refer to the user-defined charts, maps, tables and ad-hoc reports created based on the data stored in the underlying database.

11.1.7 Control Model

A control model is a grouping used under the Project level within the GUI to pair one each of the Runspec.dat and PPSpec.dat files. This group contains all of the information to control the execution of the HERS-ST Preprocessor and analysis engines.

11.1.8 Parameter Model

A parameter model is a grouping used under the Project level within the GUI to relate one each of the Params.dat, ImprCost.dat and DLTbls.dat files. This group contains all of the parametric data, costs, factors and data values used by the HERS-ST analysis engine.

11.2 ITEM HIERARCHIES

The HERS-ST GUI stores and organizes information at varying levels depending on the type of information being referenced. The following four sections define how all the information, both objects or settings, within the application are organized. Figure 11-1 shows the hierarchy of HERS-ST objects.

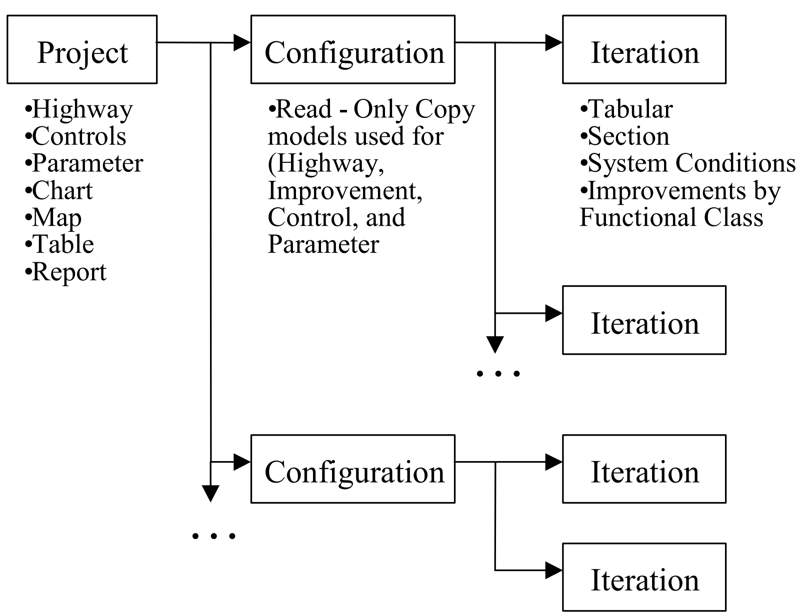


Figure 11.2-1 Hierarchy of HERS-ST Objects

11.2.1 Global Items (not shown in Figure 11.2-1)

- All of the items found in the Options window, including:
  - General Options
  - Environmental Directories
  - Support Applications
  - Highway Data and Section Condition Layouts
  - Highway Data Filter Queries
  - Highway Data Validation Rule enabled/disabled status
  - Post-Run Import Options
  - Home State
- Built-in Ad-Hoc Report Queries and Templates
- Built-In Single and Multi-Run Charts

11.2.2 Project Level Items

- Highway Model(s)
- State Improvement Model(s)
- Control Model(s)
- Parameter Model(s)
- Configuration(s)
- Charts(s)
- Map(s)
- Tables(s)
- Reports(s)

11.2.3 Configuration Level Items

- Settings (which includes Highway, State Improvement, Control and Parameter Models)
- Iteration(s)

11.2.4 Iteration Level Items

- Tabular Output
- Section Conditions
- System Conditions (SS1)
- Improvement Cost By Functional Class (SS2)

11.3 IMPLEMENTATION OF HERS-ST

As was noted previously, the HERS-ST GUI was developed using ActiveX technology. The use of ActiveX technology in a Visual Basic environment translates into the creation of object classes, which are organized into 32-bit, ActiveX dynamic link libraries (.dlls) and visual control libraries (.ocxs). Typically, and as implemented in the design of the HERS-ST GUI, the dlls are used to define and store the classes used within the business layer and the .ocx files contain the classes and forms which define the visual, end-user, interface. The organization of these classes within the various libraries has been done on a functional basis. In addition to the these libraries, a single windows executable file (.exe) provides the framework for the application, controlling how, based on user interactions, each of the objects and controls within the application interact amongst themselves and with the underlying database.

11.3.1 Custom Objects and Controls

The following table lists the Visual BASIC components developed for HERS-ST with the corresponding objects or controls contained within each library. These items will all be installed in the application directory, which by default is “c:\Program Files\HERS-ST”.

Table 11.1 Class and Control Organization

Library Name	Included Classes or Controls	Type	Description
HERS.exe	N/A	Executable	Main HERS-ST Application. Also includes MDI, wizards, option and about windows.
bcoHERSProject.dll	bcoProject	Class	Implements properties and methods to define a Project
	bcoConfiguration	Class	Implements properties and methods to define a Configuration within a project
	bcoIteration	Class	Implements properties and methods to define a Iteration within a configuration
bcoHERSModels.dll	bcoControl	Class	Implements group object for a set of bcoRunSpec and bcoPPSpec
	bcoRunSpec	Class	Implements properties and methods for each RunSpec.dat
	bcoPPSpec	Class	Implements properties and methods for each PPSpec.dat
	bcoParameter	Class	Implements group object for a set of bcoParams, bcoDLTbls and bcoImprCost
	bcoParams	Class	Implements properties and methods for each Params.dat
	bcoDLTbls	Class	Implements properties and methods for each DLTbls.dat
	bcoImprCost	Class	Implements properties and methods for each ImprCost.dat
bcoHighway.dll	bcoHighwayDS	Class	Implements properties and methods for each Highway data file
	bcoStateDS	Class	Implements properties and methods for each State Exogenous Improvement file
	bcoValidation	Class	Contains the Row Validation rules for the Highway data file
bcoSecurity.dll	bcoLogon	Class	Establishes connection to database
bcoUtilities.dll	bcoUtility	Class	Collection of general, multi-use functions
	bcoAttributes	Collection	Collection object for the bcoAttribute class
	bcoAttribute	Class	Single, variant type of object variable
	bcoIndices	Collection	Collection object for the bcoIndex class
	bcoIndex	Class	Array of variant type object variables
	bcoMatrices	Collection	Collection object for the bcoMatrix class
	bcoMatrix	Class	Multi-dimensional array of variant type object variables
bcoHERSOutput.dll	bcoSS1	Class	Implements properties and methods for each System Conditions (.SS1) file
	bcoSS2	Class	Implements properties and methods for each Functional Class by Improvement Type (SS2) file
	bcoTabularOutput	Class	Implements properties and methods for each Tabular Output file
	bcoImprovements	Class	Implements properties and methods for each Section Conditions file
	bcoFundingPeriod	Collection	Collection object for bcoImprovements
bcoHERSReports.dll	bcoReport	Control	Implements properties and methods for each user-defined ad-hoc report
	bcoChart	Control	Implements properties and methods for each user-defined chart
	bcoTable	Control	Implements properties and methods for each user-defined table (query)
	bcoGIS	Control	Implements properties and methods for each user-defined map

Library Name	Included Classes or Controls	Type	Description
bcoCommon.ocx	bcoPage	Control	Multi-page window
	bcoQuery	Control	Query Designer
bcoHighwayViews.ocx	bcoHighwayDSView	Control	Visual interface implementing functionality of bcoHighwayDS class
	bcoStateDSView	Control	Visual interface implementing functionality of bcoHighwayDS class
bcoModelViews.ocx	bcoPPSpecView	Control	Visual interface implementing functionality of bcoPPSpec class
	bcoRunSpecView	Control	Visual interface implementing functionality of bcoRunSpec class
	bcoImprCostView	Control	Visual interface implementing functionality of bcoImprCost class
	bcoParamsView	Control	Visual interface implementing functionality of bcoParams class
	bcoDLTblsView	Control	Visual interface implementing functionality of bcoDLTbls class
bcoOutputViews.ocx	bcoImprovementView	Control	Visual interface implementing functionality of bcoImprovements class
	bcoTabOutView	Control	Visual interface implementing functionality of bcoTabOut class
bcoReportViews.ocx	bcoChartView	Control	Visual interface implementing functionality of bcoChart class
	bcoGISMap	Control	Visual interface implementing functionality of bcoGIS class
	bcoReportDesigner	Control	Visual interface implementing functionality of bcoReport class
	bcoTableView	Control	Visual interface implementing functionality of bcoTable class
bcoGISctl	clsLayer	Class	Provides shape file (.shp) viewing capability

In addition to the above table, a complete set of object diagrams, which show the relationship between objects as well as list the properties, methods and events of these objects is provided in Appendix F.

11.3.2 Third-Party Controls and Components

In addition to the components developed explicitly for HERS-ST functionality, several third-party components were also implemented in this design in order to satisfy/enhance desired functionality, reduce development costs and increase software reliability. All of these third-party components and controls are royalty-free and do not require any special licensing for distribution of the HERS-ST 2.0 product. Appendix G lists the third-party components in use with the HERS-ST GUI. All of these components are installed in the System32 directory of the Windows Operating system. Typically, this is "c:\windows\system32".

In addition to these discrete files, both Microsoft's Data Access Components (MDAC), version 2.6 and Microsoft Jet 4.0, SP5 are utilized by the application. These items are installed via their own installation routines, therefore, details are not provided within this document.

11.3.3 Windows Registry Entries

Several settings, included all of the data configured in the Options windows, and window size and position are stored within the Windows Registry. Both the **HKEY_Local_Machine** and **HKEY_Current_User** branches are utilized, depending on the specific data. Under each of these keys, the HERS-ST GUI settings are found in the following path:

..\SOFTWARE\Battelle\HERS\2.0

11.3.4 Database Schema

All of the data used by the HERS-ST application is stored in an underlying database. This database was developed using Microsoft Access 2000. The following table lists each of the tables with a description of how the table is used within the framework of the application. A complete data dictionary, defining all of the columns, with notations for primary and foreign keys, data types and a brief description can be found in Appendix H. A graphical representation of the database schema is located in Appendix I.

Table 11.2 Database Tables

Table Name	Description
tdConfigurationItems	Stores a reference, including an object class and id, for each item type which is stored as part of a single configuration of HERS. This includes a read-only version of the Input Models. This table is accessed by the bcoConfiguration object. It is a child of table tdConfigurations.
TdConfigurations	Creates and stores, on a Project basis, a unique ID and related information for each saved run of the HERS-ST analysis process. This table is accessed by the bcoConfiguration object and is a child of table tdProjects.
TdControlModels	Creates and stores, on a Project basis, a unique ID and related attributes for each Control Model, which includes one each of RunSpec.dat and PPSpec.dat. This table is accessed by the bcoControl object.
TdControlObjects	Stores the attributes for each Control File. This table is accessed by the bcoRunSpec and bcoPPSpec objects and is a child of table tdControlModels.
tdFuncClassByImp	Creates and store, on a Iteration basis, a unique ID and other attributes for each Functional Class by Improvement Type (SS2) file saved to the database. This table is accessed by the bcoSS2 object.
tdFuncClassByImpDets	Stores the detailed information for each SS2 file. This table is accessed by the bcoSS2 object and is a child of table tdFuncClassByImp.
TdGIStemp	System table used by the Map feature to display information regarding the analyzed and displayed highway sections. This table is accessed by the GISctl.
TdHighways	Stores, on a Project basis, the identification and data associated with a Highway Data model. This table is accessed by the bcoHighwayDS object.
tdHighwaySections00	System table used by the Highway Data Model to display the detailed section information for each currently loaded highway models. This table is accessed by the bcoHighwayDS object and is related to, but not a direct child, of table tdHighways.
TdIterationItems	Stores a reference, including an object class and id, for each item type which is stored as part of each run within a saved configuration of HERS. This includes a all of the HERS-ST outputs, including Systems Conditions (.SS1), Functional Class by Improvement Type (SS2), Section Conditions and the Tabular Output. This table is accessed by the bcoIteration object. It is a child of table tdIterations.
TdIterations	Creates and stores, on a Configuration basis, a unique ID and related information for each saved incremental run of the HERS-ST analysis process. This table is accessed by the bcoIteration object and is a child of table tdConfigurations.
TdParamModels	Creates and stores, on a Project basis, a unique ID and related attributes for each Parameter Model, which includes one each of Params.dat, ImprCost.dat and DLTbls.dat. This table is accessed by the bcoParameter object.
tdParamObjects	Stores the attributes for each Parameter File. This table is accessed by the bcoParams, bcoImprCost and bcoDLTbls objects and is a child of table tdParamModels.
tdProjectItems	Stores a reference, which includes an object class and related ID for each of the items which are directly associated with a Project. This includes the Highway, State, Control and Parameter Models as well as all of the user-defined reports. This table is accessed by the bcoProject, bcoTable, bcoReport, bcoMap and bcoChart objects and is a child of table tdProjects.
tdProjects	This table can be considered the top-level table in the HERS-ST structure. It is referenced by the bcoProject object. Each project creates a unique ProjectID, which is referenced by all subordinate objects
tdReports	Stores, on a Project basis, the attributes associated with the charts, tables, reports and maps created by the user from the analysis data. This table is accessed by the bcoTable, bcoReport, bcoMap and bcoChart objects.

Table Name	Description
tdSectionCondDet	Stores the detailed information for each Section Conditions file saved. This table is accessed by the bcoImprovements and bcoFundingPeriods objects and is child of table tdSectionConditions.
tdSectionConditions	Creates and store, on a Iteration basis, a unique ID and other attributes for each Section Condition file saved to the database. This table is accessed by the bcoImprovements and bcoFundingPeriods objects.
tdStateFields	Stores, on a Project basis, the identification and data associated with a State Improvement Data model. This table is accessed by the bcoStateDS object.
tdStateSections00	System table used by the State Improvement Data Model to display the detailed information for each exogenous improvement on a per section basis. This table is accessed by the bcoStateDS object and is related to, but not a direct child, of table tdStateFields.
tdSysCondDets	Stores the detailed information for each SS1 file. This table is accessed by the bcoSS1 object and is a child of table tdSysConditions.
tdSysConditions	Creates and stores, on a Iteration basis, a unique ID and other attributes for each System Conditions (SS1) file saved to the database. This table is accessed by the bcoSS1 object.
tdTabularData	Creates and stores, on a Iteration basis, a unique ID and other attributes for each Tabular Output file saved to the database. This table is accessed by the bcoTabOut object.
TlLayouts	Stores the column order, column visible status and column sort order for the grid displays used in the Highway Data view and the Section Conditions view. Each layout must have a unique name per the applicable view type. This setting is a global.
TlQueries	Stores the text of each saved Highway Data filter.

11.4 HIGHWAY DATA VALIDATION RULES

HERS-ST requires as an input, highway data in the format of Highway Performance Monitoring System (HPMS) data, with two additional columns. During the import process, and also when specifically requested by the user, validation of each record can be invoked. This validation is in addition to the cell validation invoked when entering or editing data directly in a cell within the Highway Data View window within the GUI. Typically, these validations are dependent on other data in multiple columns within the section record. Appendix J provides a full list of the validation rules implemented within the software. These rules are based on those used in the HPMS Submittal Software as documented in FHWA ORDER M 5600.1B, November 6, 1996, but have been revised to accommodate the HERS-ST's need to validate more than just the HPMS sample section data and to match the 2000 HPMS format.

APPENDIX A - Input Data

A.1 Preparing the Highway Data File

The HERS-ST Preprocessor is used to prepare the highway data for HERS-ST. The Preprocessor reads the highway data file, performs a number of preliminary computations, and produces a binary file with descriptions of the current state of the highway system. This HERS-ST data file is used by the main HERS-ST program as the starting point for all analyses. At the end of each funding period HERS-ST produces one or more modified versions of this file that describe the simulated state of the highway system at the end of the funding period.

The highway data file used by the HERS-ST Preprocessor contains base-year descriptions of sample highway sections to be analyzed by HERS-ST. The Preprocessor accepts data in the format specified in the 2000 HPMS *Field Manual.*[8] The *Field Manual* provides much additional information beyond what is summarized here.

Table A-1 Universe Data Summary
(Taken from the HPMS Field Manual)

Item No.	Required Universe Items								Data Item	Data Type
	Rural				Urban					
	PAS/ NHS	MA	MaC	MiC & Loc	PAS/ NHS	MA	Col	Loc		
Identification										
1	A	A	A	A	A	A	A	A	Year of Data	Numeric; Integer
2	A	A	A	A	A	A	A	A	State Code	Numeric; Codes
3	A	A	A	A	A	A	A	A	Reporting Units- Metric or English	Numeric; Codes
4	A	A	A	A	A	A	A	A	County Code	Numeric; Codes
5	A	A	A	A	A	A	A	A	Section Identification	Character Field
6									Is Standard Sample	Numeric; Codes
7									Is Donut Sample	Numeric; Codes
8									State Control Field	Character Field
9	A	A	A	A	A	A	A	A	Is Section Grouped?	Numeric; Codes
10	A	A			A				LRS Identification*	Character Field
11	A	A			A				LRS Beginning Point*	Numeric; Decimal
12	A	A			A				LRS Ending Point*	Numeric; Decimal
13	A	A	A	A	A	A	A	A	Rural/Urban Designation	Numeric; Codes
14	A	A	A	A	A	A	A	A	Urbanized Area Sampling Technique	Numeric; Integer
15	A	A	A	A	A	A	A	A	Urbanized Area Code	Numeric; Codes
16	A	A	A	A	A	A	A	A	NAAQS Nonattainment Area Code	Numeric; Codes
System										
17	A	A	A	A	A	A	A	A	Functional System Code	Numeric; Codes
18	A	A	A	A	A	A	A	A	Generated Functional System Code	Software Calculated
19	A	A	A	A	A	A	A	A	National Highway System (NHS)	Numeric; Codes
20	A				A				Planned Unbuilt Facility	Numeric; Codes
21	A				A				Official Interstate Route Number	Character Field
22	A	A			A				Route Signing*	Numeric; Codes
23	A	A			A				Route Signing Qualifier*	Numeric; Codes
24	A	A			A				Signed Route Number*	Character Field
Jurisdiction										
25	A	A	A	A	A	A	A	A	Governmental Ownership	Numeric; Codes
26	A	A	A	A	A	A	A	A	Special Systems	Numeric; Codes
Operation										
27	A	A	A	A	A	A	A	A	Type of Facility	Numeric; Codes
28	A	A	A	A	A	A	A	A	Designated Truck Route	Numeric; Codes

[8] U.S. Department of Transportation, Federal Highway Administration, Highway Performance Monitoring System, *Field Manual*, Washington, D.C., December 2000.

Item No.	Required Universe Items								Data Item	Data Type
	Rural				Urban					
	PAS/ NHS	MA	MaC	MiC & Loc	PAS/ NHS	MA	Col	Loc		
29	A	A	A	A	A	A	A	A	Toll	Numeric; Codes
Other										
30	A	A	A	A	A	A	A	A	Section Length	Numeric; Decimal
31		A	A			A	A		Donut Area Sample AADT Volume Group Identifier[9]	Numeric; Integer
32	A	A	A		A	A	A		Standard Sample AADT Volume Group Identifier	Numeric; Integer
33	A	S&D	S&D		A	S&D	S&D		AADT*	Numeric; Integer
34	A	A	A		A	A	A		Number of Through Lanes	Numeric; Integer
35	A	S			A				Measured Pavement Roughness (IRI)*	Numeric; Decimal
36			S			S	S		Present Serviceability Rating (PSR)	Numeric; Decimal
37	A	A	A	A	A	A	A	A	High Occupancy Vehicle (HOV) Operations	Numeric; Codes
38	A	A	A	A	A	A	A	A	Electronic Surveillance	Numeric; Codes
39	A	A	A	A	A	A	A	A	Metered Ramps	Numeric; Codes
40	A	A	A	A	A	A	A	A	Variable Message Signs	Numeric; Codes
41	A	A	A	A	A	A	A	A	Highway Advisory Radio	Numeric; Codes
42	A	A	A	A	A	A	A	A	Surveillance Cameras	Numeric; Codes
43	A	A	A	A	A	A	A	A	Incident Detection	Numeric; Codes
44	A	A	A	A	A	A	A	A	Free Cell Phone	Numeric; Codes
45	A	A	A	A	A	A	A	A	On-Call Service Patrol	Numeric; Codes
46	A	A	A	A	A	A	A	A	In-Vehicle Signing	Numeric; Codes
End of universe data items.										

Key: A = Code for "All" universe, standard sample, and supplementary donut area sample sections.
S = Code for all "Standard" sample sections.
D = Code for all "Donut" area supplementary sample sections.
* = See individual data item for exceptions.

[9] The "A" in the summary table cells for the Donut Area Volume Group (Item 31) is meant to indicate that all data records (universe only and sample) for the noted functional systems <u>in a donut area</u> are to include these data.

Table A-2 Sample Data Summary
(Taken from the HPMS Field Manual)

Item No.	Required Sample Items									Data Item	Data Type
	Rural				Urban						
	Int	OPA	MA	MAC	Int	OFE	OPA	MA	Col		
Identification											
47	S	S	S&D	S&D	S	S	S	S&D	S&D	Sample Identifier	Character Field
Computational											
48			D	D				D	D	Donut Area Sample Expansion Factor	Software Calculated
49	S	S	S	S	S	S	S	S	S	Standard Sample Expansion Factor	Software Calculated
Pavement											
50	S	S	S	S	S	S	S	S	S	Surface/Pavement Type	Numeric; Codes
51	S	S	S	S	S	S	S	S	S	SN or D	Numeric; Decimal
52	S	S	S	S	S	S	S	S	S	General Climate Zone	Software Set
53	S	S	S	S	S	S	S	S	S	Year of Surface Improvement	Numeric; Integer
Geometrics											
54	S	S	S	S	S	S	S	S	S	Lane Width	Numeric; Decimal
55	S	S	S	S	S	S	S	S	S	Access Control	Numeric; Codes
56	S	S	S	S	S	S	S	S	S	Median Type	Numeric; Codes
57	S	S	S	S	S	S	S	S	S	Median Width	Numeric; Decimal
58	S	S	S	S	S	S	S	S	S	Shoulder Type	Numeric; Codes
59	S	S	S	S	S	S	S	S	S	Shoulder Width -Right	Numeric; Decimal
60	S	S	S	S	S	S	S	S	S	Shoulder Width - Left	Numeric; Decimal
61					S	S	S	S	S	Peak Parking	Numeric; Codes
62	S	S	S	S	S	S	S	S	S	Widening Feasibility	Numeric; Codes
63	S	S	S		S	S	S			Length Class A Curves	Numeric; Decimal
64	S	S	S		S	S	S			Length Class B Curves	Numeric; Decimal
65	S	S	S		S	S	S			Length Class C Curves	Numeric; Decimal
66	S	S	S		S	S	S			Length Class D Curves	Numeric; Decimal
67	S	S	S		S	S	S			Length Class E Curves	Numeric; Decimal
68	S	S	S		S	S	S			Length Class F Curves	Numeric; Decimal
69				S						Horizontal Alignment Adequacy*	Software Calculated
70	S	S	S	S						Type of Terrain	Numeric; Codes
71				S						Vertical Alignment Adequacy*	Software Calculated
72	S	S	S		S	S	S			Length Class A Grades	Numeric; Decimal
73	S	S	S		S	S	S			Length Class B Grades	Numeric; Decimal
74	S	S	S		S	S	S			Length Class C Grades	Numeric; Decimal
75	S	S	S		S	S	S			Length Class D Grades	Numeric; Decimal
76	S	S	S		S	S	S			Length Class E Grades	Numeric; Decimal
77	S	S	S		S	S	S			Length Class F Grades	Numeric; Decimal
78	S	S	S	S						Percent Passing Sight Distance*	Numeric; Integer
Traffic/Capacity											
79										Weighted Design Speed	Software Calculated
80	S	S	S	S	S	S	S	S	S	Speed Limit	Numeric; Integer
81	S	S	S	S	S	S	S	S	S	Percent Single Unit Trucks - Peak	Numeric; Integer

Item No.	Required Sample Items									Data Item	Data Type
	Rural				Urban						
	Int	OPA	MA	MAC	Int	OFE	OPA	MA	Col		
82	S	S	S	S	S	S	S	S	S	Percent Single Unit Trucks - Average Daily	Numeric; Integer
83	S	S	S	S	S	S	S	S	S	Percent Combination Trucks - Peak	Numeric; Integer
84	S	S	S	S	S	S	S	S	S	Percent Combination Trucks - Average Daily	Numeric; Integer
85	S	S	S	S	S	S	S	S	S	K-Factor	Numeric; Integer
86	S	S	S	S	S	S	S	S	S	Directional Factor	Numeric; Integer
87	S	S	S	S	S	S	S	S	S	Number of Peak Lanes	Numeric; Integer
88					S	S	S	S	S	Left Turning Lanes	Numeric; Codes
89					S	S	S	S	S	Right Turning Lanes	Numeric; Codes
90					S	S	S	S	S	Prevailing Type of Signalization	Numeric; Codes
91					S	S	S	S	S	Typical Peak Percent Green Time*	Numeric; Integer
92	S	S	S	S	S	S	S	S	S	Number At-Grade Intersections - Signals	Numeric; Integer
93	S	S	S	S	S	S	S	S	S	Number At-Grade Intersections - Stop Sign	Numeric; Integer
94	S	S	S	S	S	S	S	S	S	Number At-Grade Intersections - Other/No Control	Numeric; Integer
95	S	S	S	S	S	S	S	S	S	Peak Capacity	Software Calculated
96	S	S	S	S	S	S	S	S	S	Volume/Service Flow Ratio (V/SF)	Software Calculated
97	S	S	S	S	S	S	S	S	S	Future AADT	Numeric; Integer
98	S	S	S	S	S	S	S	S	S	Year of Future AADT	Numeric; Integer
End of sample data items.											

Key: A = Code for "All" universe, standard sample, and supplementary donut area sample sections.
S = Code for all "Standard" sample sections.
D = Code for all "Donut" area supplementary sample sections.
* = See individual data item for exceptions.

Please refer to the 2000 HPMS *Field Manual* for the general coding instructions.

Table A-3 HPMS Data Items Used by HERS-ST

Item No.	Variable Name	Description
1	YR	Year
2	STATE	State code
3	UNITS	Reporting units (English or metric)
5	SECTIONID	Section identification
6	CNTY	County code
8	SCF [1]	State control field
10	LRSID [1]	LRS identification
11	BEGMP [1]	LRS beginning point
12	ENDMP [1]	LRS ending point
13	RURURB	Rural/Urban designation
17	FC	Functional system
18	GFC	Generated functional system code
20	UNBLT [2]	Unbuilt facility code
27	FT	Type of facility (one way or two way)
30	SLEN	Section length
33	AADT	Annual average daily traffic
34	LANES	Number of through lanes
35	IRICOD [3]	International Roughness Index
36	PSR [3]	Pavement condition
37	HOV	HOV operations

Item No.	Variable Name	Description
47	SECNUM	HPMS sample identifier or other section identifier
49	EXPFAC	Expansion factor for standard HPMS sample
50	SURF	Surface type
51	SNORD	SN or D
52	CLIMATE	Climate zone
53	IMPYR	Year of surface improvement
54	LANEW	Lane width
55	ACCESS	Access control
56	MEDT	Median type
57	MEDW	Median width
58	SHLDT	Shoulder type
59	RSHLDW	Right shoulder width
60	LSHLDW	Left shoulder width
61	PKPARK	Peak parking
62	WDFEAS	Widening feasibility
63-68	LCURVE(I)	Curves by class
69	HORALN	Horizontal alignment adequacy
70	TERRN	Type of terrain
71	VERALN	Vertical alignment adequacy
72-77	LGRADE(I)	Grades by class
78	PSD	Percent passing-sight distance
79	WDS [4]	Weighted design speed
80	SPDLIM	Posted speed limit
81	PCPKSU	Percent peak single-unit commercial vehicles
82	PCAVSU	Percent average daily single-unit commercial vehicles
83	PCPKCM	Percent peak combination commercial vehicles
84	PCAVCM	Percent average daily combination commercial vehicles
85	KFAC	K factor
86	DFAC	Directional factor
87	PLANES	Number of peak lanes in peak direction
88	LTURN	Turning lanes – left
89	RTURN	Turning lanes – right
91	PCTGRN	Percent green time
92	NSIG	Number of intersections with traffic signals
93	NSTOP	Number of intersections with stop signs on sample section
94	NOINTS	Number of other intersections
95	CAPAC [4]	Peak capacity (peak direction)
97	FAADT	AADT in future year (FYEAR)
98	FADTYR	Future year for AADT forecast

1 Variable copied to output files but not otherwise used by HERS-ST.
2 Not used by HERS-ST 2.0.
3 HERS-ST requires either IRI or PSR. If both are provided, the PSR/IRI indicator identifies the value to be used.
4 Optional inputs - will be calculated by HERS-ST if not coded.

A.2 USER-SPECIFIED IMPROVEMENTS

For the first improvement, a particular type of improvement is specified for a particular FP by setting the year (Field 4) to any year in that FP and identifying the improvement type in Field 5. For HERS-type improvements, the improvement type is specified using the codes in Table A-5. [10] Other types of improvements (such as intersection modification or grade separation) should be assigned codes that are divisible by 20 when they are not combined with pavement, widening, or alignment improvements. The combination of a non-HERS-type improvement with pavement, widening, and/or alignment improvements should be assigned a code that is the sum of a code that is divisible by 20 and the appropriate code from Table A-5. [11] Improvements that are not HERS-type or are combinations of HERS-type and non-HERS-type are called *special improvements* by HERS-ST.

Table A-4 Format of State Improvements

Field	Format
1. Number of improvements	Integer
2. County Code	Integer
3. Sample Identifier	Alphanumeric
4. Year of First Improvement (four digits)	Integer
5. Type of improvement	Integer
6. Override Flag	Integer
7. Cost of Improvement	Floating Point
8. Lanes Added	Integer
9. Increase in Capacity	Integer

Fields 4 – 9 continue for up to a total of 10 improvements.

Table A-5 Codes for "HERS-Type" Improvements

IMPRCOST Code		Improvement Code: Without Alignment Improvement	Improvement Code: With Alignment Improvement
Rs	Resurface	1	11
RsSh	Resurface and improve shoulders	2	12
MinW	Resurface and widen lanes (minor widening)	3	13
MWNC	Resurface and add normal-cost lanes (major widening)	4	14
MWHC	Resurface and add high-cost lanes	5	15
RC	Pavement reconstruction	6	16
RCWL	Pavement reconstruction with wider lanes	7	17
RCNC	Pavement reconstruction and add normal-cost lanes	8	18
RCHC	Pavement reconstruction and add high-cost lanes	9	19

If the first improvement involves adding lanes, the number of lanes to be added is specified in Field 8. An entry in this field is required for improvement types that end in 4, 5, 8, or 9; and this field only has an effect for improvement types that end in 4, 5, 6, or 9 (i.e., the lanes specified in Field 8 are added only if an "add lanes" improvement is specified). On two-way roads, HERS-ST 2.0 normally assumes that, after the addition of lanes, the number of travel lanes will be even, and the current

[10] For unpaved sections, all improvements should entail pavement reconstruction. User-specified improvements that do not entail pavement reconstruction are treated as entailing reconstruction and a warning message is printed.
[11] For example, the user might use an improvement type of 20 (or 40) to represent construction of an overpass. The construction of an overpass combined with resurfacing the entire section would then be represented by Type 21 (or 41).

system does not have procedures for estimating capacity if the number of travel lanes will be odd. Accordingly, if the resulting number of lanes will be odd, the increase in capacity must be specified by the user in the last of the fields describing the improvement (Field 9 for the first improvement). Other-wise, a message is printed and the number of added lanes is adjusted appropriately. (If an odd number of added lanes is specified, the number is increased by one; otherwise, the number of added lanes is reduced by one.) If lanes are to be added but the lanes-added field is zero, HERS-ST adds either one lane (on one-way facilities) or the minimum number of additional lanes that will produce an even number of lanes (on two-way facilities), and a message to this effect is printed.

The initial costs of a user-specified improvement may be provided (in thousands of dollars), and the change in peak-hour capacity may be provided (in passenger-car equivalents per hour). For the first user-specified improvement, Fields 7 and 9 are used. For rural two- and three-lane roads, capacity changes should be specified as changes in two-way capacity; for all other roads they should be specified as changes in peak-period, peak-direction capacity. For HERS-type improvements, if these fields are blank or zero-filled, the HERS-ST estimates of improvement costs and/or new capacity will be used. For all special improvements, these fields must contain non-zero values.

The override flag (Field 6 for the first user-specified improvement) is used to indicate whether HERS-ST has any leeway in modifying a user-specified improvement. For HERS-type improvements (Types < 20) and pure non-HERS-type improvements (Types divisible by 20), this flag may be set to either zero or one. For improvements that are combinations of HERS-type and non-HERS-type improvements (Type greater than 20 and not divisible by 20), this flag must be set to one.

If the override flag is set to one, the improvement is selected just as described in the set of six fields. If it is set to zero, these fields describe the *minimum* improvement that will be selected. In this case, HERS-ST may identify a "more aggressive" improvement that warrants evaluation; i.e., an improvement that incorporates more widening than requested and/or also improves the section's alignment. If any more aggressive improvements are identified, the incremental benefits and costs of these improvements are estimated and used for determining whether any of the additional options should be implemented.

In addition to controlling whether HERS-ST can modify a user-specified improvement, the override flag controls the insertion by HERS-ST of improvements prior to the implementation of a user-specified improvement. If the override flag for the next user-specified improvement is one, HERS-ST does not consider any improvements until after the corresponding FP. On the other hand, if it is zero, HERS-ST considers the possibility that a pavement or widening improvement may be warranted in an earlier FP and, if so, an appropriate improvement is selected for the earlier period. In this case, if the user-specified improvement is of Type 1, 2, or 6 (i.e., the kind of improvement that can be analyzed by a Pavement Management System), the two improvements are combined and assigned to the earlier FP (but only if the user-specified improvement would otherwise be implemented prior to the end of the last FP to be analyzed during the run). When two improvements are combined in this way, any subsequent user-specified improvements with override flags of zero are advanced appropriately. If the user-specified improvement is not of Type 1, 2, or 6, its timing is not adjusted, but HERS-ST prints a message to alert the user to the possibility that the number of improvements selected for the section may be more than are warranted.

As implied in the preceding paragraph, the override flag can be used to prevent HERS-ST from selecting improvements for a section in one or more FPs. For this purpose, a set of six user-specified improvement fields is used with an appropriate year in the year field, an improvement code of zero, and an override flag of one. If these fields represent the first user-specified "improvement" to be implemented (i.e., if they are Fields 4-9), no improvements will be considered by HERS-ST until *after* the FP corresponding to the coded year.

If there are one or more earlier user-specified improvements coded, the period when no improvements are considered starts after the last of the user-specified improvements. For example, if the first user-specified improvement is requested for FP 1, the second set of improvement fields can be used in this way to specify that no subsequent improvements be considered until FP 4 (by setting the year in the second set of improvement fields to a year that falls in FP 3). Similarly, if the *first* set of improvement fields contains an improvement code of zero, an override flag of one, and the same year (in FP 3) in the year field, *no* improvement will be considered until FP 4.

In each FP, HERS-ST automatically selects all user-specified improvements for implementation regardless of their benefit/cost ratios (BCR). If a funding constraint is in effect, the cost of these improvements is subtracted from the budget for the FP before any consideration is given to selecting other improvements or choosing to go beyond the user-specified minimum improvement for any section for which such an improvement is specified. If the cost of implementing all user-specified improvements exceeds the funding constraint for the FP, a message is printed and the funding constraint for the next FP is reduced accordingly. Similarly, if a performance goal is in effect, the benefits of user-specified improvements are taken into account before considering any improvements or improvement options that are not user specified.

A.2.1 Benefits and Costs

This section provides details of how HERS-ST estimates the user benefits and improvement costs of user-specified improvements and also the corresponding incremental benefits and incremental costs of replacing a user-specified improvement by a more aggressive improvement.

Improvement Costs

If the cost of any user-specified improvement is provided, HERS-ST uses that cost as the cost of the improvement. Otherwise, if the improvement is a HERS-type improvement, the cost is estimated using the HERS-ST procedure for estimating improvement costs. If no cost is provided for a special improvement, HERS-ST prints a warning message and sets the improvement cost to a default value.[12]

When evaluating the possibility of replacing a HERS-type user-specified improvement (e.g., resurfacing, as identified by a State's Pavement Management System) by a more aggressive improvement (e.g., resurface and add lanes), HERS-ST estimates the *incremental* cost of replacing the former improvement by the latter one. This incremental cost is estimated as the difference between estimates of the costs of the two improvements that are *both* obtained using HERS' procedure for estimating improvement costs (regardless of whether the user has provided an exogenous cost estimate for the user-specified improvement).

Consider the possibility of replacing a non-HERS-type user-specified improvement (Type divisible by 20) by a combination of that improvement and a HERS-type of improvement. The cost of the combined improvement is estimated by using the HERS-ST procedure for estimating improvement costs to estimate the cost of the HERS-type of improvement, and adding this cost to the cost of the original user-specified improvement. Thus, the resulting estimate of the incremental cost of adding the HERS-type improvement ignores any efficiencies obtained by implementing both improvements simultaneously; and so there may be a tendency to overestimate the incremental cost. If the first improvement applies only to an intersection or interchange and the second applies to an entire section, this effect is likely to be fairly small[13] and so may be ignored. However, if both improvements apply to the entire section, the effect may be more significant. For this reason, HERS-ST will tend to overestimate the incremental cost of adding a HERS-type improvement to a user-specified improvement that affects an entire section. Also for this reason, HERS-ST requires that the override flag be set to one for user-specified improvements that combine HERS-type and non-HERS-type improvements.

[12] When the special improvement combines a non-HERS-type improvement with a HERS-type improvement, the default cost is the cost of the HERS-type improvement. Otherwise, it is one dollar per section.

[13] One potential efficiency is a reduction in the disruptive effects of highway construction. However, because the costs of such disruption are not currently estimated by either HERS-ST or HERS-ST, there is no need to adjust for the reduction in disruption.

User Benefits

HERS-ST estimates the user benefits of an improvement as the net reduction in user costs resulting from changes in the physical characteristics of the improved section (including increases in the number of lanes) and from the resulting increases in capacity and average speed.

In the case of user-specified improvements, any increase in the number of lanes *must* be specified by the user and any increase in capacity *may* be specified. The user benefits of a non-HERS-type improvement (Type divisible by 20) are estimated entirely from these two increases. For such improvements, if both fields are zero, estimated benefits will be zero. (However, if only the second field is zero, increased capacity will be estimated from the increase in the number of lanes.)

User-specified improvements that either are purely HERS-type (Type < 20) or are a combination of HERS-type and non-HERS-type (Type not divisible by 20), may produce other changes in the physical characteristics of the section. These are simulated by HERS-ST, and thus they provide another potential source of information for estimating user benefits. For these sections, the estimates of user benefits reflect any non-capacity effects of these changes plus either the user-coded change in capacity or, if the capacity change is not coded, the HERS-ST estimate of change in capacity.

When evaluating the possibility of replacing a user-specified improvement by a more aggressive improvement, HERS-ST estimates the *incremental* user benefits of the replacement by analyzing the effects of the replacement on the physical characteristics of the section and the resulting effects on user benefits. This process is straightforward when the user does *not* specify the capacity effects of the user-specified improvement, but it requires some clarification for the case in which the user does specify these effects. In the latter case, we distinguish several different estimates of capacity:

- Estimated capacity before implementation of the user-specified improvement;
- Estimated capacity after implementation of this improvement – obtained by adding the user-coded capacity effect of the improvement to (a);
- A separate estimate of capacity after implementation of the improvement that is produced by HERS-ST entirely from the physical characteristics of the section after improvement (ignoring the user-coded capacity effect); and
- HERS-ST's estimate of capacity after implementation of the more aggressive improvement (obtained entirely from the physical characteristics of the section without reference to the user-specified capacity effect of the original improvement).

The benefits of the replacement are then estimated by using (b) as estimated capacity without the replacement, and (b) + (d) - (c) as estimated capacity with the replacement.[14]

[14] A similar process is used to estimate the capacity effects of any improvement that is designated or considered for implementation in subsequent FPs.

APPENDIX B - Parameter Data

Table B-1 Params.DAT Elements

Element		Description
Attribute	FileID	File identification
	DsgnPeriod	Design period in years
	PDRMax	Maximum pavement deterioration rate
	VLife	Value of life in dollars
	FICRY	Year to which fatality/crash ratios and injury/crash ratios correspond
	APDFCR	Annual percentage decline in fatalities per crash
	APDICR	Annual percentage decline in injuries per crash
	APDCR	Annual percentage decline in crash rates
	RMLDD	Driveway density for rural multi-lane roads per mile
	RMLRHR	Roadside hazard rating for rural multi-lane roads
	RMLIMax	Maximum number of intersections per mile for rural multi-lane roads
	DDR2	Driveway density for rural 2-lane roads per mile
	IR2Max	Maximum number of intersections per mile on rural 2-lane roads
	RHRR2	Roadside hazard rating for rural 2-lane roads
	RHR3LI	Roadside hazard rating for 3-legged intersections
	PRTL	Probability that a 3-legged intersection has a right-turn lane
	AIAR2	Adjusted intersection angle for rural 2-lane roads
	DINCCR	Ratio of incident delay cost to the value of travel time
	TRISF	Travel rate index scale factor
	PPDSF	Peak period delay scale factor
	PCTSF	Percent congested travel scale factor
	PPVO	Peak period of vehicle occupancy for urbanized areas
	UAPYear	Latest year for which urbanized area population values are available
List	WFOvrd	Widening feasibility override by function class
	LnsMax	Maximum number of lanes by function class
	PavThk	New pavement thickness after reconstruction and resurfacing in inches
	TrkFac	Truck growth factor by function class
	APLVM	Aggregate Probabilistic Limiting Velocity Model
	PSRRec	Present Serviceability Rating (PSR) after reconstruction
	PSRInc	Increase in Present Serviceability Rating (PSR) after resurfacing
	PSRMax	Maximum Present Serviceability Rating (PSR) after resurfacing
	RngLim	Range limits of anticipated traffic loads in Equivalent Single Axle Loads
	SNCNew	Coefficients for calculating new Structural Number (SN)
	PDRAF	Pavement deterioration rate adjustment factor for pavement types
	PLMax	Maximum pavement life by section type in years
	InjCost	Cost per injury by function class in dollars
	PDCost	Property damage costs by function class in dollars
	FCR	Fatality to crash ratio by function class
	ICR	Injury to crash ratio by function class
	SPM	Signals per mile for urban multi-lane roads
	PDEVEL	Probability that rural road is in area of dense development
	CCGRR2	Crest Curve Grade Rate (CCGR) on rural 2-lane roads
	PCG	Parameter for Clearing and Grubbing (PCG) by terrain
	PEW	Parameter for Earth Work (PEW) by terrain
	CDP	Culvert and Drainage Parameters (CDP) by terrain
	STFCT	State cost factors by state
	BPM	Bottlenecks per mile
	IncFac	Incident rate factor to account for effects of policy on incident rates
	STAFac	Signal timing adjustment factor
	UAPop	Urbanized area population by year
Table	EAF	Efficiency adjustment factor for the operating cost components
	UPrice	Unit prices of the operating cost components in dollars
	FETax	Fuel excise tax indices by vehicle type per funding period
	PrIdx	Price indexes for costs in dollars relative to the reference year
	VTTCC	Value of travel time cost components in dollars

B.1 THE PARAMS.DAT FILE

B.1.1 Federal Widening Feasibility Override

HERS-ST uses WFOvrd to provide the analyst with the opportunity to override the section-specific widening feasibility codes. Normally, the amount of widening on a section is controlled by the section's widening feasibility code. If WFOvrd allows more widening than the section-specific code, then HERS-ST will consider widening improvements up to the WFOvrd limit. Although the section-specific code may be decremented following a widening improvement, WFOvrd, which applies to all sections in the sample, is never decremented.

When HERS-ST adds lanes due to WFOvrd overriding the section-specific code, the lanes are added as "high cost lanes." Depending upon the values in IMPRCOST, high cost lanes may have a different cost than "normal cost lanes" (see paragraph B.2.1, "Improvement Costs Without Alignment Modification," for information about the cost of high and normal cost lanes). High cost lanes are reported separately in the output statistics.

B.1.2 Maximum Number of Lanes

The first of the two entry lines contains entries for each of the four rural functional classes: entries for the five urban functional classes follow. The entry represents the maximum number of lanes (LnsMax) allowed on any section within the functional class, *not* the number of lanes which can be added to any section. The maximum entry is 99, the minimum entry is zero. HERS-ST will not remove lanes from any section reported as having more than the maximum. Also, HERS-ST always builds to an even number of lanes, so when the entry is an odd number, HERS-ST will only build to one less than the entry.

For some sections, these values may impose significant limits on needed increases in highway capacity. Setting these values to zero prevents HERS-ST from adding any additional lanes, and may be useful in estimating pavement improvement needs separately from capacity needs.

B.1.3 New Pavement Thickness

The PavThk entries are for new pavement thickness in inches. The entries on line 9 are used for the reconstruction of flexible pavements and the resurfacing of flexible pavements with flexible overlays. The entries on line 14 are used for the reconstruction of rigid pavements. (Flexible overlays on rigid pavements are treated separately.) The first value is used for sections with total Equivalent Single Axle Loads (ESALs) during the design period no greater than the first Range Limit (RNGLimRngLim(1)); the second value is used for sections with design period ESALs between RNGLimRngLim(1) and RINGLIM(2), etc. (The RNGLimRngLim values are entered on line 72 of this file.)

B.1.4 Truck Growth Factors

The truck growth factors (TrkFac) are entered by functional class; line 17 for the rural, and lines 18 and 19 for the urban (line 19 contains only urban collectors). This factor expresses the annual rate of growth (expressed as a ratio) in the percentage of vehicles that are "trucks" (i.e., have six or more tires) relative to total traffic on the section. Thus, if the initial percentage of all trucks on a section is five percent, after one year of truck growth at an annual rate of ten percent, the percentage of all trucks on the section would be five and a half percent (5.5%). This entry adjusts the ratio between truck and non-truck (automobile) vehicles, and is applied to each section's percentage of trucks. It is separate from each section's traffic growth rate. The "neutral" (and default) entry is 1.000; the entry for ten percent truck growth would be 1.100. Do not enter zero, as this will eliminate all trucks.

B.1.5 Efficiency Adjustment Factors

The data which underlie the HERS-ST equations for calculating operating costs date from 1980. The efficiency adjustment factors serve to index changes in the consumption rate of the operating cost components from 1980 to the data year.

The entries are arranged in five lines, one for each operating cost component, with seven entries on each line, one corresponding to each vehicle type. The five operating cost components are:

- Fuel;
- Oil;
- Tires;
- Maintenance and Repair; and
- Depreciation.

The seven vehicle types, listed by number, are:

1. Small automobiles;
2. Medium/Large automobiles;
3. Pickups and vans (4-tire trucks);
4. Six-tire trucks;
5. Three (or more) axle single unit trucks;
6. Three or four axle combination trucks; and
7. Five (or more) axle combination trucks.

The "neutral" entry is 1.0. In the version of PARAMS.DAT included in the distribution package, this value is used for the tire wear and maintenance and repair entries, as separate adjustments for these components were not needed during this time period. A higher value indicates increased efficiency in consumption of the cost component. For example, entering a value of two for fuel component for small automobiles implies that only half the fuel is consumed as was previously required.

B.1.6 Unit Prices for Operating Cost Components

This set of entries is arranged identically to the efficiency adjustment factors: by component and by vehicle type. A comment column indicates the units used in pricing each component: gallons for fuel, quarts for oil[15], tires by each, maintenance and repair by a thousand miles of travel, and depreciation by vehicle. The comment line also indicates the year for which the price is measured. With the exception of fuel prices, which are in 2000 dollars, the version of PARAMS.DAT included in the distribution package lists 1995 values for the component prices.

B.1.7 Price Indices for Costs

HERS-ST provides two approaches to updating costs to the data year: updating of the cost values to data year dollars, or indexing costs from the entry year using the Pridx indices. Whichever method is chosen, all costs should resolve to dollars of the data year. Several indices are applied to a range of values (such as all rural improvement costs); these values should all be of the same year dollars, as the index will be applied to them all. The "neutral" index value (used when the costs are entered in data year dollars) is 100.

For example, in the version of PARAMS.DAT included in the distribution package, which is constructed for the 1997 data year, the cost of fuel is listed in 1997 dollars: therefore, it's index value is 100. The other four operating cost components are listed in 1995 dollars; their indices have values which adjust each cost to 1997 dollars.

The primary sources for the price indices include the Consumer Price Indices (CPI) published by the U. S. Bureau of Labor Statistics (BLS); and the U. S. Department of Commerce, Bureau of Economic Analysis (BEA). The table lists the base year for each cost, which is the dollar year in which the data are entered.

[15] The cost for oil includes the cost of the labor to change it.

Two of the entries, Fuel and Value of Life, are entered in 1997 dollars, and therefore an index of 100 is used. Fuel prices for two-axle vehicles were derived by subtracting federal and state gasoline taxes[16] from the 1997 retail price of gasoline, and fuel prices for larger vehicles were derived by subtracting taxes on diesel fuel from the average 1997 retail price of highway diesel fuel.[17] The value of life entry was specified by the U. S. Department of Transportation.

The entry for urban alignment costs includes a factor converting the 1988 costs of alignment improvements (which were based upon rural costs) to urban costs.

If you enter cost values for a new dollar year in dollars of that year, set the appropriate indices to 100.

B.1.8 Variables for the APLVM Routine

These four entries (VR1, VR2, PSRB, and VRSLOP) are used by the "Aggregate Probabilistic Limiting
Velocity Model" (APLVM) in calculating a section's "free-flow" speed. Specifically, these entries define the limit imposed on speed due to the roughness of the pavement (VROUGH).

The default value (5.0) of VR1 sets the maximum speed on pavement with a PSR of zero at five miles per hour. The default value (20.0) of VR2 sets the maximum speed on pavement with a PSR equal to the value in PSRB (the default entry is 1.0) at twenty miles per hour. The entry VRSLOP indicates the slope at which speed increases as PSR increases above PSRB. The default value of VRSLOP is 32.5; a section with a PSR rating of 2.0 would thus have a VROUGH limit of 52.5 miles per hour (VR2+VRSLOP x (PSR-PSRB)).

B.1.9 Variables for the PAVIMP Routine

The first three entries used by the pavement improvement routine (PAVIMP) are used in determining a section's PSR after improvement. They are structured the same way: the first line is for rural sections, the second for urban, with four columns of entries on each line. The columns are arranged by surface type. From left to right, these are: high flexible; high rigid; intermediate; and low.

The PSRRec entries are used to assign PSR values to sections which have undergone pavement reconstruction. For sections receiving a resurfacing improvement, the appropriate value from PSRInc is added to the section's PSR at the time of improvement. The resultant PSR is limited by the corresponding value in PSRMax.

For pavements being reconstructed, HERS-ST assumes that pavement thickness is a function of pavement material (determined by surface type) and traffic load during the design period. The range limit entries in RNGLimRngLim establish six levels of anticipated traffic load during the design period, which correspond to the PavThk entries on lines nine and fourteen. Using the default values as an example, a rigid section with 49,000 ESALS anticipated during the design period (thus falling in the lowest range limit in the left most column) would be reconstructed with a pavement 6.5 inches thick (taken from the corresponding column in the PavThk entry).

The SNCNew entries are used in calculating a new structural number (SN) for flexible pavements after improvement. The default entries are selected to approximate the relationship between SN and pavement thickness presented in Table IV-3 of the HPMS Field Manual [18] .

[16] U. S. Department of Transportation, Federal Highway Administration, *Highway Statistics, 199*7, Washington, D.C., 1998, Table MF-121T.
[17] U.S. Department of Energy, Energy Information Administration, "On-Highway Diesel Fuel Price Survey," Form EIA-888, 1995.
[18] U.S. Department of Transportation, Federal Highway Administration, Highway Performance Monitoring System *Field Manua*l, Washington, D.C., Table IV-2, December 1, 1987.

B.1.10 Variables for the FORCST Routine

The FORCST routine predicts future pavement condition when a section has not undergone improvement. The two PDRAF entries provide a means of adjusting the deterioration rate of flexible and rigid pavements. The default is the neutral value, 1.0. The MAXPD entry limits the amount PSR can be decreased in a year.

The maximum pavement life entries are arranged in two lines: the first for flexible, and the second for rigid, pavements. The three columns correspond to heavy, medium, and light pavement sections, respectively. The default entry values are set to the hard-coded values used in the model.

B.1.11 Variables for the SAFETY Routine

Fortunately, the large number of entries for the SAFETY routine can be divided into three groups: entries specifying the costs of safety incidents; ratios which determine the number of incidents per crash, and adjustments to those ratios; and entries of safety parameters for rural and urban multilane freeways. Many of the entries (InjCost, PDCost, FCR, and ICR) are entered by functional class, with one entry per line. Within each rural/urban set, the entries begin with Interstate and proceed to the lowest functional class.

HERS' places values on safety incidents by calculating the number of crashes likely to occur on a section. The number of fatalities and injuries per crash are determined by the crash ratios; the number of fatalities and injuries are multiplied by their respective costs. Property damage is assumed to occur for each crash, therefore no per crash ratios are required.

The first entry is the value of life: the cost in dollars of each fatality. The default value of $2.7 million is the U. S. Department of Transportation estimate used in the preparation of the 1999 *C&P Repor*t. When preparing to evaluate using a different data year, you should examine these values for possible modification, or else index them using the appropriate Pridx entries.

The second group of entries begins with the ratios of fatalities per crash and injuries per crash. Most users will not need to alter the crash ratios, or the next entry (FICRY), which identifies 1995 as the year to which these rates apply. The next three entries allow you to specify an annual percentage decline in the ratios of fatalities per crash (APDFCR), injuries per crash (APDICR), and overall crash rates (APDCR).

The next three lines contain the entries for safety parameters used in determining crash rates for rural multilane sections. The default values for RMLDD (driveway density for, in the left entry, rural type development, and, on the right, dense development) and RMLRHR (roadside hazard rating). The entry for RMLIMax, the maximum number of intersections per mile, is used as the upper limit for the variable INTSPM (intersections per mile). The next line contains the entries (MINSPM, left entry, and MAXSPM, right entry) for the minimum and maximum number of signals per mile on urban multilane sections.

Other than dollar year adjustments to the value of life and injury and property damage costs, you will likely prefer to use the supplied entries for the safety parameters unless you are specifically analyzing the functioning of the HERS-ST safety model.

B.1.12 Variables for the R2LANE Routine

The R2LANE routine calculates the number of crashes per 100 million vehicle miles of travel on rural two lane sections. As with the non-cost safety rates, you will likely prefer to use the supplied values. IR2Max (maximum number of intersections per mile) is used to limit/scale the variables NSIG and NOINT.

B.1.13 Value of Travel Time Cost Components

This set of entries consists four lines, each containing entries for one of the four components of travel time cost:

- TTCPPH — Travel time cost per person per hour;
- VDEPPH — Vehicle depreciation cost per hour;
- INVCPH — Inventory cost per hour; and
- AVO — Average vehicle occupancy.

The seven entries per line are in order of vehicle types. The input values supplied are in 1995 dollars. While you may wish to adjust these values to a different dollar year, you may prefer to use the appropriate price index (Pridx).

B.1.14 Variables for the ALNCST Routine

All three sets of alignment cost (ALNCST) entries consist of three lines, one line each for flat, rolling, and mountainous terrain.

The last set of three lines consists of heterogeneous entries. The first column is for ANBC, the average number of box culverts per mile. The second column is for ANPC, the average number of pipe culverts per mile.

B.1.15 State Cost Factors

HERS-ST reads and interprets the two first columns of each line. The first column is the state's Federal Information Processing Standards (FIPS) code (see Table B-2). The second column lists a cost factor for each state. The cost factors are derived from *Price Trends* [19] as a three-year rolling average, and are applied to all capital costs associated with the improvement. The factors in the default file are for 1997.

You will want to consider these entries when changing to a different dollar year. If your analysis is confined to one or several states, and you have specific improvement costs you wish to use (in the IMPRCOST.DAT file), you will probably want to set the STFCT entries for those states to 1.0. [20]

[19] Office of Infrastructure, Office of Program Administration, *Price Trends for Federal-Aid Highway Construction*, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., quarterly.

[20] Alternatively, when processing sections which reside within a single state, these factors could be used to differentiate between improvement costs in various counties or districts. This requires identifying each set of sections with like improvement costs with a unique value in the State Code field of the section data records, and then setting the cost factor index to represent these costs.

Table B-2 FIPS State Codes

State	Code	State	Code	State	Code
Alabama	01	Maine	23	Pennsylvania	42
Alaska	02	Maryland	24	Rhode Island	44
Arizona	04	Massachusetts	25	South Carolina	45
Arkansas	05	Michigan	26	South Dakota	46
California	06	Minnesota	27	Tennessee	47
Colorado	08	Mississippi	28	Texas	48
Connecticut	09	Missouri	29	Utah	49
Delaware	10	Montana	30	Vermont	50
District of Columbia	11	Nebraska	31	Virginia	51
Florida	12	Nevada	32	Washington	53
Georgia	13	New Hampshire	33	West Virginia	54
Hawaii	15	New Jersey	34	Wisconsin	55
Idaho	16	New Mexico	35	Wyoming	56
Illinois	17	New York	36		
Indiana	18	North Carolina	37	Puerto Rico	72
Iowa	19	North Dakota	38	American Samoa	60
Kansas	20	Ohio	39	Guam	66
Kentucky	21	Oklahoma	40	Virgin Islands	78
Louisiana	22	Oregon	41		

Table B-3 ImpCost.Dat Elements

Element		Description
Attribute	FileID	File identification
	CGCost	Clearing and grubbing cost per square yard in dollars
	FSTPCost	Pavement cost for flexible surface treatment per square yard in dollars
	CRSCost	Additional cost for continuously reinforced slabs per square yard in dollars
	NBCost	Average cost of a new bridge in dollars
	FnCost	Average cost of new fencing per mile in dollars
	LtCost	Average cost of highway lighting per mile in dollars
List	RRWCost	Rural right-of-way costs in thousands of dollars per lane-mile
	URWCost	Urban right-of-way costs in thousands of dollars per lane-mile
	EWCost	Cost of earth work per cubic yard in dollars
	DrCost	Cost of drainage work per foot in dollars
	FAPCost	Pavement cost for flexible aggregates for base or sub-base
	FACPCost	Pavement cost for flexible asphaltic concrete for surface or base
	RSPCost	Pavement cost for un-reinforced rigid slabs per square yard in dollars
	GrCost	Cost of guard rails and curbs per mile in dollars
	PTLCost	Cost of painting traffic lines per mile in dollars
	OUCost	Optional costs for addressing substandard conditions on urban freeways
Table	RICost	Rural improvement costs in thousands of dollars per line-mile.
	UICost	Urban improvement costs in thousands of dollars per line-mile.

B.2 THE IMPRCOST.DAT FILE

The improvement cost file, IMPRCOST.DAT, contains data HERS-ST uses in estimating the cost of improvements.

The costs of improvements that do not include alignment modifications are specified in the first two sections of this file, and most of the remainder of the file contains cost parameters used to estimate the incremental cost of alignment improvements. The last section contains optional additional costs for addressing four specific conditions of substandard urban freeways.

In addition to the values entered in IMPRCOST, there are three additional factors which influence the effective cost of improvements used within HERS. First is the price index (Pridx in

PARAMS.DAT) which can be used to adjust the dollar year of the costs. Second is the improvement cost scale factor (in RUNSPEC.DAT), which is applied to all improvement costs, and can be used to examine assumptions about the cost of improvements. These two factors are applied during HERS' initialization sequence to yield a set of improvement costs which reflect the national average. The third factor is the state cost factors. During the capital cost computation, the factor for the section's state is applied against the national average to yield a state-specific cost.

It is important to keep these three factors in mind when adjusting to a different dollar year, or if you have a different set of costs you wish to employ. If, for example, you wanted to use specific costs, you would want to enter the costs in IMPRCOST, use the price indices to adjust the dollar year (if necessary), set the improvement cost scale factor to 1.0, and set the state cost factors to 1.0 for all states represented in your data set. You might then wish to examine the sensitivity of the model to the improvement costs you used by scaling them up and down by, for example, five and ten percent, using the improvement cost scale factor.

B.2.1 Improvement Costs Without Alignment Modification

The improvement costs in the first two sections of the default file (those which do not include alignment modifications) are in thousands of 1995 dollars. You can adjust these costs uniformly to dollars of another year by modifying the price indices for improvement costs in the PARAMS.DAT file, or you can modify them individually. However, be sure to specify all costs used by HERS-ST in the same year dollars.

The costs provided represent a national average of costs. They were computed as a three-year rolling average of costs taken from FHWA's Composite Bid Price Index for Federal-Aid Highway Construction.[21] The table of state cost factors in PARAMS.DAT is used to adjust these costs to reflect the cost differences between states.

The abbreviations at the head of the columns represent the following improvements:

- RCHC Reconstruction with lanes added at high cost;
- RCNC Reconstruction with lanes added at normal cost;
- RCWL Reconstruction with wider lanes;
- RC Pavement reconstruction (includes improvements to shoulders);
- MWHC Major widening (resurfacing and adding lanes) with lanes added at high cost (also known as RSHC: resurfacing with lanes added at high cost);
- MWNC Major widening (resurfacing and adding lanes) with lanes added at normal cost (also known as RSNC: resurfacing with lanes added at normal cost);
- MinW Minor widening (resurfacing and widening lanes, also known as RSWL, resurfacing with wider lanes);
- RsSh Resurfacing with shoulder improvements; and
- Rs Resurfacing.

These costs are applied to that portion of a section that does not require alignment improvement; if the alignment is not to be modified, these costs are applied to the entire section.

"High cost lanes" are lanes added beyond the state-supplied widening feasibility code for a section up to the limit of either (a) the Federal widening feasibility override value coded in WFOvrd (in PARAMS.DAT) or (b) the maximum allowable number of lanes per functional class specified in LnsMax (also in PARAMS.DAT). It is possible for a section to have one or two lanes added at normal cost and additional lanes added at high cost. There are, in fact, four different formulas by which HERS-ST calculates improvement costs. Of particular note is that, for urban major widening, only added lanes are included in the cost calculation. This should be considered when devising

[21] Office of Infrastructure, Office of Program Administration, *Price Trends for Federal-Aid Highway Constructio*n, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., quarterly.

costs for improvements. This is why, in the default file, the per-lane-mile costs for urban major widening are greater than the per lane-mile costs for reconstruction with additional lanes. Note that in the default file, the costs for adding rural high cost lanes are the same as for adding lanes at normal cost.

On sections where costs are computed using both costs (e.g., two lanes at normal cost plus two lanes at high cost), for output purposes the section is categorized as having been improved with high cost lanes only.

B.2.2 The Cost of Improvements with Modified Alignment

Other improvement costs used by HERS-ST (specifically the alignment related costs and the costs of upgrading substandard urban freeways) are shown in the default IMPRCOST.DAT file in 1988 dollars. These can be adjusted to dollars of another year by modifying the appropriate price index for alignment related costs in the PARAMS.DAT file. The price index in the default PARAMS.DAT file adjusts these costs to 1997 dollars.

HERS-ST computes alignment costs based upon estimated amounts of clearing and grubbing; earthwork; drainage and culverts; structures; additional right-of-way; miscellaneous costs (including curbs and guard rails at shoulder or median, fencing, painting, and lighting); and base and surface pavements required. Additional entries affecting the cost of improving alignment include: box culverts per mile; clearing and grubbing parameter; earthwork parameters; generic drainage parameter; and pipe culverts per mile. (All of these entries are made in the PARAMS.DAT file.)

B.2.3 Optional Urban Improvement Costs

The final section of the IMPRCOST file[22] is used to enable HERS-ST to compute the extra cost of addressing four substandard conditions on urban freeways. These conditions are un-surfaced shoulders, lack of full access control, lack of a positive-barrier median, and a median width that is below the design standard. These corrections are only made when reconstructing the section. Specifying the costs of correcting these conditions (in thousands of dollars per mile) enables HERS-ST to consider the costs as well as the benefits of correcting these conditions. This reduces the benefit/cost ratio for reconstructing the section and reduces the likelihood that HERS-ST will select the reconstruction improvement for implementation.

Table B-4 DLTbls.DAT Elements

Element		Description
Attribute	FileID	File identification
List	CrvCat GrdCat MedWidth ULnWidth URSWidth USfType	Design standard for the highest curve category allowed Design standard for the highest grade category allowed Design standard for median-width in feet Design standard for urban lane-width in feet Design standard for urban shoulder-width in feet Design standard for urban surface-type
Table	IRI PSR SfType VCR LnWidth RSWidth ShType HAlign VAlign	Design standard for the International Roughness Index (IRI) Design standard for the Present Serviceability Rating (PSR) Design standard for the type of surface Design standard for Volume to Capacity Ratio (VCR) Design standard for lane width in feet Design standard for the right shoulder width in feet Design standard for the shoulder type Design standard for horizontal alignment Design standard for vertical alignment

[22] The portion of the file headed "Construction Costs of New Facilities..." is not currently used by HERS-ST.

B.3 THE DLTBLS.DAT FILE

The deficiency table file, DLTBLS.DAT contains criteria used by HERS-ST in assessing section deficiencies; designing candidate improvements; determining the effects of improvements; and reporting output statistics. The file contains fourteen entry sets for different section characteristics.

The first eight entry sets for Pavement Condition, Surface Type, V/C Ratio, Lane Width, Right-Shoulder Width, Shoulder Type, Horizontal Alignment and Vertical Alignment, each contain entries for four or five types of criteria. In each of the first eight entry sets, each line represents a group of sections which share the same criteria. Rural sections are grouped by terrain type (flat, rolling, mountainous), functional class, and (except for Interstates) by volume level. An example of such a section group would be “rural collectors in mountainous terrain with daily traffic between 400 and 1000 vehicles”. Urban sections are grouped by functional class. Each column of entries represents a different criteria type.

The last six entry sets for Curve Categories, Grade Categories, Median Width, Lane Width, Shoulder Width and Surface Type, each contain a single entry column for design standards. The last three of these six sets were not included in the earlier entry sets because for these section characteristics the grouping of urban sections for design standards is different than that used for the other criteria.

The DLTBLS.DAT file contains six criteria types:

- Design Standards (DSs);
- Unacceptability Levels (ULs);
- Deficiency Levels (DLs);
- Serious Deficiency Levels (SDLs); and
- Reconstruction Levels (RLs).

Note that the function of these criteria types is not always readily apparent from their names, so it is important to examine how HERS-ST utilizes each type before changing any values. The deficiency levels (DLs) are the most critical of the six criteria.

B.3.1 Design Standards

HERS-ST references the design standards when designing and implementing improvements. For example, when reconstructing a section, HERS-ST will increase the right shoulder width to the design standard (unless widening is not feasible or the section is curbed).

The design standards for curve and grade categories specify the highest curve or grade class allowed under the design standard. The curve and grade categories are used by the HERS-ST Preprocessor (but not by HERS-ST); both programs use the design standards for median width. Accordingly, the Preprocessor will be rerun whenever these design standards are revised.

B.3.2 Unacceptability Levels

Unacceptability levels (ULs) are utilized only when you have enabled the mandatory improvements option in the RUNSPEC.DAT file. See paragraph 8.3.6, ”Mandatory Improvements.”

If the mandatory improvements switch is not enabled, HERS-ST ignores the ULs entered in the DLTBLS.DAT file. This mandatory improvements option was not used in preparation of data for the *1999 Conditions and Performance Report.*

If the mandatory improvements switch has been enabled, HERS-ST uses the ULs to identify sections that qualify for improvements to correct the unacceptable conditions. Sections whose pavement condition and V/C ratios do not violate the ULs are not considered for mandatory improvements, even though other section characteristics may be unacceptable. However, when unacceptable pavement conditions are corrected, all other unacceptable conditions are corrected as well. Typically, mandatory improvements will be implemented automatically regardless of their benefit-cost ratio, unless the analysis is constrained by available funding.

B.3.3 Deficiency Levels

The deficiency levels (DLs) are the most critical of the six criteria. HERS-ST utilizes deficiency levels to identify deficiencies that warrant analysis by HERS. HERS-ST will only consider improving a section if one of the following three conditions is met: the section is unpaved and the surface type DL specifies pavement; at the end of the funding period the PSR is below the pavement condition DL; or at the end of the funding period the V/C ratio is above the V/C DL. After one of these conditions has been met, HERS-ST will design alternative improvement options to correct these deficiencies, and any other characteristics that violate a DL threshold.

For example, if a section has only a shoulder type deficiency, HERS-ST will not evaluate any potential improvements. However, if a section has both a pavement deficiency and a shoulder type deficiency, HERS-ST will identify two improvements for evaluation, resurfacing (to correct the pavement deficiency) and resurfacing with shoulder improvements (to correct both conditions). HERS-ST will subject both these alternatives to benefit cost analysis and may implement one of them, depending on the constraints of the scenario.

A major function of the DLs to reduce computation time by limiting the number of potential improvements analyzed by HERS. If the DLs were set equal to the design standards, this would cause HERS-ST to analyze a number of potential improvements that would be extremely unlikely to be cost-beneficial. Relaxing the DLs will limit the number of potential improvements analyzed by HERS-ST and significantly decrease computation time. However, relaxing the DLs too far may cause HERS-ST to ignore potential improvements that would be cost-beneficial.

B.3.4 Serious Deficiency Levels

The serious deficiency levels (SDLs) are typically set to describe more severe levels of inadequacy than the DLs. When a section has a seriously deficient condition, HERS-ST will design all candidate improvements to correct that deficiency. For example, if a section has a pavement deficiency and a seriously deficient shoulder type, HERS-ST will consider only resurfacing with shoulder improvements as an improvement option. HERS-ST will subject this improvement option to benefit cost analysis and may implement it, depending on the constraints of the scenario. HERS-ST would not consider resurfacing alone, because it would not address the serious shoulder deficiency.

SDLs also can have a significant impact on HERS-ST computation time, by limiting the number of alternative improvements analyzed for a given section. If all SDLs are set equal to the DLs, HERS-ST considers the smallest number of improvement alternatives. The larger the difference between the corresponding SDLs and DLs, the more likely HERS-ST is to consider a wider range of possible improvement options on any section. Note that even if several serious deficiencies occur, HERS-ST will not consider improving a section unless one of the three conditions identified in paragraph B.3.3 are met.

B.3.5 Reconstruction Levels

Reconstruction levels (RLs) are provided only for pavement conditions. They are always set lower than the DLs and represent the level at which resurfacing the pavement is no longer an option: reconstruction is the only way to restore the pavement. In this way, the RLs reflect engineering considerations and are inherently objective. (DLs, SDLs, and ULs are inherently subjective criteria.) Because HERS-ST considers only one type of pavement improvement for each section, there is no need for SDLs for pavement condition.

While the PSR at the end of the funding period is compared to the DL, it is the pavement condition at the beginning of the funding period, which is compared to the RL. The reason for this is that HERS-ST assumes pavements whose PSR would fall below the RL during a funding period would be resurfaced while resurfacing was still an option.

APPENDIX C - Control Data

Table C-1 PPSpec.DAT Elements

Element		Description
Attribute	FileID	File identification
	HwyFile	Name of the original highway data file to preprocessed
	HERSFile	Name of the HERS-ST data file to be created
	DistFile	Name of the truck VMT distribution file to be created
	StInFile	Name of the input file that contains the state specified improvements
	StOutFile	Name of the binary state specified improvement file to be created
	Format	Selects between the 1993 and 1999 highway data format
	BaseYear	Base year of data
	PSRUPS	PSR for unpaved sections
	CapOvrd	Selects the use of coded capacities
	TGRMax	Maximum annual traffic growth rate (%)
	TGRNew	Description of new Traffic Growth Rate (TGR) Input
	TGR	TGR for sections whose growth rate exceeds the maximum (%)
	PGTMax	Top limit for the percentage of green time (%)
	PGTMin	Bottom limit for the percentage of green time (%)
	AADTCRMax	Upper limit for AADT/Capacity ratio
	MRErr	Report AADT over capacity
	TCDMax	Maximum average number of traffic control devices
	NTDErr	Report when traffic control devices exceed maximum
	SPLMax	Maximum speed limit in miles per hour
	RUErr	Report inconsistent coding of the RurUrb highway data field
	AASwitch	Selects the use of the coded values for alignment adequacy
	PLErr	Report peak lane errors
	PSRIRI	Indicates priority when both PSR and IRI are coded
	Override	Select between the HERS-ST basic and override operating modes
List	PGTRUR	Default percentage of green time for listed items

C.1 PREPARING PPSPEC.DAT

C.1.1 Preparing PPSPEC, the Preprocessor Control File

The Preprocessor control file, PPSPEC.DAT, contains 19 user entry fields. Three of these identify the input and output files; one identifies the base data year; twelve specify limits or defaults for input data; and three control the generation of messages by Preprocessor. Typically, only the three entries dealing with input and output files need be changed.

For each field, Table C-2 lists the line number and the columns in which Preprocessor expects to find the item. Specific fields names, when applicable, are shown within parentheses in upper case.

Table C-2. The Fields of PPSPEC.DAT

Line	Columns	Content
6	1-23	**HPMS section data file name** -- the input file.
7	1-23	**HERS-ST binary file name** --an output file.
8	1-23	**Distribution file name** -- an output file.
9	1-2	**Base Year of Section Data**. (BaseYear) This must match the data year of the section data or a program error may result.
10	1-3	**Default PSR for Unpaved Sections**. (PSRUPS) Must be greater than zero: if zero used, 1.0 will be substituted. This value is used as the PSR for all unpaved sections.
12	1-4	**Maximum Annual Traffic Growth Rate**, in percent. (TGRMax)
13	1	**Description of New Traffic Growth Rate Input**. If one, then the default rate on line 18 will be used for all sections with initial growth rates above TGRMax. If two, then Preprocessor will interactively query the operator for each section with an initial growth rate above TGRMax.
18	1-4	**Traffic Growth Rate for Sections Whose Initial Growth Rate Exceeds TGRMax** (only when the entry on line 13 is one).
20	1	**Error Reporting Flag**. Set to one to have Preprocessor print an error message for each section missing both SNorD and PAVSEC data, or set to zero to turn off this error message. (Preprocessor will infer both from surface type.)
24	1-2	**Upper Limit for Percentage Of Green Time**. (PGTMax) Preprocessor will use this value for sections with reported percentage of green time above this value.
25	1-2	**Lower Limit for Percentage Of Green Time**. (PGTMin) Preprocessor will use this value for sections with reported percentage of green time below this value.
26	1-2	**Default Percentage of Green Time for Principal Arterials**. (PGTRUR) Preprocessor will use this value for principal arterial sections with traffic signals but no reported percentage of green time.
26	4-5	**Default Percentage of Green Time for Minor Arterials**. (PGTRUR) Preprocessor will use this value for minor arterial sections with traffic signals but no reported percentage of green time.
26	7-8	**Default Percentage of Green Time for Collectors**. (PGTRUR) Preprocessor will use this value for collectors with traffic signals but no reported percentage of green time.
28	1-2	**Upper Limit for AADT/Capacity Ratio**. (AADTTCRMax) Preprocessor will use AADTTCRMax, and adjust capacity accordingly, on sections whose AADT/ capacity ratio is above this value.
29	1	**Error Reporting Flag**. Set to one to have Preprocessor print an error message for each section whose AADT/capacity ratio exceeds AADTTCRMax, or set to zero to turn off this error message.
33	1-2	**Upper Limit for Average Number of Stop Signs and Traffic Signals Per Mile**. (TCDMax) Preprocessor will use this value for sections with greater density of traffic control devices.
35	1	**Error Reporting Flag**. Set to one to have Preprocessor print an error message for each section whose traffic control device density exceeds TCDMax, or set to zero to turn off this error message.
41	2	**Maximum Speed Limit** in miles per hour.

Table C-3 RunSpec.DAT Elements

Element		Description
Attribute	FileID	File identification
	RunNumber	Run number to appear at top of every page of the report
	RunDescription	A description to appear at top of every page of the report
	Overwrite	Allows HERS-ST input data file to be overwritten while processing
	Delete	Allows HERS-ST to delete files describing the system at the end of analysis
	HERSFile	Name of the HERS-ST data file to be processed
	StOutFile	Name of the state implementations file from the Preprocessor
	DistFile	Name of the truck VMT distribution file
	PrintFile	The output-tables file (PRN for printer)
	Period	Length of funding period (Years)
	Periods	Number of funding periods to be analyzed
	AADT	Type of Average Annual Daily Traffic (AADT) calculation to perform
	LRS	Long Run Share (LRS) of elasticity
	SRE	Short Run Elasticity (SRE)
	Discount	Discount rate in percent
	Backlog	Backlog printing option
	ImprSt	Specify if state specified exogenous improvements are printed
	WarnMSI	Specify if warning messages for exogenous improvements are issued
	WarnMsg	Specify if the warning messages are sent to a file or the screen
	NTDMax	Maximum number traffic control devices per mile
	MndImp	Priority given to mandatory improvements
	Needs	Specify the type of needs analysis
	BCRMin	Minimum Benefit/Cost Ratio
	Objective	Specify an analysis objective
	MCC	Maintenance of current conditions
	CSpec	Description of constraint (or goal) specification
	AIUnit	Units of funds to be used for improvements of unacceptable conditions
	MCUnit	Units of funds for specified goal for maintenance cost
	PPDUnit	Units of the peak period delay
	BCAPMax	Maximum length of BCAP in years
List	CostUnits	Units of costs
	VMTUnits	Units of Vehicle Miles Traveled (VMT)
	MsgInterval	Number of items to be processed between printings of messages
Table	FAPG	Funds available or performance goals for each period
	FRDS	Portion of funds reserved for mandatory improvements of deficient sections
	CostWts	Cost weights used in calculating goal
	IBCRWts	Weights used in calculating incremental benefit/cost ratio
	Outputs	HERS-ST output options

C.2 PREPARING RUNSPEC.DAT

RUNSPEC.DAT, the HERS-ST control file, is rather more involved than the Preprocessor control file, containing 397 data fields. Of these, 144 comprise two matrices used in setting constraints; 181 are used to set weights used in calculating performance goals and BCRs; and 49 are used to specify output options. This leaves 27 unique entry fields.

Unlike the Preprocessor, which always performs the same processing task, the HERS-ST program can perform any one of several different types of analysis (as discussed in paragraph 8.3, "HERS-ST Analysis Types"). The four control fields identified in Table C-2, "The Fields of PPSPEC.DAT," are used to select the type of analysis.

C.2.1 Run Number Field

The eight characters comprising the run number will be printed on each page of the HERS-ST output. It is useful to choose unique combinations that encode meaningful information about the run.

C.2.2 Run Description

Like the Run Number, the Run Description will be printed on each page of the HERS-ST output. The entry field consists of two lines, each 50 characters in length.

C.2.3 Input File Overwrite Switch

When set to zero, HERS-ST will create a copy of the binary input file. Messages about the progress of the copy operation will be displayed on the screen. This preserves the input file for subsequent re-use. When this switch is set to one, HERS-ST will overwrite the binary input file. We suggest having HERS-ST create a copy (the switch set to zero).

C.2.4 File Delete Switch

At the end of each funding period, the program produces an updated HERS-ST binary file describing the simulated condition of the sample sections. This file is then used as the input file for processing during the next funding period. The file is also produced after the last funding period. If the file delete switch is set to one, this file will be deleted.

If you set this switch to zero, the program will save the file. This allows you the option of using this file as input to a subsequent HERS-ST run. If you allowed HERS-ST to overwrite the input file (by setting the input file overwrite switch to one), the output file will have the same name as the input file. If you specified that HERS-ST preserve the input file, the output file is titled XXHERS01.BIN.

C.2.5 File Names

The HERS-ST program requires three names and an optional name: if exogenous improvements are to be processed, the input file (which is an output from the Preprocessor) must also be specified. When the field is blank, no exogenous improvements will be processed. Two of these, the HERS-ST binary data file, and the distribution file, are outputs of the HERS-ST Preprocessor. The third is the name of the file HERS-ST is to create which will contain the output print pages. This file should not exist at the time the model begins execution, as HERS-ST will not over-write an existing output file.

C.2.6 Length of Funding Period Field

The default value of five years is recommended. HERS-ST uses the funding period length as the length of the benefit-cost analysis period and, for most sections, bases the decision of whether to improve in the current funding period or a later funding period on a benefit-cost analysis period equal in length to a single funding period. With a shorter funding period, the benefit stream following an improvement is also shorter, and the number of improvements meeting the benefit-cost criteria drops. With a longer funding period, more improvements will meet the benefit-cost criteria as a result of the longer benefit stream.

C.2.7 Number of Funding Periods Field

While HERS-ST can be set to process up to 99 funding periods, the two matrices used to define fund and performance constraints are limited to four funding periods of specific input values. When processing more than four funding periods in a constrained mode, HERS-ST will use the entries for the fourth funding period for all subsequent funding periods.

C.2.8 AADT Calculation Field

This field selects the algorithm used by HERS-ST in forecasting baseline traffic volume growth. The options are:

1. "original" method — concave geometric growth;
2. "straight line" method — linear growth.

The concave geometric is a constant growth rate formula in which traffic increases (or decreases) as a fixed percentage of the previous year's volume. The linear growth method adds the same number of vehicles in each year. The *1999 Conditions and Performance Report* was prepared using the linear option.

C.2.9 Elasticities

HERS-ST models the effect on traffic volume of changes to the price of highway travel. An increase in the price to the user results in a decrease in demand and traffic volume: a decrease in price prompts a rise in demand and traffic volume. The components of the user price are travel time, vehicle operating costs, and the costs of "safety incidents" (property damage, injury and fatality costs, and the cost of delay due to crashes). Highway section characteristics affecting these cost components include PSR, capacity, and traffic volume.

The elasticities govern the relationship between the percentage of price change and the percentage of volume change. For example, an elasticity of one means that a price change of 10% results in a volume change of 10%. The elasticity values are negative so that price and volume will move in opposite directions: i.e., an increase in price brings about a decrease in volume, and vice versa. Significant short-run elasticity effects will occur within one year of a price change, while other long-run effects may occur for upwards of 20 years.

The HERS-ST model requires values for two components of elasticity. The short-run elasticity (SRE) represents the portion of elasticity that will occur within a funding period. The long-run share (LRS) represents the portion of long-run elasticity (LRE) that will occur between funding periods. The supplied values, -1.0 for short-run elasticity and -0.6 for long-run share, were used in the preparation of the 1999 *Conditions and Performance Report* and are the products of considerable research and expert review.

The LRS is sensitive to the length of the funding period. The longer the funding period, the higher the long-run share of elasticity to be applied between funding periods; the shorter the funding period, the lower the value to be used. The SRE theoretically represents effects that are expected to occur within one year, and generally should not be sensitive to funding period length. However, for long funding periods, the user may want to select an SRE value towards the higher end of the recommended range.

Studies to date have shown long range elasticities in a -1.0 to -2.0 range; including short-run elasticities from -0.5 to -1.0 and long-run shares from -0.5 to -1.0. Table C-4, "Recommended SRE and LRS Values by Funding Period Length," shows suggested short-run elasticity and long-run share values for funding periods of various lengths. The first set of values are derived from the 1999 *Conditions and Performance Report*, adjusted for funding period length, and are consistent with the upper end of the recommended elasticity ranges. The second set of values represent the lower end of the recommended elasticity ranges. Note that the 20-year funding period row is included to show the long-run elasticities from which the long-run shares for different funding periods are derived. It is not recommended that users select funding periods longer than seven years.

The model will reject entries greater than or equal to -0.

Table C-4 Recommended SRE and LRS Values by Funding Period Length

Funding Period Length	1999 C&P Report Values		Lower Range of Recommended Values	
	SRE	LRS	SRE	LRS
1 Year	-1.0	-0.150	-0.5	-0.075
2 Years	-1.0	-0.285	-0.5	-0.143
3 Years	-1.0	-0.404	-0.5	-0.202
4 Years	-1.0	-0.508	-0.5	-0.254
5 Years	-1.0	-0.600	-0.5	-0.300
6 Years	-1.0	-0.679	-0.5	-0.340
7 Years	-1.0	-0.747	-0.5	-0.374
20 Years	-1.0	-1.000	-0.5	-0.500

C.2.10 Discount Rate

The discount rate is the value used to calculate the discounted present value of future benefits and costs. Increasing the discount rate decreases the discounted present value of the benefits and decreases the BCRs calculated for all improvements. The supplied value of seven percent is recommended by the Office of Management and Budget.

C.2.11 Maximum Number of Traffic Devices Per Mile

This entry limits the effective number of traffic control devices (stop signs and traffic signals) per mile.

C.2.12 Mandatory Improvement Switch

This is the first of the four HERS-ST control fields; it's field name is MndImp. To instruct the model to implement mandatory improvements, set this switch to one. Set the switch to zero to avoid mandatory improvements. See paragraph 8.3.6, "Mandatory Improvements," for background information. This option was not used (it was set to zero) in preparation of data for the *1999 Conditions and Performance Report*.

C.2.13 Full Needs Switch

The second control field, this switch (Needs) selects the full needs analysis type when it is set to one: it must be set to zero to select any other type of analysis.

C.2.14 Minimum BCR

This entry (BCRMin) is required when the Objective entry is set to 3, and is ignored otherwise. It specifies the minimum required benefit-cost ratio of all implemented improvements during a minimum BCR run.

C.2.15 Objective

This control field (Objective) selects the analytical objective to be performed. Set to one to select constraint by funds, to two for constraint by performance, or three for minimum BCR. This entry is ignored when the full needs switch is set to one, and is required otherwise.

C.2.16 Maintain Current Conditions Switch

This switch is the last of the four control fields. During performance constrained analysis, this switch (MCC) specifies the source of the performance goals. Set to one to use the initial performance of the system as the performance goal (a maintain performance analysis); set to zero to specify performance goals in the first matrix. This switch is only active during a performance-constrained run: HERS-ST ignores MCC when Objective is not set to 2.

C.2.17 Constraint Specification

The CSpec parameter allows you to specify how to subdivide the highway system when running a constrained fund or performance goal analysis. Analysis (including selection of improvements, evaluation of performance goals, and the application of funding constraints) is performed separately for each group:

- By each Functional Class;
- By Principal Arterial/Other and Rural/Urban;
- By Principal Arterial/Other;
- By Rural/Urban; and
- For the Whole System at Once.

Generally, the larger the grouping, the more opportunity is given to the model to select improvements with the highest benefits. For example, a performance constrained run over the whole system should yield a higher average BCR than an otherwise identical run performed over each functional class. This is because the model is able to select the "next best improvement for the system" from all candidate improvements for each section. When run by functional class, the selection universe consists only of improvements to sections in that class. However, it should be expected that, in a "whole system" run, the levels of performance of individual functional classes will be above and below the system level, with one or more functional classes relatively "over-improved," and several others correspondingly "under-improved." In the "functional class" run, the performance level is maintained for each class, and improvements within each class are selected by benefit/cost analysis, but the benefit/cost ratios of the last improvement in each class may differ by several percentage points.

Note that HERS-ST will use the entry in this field when determining which portions of the two matrices to reference for available funds and/or performance constraints.

C.2.18 First Matrix: Funds Available or Performance Goals

This matrix is used to enter either of two sets of values: available funds (when performing constrained fund analysis) or performance goals (for performance constrained analysis with user-specified goals). For available funds, values are entered in millions of dollars. For performance goals, values are entered in dollars or incidents per vehicle mile traveled, or in dollars per mile, depending upon the type of performance goal specified in the Cost Weights entries. The matrix is ignored during minimum BCR runs and maintain performance runs.

The matrix consists of five sets of one to 9 lines, each set corresponding to one of the functional class groupings of CSpec. HERS-ST will use the value in CSpec to determine which set holds the entry values, and ignores the other sets. Each line has 4 entry fields (arranged in columns) corresponding to the first 4 funding periods. If HERS-ST encounters a zero in a field designated for the second, third, or fourth funding period, it will assume that the entry for the previous funding period is intended for the zero-filled entry. If more than four funding periods are specified in the number of funding period's field, the values used for the fourth funding period will be used for all subsequent funding periods.

Note that when entering values for a performance constrained run, the entered performance goals should represent the sum of the various goal cost components selected in the cost weights (CostWts) table.

C.2.19 Second Matrix: Funds Reserved for Deficient Sections

This matrix is only used during fund constrained runs with mandatory improvements. During this type of analysis, HERS-ST will interpret the values in this matrix as specifying which portion of the overall funds (specified in the first matrix) are not available for mandatory improvements, but are to be invested in improvements with the highest BCRs.

This matrix has the same structure as the first matrix, with the active set of entries designated by CSpec. If HERS-ST encounters a zero in a field designated for the second, third, or fourth funding period, it will assume that the entry for the previous funding period is intended for the zero-filled entry. If more than four funding periods are specified in the number of funding period's field, the values used for the fourth funding period will be used for all subsequent funding periods. A separate entry, Units of Funds (AIUnit), determines whether entries are in millions of dollars, or a percentage of the values in the first matrix.

C.2.20 Cost Weights and Maintenance Cost Units

The cost weights table (CostWts) consists of eleven pairs of lines. Each line-pair represents a cost component used in establishing a performance goal, and includes an entry field for each of the nine functional classes. The first line of each pair contains the four rural entry fields: the second line the five urban entries. Setting an entry field to zero removes that cost component/functional class combination from the performance goal. To evenly weight cost components, set the desired values to 1.0. Entries must be greater than or equal to zero.

These entries are required when executing any performance constrained run, whether the goal is to maintain a current performance level or to achieve a user-specified level, and ignored otherwise.

Three types of goal can be specified using the weight entry fields and the Maintenance Cost Units (MCUnit) field: dollars per vehicle mile; safety incidents per vehicle mile; and maintenance costs per highway mile.

The usual form is the performance goal specified in dollars per vehicle mile. The goal can be composed of any combination of operating cost, travel time cost, property damage cost, injury cost, cost of delay due to crashes, maintenance cost, and emissions damage cost: at least one entry field in one of these cost components must be non-zero. Typically, all weights for each of these cost components are set to 1.0. The “Number of” entries for crashes, injuries, and fatalities must all be set to zero. The MCUnit field must be set to one.

The second form of performance goal is the “number of” safety incidents per vehicle mile. The three safety incidents are crashes, injuries, and fatalities. At least one entry field in one of these categories must be non-zero. The entries for all other cost component categories must be set to zero.

The final form of performance goal is annual maintenance costs per highway mile. At least one of the entry fields for maintenance cost must be non-zero; all other cost component entries must be zero; and MCUnit must be set to two.

C.2.21 Incremental BCR Weights

This table is constructed similarly to CostWts, containing nine line pairs which correspond to the nine benefits which comprise the numerator of the benefit-cost ratio. This table permits you to weight the benefits in the numerator of the BCR. For example, agency benefits might be weighted twice as heavily as highway user benefits.

The sequence in which potential improvements are selected by HERS-ST is determined by their incremental benefit/cost ratio (IBCR). For any potential improvement, this ratio is obtained by estimating the discounted present value of all incremental costs and benefits. When choosing weights for the various benefits, it is important to recognize that improvements are selected only if weighted benefits exceed cost; hence, use of weights less than one tends to reduce the set of improvements considered for implementation.

These entries are used in all types of analysis.

C.2.22 Output Options

Use the Output Options entries to select the optional output pages that you need to evaluate a specific scenario. (These pages are in addition to the three "System Conditions" pages that are always produced for each funding period and the overall analysis period.) At the end of each funding period and at the end of the overall analysis period, an extensive variety of statistics can be produced describing changes in the highway system, the improvements selected, and the costs and resulting benefits. All the information is expanded to describe the larger universe represented by the sample highway sections.

The following output pages can be selected for the end of each funding period and summed for the total analysis period:

- Total initial cost of selected improvements;
- Lane-Miles improved;
- Lane-Miles of mandatory improvements;
- Lane-Miles of non-mandatory improvements;
- Net present value of the residual value of all improvements;
- Average B/C ratio of selected improvements;
- Capital requirements by IBCR range;
- Sample sections improved by IBCR range;
- Miles improved by IBCR range;
- Travel-time benefits to user-benefits ratios; and
- Lane-miles added.

The following output pages can be selected for the end of each funding period:

- Total benefits in the last year of period;
- Maintenance-cost savings in the last year of period;
- User benefits in the last year of period;
- Travel-time savings in the last year of period;
- Operating-cost savings in the last year of period;
- Safety benefits in the last year of period;
- Crashes avoided in the last year of period;
- Injuries avoided in the last year of period;
- Lives saved in the last year of period;
- VMT for improved sections in the last year of period;
- Miles improved;
- Miles of mandatory improvements;
- Miles of non-mandatory improvements;
- Pollution damage savings in last year of period;
- Deficiencies as % of VMT; and
- Deficiencies as % of miles.

To select a specific page at the end of each funding period, enter a one in column one. For those entries with optional end of overall analysis period pages, enter a one in column two. Enter zeroes to exclude pages from being generated. For example, if you are performing an analysis without mandatory improvements, you would set the mandatory/non-mandatory entries for miles and lane-miles improved to zero.

C.2.23 Units of Costs

These entries permit you to scale specific output pages to match your sample data. The nine scalable output pages are:

- Total initial cost of selected improvements;
- Net present value of the residual value of all improvements;
- Total benefits in the last year of period;
- Maintenance-cost savings in the last year of period;
- User benefits in the last year of period;
- Travel-time benefits to user-benefits ratios;
- Operating-cost savings in the last year of period;
- Safety benefits in the last year of period; and
- Capital requirements by IBCR range.

Set the page's entry to one for output in millions of dollars, or to two for output in thousands of dollars. Note that all HERS-ST output dollars are in "constant year dollars."

C.2.24 Units of VMT

These entries allow you to scale the VMT outputs. The first entry permits you to scale the page containing VMT for improved sections in the last year of period, and the second controls the scaling of VMT on the basic report page. Set the entries to one for millions of vehicle-miles; two for thousands of vehicle-miles; or three for billions of vehicle-miles.

C.2.25 Message Interval Selection

While processing, HERS-ST outputs messages to the screen to indicate its progress. These two entries allow you to control the interval at which HERS-ST generates these messages. You may want to set this number to about one-tenth of the number of records in your data set in order to receive comforting evidence that the model is processing normally. You may set these entries to zero to avoid the message entirely. If you set the interval above the number of sections in your dataset, the model will generate messages for zero sections processed, selected, and implemented. Note that the model will only print the "number of improvements selected" message during a constrained run.

Each of the two entries control several output message sets. The "number of sections processed" entry controls the interval between messages counting:

- the evaluation of improvements to address unacceptable conditions;
- the evaluation of improvements to address deficiencies; and
- the implementation of selected improvements.

The "number of selected improvements" entry controls the interval between messages counting:

- the selection of improvements to correct unacceptable conditions; and
- the selection of improvements to correct deficiencies.

If you set either of these entries to zero, the messages controlled by that entry are suppressed.

Table C-5 Coding Conventions for RUNSPEC File

Types of Analysis	Control Fields				Data Fields			
	Needs	Objective	MCC	MndImp	BCRMin	First Matrix	Second Matrix and AlUnit	CostWts
Minimum BCR (no mandatory improvements)	0	3	—	0	R	—	—	—
Minimum BCR (with mandatory improvements)	0	3	—	1	R	—	—	—
Full Needs	1	—	—	—	—	—	—	—
Constrained Fund (no mandatory improvements)	0	1	—	0	—	R	—	—
Constrained Fund (with mandatory improvements)	0	1	—	1	—	R	R	—
Performance Constrained (no mandatory improvements)	0	2	0	0	—	R	—	R
Performance Constrained (with mandatory improvements)	0	2	0	1	—	R	—	R
Maintain Performance (no mandatory improvements)	0	2	1	0	—	—	—	R
Maintain Performance (with mandatory improvements)	0	2	1	1	—	—	—	R

Where: "R" indicates a value or values are required; "—" indicates that this field will be ignored.

APPENDIX D - Output Files

D.1 SYSTEMS CONDITIONS OUTPUT

The standard output describing the condition of the highway system appears in several guises. The first presents the initial condition of the highway system as contained in the input HPMS data. The same format is used to present the state of the system after each funding period, and also to detail the changes that have occurred for each data item during the course of the funding period. Both of these pages are printed for each funding period. Finally, a page is printed detailing the changes between the initial condition of the system and the state of the system at the end of the overall analysis period. Thus, this format would be used to print ten pages for each four funding period run.

The system conditions output page summarizes the following information for each functional class, with rural and urban subtotals, and an overall total:

- System conditions — system miles; average PSR and IRI; average speed; congestion and total delay; and vehicle miles traveled.
- User costs — user costs per thousand vehicle miles are listed for: travel time costs; operating costs (for four-tire vehicles, trucks, and all vehicles); crash costs; and total user costs.
- Safety rates — rates per 100 million vehicle miles for crashes, injuries, and fatalities.
- Agency costs — the average annual maintenance costs per mile.
- External costs — the average cost of damage due to vehicle-induced air pollution per thousand vehicle miles.
- VMT below USTs — the percentage of vehicle miles traveled which occurs below the minimum tolerable conditions (specified in PARAMS.DAT) for PSR; V/C ratio; lane width; shoulder width; shoulder type; surface type; and horizontal and vertical alignment.[23]

For constrained fund runs, the model prints the benefit-cost ratio of the last selected improvement at the bottom of the “Changes During Period” page. This is the lowest BCR selected: all other improvements selected during the period have higher BCRs. This output reflects the CSpec setting: if, for example, CSpec was set to indicate that HERS-ST should consider rural and urban sections separately, separate lowest BCRs for rural and urban sections groups would be shown. For performance-constrained runs, HERS-ST would output, in addition to the BCR of the last selected improvement, the performance goal specified (which may have been user-supplied or, if maintain current conditions, calculated by HERS), and the performance level achieved. Again, the goals specified and levels achieved reflect the CSpec setting.

D.2 FUNCTIONAL CLASS BY IMPROVEMENT TYPE OUTPUT

The second format for printed HERS-ST output is organized by functional class (columns) and improvement type (rows). The upper portion of each page reports data for all improvements; the lower portion reports for only those sections on which all or a portion of the section's alignment was improved. HERS-ST uses this format to present two types of data: summary data about the improvements selected during each funding period; and data expressing the effects of the selected improvements on the improved sections during the last year of the funding period.

The twenty-one pages printed in this format are optional, and seven of them can be specified for the overall analysis period.

D.2.1 Summary Data About Selected Improvements

These ten output pages provide information about the improvements HERS-ST has selected for implementation during each funding period. The topics generally quantify the aggregated selected improvements: how many miles, how much capital investment, etc.

[23] The horizontal alignment failure rates for urban collectors and minor arterials and the vertical alignment failure rates for all urban sections are zero, since HERS-ST (like HPMS) does not incorporate any standards for evaluating the alignment adequacy of these sections

D.2.2 Effects of Implementing Improvements

The specific pages which present estimates of the costs and benefits of implementing improvements are presented as the annual costs and benefits in the last year of the funding period that result from implementing all improvements in the middle of the period.

These pages of output indicate that, although improvements are selected only if they produce overall benefits, at least some selected improvements may increase certain types of costs (shown as negative benefits in the tables). In particular, adding lanes to urban sections generally increases the number of fatalities (due to higher speeds). Also, adding lanes to urban or rural sections sometimes increases the number of crashes and the number of injuries occurring and can increase maintenance costs. Although net reductions in vehicle operating costs are usually appreciable, on some sections these costs show a net increase (due to higher operating speeds) and so some negative entries may appear in the "Operating-Cost Savings" table. Similarly, the increased traffic on improved sections may result in more safety incidents (even despite a decrease in the rates of safety incidents) and negative entries in the safety benefits pages.

The "VMT on Improved Sections" page of optional output presents forecast VMT for the last year of the funding period for sections improved during the period. These forecasts are presented by functional system and improvement type in the same format used for presenting the costs and benefits of the improvements. The VMT forecasts can be used in conjunction with the estimates of costs and benefits to derive estimates of costs and benefits per vehicle mile for improved sections by functional system and improvement type.

D.2.3 Output Statistics by IBCR Range

This output format is arranged similarly to the previous (functional classes in columns, and improvement type in rows), with the addition of, for each improvement type, seven different ranges of IBCR values:

- 1.0 — 1.2
- 1.2 — 2.0
- 2.0 — 3.0
- 3.0 — 4.0
- 4.0 — 5.0
- 5.0 — 6.0
- greater than 6.0

There is also a total row for each improvement type, and an "Overall" section which contains information for all improvement types by IBCR range. The additional rows result in a format which prints on two pages.

These pages provide a profile of the benefits returned per the capital invested in the improvements. They include only the non-mandatory improvements: mandatory improvements, which do not have to pass any minimum BCR threshold, would often fall below the lowest IBCR range of 1.0.

The "Travel-Time Benefits to User-Benefits Ratios" page expresses, within each IBCR range, the percentage of total user benefits (which includes travel-time savings, operating cost savings, and safety benefits) which is derived from travel-time savings. It also demonstrates the complexity which often accompanies interpretation of the HERS-ST output. At first glance, the user might well be puzzled by the presence of both negative percentages and percentages greater than 100 in the output data.

The negative percentages can arise when the total user benefits are negative. This would usually be driven by safety benefits, which are often negative, reflecting the greater number of accidents at high speed. Coupled with a positive benefit from travel-time savings, this yields a negative percentage. But if total user benefits are negative, why was the improvement selected? The other benefit components are agency costs, residual value, and emission benefits: a large enough sum of these can produce positive benefits which, if the capital costs are modest, could qualify the improvement.

Similarly, a significant safety dis-benefit could result in a positive sum of total user benefits which is less than the travel-time benefit. This produces travel-time benefits which are greater than 100% of the total user benefit.

Table D-1 Section File Format and Column Headings

Field	Column Heading	Data Type
Section Identification		
1. Record number	RECNO	I
2. County code	CNTY	I
3. Section identification	SECID	A
4. Sample identifier	SAMPID	A
5. LRS identification	LRSID	A
6. LRS beginning point	BEGMP	F
7. LRS ending point	ENDMP	F
Deficiencies		
8. PSR	PSR0	F
9. Volume/Capacity ratio	VCR0	F
10. Lane width	LW0	I
11. Shoulder type	SHLT0	I
12. Right shoulder width	RSHLW0	I
13. Horizontal alignment adequacy	HORA0	I
14. Vertical alignment adequacy	VERA0	I
Improvement		
15. Improvement type	ITYPE	I
16. Lanes added	LADD	I
17. Increase in capacity	CAPINC	F
18. Type of selection	TYPSEL	I
19. BCR	BCR	F
Characteristics at End of FP		
20. Volume/Capacity ratio	VCR	F
21. Average speed	SPD	F
22. PSR	PSR	F
23. IRI (inches/mile)	IRI	F
24. Total lanes	TLAN	I
25. Peak lanes - peak direction	PLAN	I
26. Peak lanes - opposite direction	CPLAN	I
27. Peak capacity - peak direction	PCAP	F
28. Peak capacity - opposite direction	CPCAP	F
29. Off-peak capacity	OPCAP	F
30. Access control	ACCESS	I
31. Lane width	LWID	I
32. Shoulder type	SHLT	I
33. Right shoulder width	RSHLW	I
34. Median type	MEDT	I
35. Median width	MEDW	I
36. Widening feasibility	WFEAS	I
37. Horizontal alignment adequacy	HORA	I
38. Vertical alignment adequacy	VERA	I
39. AADT	AADT	F
40. Emissions costs	EMC	F
Costs and Benefits		
41. Improvement cost	IMPC	F
42. Emissions benefits	EMB	F
43. Travel-time benefits	TTB	F
44. Operating-cost benefits	OPCB	F
45. Safety benefits	SAFB	F
46. Total benefits	TOTB	F
State Control Field		
47. State control field	SCF	A

D.3 THE SECTION FILES

The first data item in each record contains the record number of the HPMS file containing the original description of the section. This number may be useful in locating the record.

Items 2 - 7 contain additional identification of the section. These items are obtained from Items 6, 5, 47, and 10 - 12 of the corresponding HPMS record.

Items 8 - 14 identify deficiencies that will exist by the end of the FP if the section is not improved, except PSR0, which is the same as that in the HPMS input record (it is the value at the beginning of the funding period under analysis). Four of these items (PSR, lane width, shoulder type, and right shoulder width) correspond to items in the HPMS file. Volume/capacity (v/c) ratio (Item 8) is HERS' estimate of the ratio of design-hour volume to peak-period hourly capacity. Horizontal and vertical alignment adequacy (Items 12 and 13) are either derived from information supplied on curves and grades by class (input Items 63 - 68 and 72 - 77) or they are obtained from the input values for horizontal and vertical alignment adequacy (input Items 69 and 71). In both cases, they use the HPMS codes for alignment adequacy. A simplified description of these codes[24] is:

1. All curves (or grades) meet design standards.
2. Some curves (or grades) do not meet design standards, but they do not affect speed or safety.
3. Infrequent curves (or grades) affect speed or safety.
4. Several curves (or grades) affect speed or safety.

Items 8 - 14 are printed only when the corresponding characteristic of the section is or will be deficient by the end of the FP. Otherwise, asterisks are printed in these fields. The next five items describe the improvement that is finally selected for the section, if any. If one or more potential improvements are identified but none are selected, these items describe the rejected improvement with the highest BCR. If no potential improvement is evaluated in this FP, these items are blank. The use of these items when an improvement is selected is described below:

15. *Improvement typ*e. A code identifying the type of improvement. The codes used for the improvement types that can be generated in basic runs are shown in the last two columns of Table A-5. As discussed in paragraph 8.2.2, in override runs, the HERS-ST user may introduce additional codes to represent other types of (user-specified) improvements. The improvement types shown in Table A-5, are the only ones analyzed by the National HERS system. In Chapter 8, these improvement types are referred to as "HERS-type" improvements.

16. *Lanes added* is the number of lanes added by the improvement (if any).

17. *Increase in capacity.* The increase in peak-period peak-direction capacity (if any) produced by this improvement.

18. *Type of selectio*n. This field identifies the roles played by HERS-ST and the user in the improvement selection process. The codes used by HERS-ST 2.0 are:

    0. Improvement was evaluated by HERS-ST but not selected.
    1. Improvement was selected by HERS-ST.
    2. Improvement was specified by user. (User requested HERS-ST *not* to add additional options).
    3. Improvement was requested by user; HERS-ST did not find any cost-effective options to add.
    4. Improvement combines options requested by user with options added by HERS.
    5. Improvement combines a HERS-ST selection for this FP with a Type 1, 2 or 6 improvement requested by the user for a subsequent FP.

[24] More formal descriptions of the alignment adequacy codes are contained in FHWA, *Highway Performance Monitoring System Field Manua*l, December 2000.

It should be noted that HERS-ST ST 2.0 produces information about some improvements that were *not* selected.

*19. BC*R. Normally, the BCR of the improvement is the discounted present value (at the time of improvement implementation) of the sum of the user and agency benefits of the improvement divided by the implementation costs. An exception occurs when the system is operating under a funding constraint or with a performance goal (i.e., when objective type is 1 or 2) and two (or more) alternative improvements are provisionally selected for a section in sequence. In this case, the BCR of the improvement is an *incremental* BCR; i.e., it is derived from the incremental benefits and costs of choosing the improvement that is finally selected to replace the last previous improvement that had been provisionally selected.

The next 21 items describe the section at the end of the FP. Items 22 - 25, 27, 30 - 36, and 39 correspond to items in the HPMS file. Items 20, 37, and 38 correspond to Items 9, 13, and 14 of the SECNSnn file and are described above. Items 21 and 40 are the program's estimates of: the overall average speed on the section (in mph); and the external costs of emissions in the last year of the FP generated by vehicles using the section (in thousands of dollars). Item 39 is HERS' estimate of AADT at the end of the FP.

Item 26 is the number of "counterpeak" lanes; i.e., the number of peak-period lanes in the "non-peak" direction. This value is usually obtained by subtracting the number of peak lanes in the peak direction (Item 25) from the total number of (off-peak) through lanes (Item 24). However, for some sections, HERS-ST infers the likely existence of extra peak-period lanes resulting from parking restrictions or use of shoulders as travel lanes during the peak period. For these sections, total peak lanes (Items 25 and 26) will exceed (off-peak) through lanes (Item 24). For rural sections with less than four lanes, "peak" lanes represent the total number of lanes in both directions, and counterpeak lanes equals zero.

Corresponding to peak, counterpeak, and through lanes are three values of capacity: peak, counterpeak, and off-peak capacity (Items 27 - 29). For rural roads with less than four lanes, the peak and off-peak capacities are two-way capacity, and counterpeak capacity is zero. For all other roads, the three capacities are one-way capacities. Peak capacity is the capacity coded in the HPMS record. Off-peak and counterpeak capacities may be equal to or smaller than peak capacity.

The next part of the record contains information about the costs and benefits of any improvement. The first of these fields contains improvement costs (in thousands of dollars) supplied by the user and/or estimated by the program. When section-specific estimates of improvement costs are not supplied by the user (in the STATEIMP.DAT file), the HERSST program estimates the costs of improvements using cost information provided in the IMPRCOST.DAT and PARAMS.DAT files. (See Section Appendix B.)

When section-specific estimates of improvement costs for a specific improvement are supplied by the user in the STATEIMP.DAT file, these costs are used for that improvement. If the HERSST program chooses to combine this improvement with an additional widening option, the *incremental* cost of this option is estimated using the costs supplied in the IMPRCOST.DAT and PARAMS.DAT files. If the program chooses to add alignment improvements to the section, the incremental costs of the alignment improvement are estimated and added to the total.

The next five fields are the program's estimates of the user and external benefits of the improvement in the last year of the FP, in thousands of dollars. Separate estimates are provided of benefits because of reductions in emissions costs, travel time, operating costs, and crash costs, along with the sum of all four types of benefits. Negative values in the fields for emissions benefits or safety benefits indicate an estimated *increase* in emissions or safety costs. For improvements that are estimated by the program to result in increased use of the section, estimated benefits include the benefits to new users of the section (estimated per new vehicle to equal half the per-vehicle benefits to old users). If no potential improvement is evaluated in the FP, these fields are blank.

The final field of the record reproduces the contents of the State Control Field (Field 8 of the HPMS record).

Table D-2 .SS1 File Acronyms

Acronym	Meaning
APSR	Average PSR
AIRI	Average IRI (inches per mile)
ASPD	Average Speed
CONG	Congestion Delay (hours per 1000 VMT)
TDEL	Total Delay (hours per 1000 VMT)
VMT	VMT (in user-selected units: millions, thousands, or billions)
TTC	Travel Time Costs ($ per 1000 VMT)
4TOC	4-Tire Vehicle Operating Costs ($ per 1000 VMT)
TKOC	Truck Operating Costs ($ per 1000 VMT)
AVOC	Operating Costs — All Vehicles ($ per 1000 VMT)
CRAC	Crash Costs ($ per 1000 VMT)
TUC	Total User Costs ($ per 1000 VMT)
CRAR	Crash Rate (per 100 million VMT)
ICR	Injury Rate (per 100 million VMT)
FCR	Fatality Rate (per 100 million VMT)
MNT	Average Annual Maintenance Costs ($ per mile)
EMIC	Average Pollution Damage Cost ($ per 1000 VMT)
%PSR	% VMT below User Specified Thresholds (USTs) for PSR
%VC	% VMT below USTs for Volume/Capacity Ratio
%LNW	% VMT below USTs for Lane Width
%SHW	% VMT below USTs for Shoulder Width
%SHT	% VMT below USTs for Shoulder Type
%SFT	% VMT below USTs for Surface Type
%HAL	% VMT below USTs for Horizontal Alignment
%VAL	% VMT below USTs for Vertical Alignment

APPENDIX E - Predefined Queries and Charts

Table E-1 Predefined Queries

Name	Source	Description
Average Annual Funding	Improvement Costs (SS2)	This query retrieves the *Total Initial Cost* of the design period and divides it by the length of the design period. The length of the design period is the length of the funding period multiplied by the number of funding periods. One value is returned per iteration.
Average PSR	System Conditions (SS1)	This query retrieves the *Average Total PSR (APSR)* of the last funding period. One value is returned per iteration.
Average Effective Speed	System Conditions (SS1)	This query retrieves the *Total Overall Average Speed (ASPD-Overall)* of the last funding period. One value is returned per iteration.
Congestion Delay	System Conditions (SS1)	This query retrieves the *Total Congestion Delay (DEL-Other)* of the last funding period. One value is returned per iteration.
Average Crash Rate	System Conditions (SS1)	This query retrieves the *Total Average Crash Rate (CRAR)* of the last funding period. One value is returned per iteration.
Average Annual User Costs	System Conditions (SS1)	This query retrieves the *Total User Costs (TUC)* and *Vehicle Miles Traveled (VMT)* of the last funding period and multiplies them together. The result is divided by the length of the design period. The length of the design period is the length of the funding period multiplied by the number of funding periods. One value is returned per iteration.
User Benefits	Improvement Costs (SS2)	This query retrieves the *Total Initial Cost* and the *Total Average Benefit/Cost Ratio* for the design period and multiplies them together. The result is divided by the length of the design period. The length of the design period is the length of the funding period multiplied by the number of funding periods. One value is returned per iteration.
Volume/Capacity Ratio	System Conditions (SS1)	This query retrieves *Percent of Deficient VCR Miles (%Miles-VCDL)* of the last funding period. One value is returned per iteration.
Total Initial Cost	Improvement Costs (SS2)	This query retrieves *Total Initial Cost* for the design period. One value is returned per iteration.
Minimum BCR	Run Iterations	This query retrieves the value of the minimum Benefit/Cost Ratio used for the run iterations of a multiple minimum BCR configuration. A configuration for a single run will return a 0. One value is returned per iteration.

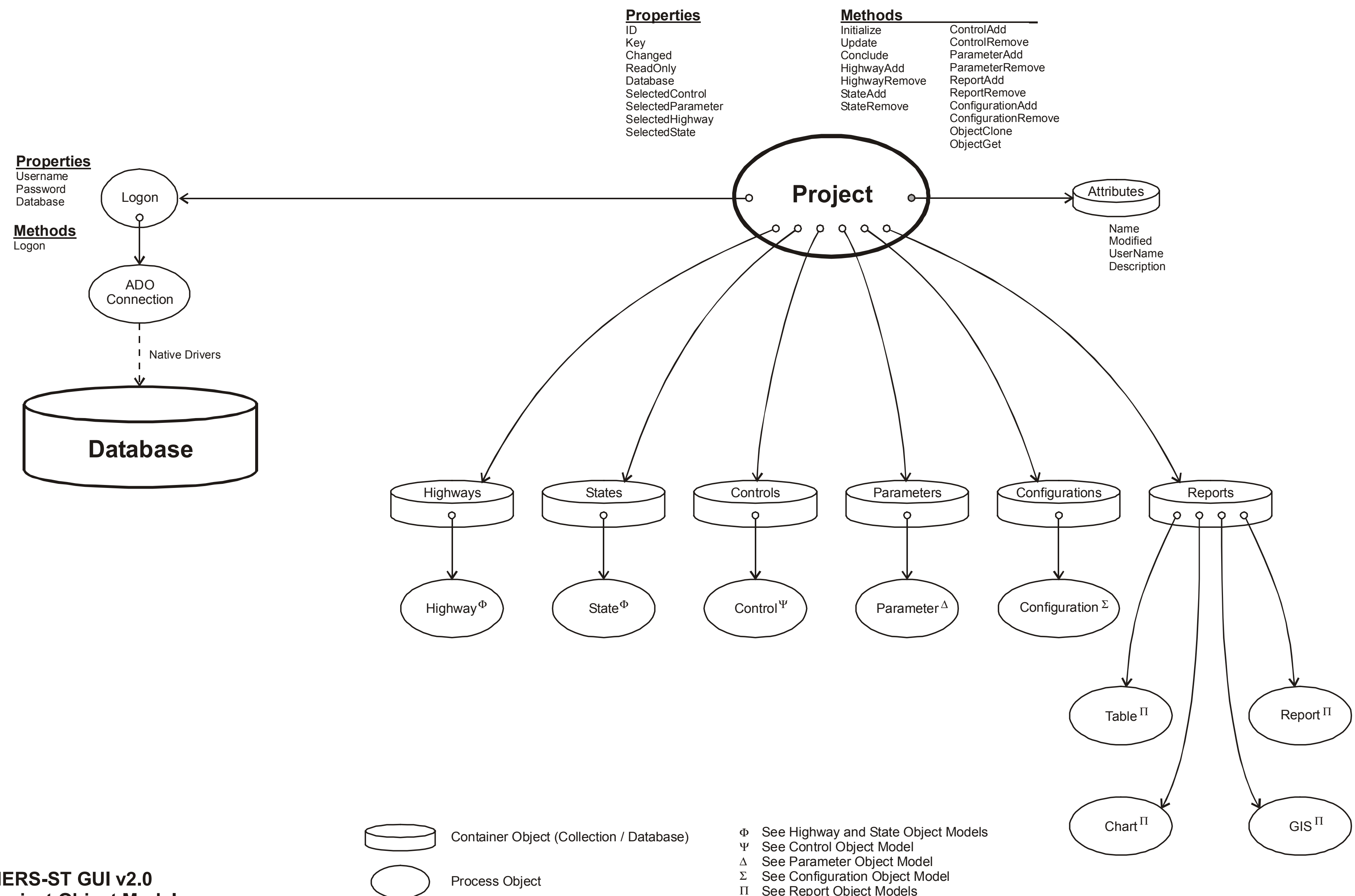
Table E-2 Predefined Charts (Multiple Run)

Name	Axis	Description
Annual Investment vs. Pavement Conditions	X-Axis	Result of Average Annual Funding query.
	Y-Axis	Result of *Average PSR* query.
Annual Investment vs. Effective Speed	X-Axis	Result of Average Annual Funding query.
	Y-Axis	Result of Average Effective Speed query.
Annual Investment vs. Congestion Delay	X-Axis	Result of Average Annual Funding query.
	Y-Axis	Result of *Congestion Delay* query.
Annual Investment vs. Crash Rate	X-Axis	Result of Average Annual Funding query.
	Y-Axis	Result of Average Crash Rate query.
Annual Investment vs. User Costs	X-Axis	Result of Average Annual Funding query.
	Y-Axis	Result of Average Annual User Costs query.
Annual Investment vs. User Benefit	X-Axis	Result of Average Annual User Costs query.
	Y-Axis	Result of *User Benefits* query.
Annual Investment vs. Volume/Capacity Ratio	X-Axis	Result of Average Annual User Costs query.
	Y-Axis	Result of Volume/Capacity Ratio query.
Annual Investment vs. System-Wide Backlog	X-Axis	Result of Average Annual User Costs query.
	Y-Axis (Plot1)	Query SS1 for the *Percent of Deficient PSR Miles (%MILES-PSRDL)* of the last funding period. One value is returned per iteration.
	Y-Axis (Plot2)	Query SS1 for the *Percent of Deficient VCR Miles (%MILES-VCDL)* of the last funding period. One value is returned per iteration.
	Y-Axis (Plot3)	Query SS1 for the *Percent of Deficient Horizontal Alignment Miles (%MILES-HORALIGNDL)* of the last funding period. One value is returned per iteration.
	Y-Axis (Plot4)	Query SS1 for the *Percent of Deficient Vertical Alignment Miles (%MILES-VERTALIGNDL)* of the last funding period. One value is returned per iteration.
Initial Costs vs. Minimum BCR	X-Axis	Result of *Total Initial Cost* query.
	Y-Axis	Result of *Minimum BCR* query.

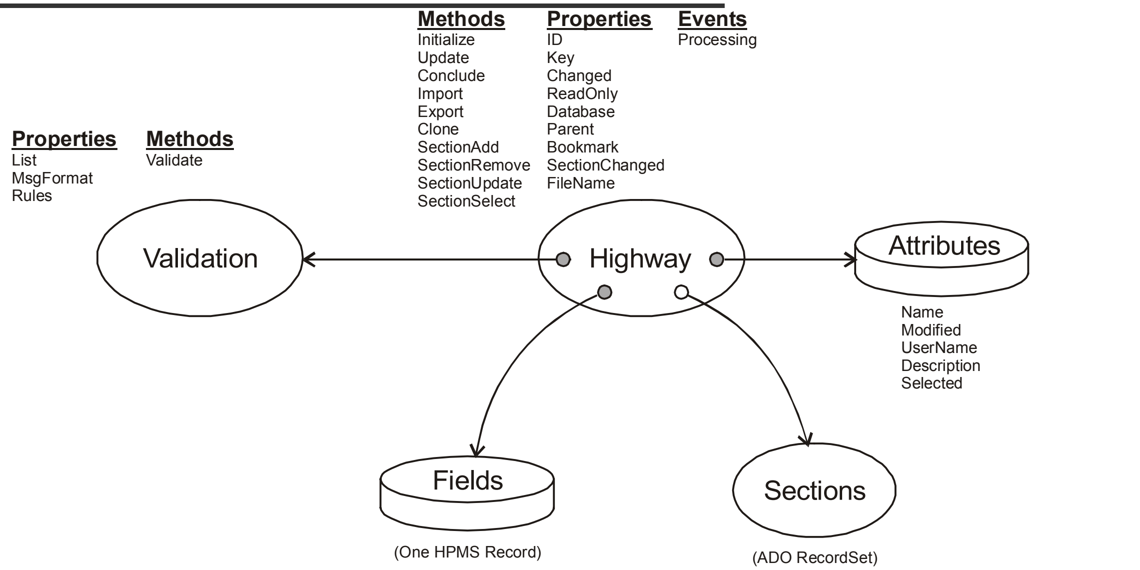
Table E-3 Predefined Charts (Single Run)

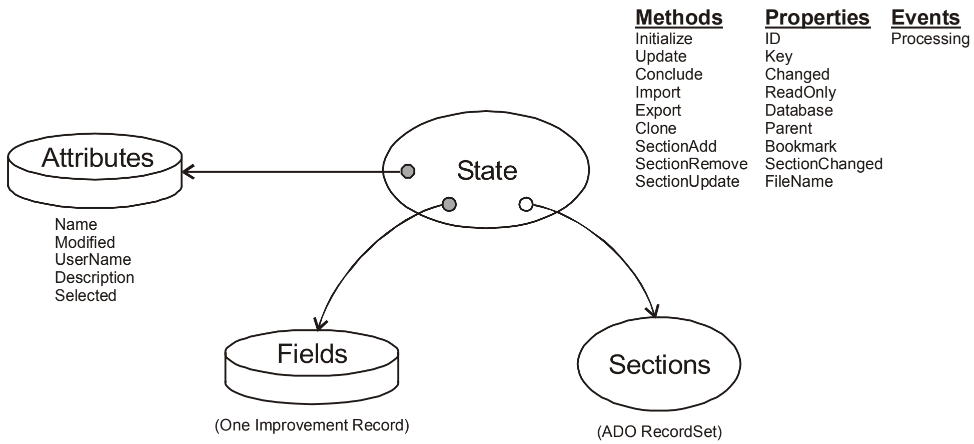
Name	Axis	Description
Funding Level per Improvement Type	X-Axis	Improvement Types.
	Y-Axis (Bar 1)	Query SS2 for the *Initial Cost* for each improvement type for the first funding period. Ten values are returned, one for each improvement type.
	Y-Axis (Bar n)	Repeat previous query for each funding period.
Backlog per Funding Period	X-Axis	Funding Periods.
	Y-Axis (Bar 1)	Query SS1 for the *Percent of Deficient PSR Miles (%MILES-PSRDL)* for each funding period. One value is returned per funding period.
	Y-Axis (Bar 2)	Query SS1 for the *Percent of Deficient VCR Miles (%MILES-VCDL)* for each funding period. One value is returned per funding period.
	Y-Axis (Bar 3)	Query SS1 for the *Percent of Deficient Horizontal Alignment Miles (%MILES-HORALIGNDL)* for each funding period. One value is returned per funding period.
	Y-Axis (Bar 4)	Query SS1 for the *Percent of Deficient Vertical Alignment Miles (%MILES-VERTALIGNDL)* record for each funding period. One value is returned per funding period.

APPENDIX F - Object Diagrams

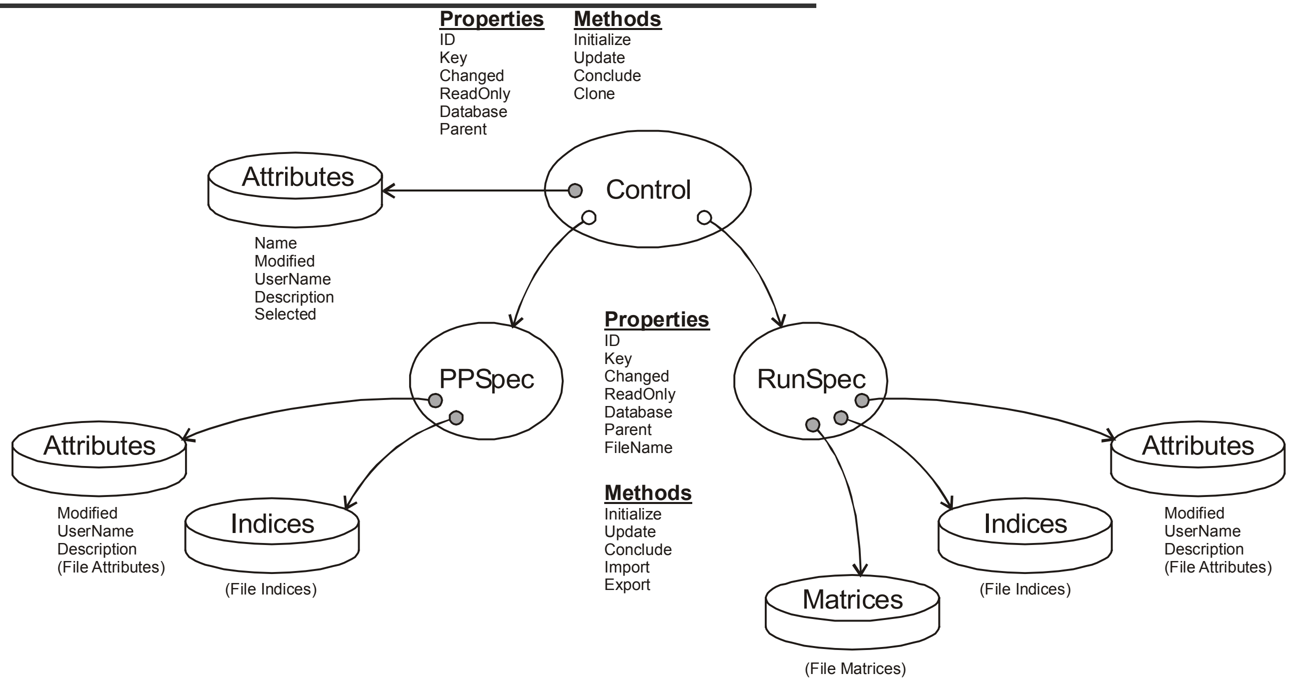


HERS-ST GUI v2.0
Project Object Model

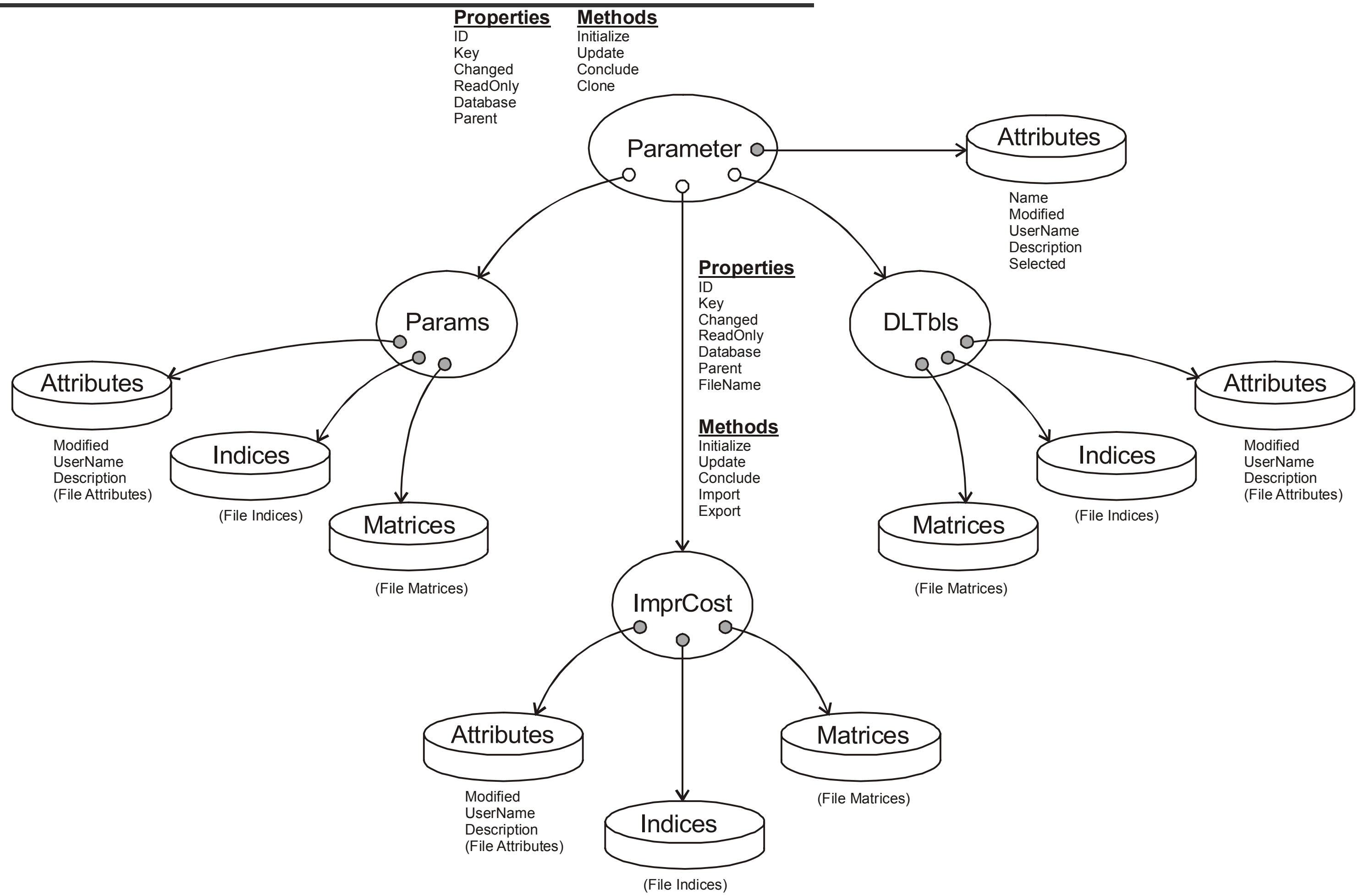




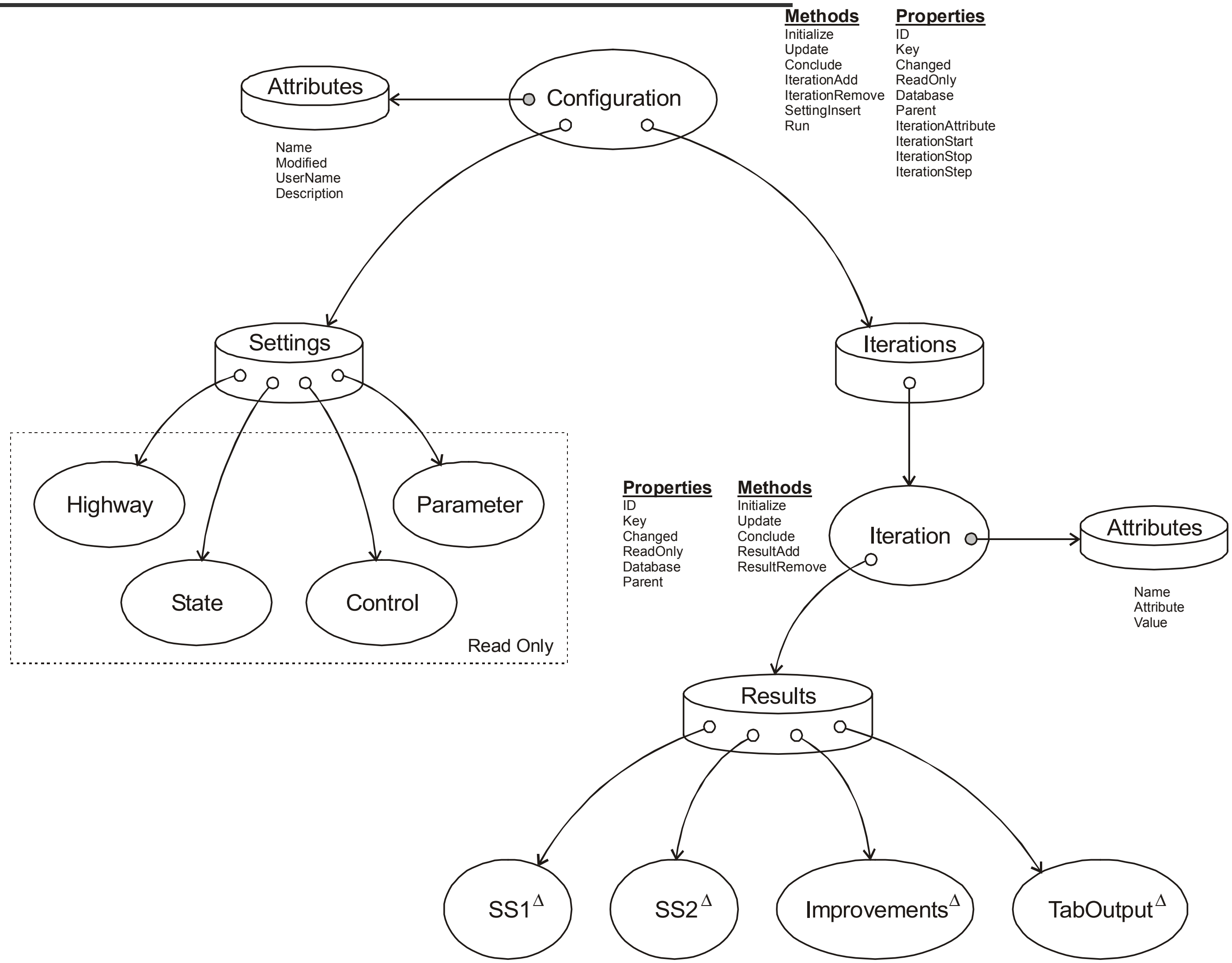
HERS-ST GUI v2.0
Highway and State Object Models



HERS-ST GUI v2.0
Control Object Model

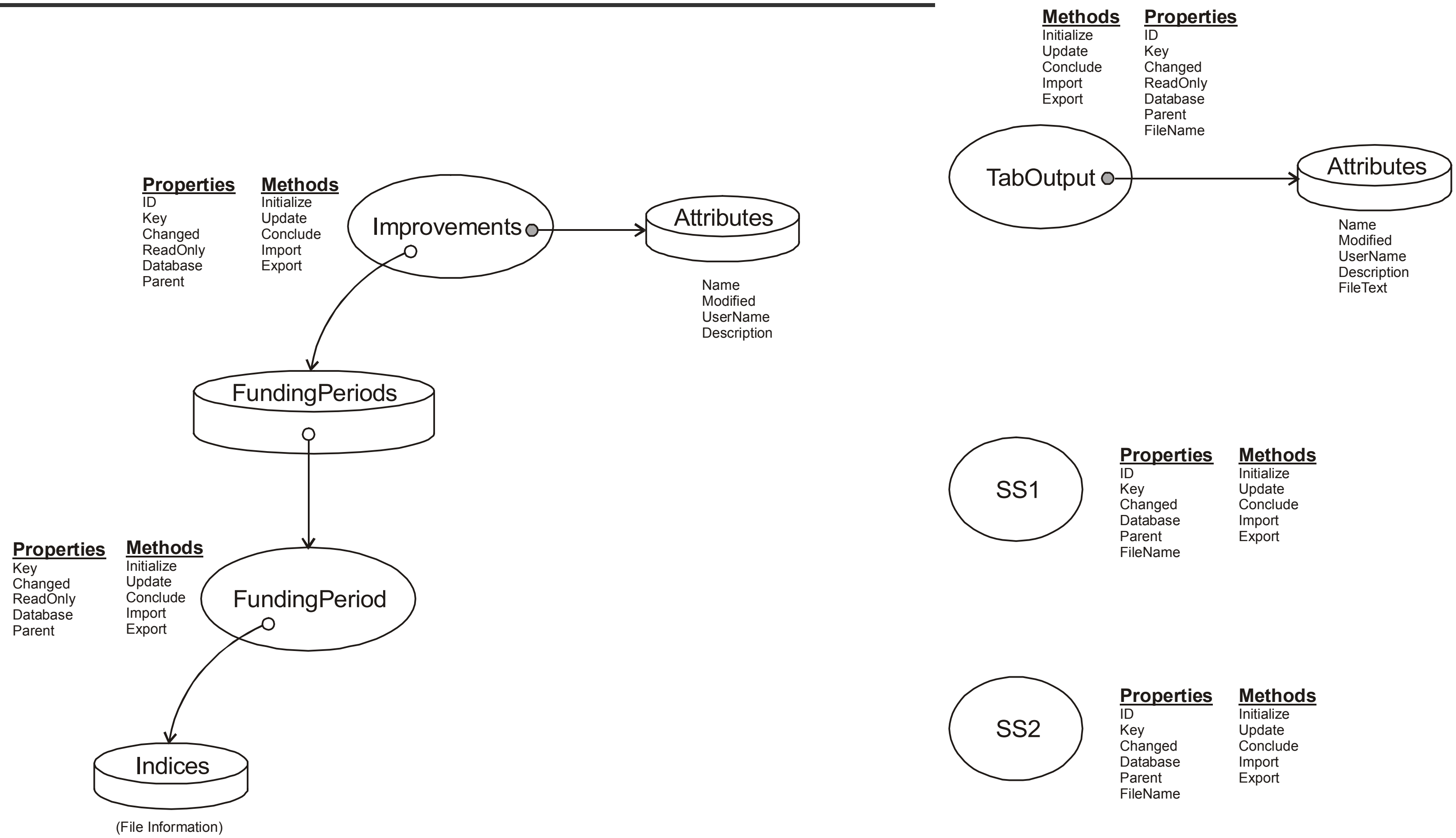


HERS-ST GUI v2.0
Parameter Object Model

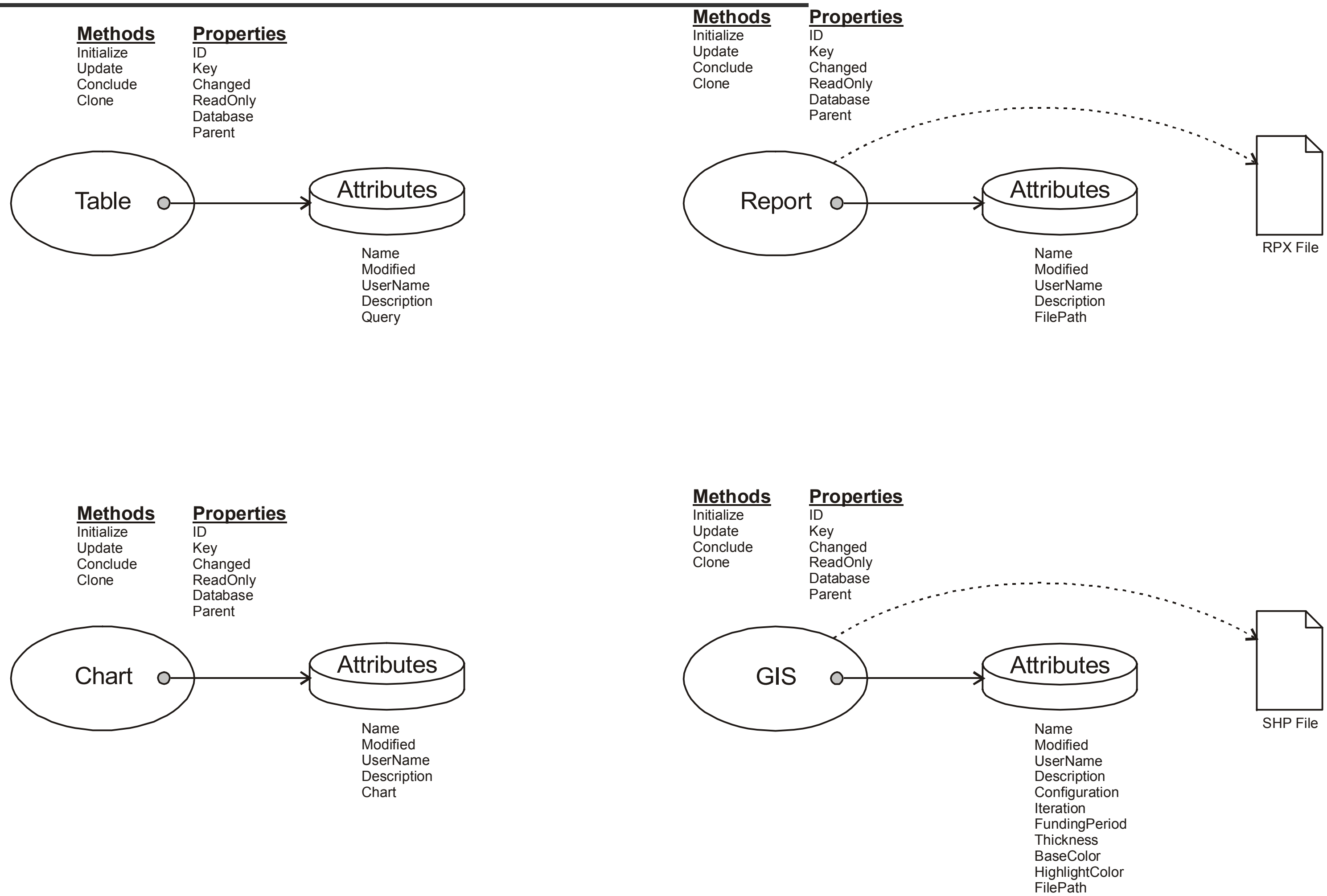


HERS-ST GUI v2.0
Configuration Object Model

Δ See Result Object Models



HERS-ST GUI v2.0
Result Object Models



HERS-ST GUI v2.0
Report Object Models

APPENDIX G - Third Party Controls and Components

File	Description	Version	Vendor
dbc32.lic	License file for dbGIS	N/A	Abaco srl
dbcdbf32.dll	Dbase Driver	1.600.0.0	Abaco srl
dbcdib32.dll	Device Independent Bitmap Drivers	1.600.0.0	Abaco srl
dbcdll32.dll	Function Library	1.600.0.0	Abaco srl
dbcdwg32.dll	AutoCAD dwg Drivers	1.600.0.1	Abaco srl
dbcdxd32.dll	? Drivers	1.600.0.0	Abaco srl
dbcgdi32.dll	GDI Drivers	1.600.0.0	Abaco srl
dbcgeo32.dll	GIS Drivers	1.600.0.1	Abaco srl
dbclst32.dll	LST Drivers	1.600.0.0	Abaco srl
dbcocx32.ocx	DbCAD dev Control	1.600.0.0	Abaco srl
dbctif32.dll	TIF Drivers	1.600.0.0	Abaco srl
ngshpdrv.dll	Shape file drivers	1.5.1.0	Abaco srl
olch2x7.ocx	Chart 7.0 2D OLE/ActiveX Control	7.0.23.0	ComponentOne
vsflex7.ocx	VSFlexGrid 7.0 Pro (ADO Bound)	7.0.1.151	ComponentOne
vsflex7l.ocx	VSFlexGrid 7.0 Pro (Light)	7.0.0.78	ComponentOne
vsprint7.ocx	VSPrinter7	7.0.0.49	ComponentOne
vsvport7.ocx	VSViewPort7	7.0.0.4	ComponentOne
ab2dll.dll	ActiveBar 2.0 Control	2.0.1.1111	Data Dynamics
ardespro2.dll	Active Reports Design Time Components	2.0.0.1170	Data Dynamics
arpro2.dll	Active Reports	2.0.0.1170	Data Dynamics
arview2.ocx	Active Reports View Control	2.0.0.1170	Data Dynamics
excelexpt.dll	Microsoft Excel export filter	2.0.0.1160	Data Dynamics
htmlexpt.dll	HTML export filter	2.0.0.1154	Data Dynamics
pdfexpt.dll	Adobe Acrobat export filter	2.0.0.1159	Data Dynamics
proplist.ocx	Property List box Control	1.0.0.1168	Data Dynamics
rtfexpt.dll	RTF export filter	2.0.0.1165	Data Dynamics
textexpt.dll	Text Export Filter	2.0.0.1159	Data Dynamics
pvtreex.ocx	TreeViewX v8.0	8.0.4.0	Infragistics
asycfilt.dll	Asynchronous Filters	2.40.4517	Microsoft
comcat.dll	Component Category Manager Library	5.0.2195.1	Microsoft
comdlg32.ocx	Common Dialog	6.0.84.18	Microsoft
mfc42.dll	Foundation Class Library	6.0.8665.0	Microsoft
mscomct2.ocx	Common Controls 2	6.0.88.4	Microsoft
mscomctl.ocx	Common Controls	6.0.88.62	Microsoft
msflxgrd.ocx	FlexGrid	6.0.84.18	Microsoft
msvbvm60.dll	Visual BASIC 6.0 virtual machine	6.0.89.64	Microsoft
msvcrt.dll	C Run-Time	6.1.9359.0	Microsoft
oleaut32.dll	OLE Automation	2.40.4517.0	Microsoft
olepro32.dll	OLE Pro	5.0.4517.0	Microsoft
scrrun.dll	Scripting Runtime	5.6.0.6626	Microsoft
stdole32.tlb	Standard OLE Type Library	2.10.3027.1	Microsoft
sysinfo.ocx	System Info	6.0.81.69	Microsoft
tabctl32.ocx	Tab Control 32-Bit	6.0.90.43	Microsoft
siqrybld.ocx	QueryBuilder	2.0.0.129	SiLogic

APPENDIX H - Data Dictionary

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdConfigurationItems	fnItemID	Long Integer	4	Yes	No	Unique number assigned to each detail of a configuration
tdConfigurationItems	fwConfigID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdConfigurations)
tdConfigurationItems	fsRefClass	Text	50		No	Refers to the object type (bcoHighwayDS, bcoControl, bcoParameter, bcoStateDS) and corresponding table. Paired with fwRefID to relate to specific record.
tdConfigurationItems	fwRefID	Long Integer	4		No	Combined with fsRefClass, points to a specify object in another table
tdConfigurations	fnConfigID	Long Integer	4	Yes	No	Unique number assigned to each Configuration
tdConfigurations	fwProjectID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdProjects)
tdConfigurations	fsName	Text	50		No	User-specified name of a specific configuration
tdConfigurations	fsDescription	Text	255		Yes	User-specified description of a specific configuration
tdConfigurations	fsUserName	Text	50		No	User whom last modified the object
tdConfigurations	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdControlModels	fnModelID	Long Integer	4	Yes	No	Unique number assigned to each Control Model
tdControlModels	fsName	Text	50		No	User-specified name of the control model
tdControlModels	fsDescription	Text	255		Yes	User-specified description of the control model
tdControlModels	fsUserName	Text	50		No	User whom last modified the object
tdControlModels	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdControlObjects	fnControlID	Long Integer	4	Yes	No	Unique number assigned to each Control Model detail
tdControlObjects	fwModelID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdControlModels)
tdControlObjects	fsClass	Text	50		No	Object type (bcoPPSpec or bcoRunSpec)
tdControlObjects	fsDescription	Text	255		Yes	User-specified description of the control model files
tdControlObjects	foFile	Memo			No	Stores delimited text of data contained in a single control model file, either PPSpec or RunSpec
tdControlObjects	fsUserName	Text	50		No	User whom last modified the object
tdControlObjects	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdFuncClassByImp	fnFuncClassByImpID	Long Integer	4	Yes	No	Unique number assigned to each Functional Class by Improvement Type (SS2) data file
tdFuncClassByImpDets	fnFuncClassDetID	Long Integer	4	Yes	Yes	Unique number assigned for each SS2 detail
tdFuncClassByImpDets	fwFuncClassByImpID	Long Integer	4		Yes	Foreign Key which ties record to higher level table (tdFuncClassByImp)
tdFuncClassByImpDets	fsFundingPeriod	Text	20		Yes	Funding Period
tdFuncClassByImpDets	fsCategory	Text	10		Yes	Indicates sub grouping of data (Initial Cost or Average BCR)
tdFuncClassByImpDets	ImpType	Text	100		Yes	Improvement Type
tdFuncClassByImpDets	RuralInt	Single	4		Yes	Rural Interstate
tdFuncClassByImpDets	RuralOPA	Single	4		Yes	Rural - Other Principal Arterial
tdFuncClassByImpDets	RuralMA	Single	4		Yes	Rural - Major Arterial

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdFuncClassByImpDets	RuralMajCol	Single	4		Yes	Rural - Major Collector
tdFuncClassByImpDets	RuralTotal	Single	4		Yes	Rural Total
tdFuncClassByImpDets	UrbanInt	Single	4		Yes	Urban - Interstate
tdFuncClassByImpDets	UrbanOFE	Single	4		Yes	Urban - Other Freeway or Expressway
tdFuncClassByImpDets	UrbanOPA	Single	4		Yes	Urban - Other Principal Arterial
tdFuncClassByImpDets	UrbanMA	Single	4		Yes	Urban - Other Major Arterial
tdFuncClassByImpDets	UrbanCol	Single	4		Yes	Urban - Collector
tdFuncClassByImpDets	UrbanTotal	Single	4		Yes	Urban - Total
tdFuncClassByImpDets	Total	Single	4		Yes	Total
tdGIStemp	Key	Text	50		No	For internal use. Refers to object using the temp data
tdGIStemp	ShapeID	Long Integer	4		No	ID of each shape from the spatial data
tdGIStemp	fnSectCondDetID	Long Integer	4	Yes	No	Unique number assigned to each section in the Sections data
tdGIStemp	fwSectCondID	Long Integer	4		No	Relates information to high level info in table (tdSectionConditions)
tdGIStemp	fwFundingPeriod	Integer	2		No	Funding Period of Improvement
tdGIStemp	RECNO	Long Integer	4		No	Record Number
tdGIStemp	CNTY	Long Integer	4		No	County Code (from Highway Data)
tdGIStemp	SECTID	Text	14		No	Section Identification (from Highway Data)
tdGIStemp	SAMPID	Text	14		No	Sample Identifier (from Highway Data)
tdGIStemp	LRSID	Text	14		No	LRS Identification (from Highway Data)
tdGIStemp	BEGMP	Single	4		No	LRS Beginning Point (from Highway Data)
tdGIStemp	ENDMP	Single	4		No	LRS Ending Point (from Highway Data)
tdGIStemp	PSR0	Single	4		No	Original Present Serviceability Rating (from Highway Data)
tdGIStemp	VCR0	Single	4		No	Original Volume Capacity ration (from Highway Data)
tdGIStemp	LW0	Long Integer	4		No	Original Lane Width (from Highway Data)
tdGIStemp	SHLT0	Long Integer	4		No	Original Shoulder Type (from Highway Data)
tdGIStemp	RSHLW0	Long Integer	4		No	Original Right Shoulder Width (from Highway Data)
tdGIStemp	HORA0	Long Integer	4		No	Original Horizontal Alignment Adequacy (from Highway Data)
tdGIStemp	VERA0	Long Integer	4		No	Original Vertical Alignment Adequacy (from Highway Data)
tdGIStemp	ITYPE	Integer	2		No	Improvement Type
tdGIStemp	LADD	Integer	2		No	Lanes Added
tdGIStemp	CAPINC	Single	4		No	Increase in Capacity
tdGIStemp	TYPSEL	Integer	2		No	Type of Selection
tdGIStemp	BCR	Single	4		No	Benefit to Cost Ratio
tdGIStemp	VCR	Single	4		No	Volume to Capacity Ratio (at End of FP)
tdGIStemp	AES	Single	4		No	Average Effective Speed (at End of FP)

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdGIStemp	PSR	Single	4		No	Present Serviceability Rating (at End of FP)
tdGIStemp	IRI	Single	4		No	Measured Pavement Roughness (at End of FP)
tdGIStemp	TLAN	Integer	2		No	Total Lanes (at End of FP)
tdGIStemp	PLAN	Integer	2		No	Peak Lanes, Peak Direction (at End of FP)
tdGIStemp	CPLAN	Integer	2		No	Peak Lanes, Opposite Direction (at End of FP)
tdGIStemp	PCAP	Single	4		No	Peak Capacity, Peak Direction (at End of FP)
tdGIStemp	CPCAP	Single	4		No	Peak Capacity, Opposite Direction (at End of FP)
tdGIStemp	OPCAP	Single	4		No	Off-Peak Capacity (at End of FP)
tdGIStemp	ACCESS	Long Integer	4		No	Access Control (at End of FP)
tdGIStemp	LWID	Integer	2		No	Lane Width (at End of FP)
tdGIStemp	SHLT	Integer	2		No	Shoulder Type (at End of FP)
tdGIStemp	RSHLW	Integer	2		No	Right Shoulder Width (at End of FP)
tdGIStemp	MEDT	Integer	2		No	Median Type (at End of FP)
tdGIStemp	MEDW	Integer	2		No	Median Width (at End of FP)
tdGIStemp	WFEAS	Integer	2		No	Widening Feasibility (at End of FP)
tdGIStemp	HORA	Long Integer	4		No	Horizontal Alignment Adequacy (at End of FP)
tdGIStemp	VERA	Long Integer	4		No	Vertical Alignment Adequacy (at End of FP)
tdGIStemp	AADT	Single	4		No	Average Annual Daily Traffic (at End of FP)
tdGIStemp	EMC	Single	4		No	Emission Costs (at End of FP)
tdGIStemp	IMPC	Single	4		No	Improvement Cost (at End of FP)
tdGIStemp	EMB	Single	4		No	Emissions Benefits (at End of FP)
tdGIStemp	TTB	Single	4		No	Travel-Time Benefits (at End of FP)
tdGIStemp	OPCB	Single	4		No	Operating-Cost Benefits (at End of FP)
tdGIStemp	SAFB	Single	4		No	Safety Benefits (at End of FP)
tdGIStemp	TOTB	Single	4		No	Total Benefits (at End of FP)
tdGIStemp	SCF	Text	102		No	State Control Field (from Highway Data)
tdHighways	fnHighwayID	Long Integer	4	Yes	No	Unique number assigned for each Highway Input Data file
tdHighways	fsName	Text	50		No	User-specified name of the Highway Data Source model
tdHighways	fsDescription	Text	255		Yes	User-specified description of the Highway model
tdHighways	fsUserName	Text	50		No	User whom last modified the object
tdHighways	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdHighways	foFile	OLE Object			No	Stores delimited text of data for a single Highway model
tdHighwaySections00	Selected	Yes/No	1		No	Record is selected for export ('Checked')
tdHighwaySections00	Error	Yes/No	1		No	Record violates one or more validation rules
tdHighwaySections00	ID	Long Integer	4	Yes	No	Unique Identification number of record (Database Assigned)

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdHighwaySections00	Key	Text	50		No	Unique Identification number of record (Software Assigned)
tdHighwaySections00	Comment	Text	100		No	User-specified Comment
tdHighwaySections00	Year	Integer	2		No	Year of Data
tdHighwaySections00	State	Integer	2		No	State Code
tdHighwaySections00	Metric	Yes/No	1		No	Reporting Units - Metric or English
tdHighwaySections00	County	Integer	2		No	County Code
tdHighwaySections00	SectionID	Text	14		Yes	Section Identification
tdHighwaySections00	Sample	Yes/No	1		No	Is Standard Sample
tdHighwaySections00	Donut	Yes/No	1		No	Is Donut Sample
tdHighwaySections00	StateControl	Text	102		Yes	State Control Field
tdHighwaySections00	GroupedSection	Yes/No	1		No	Is Section Grouped
tdHighwaySections00	LRSID	Text	14		Yes	LRS Identification
tdHighwaySections00	LRSStart	Single	4		No	LRS Beginning Point
tdHighwaySections00	LRSEnd	Single	4		No	LRS Ending Point
tdHighwaySections00	RurUrb	Byte	1		No	Rural/Urban Designation
tdHighwaySections00	UrbSampTech	Byte	1		No	Urbanized Area Sampling Technique
tdHighwaySections00	UrbAreaCode	Integer	2		No	Urbanized Area Code
tdHighwaySections00	NonAttainCode	Integer	2		No	NAAQS Nonattainment Area Code
tdHighwaySections00	FunctSys	Integer	2		No	Functional System Code
tdHighwaySections00	GenFuncSys	Byte	1		No	Generated Functional System Code
tdHighwaySections00	NHS	Byte	1		No	National Highway System
tdHighwaySections00	UnbuiltFac	Byte	1		No	Planned Unbuilt Facility
tdHighwaySections00	InstRtNum	Text	7		Yes	Official Interstate Route Number
tdHighwaySections00	RouteSign	Byte	1		No	Route Signing
tdHighwaySections00	RouteSignQual	Byte	1		No	Route Signing Qualifier
tdHighwaySections00	SignRouteNum	Text	10		Yes	Signed Route Number
tdHighwaySections00	GovOwn	Byte	1		No	Governmental Ownership
tdHighwaySections00	SpecSys	Yes/No	1		No	Special Systems
tdHighwaySections00	TypeOfFac	Byte	1		No	Type of Facility
tdHighwaySections00	DesTrkRoute	Yes/No	1		No	Designated Truck Route
tdHighwaySections00	Toll	Yes/No	1		No	Toll
tdHighwaySections00	SecLength	Single	4		No	Section Length
tdHighwaySections00	DonutAADTVolGrp	Byte	1		No	Donut Area Sample AADT Volume Group Identifier
tdHighwaySections00	StdAADTVolGrop	Single	4		No	Standard Sample AADT Volume Group Identifier
tdHighwaySections00	AADT	Long Integer	4		No	Annual Average Daily Traffic

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdHighwaySections00	ThruLanes	Integer	2		No	Number of Through Lanes
tdHighwaySections00	IRI	Single	4		No	Measured Pavement Roughness
tdHighwaySections00	PSR	Single	4		No	Present Serviceability Rating
tdHighwaySections00	HOVOps	Byte	1		No	High Occupancy Vehicle Operations
tdHighwaySections00	HWSurvSysA	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysB	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysC	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysD	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysE	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysF	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysG	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysH	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	HWSurvSysI	Yes/No	1		No	Highway Surveillance Systems
tdHighwaySections00	SampID	Text	14		Yes	Sample Identifier
tdHighwaySections00	DonutExpFact	Double	8		No	Donut Area Sample Expansion Factor
tdHighwaySections00	StdExpFact	Double	8		No	Standard Sample Expansion Factor
tdHighwaySections00	SuftPvmtType	Byte	1		No	Surface/Pavement Type
tdHighwaySections00	SNorD	Single	4		No	Structural Number or Depth
tdHighwaySections00	ClimateZone	Byte	1		No	General Climate Zone
tdHighwaySections00	YearSurfImp	Integer	2		No	Year of Surface Improvement
tdHighwaySections00	LaneWidth	Single	4		No	Lane Width
tdHighwaySections00	AccessCtrl	Byte	1		No	Access Control
tdHighwaySections00	MedType	Byte	1		No	Median Type
tdHighwaySections00	MedWidth	Byte	1		No	Median Width
tdHighwaySections00	ShoulderType	Byte	1		No	Shoulder Type
tdHighwaySections00	RtShoulderWidth	Single	4		No	Right Shoulder Width
tdHighwaySections00	LtShoulderWidth	Single	4		No	Left Shoulder Width
tdHighwaySections00	PeakParking	Byte	1		No	Peak Parking
tdHighwaySections00	WideFeas	Byte	1		No	Widening Feasibility
tdHighwaySections00	CurvesByClassA	Single	4		No	Curves by Class
tdHighwaySections00	CurvesByClassB	Single	4		No	Curves by Class
tdHighwaySections00	CurvesByClassC	Single	4		No	Curves by Class
tdHighwaySections00	CurvesByClassD	Single	4		No	Curves by Class
tdHighwaySections00	CurvesByClassE	Single	4		No	Curves by Class
tdHighwaySections00	CurvesByClassF	Single	4		No	Curves by Class

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdHighwaySections00	HorzAlignAdeq	Byte	1		No	Horizontal Alignment Adequacy
tdHighwaySections00	TerrainType	Byte	1		No	Type of Terrain
tdHighwaySections00	VertAlignAdeq	Byte	1		No	Vertical Alignment Adequacy
tdHighwaySections00	GradesByClassA	Single	4		No	Grades by Class
tdHighwaySections00	GradesByClassB	Single	4		No	Grades by Class
tdHighwaySections00	GradesByClassC	Single	4		No	Grades by Class
tdHighwaySections00	GradesByClassD	Single	4		No	Grades by Class
tdHighwaySections00	GradesByClassE	Single	4		No	Grades by Class
tdHighwaySections00	GradesByClassF	Single	4		No	Grades by Class
tdHighwaySections00	PctPassSightDis	Integer	2		No	Percent Passing Sight Distance
tdHighwaySections00	WghtDsgnSpeed	Integer	2		No	Weighted Design Speed
tdHighwaySections00	SpeedLim	Integer	2		No	Speed Limit
tdHighwaySections00	PctPkSUTrks	Integer	2		No	Percent Peak Single Unit Trucks
tdHighwaySections00	PctAvgDlySUTrks	Integer	2		No	Percent Average Daily Single Unit Trucks
tdHighwaySections00	PctPkCTrks	Integer	2		No	Percent Peak Combination Trucks
tdHighwaySections00	PctAvgDlyCTrks	Integer	2		No	Percent Average Daily Combination Trucks
tdHighwaySections00	KFact	Integer	2		No	K-Factor
tdHighwaySections00	DirFact	Integer	2		No	Directional Factor
tdHighwaySections00	NumPkLanes	Integer	2		No	Number of Peak lanes
tdHighwaySections00	LtTurnLanes	Byte	1		No	Left Turning Lanes
tdHighwaySections00	RtTurnLanes	Byte	1		No	Right Turning Lanes
tdHighwaySections00	PrvalTypSignal	Byte	1		No	Prevailing Type of Signalization
tdHighwaySections00	TypPkPGT	Integer	2		No	Typical Peak percent Green Time
tdHighwaySections00	AtGrdInterSignals	Integer	2		No	Number of At-Grade Intersections with Signals
tdHighwaySections00	AtGrdInterSigns	Integer	2		No	Number of At-Grade Intersections with Signs
tdHighwaySections00	AtGrdInterOther	Integer	2		No	Number of At-Grade Intersections with Other or No Controls
tdHighwaySections00	PkCap	Long Integer	4		No	peak Capacity
tdHighwaySections00	VSF	Single	4		No	Volume/Service Flow Ratio
tdHighwaySections00	FutureAADT	Long Integer	4		No	Future AADT
tdHighwaySections00	FutureAADTYear	Integer	2		No	Year of Future AADT
tdHighwaySections00	Unknown1	Integer	2		No	TBD
tdHighwaySections00	Unknown2	Integer	2		No	TBD
tdIterationItems	fnItemID	Long Integer	4	Yes	No	Unique number assigned to each detail of an iteration
tdIterationItems	fwIterationID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdIterations)

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdIterationItems	fsRefClass	Text	50		No	Refers to the object type (bcoSS1, bcoSS2, bcoTabularOutput, bcoImprovements) and corresponding table. Paired with fwRefID to relate to specific record.
tdIterationItems	fwRefID	Long Integer	4		No	Combined with fsRefClass, points to a specify object in another table
tdIterations	fnIterationID	Long Integer	4	Yes	No	Unique number assigned to each Iteration
tdIterations	fwConfigID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdConfigurations)
tdIterations	fsName	Text	50		Yes	User-specified name of the specific iteration
tdIterations	fsAttribute	Text	50		Yes	Name of parameter varied during multi-run
tdIterations	fwValue	Double	8		No	Value of the parameter specified by fsAttribute
tdParamModels	fnModelID	Long Integer	4	Yes	No	Unique number assigned to each Parameter Model detail
tdParamModels	fsName	Text	50		No	User-specified name of the parameter model
tdParamModels	fsDescription	Text	255		Yes	User-specified description of the Parameter model
tdParamModels	fsUserName	Text	50		No	User whom last modified the object
tdParamModels	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdParamObjects	fnParamID	Long Integer	4	Yes	No	Unique number assigned to each Parameter Model
tdParamObjects	fwModelID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdParamModels)
tdParamObjects	fsClass	Text	50		No	Object type (bcoDLTbls, bcoImprCost, bcoParams)
tdParamObjects	fsDescription	Text	255		Yes	User-specified description of the Parameter model file
tdParamObjects	foFile	Memo			No	Stores delimited text of data contained in a single parameter model file, either Params, ImprCost or DLTbls
tdParamObjects	fsUserName	Text	50		No	User whom last modified the object
tdParamObjects	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdProjectItems	fnItemID	Long Integer	4	Yes	No	Unique number assigned to each model in a Project
tdProjectItems	fwProjectID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdProjects)
tdProjectItems	fsRefClass	Text	50		No	Refers to the object type (bcoHighwayDS, bcoControl, bcoParameter, bcoStateDS) and corresponding table. Paired with fwRefID to relate to specific record.
tdProjectItems	fwRefID	Long Integer	4		No	Combined with fsRefClass, points to a specify object in another table
tdProjects	fnProjectID	Long Integer	4	Yes	No	Unique number assigned to each Project
tdProjects	fsName	Text	50		No	User-specified name of the Project
tdProjects	fsDescription	Text	255		Yes	User-specified description of the Project
tdProjects	fsUserName	Text	50		No	User whom last modified the object
tdProjects	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdReports	fnReportID	Long Integer	4	Yes	No	Unique number assigned to each user-defined report
tdReports	fwProjectID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdProjects)

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdReports	fsName	Text	50		No	User-specified name of the report
tdReports	fsDescription	Text	255		Yes	User-specified description of a user-defined report
tdReports	fsUserName	Text	50		Yes	User whom last modified the object
tdReports	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdReports	fsRefClass	Text	50		No	Refers to the specific report object type (bcoGIS, bcoTable, bcoReport, bcoChart) being stored.
tdReports	foReport	Memo			No	Stores a path/filename to the XML file contain a user-defined ad-hoc report
tdSectionCondDet	fnSectCondDetID	Long Integer	4	Yes	No	Unique number assigned to each section in the Sections data
tdSectionCondDet	fwSectCondID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdSectionConditions)
tdSectionCondDet	fwFundingPeriod	Integer	2		No	Funding Period of Improvement
tdSectionCondDet	RECNO	Long Integer	4		No	Record Number
tdSectionCondDet	CNTY	Long Integer	4		No	County Code (from Highway Data)
tdSectionCondDet	SECTID	Text	14		No	Section Identification (from Highway Data)
tdSectionCondDet	SAMPID	Text	14		No	Sample Identifier (from Highway Data)
tdSectionCondDet	LRSID	Text	14		No	LRS Identification (from Highway Data)
tdSectionCondDet	BEGMP	Single	4		No	LRS Beginning Point (from Highway Data)
tdSectionCondDet	ENDMP	Single	4		No	LRS Ending Point (from Highway Data)
tdSectionCondDet	PSR0	Single	4		No	Original Present Serviceability Rating (from Highway Data)
tdSectionCondDet	VCR0	Single	4		No	Original Volume Capacity ration (from Highway Data)
tdSectionCondDet	LW0	Long Integer	4		No	Original Lane Width (from Highway Data)
tdSectionCondDet	SHLT0	Long Integer	4		No	Original Shoulder Type (from Highway Data)
tdSectionCondDet	RSHLW0	Long Integer	4		No	Original Right Shoulder Width (from Highway Data)
tdSectionCondDet	HORA0	Long Integer	4		No	Original Horizontal Alignment Adequacy (from Highway Data)
tdSectionCondDet	VERA0	Long Integer	4		No	Original Vertical Alignment Adequacy (from Highway Data)
tdSectionCondDet	ITYPE	Integer	2		No	Improvement Type
tdSectionCondDet	LADD	Integer	2		No	Lanes Added
tdSectionCondDet	CAPINC	Single	4		No	Increase in Capacity
tdSectionCondDet	TYPSEL	Integer	2		No	Type of Selection
tdSectionCondDet	BCR	Single	4		No	Benefit to Cost Ratio
tdSectionCondDet	VCR	Single	4		No	Volume to Capacity Ratio (at End of FP)
tdSectionCondDet	AES	Single	4		No	Average Effective Speed (at End of FP)
tdSectionCondDet	PSR	Single	4		No	Present Serviceability Rating (at End of FP)
tdSectionCondDet	IRI	Single	4		No	Measured Pavement Roughness (at End of FP)

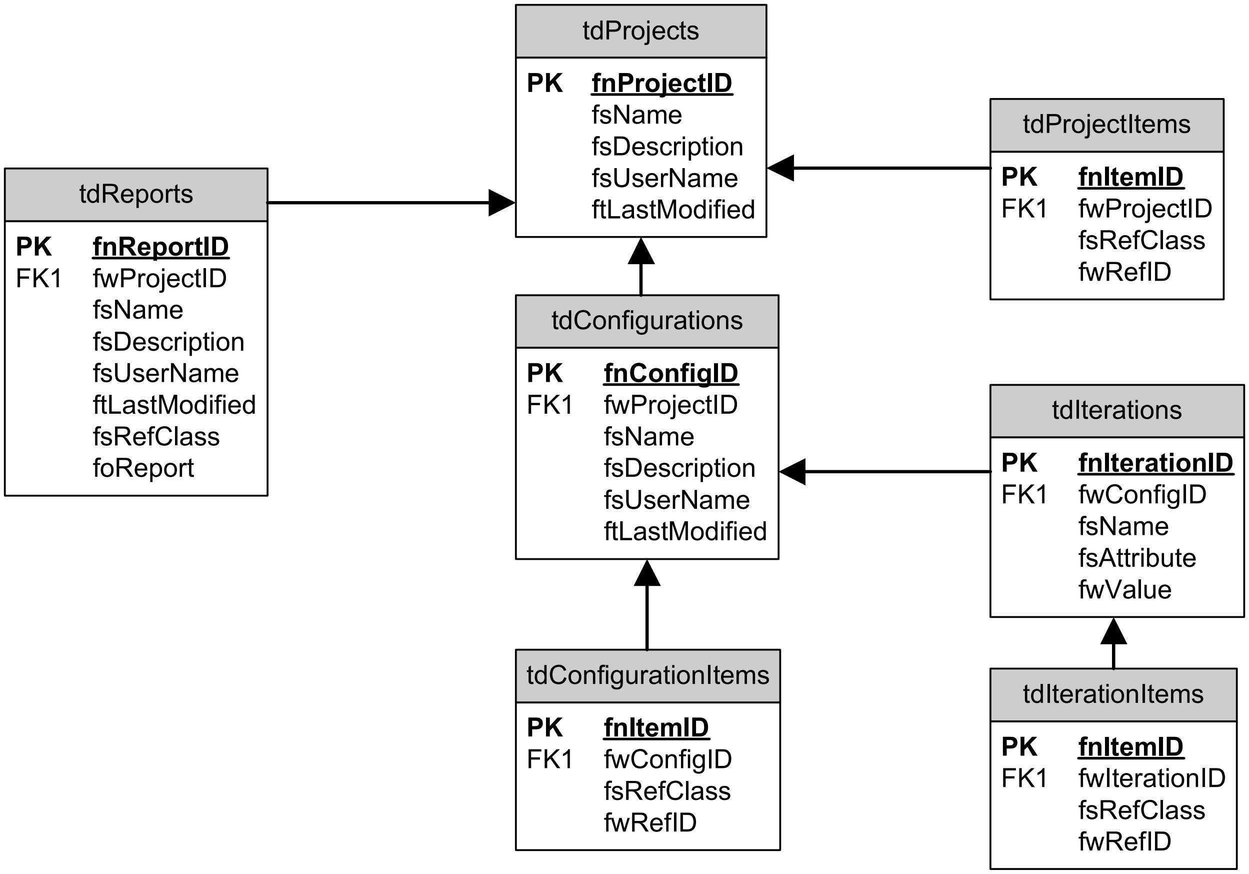
Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdSectionCondDet	TLAN	Integer	2		No	Total Lanes (at End of FP)
tdSectionCondDet	PLAN	Integer	2		No	Peak Lanes, Peak Direction (at End of FP)
tdSectionCondDet	CPLAN	Integer	2		No	Peak Lanes, Opposite Direction (at End of FP)
tdSectionCondDet	PCAP	Single	4		No	Peak Capacity, Peak Direction (at End of FP)
tdSectionCondDet	CPCAP	Single	4		No	Peak Capacity, Opposite Direction (at End of FP)
tdSectionCondDet	OPCAP	Single	4		No	Off-Peak Capacity (at End of FP)
tdSectionCondDet	ACCESS	Long Integer	4		No	Access Control (at End of FP)
tdSectionCondDet	LWID	Integer	2		No	Lane Width (at End of FP)
tdSectionCondDet	SHLT	Integer	2		No	Shoulder Type (at End of FP)
tdSectionCondDet	RSHLW	Integer	2		No	Right Shoulder Width (at End of FP)
tdSectionCondDet	MEDT	Integer	2		No	Median Type (at End of FP)
tdSectionCondDet	MEDW	Integer	2		No	Median Width (at End of FP)
tdSectionCondDet	WFEAS	Integer	2		No	Widening Feasibility (at End of FP)
tdSectionCondDet	HORA	Long Integer	4		No	Horizontal Alignment Adequacy (at End of FP)
tdSectionCondDet	VERA	Long Integer	4		No	Vertical Alignment Adequacy (at End of FP)
tdSectionCondDet	AADT	Single	4		No	Average Annual Daily Traffic (at End of FP)
tdSectionCondDet	EMC	Single	4		No	Emission Costs (at End of FP)
tdSectionCondDet	IMPC	Single	4		No	Improvement Cost (at End of FP)
tdSectionCondDet	EMB	Single	4		No	Emissions Benefits (at End of FP)
tdSectionCondDet	TTB	Single	4		No	Travel-Time Benefits (at End of FP)
tdSectionCondDet	OPCB	Single	4		No	Operating-Cost Benefits (at End of FP)
tdSectionCondDet	SAFB	Single	4		No	Safety Benefits (at End of FP)
tdSectionCondDet	TOTB	Single	4		No	Total Benefits (at End of FP)
tdSectionCondDet	SCF	Text	102		No	State Control Field (from Highway Data)
tdSectionConditions	fnSectCondID	Long Integer	4	Yes	No	Unique number assigned to each set of sections for a funding period
tdSectionConditions	fsSectCondName	Text	50		No	User-specified name of the Section Condition result data
tdSectionConditions	fsSectCondDesc	Text	255		No	User-specified description
tdSectionConditions	fsUserName	Text	50		No	User whom last modified the object
tdSectionConditions	ftCreateDate	Date/Time	8		No	Date and Time the object was saved or updated
tdStateFields	fnStateID	Long Integer	4	Yes	No	Unique number assigned to state-specified improvement
tdStateFields	fsName	Text	50		No	User-specified name of the State Improvement data
tdStateFields	fsDescription	Text	255		Yes	User-specified description of the State Improvement model
tdStateFields	fsUserName	Text	50		No	User whom last modified the object
tdStateFields	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tdStateFields	foFile	OLE Object			No	Stores delimited test of data for a single State Improvement model

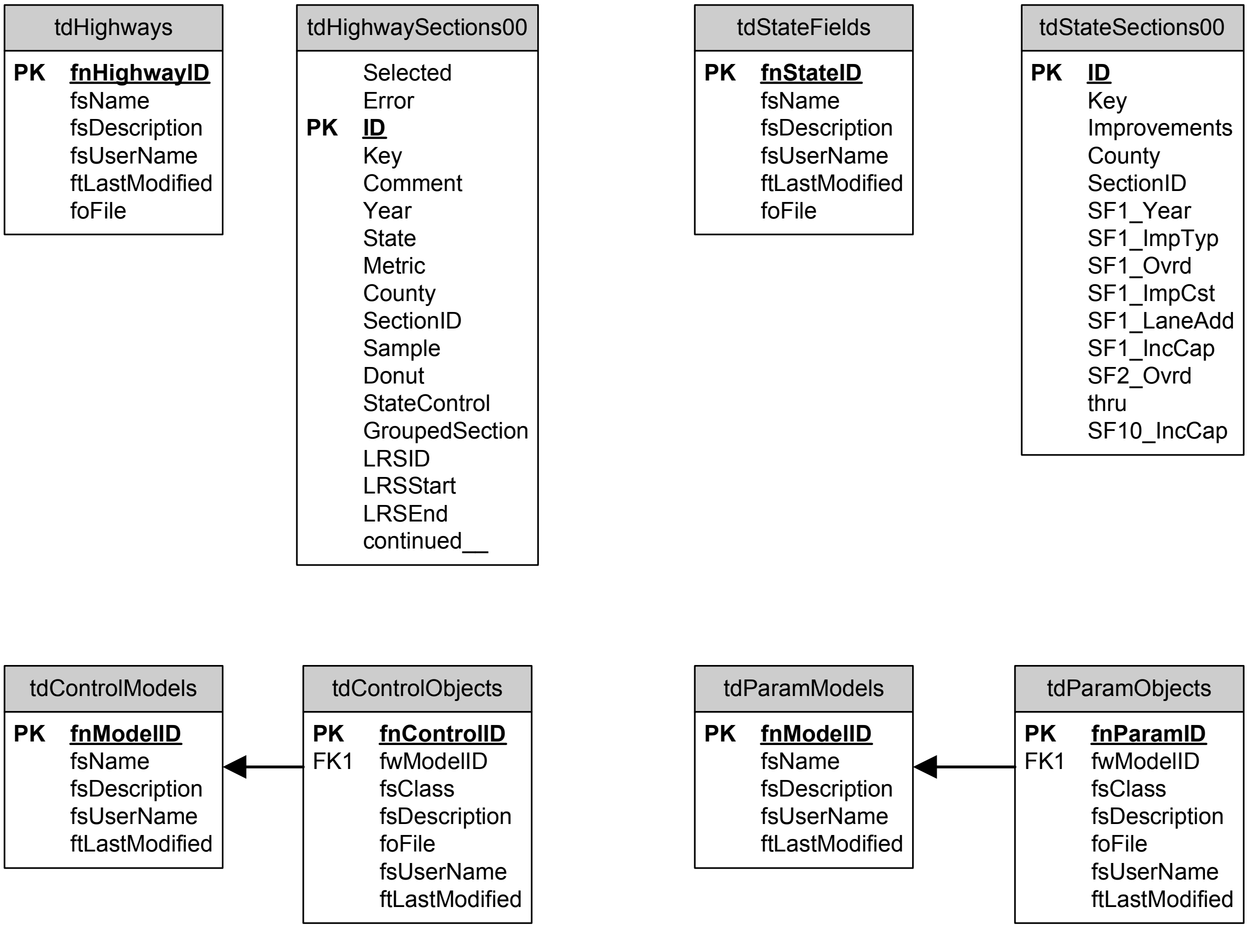
Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdStateSections00	ID	Long Integer	4		No	Foreign Key which ties record to higher level table (tdStateFields)
tdStateSections00	Key	Text	50		Yes	For internal use. Refers to object using the temp data
tdStateSections00	Improvements	Integer	2		No	Number of Improvements for the Section
tdStateSections00	County	Integer	2		No	County Code
tdStateSections00	SectionID	Text	14		Yes	Section Identification
tdStateSections00	SF1_Year	Integer	2		No	Year of Improvement - Improvement 1
tdStateSections00	SF1_ImpTyp	Integer	2		No	Improvement Type - Improvement 1
tdStateSections00	SF1_Ovrd	Long Integer	4		No	Override Flag - Improvement 1
tdStateSections00	SF1_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 1
tdStateSections00	SF1_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 1
tdStateSections00	SF1_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 1
tdStateSections00	SF2_Year	Integer	2		No	Year of Improvement - Improvement 2
tdStateSections00	SF2_ImpTyp	Integer	2		No	Improvement Type - Improvement 2
tdStateSections00	SF2_Ovrd	Long Integer	4		No	Override Flag - Improvement 2
tdStateSections00	SF2_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 2
tdStateSections00	SF2_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 2
tdStateSections00	SF2_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 2
tdStateSections00	SF3_Year	Integer	2		No	Year of Improvement - Improvement 3
tdStateSections00	SF3_ImpTyp	Integer	2		No	Improvement Type - Improvement 3
tdStateSections00	SF3_Ovrd	Long Integer	4		No	Override Flag - Improvement 3
tdStateSections00	SF3_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 3
tdStateSections00	SF3_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 3
tdStateSections00	SF3_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 3
tdStateSections00	SF4_Year	Integer	2		No	Year of Improvement - Improvement 4
tdStateSections00	SF4_ImpTyp	Integer	2		No	Improvement Type - Improvement 4
tdStateSections00	SF4_Ovrd	Long Integer	4		No	Override Flag - Improvement 4
tdStateSections00	SF4_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 4
tdStateSections00	SF4_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 4
tdStateSections00	SF4_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 4
tdStateSections00	SF5_Year	Integer	2		No	Year of Improvement - Improvement 5
tdStateSections00	SF5_ImpTyp	Integer	2		No	Improvement Type - Improvement 5
tdStateSections00	SF5_Ovrd	Long Integer	4		No	Override Flag - Improvement 5
tdStateSections00	SF5_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 5
tdStateSections00	SF5_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 5
tdStateSections00	SF5_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 5

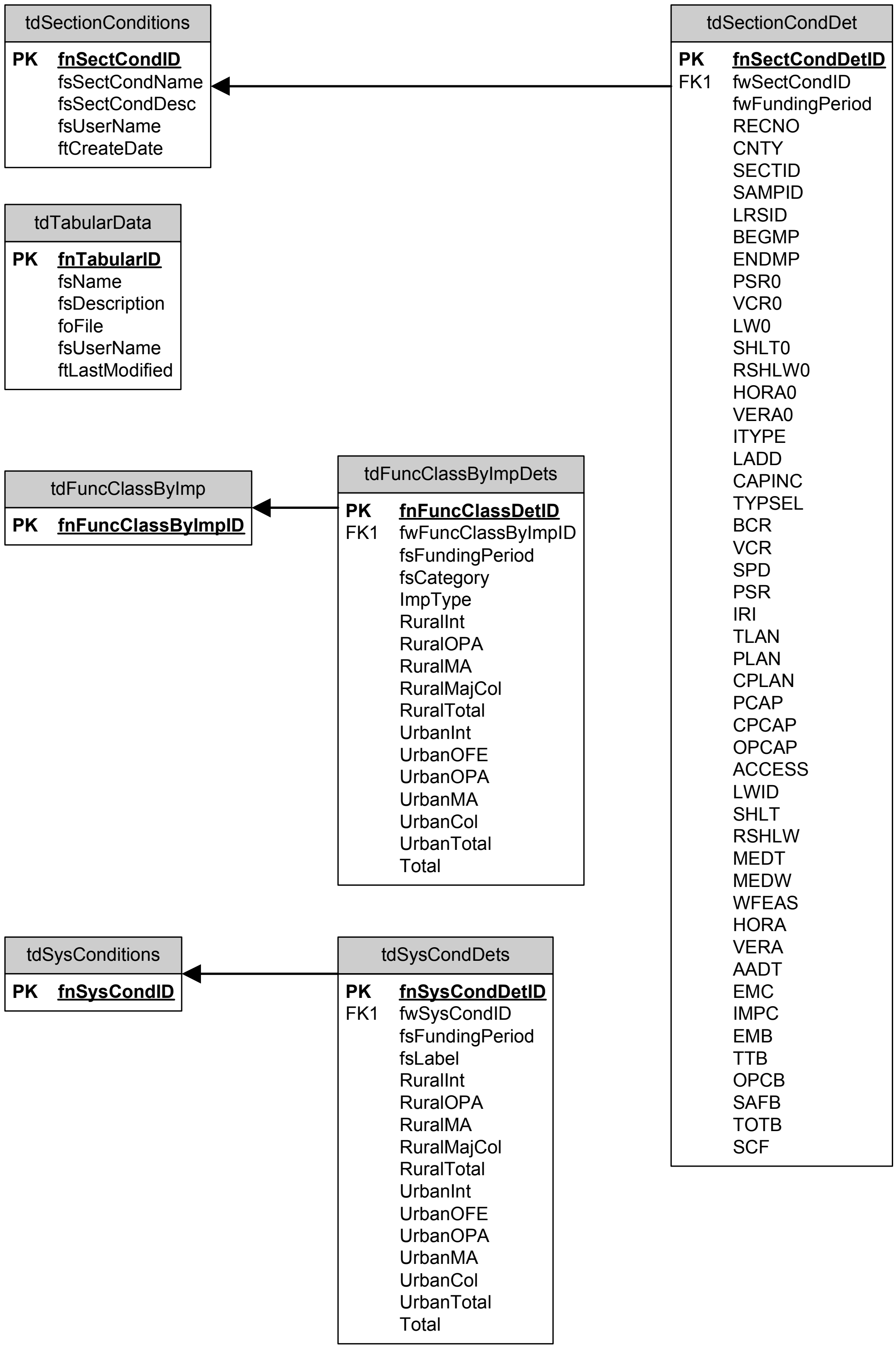
Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdStateSections00	SF6_Year	Integer	2		No	Year of Improvement - Improvement 6
tdStateSections00	SF6_ImpTyp	Integer	2		No	Improvement Type - Improvement 6
tdStateSections00	SF6_Ovrd	Long Integer	4		No	Override Flag - Improvement 6
tdStateSections00	SF6_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 6
tdStateSections00	SF6_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 6
tdStateSections00	SF6_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 6
tdStateSections00	SF7_Year	Integer	2		No	Year of Improvement - Improvement 7
tdStateSections00	SF7_ImpTyp	Integer	2		No	Improvement Type - Improvement 7
tdStateSections00	SF7_Ovrd	Long Integer	4		No	Override Flag - Improvement 7
tdStateSections00	SF7_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 7
tdStateSections00	SF7_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 7
tdStateSections00	SF7_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 7
tdStateSections00	SF8_Year	Integer	2		No	Year of Improvement - Improvement 8
tdStateSections00	SF8_ImpTyp	Integer	2		No	Improvement Type - Improvement 8
tdStateSections00	SF8_Ovrd	Long Integer	4		No	Override Flag - Improvement 8
tdStateSections00	SF8_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 8
tdStateSections00	SF8_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 8
tdStateSections00	SF8_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 8
tdStateSections00	SF9_Year	Integer	2		No	Year of Improvement - Improvement 9
tdStateSections00	SF9_ImpTyp	Integer	2		No	Improvement Type - Improvement 9
tdStateSections00	SF9_Ovrd	Long Integer	4		No	Override Flag - Improvement 9
tdStateSections00	SF9_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 9
tdStateSections00	SF9_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 9
tdStateSections00	SF9_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 9
tdStateSections00	SF10_Year	Integer	2		No	Year of Improvement - Improvement 10
tdStateSections00	SF10_ImpTyp	Integer	2		No	Improvement Type - Improvement 10
tdStateSections00	SF10_Ovrd	Long Integer	4		No	Override Flag - Improvement 10
tdStateSections00	SF10_ImpCst	Long Integer	4		No	Cost of Improvement - Improvement 10
tdStateSections00	SF10_LaneAdd	Long Integer	4		No	Lanes Added - Improvement 10
tdStateSections00	SF10_IncCap	Long Integer	4		No	Increase in Capacity - Improvement 10
tdSysCondDets	fnSysCondDetID	Long Integer	4	Yes	Yes	Unique number assigned to each SS1 detail
tdSysCondDets	fwSysCondID	Long Integer	4		Yes	Foreign Key which ties record to higher level table (tdSysConditions)
tdSysCondDets	fsFundingPeriod	Text	40		Yes	Funding Period
tdSysCondDets	fsLabel	Text	30		Yes	Identifies the type of data contained in this record
tdSysCondDets	RuralInt	Single	4		Yes	Rural Interstate

Table	Column	Data Type	Size	Primary Key	Allow Zero Length	Description
tdSysCondDets	RuralOPA	Single	4		Yes	Rural - Other Principal Arterial
tdSysCondDets	RuralMA	Single	4		Yes	Rural - Major Arterial
tdSysCondDets	RuralMajCol	Single	4		Yes	Rural - Major Collector
tdSysCondDets	RuralTotal	Single	4		Yes	Rural Total
tdSysCondDets	UrbanInt	Single	4		Yes	Urban - Interstate
tdSysCondDets	UrbanOFE	Single	4		Yes	Urban - Other Freeway or Expressway
tdSysCondDets	UrbanOPA	Single	4		Yes	Urban - Other Principal Arterial
tdSysCondDets	UrbanMA	Single	4		Yes	Urban - Other Major Arterial
tdSysCondDets	UrbanCol	Single	4		Yes	Urban - Collector
tdSysCondDets	UrbanTotal	Single	4		Yes	Urban - Total
tdSysCondDets	Total	Single	4		Yes	Total
tdSysCondtions	fnSysCondID	Long Integer	4	Yes	No	Unique number assigned to each System Condition (SS1) data file
tdTabularData	fnTabularID	Long Integer	4	Yes	No	Unique number assigned to each Tabular Output data file
tdTabularData	fsName	Text	50		No	User-specified name of the Tabular result data
tdTabularData	fsDescription	Text	255		Yes	User-specified description
tdTabularData	foFile	OLE Object			No	Stores full ASCII text of the Tabular Output file for a single execution of the HERS-ST Analysis
tdTabularData	fsUserName	Text	50		No	User whom last modified the object
tdTabularData	ftLastModified	Date/Time	8		No	Date and Time the object was saved or updated
tlLayouts	fsName	Text	50	Yes	No	User-specified name of the Layout
tlLayouts	fsRefClass	Text	50	Yes	No	Refers to the object type for which the layout is related (bcoHighwayDS, bcoImprovements)
tlLayouts	foLayout	Memo			Yes	Stores a delimited string of settings used by the Layout object
tlQueries	fsName	Text	50		No	User-specified name of the filter Query
tlQueries	fsQuery	Text	250		Yes	SQL Where clause

APPENDIX I - Database Schema


tdProjects
PK fnProjectID
fsName
fsDescription
fsUserName
ftLastModified
tdProjectItems
PK fnItemID
FK1 fwProjectID
fsRefClass
fwRefID
tdReports
PK fnReportID
FK1 fwProjectID
fsName
fsDescription
fsUserName
ftLastModified
fsRefClass
foReport
tdConfigurations
PK fnConfigID
FK1 fwProjectID
fsName
fsDescription
fsUserName
ftLastModified
tdIterations
PK fnIterationID
FK1 fwConfigID
fsName
fsAttribute
fwValue
tdConfigurationItems
PK fnItemID
FK1 fwConfigID
fsRefClass
fwRefID
tdIterationItems
PK fnItemID
FK1 fwIterationID
fsRefClass
fwRefID


tdHighways
PK fnHighwayID
fsName
fsDescription
fsUserName
ftLastModified
foFile
tdHighwaySections00
Selected
Error
PK ID
Key
Comment
Year
State
Metric
County
SectionID
Sample
Donut
StateControl
GroupedSection
LRSID
LRSStart
LRSEnd
continued__
tdStateFields
PK fnStateID
fsName
fsDescription
fsUserName
ftLastModified
foFile
tdStateSections00
PK ID
Key
Improvements
County
SectionID
SF1_Year
SF1_ImpTyp
SF1_Ovrd
SF1_ImpCst
SF1_LaneAdd
SF1_IncCap
SF2_Ovrd
thru
SF10_IncCap
tdControlModels
PK fnModelID
fsName
fsDescription
fsUserName
ftLastModified
tdControlObjects
PK fnControlID
FK1 fwModelID
fsClass
fsDescription
foFile
fsUserName
ftLastModified
tdParamModels
PK fnModelID
fsName
fsDescription
fsUserName
ftLastModified
tdParamObjects
PK fnParamID
FK1 fwModelID
fsClass
fsDescription
foFile
fsUserName
ftLastModified


tdSectionConditions
PK fnSectCondID
fsSectCondName
fsSectCondDesc
fsUserName
ftCreateDate
tdTabularData
PK fnTabularID
fsName
fsDescription
foFile
fsUserName
ftLastModified
tdFuncClassByImp
PK fnFuncClassByImpID
tdSysConditions
PK fnSysCondID
tdFuncClassByImpDets
PK fnFuncClassDetID
FK1 fwFuncClassByImpID
fsFundingPeriod
fsCategory
ImpType
RuralInt
RuralOPA
RuralMA
RuralMajCol
RuralTotal
UrbanInt
UrbanOFE
UrbanOPA
UrbanMA
UrbanCol
UrbanTotal
Total
tdSysCondDets
PK fnSysCondDetID
FK1 fwSysCondID
fsFundingPeriod
fsLabel
RuralInt
RuralOPA
RuralMA
RuralMajCol
RuralTotal
UrbanInt
UrbanOFE
UrbanOPA
UrbanMA
UrbanCol
UrbanTotal
Total
tdSectionCondDet
PK fnSectCondDetID
FK1 fwSectCondID
fwFundingPeriod
RECNO
CNTY
SECTID
SAMPID
LRSID
BEGMP
ENDMP
PSR0
VCR0
LW0
SHLT0
RSHLW0
HORA0
VERA0
ITYPE
LADD
CAPINC
TYPSEL
BCR
VCR
SPD
PSR
IRI
TLAN
PLAN
CPLAN
PCAP
CPCAP
OPCAP
ACCESS
LWID
SHLT
RSHLW
MEDT
MEDW
WFEAS
HORA
VERA
AADT
EMC
IMPC
EMB
TTB
OPCB
SAFB
TOTB
SCF

APPENDIX J - Highway Data Validation Rules

Number	Description
1	Sections cannot exist for unbuilt or unopened facilities. Condition: The **UnbuiltFac** (20) field equals 2 (Unbuilt)
2	A paved section with a two-way road but only one lane cannot exist. Condition: The **TypeOfFac** (27) field equals 2 (Two-Way Road) AND The **ThruLanes** (34) field equals 1 AND The **SurfPvmtType** (50) field is greater than 1 (Unpaved)
3	Sections must have an AADT greater than zero. Condition: The **AADT** (33) field is not greater than 0
4	Sections must have at least one lane. Condition: The **ThruLanes** (34) field is not greater than 0
5	The length of all sections in a volume group cannot exceed the total length of the group. Condition: The **StdExpFact** (49) field is less than 1
6	Paved sections must have either a Measured Pavement Roughness (IRI) or a Pavement Condition (PSR). Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **IRI** (35) and **PSR** (36) fields equal 0 AND The **SurfPvmtType** (50) field is greater than 1 (Unpaved)
7	Sections must have a lane width greater than zero. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **LaneWidth** (54) field equals 0
8	A paved rural section must have a peak capacity greater than zero. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is greater than 1 (Unpaved) AND The **RurUrb** (13) field equals 1 (Rural) AND The **PkCap** (95) field equals 0
9	A paved urbanized or small urban section must have a peak capacity greater than zero. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **RurUrb** (13) field is greater than 1 (Rural) AND The **PkCap** (95) field equals 0
10	An urbanized or small urban section with at least one intersection must have a percentage of green time greater then zero. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **TypPkPGT** (91) field equals 0 AND The **AtGrdInterSignals** (92) field is greater than 0

Number	Description
11	A section must have a future AADT value. Condition: The **FutureAADT** (97) field equals 0
12	A section must have a future AADT year. Condition: The **FutureAADTYear** (98) field equals 0
13	An interstate section is not usually one-way. Condition: The **TypeOfFac** (27) field equals 1 (One-Way Road) AND The **GenFuncSys** (18) field equals 1 (Interstate)
14	An interstate section usually has an AADT of 1000 or greater. Condition: The **GenFuncSys** (18) field equals 1 (Interstate) AND The **AADT** (33) field is less than 1000
15	Two-way interstate sections usually have four or more lanes. Condition: The **TypeOfFac** (27) field equals 2 (Two-Way Road) AND The **ThruLanes** (34) field is less than 4 AND The **GenFuncSys** (18) field equals 1 (Interstate)
16	An interstate section usually has a surface of a high flexible or better type construction and materials. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is less than 4 (High Flexible) AND The **GenFuncSys** (18) field equals 1 (Interstate)
20	An interstate section with a supplied pavement condition usually is rated at 2.0 or greater. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **IRI** (35) field equals 0 AND The **PSR** (36) field is not 0 and less than 2 AND The **GenFuncSys** (18) field equals 1 (Interstate)
21	An interstate section usually has full access control. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **AccessCtrl** (55) field does not equal 1 (Full) AND The **GenFuncSys** (18) field equals 1 (Interstate)
22	An interstate section usually has a width of twelve feet or greater. Condition: The **LaneWidth** (54) field is less than 12 AND The **GenFuncSys** (18) field equals 1 (Interstate)
23	An interstate section usually has shoulders and also is built of materials better then bare earth. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **ShoulderType** (58) field equals 1 (None) or 5 (Earth) AND The **GenFuncSys** (18) field equals 1 (Interstate)

Number	Description
24	<u>An uncurbed interstate section having shoulders built of materials better than bare earth usually also has shoulder widths greater than eight feet.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **ShoulderType** (58) field is between 1 (None) and 5 (Earth) AND The **RtShoulderWidth** (59) field is less than 8 AND The **GenFuncSys** (18) field equals 1 (Interstate)
25	<u>An interstate section usually has a median of some type.</u> Condition: The **MedType** (56) equals 4 (None) AND The **GenFuncSys** (18) field equals 1 (Interstate)
26	<u>An interstate section usually has a median width of greater than zero.</u> Condition: The **MedWidth** (57) equals 0 AND The **GenFuncSys** (18) field equals 1 (Interstate)
27	<u>An interstate section usually has curves that can be negotiated safely at the prevailing speed limit for the section.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **HorzAlignAdeq** (69) field is greater than 2 (Acceptable) AND The **GenFuncSys** (18) field equals 1 (Interstate)
28	<u>An interstate section usually has grades that provide safe sight distance and can be negotiated by trucks safely at the prevailing speed limit for the section.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **VertAlignAdeq** (71) field is greater than 2 (Acceptable) AND The **GenFuncSys** (18) field equals 1 (Interstate)
29	<u>An interstate section usually has a speed limit of 50 mph or greater.</u> Condition: The **SpeedLim** (80) field is less than 50 AND The **GenFuncSys** (18) field equals 1 (Interstate)
30	<u>A rural interstate section usually has a design speed of 70 mph or greater.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **RurUrb** (13) field equals 1 (Rural) AND The **WghtDsgnSpeed** (79) field is less than 70 AND The **GenFuncSys** (18) field equals 1 (Interstate)
31	<u>An interstate section usually has no turning lanes or provisions to do so.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **LtTurnLanes** (88) field or **RtTurnLanes** (89) field is greater than 0 AND The **GenFuncSys** (18) field equals 1 (Interstate)
32	<u>A rural interstate section usually does not have signalized intersections.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **RurUrb** (13) field equals 1 (Rural) AND The **PrvalTypSignal** (90) field equals 1, 2 or 3 (Signalized) AND The **GenFuncSys** (18) field equals 1 (Interstate)

Number	Description
33	An interstate section usually has zero percent green time, since there are no signalized intersections. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **TypPkPGT** (91) field is greater than 0 AND The **GenFuncSys** (18) field equals 1 (Interstate)
34	An urban interstate section usually has no parking allowed. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **RurUrb** (13) field does not equal (Rural) AND The **PeakParking** (61) field is not equal to 3 (No Parking) AND The **GenFuncSys** (18) field equals 1 (Interstate)
36	An interstate section usually has no intersections. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **AtGrdInterSignals** (92) field or **AtGrdInterSigns** (93) field or **AtGrdInterOther** (94) field is greater than 0 AND The **GenFuncSys** (18) field equals 1 (Interstate)
38	A two-way one-lane section is usually paved. Condition: The **TypeOfFac** (27) field equals 2 (Two-Way Road) AND The **ThruLanes** (34) field equals 1 AND The **SurfPvmtType** (50) field equals 1 (Unpaved)
39	A section usually has less than 13 lanes. Condition: The **ThruLanes** (34) field is greater than 12
40	The summed average daily percentage of trucks of a section is usually 50% or less. Condition: The **PctAvgDlySUTrks** (82) field PLUS The **PctAvgDlyCTrks** (84) field is greater than 50
41	The summed percentage of peak trucks of a section is usually 50% or less. Condition: The **PctPkSUTrks** (81) field PLUS The **PctPkCTrks** (83) field is greater than 50
42	A section usually has a volume/service flow ratio of 1.20 or less. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **VSF** (96) field is greater than 1.2
43	A section with an AADT of 250 or greater usually does not have a future AADT increase of greater than 200 percent of its current AADT. Condition: The **AADT** (33) field is greater than 250 AND 100 * (20 * (ΔAADT / ΔYEAR) / **AADT**) > 200 Where: ΔAADT = **FutureAADT** - **AADT** ΔYEAR = **FutureAADTYear** – **Year**

Number	Description
44	A section with an AADT of 250 or greater usually does not have a future AADT value decrease of more than 25 percent. Condition: The **AADT** (33) field is greater than 250 AND 100 * (20 * (ΔAADT / ΔYEAR) / **AADT**) < -25 Where: ΔAADT = **FutureAADT** - **AADT** ΔYEAR = **FutureAADTYear** – **Year**
45	<u>A rural section in flat terrain usually does not have grades and vertical curves that are below minimum design standards.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **RurUrb** (13) field equals 1 (Rural) AND The **TerrainType** (70) field equals 1 (Level) AND The **VertAlignAdeq** (71) field is greater than 2 (Acceptable)
46	<u>A section with parking on both sides cannot have shoulders.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **ShoulderType** (58) field is not 1 (None) or 6 (Barrier) AND The **PeakParking** (61) field equals 2 (Both Sides)
47	<u>A section improved in the last two years usually has a PSR greater than or equal to 2.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **Year** (1) MINUS **YearSurfImp** (53) is greater than 2 AND The **IRI** (35) field equals 0 AND The **PSR** (36) field is not 0 and less than 2
48	<u>Sections improved in the last two years usually have a roughness less than 100.0 feet/mile.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **Year** (1) MINUS **YearSurfImp** (53) is greater than 2 AND The **IRI** (35) field is not 0 and greater than 100
49	<u>A paved section usually has an IRI of 25 feet/mile or more.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **IRI** (35) field is not 0 and less than 25
50	<u>A paved section usually has an IRI of 400 feet/mile or less.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **IRI** (35) field is not 0 and greater than 400
51	<u>A section with a PSR greater than 4.0 usually has an IRI of 150 feet/mile or less.</u> Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **PSR** (36) field is not 0 and is greater than 4 AND The **IRI** (35) field is not 0 and is greater than 150

Number	Description
52	A section with a PSR less than 2.0 usually has an IRI of 100 feet/mile or more. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **PSR** (36) field is not 0 and is less than 2 AND The **IRI** (35) field is not 0 and is less than 100
53	A section usually has a K-factor of 5 or larger. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **KFact** (85) field is less than 5
54	A section usually has a K-factor of 19 or less. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **KFact** (85) field is greater than 19
55	A two-way section usually has a directional factor of 70 or less. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **DirFact** (86) field is not 100 and is greater than 70
56	Sections usually have a speed limit that is a multiple of 5. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **SpeedLim** (80) field is not divisible by 5
62	A non-interstate, paved section should have a PSR greater than 1.0. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **GenFuncSys** (18) field is not 1 (Interstate) AND The **SurfPvmtType** (50) field is not 1 (Unpaved) AND The **PSR** (36) field is not 0 and is less than 1 AND The **IRI** (35) field equals 0
63	Urban principal arterials and other freeway and expressway sections with signals usually have a green time of 35% or greater. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **GenFuncSys** (18) field equals 2 or 3 (Arterial) AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **TypPkPGT** (91) field is less than 35 AND The **AtGrdInterSignals** (92) field is greater than 0
64	Urban principal arterials with signals usually have a green time of 90% or less. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **GenFuncSys** (18) field equals 2 (Principal Arterial) AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **TypPkPGT** (91) field is greater than 90 AND The **AtGrdInterSignals** (92) field is greater than 0
65	Urban minor arterials with signals usually have a green time of 90% or less. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **GenFuncSys** (18) field equals 3 (Minor Arterial) AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **TypPkPGT** (91) field is greater than 90 AND The **AtGrdInterSignals** (92) field is greater than 0

Number	Description
66	Urban collectors and local roads with signals usually have a green time of 80% or less. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **GenFuncSys** (18) field equals 4, 5 or 6 (Collectors, Local) AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **TypPkPGT** (91) field is greater than 80 AND The **AtGrdInterSignals** (92) field is greater than 0
67	Urban principal arterials usually have access control. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **GenFuncSys** (18) field equals 2 (Principal Arterial) AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **AccessCtrl** (55) field equals 3 (None)
68	The primary arterial system is normally in a paved condition. Condition: The **TypeOfFac** (27) field is 1 or 2 (Road) AND The **FunctSys** (17) field is 1, 2, 11, 12 or 14 (Interstate, Arterial) AND The **SurfPvmtType** (50) field equals 1 (Unpaved)
69	The peak percentage of daily single-unit trucks cannot be more than the average percentage of daily single-unit trucks. Condition: The **PctPkSUTrks** (81) field is greater than **PctAvgDlySUTrks** (82)
70	The peak percentage of daily combination trucks cannot be more than the average percentage of daily combination trucks. Condition: The **PctPkCTrks** (83) field is greater than **PctAvgDlyCTrks** (84)
71	A one-way section cannot have a median. Condition: The **TypeOfFac** (27) field equals 1 or 3 (One-Way) AND The **MedType** (56) field does not equal 4 (None) AND The **MedWidth** (57) field is greater than 0
72	A one-lane section cannot have a median. Condition: The **ThruLanes** (34) field equals 1 AND The **MedType** (56) field does not equal 4 (None) AND The **MedWidth** (57) field is greater than 0
73	The primary arterial system is not normally one lane. Condition: The **ThruLanes** (34) field equals 1 AND The **RurUrb** (13) field equals 1 (Rural) AND The **GenFuncSys** (18) field equals 1 or 2 (Interstate, Principal Arterial) Condition: The **ThruLanes** (34) field equals 1 AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **GenFuncSys** (18) field equals 1, 2 or 3 (Interstate, Arterial)
78	A non-freeway section usually has a speed limit of 55 mph or less. Condition: The **ThruLanes** (34) field is less than 4 AND The **RurUrb** (13) field does not equal 1 (Rural) AND The **SpeedLim** (80) field is greater than 55

FHWA-IF-02-059