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Flood Impact Analysis

User's Manual

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The HEC-FIA software enables users to calculate flood damage in terms of direct and indirect economic, agricultural and life loss estimates for a single flood event. The analysis period is the duration of a single flood event. The software calculates agricultural damage and urban damage for use after an event and summarizes the results in reports. HEC-FIA can also look at dam failure events and evaluate the consequences to support risk assessments for dams. HEC-FIA uses Simplified LIFESim to evaluate the impacts to human life.

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Flood Impact Analysis Package, HEC-FIA, User's Manual

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CHAPTER 1

Introduction

1.1   Overview

The Hydrologic Engineering Center (HEC) developed the Flood Impact Analysis (HEC-FIA) software to analyze the consequences from a flood event. The software calculates structure and content damages, agricultural losses, and estimates potential life loss. These computations are performed by evaluating deterministically input single events where the HEC-FIA computation uses uncertainty to describe the damageable elements and their susceptibility to flooding. The results from these computations support U.S. Army Corps of Engineers (USACE) planning studies by supporting other social effects (OSE) account estimates associated with event-based loss of life, property, content and agricultural damage estimates in the user-defined study area. The HEC-FIA software supports dam and levee safety programs by allowing users to evaluate the consequences associated with poor performance (e.g., levee or dam failure) and to perform scalable analyses in support of screening decisions. The software allows for the rapid evaluation of actual events, supporting real-time water management decision-making during the operation of a system of flood risk management infrastructure.

This User's Manual details Version 3.1 of HEC-FIA. Version 3.1 is an update to Version 3.0 of HEC-FIA. HEC-FIA is the successor to the Project Benefit Accomplishment (HEC-PBA) software. HEC-FIA includes the damage-analysis capabilities summarized above and discussed in detail below. The software features the ability to analyze geo-referenced gridded data, utilizes HEC-DSS (HEC's Data Storage System) datasets, produces plots and tabular reports, and interfaces with geographic information systems (GIS). HEC-FIA also includes a graphical user interface (GUI) that allows the user to enter and edit data necessary for flood impact analysis.

In addition to the capabilities listed above, the HEC-FIA software Version 3.1 provides new computation features and methods. In the HEC-FIA framework, the components of the watershed configuration were expanded to include HEC-ResSim reservoirs and common computation points with holdout distribution areas. The watershed configuration was enhanced with the addition of an improved method for computing reduced flood damages. The flood damages reduced method uses structures for the damage computation rather than aggregated stage damage functions, which is an improvement over the previous method. Finally, the addition of a reconstruction simulation capability extended the HEC-FIA software to enable the user to compute and analyze estimated damages for a subsequent event following reconstruction from a preceding flood event.

1.2   Purpose

The HEC-FIA software provides the capability to estimate a variety of flood impacts associated with actual or modeled events. HEC-FIA is designed to facilitate:

- Assessment of disaster impacts after a flood.

- Real-time flood impact analysis to assist with decision-making and response activities.

- Development of annual reports, required by USACE headquarters and Congress, that detail the reduction in flood damages resulting from USACE projects.

- Development of consequence estimates to support risk assessments for the Dam Safety and Levee Safety Programs.

HEC-FIA evaluates impacts to a study area, and the damageable elements are defined through the addition of user defined agricultural inventories, structural inventories, critical infrastructure, and impact response curves. These damageable elements can be impacted by hydraulic parameters which can be described through two main data formats, either geo-referenced gridded model outputs (which describe depth, arrival time, duration and depth times velocity) or through a set of geo-referenced hydrographs (stage, or flow with accompanying rating curves) which represent a single event. For the specified analysis period of that single event, the software can estimate:

Estimate	Project Minimum Requirements
• Structure damage • Content damage • Car damage	To estimate these damages, HEC-FIA requires a user-defined structure inventory, and the hydraulic information must include maximum depth for the flood event.
• Population impacted • Life loss	To estimate these impacts, HEC-FIA requires a user-defined structure inventory with the population for each structure provided. In addition, the hydraulic information must include maximum depth and arrival time for the flood event. Emergency planning zones (formerly impact areas), and at least one warning issuance scenario are also required.
• Indirect income and job losses	The basic requirements for estimating life loss are necessary for this estimate. In addition, the user must define the total supply of available labor and capital for the entire county (or counties) in the study area.
• Agricultural losses	The basic requirements include importing gridded agricultural data, and the user-provided hydraulic information must contain flood duration and arrival time.
• Impacts based on exceeding high stage or flow thresholds • Impacts based on falling below low stage or flow thresholds	To estimate these damages, the HEC-FIA project must include a user-defined structure inventory, and the hydraulic information must include maximum depth for the flood event. In addition, the user must define impact response curves to set the stage or flow thresholds.
• Impacts to critical infrastructure	To estimate these impacts, HEC-FIA requires a user-defined critical structure inventory, and the hydraulic information must include maximum depth for the flood event.
• Flood Damages Reduced	The basic requirements for estimating Flood Damages Reduced is a user-defined structure inventory. In addition, the hydraulic information for the flood event must include either regulated vs. unregulated, and/or leveed vs. not leveed.
• Reconstruction	To estimate these damages, HEC-FIA requires a user-defined structure inventory. In addition, the hydraulic information must include maximum depth and arrival time for the flood event.

HEC-FIA includes a number of reports that detail these impacts. The impacts can be sorted by geographic area based on any user supplied polygon (e.g., impact area, emergency planning zone).

To calculate impacts, HEC-FIA requires the user to identify the study, assemble and enter data, and execute the software. These analysis steps are covered in detail in this manual.

1.3   HEC-FIA

HEC-FIA (Figure 1.1) can be used to assess structural and nonstructural changes within a floodplain. The software is designed to be scalable; if users do not have high resolution data, HEC-FIA can support the user through accessing national datasets for inputs like structures and agriculture. If the user determines that more detail is needed, it is simple for the user to incorporate higher resolution input data to replace the low resolution input data. The output from HEC-FIA can support decision-making processes to ensure that the projects do not present unacceptable risks to the environment, public, and property.
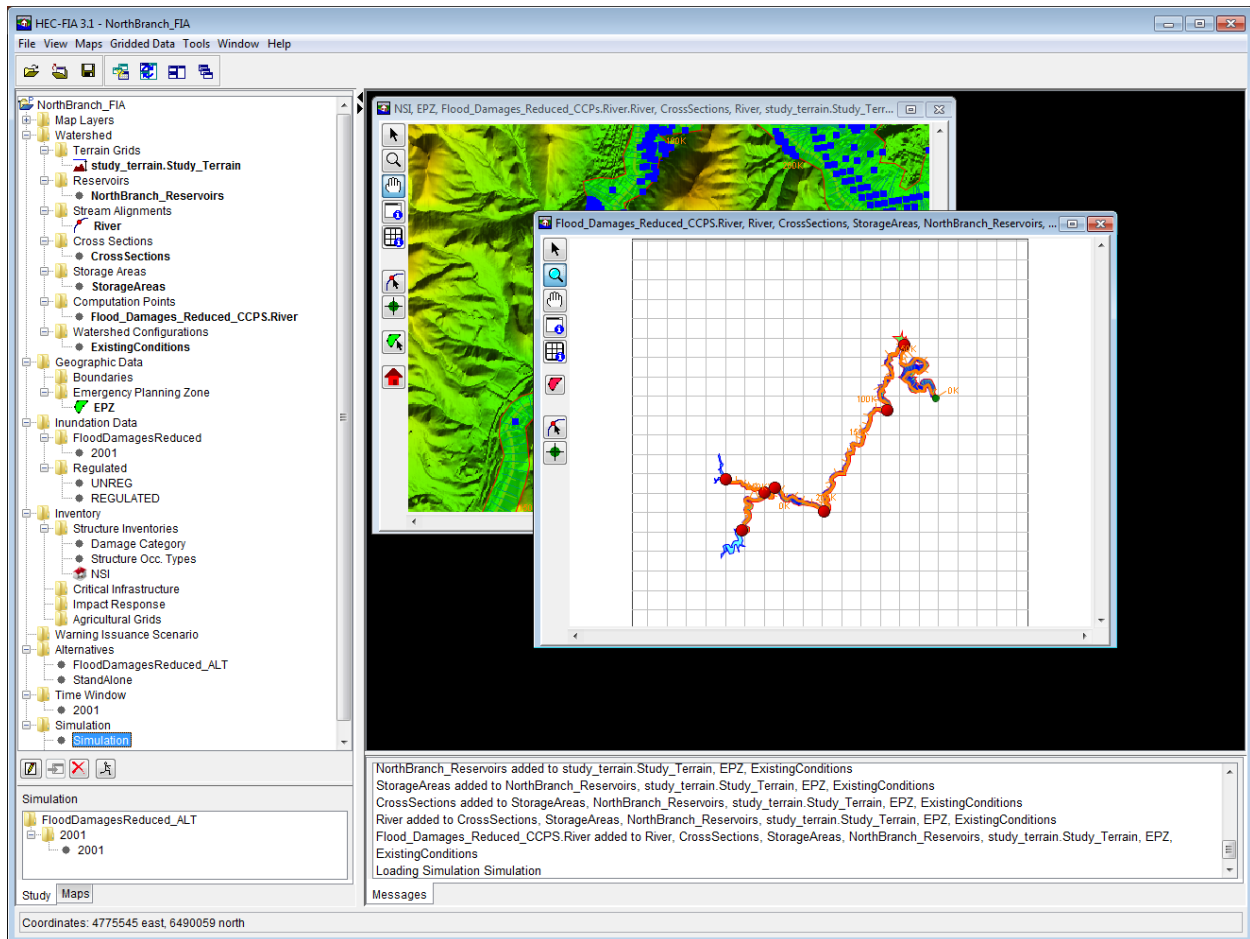
Figure 1.1 HEC-FIA Project

HEC-FIA supports several USACE missions:

- Dam and Levee Safety – HEC-FIA supports this mission by providing estimates for consequences from single events which can represent dam failure, levee failure, or exceedance of existing infrastructure. The software is utilized to provide information that can be used to assist in screening level decisions at lower resolution and accuracy, all the way through detailed assessments to support a decision document.

- Water Management – HEC-FIA can be utilized for evaluating real time consequence estimates to support decisions regarding actions taken during flood operations for a system of existing projects. HEC-FIA is also utilized to create estimates to support after-action reporting for a historic event.

- Planning – HEC-FIA is available to assist planners in evaluating consequences such as life loss estimation, agricultural damages, and indirect production and job losses. HEC-FIA can be utilized within HEC-WAT (HEC's Watershed Analysis Tool) with the Flood Risk Analysis (FRA) compute option to evaluate the full range of hydrologic, hydraulic, geotechnical, and economic uncertainties to assist planners in evaluating the aforementioned consequences and to evaluate a standard benefit within uncertainty through the evaluation of alternatives much like HEC-FDA (HEC's Flood Damage Reduction Analysis software).

1.3.1   Identifying a Study

The first step of any HEC-FIA study (i.e., reconnaissance, or feasibility) is the definition of the study extent. A study extent is typically represented by a polygon of the area that has the possibility of getting wet when a large event is being assessed. The Project Delivery Team (PDT), under the direction of a Project Manager (PM), should start the process of defining the study area by meeting to acquaint themselves with the type (i.e., reconnaissance, feasibility, watershed, restoration) and location of the study to be conducted.

The PDT evaluates existing data; identifies data which needs to be gathered, and selects or builds the hydrology and hydraulics models needed to provide simulation results. This determination allows the PDT to make a rough estimate of the study extent and various other data elements such as the stream alignment which may be defined within some geospatial mapping product. With a map in hand, the PM should lead the PDT to choose the study boundaries, identifying gage locations, subbasin delineations, emergency planning zones (formerly defined as impact areas in HEC-FIA Version 3.0), and location of measures (i.e., reservoirs, levees).

1.3.2   Creating a Project

After the PDT has identified the study area, an HEC-FIA project can be created (see Figure 1.1). A **project** in HEC-FIA is a combination of the input data describing a geographic location and hydraulic events which describe the flood hazard. The first step is to define a **watershed configuration**, which is a physical representation of the watershed (for example, the *Without Project Condition*). A watershed configuration can also be an alternative that changes physical or structural elements in the study area (for example adding a levee).

A **watershed configuration** consists of a terrain grid, reservoirs, stream alignment, cross sections, related one-dimensional storage areas (two-dimensional storage areas from HEC-RAS 5.0 are handled through gridded data, not watershed elements), and a set of common computation points. Not all elements of the watershed are required for HEC-FIA to compute hydraulic information at a location, but there are minimum requirements dependent upon the desired methodology to evaluate hydraulic information at an independent location. For example, if a user is defining the hydraulic events using gridded data, the grids describing the event (in terms of depth, duration, depth times velocity and arrival time) are sufficient to describe how the watershed responds to a given event, and therefore the only watershed element required is a terrain grid. Each watershed configuration would be representative of different structural alternatives. To compare alternatives, a watershed configuration representing the *Without Project Condition* (it can be named whatever the user would like) would be required to evaluate a net benefit for the specific event. For a detailed description of the necessary input, refer to the HEC-FIA *Technical Guide* (Chapter 3) and the HEC-FIA *Applications Guide* (Chapter 2, Section 2.4).

Geographic data describes discrete parts of the study area. Boundaries allow the user to report information in the study area by specific areas. Emergency planning zones (formerly termed impact areas in HEC-FIA Version 3.0) are used in the life loss computations to define the geographic extent and type of warning system and mobilization relationship to be used within the study area.

Computing consequences in an HEC-FIA project requires **inundation data**. Inundation data provides a pattern for HEC-FIA simulations, through defining the source and type of hydraulic information at any point in the study area. Inundation data can be in the form of grids, which define an event, representing the maximum depth at each grid cell and the arrival time of the non-evacuation depth (recorded in decimal hours from the start time of the simulation). Alternatively, inundation data can be provided as a HEC-DSS file that contains stage hydrographs at cross sections and storage areas throughout the study area. In this case, the cross sections and storage areas define the geographic locations of the stage hydrographs. The inundation data configurations define the structure and data available to define hydraulic parameters throughout the watershed. The final step is to create an event for each inundation configuration which represents the specific characteristic of the flood in question at all locations within the watershed.

A **structure inventory** is required to estimate direct economic damages for a flood event. To estimate life loss for an event, the structure inventory must be supplied with a population estimate at each structure. **Damage categories** are the first aggregation level for structures, in the inventory. These damage categories represent a high level grouping for structures. They are used in the Economic Consequence Assessment Model (ECAM) process to determine population and capital impacted for each event. **Structure occupancy types** are the next level of aggregation for structures in HEC-FIA, and these are imperative for any consequence calculation. The occupancy types describe depth-damage relationships, life loss parameters, general information about the structures, and contain information about uncertainty computations associated with the structure inventory. Each structure is required to have an occupancy type and damage category.

Other optional input data elements for an HEC-FIA project include critical infrastructure, definitions of impact response tables, agriculture data, and the definition of warning issuance scenarios. These additional input data elements are defined in this User's Manual.

An **alternative** in HEC-FIA is combination of inundation data, emergency planning zone (geographic data), and structure inventory; and can also include critical infrastructure, impact response, warning issuance, or an agriculture inventory. Not all alternative elements are required for an HEC-FIA compute, but there are minimum requirements dependent upon the desired methodology to evaluate the flood impact analysis. Once an alternative is defined, then a **time window** needs to be created. The time window defines the start and end times for a **simulation**. Each HEC-FIA simulation is defined by the combination of the specified alternative, hydraulic event, and time window.

1.4   Starting HEC-FIA

When starting HEC-FIA, double-click the **HEC-FIA** icon on from desktop of a computer, or from the taskbar click **Start**, point to **All Programs**, point to **HEC**, point to **HEC-FIA**, and then click **HEC-FIA**. The splash dialog box for HEC-FIA opens (Figure 1.2).

The splash dialog box (Figure 1.2) appears for a few seconds, and then the main window of HEC-FIA appears. A user is now ready to start using HEC-FIA.
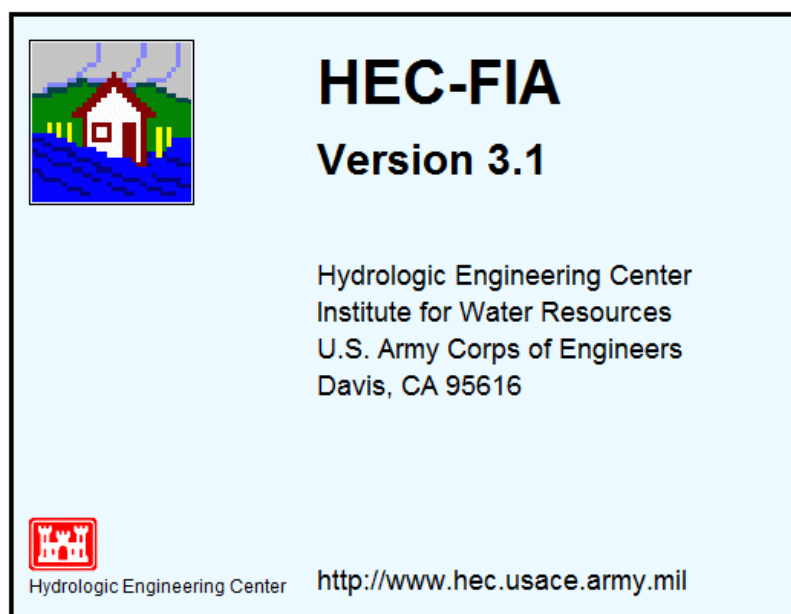
Figure 1.2 HEC-FIA Splash Dialog Box

1.5   Organization of Manual

The organization of this manual is shown in Table 1.1. A description of the HEC-FIA interface is provided in Chapter 2. The capabilities of HEC-FIA are described in Chapters 3 through 12.

Table 1.1 Summary of Contents of User's Manual

Topic	Chapter
The layout of the HEC-FIA GUI	Chapter 2
Creating and managing HEC-FIA projects	Chapter 3
How to work with map layers	Chapter 4
How to define watershed elements (terrain grids, reservoirs, stream alignment, cross sections, storage areas, computation points, watershed configurations)	Chapter 5
Define geographic data (boundaries, emergency planning zones)	Chapter 6
Creating inundation configurations	Chapter 7
How to add and define structure and other inventories	Chapter 8
Creating warning issuance scenarios	Chapter 9
How to create alternatives	Chapter 10
How to define a time window	Chapter 11
How to run simulations & review results	Chapter 12
References	Appendix A
How to prepare data for use in HEC-FIA	Appendix B
How to setup coordinate systems	Appendix C
How to edit map layer display properties	Appendix D
How to use the Color Chooser	Appendix E
How to use HEC-DSSVue	Appendix F
Importing data from HEC-RAS	Appendix G
Terms and Conditions for Use	Appendix H

1.6   Additional HEC-FIA Documentation

HEC-FIA Applications Guide contains examples that demonstrate the various aspects of HEC-FIA. Each example consists of a problem description, data for the analysis, step by step input and explanation of results.

HEC-FIA Technical Reference Manual describes the theory and computational methodology behind the HEC-FIA computations. Equations are presented which allow the user to understand how various inputs impact results.

This User's Manual, the HEC-FIA *Applications Guide*, *Technical Reference Manual*, and the HEC-FIA Version 3.1 software are available for download for free from the HEC web site (http://www.hec.usace.army.mil/software/hec-fia/).

CHAPTER 2

HEC-FIA Interface

This chapter begins with an introduction to the layout of the HEC-FIA GUI, including display elements, **Title Bar**, and tools. The chapter then gives an overview of the map windows in HEC-FIA. The **Title Bar** (Figure 2.1) displays the version of HEC-FIA and the name of the project, if a project is opened.

2.1   HEC-FIA Main Window

The HEC-FIA main window (Figure 2.1) displays the HEC-FIA user interface. The user interface allows the user to define and view the study area, create and edit structure inventories, alternatives, and other model elements, and then run simulations and view results. The HEC-FIA main window (Figure 2.1) is laid out in panes that allow the user to view HEC-FIA project data at the same time or to display different yet simultaneous, views of the project data. From the main window the **Map Window**(s), **Menu**, **Tool**, and **Status Bar**(s) are viewable in addition to the **Desktop**, **Message**, **Content** and **Study Pane**(s).
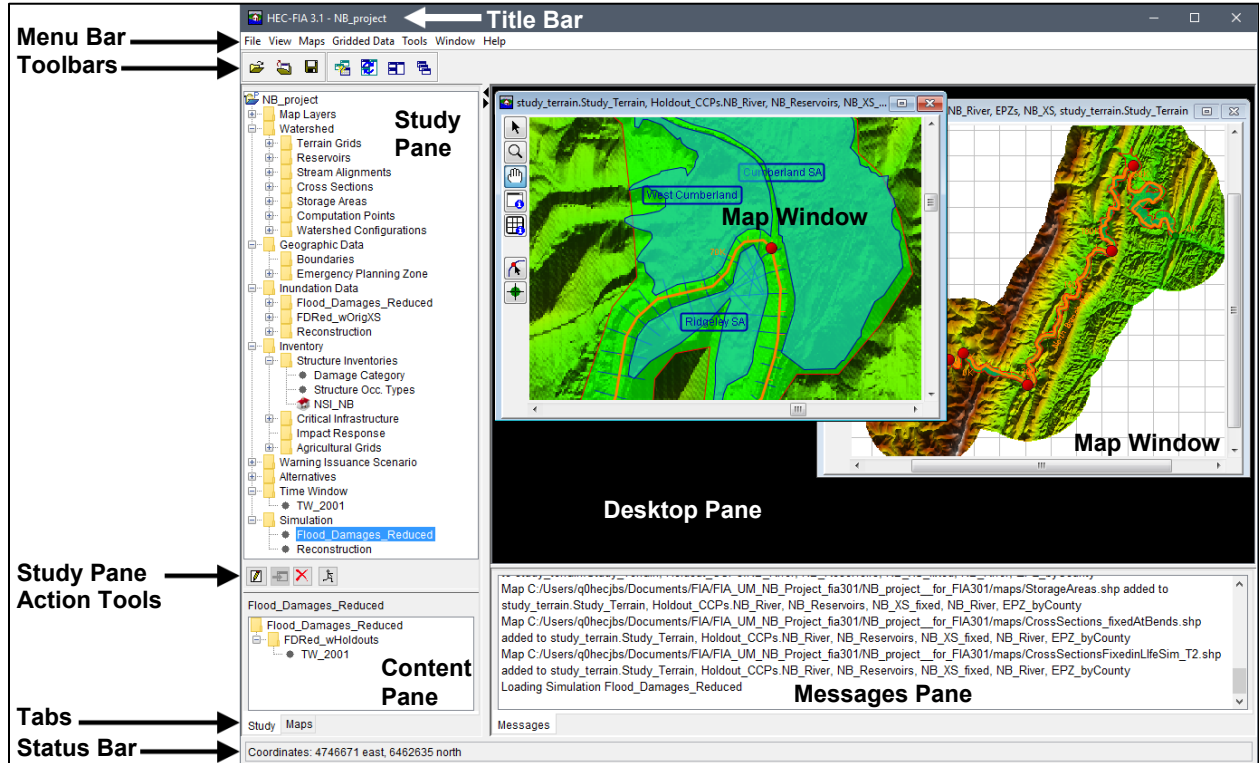
Figure 2.1 HEC-FIA Main Window – Study View

Note, if these items are not viewable from the main window it is likely that a study has not been loaded or some default views, managed from the **Views** menu located on the **Menu Bar**, have been altered.

2.2   Panes

Study Pane   Provides an overview of items that have been defined for an HEC-FIA project in a **Study Tree** (Figure 2.2). The **Study Pane** displays information about the map layers; watershed elements (terrain grids, reservoirs, stream alignments, cross sections, storage areas, computation points, and watershed configurations); geographic data (boundaries, emergency planning zones); inundation data; inventory data (structure inventories, critical infrastructure, impact response, agricultural grids); warning issuance scenarios; alternatives; time windows; and, stimulations.
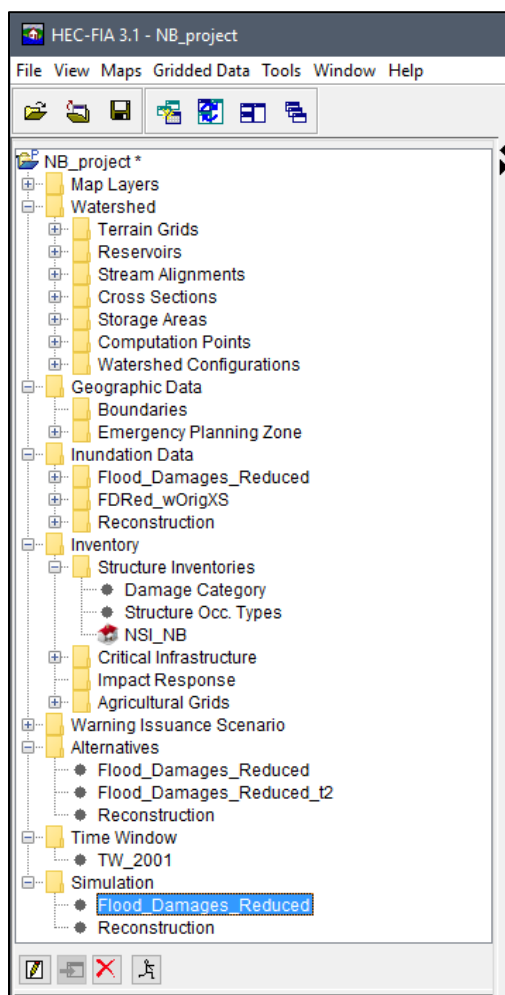
Figure 2.2 HEC-FIA Study Pane and
Study Pane Action Tools –
Study View

The **Study Pane** contains a toolbar of action tools (Figure 2.3), that will allow the user to edit, display in map window, delete, and compute an item that has been selected in the **Study Tree** (Figure 2.2). For example, in Figure 2.2 a simulation has been selected and the available action tools are edit, delete, and compute the simulation.

Figure 2.3 Study Pane Action Toolbar

Content Pane   The study view (refer to Section 2.3) for this pane (Figure 2.4) provides details on selected HEC-FIA components from the **Study Pane** (Figure 2.2). For example, in Figure 2.2, an HEC-FIA simulation has been selected – *Simulation*. The **Content Pane** displays the elements of that selected simulation (Figure 2.2 and Figure 2.4). Information includes the alternative and the time window. The **Content Pane** (study view) also allows the user to review available simulation results. Note, from the HEC-FIA interface, the internally generated simulation results can only be accessed from the **Content Pane**. Refer to Chapter 12, Section 12.3 for more information regarding simulation results.
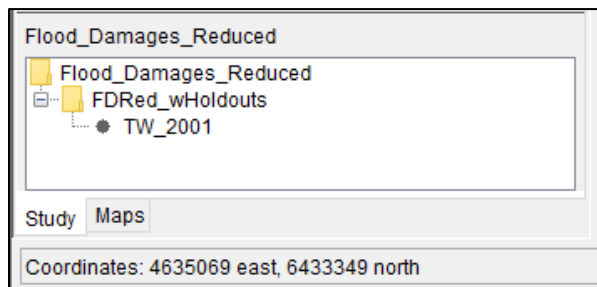
Figure 2.4 Content Pane – Study View

For a map view, the **Content Pane** displays the map layers associated with the selected map window listed in the **Study Pane**. Refer to Section 2.3 for more information regarding the map view.

Desktop Pane   The **Desktop Pane** (Figure 2.5) is where the different map windows that are available from HEC-FIA will display. For example, in Figure 2.5, the **Desktop Pane** contains two map windows for specific watershed elements for an example HEC-FIA project. These two map windows provide the user with two graphical representations of an example project's watershed elements. Refer to Section 2.6 for more information regarding map windows.
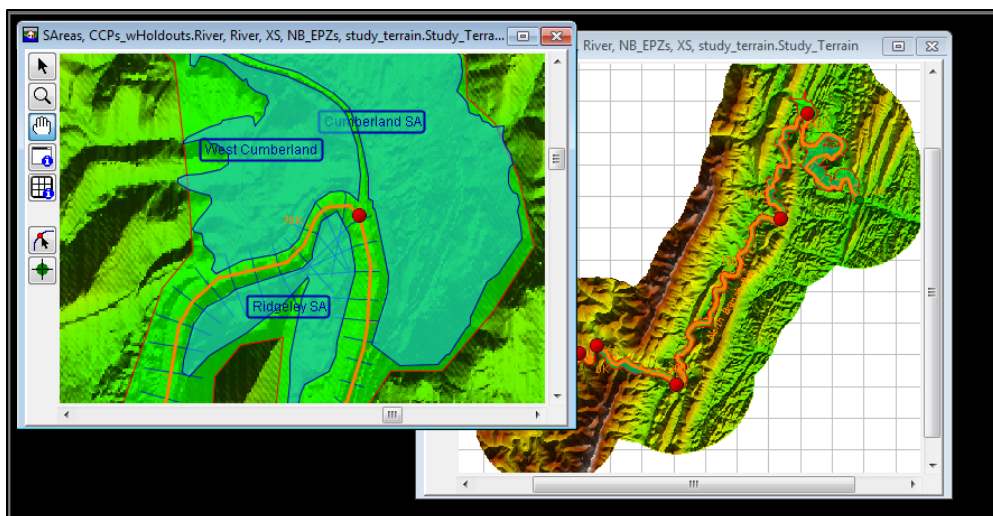
Figure 2.5 Desktop Pane

Message Pane   The **Message Pane** (Figure 2.6) contains messages that the HEC-FIA software is providing for informational purposes. The information in the **Message Pane** is a record of HEC-FIA software activities, recording the opening of a study, opening map windows, accessing HEC-DSS, and many other HEC-FIA activities.
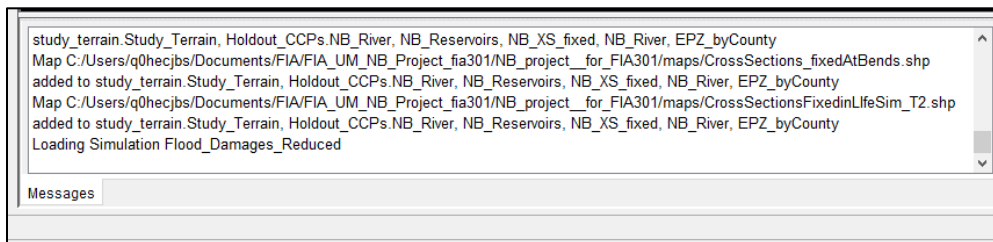
Figure 2.6 Messages Pane

2.3   Tabs

HEC-FIA has two tabs, the **Study** and the **Maps** tabs. The tabs provide different views of the available data in the project and users can perform certain operations for a project from the tabs. Depending on the selected tab, the **Study Pane** and **Content Pane** information will change. The **Study** tab, which is the default tab, provides a view of the project data. The **Maps** tab provides a view of the available map layers.

Study   The default tab (Figure 2.1) provides a view of the project data in a tree (**Study Tree**) in the **Study Pane**. The user can create and manage project data from the **Study Tree**. Also, from the **Study Tree** a user can create, edit, and delete alternatives, time windows, and simulations. From the **Content Pane** (Figure 2.4), the user can view detailed information about items selected from the **Study Tree** and access results for individual simulations.

Maps   This tab (Figure 2.7) provides a view of the available map windows currently open in the **Desktop Pane** (Figure 2.5). The maps windows are displayed by type in the **Study Pane** portion (Figure 2.7). In the **Content Pane** portion (Figure 2.7), information about the map layers for the active map window are displayed in a tree (**Map Layers Tree**). Also, from the **Content Pane** in the **Maps View**, the user can turn layers on or off, adjust properties of the layers, and order the layers for viewing in the associated map window.
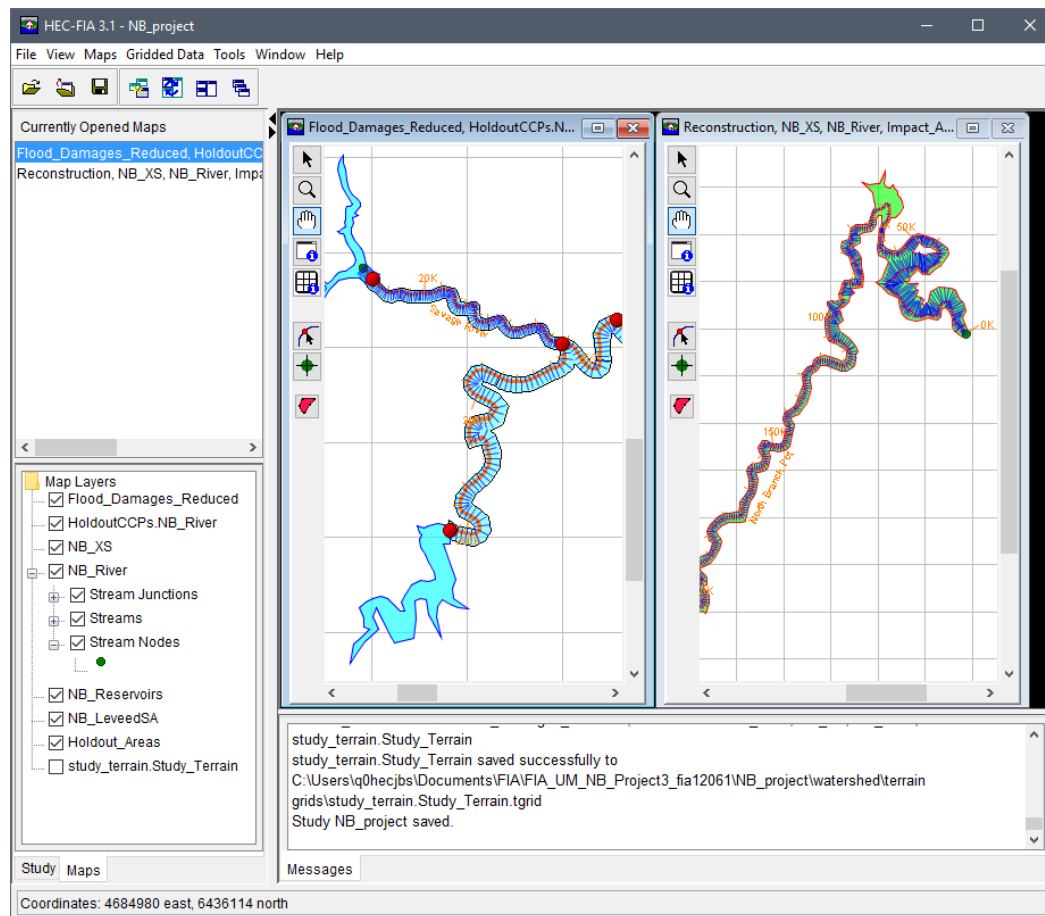
Figure 2.7 HEC-FIA Main Window – Maps View

2.4   Menu Bar

The **Menu Bar** of HEC-FIA provides the user with many commands to perform various functions. Seven menus are available: **File**, **View**, **Maps**, **Gridded Data**, **Tools**, **Window**, and **Help** menus. All **Menu Bar** menus are available in both the study and map views.

The **File** menu (Table 2.1) allows the user to perform study management functions such as creating, opening, closing, and saving an HEC-FIA project. It also provides commands that will allow users to enter and view information about study properties; open recently viewed HEC-FIA projects; and, exit the HEC-FIA software.

Table 2.1 HEC-FIA File Menu Commands

Commands	Description
New Study	create a new HEC-FIA project; opens the **Create New Study** dialog box
Open Study	open an HEC-FIA project; opens the **Open Study Browser**
Save Study	save the current HEC-FIA project.
Save Study As	make a copy of the current HEC-project; opens the **Save Study As** dialog box.
Close Study	close the current HEC-FIA project.
Study Properties	Opens the Study Properties dialog box. Provides general information about the HEC-FIA project; user can turn on/off map window grids; and, change background color.
Recent Studies	List the studies (last five) that have been opened.
Exit	Exit the HEC-FIA software.

The **View** menu (Table 2.2) is where an HEC-FIA user can setup the HEC-FIA main window. The user can select which toolbars and panes to display and not display; create and use layouts of the main window; manage layouts; set display units for plotting and tabulating (English, SI); and, display the active map window in either the watershed coordinate system or web coordinate system.

Table 2.2 HEC-FIA View Menu Commands

Commands	Description
Toolbars	from this menu item the user can toggle on/off the following toolbars that available in the HEC-FIA framework – **Standard** or **Maps**
Study Pane	menu item that toggles on/off the **Study Pane** in the HEC-FIA main window.
Messages Pane	menu item that toggles on/off the **Message Pane** in the HEC-FIA main window.
Status Bar	menu item that toggles on/off the **Status Bar** in the HEC-FIA main window.
Toggle Views	menu item that toggles on/off display of the **Desktop Pane**
Save Current Layout	opens the **Create Layout** dialog box.
Restore Layout	menu item provides a list of layouts that a user can choose from.
Layout Manager	opens the **Layout Manager** dialog box.
Set Display Units	user can set the display units for the HEC-FIA project – English (Watershed) (default) or SI.
Displayed Coordinate System	user can set the displayed coordinate system for the HEC-FIA project – Web Coordinate System or Watershed Coordinate System (default).

From the **Maps** menu (Table 2.3), an HEC-FIA user can setup map layers and map windows for the HEC-FIA project. Commands include setting spatial properties; open a new map window; view the settings of the current map window that is being displayed; zoom the active map window out to its full extents; and, save the contents of the active map window as a graphics file.

Table 2.3 HEC-FIA Maps Menu Commands

Commands	Description
Default Map Properties	opens the **Default Map Properties for** dialog box.
New Map Window	opens a map window in the **Desktop Pane** that displays the map layers selected for the HEC-FIA project.
Map Window Settings	opens the **Map Window Settings** dialog box.
Zoom to Map Extents	zoom the active map window out to its full extents.
Save Map Image	opens a Save Browser that allows the user to save the active map window as a graphic (**.wmf*, **.jpg*, **.png*).

The **Gridded Data** (Table 2.4) menu provides the capability to create grids that HEC-FIA can use and display.

Table 2.4 HEC-FIA Gridded Menu Command

Commands	Description
Convert Grids	opens an **Open** browser that allows the user to select either an ArcInfo (**.asc*) DEM file or an ESRI FLT (**.flt*) file; which is converted to a **.tif* file.

The **Tools** menu (Table 2.5) provides access to HEC-DSS data (HEC-DSSVue); provides options for HEC-FIA startup, setting system properties, viewing threads, setup simulation and compute color, and plug-in information; view the log for HEC-FIA, and monitor memory usage.

Table 2.5 HEC-FIA Tools Menu Commands

Commands	Description
HEC-DSSVue	opens the HEC-DSSVue application.
Options	open the **Options** dialog box.
Console Output	opens the **Console Window** which contains the HEC-FIA log for the study.
Memory Monitor	opens the **Memory Monitor** dialog box; displays HEC-FIA memory usage.

From the **Window** menu (Table 2.6), the HEC-FIA user can control the appearance of the map windows in the **Desktop Pane** (Figure 2.5) of the HEC-FIA main window.

Table 2.6 HEC-FIA Window Menu Commands

Commands	Description
Tile	Menu item that allows the user to organize all of the currently opened map windows in either a vertical or horizontal tile.
Cascade	Menu item that allows the user to, place one map window on top of the next in a cascading fashion.
Next Window	Menu item that brings the next map window in the list of currently opened map windows to the top.
Previous Window	Menu item that brings the previous map window that was on top to the top.
Window Selector	Menu item that provides a list of the currently opened map windows.
Window	Menu item that lists the currently opened map windows.

From the **Help** menu (Table 2.7), the user can access the HEC-FIA User's Manual, view the HEC-FIA Terms and Conditions for Use (TCU), and display current version information about HEC-FIA.

Table 2.7 HEC-FIA Help Menu Commands

Commands	Description
User's Manual	opens the HEC-FIA User's Manual.
Terms and Conditions for Use	opens the **HEC-FIA Terms and Conditions for Use (TCU)**.
About	opens the **About Box** for HEC-FIA.

2.5   Toolbar

The **Toolbar** of the HEC-FIA main window (Figure 2.1) provides quick access to the most frequently used options from the HEC-FIA **Menu Bar**. Two toolbars are available from the main toolbar:

Standard   Three tools are available from the **Standard** toolbar (Figure 2.8). The tools allow the user to open a study, close a study, and save a study. These tools have the same function as items under the **File** menu (see Table 2.1).

Figure 2.8 Standard Toolbar

Maps   Four tools are available from the **Maps** toolbar (Figure 2.9). The tools allow the HEC-FIA user to control the appearance of map windows in the **Desktop Pane** (Figure 2.5); create a new map window; synchronize active map windows; tile; and, cascade. These tools have the same function as items under the **Window** menu (see Table 2.6).

Figure 2.9 Maps Toolbar

To toggle these toolbars on and off, from the HEC-FIA **Menu Bar**, from the **View** menu, point to **Toolbars**, and select the toolbar the user wishes to toggle on and off.

2.6   Map Windows

Map windows (Figure 2.10) are a way to graphically display stream alignments, watershed configurations, inventories, alternatives, and other HEC-FIA project elements. Depending on the project data displayed in the map window, different map window tools or other capabilities become available. For example, from an alternative map window the user can open editors and view results.
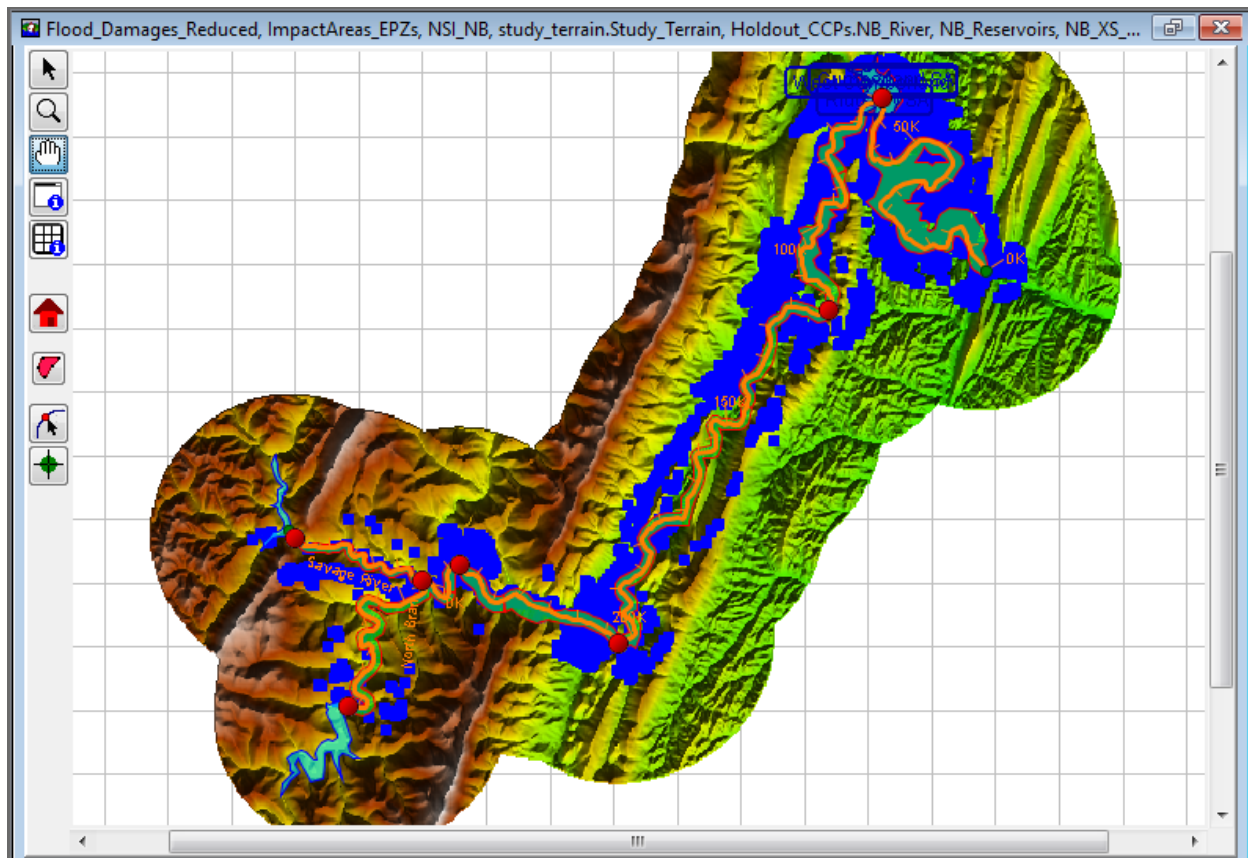
Figure 2.10 Map Window Example

2.6.1 Opening Map Windows

Two ways are available to open map windows in the **Desktop Pane** (Figure 2.5): from the **Study Pane**, from the **Study Tree** (Figure 2.11), double-click on a stream alignment, alternative, structure inventories or other HEC-FIA project elements; or, from the shortcut menu of a stream alignment, structure inventories or other HEC-FIA project elements.

To open a map window by double-clicking:

1. From the **Study Pane**, from the **Study Tree**, the user can double-click on stream alignments, alternatives, structure inventories or other HEC-FIA project elements to open map windows in the **Desktop Pane**.

2. For example, in Figure 2.11, from the **Study** tab, double-click on the *NSI_NB* structure inventory. A map window opens displaying the structures associated with the *NSI_NB* structure inventory.
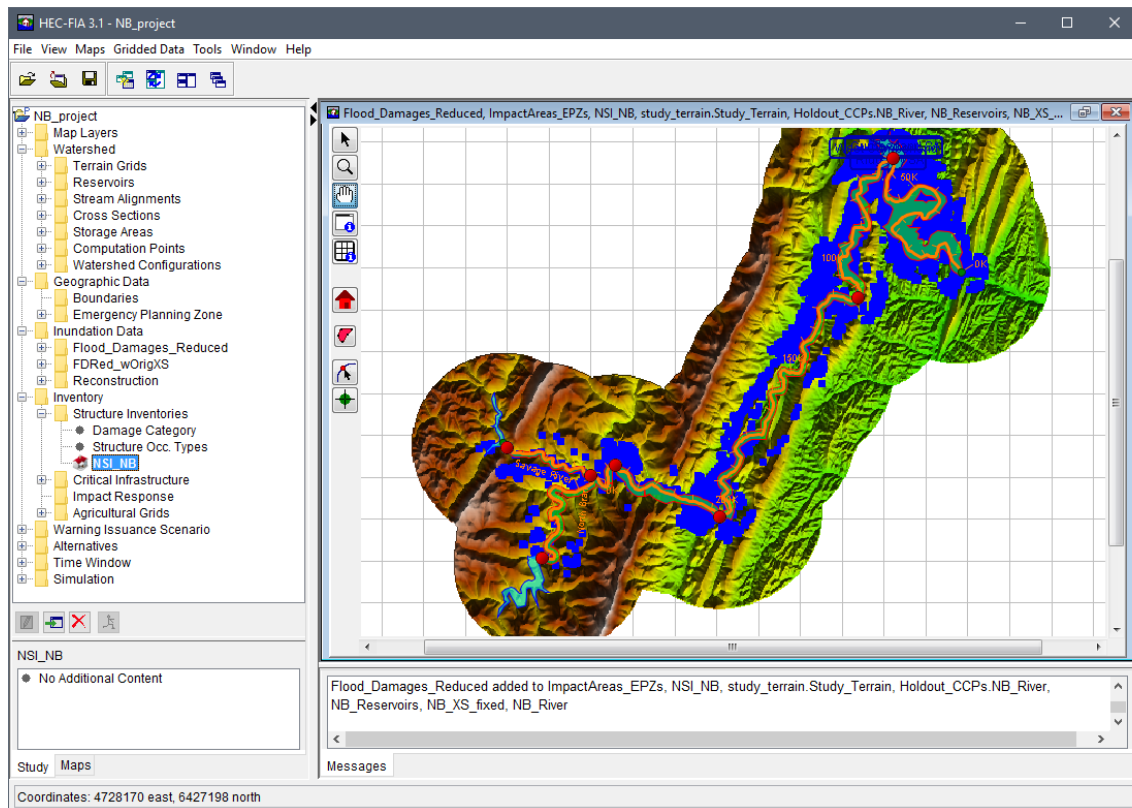
Figure 2.11 Display Structure Inventory Map Window – Study Pane

To open a map window from a shortcut menu:

1. From the **Study** tab, from the shortcut menus available for stream alignments, alternatives, structure inventories, or other HEC-FIA project elements, the **Display in Map Window** command (Figure 2.12) displays map windows in the **Desktop Pane**.

2. For the example in Figure 2.12, from the **Study** tab, right-click on *NB_River*. From the shortcut menu, click **Display in Map Window**, a map window opens displaying the elements for the stream alignment.
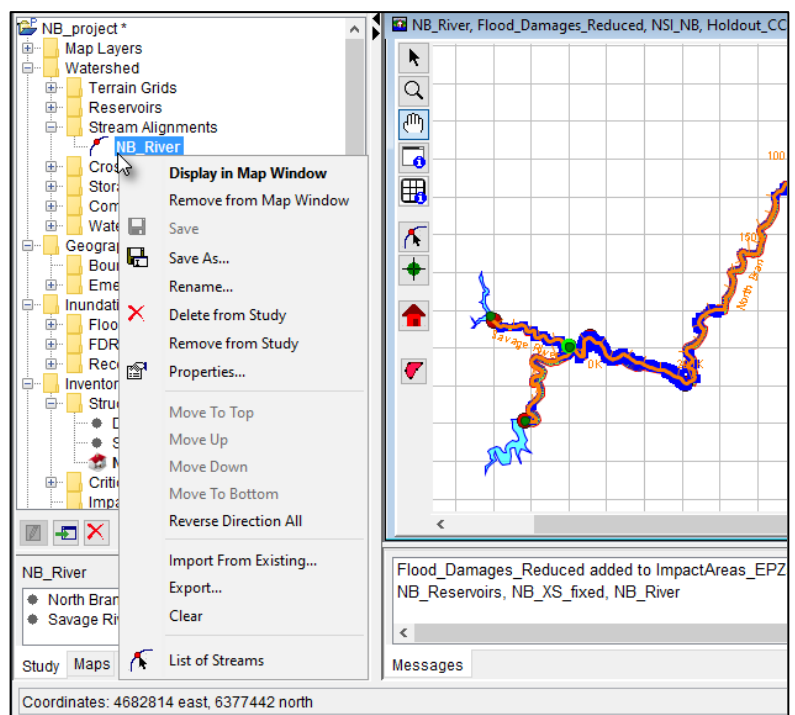
Figure 2.12 Display Stream Alignment Map Window – Shortcut Menu

2.6.2   New Map Window

HEC-FIA provides a mechanism for the user to build a map window. Instead of double-clicking on a stream alignment, structure inventories or other HEC-FIA project elements, the user can build a map window.

To create a map window:

1. From the **Maps** menu, click **New Map Window** (Figure 2.13), in the **Desktop Pane** a map window opens, with the map layers for the study automatically loaded.
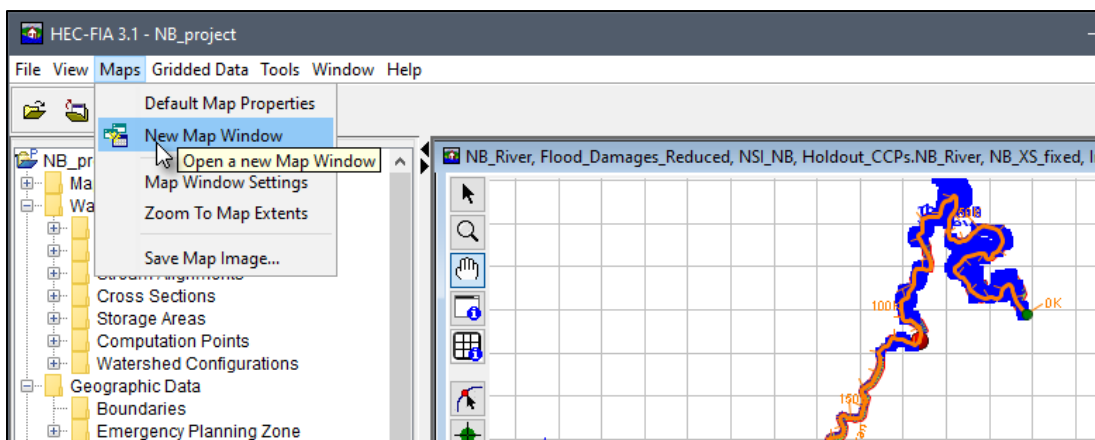
Figure 2.13 Maps Menu – New Map Window Command

2. To add the elements of an HEC-FIA alternative, from the **Study Tree**, from the **Alternatives** list, double-click on an alternative (e.g., *Flood_Damages_Reduced* in Figure 2.14). The elements that make up the selected alternative now display in the new map window and the map window now is an alternative map window.

3. The map window is saved when the project is saved. The next time the project is opened, the map window displays as it appeared when the project was saved.

2.6.3   Map Window Tools

Map window tools allow the user to select structures, zoom in and out the map window, pan in the map window, get information on shapefiles and grids in the map window, and edit stream alignments. The following is an overview of available map window tools. Note, besides the primary tools (**Pointer/Selector**, **Zoom**, **Pan**, **Shapefile Query**, and **Grid Query**), the available map window tools vary depending on the study elements open in a map window.
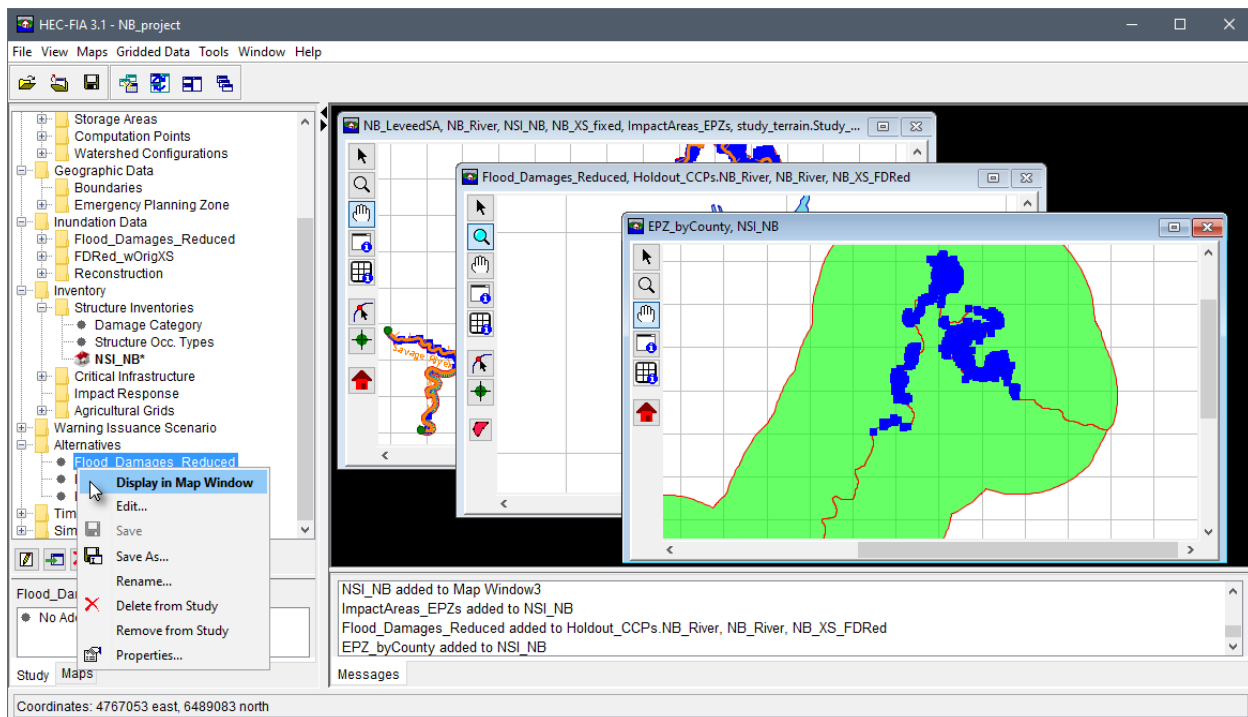
Figure 2.14 New Map Window – Alternative Added

Pointer/Selector Tool – use this primary tool to edit and delete structures. This tool can also be used to edit information contained in the displayed alternative, such as adding impact response rules to cross sections, viewing hydrographs at cross sections, editing critical infrastructure, or defining warning issuance rules. This tool is always available and always functional.

Zoom Tool – use this primary tool to zoom in and out of the map window. This tool is selected by default. To zoom in, hold the mouse button down and outline the area that is to be zoomed in on. To zoom out, click the right mouse button (right-click). This tool is always available and always functional.

Pan Tool – use this primary tool to move the map window while zoomed in. This tool is always available and always functional.

Shapefile Query Tool – use this primary tool to query shapefile information at specific points on a shapefile. This tool is always available, but is only functional when a shapefile is uploaded to a project and displayed in the map window.

Grid Query Tool – use this primary tool to query gridded data. For an inundation grid, a click displays depth values. For an arrival time grid, a click displays the computed arrival time of flood waters during an event for the point at which the user clicked. For a duration grid, the values of the duration of water during a flood event for the cell are displayed where the user clicked. For a digital terrain model, the tool queries elevation values. This tool is always available, but is only functional when terrain or inundation grids have been added to a project and displayed in the map window.

High Ground Tool – use this watershed configuration tool to create or edit high ground polygons. This tool is only available when a watershed configuration is open in a map window.

Stream Alignment Tool – use this tool to create or edit stream alignment elements. To create streams, with the tool selected, hold the **CTRL** key and left-click to start the stream. Each subsequent left-click adds vertex point to the line. When finished, release the **CTRL** key and left-click on the location of the final point. A **Create New Stream** dialog opens and users can enter the **Name** of the stream and a short **Description** (optional, but recommended). Click **OK** to create the stream. When an existing stream already exists in the stream alignment a **Connect Stream Reaches** dialog opens asking the user if the upstream end of the created stream should be connected to the existing stream. Click **Yes** to connect the streams. This tool is only available when a stream alignment is displayed in the map window.

Stream Node Tool – use this tool to add a stream node to the imported or created stream alignment. This tool is only available when a stream alignment is displayed in the map window.

Structure Tool – use this tool to copy, delete, edit, and get information for an individual structure. This tool is only available when a structure inventory is displayed in the map window.

2.6.4   Using Shortcut Menus

Using the previously described **Map Window Tools**, users can edit the project elements displayed in the window using shortcut menus. For example, when users engage the **Structure Tool**, they can locate an individual structure they wish to edit, right-click, and perform a variety of actions from a shortcut menu, as shown in Figure 2.15.
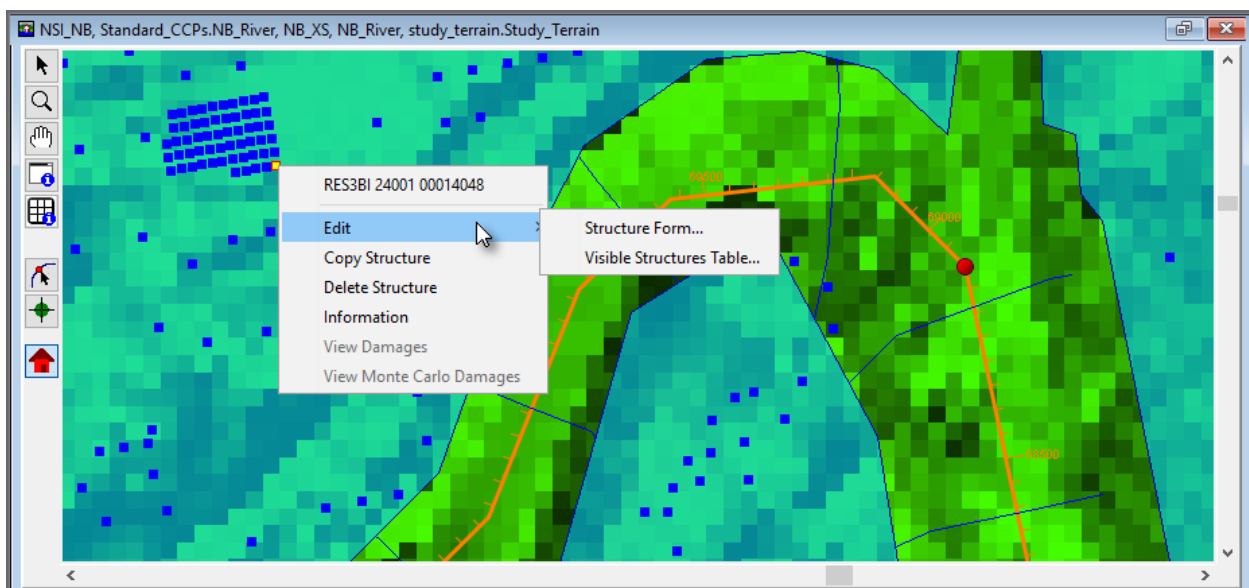
Figure 2.15 Map Window – Structure Shortcut Menu Commands

The shortcut menu makes creating and editing projects in HEC-FIA efficient and intuitive. The editing capabilities for different project elements and data are described in their respective chapters of this manual.

2.6.5   Properties of a Map Window

The basic properties of a map window are the geographic extents, zoom factor, available map layers, grid, and background color. From the **Maps** menu, click **Maps Window Settings**, the **Map Window Settings** dialog box (Figure 2.16) displays. This dialog box provides information about the current map window that is open and selected (active in the **Desktop Pane**). The user can toggle on/off map layers; toggle on/off the grid in the map window; and, the user can change the background color of the map window.

To edit and view the active map window's properties:

1. From the **Maps** menu, click **Map Window Properties**, the **Map Window Settings** dialog box opens (Figure 2.16).

2. From the **Current View Extents** box, the user can view the extents of the map window and the current zoom factor.
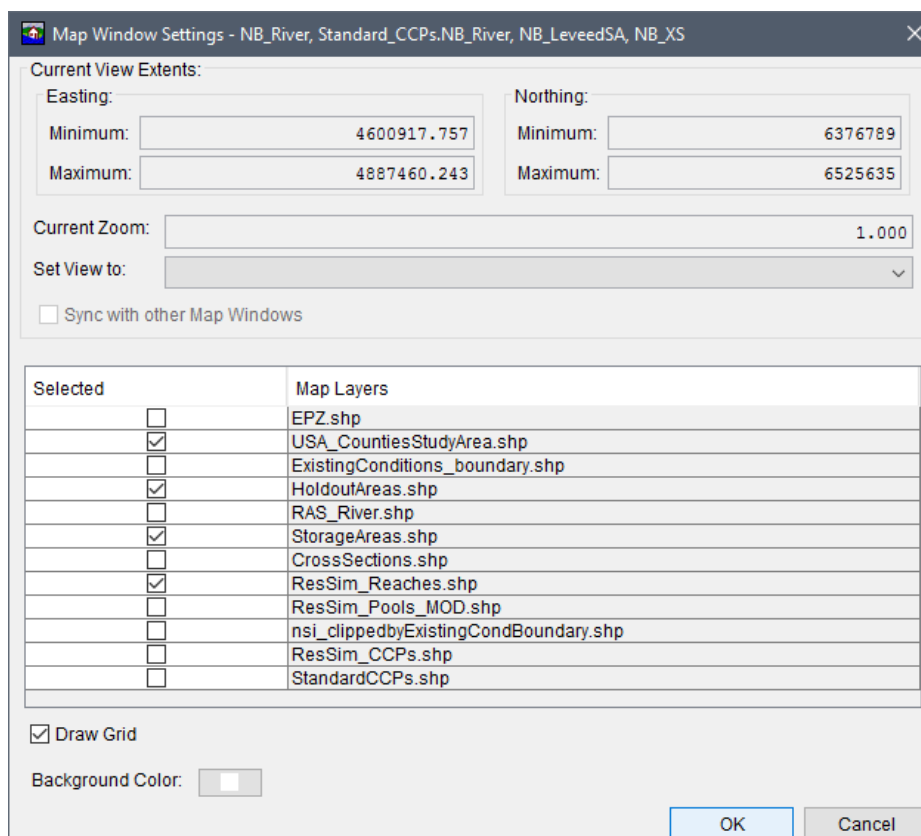
Figure 2.16 Map Window Settings – Active Map Window – Example

3. The map layers associated with the active map window are listed in the table on the **Map Window Settings** dialog box (Figure 2.16). The user can remove a map layer from the

active map window by clicking to uncheck the checkbox for the layer in the **Selected** column. For example, in Figure 2.16, if user does not want to display the map layer associated with the HEC-ResSim holdout areas, click to clear the checkbox ☐ in the **Selected** column associated with *HoldoutAreas.shp*. Click **OK**, the **Map Windows Settings** dialog box closes, and the map layer no longer displays in the active map window.

4. By clicking **Draw Grid** (Figure 2.16), the user can turn on (selected by default) and off the grid that is displayed in the active map window.

5. The default background color for the active map window is white, by clicking **Background Color**; a **Color Chooser** dialog box opens (Figure 2.17). From the **Swatches** tab click on a color, click **OK**, the **Color Chooser** dialog box (Figure 2.17) closes. See Appendix F for further details on the color chooser. From the **Map Windows Setting** dialog box (Figure 2.16), click **OK**. The **Map Windows Setting** dialog box closes and the background color of the active map window changes.
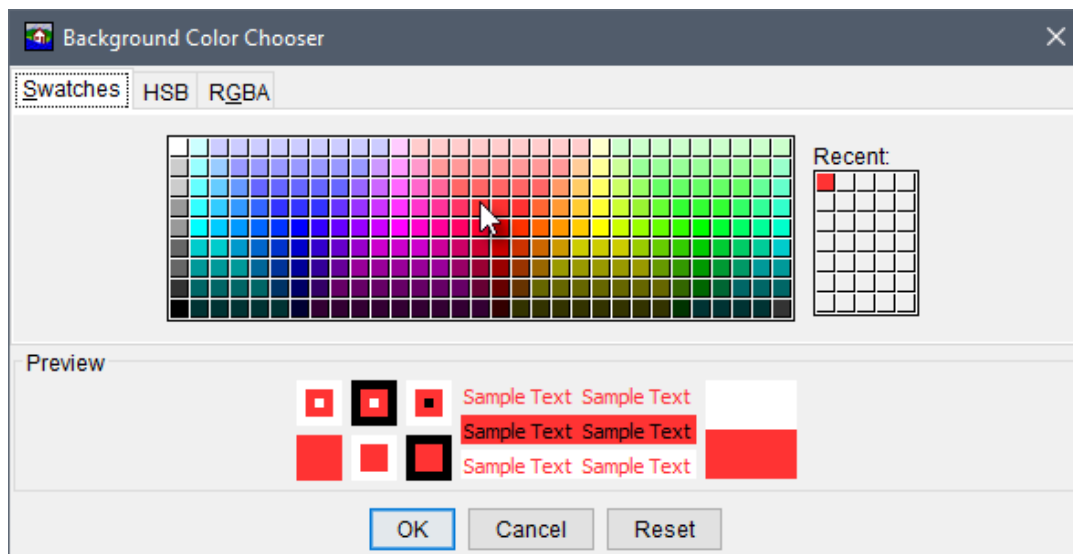
Figure 2.17 Background Color Chooser – Example Recent Selection

2.6.6 Saving a Map Window to a Graphics File

HEC-FIA allows the user to save the active map window to a graphics file for inclusion in reports and presentations. HEC-FIA has three possible formats: Windows Metafile (**.wmf*; default), JPEG (**.jpg*, **.jpeg*) and Portable Network Graphics (**.png*).

To create a graphics file of the active map window:

1. From the **Maps** menu, click **Save Map Image**, the **Save Browser** opens (Figure 2.18).

2. Browse to the location where the file is to be saved, in the **File name** box type a name. From the **Files of type** list select the graphics file type (i.e., Windows Metafile - **.wmf*; JPEG - **.jpg*, **.jpeg*; Portable Network Graphics - **.png*) that is to be created.
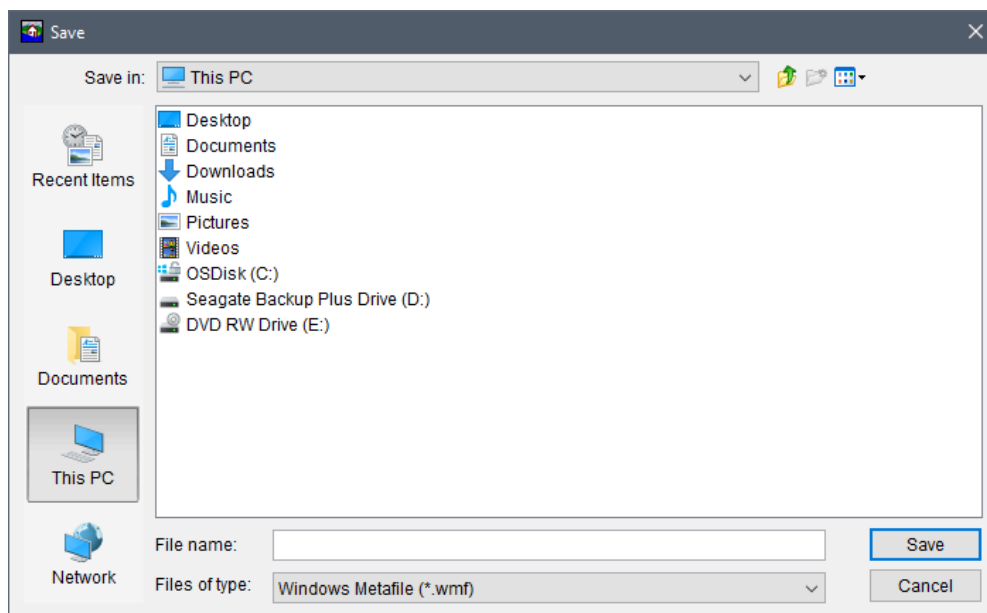
Figure 2.18 Save Browser – Save Map Window to Graphics File

3. Click **Save**, the **Save Browser** closes (Figure 2.18), and a file with the appropriate extension is created in the selected location. The file contains an image of the active map window.

CHAPTER 3

Creating and Managing Projects

Data management by HEC-FIA is largely done behind the scenes. Files are automatically created and named by HEC-FIA to store information. Information regarding the project are stored in ASCII text files, XML files, ASCII serialized files, and database files (**.dbf*, **.mdx*, **.dbt*).

3.1   Managing Projects

In HEC-FIA, the set of files associated with a particular water resources study is called a **project**. HEC-FIA creates a directory (folder) with the project name specified, and stores all the files associated with the project in that directory.

Commands available in the **File** menu (Figure 3.1) allows the user to create a new project, open an existing project, close the current project, save the current project, save the current project as another project, and review project properties.
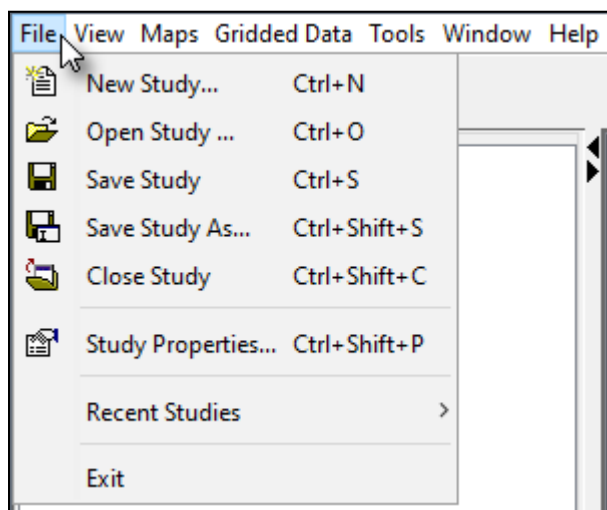
Figure 3.1 File Menu Commands

3.1.1   Creating a New Project

To create a new project:

1. From the **File** menu, click **New Study**, the **Create New Study** dialog box opens (Figure 3.2).

2. From the **Create New Study** dialog box, enter a name (required) in the **Study Name** box, and in the **Description** box, enter a description (optional, but recommended) for the new project.
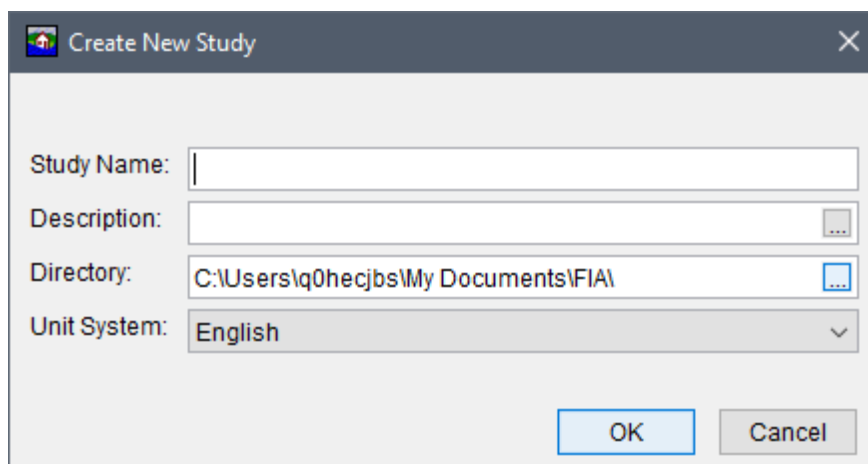
Figure 3.2 Create New Study Dialog Box

3. In the **Directory** box, either enter the name of the directory where the HEC-FIA project is to be stored, or click ⬚, an **Open Browser** (Figure 3.3) opens. The user can navigate to the directory where the HEC-FIA project is stored on the user's computer or network.

4. The **Unit System** dropdown allows the user to select either **English** (default) or **SI** units for the project.
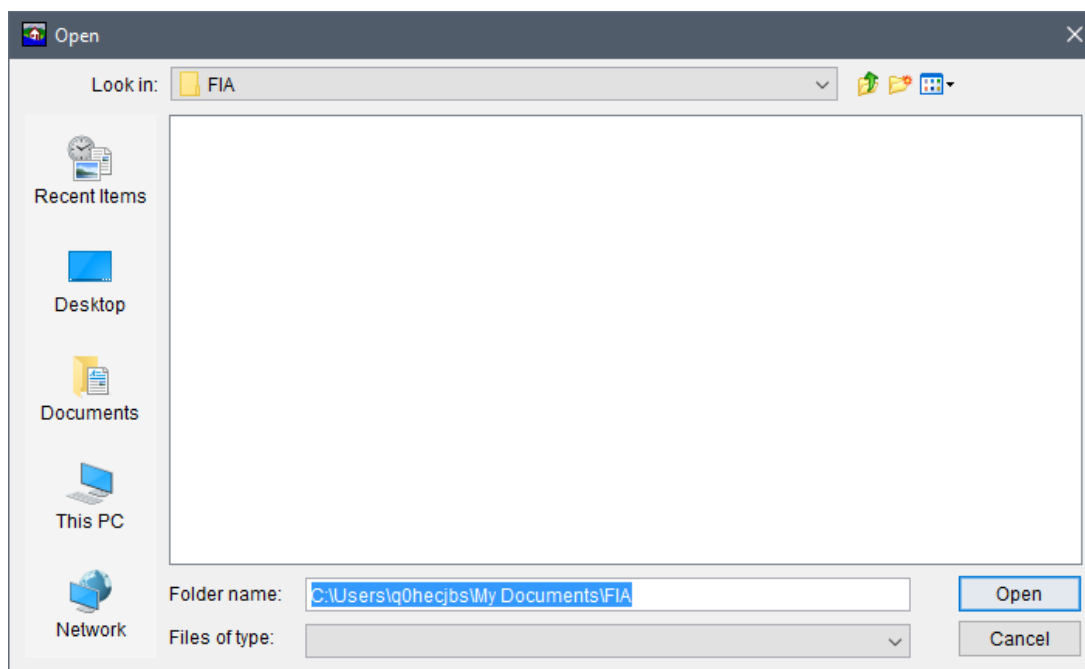
Figure 3.3 Open Browser Window

5. Click **OK**, the **Create New Study** dialog box closes (Figure 3.2). The HEC-FIA main window now has the name of the project in the **Title Bar**.

6. A map window opens in the **Desktop Pane** and in the **Study Pane** (see Chapter 2, Section 2.3.1) displaying the project.

7. A directory with the project name and associated files is being created for the project. For further details on the project directory and files, see Section 3.2.

3.1.2   Opening an Existing Project

Two ways are available to open existing projects in HEC-FIA. The first is to open the project by selecting it from the list of most-recently-opened projects. To do this, from the **File** menu (Figure 3.1), point to **Recent Studies**, and select the name of the project from the list of the previous five opened projects. HEC-FIA automatically loads the selected project. The second way to open an existing project is described below.

1. From the **File** menu, click **Open Study**, an **Open Study Browser** (Figure 3.4) opens.
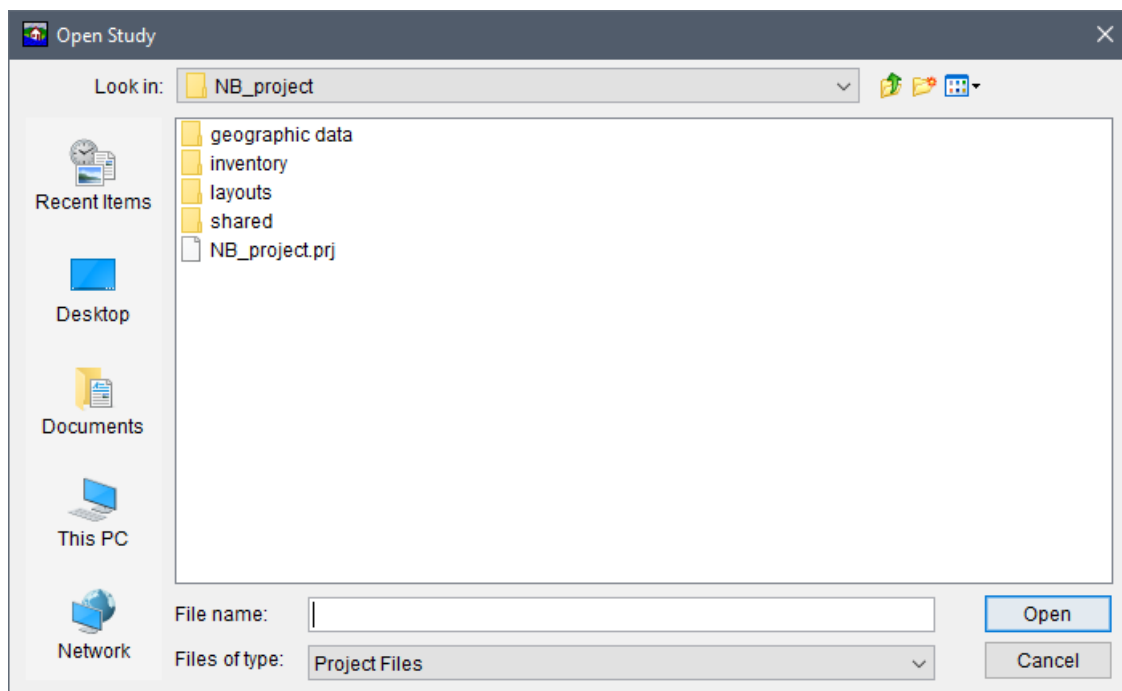
Figure 3.4 Open Study Browser Window

2. From the **Open Study Browser**, browse to the location of the existing HEC-FIA project (e.g., *NB_project.prj*). Note, by default, HEC-FIA is looking for a file with the Project Files extension **.prj*.

3. Select the project name, click **Open**, the **Open Study Browser** closes, and the selected project opens in HEC-FIA (Figure 3.5).
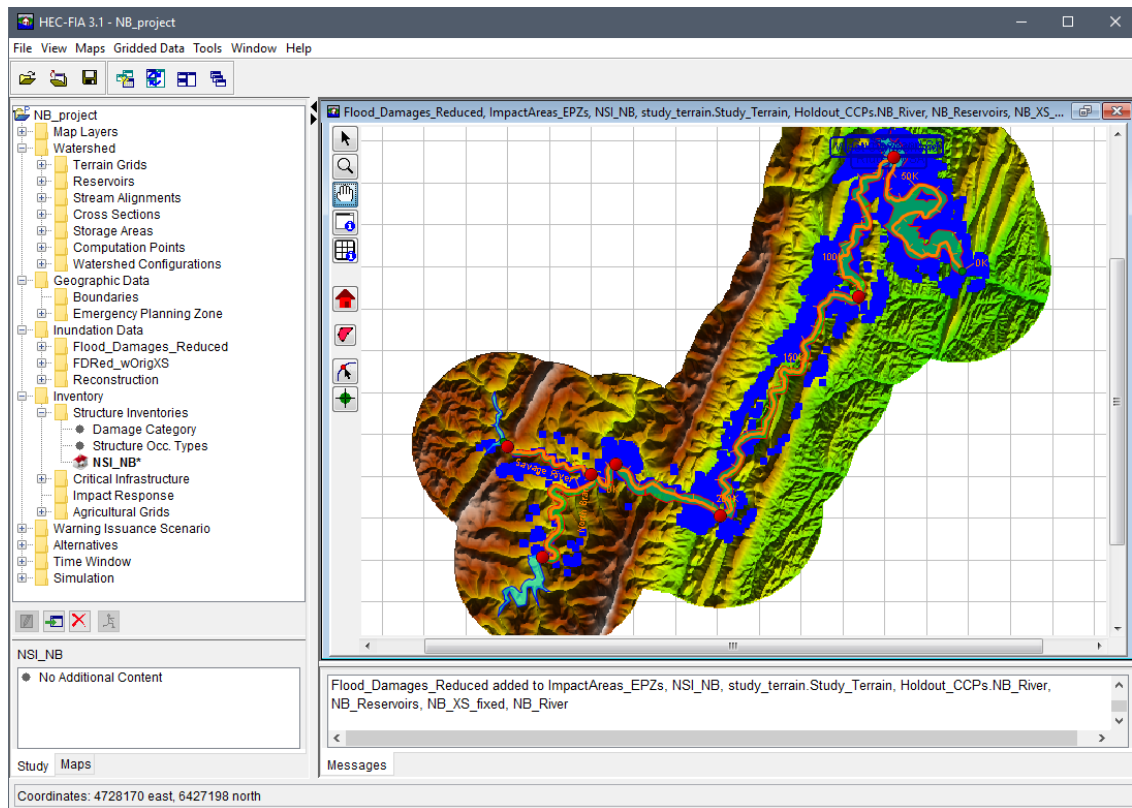
Figure 3.5 Example – Opened HEC-FIA Project

3.1.3 Close a Project

To close an active project, from the **File** menu (Figure 3.1), click **Close Study** and the project automatically closes. All changes that were made are automatically saved when exiting HEC-FIA.

3.1.4 Save a Project

To save a project, from the **File** menu (Figure 3.1), click **Save Study**, and HEC-FIA automatically saves the project. Saving a project saves all unsaved project elements. Project elements that are not saved are marked by an asterisk (*); for example the *NSI_NB* structure inventory displayed in Figure 3.5.

3.1.5 Save a Project As

To save a project as a different project:

1. From the **File** menu, click **Save Study As**, the **Save Study As** dialog box opens (Figure 3.6).
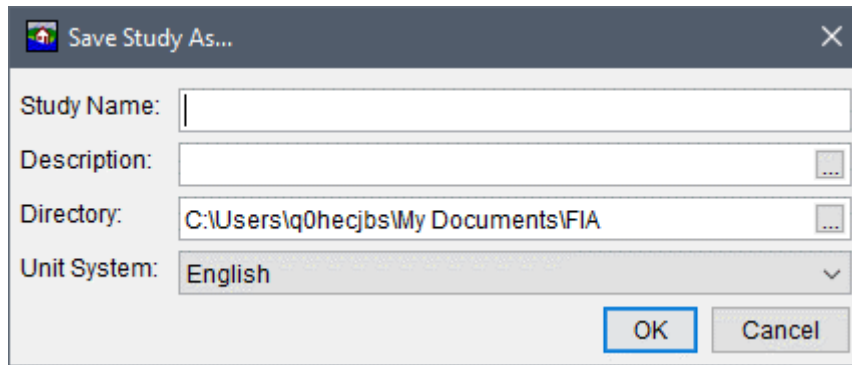
Figure 3.6 Save Study As Dialog Box

2. From the **Save Study As** dialog box, enter a name (required) in the **Study Name** box, and in the **Description** box, enter a description (optional, but recommended) for the new project.

3. In the **Directory** box, either enter the name of the directory where the HEC-FIA project is to be stored, or click ▢, an **Open Browser** (Figure 3.3) opens. The user can navigate to the directory where the HEC-FIA project is stored on the user's computer or network.

4. The **Unit System** list allows the user to select either **English** (default) or **SI** units for the project.

5. Click **OK**, the **Save Study As** dialog box closes (Figure 3.6). A progress window opens, providing information on the copying of the project. When that closes, the HEC-FIA main window now has the name of the project in the **Title Bar**.

7. The new project is named in the **Study Tree** and all data associated with the original project is now available.

8. A directory with the project name and associated files is created for the project. For further details on the project directory and files, see Section 3.2.

3.1.6   Project Properties

To view the properties for an active project, from the **File** menu (Figure 3.1), click **Study Properties** and the **Study Properties** dialog box opens (Figure 3.7). This dialog displays the name of the project, the project description (which the user can edit), location of the project file (**.prj*), the selected unit system, coordinate system, the Windows User ID name of the team member that created the project, and the date and time the study was created.

Certain map window property options are provided in the **Study Properties** dialog box (Figure 3.7). For instance, the default property of synchronize map windows, the property to draw a grid, and the background color of the grid can all be set via this interface.
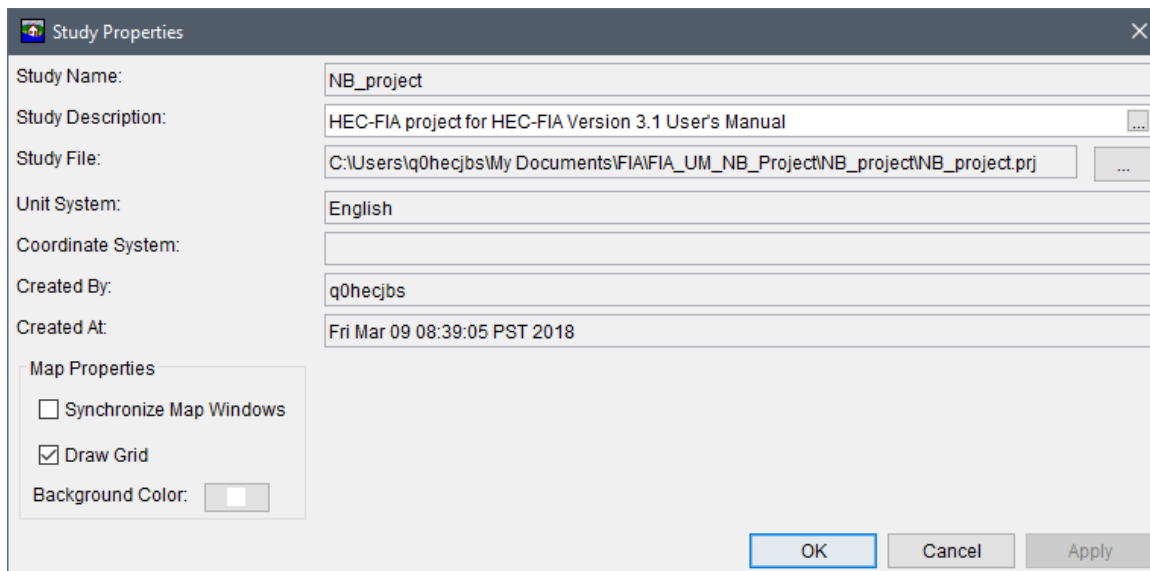
Figure 3.7 Study Properties Dialog Box

3.2   Project Directories and Files

Figure 3.8 shows an example of how HEC-FIA organizes the directories and files that are created in the project directory. In this example, the study directory is */NB_project*. As data is entered, other files and subdirectories are created. Table 3.1 describes each directory and file that is shown in Figure 3.8.

3.3   Automatic Backup Files

As stream alignments, map layers, and data are added to a project, the files and directories listed in Table 3.1 are created, along with automatic backup files. One case of this is a *NB_project.prj* file and a *NB_project.prj.bak* file are created when the project is created. For example, when a map layer is added to a map window, the *.bak* file of the project's *.prj* file (where map window properties are stored) would not have any reference to the added map layer, since the backup file reflects the state previous to the current changes. So every time the user **Save**'s a project, the *.bak* file is updated to the previous state of the file being saved, and edits are saved in the *.prj* file.

Automatic backup files are created for all project, alternative, simulation, and results files. It is important to note that HEC-DSS files are not automatically backed up. Since the *.bak* file reflects the previous state of that file, the user can go back to the previous state by eliminating the actual file, and deleting the *.bak* extension of the backup file (this should be done while the HEC-FIA project is closed). This procedure would allow the information for that previous state (recorded in the backup file) to become the current state. The overall effect would be "undoing" all changes the user made in the last cycle even if the changes have been saved or automatically saved. One should note, as soon as the HEC-FIA project is re-opened, the model files are all "backed up" so the *.bak* file is automatically updated. Therefore, if the user wants to eliminate saved changes, deletion of the *.bak* file must occur before re-opening the project.

```
📁 NB_project
   📄 Default.ag
   📄 NB_project.log
   📄 NB_project.prj
   📄 NB_project.projection
   📄 programOrder.xml
   📁 alternatives
      📄 ALT_CrossSections.alternative
      📄 ALT_Grids.alternative
      📄 ALT_Reconstruction.alternative
   📁 fia
      📄 ActivityTypeDistributions.dat
      📄 global.fgd
      📄 ImpactArea.lifesim
   📁 geographic data
      📁 boundaries
         this directory contains all the boundary informaiton defined for the HEC-FIA project
      📁 impact areas
         📄 Fia.dss
         📄 ImpactArea.fsys
      📁 emergency planning zones
         this directory contains all the emergency planning zones information defined for the HEC-FIA project
   📁 inundation data
      this directory contains sub-directories based on the inundation type created; sub-directories contain all of the information
      about the inundation data
   📁 inventory
      📁 structure inventories
         this directory contains all the files that describe structure inventory information
      📁 critical infrastructure
         this directorectory contains all the files that describe critical infrastructure information
      📁 Agricultural Data
         this directory contains all the files that describe agricultural information
      📁 impact response
         this directory contains all the files that describe impact response information
   📁 layouts
   📁 maps
   📁 runs
      📁 Alternative One
      📁 Life_Loss
      📁 Cross Sections
      📁 Reconstruction
   📁 shared
   📁 simulation
   📁 study
   📁 time windows
   📁 warning issuance scenario
   📁 watershed
      this directory contains sub-directories based on the watershed element that is created; sub-directories contain all of the
      information about watershed elements
```

Figure 3.8 Example HEC-FIA Project Directory Structure

Important: If the HEC-FIA project was created in HEC-FIA Version 3.0.1 (and older) and then updated in HEC-FIA Version 3.1, the file structure will be different than a study created from scratch in HEC-FIA Version 3.1.

Table 3.1 Example HEC-FIA Directories and Files

File or Directory Name	Contents
📁 NB_project	Project directory that is created when a user creates a new project (see Section 3.1.1).
📄 NB_project.prj 📄 NB_project.prj.bak	ASCII text file created by HEC-FIA when a project is created. Contains the name and description of the project, what user created the project, map coordinate information, and references to HEC-FIA project elements. The *.bak* file is an automatic backup file of the *.prj* file.
📄 Default.ag 📄 Default.ag.bak	ASCIISerializer text file created by HEC-FIA when a project is created. Contains information for a default analysis group. The *Default.ag.bak* file is an automatic backup file of the *Default.ag* file.
📄 programOrder.xml 📄 programOrder.xml.bak	An XML file created by HEC-FIA when a project is created. The *programOrder.xml.bak* file is an automatic backup file of the *programOrder.xml* file.
📄 NB_project.projection 📄 NB_project.projection.bak	ASCII text file created by HEC-FIA when the projection for the project is set. Contains the projection information for the HEC-FIA project. The *.bak* file is an automatic backup file of the *.projection* file.
📁 alternatives	Sub-directory created by HEC-FIA when an alternative is created.
📄 ALT_CrossSections.alternative 📄 ALT_Grids.alternative 📄 ALT_Reconstruction.alternative	An XML file that is created by HEC-FIA when an alternative is created. This file contains information on an HEC-FIA alternative.
📁 fia	Sub-directory copied by HEC-FIA Version 3.1 for a project created in Version 3.0.1 (or older). Contains legacy files that define data items for life loss calculations, global data, and impact area data for life loss calculations.
📄 ActivityTypeDistributions.dat 📄 Global.fdg 📄 ImpactArea.lifesim	**ActivityTypeDistributions.dat** is an ASCII text file that contains user entered information for life loss calculations. **Global.fgd** is an ASCII text file that contains global information (boundary information, agriculture and urban price index factors, monetary units, system units). **ImpactArea.lifesim** is an ASCII Serializer text file that contains impact area data for life loss calculations.
📁 geographic data	Sub-directory created by HEC-FIA when geographic data is created. Several sub-directories are created: **boundaries** - this directory contains all of the information about boundary data. **emergency planning zones** - this directory contains all of the information about EPZ including impact areas data updated from HEC-FIA Version 3.0.1 (or older). **impact areas** - this directory is copied by HEC-FIA Version 3.1 for a project created in Version 3.0.1 (or older). Contains original impact area information.
📁 inundation data	Sub-directory created by HEC-FIA when inundation data is defined. Also, created are sub-directories depending on which inundation type is selected - CCP only; cross sections only configuration; grids cross sections configuration; grids only configuration; and holdouts.

📁 inventory	Sub-directory created by HEC-FIA when a structure inventory is created. Several sub-directories are created:
	   structure inventories - this directory contains all of the information about the structure inventory, damage categories and structure occupancy types.
	   critical infrastructure - this directory contains all of the critical infrastructure information.
	   Agricultural Data - this directory contains all of the agricultural data information.
	   impact response - this directory contains all of the impact response information.

📁 layouts	Sub-directory created by HEC-FIA when a project is created. This folder contains the saved layouts for the **Desktop Pane**.
📁 maps	Sub-directory created by HEC-FIA when a project is created and is used to store map layers and GIS coverages associated with a project. It is strongly **encouraged** that all maps (of any type) related to the HEC-FIA project be added to this directory. When adding map layers to a HEC-FIA, *maps* are the location where the maps are copied (**Select Map Layer to Add** dialog box with **Create Copy** option selected).
📁 runs	Sub-directory created by HEC-FIA when a simulation is created. Contains sub-directories that are created (with name of alternative that is associated with the simulation) for each simulation that is computed. All HEC-FIA results are stored to this directory.
📁 shared	Sub-directory created by the HEC-FIA when a study is created. This folder is a place to store files that might be used by the study.
📁 simulation	Sub-directory created by HEC-FIA when a simulation is created.
📄 Reconstruction.simulation	ASCII text file created by HEC-FIA when a simulation is created. Contains the name and description of the simulation, the name of the associated HEC-FIA alternative, event name, and the time window name.
📁 study	Sub-directory copied by HEC-FIA Version 3.1 for a project created in Version 3.0.1 (or older). Contains legacy database files (**.dbf*, **.dbt*, **.mdx*) that contain the data when creating measures, impact areas, and common computation points.
📁 time windows	Sub-directory created by HEC-FIA when a **Time Window** is created.
📄 TimeWindow.timewindow 📄 TimeWindow.timewindow.bak	ASCIISerializer text file created by HEC-FIA when a time window is created. Contains the name and description of the time window, and the start and end dates of the time window. The **.bak* file is an automatic backup file of the **.timewindow* file.
📁 warning issuance scenario	Sub-directory created by HEC-FIA when a **Warning Issuance Scenario** is created.
📁 watershed	Sub-directory created by HEC-FIA when a project is created. Sub-directories are created for each HEC-FIA watershed element that is defined – computation points, reservoirs, storage areas, stream alignments, terrain grids, watershed configurations, and cross sections.

CHAPTER 4

Map Layers

4.1 Map Layers Concepts

In order to make viewing, editing, and reviewing data simpler in HEC-FIA 3.1, most data elements have geospatial components that are interactive through the map window. To enable the geospatial features of model elements, HEC-FIA Version 3.1 has the ability to import model data from shapefiles. If the user wishes to provide auxiliary maps for visualization purposes, (but not for model data) that is possible also. The geospatial data formats HEC-FIA supports are reviewed in the following sections.

4.2 Map Layer Formats

In HEC-FIA, digital maps are referred to as map layers. When a map layer is added to a study, the software displays it in the map window. HEC-FIA can use certain types of map layers as data sources. The map layer formats that HEC-FIA can display are listed in Table 4.1.

Table 4.1 Map Layer Formats Compatible with HEC-FIA

Description	Common Filename Extension
USGS digital line graph	*.dlg
AutoCAD® DXF	*.dxf
ArcGIS® Shapefile	*.shp
Raster image	*.png, *.jpg, *.gif, *.bmp
ASCII NetTin	*.net
USGS DEM	*.dem, *.flt
Floating point binary	*.flt
ArcGIS® Grid Exports	*.asc,
LizardTech® MrSID®	*.sid
HEC-FIA SMRMP	*.smrmp
Open Street Maps	*.osm
Virtual Format	*.vrt

Typical data map layers required for a study include:

- Stream centerline shapefile (i.e., *RAS_River.shp*)
- Census block, parcel, or structure point shapefile (i.e., *Census_Block_Clip.shp*)

- Emergency planning zones shapefile (i.e., *EPZ.shp*)

Typical data map layers used but not required for a study include:

- Study Area shapefile (i.e., *USA_CountiesStudyArea.shp*)
- Cross Sections shapefile (i.e., *CrossSections.shp*)
- Storage Area shapefile (i.e., *StorageAreas.shp*)
- Computation Point shapefile (i.e., *ResSim_CCPs.shp*)

4.2.1 USGS Digital Line Graph (.dlg)

U.S. Geological Survey (USGS) Digital Line Graphs (DLGs) are created from two sources using manual and automated digitizing methods. The two sources are aerial photographs and cartographic sources. DLG files are vector representations of the data. When HEC-FIA interacts with a *.dlg* file, it automatically creates a *.dlgbin* file for use.

4.2.2 AutoCAD® DXF (.dxf)

A Drawing Interchange File (*.dxf*) is created by a Computer-Aided Design (CAD) package, AutoCAD®. This format is a tagged data representation of an AutoCad® drawing file. The *.dxf* format is commonly used for data exported from other CAD and GIS software.

4.2.3 ArcGIS® Shapefiles (.shp)

This file type is the native data structure for the ArcGIS® software. Shapefiles store non-topological geometry and attribute information for the spatial features of a data set in a particular format. Usually there are four component files associated with a shapefile: *.dbf*, *.shp*, *.prj*, and *.shx*. The *.shp* file contains the shapes (points, polylines, or polygons) that are displayed in the layer. Each shape has a record in the *.dbf* file containing descriptive data called "attributes". The *.prj* file contains the projection information for the shapefile. Finally, the *.shx* file contains an index that links each shape to its record in the *.dbf* file. For more information on shapefiles, see the *ESRI Shapefile Technical Description* available here: http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf.

4.2.4 Raster Image

The raster image formats supported by HEC-FIA are: JPEG format (*.jpg*), Graphics Interchange Format (*.gif*), Portable Network Graphic (*.png*), and, bitmap (*.bmp*). To import a raster image:

1. From the **Study Tree**, which is in the **Study Pane**, right-click on the **Map Layers** folder. From the shortcut menu (Figure 4.1), click **Import Image(s)**; an **Open** browser window (Figure 4.2) opens.

2. Browse to the location of the image that is to be uploaded. Click on the name of image that could be used for the project. The name appears in the **File name** box. Click **Import**,

the **Open** browser closes and the **Define Image Extents** dialog box opens (Figure 4.3).
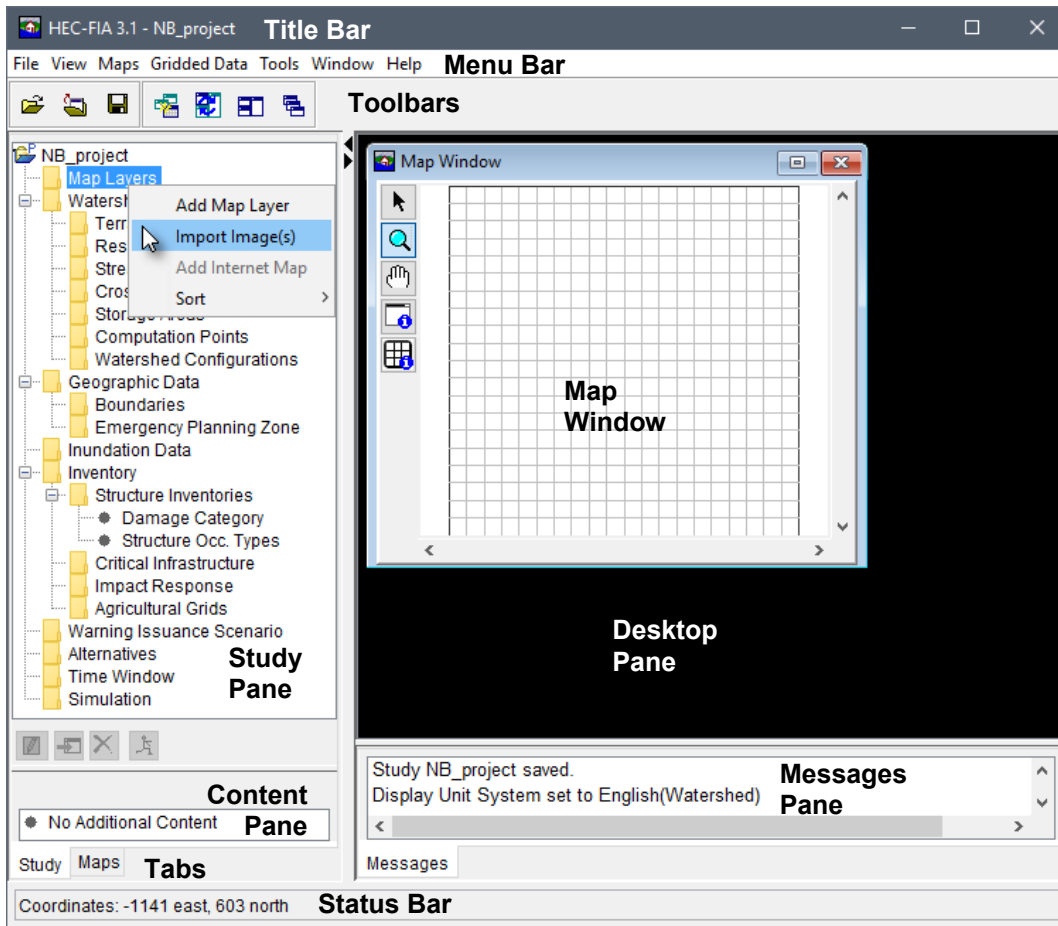
Figure 4.1 Study Tree – New Project – Map Layers Shortcut Menu
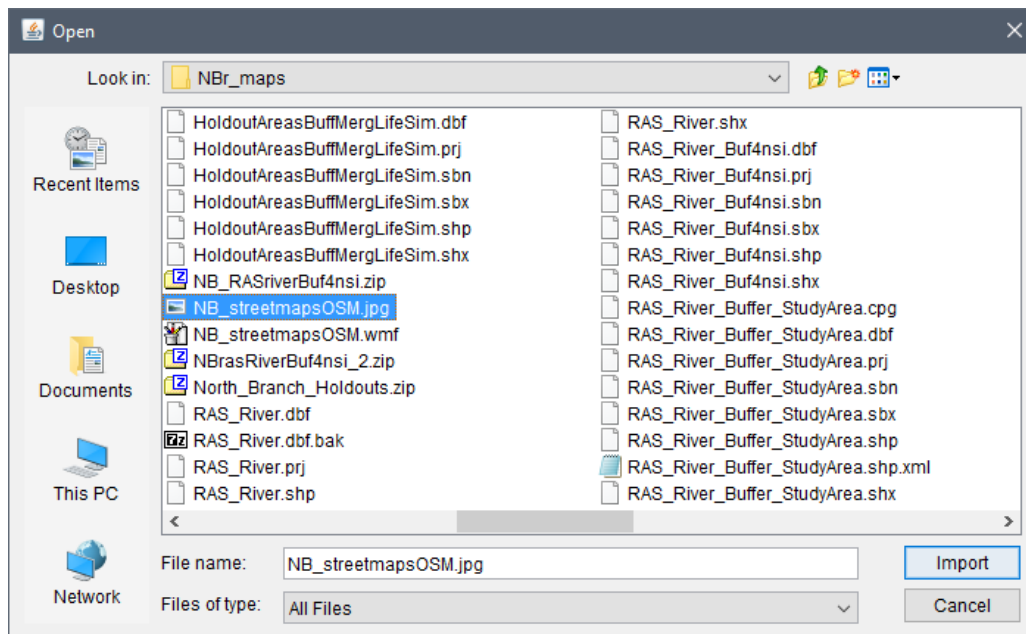
Figure 4.2 Open Browser Window

4. Enter the extents of the image; once defined, click **Finish**. The filename of the selected image displays under the **Map Layers** folder in the **Study Tree** and the image file is stored in the *maps* folder of the study directory.
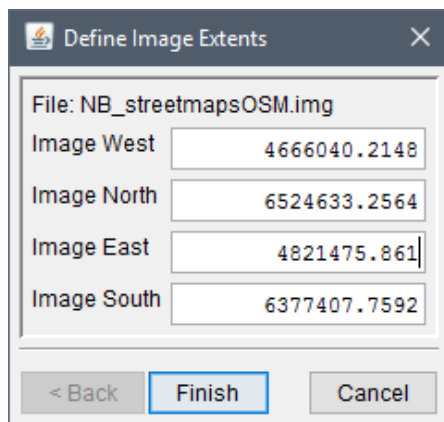
Figure 4.3 Define Image Extents Dialog Box

4.2.5   USGS DEM (.dem)

The U.S. Geological Survey (USGS) published the file format USGS DEM (as of 2006 USGS no longer directly distributes elevation data in the DEM format). A raster file format, **.dem* files usually contain terrain elevations, but the file format can be used for representing any surface. The format, published by the USGS, allows internal documentation of coordinate system, date of publication, etc. These values are referenced horizontally, either to a Universal Transverse Mercator (UTM) projection or to a geographic coordinate system.

4.2.6   Floating Point Binary (.flt)

The **.flt* file is a similar format (ESRI binary grid file), but split into two files: an ASCII header (**.hdr*) file and an **.flt* file which contains binary representations of the cell values. The binary file (**.flt*) contains 32-bit floating data that is stored line by line from north to south (topological elevation values). The **.hdr* file contains the geo-referencing information. Both files need to be stored in the same place.

4.2.7   ArcGIS® Grid Exports (.asc)

The **.asc* file is an ASCII file format representation of a grid. The file consists of keywords followed by values defining the number of columns, number of rows, lower left corner, cell size, no data value, and each cell value.

4.2.8   HEC-FIA SMRMP (.smrmp)

The Segmented Multi-Resolution Multi-Parameter (SMRMP) file was created to operate gridded data (namely, digital terrain grids, inundation depth grids, and arrival time grids) more efficiently in HEC-FIA. When users add terrain and inundation data (see Chapter 7), the user is prompted to

convert to SMRMP format. This file type is not recommended and is only being maintained for existing projects which have the *.smrmp* format a conversion tool to export to any another file format is not available.

4.2.9 ASCII NetTin (.net)

An ASCII file format is used to represent a triangulated irregular network (TIN). TIN data are stored in a simple format that defines the nodes, edges, and triangles contained in the TIN. This format is common for transferring TIN data between software.

4.2.10 LizardTech® MrSID® (.sid)

MrSID® (multi-resolution seamless image database) is a propriety geo-referenced image file format developed by LizardTech® for use with geographic information systems (GIS). This format compresses large raster image files like aerial photographs or satellite imagery for easier viewing. Some MrSID images contain geo-referencing and positioning information which can be placed in the watershed.

4.2.11 Open Street Maps (.osm)

An XML file created by RMA to store user preferences regarding streaming services. This file is generated by HEC-FIA in the project's *maps* directory (see Chapter 3 for the HEC-FIA project file directory structure). This file should not be edited by the user.

4.2.12 Virtual Format (.vrt)

The *.vrt* format is a format driver for GDAL (Geospatial Data Abstraction Library) and allows for a virtual GDAL dataset to be composed of other GDAL datasets. The primary use of this format is to group a series of grids that should be associated together. This file format allows multiple depth grids for the same event to create a mosaic single grid. Relative file paths are saved in an XML format, as well as a histogram describing the frequency of cell values across all grids within the *.vrt*.

4.3 Add Map Layers

The user can add as many types of map layers as needed. However, the user must make sure that all map layers use the same origin and measurement units. In GIS jargon, all map layers must use the same projection.

When a map layer is added to an HEC-FIA project, the software reads the coordinates of points, lines, and polygons on the map layer and resets the geographic extents of the watershed to the smallest rectangle that contains all objects in the map layer. If a shapefile is used to import a stream alignment, the units of the stream alignment are based on the units of the projection.

To add a map layer:

1. From the **Study Tree**, right-click on the **Map Layers** folder. From the shortcut menu (Figure 4.1), click **Add Map Layer**, and the **Select Map Layer to Add** browser window opens (Figure 4.4).

2. Browse to the location where the map layers are located. Select an individual map layer by clicking on the filename, or add multiple map layers by holding down the CTRL key and selecting the map layers that could be part of the HEC-FIA project.

3. **Create Copy**, selected by default, creates a copy of the selected files in the *maps* folder within the current study directory. Storing all the data in the project directory is recommended as this makes the project easier to store and share. If **Create Copy** is unchecked, the path to the file is stored relative to the project file; however, if either the map file itself, or the study project file is moved, HEC-FIA can no longer display the map file.

Figure 4.4 Select Map Layer to Add Browser Window

4. Once the necessary files are selected, click **Open**. The **Select Map Layer to Add** browser window closes (Figure 4.4). A **Set Study Coordinate System** window (Figure 4.5) opens. The window is asking the user if the coordinate system for the HEC-FIA project should be set to the coordinate system of the first selected map layer (i.e., *CrossSections.shp*). Click **Yes**, if the coordinate system of the first selected map layer is correct. The **Set Study Coordinate System** window closes, and the map layers display in the map window.

5. The filenames of the selected map layers display under the **Map Layers** folder in the **Study Tree**. To save the HEC-FIA project, from the toolbar click 🖫.
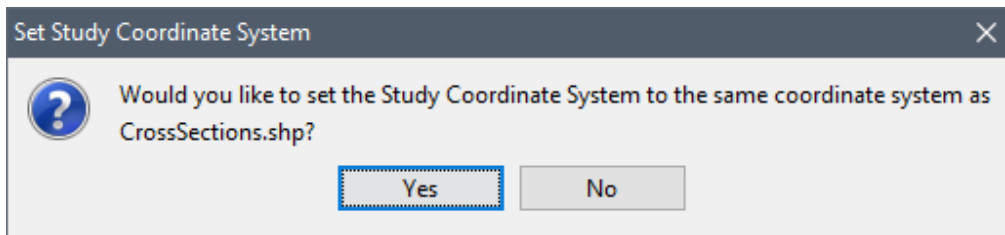
Figure 4.5 Set Study Coordinate System Dialog

4.4   Remove Map Layers/Images

From the **Study Tree**, which is in the **Study Pane** of the HEC-FIA software, two methods are available to remove map layers/images. The first is to remove individual map layers/images from an HEC-FIA project:

1.   From the **Study Tree**, from the **Map Layers** folder, right-click on the name of the map layer/image to be removed. From the map layer's shortcut menu (Figure 4.6), click **Remove Map Layer**.

2.   A **Confirm Removal** window opens asking the user if it is okay to remove the selected map layer/image from the HEC-FIA project. Click **Yes**, to close the **Confirm Removal** window, and remove the selected map layer from the HEC-FIA project.
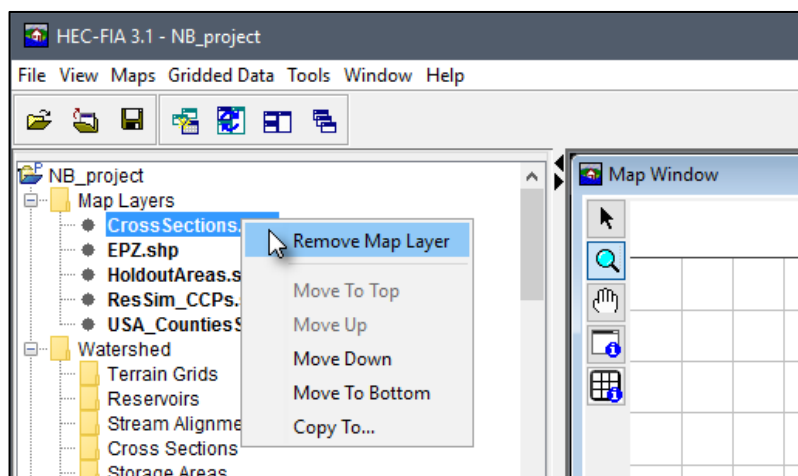
Figure 4.6 Remove Map Layer – Map Layer Shortcut Command

3.   The physical file(s) associated with the map layer/image remains in the HEC-FIA project directory (*maps* folder) on the hard drive. The names of the map layers/images are no longer displayed from the **Study Tree** under the **Map Layers** folder.

The other available method allows the user to remove multiple map layers/images from an HEC-FIA project:

1.   From the **Study Tree**, right-click on the **Map Layers** folder, from the **Maps Layers** shortcut menu (Figure 4.7), click **Remove Map Layer**. The **Remove Map Layers from Study** (Figure 4.8) dialog box opens.
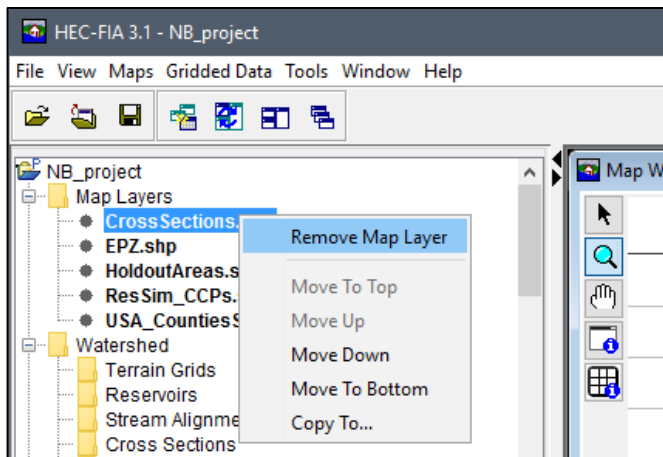
Figure 4.7 Map Layers Shortcut Menu Commands

2. Select an individual map layer/image by clicking on the filename, or select multiple map layers/images by holding down the CTRL key and selecting the images that are to be removed from the HEC-FIA project.
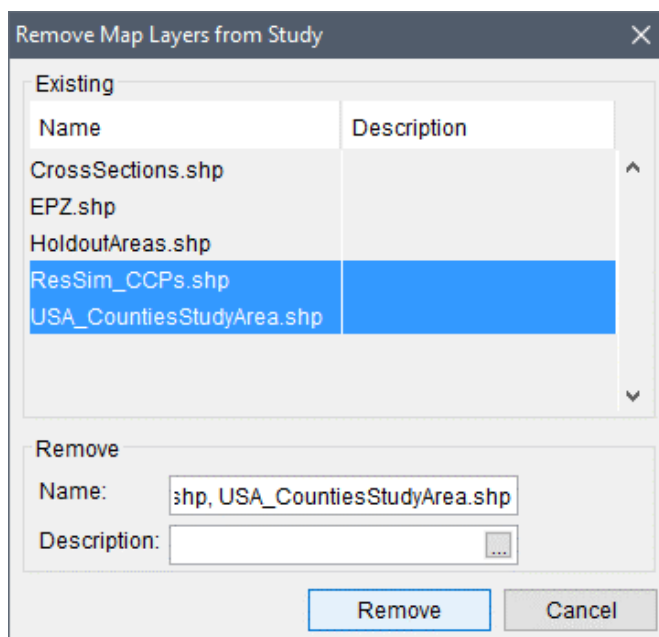
Figure 4.8 Remove Map Layers from Study Dialog Box

3. Click **Remove**, a **Warning** dialog displays. This dialog asks the user if the selected map layers/images should be removed from the HEC-FIA project. Click **Yes**, to close the **Warning** dialog.

4. The **Remove Map Layers from Study** dialog box (Figure 4.8) closes. The physical file(s) associated with the map layers/images remains in the HEC-FIA project directory (*maps* folder) on the hard drive. The names of the map layers/images are no longer displayed from the **Study Tree** under the **Map Layers** folder. To save the HEC-FIA project, from the **Standard** toolbar click 🖫.

4.5   Add OSM Map

Knowing where the HEC-FIA project is located in reference to known locations can be quite helpful when communicating with stakeholders. From the **Study Tree**, right-click **Maps Layers** and click **Add Internet Map** from the shortcut menu (Figure 4.1). Automatically a *streetmaps.osm* (Open Street Map) is loaded and displayed the active map window. Note, HEC-FIA offers a list of several internet maps to select from if the default (Open Street Map) is not preferred. To select a different map source, click the **Maps** tab. From the **Maps** tab, from the **Content Pane**, from the **Map Layers** tree, right-click the **Internet Map** layer, and click **Properties** from the shortcut menu. The **Map Tile Source** window opens. From the **Map Source** list, select the desired internet map, and click **Ok** to load the selected map.

4.6   Adjust Map Layers

Once a map layer is part of an HEC-FIA project, users have limited options to organize layers; display or hide layers; display the legend of the selected map layer; edit display properties of the map layer; set scale factors; copy to another location, and view the attributes table of certain map layer types. It is recommended that the user utilize a GIS software instead of HEC-FIA, if extensive display options (e.g., edit display properties by attributes, adding map layer labels by attribute, etc.) are needed. From the HEC-FIA main window, click the **Maps** tab (Figure 4.9).
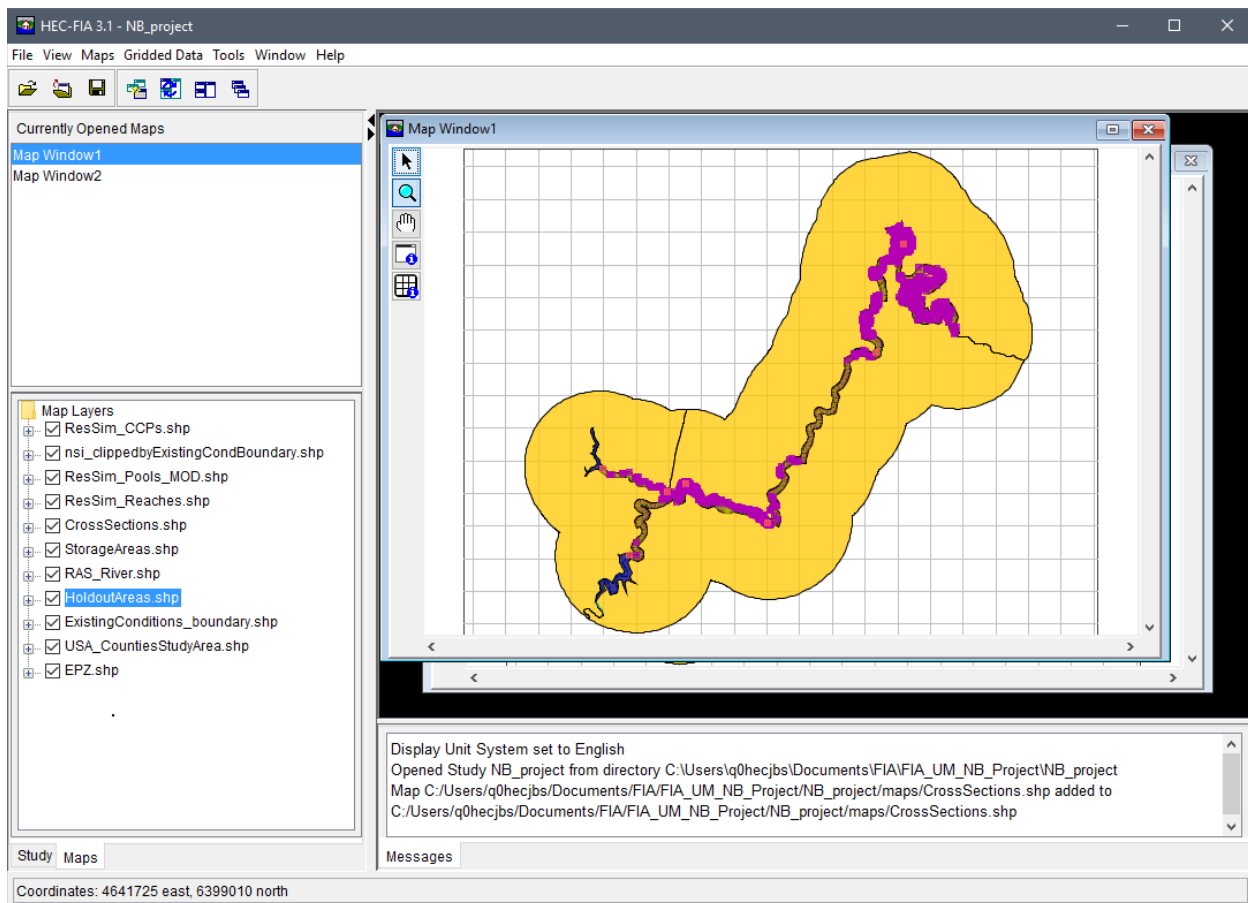
Figure 4.9 HEC-FIA Main Window – Maps Tab

Now the user can see which map window is currently active and what layers make up that map window. A list of the open map windows are displayed in the **Currently Open Maps Pane**, and the selected map layer is the active map layer (e.g., *Map Window1*) in the **Desktop Pane**.

The **Content Pane** for the **Maps** tab contains the **Map Layers Tree** for the active map window. The **Map Layers Tree** lists all map layers in the active map window with the layer listed at the top overlaying subsequent layers in lower in the list. The user can turn map layers on/off, adjust properties of the map layers, and order the map layers for viewing in the associated map window. For example, to change the color and the fill aspects of the *HoldoutAreas.shp* do the following:

1. From the **Map Layers Tree**, right-click on *HoldoutAreas.shp*, the shapefile shortcut menu displays (Figure 4.10). This shortcut menu allows the user to expand/collapse the *HoldoutAreas.shp* leaf; move the shapefile to different positions in the tree (**Move To Top/Move To Bottom**, **Move up/Move Down**); show the legend of the shapefile; change the label of the shapefile; edit the properties of the shapefile; set/remove scale factors; copy the map layer to another location; and open the attribute table of the shapefile.

2. From the shapefile shortcut menu (Figure 4.10), click **Properties**, the **Edit Polygon Properties** dialog box opens (Figure 4.11). The *HoldoutAreas.shp* file is a polygon shapefile. To edit the fill of the active map layer, from the **Fill** tab, change the color or not have a fill. To turn off fill, click **Display Fill**, the check mark clears, meaning that fill is turned off.
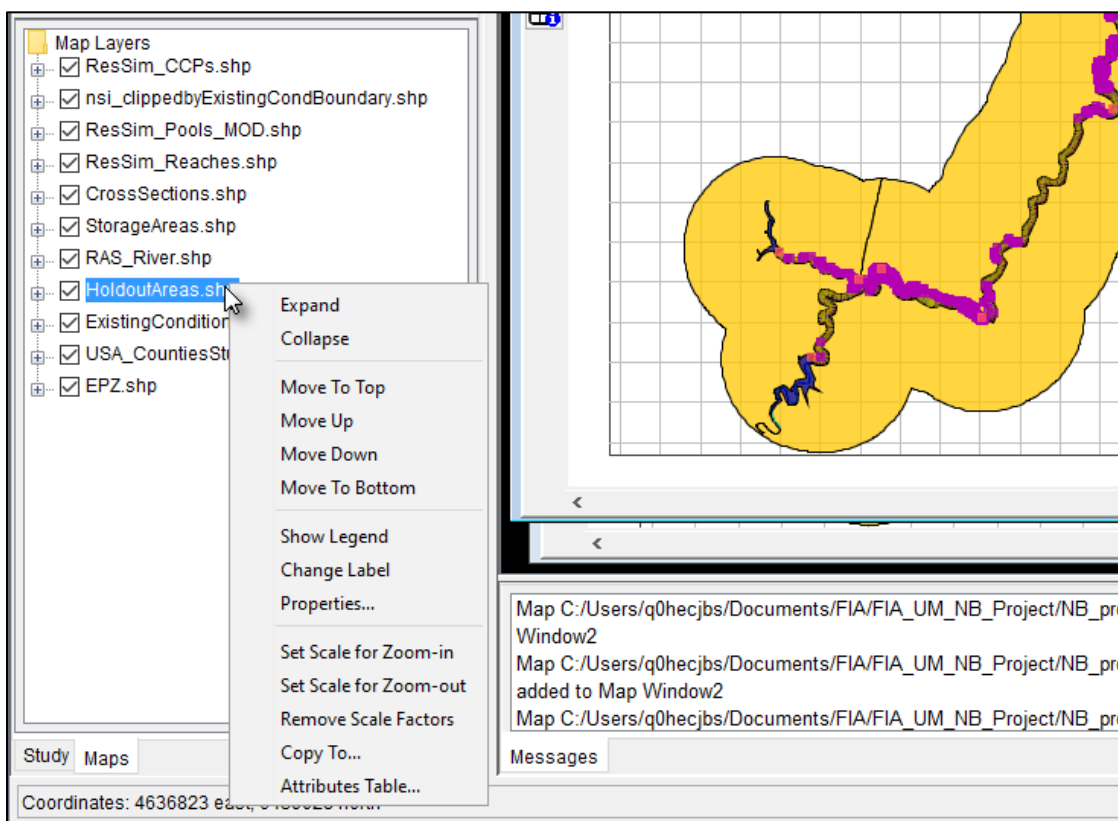
Figure 4.10 Map Layers Tree – Map Layer Shortcut Menu Commands

To change the outline color of the subbasin layer, from the **Edit Polygon Properties** dialog box (Figure 4.11), click the **Border** tab. From the **Color** list, select a color ("cyan"), click **OK**. The **Edit Polygon Properties** dialog box closes and the changes to the polygon map layer appear in the map window.
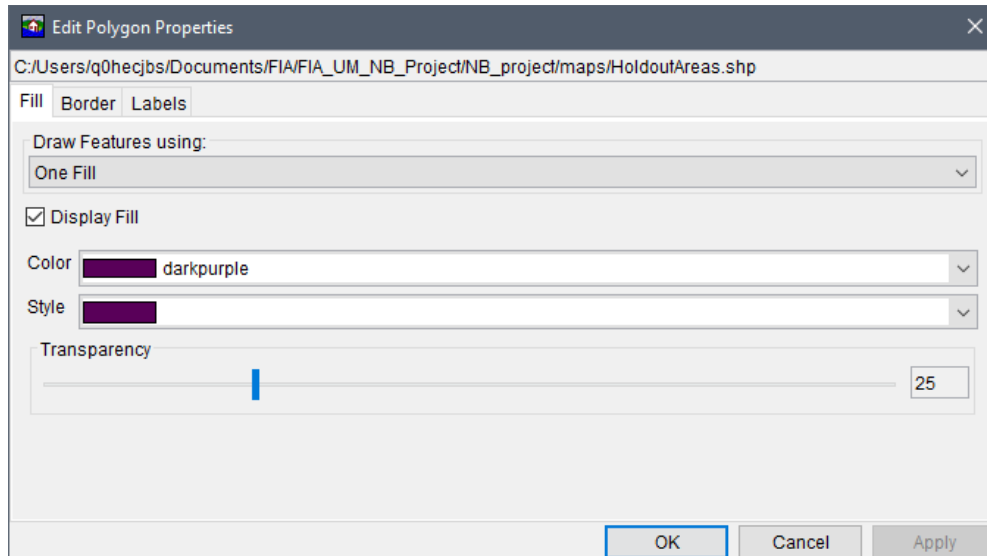
Figure 4.11 Edit Polygon Properties Dialog Box – Fill Tab

3. To turn off a map layer, click the checkbox by *HoldoutAreas.shp*, the polygon no longer appears on the map window.

4. To display the map window zoomed in, select the **Zoom Tool** . Draw a box around the map layers that are displayed in the map window. From the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for {*Project Name*}** dialog box opens (Figure 4.12).
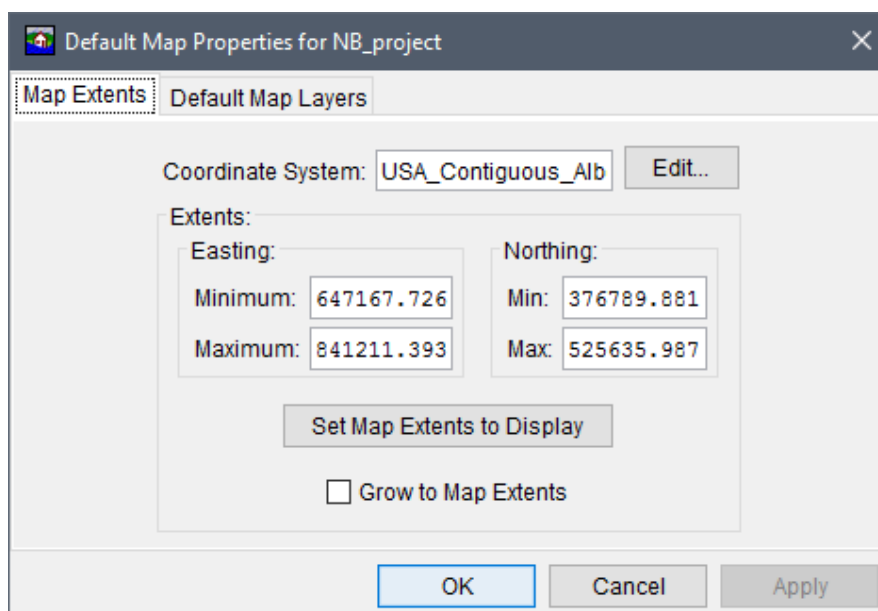
Figure 4.12 Default Map Properties for {*Project Name*} Dialog Box

5. Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for {*Project Name*}** dialog box closes. This action sets the extents for the map window so that when the HEC-FIA project is opened the next time the map window is zoomed in to the tighter area.

CHAPTER 5

Watershed

In HEC-FIA, a watershed configuration describes a modeled physical state of the watershed. The modeled physical state can represent a without project condition or a modeled alternative state. The elements used to describe the physical state of the watershed are listed below:

- terrain grids
- reservoirs
- stream alignment
- cross sections set
- storage areas (with or without corps projects or leveed areas)
- common computation point (CCPs) set (standard or with holdout distribution areas (described in Section 5.6.2))

These model elements are used to represent a state of the watershed being modeled. Not all of the elements are required for HEC-FIA to compute hydraulic information at a location, but there are minimum requirements dependent upon the desired methodology selected to evaluate hydraulic information at a location.

- When providing all gridded data for evaluating hydraulic information at point locations; all that is required for the watershed configuration is a terrain grid.

- When gridded depths are provided but cross sections are being used for arrival times, the watershed configuration needs to include terrain data, and a cross section set.

- When data is provided as hydrographs at cross sections, the watershed configuration needs terrain and a set of cross sections.

- When hydrographs are provided at common computation points, the watershed configuration requires a stream alignment, a terrain, and a set of common computations points.

- When the Flood Damages Reduced compute option is used, the watershed configuration needs to include terrain data, stream alignment, cross sections and a project: either storage areas (with levees) or reservoirs. If reservoirs are included then CCPs with holdout distribution areas must also be included in the watershed configuration.

5.1   Terrain Grids

Terrain data is required in HEC-FIA to assign elevations to structures. HEC-FIA accepts terrain data in the following formats (review Chapter 4, Section 4.2 for descriptions of the supported terrain formats):

- GeoTiff (**.tif*)
- Ascii Format (**.asc*)
- Floating point binary (**.flt*)
- Segmented Multi-Resolution Multi-Parameter (SMRMP) grid format (**.smrmp*)
- Virtual format (**.vrt*)

The GeoTiff format is the recommended format and a user should convert the other gridded data types to the GeoTiff format. Note that no conversion process has been developed for **.smrmp* to any other file format. **Note:** Since terrain files are typically large HEC-FIA does not copy terrain files to the *maps* directory. Therefore, if the user wishes to include terrain files with the final HEC-FIA project to others, the terrain files need to be copied to the *maps* directory manually.

To add a GeoTiff terrain grid:

1. From the **Study Tree**, which is in the **Study Pane**, from the **Watershed** folder, right-click on the **Terrain Grids** folder. A shortcut menu (Figure 5.1), click **Add Terrain Model**; the **Open Browser** opens (Figure 5.2).
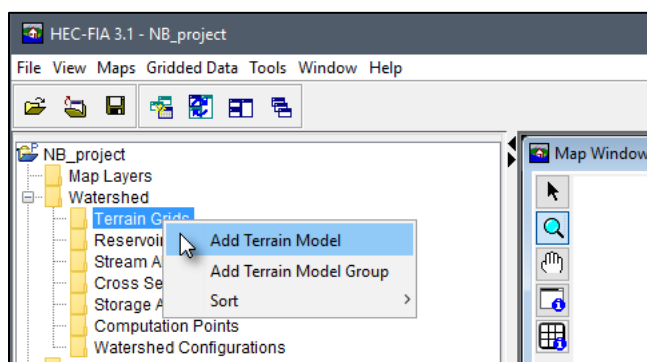
Figure 5.1 Terrain Grids – Shortcut Menu Commands
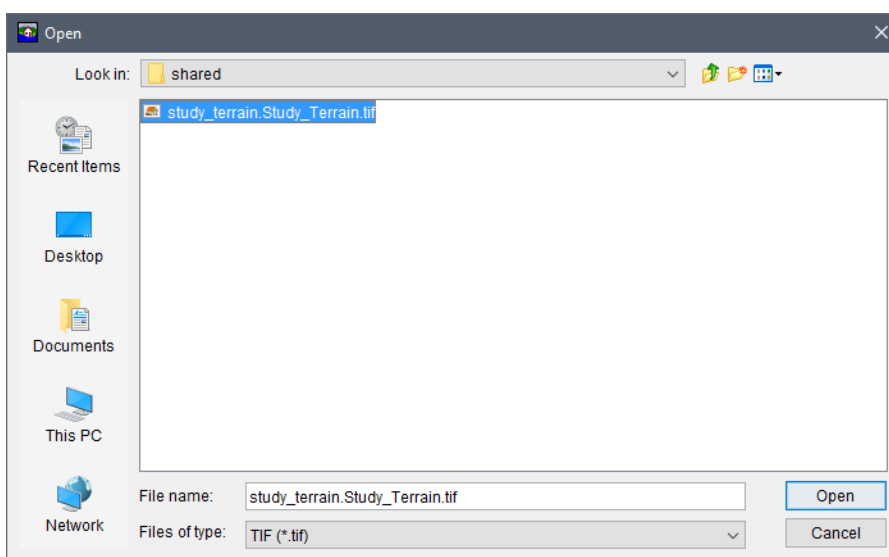
Figure 5.2 Open Browser Window

2.   Browse to the location of the desired terrain grid. Note the default file type is TIF (**.tif*).

3.   Select the appropriate type from the **Files of type** list (Figure 5.2). When the user chooses the appropriate file, the name of the file appears in the **File name** box (i.e., *study_terrain.Study_Terrain.tif*). To select the file, click **Open**.

4.   The **Open Browser** closes (Figure 5.2), a map window opens in the **Desktop Pane**, displaying the terrain grid, and the name of the terrain grid displays in the **Study Pane** under the **Watershed** folder, under the **Terrain Grids** folder.

5.   To display elevation values from the terrain grid, use the **Grid Query Tool** ⊞ (Figure 5.3) available from the map window **Toolbar**. To display the elevation for a given point, select the **Grid Query Tool**, click on a location on the terrain grid, a tooltip displays the elevation for that location (Figure 5.3).
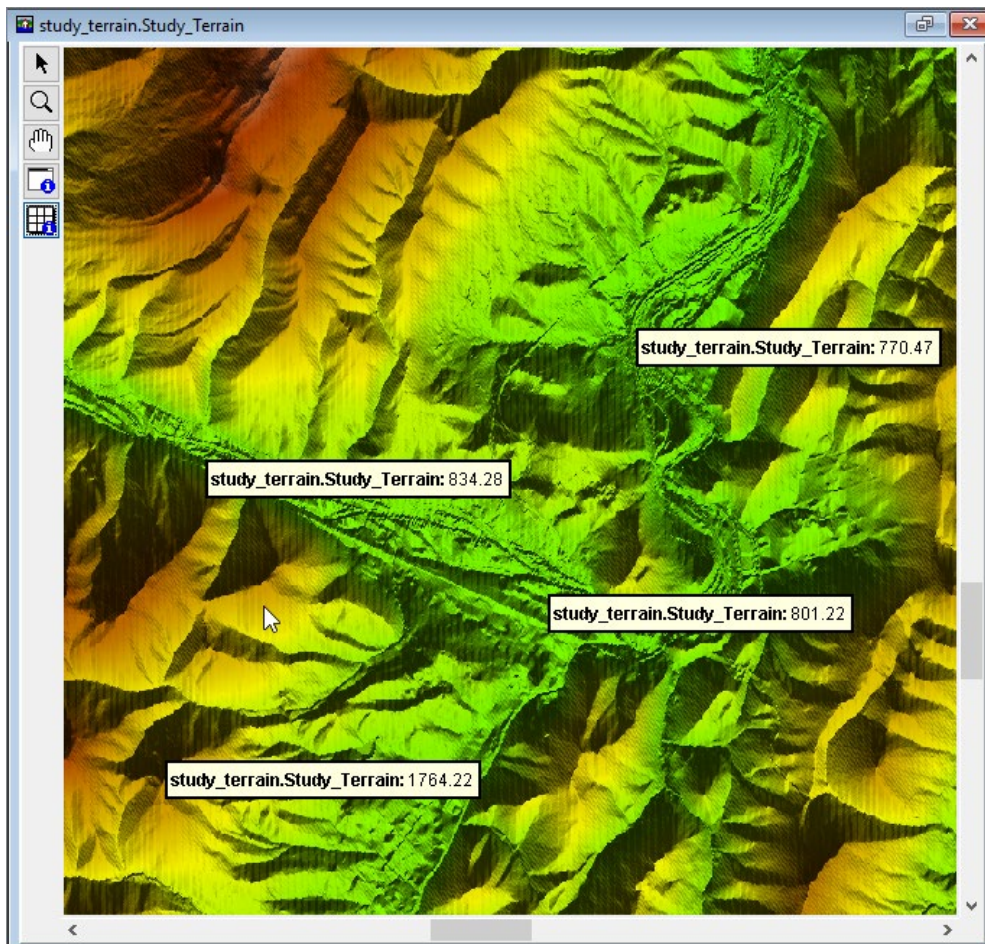
Figure 5.3 Map Window – Grid Query Tool

6.   To clear the elevation labels, zoom or pan in the map window. Alternatively, from the **Study Tree**, from the **Watershed** folder, from the **Terrain Grids** folder, right-click on the filename of the terrain grid. The terrain grid shortcut menu displays (Figure 5.4). From the terrain grid shortcut menu, click **Clear elevations and depth query results**, the elevations are cleared from the map window.
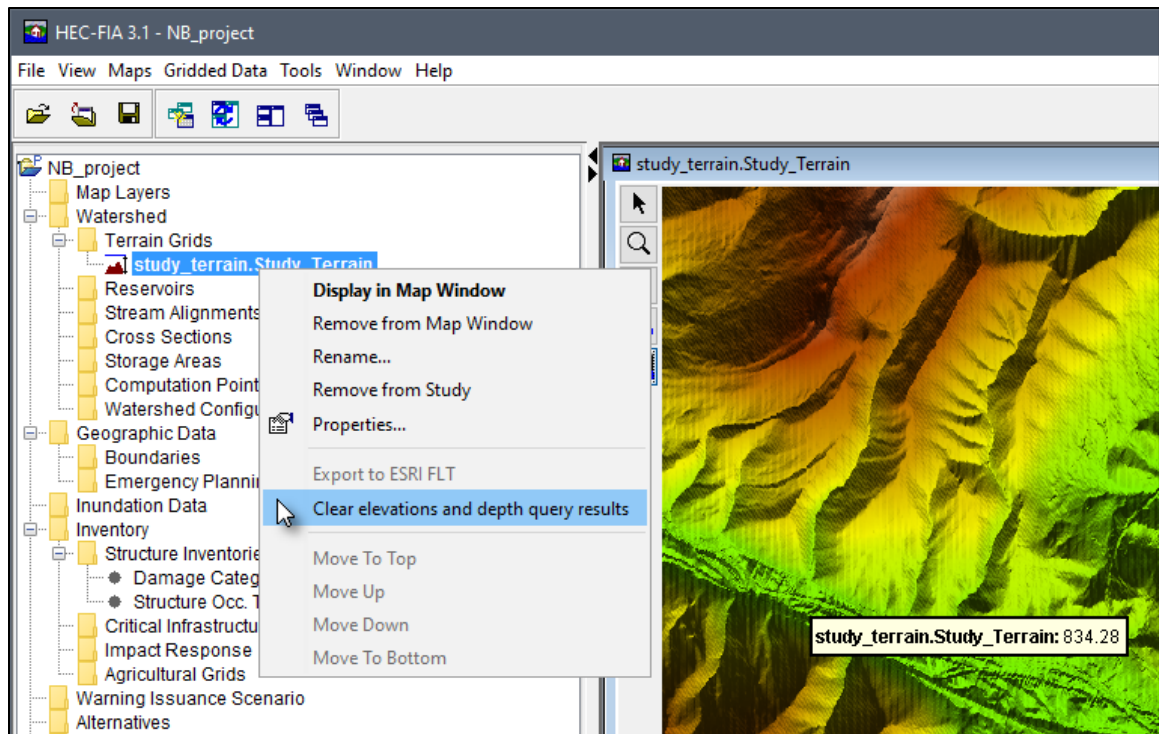
Figure 5.4 Terrain Data – Shortcut Menu Commands

To add a non-GeoTiff terrain grid:

1. When a non-GeoTiff (i.e., **.flt*, **.asc*) terrain grid is selected, a **Message** dialog opens (Figure 5.5). The **Message** dialog is letting the user know that the selected file is not a GeoTiff file, and asks if the user wants to convert the selected file. This conversion is not required, but is recommended. HEC-FIA runs more efficiently with grids that are converted to the GeoTiff format, especially large grids.
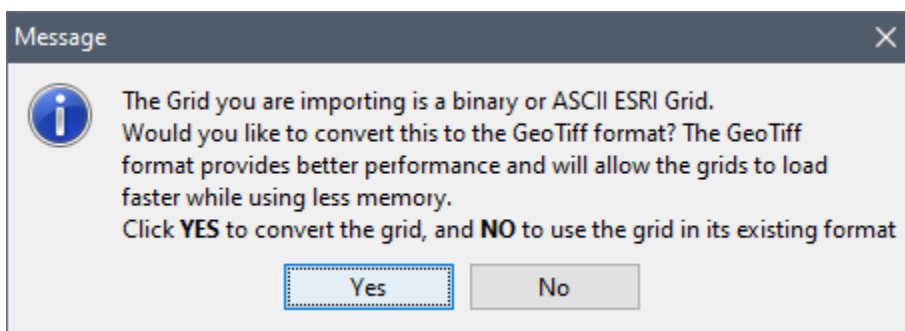
Figure 5.5 Message Dialog – Conversion of Non-GeoTiff Terrain Grid

Note, if the supplied grid uses an unsupported projected or geographic coordinate reference system, then the conversion to GeoTiff will fail. If HEC-FIA cannot convert the provided terrain then users can either import the terrain without converting the grid, or convert the gridded data to the GeoTiff format utilizing a geographic information systems (GIS) software.

2. Click **Yes**, the **Message** dialog closes and a progress dialog box opens displaying the progress of the GeoTiff conversion process. This process could take several minutes depending on the size of the grid.

3. When the conversion is finished, the progress dialog box closes. The terrain data is now displayed in the map window and the name of the terrain file appears under the **Terrain Grids** folder on the **Study Tree**. The terrain file is created at the same location as the original non-GeoTiff grid.

Note, terrain files can be large, and drawing the terrain in a map window can use a large percentage of the available memory allocated to HEC-FIA. Typically, performance will improve if the terrain is turned off. To turn off the terrain display, from the **Study Tree**, from the **Watershed** folder, from the **Terrain Grids** folder, right-click on the filename of the terrain grid and click **Remove from Map Window** from the terrain grid shortcut menu (Figure 5.4). Click **Yes**, to confirm the removal of the terrain file from the active map window (Figure 5.6). This step does not remove the terrain from the study, but simply removes the terrain from the map window.
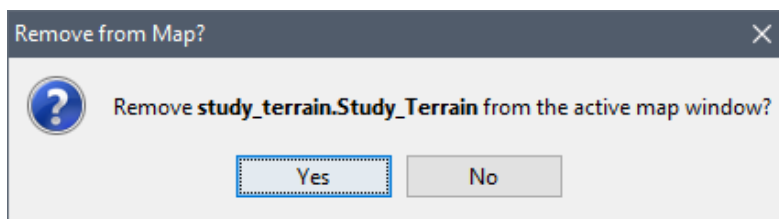
Figure 5.6 Terrain – Remove from Map Dialog Box

5.2   Import Reservoirs

Reservoirs are new watershed elements for HEC-FIA Version 3.1. They can be used to represent HEC-ResSim reservoirs in the study for the new Flood Damages Reduced compute option. Reservoirs are one-dimensional areas which represent the HEC-ResSim reservoirs in the study area. For projects which include reservoirs in the Flood Damages Reduced compute, HEC-FIA requires reservoirs in the watershed configuration (refer to Section 5.7), as well as common computation points (CCPs) with holdout distribution areas (as described in Section 5.6.2). Note, the reservoir set must be imported prior to importing the CCPs with holdout distribution areas.

Important: The user-defined reservoir names must match the reservoir names in the linked HEC-DSS (HEC's Data Storage System) file containing the holdouts time series exported from HEC-ResSim. Watershed components are linked to HEC-DSS files from created inundation configurations; for more information regarding inundation configurations review Chapter 7 of this manual.

To import a reservoir set:

1. Migrate to the **Study Tree**, from the **Watershed** folder, right-click on the **Reservoirs** folder (Figure 5.7). From the shortcut menu, click **Import**; the **Import Reservoirs** dialog box opens (Figure 5.8).
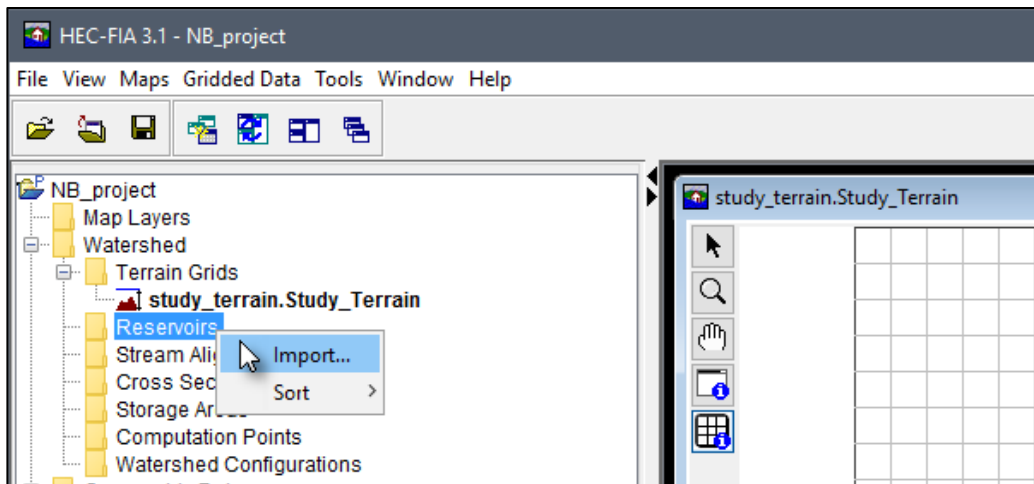
Figure 5.7 Reservoirs – Shortcut Menu Command

2. Enter a name for the reservoir set in the **Reservoir Name** text box (Figure 5.8). **Important**: The user-defined reservoir names must match the reservoir names (listed at the end of the C Part) in the linked HEC-DSS file containing the holdouts time series exported from HEC-ResSim.
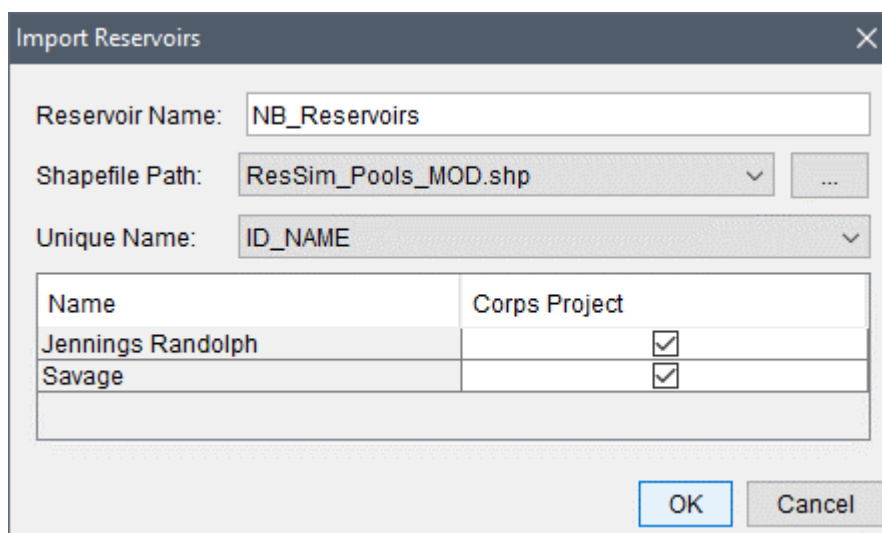
Figure 5.8 Import Reservoirs Dialog Box – Example

3. The **Shapefile Path** lists the available polygon shapefiles that have been added as map layers to the project. If a map layer that represents the reservoirs has not been added to the HEC-FIA project, click the ⬚ button. The **Open** browser window opens (Figure 5.9).

    Browse to the location of the shapefile that represents the reservoirs, select the shapefile (**.shp*) filename (i.e., *ResSim_Pools_MOD.shp*), and click **Open**. The **Open** browser window closes, and the **Import Reservoirs** dialog box (Figure 5.8) is populated with information from the selected shapefile.
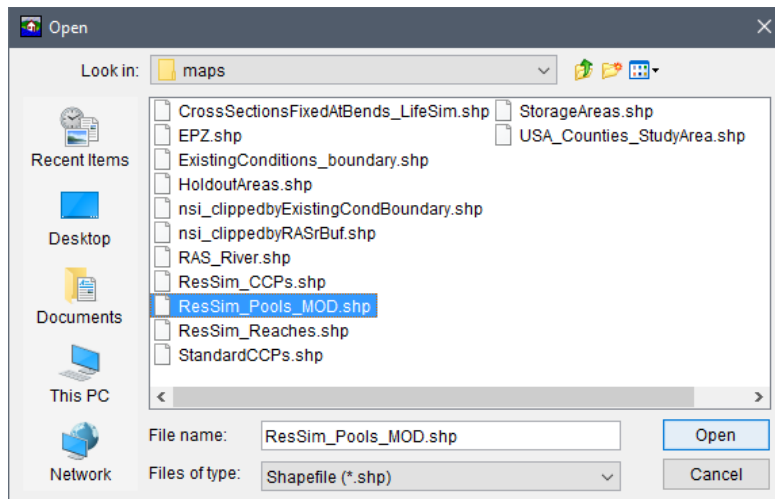
Figure 5.9 Open Browser Window

4.   From the **Unique Name** list (Figure 5.8), select the appropriate field name that contains the reservoir names. For the example provided in Figure 5.8, *ID_NAME* is the correct unique name for the reservoir names in the selected shapefile.

5.   When the correct unique name has been selected, a table populates with the unique reservoir names and provides a checkbox which allows the user to identify if the reservoir is a USACE project (false, or unchecked, by default). If the reservoir is a USACE project, then check the ☑ checkbox in the **Corps Project** column of the table (Figure 5.8).

6.   Click **OK**, the **Import Reservoirs** dialog box closes (Figure 5.8). The name of the reservoir set appears in the **Study Tree** under the **Reservoirs** folder.

To display the imported reservoirs in an active map window, from the **Study Tree**, from the **Watershed** folder, from the **Reservoirs** folder, right-click on the filename of the reservoir set (e.g., *NB_Reservoirs*) and click **Display in Map Window** from the shortcut menu (Figure 5.10). The reservoirs will display in the active map window.
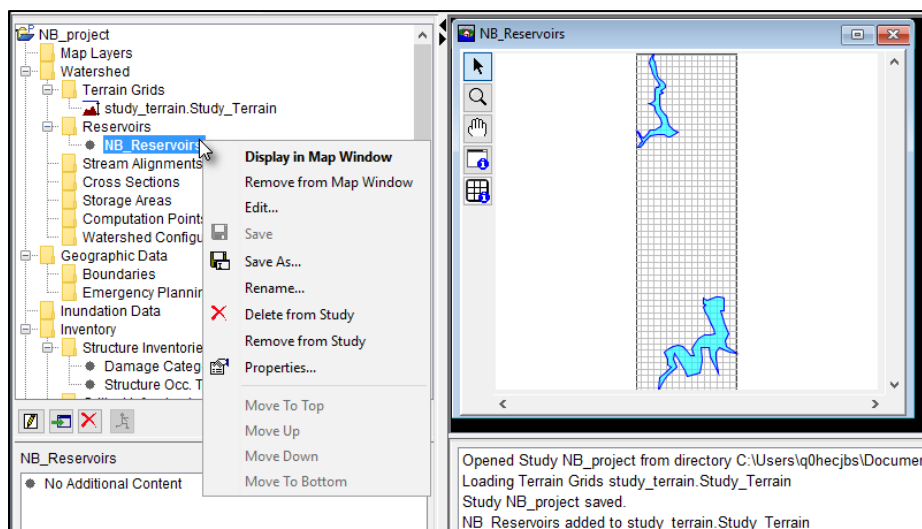
Figure 5.10 Reservoirs Data – Shortcut Menu Commands

Once imported, the reservoir set can be edited:

1. From the **Study Tree**, under the **Watershed** folder, under the **Reservoirs** folder, right-click on the reservoir set (e.g., *NB_Reservoirs*). From the shortcut menu click **Edit** (Figure 5.10) and the **Edit Reservoirs** dialog box opens (Figure 5.11).

2. The user can edit the reservoir name(s) from the **ResName** column. Either click the cell once to replace the name or double-click to edit part of the reservoir name. From the **CorpsPrj** column the user can check or uncheck the checkbox that categorizes the reservoir as either a USACE project (checked) or not (unchecked). Once edits are complete, click **Ok** to close the dialog and save the edited file. Alternatively, click **Cancel** to close the dialog without saving changes.
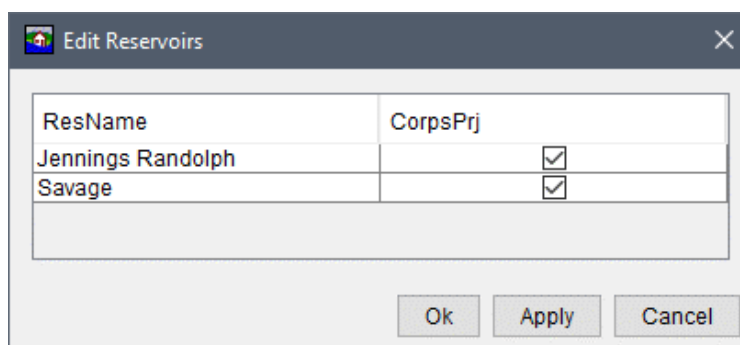
Figure 5.11 Edit Reservoirs Dialog Box – Example

5.3   Stream Alignment

Stream alignments represent the stream system in the study. The alignment indicates where confluences and bifurcations occur and provides a sense of distance and scale. A stream alignment is a one-dimensional river coordinate system, which defines the natural downstream flow network. Stream alignments are composed of a stream centerline and a series of stream nodes, or vertex points. A **stream** typically begins or ends at a confluence, bifurcation, or at the boundary of the river system. A stream is composed of vertex points located along the stream centerline, with the beginning and ending vertex points being stream nodes. Also, from the stream centerline, stationing is provided relative to its global location and specific to the study.

In HEC-FIA a stream alignment is optional and is typically used when evaluating consequences by common computation points in CWMS (Corps Water Management System) or the HEC-WAT (Watershed Analysis Tool) software. Stream alignments used by HEC-FIA could possibly be developed in an HEC-ResSim (Reservoir System Simulation) model, or an HEC-RAS (River Analysis System) model.

5.3.1   Import a Stream Alignment

To import a stream alignment:

1.   From the **Study Tree**, from the **Watershed** folder, right-click on the **Stream Alignments** folder. From the shortcut menu, click **Import**; the **Import Stream Alignment** dialog box opens (Figure 5.12).
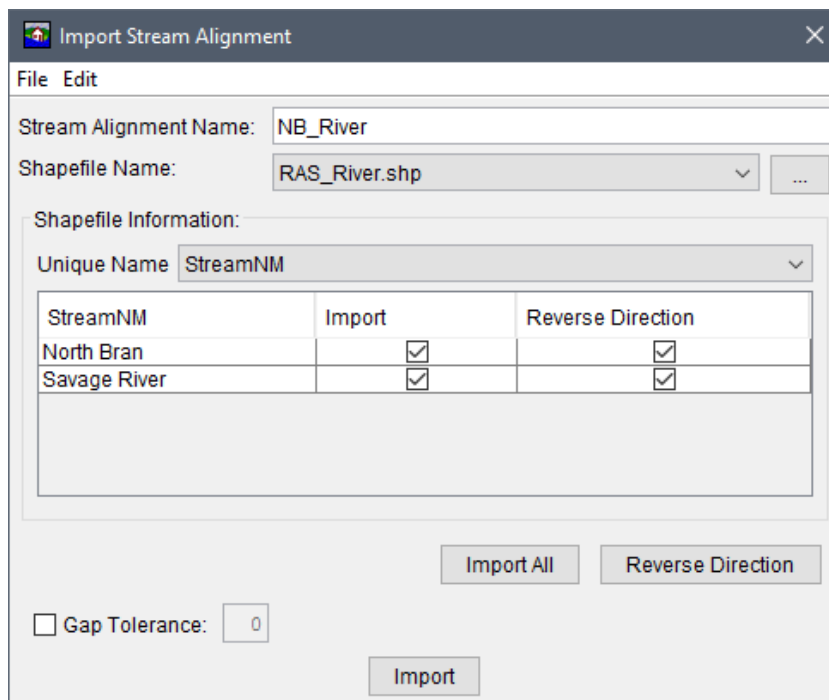
Figure 5.12 Import Stream Alignment Dialog Box – Example

2.   Enter a unique name for the stream alignment in the **Stream Alignment Name** text box (Figure 5.12).

3.   The **Shapefile Name** box lists the available shapefiles that have been added as map layers. If a map layer that represents a stream alignment has not been added to the HEC-FIA project, from the **File** menu, click **Choose Shapefile**; alternatively click the [...] button. The **Choose Shapefile** browser window opens (Figure 5.13). Browse to the location of the shapefile that represents the stream alignment, select the filename (i.e., *RAS_River.shp*), and click **Open**. The **Choose Shapefile** browser window closes, and the **Import Stream Alignment** dialog box (Figure 5.12) is populated with information from the selected shapefile.

4.   From the **Unique Name** list (Figure 5.12), select the appropriate field name that contains the stream names. For example, in Figure 5.12, *StreamNM* is the correct unique name for the stream names in the selected shapefile.

5.   When the correct unique name has been selected, the table lists the unique stream names. If each stream is a contiguous line with one upstream point and one downstream point, then the checkbox in the **Import** column of the table (Figure 5.12) is set. If something is wrong with the line that represents a stream, the checkbox will not be selected, and HEC-FIA does not import that stream element. This problem could be due to lines that are not continuous within one segment.

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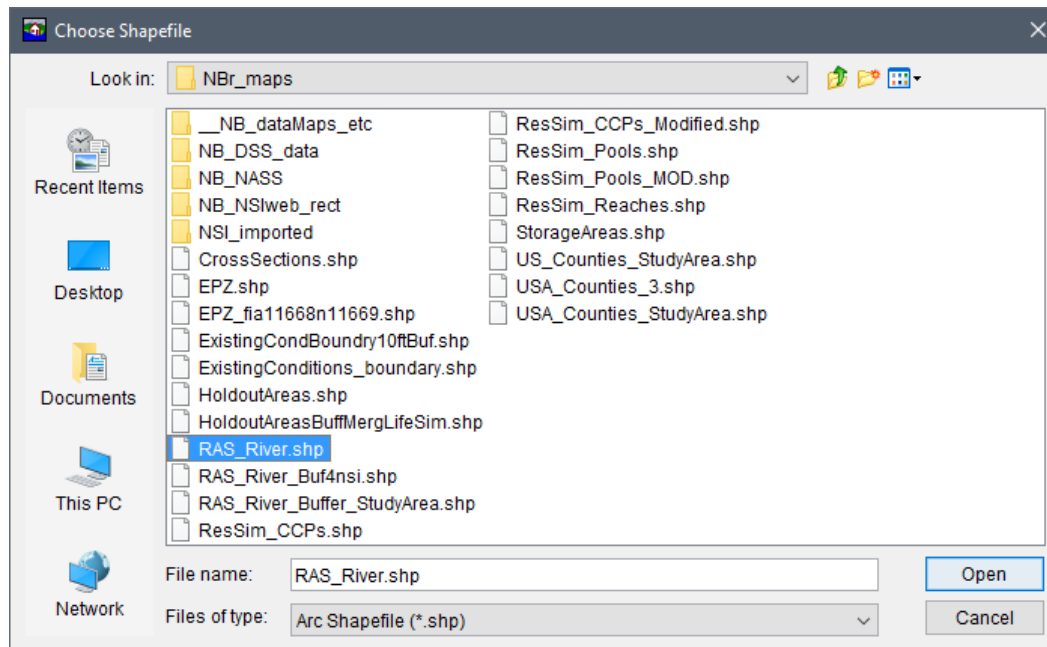
Figure 5.13 Choose Shapefile Browser Window

6. By default, HEC-FIA assumes the downstream end of the river is at the beginning of each line segment, which is the first vertex point when the line shapefile was drawn. If the default assumption is not correct for the selected shapefile (i.e., *RAS_River.shp*) and the stream segments were drawn from the upstream end of the river to the downstream end, then the user can reverse the direction of the stream segment. Check the **Reverse Direction** checkbox for the incorrect stream segment (drawn from the upstream direction to the downstream direction) to import the stream alignment correctly.

7. Click **Import**, the **Import Stream Alignment** dialog box closes (Figure 5.12). A message box appears when the stream alignment has been imported and the stream alignment displays in the active map window. The name of the stream alignment appears in the **Study Tree** under the **Stream Alignments** folder.

The stream alignment displays in the map window with assigned stationing. Stream stationing is assigned to a stream segment when the stream alignment is created, and HEC-FIA assumes the downstream end of the river (river station equal to zero) is at the beginning of each line segment that is when drawn is the first vertex in the line. Stationing should begin at the downstream end and ascend while proceeding upstream. HEC-FIA uses the units set by the coordinate system of the base shapefile. So, if horizontal units are in feet for the original shapefile, the stationing represents feet.

If the stream alignment appears with stationing of *0K* (zero thousand units) at the upstream end of the alignment, then the stream alignment was imported incorrectly. To correct this issue from the **Study Tree**, from the **Watershed** folder, from the **Stream Alignment** folder, right-click on the stream alignment (e.g., *NB_River*). From the shortcut menu click **Reverse Direction All** (Figure 5.14) and a **Confirm Reverse Direction** warning dialog box opens. Click **Yes**, to confirm and reverse the direction of all stream segments in the stream alignment.
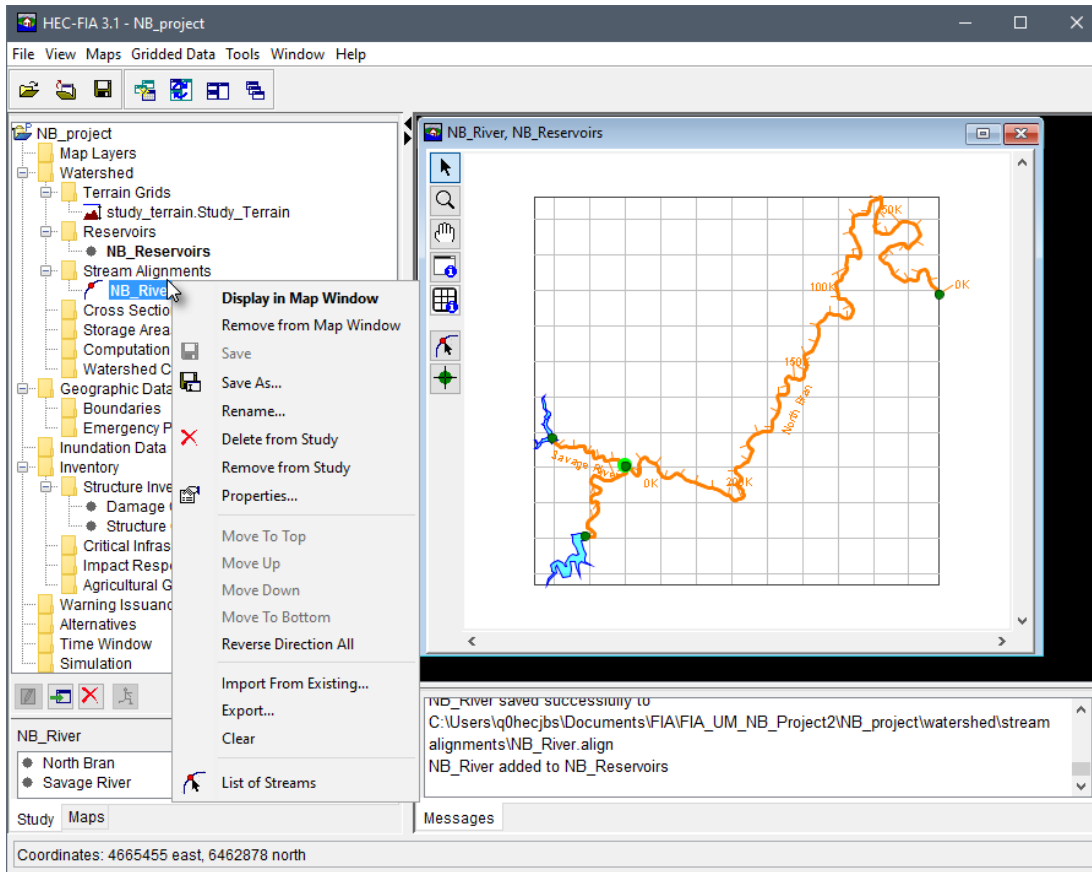
Figure 5.14 Stream Alignments Data – Study Tree Shortcut Commands

5.3.2   Changing the Stream Alignment

To make changes to the stream alignment, from the map window, select the **Stream Alignment Tool** (Figure 5.15). Using the **Stream Alignment Tool** a user can add stream segments to a stream alignment, and by right-clicking on a stream segment access the map window stream alignment shortcut menu (Figure 5.15). From the shortcut menu, a user can delete, rename, reverse the direction, disconnect the upstream or downstream ends, and edit stream segments.
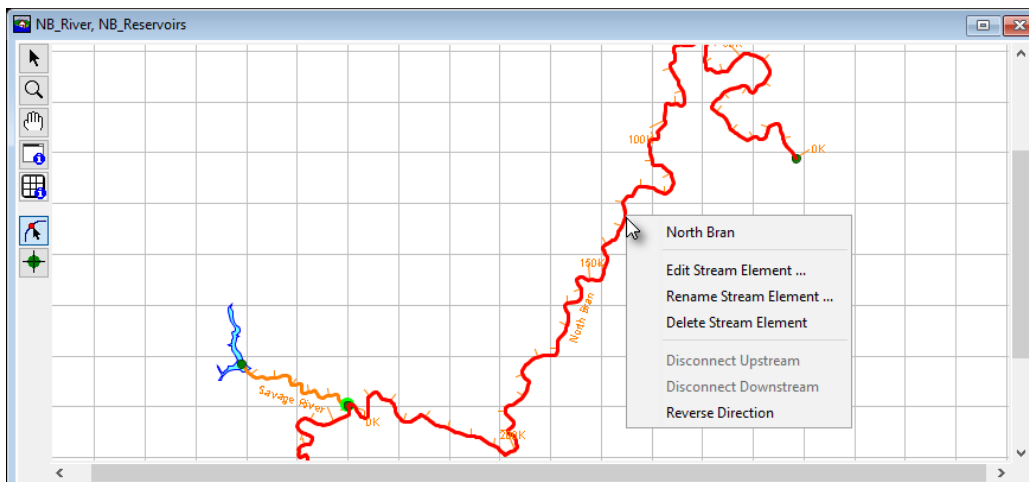
Figure 5.15 Map Window – Stream Alignment Tool – Shortcut Commands

5.4   Import a Cross Section Set

A **cross section set** is used to define the locations of **cross sections** within the HEC-FIA project area, as well as to map HEC-DSS data by using pathnames (A, B, and C parts). Watershed components are linked to HEC-DSS files from created inundation configurations; for more information regarding inundation configurations review Chapter 7 of this manual. A cross section is used to pass information about the depth and extents of water in a river reach and within the floodplain. Cross sections usually have river, reach, and river station values that are used to make each one unique. Cross sections are imported separately from **storage areas** (refer to Section 5.5) in HEC-FIA Version 3.1; therefore, if the study does not require storage areas, and only cross sections, then the user can just import a cross section set.

HEC-RAS project alternatives may include cross sections that cover the overbank areas in the *Without Project Condition*, and cross sections that connect to a lateral structure (e.g., a levee) with a storage area in the W*ith Project Condition*. This type of situation would require that two cross section sets be imported into HEC-FIA, each for a different **watershed configuration** (refer to Section 5.7). Having the two watershed configurations would be one way to compare a without levee scenario to a with levee scenario. From the latest version of HEC-RAS, the HEC-RAS Mapper tool can be used to export cross sections and storage areas to shapefiles; see Appendix G for further information on exporting data from HEC-RAS. Once the shapefiles have been generated, it is a good idea to copy the shapefiles to the *maps* directory of the HEC-FIA project.

To import cross sections:

1. From the **Study Tree**, from the **Watershed** folder, right-click on the **Cross Sections** folder. From the shortcut menu, click **Import**; the **Import Cross Sections** dialog box opens (Figure 5.16).
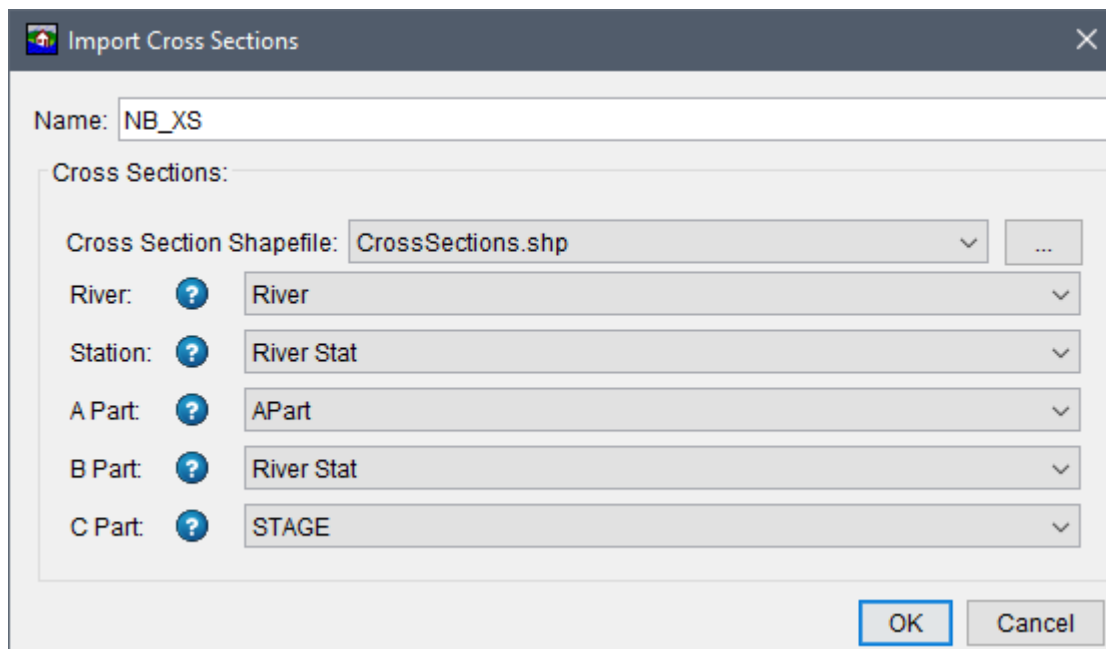
Figure 5.16 Import Cross Sections Dialog Box

2. In the **Name** text box, enter a name for the cross section set.

3. The **Cross Section Shapefile** (Figure 5.16) lists the available polyline shapefiles that have been added as map layers to the project. If a map layer that represents the cross sections has not been added to the HEC-FIA project, click the ⬚ button. The **Open** browser window opens (Figure 5.9). Browse to the location of the cross section shapefile, select the shapefile (e.g., *CrossSections.shp*), click **Open**. The browser window closes and the name of the selected shapefile appears in the **Cross Section Shapefile** list.

4. Next use the dropdown lists to indentify the attributes in the selected shapefile which represent the **River**, **Station**, **A Part**, **B Part** and **C Part** information (Figure 5.17). Note the **Help** 🔵 icon; hover over the **Help** icon to view tooltips for each cross section component (Figure 5.17).

    The **River** list allows HEC-FIA to group the cross sections that are on the same river. The **Station** (river stationing) list allows HEC-FIA to sort the stationing values on the cross section in ascending order. These two steps allow HEC-FIA to create a polygon for the area in between any two cross sections so that structures can identify which cross sections to retrieve hydraulic data from during a cross section compute. **Important:** Make certain that the data in the shapefile database matches the HEC-DSS data record for each cross section exactly, so that HEC-FIA can find the correct data during a computation. Also, all watershed elements included in a watershed configuration (refer to Section 5.7) should contain matching names across the elements. For example, the stream names selected for an imported cross section set should match the river names in the imported stream alignment.
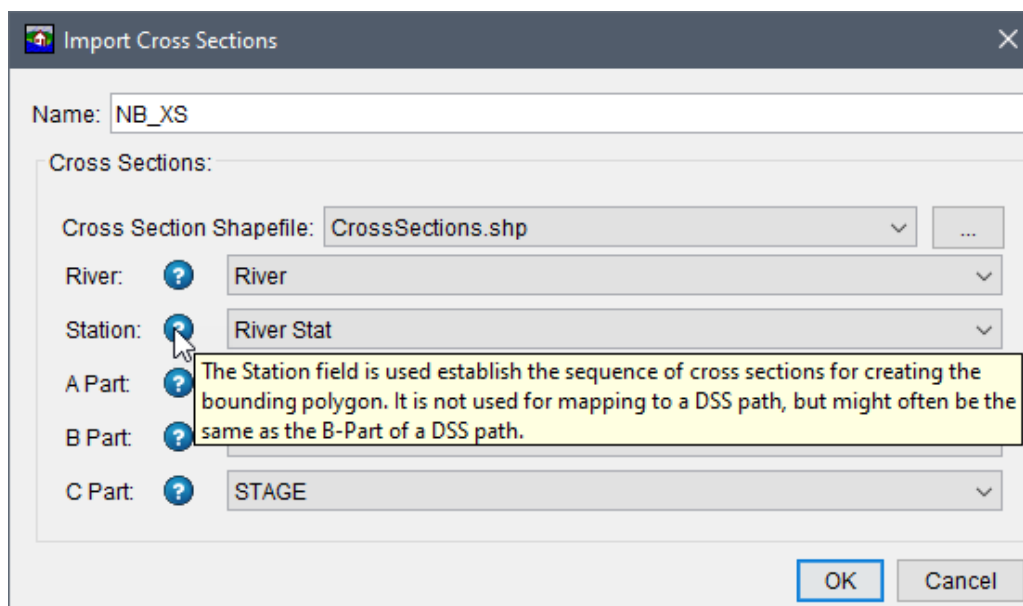
Figure 5.17 Import Cross Sections – Help Icon Tooltip – Example

5. The **A Part**, **B Part** and **C Part** lists (Figure 5.17) allow the user to define a partially qualified HEC-DSS path that will be used later by HEC-FIA to link to the HEC-RAS outputs; e.g., stage hydrographs. The **A Part** is generally a river identifier (e.g., *APart* in

Figure 5.16), although for HEC-RAS it is the river and reach names concatenated with a space in between. The **B Part** is generally a point location parameter (e.g., *River Stat* in Figure 5.16); HEC-RAS uses the river stationing for this part. The **C Part** list contains the option to set type of hydraulic data (e.g., *STAGE* or *FLOW*). In general, the **C Part** should be set to *STAGE* when using data from cross sections. It is important to note that HEC-FIA interprets the HEC-DSS record as stage when calculating damages at structures.

6. Click **OK**, the **Import Cross Sections** dialog box closes (Figure 5.17). The name of the cross section data (e.g., *NB_XS*) appears in the **Study Tree** under the **Cross Sections** folder and the cross sections are displayed in the active map window.

Once imported, the cross section set can be edited:

1. From the **Study Tree**, from the **Watershed** folder, from the **Cross Sections** folder, right-click on the cross section set (e.g., *NB_XS*). From the shortcut menu click **Edit** (Figure 5.10) and the **Edit Cross Section Time Series Mappings** dialog box opens (Figure 5.18).

2. The user can view and edit the cross section time series from the **Edit Cross Section Time Series Mappings** dialog box (Figure 5.18). Either click the cell once to replace the text or double-click to edit part of the text. Once viewing or editing is complete, click **Ok** to close the dialog and save modifications. Alternatively, click **Cancel** to close the dialog without saving changes.

LOCATION	PARAMETER	River	RiverStati	APART	BPART	CPART
North Branch Pot Main Stem 218676	STAGE	North Branch Pot	218676	North Branch Pot Main Stem	218676	STAGE
North Branch Pot Main Stem 218376.*	STAGE	North Branch Pot	218376.*	North Branch Pot Main Stem	218376.*	STAGE
North Branch Pot Main Stem 218076	STAGE	North Branch Pot	218076	North Branch Pot Main Stem	218076	STAGE
North Branch Pot Main Stem 217776.*	STAGE	North Branch Pot	217776.*	North Branch Pot Main Stem	217776.*	STAGE
North Branch Pot Main Stem 217476	STAGE	North Branch Pot	217476	North Branch Pot Main Stem	217476	STAGE
North Branch Pot Main Stem 217209.*	STAGE	North Branch Pot	217209.*	North Branch Pot Main Stem	217209.*	STAGE
North Branch Pot Main Stem 216942.*	STAGE	North Branch Pot	216942.*	North Branch Pot Main Stem	216942.*	STAGE
North Branch Pot Main Stem 216676	STAGE	North Branch Pot	216676	North Branch Pot Main Stem	216676	STAGE

Figure 5.18 Edit Cross Section Time Series Mappings Dialog Box – Example

5.5   Import Storage Areas

A **storage area** typically represents where water goes if a lateral structure like a levee is overtopped. Storage areas are usually given a unique name and are not necessarily tied to a river or river station. If the project requires storage areas (e.g., for a Flood Damages Reduced compute, with vs. without levees scenarios, etc.) then cross sections must be imported as well (refer to Section 5.4) as both datasets are intended to be used together.

To import storage areas:

1. From the **Study Tree**, from the **Watershed** folder, right-click on the **Storage Areas** folder. From the shortcut menu, click **Import**; the **Import Storage Areas** dialog box opens (Figure 5.19).
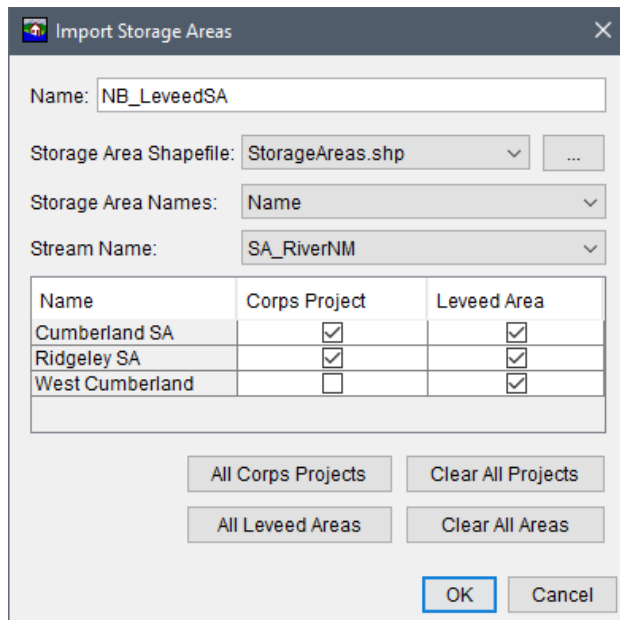
Figure 5.19 Import Storage Areas Dialog Box

2.   In the **Name** text box, enter a name for the storage areas set.

3.   The **Storage Area Shapefile** (Figure 5.19) lists the available polygon shapefiles that have been added as map layers to the project. If a map layer that represents the storage areas has not been added to the HEC-FIA project, click the ⎵ button. The **Open** browser window opens (Figure 5.9). Browse to the location of the storage area shapefile, select the shapefile, click **Open**. The browser window closes and the name of the selected shapefile appears in the **Storage Area Shapefile** list (e.g., *StorageAreas.shp*).

4.   From the **Storage Area Names** list (Figure 5.19), select the appropriate field name that contains the storage area attribute names (e.g., *Name*).

5.   Next, from the **Stream Name** list, select the field that contains the stream name associated with the storage areas (e.g., *SA_RiverNM*). Note, all watershed elements included in a watershed configuration (refer to Section 5.7) should contain matching names across the elements. For example, the stream names selected for imported storage areas should match the names in the imported stream alignment.

6.   When the unique **Storage Area Names** field has been selected, a table populates with the storage area names contained in the selected field. The table also provides the **Corps Project** and **Levee Area** columns which contain checkboxes that allow the user to identify the storage area as a USACE project and/or leveed (by default both columns are false with checkboxes unchecked). If a storage area is a USACE project, then check the checkbox ☑ in the **Corps Project** column of the table (Figure 5.19). Also, if the storage area is leveed, then check the checkbox ☑ in the **Leveed Area** column of the table.

7.   Click **OK**, the **Import Storage Areas** dialog box closes (Figure 5.19). The name of the storage area set appears in the **Study Tree** under the **Storage Areas** folder.

To display the imported storage areas in an active map window, from the **Study Tree**, from the **Watershed** folder, from the **Storage Areas** folder, right-click on the filename of the storage areas (e.g., *NB_LeveedSA*) and click **Display in Map Window** from the shortcut menu (Figure 5.10). The storage areas will display in the active map window.

Once imported, the storage areas can be edited:

1. From the **Study Tree**, from the **Watershed** folder, from the **Storage Areas** folder, right-click on the storage areas name (e.g., *NB_LeveedSA*). From the shortcut menu click **Edit** (Figure 5.10) and the **Storage Areas** dialog box opens (Figure 5.20).

| SA_Name	RiverName	CorpsPrj	LeveedArea	APart	BPart	CPart
Cumberland SA	North Bran	☑	☑	Storage Area	Cumberland SA	Stage
Ridgeley SA	North Bran	☑	☑	Storage Area	Ridgeley SA	Stage
West Cumberland	North Bran	☐	☑	Storage Area	West Cumberland	Stage
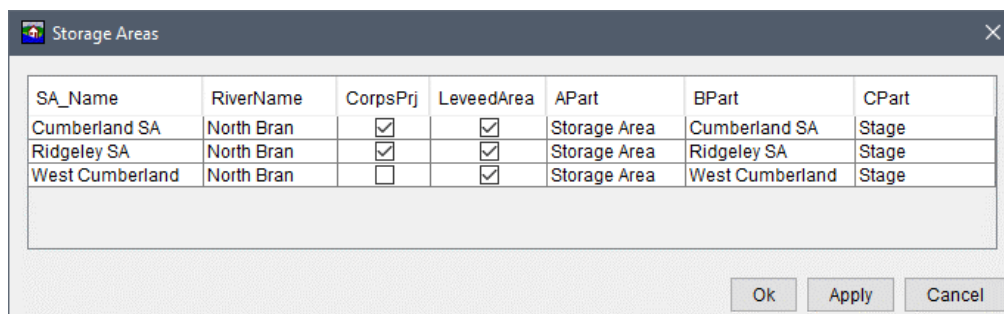
Figure 5.20 Edit – Storage Areas Dialog Box

2. The user can view and edit the storage area information from the **Storage Areas** dialog box (Figure 5.20). Either click the cell once to replace the text or double-click to edit part of the text. From the **CorpsPrj** column the user can check or uncheck the checkboxes that categorizes the storage area as either a USACE project (checked) or not (unchecked). Likewise, from the **LeveedArea** column the user can check or uncheck the checkboxes that indicates the storage area as either leveed (checked) or not leveed (unchecked).

3. Further, as illustrated in Figure 5.20, the **Storage Areas** dialog box, the import completes the **APart**, **BPart**, and **CPart** for the storage areas automatically. The A Part and C Part information is set by HEC-FIA to *Storage Area* and *Stage*, respectively. The B Part is set based on the unique **Storage Area Names** field provided by the user during import (from the **Import Storage Areas** dialog box).

4. Once edits are complete, click **Ok** to close the dialog and save the edited file. Alternatively, click **Cancel** to close the dialog without saving changes.

5.6   Import Common Computation Points

Common computation points (CCPs) are locations along the stream alignment where mapped HEC-DSS time series information is exchanged between models by linking HEC-DSS pathnames (e.g., between HEC-ResSim and HEC-FIA). Linking of HEC-DSS time series information is done during the CCP import process (as described in the following steps) and when defining events for created inundation configurations (refer to Chapter 7). Two import options are available for importing CCPs: **Standard CCPs** (original import option), or **CCPs with Holdout Distribution Areas** (a new import option in HEC-FIA Version 3.1 for use in the Flood Damages Reduced compute option).

5.6.1   Standard CCPs

Standard CCPs are not typically used when evaluating consequences. However, standard CCPs can be helpful if a quick real-time analysis needs to be completed and HEC-RAS is not part of the CWMS model sequence. If very few damages are expected to occur in an area of the watershed, sometimes hydrologic routing used with a stage-flow rating curve is adequate (a HEC-RAS model can still be used to generate the stage-flow relationship). Since HEC-FIA can only have one provider of hydraulic data per alternative, separate alternatives (or HEC-FIA projects) have to be created for these areas.

Important: Make certain that the attributes in the shapefile's database which contain information pertaining to the HEC-DSS pathname parts matches the linked HEC-DSS record for each CCP exactly, so that HEC-FIA can find the correct inundation data during a compute. Watershed components are linked to HEC-DSS files from created inundation configurations; for more information regarding inundation configurations review Chapter 7 of this manual.

To import standard common computation points (CCPs):

1.   From the **Study Tree**, from the **Watershed** folder, right-click on the **Computation Points** folder. From the shortcut menu, point to **Import** and click **Standard CCPs** (Figure 5.21); the **Import Computation Points** dialog box opens (Figure 5.22).
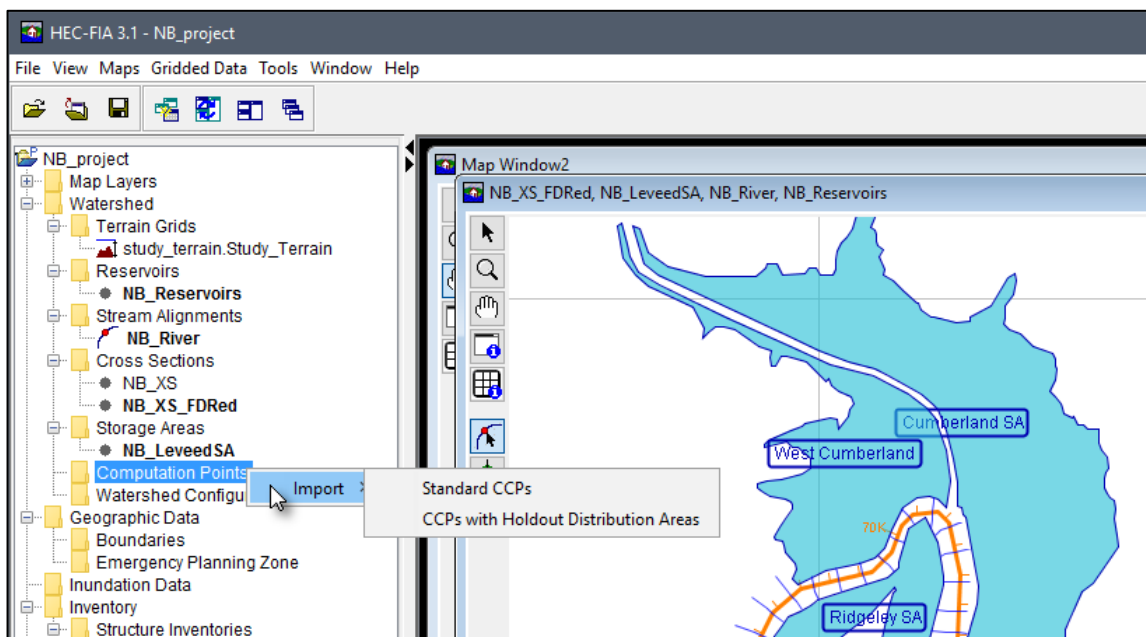
Figure 5.21 Computation Points –Shortcut Import Submenu Options

2.   Provide a name for the standard CCP layer in the **Name** box on the **Import Computation Points** dialog box (Figure 5.22).

3.   Select the appropriate stream alignment from the **Stream Alignment** list (e.g., *NB_River*).
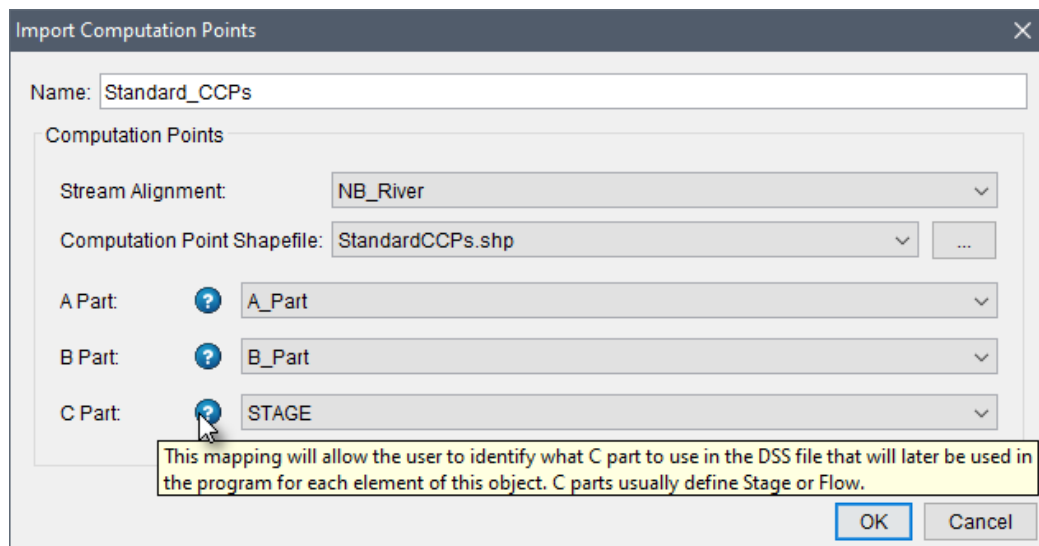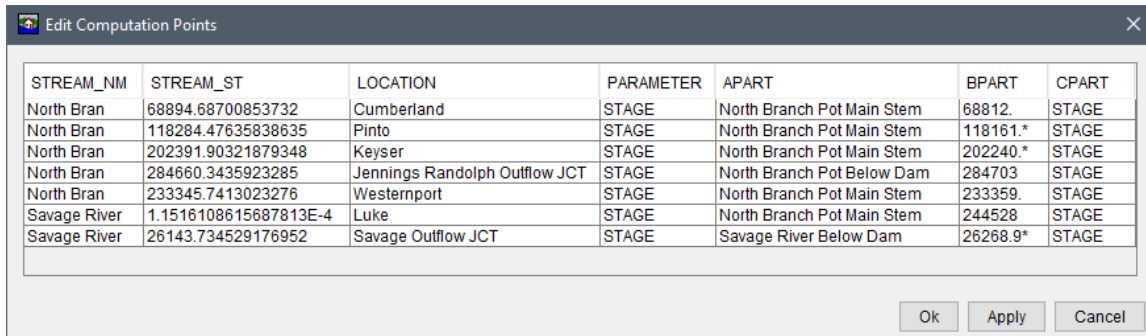
Figure 5.22 Import Computation Points Dialog Box – Standard CCPs

4.   The **Computation Point Shapefile** (Figure 5.22) lists the available point shapefiles that have been added as map layers to the project. If a map layer that represents the standard CCPs has not been added to the HEC-FIA project, click the ⬚ button. The **Open** browser window opens (Figure 5.9). Browse to the location of the standard CCPs shapefile, select the shapefile, click **Open**. The browser window closes and the name of the selected shapefile appears in the **Computation Point Shapefile** list (e.g., *StandardCCPs.shp*).

5.   Next, the user needs to define information about the CCP shapefile using the dropdown lists provided. Standard CCPs only need the **A Part**, **B Part** and **C Part** lists (Figure 5.22) defined. When importing CCPs from HEC-HMS or HEC-ResSim the **A Part** is not selected (blank). Note the **Help** ❓ icon; hover over the **Help** icon to view tooltips for each standard CCP component (Figure 5.22).

6.   Now that everything is defined, click **OK**. The **Import Computation Points** dialog box (Figure 5.22) closes. The imported standard CCPs will display in the active map window. Under the **Computation Points** folder in the **Study Tree**, the name of the standard CCP set with the selected stream alignment name (*Standard_CCPs.NB_River*) appears.

Once imported, the standard CCPs can be edited:

1.   From the **Study Tree**, from the **Watershed** folder, from the **Computation Points** folder, right-click on the standard CCPs name (e.g., *Standard_CCPs.NB_River*). From the shortcut menu click **Edit** (Figure 5.10) and the **Edit Computation Points** dialog box opens (Figure 5.23).

2.   The user can view and edit the standard CCPs information from the **Edit Computation Points** dialog box (Figure 5.23). Either click the cell once to replace the text or double-click to edit part of the text. HEC-FIA completes the **STREAM_NM** and **STREAM_ST** values based on the location of the standard CCP along the selected Stream Alignment; therefore, the user should not modify these columns.

STREAM_NM	STREAM_ST	LOCATION	PARAMETER	APART	BPART	CPART
North Bran	68894.68700853732	Cumberland	STAGE	North Branch Pot Main Stem	68812.	STAGE
North Bran	118284.47635838635	Pinto	STAGE	North Branch Pot Main Stem	118161.*	STAGE
North Bran	202391.90321879348	Keyser	STAGE	North Branch Pot Main Stem	202240.*	STAGE
North Bran	284660.3435923285	Jennings Randolph Outflow JCT	STAGE	North Branch Pot Below Dam	284703	STAGE
North Bran	233345.7413023276	Westernport	STAGE	North Branch Pot Main Stem	233359.	STAGE
Savage River	1.1516108615687813E-4	Luke	STAGE	North Branch Pot Main Stem	244528	STAGE
Savage River	26143.734529176952	Savage Outflow JCT	STAGE	Savage River Below Dam	26268.9*	STAGE

Figure 5.23 Edit Computation Points – Standard CCPs – Example

3. Once edits are complete, click **Ok** to close the dialog and save the edited file. Alternatively, click **Cancel** to close the dialog without saving changes.

5.6.2   CCPs with Holdout Distribution Areas

The new option in HEC-FIA Version 3.1 to import **CCPs with Holdout Distribution Areas** was created to be used with an imported reservoir set (refer to Section 5.2) when including reservoirs in a Flood Damages Reduced compute. In the Flood Damages Reduced compute, the CCPs with holdout areas represent locations within the HEC-ResSim watershed where hydrograph time series information is written for holdout computes. In HEC-ResSim, holdouts indicate the effects of reservoir regulation (by calculating the amount of water stored by the reservoir) as described in Chapter 13 of the HEC-ResSim User's Manual. In HEC-FIA, holdout distribution areas define the geographic extent of the influence of the reservoirs for the associated CCP location, and HEC-FIA uses the reservoirs' influence to apportion a calculated damage estimate in the holdout distribution areas. Review Chapter 10 and Chapter 12 of this manual for more information regarding Flood Damages Reduced.

Important: The user-defined holdout CCP names must match the CCP names in the linked HEC-DSS file containing the HEC-ResSim exported holdouts time series. Watershed components are linked to HEC-DSS files from created inundation configurations; for more information regarding inundation configurations review Chapter 7 of this manual. To import common computation points (CCPs) with holdouts:

1. From the **Study Tree**, from the **Watershed** folder, right-click on the **Computation Points** folder. From the shortcut menu, point to **Import** and click **CCPs with Holdout Distribution Areas** (Figure 5.21); the **Import Computation Points** dialog box opens (Figure 5.24).

2. Provide a name (e.g., *HoldoutCCPs*) for the CCP with holdouts layer in the **Common Computation Point Set** box on the **Import Computation Points** dialog box (Figure 5.24).

3. The **CCP Shapefile** (Figure 5.24) lists the available point shapefiles that have been added as map layers to the project. If a map layer that represents the CCPs has not been added to the HEC-FIA project, click the [⋯] button. The **Open** browser window opens (Figure 5.9). Navigate to the CCPs shapefile (for the Flood Damages Reduced compute), select

the shapefile, and click **Open**. The browser window closes and the name of the selected shapefile appears in the **CCP Shapefile** list (e.g., *ResSim_CCPs.shp*).

4. For the selected CCP shapefile, from the **CCP Name** list, select the attribute which contains the CCP names (e.g., *ID_NAME*). **Important**: The user-defined holdout CCP names must match the CCP names in the linked HEC-DSS file containing the holdouts time series exported from HEC-ResSim. Watershed components are linked to HEC-DSS files from created inundation configurations (review Chapter 7 of this manual).
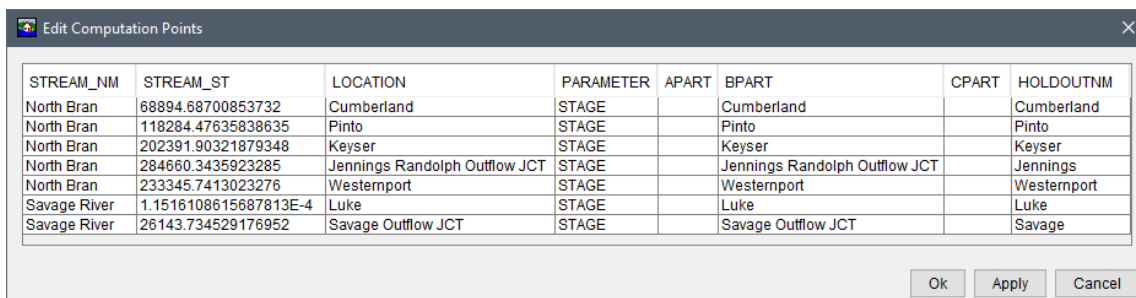
Figure 5.24 Import Computation Points Dialog Box – CCPs with Holdout Distribution Areas

5. Next, the user needs to define HEC-DSS mapping information for the CCP shapefile using the **A Part** and **B Part** dropdown lists provided (Figure 5.24). In general, when importing CCPs from HEC-ResSim the **A Part** is not selected (blank). **Important**: The **B Part** must match the CCP names in the linked HEC-DSS file containing the holdouts time series exported from HEC-ResSim.

6. The **Holdout Distribution Area Shapefile** (Figure 5.24) lists the available polygon shapefiles that have been added as map layers to the project. If a map layer that represents the holdout areas has not been added to the HEC-FIA project, click the [...] button. The **Open** browser window opens (Figure 5.9). Browse to the location of the holdout areas shapefile, select the shapefile, and click **Open**. The browser window closes and the name of the selected shapefile appears in the list (e.g., *HoldoutAreas.shp*).

7. For the selected holdout distirbution areas shapefile, from the **Holdout Distribution Area Name** list select the attribute which contains the names of the holdout areas (e.g., *Name*).

8. The CCPs **Name** and **Holdout Distribution Area** table, located at the bottom of the dialog (Figure 5.24), automatically populates with the names of the CCPs and holdout areas. Each CCP must correspond to a specific holdout area. **Note:** The **Holdout Distribution Area** column allows the user to manually change automatically selected holdout distribution area name(s) by using the list(s) to select a different holdout name for the corresponding CCP.

9. Select the appropriate imported stream alignment (review Section 5.3) from the **Stream Alignment** list (e.g., *NB_River*).

10. Select the appropriate imported reservoir set (review Section 5.2) from the **Reservoir Set** list (e.g., *NB_Reservoirs*). **Important**: The reservoir names must match the **C Part** must match the CCP names in the linked HEC-DSS file containing the holdouts time series exported from HEC-ResSim.

11. Now that everything is defined, click **OK**. The **Import Computation Points** dialog box (Figure 5.24) closes. The imported CCPs will display in the active map window. Under the **Computation Points** folder in the **Study Tree**, the name of the CCP set with the selected stream alignment name (*HoldoutCCPs.NB_River*) appears. Note, the holdouts polygon shapefile will not display in the map window with the CCPs; however, the user can import the holdout distribution areas shapefile as a boundary layer (review Chapter 6 of this manual regarding geographic data).

Once imported, the CCPs (with holdout distribution areas) can be edited:

1. From the **Study Tree**, from the **Watershed** folder, from the **Computation Points** folder, right-click on the holdout CCPs name (e.g., *HoldoutCCPs*). From the shortcut menu click **Edit** (Figure 5.10) and the **Edit Computation Points** dialog box opens (Figure 5.25).

Edit Computation Points							×
STREAM_NM	STREAM_ST	LOCATION	PARAMETER	APART	BPART	CPART	HOLDOUTNM
North Bran	68894.68700853732	Cumberland	STAGE		Cumberland		Cumberland
North Bran	118284.47635838635	Pinto	STAGE		Pinto		Pinto
North Bran	202391.90321879348	Keyser	STAGE		Keyser		Keyser
North Bran	284660.3435923285	Jennings Randolph Outflow JCT	STAGE		Jennings Randolph Outflow JCT		Jennings
North Bran	233345.7413023276	Westernport	STAGE		Westernport		Westernport
Savage River	1.15161086156887813E-4	Luke	STAGE		Luke		Luke
Savage River	26143.734529176952	Savage Outflow JCT	STAGE		Savage Outflow JCT		Savage

Figure 5.25 Edit Computation Points – CCPs with Holdout Distribution Areas – Example

2. The user can view and edit the CCPs information from the **Edit Computation Points** dialog box (Figure 5.25). Either click the cell once to replace the text or double-click to edit part of the text. HEC-FIA completes the **STREAM_NM** and **STREAM_ST** values based on the location of the CCP along the selected stream alignment; therefore, the user should not modify these columns.

3. Once edits are complete, click **Ok** to close the dialog and save the edited file. Alternatively, click **Cancel** to close the dialog without saving changes.

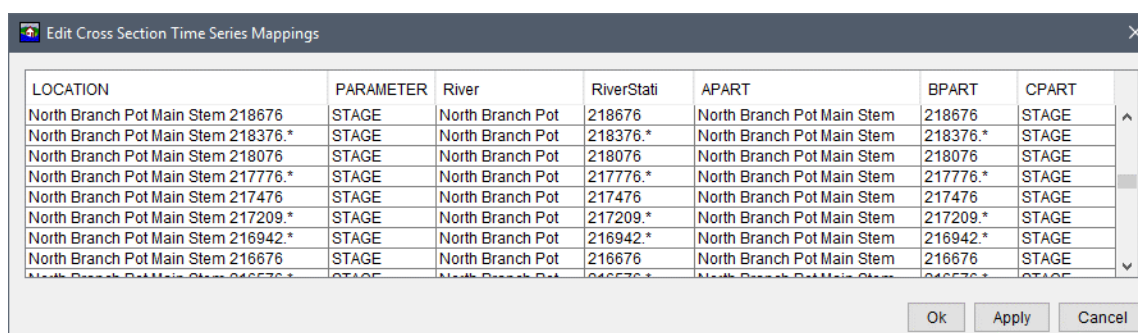## 5.7   Create a Watershed Configuration

A watershed configuration is a required element in HEC-FIA, and replaces the project configuration used by versions of the software preceding HEC-FIA Version 3.0. The watershed configuration is the HEC-FIA representation of a modeled watershed, which may be representative of the actual watershed or of some structural representation of an alternative that changes elements in the watershed. Many watershed configurations can be created, and the user

can define many versions of any element in the watershed configuration to represent different project alternatives. For example, one project alternative may include cross sections that cover the overbank areas in the *Without Project Condition*, and another project alternative may include cross sections that connect to a lateral structure (e.g., a levee) with a storage area in the W*ith Project Condition*.

The base elements of an HEC-FIA watershed configuration consists of a terrain grid, a reservoir set, a stream alignment, a cross sections set, a storage areas set, and a set of common computation points (either standard CCPs or holdout CCPs). Not all of these base elements are required for HEC-FIA to compute a hydraulic event at a location in the study area.

Important: All watershed elements included in a watershed configuration should contain matching names across the elements. For example, if the watershed configuration is created for the new Flood Damages Reduced compute that contains HEC-RAS leveed storage areas and HEC-ResSim reservoirs with holdout CCPs, then the reservoirs, stream alignment, cross sections, storage areas, and CCPs with holdout distribution areas should all contain the same naming convention across all elements. In other words, the river name shapefile attribute selected for the imported cross sections set (review Section 5.4) and the imported storage areas set (review Section 5.5) should match the river names in the imported stream alignment (review Section 5.3). There is one exception to this rule; during the compute if HEC-FIA cannot locate the river based on the name provided for the imported storage areas set, then HEC-FIA will determine the stream for the storage area using the centroid of the storage area polygon.

Once the elements of the watershed have been defined using the processes described above, a watershed configuration can be created, as follows:

1. From the **Study Tree**, from the **Watershed** folder, right-click on the **Watershed Configurations** folder. From the shortcut menu, click **New** (Figure 5.26); the **Create New Watershed Configurations** dialog box opens (Figure 5.27).
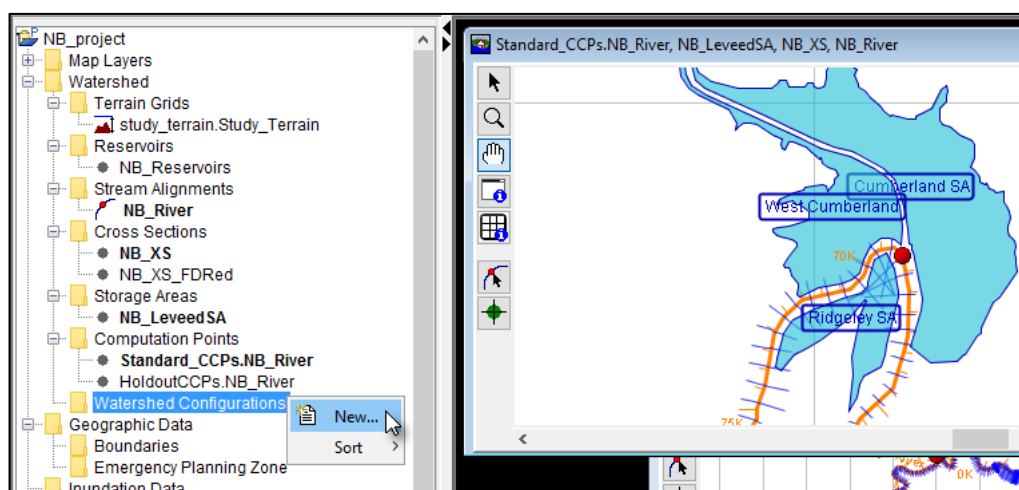
Figure 5.26 Watershed Configurations – Shortcut Menu Commands
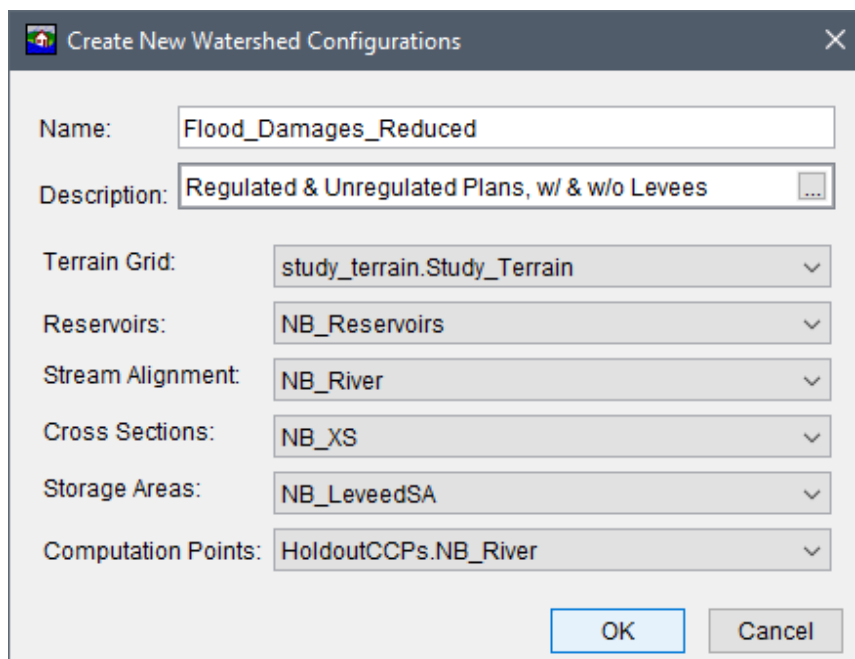
Figure 5.27 Create New Watershed Configuration – Example

2. Provide a name for the Watershed Configuration in the **Name** box on the **Create New Watershed Configurations** dialog box. From the **Description** box enter a short description (optional, but recommended). Entered descriptions will appear as a tooltip when the user hovers the cursor over the created watershed configuration's name from the **Study Tree**.

3. Next use the **Terrain Grid**, **Reservoirs**, **Stream Alignment**, **Cross Sections**, **Storage Areas**, and/or **Computation Points** lists to select the desired elements to describe the physical state of the watershed for the new watershed configuration. Each dropdown lists the user-defined name for the imported watershed elements.

    Note: When a reservoir set is selected from the **Reservoir** list (Figure 5.27) then from the **Computation Points** list the correct CCPs with holdout distribtuion areas should be selected that matches the reservoir set and the selected **Stream Alignment**. For example, if a reservoir set is selected then the **Computation Points** list only provids CCPs with holdout distribution areas. Furthermore, the **Computation Points** list only provides CCPs associated with the stream alignment selected from the **Stream Alignment** list (e.g., *NB_River* in Figure 5.27).

4. Now that everything is defined, click **OK**. The **Create New Watershed Configurations** dialog box (Figure 5.27) closes. Under the **Watershed Configurations** folder in the **Study Tree**, the name of the watershed configuration (e.g., *Flood_Damages_Reduced*) appears.

CHAPTER 6

Geographic Data

With geographic data, users can define important watershed boundaries using geospatial definitions. A user could either create boundaries or emergency planning zones (formerly defined as impact areas). Boundaries are used to define areas for aggregation and reporting. Emergency planning zones (EPZs) are used in the life loss computation to describe the geographic extent of specific warning systems and mobilization relationships. EPZ's typically correspond with Emergency Management Authorities, or whatever geographic region would contain the same warning system, or mobilization relationship.

6.1   Boundaries

Boundaries are geographic areas (e.g., USACE Districts, states, Congressional District, counties, HEC-ResSim holdout areas, etc.) used by HEC-FIA for reporting including the USACE's annual report to Congress. With large scale watersheds, users may need to create reports for many different overlapping authorities, and these boundaries help simplify the reporting function. Boundary delineations can be imported through shapefiles into HEC-FIA. To import boundaries:

1.   From the **Study Pane**, which is in the **Study Pane**, from the **Geographic Data** folder, right-click on the **Boundaries** folder. From the shortcut menu (Figure 6.1), click **Import**; the **Import Boundary Shape** dialog box opens (Figure 6.2).
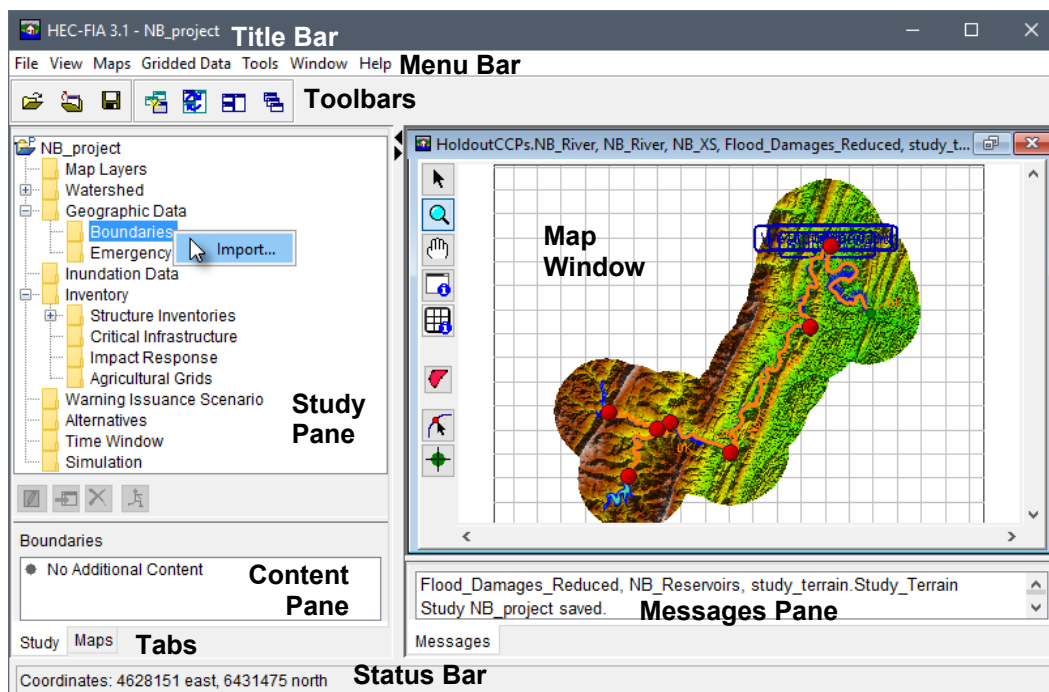
Figure 6.1 HEC-FIA Main Window – Boundaries Shortcut Command
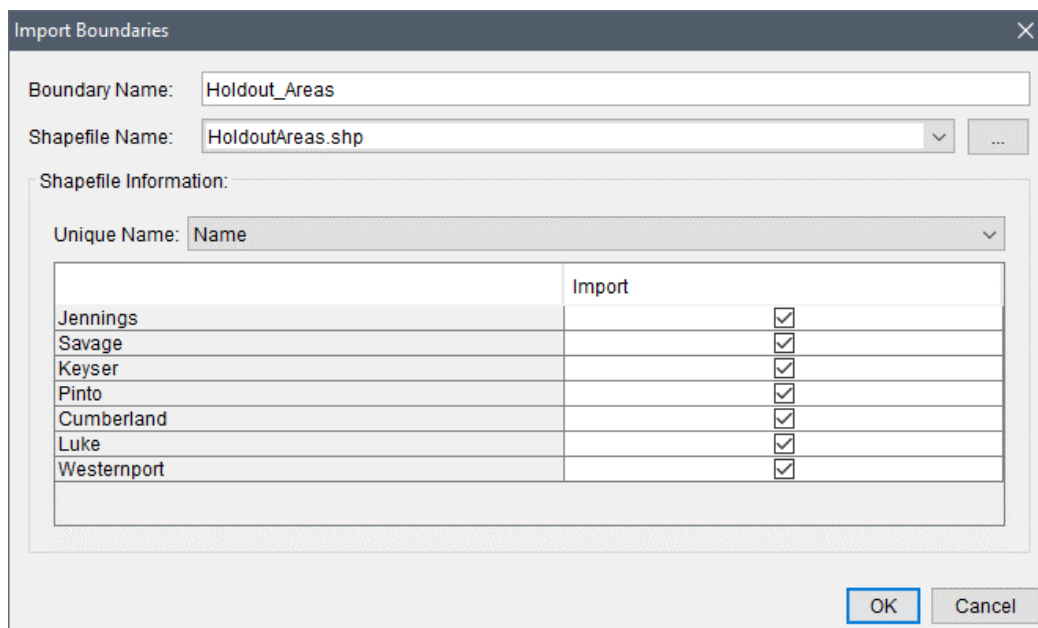
Figure 6.2 Import Boundaries Dialog Box

2.   From the **Import Boundaries** dialog box, in the **Boundary Name** text box, a name must be entered (i.e., Holdout Areas, State, Counties).

3.   The **Shapefile Path** lists the available polygon shapefiles that have been added as map layers to the project. If a map layer that represents the boundaries has not been added to the HEC-FIA project, click the [...] button. The **Open** browser window opens (Figure 6.3). Browse to the location of the shapefile that represents the boundary file, select the shapefile (**.shp*) filename (i.e., *HoldoutAreas.shp*), and click **Open**. The **Open** browser window closes, and the **Import Boundaries** dialog box (Figure 6.2) is populated with information from the selected shapefile.
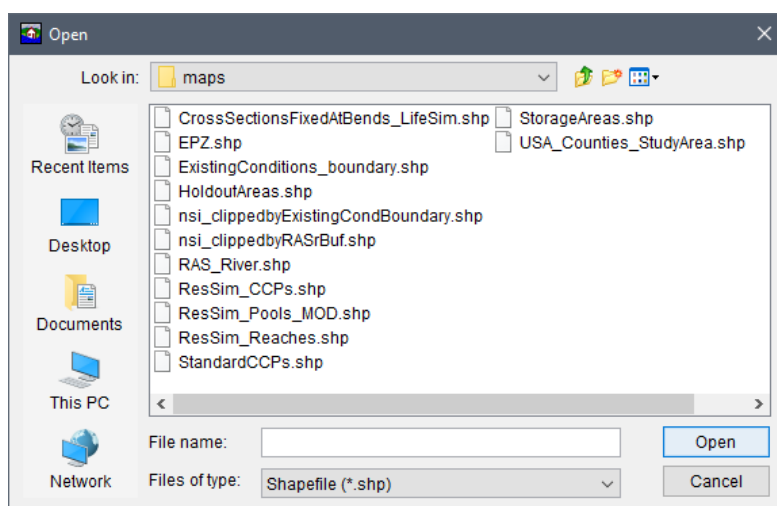
Figure 6.3 Open Browser Window

4. From the **Unique Name** list, select from the shapefile the data field that contains the name of the boundary. Once selected, the table on the **Import Boundaries** dialog box (Figure 6.2) lists the available boundary information.

5. Click **OK**, the **Import Boundaries** dialog box (Figure 6.2) closes. Information from the selected shapefile is now part of a boundary layer.

6.2 Emergency Planning Zones

Emergency planning zones (EPZs) are used by HEC-FIA for defining common life loss input parameters for groups of structures and for aggregating consequence results. EPZs are usually defined by the geographic domain of the authority responsible for issuing warnings for natural disasters. If a shapefile has been added to the study that represents the EPZs (using a polygon feature class), the user can import the EPZs from that shapefile. A new option added in HEC-FIA Version 3.1 is the ability to import Impact Area System FSYS files (**.fsys*), which are HEC-FIA Version 3.0.1 (or older) impact area legacy files. The new ability to import HEC-FIA legacy **.fsys* files as EPZs allows the user to use previously created and defined impact areas as EPZs in HEC-FIA Version 3.1 projects.

6.2.1 Import from Polygon Shapefiles

To import emergency planning zones from a polygon shapefile:

1. From the **Study Tree**, from the **Geographic Data** folder, right-click on the **Emergency Planning Zone** folder. From the shortcut menu (Figure 6.4), click **Import**; the **Import Emergency Planning Zones** dialog box opens (Figure 6.5).
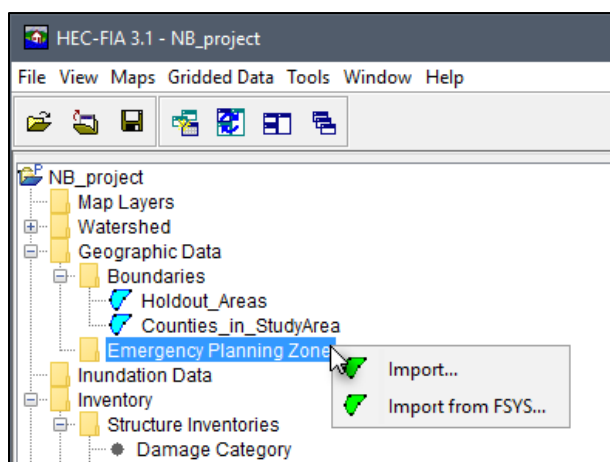
Figure 6.4 Emergency Planning Zone – Study Tree Shortcut Menu

2. From the **Import Emergency Planning Zones** dialog box (Figure 6.5), in the **Emergency Planning Zone Name** text box, a name must be entered (i.e., *Impact_Areas_EPZs*). This action creates an emergency planning zone set. Since EPZs allow users to change warning system types and population index factors, typical naming conventions include descriptions of what warning system and population index factor the user is using.
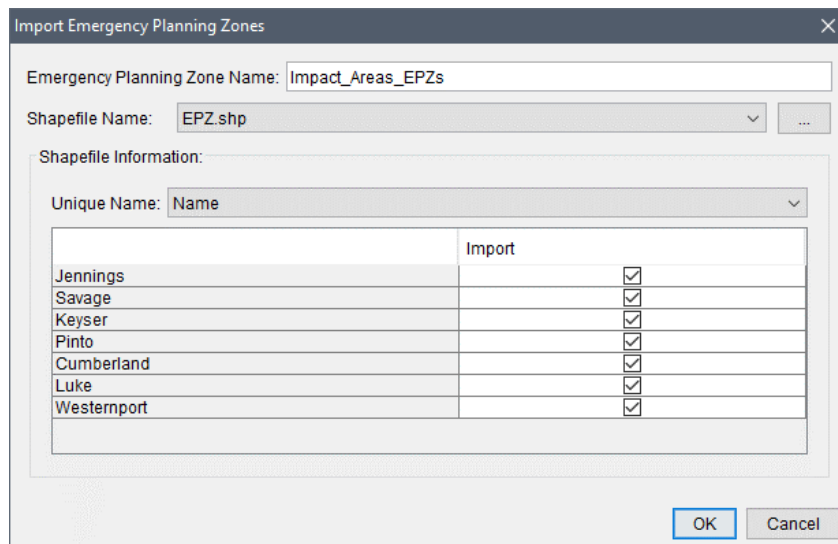
Figure 6.5 Import Emergency Planning Zones Dialog Box – Example

3. The **Shapefile Name** lists the available polygon shapefiles that have been added as map layers to the project. If a map layer that represents the emergency planning zones has not been added to the HEC-FIA project, click the [...] button. The **Open** browser window opens (Figure 6.3). Browse to the location of the shapefile that represents the EPZs file, select the shapefile (**.shp*) filename (i.e., *EPZ.shp*), and click **Open**. The **Open** browser window closes, and the **Import Emergency Planning Zones** dialog box (Figure 6.5) is populated with information from the selected shapefile.

4. From the **Unique Name** list, select from the shapefile the data field that contains the name of the emergency planning zones. Once selected the table on the **Import Emergency Planning Zones** dialog box (Figure 6.5) lists the available EPZ information. If each EPZ is a contiguous polygon, then the checkbox in the **Import** column of the table (Figure 6.5) is checked ☑ by default. If something is wrong with the polygon that represents an EPZ, the unchecked ☐ checkbox is disabled (greyed out), and the EPZ cannot be imported until the issue is resolved.

5. Click **OK**, the **Import Emergency Planning Zones** dialog box (Figure 6.5) closes. Information from the selected shapefile is now part of an emergency planning zones set.

6.2.2   Import from FSYS Files

To import emergency planning zones from an FSYS file (usually generated by an earlier version of HEC-FIA):

1. From the **Study Tree**, from the **Geographic Data** folder, right-click on the **Emergency Planning Zone** folder. From the shortcut menu (Figure 6.4), click **Import from FSYS**; the **Open** browser window opens (Figure 6.6).

2. From the **Open** browser window (Figure 6.6), navigate to the location of the FSYS file that represents the impact area system (**.fsys*), select the filename (i.e.,

Impact_Areas.fsys), and click **Open**. The **Open** browser window closes, and the information from the selected FSYS file is now part of an emergency planning zones set.
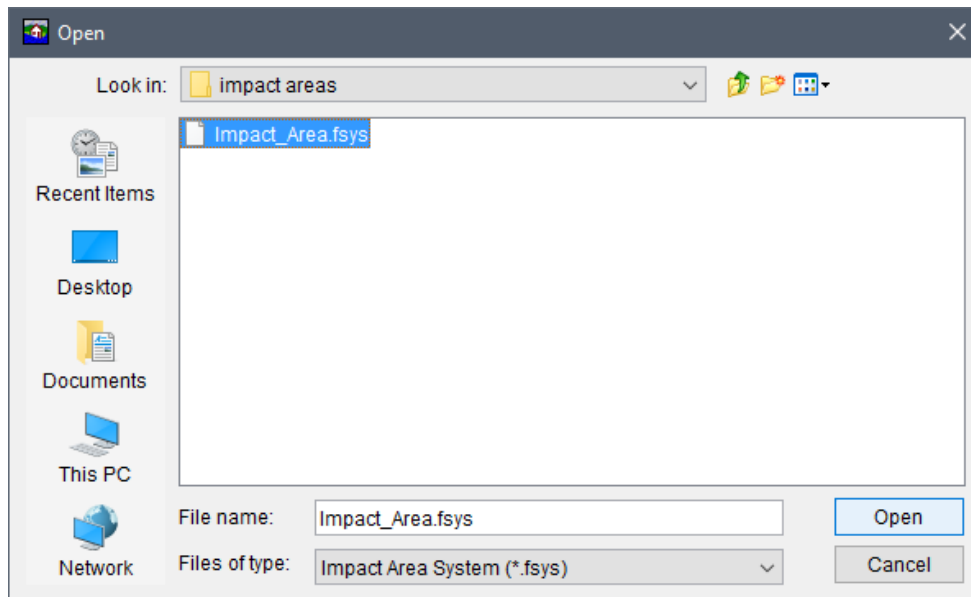
Figure 6.6 Open Browser Window – Import EPZs from HEC-FIA FSYS Files

6.2.3   Define Life Loss Parameters

Life loss parameters are defined for an existing emergency planning zones set. Warning systems and mobilization functions can be defined independently for each zone. User-defined warning systems (day and/or night first alert) and mobilization functions (protective action initiation) can be defined, which allow the user to enter the most representative function values for an EPZ (common procedure when the user conducts an expert elicitation with the local Emergency Management Agency). Warning systems and mobilization curves can be created through an expert elicitation process which has been created by Drs. Mileti and Sorenson (Appendix A). In addition, users can contact the Consequences Community of Practice for guidance.

To define life loss parameters for emergency planning zones:

1. From the **Study Tree**, from the **Geographic Data** folder, from the **Emergency Planning Zone** folder, right-click on a defined EPZ set (i.e., *Impact_Areas_EPZs*). Click **Edit**, from the shortcut menu (Figure 6.7); the **Emergency Planning Zone Editor** opens (Figure 6.8).

2. From the **Emergency Planning Zone Editor**, click the **Life Loss Parameters** tab (Figure 6.8).

3. To apply the same life loss parameters to all EPZs, check the ☑ checkbox to **Apply to all emergency planning zones** (Figure 6.8). Note, the three tabs (**Day First Alert**, **Night First Alert**, and **Protective Action Initiation** tabs) located within the **Life Loss Parameters** tab. The following sections provide instructions for setting the life loss parameters.
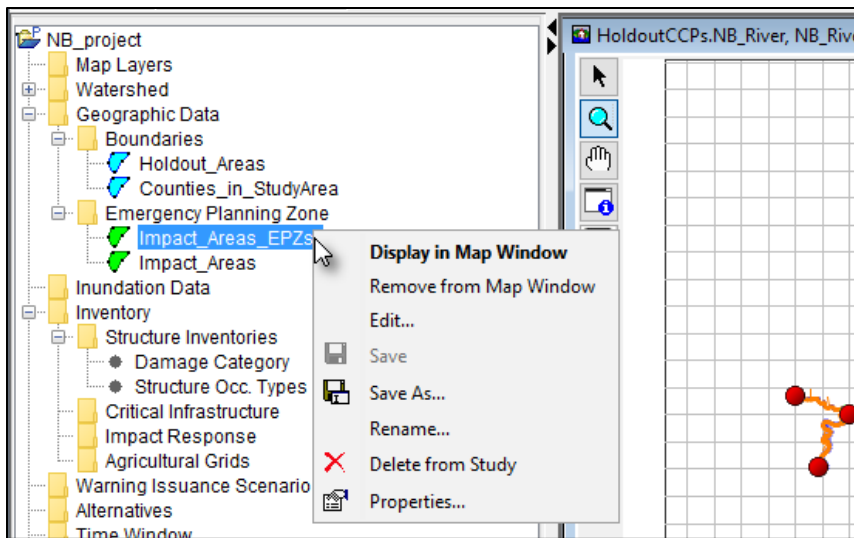
Figure 6.7 Emergency Planning Zones Set – Shortcut Menu Commands
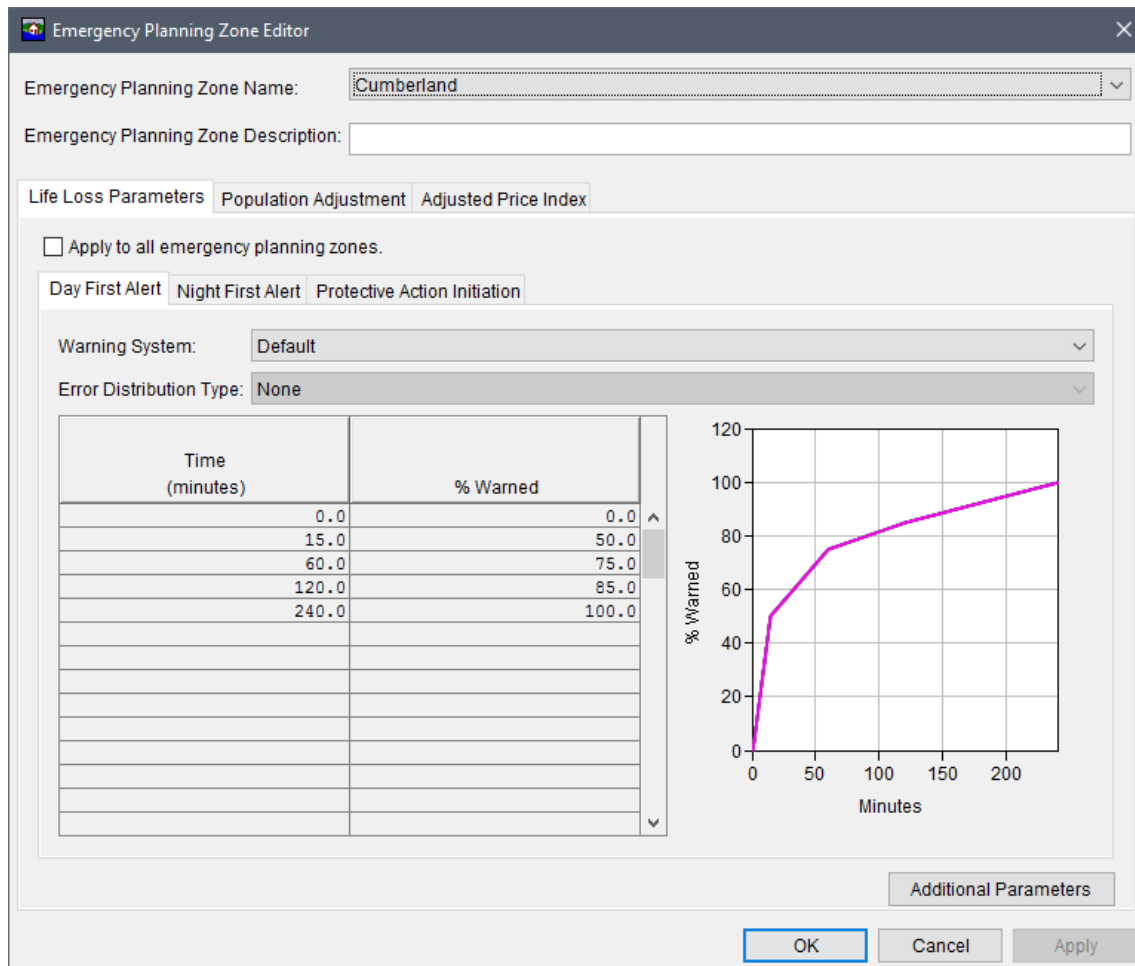
Figure 6.8 Emergency Planning Zone Editor – Example – Life Loss Parameters Tab

Day or Night Warning System Functions

For the **Day First Alert** and **Night First Alert** tabs, the **Warning System** functions are set using the same instructions. To define the day and/or night first alert warning system functions:

4. From either the **Day First Alert** or **Night First Alert** tab, from the **Warning System** list (Figure 6.9), select the warning system that is applicable to the community(s) within the selected EPZ. The warning systems list for created EPZ contains: *Default*, *Above Average*, *Below Average*, and *User Defined*.

    Note: For EPZs imported from FSYS impact areas, the warning systems list contains the warning system function defined for the FSYS impact area (e.g., *Sirens* in Figure 6.9) in addition to *Default*, *Above Average*, *Below Average*, and *User Defined*.
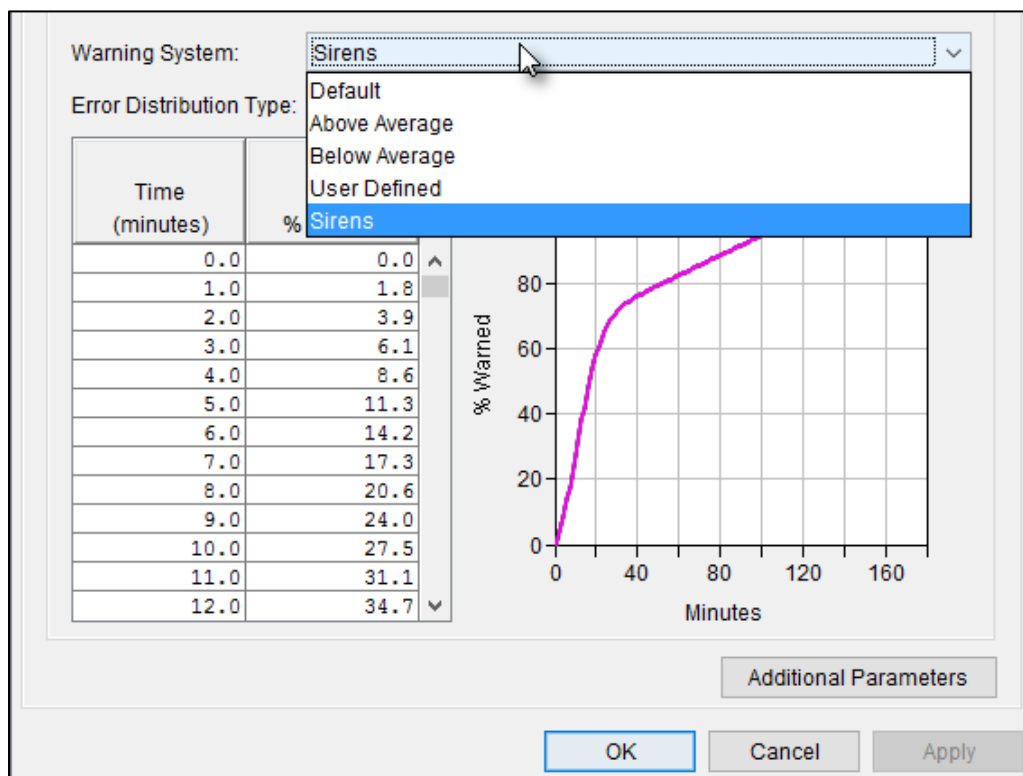
Figure 6.9 Day or Night – Warning System Curves – Available and Imported from FSYS

The warning system defines the amount of time it takes from a warning issuance to the moment population at risk receives the warning. This information is determined by reviewing local emergency management plans for information on warning systems in the inundated area. Select the emergency warning system that most closely represents the system used by the local Emergency Management Agency.

5. Additionally, curves can be created through an expert elicitation process which has been created by Drs. Mileti and Sorenson (Appendix A). These curves can be created by selecting **User Defined** (Figure 6.9) from the **Warning System** list. An **Input** dialog opens (Figure 6.10).
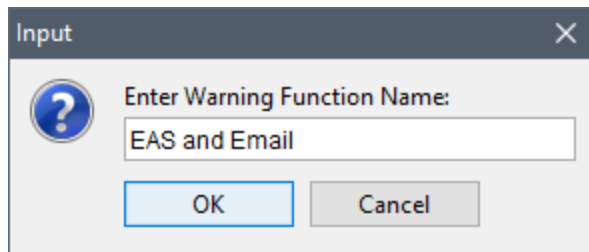
Figure 6.10 Warning System Function – User Defined – Input Dialog

6. From the **Input** dialog, enter the name of the warning system function (e.g., *EAS and Email*), click **OK**. The **Input** dialog closes, the name of the function appears in the **Warning System** list (i.e., *EAS and Email*) and the user now needs to define the parameters for the new function.

7. The **User Defined** warning system enables the **Error Distribution Type** list (Figure 6.11).The error distribution type list for user-defined warning systems contains the following options: *None* (default), *Normal*, *Log Normal*, *Triangular*, and *Uniform*. From the **Error Distribution Type** list (Figure 6.11), the user can select a distribution type and define the proper uncertainty parameters for every ordinate in the curve.
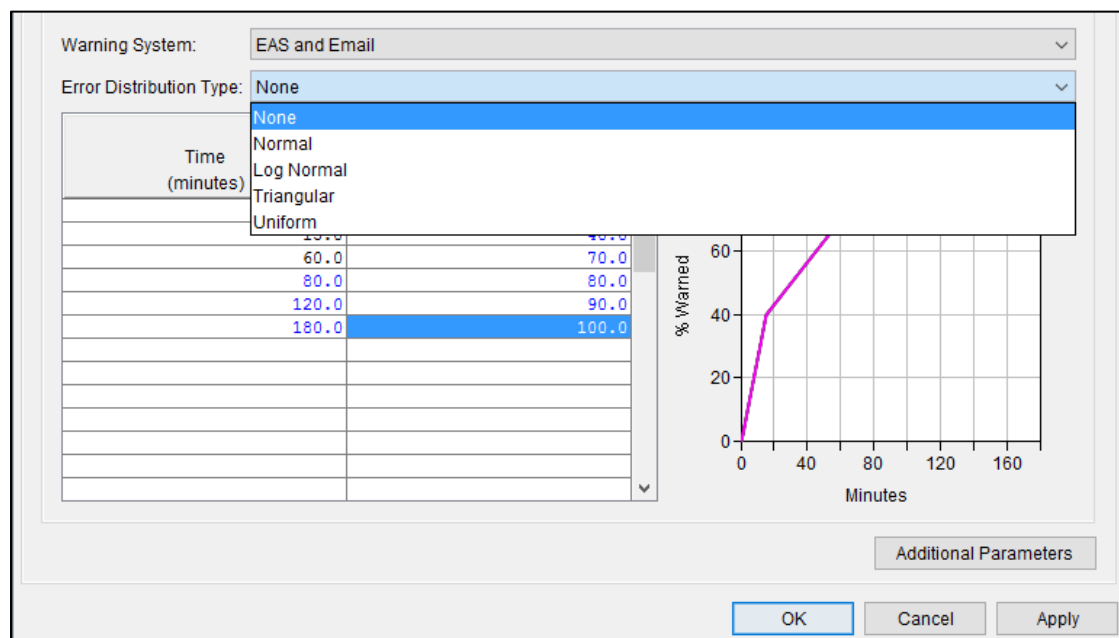
Figure 6.11 Day or Night – User Defined Warning System – Available Error Distribution Types

Protective Action Initiation Mobilization Functions

8. To define protective action initiation (PAI) mobilization information for the life loss calculations, select the **Protective Action Initiation** tab. From the **Protective Action Initiation** list (Figure 6.12), select the mobilization function (from the list provided: *Default*, *Above Average*, *Below Average*, and *User Defined*) that is applicable to the community(s) in the selected emergency planning zone. A PAI mobilization curve defines the amount of time it takes after an individual(s) receives a warning to the moment when

the individual(s) leaves their home. For a typical reconnaissance study, **Default** functions (Figure 6.12) might be used, but a **Default** function is a major source of uncertainty.

9. Additionally, curves can be created by selecting **User Defined** (Figure 6.12) from the **Protective Action Initiation** list. An **Input** dialog opens (Figure 6.13), enter the name of the mobilization function, and click **OK**. The **Input** dialog closes, the name of the function appears in the **Protective Action Initiation** list (i.e., *Pre-Good_Percep-Unk*) and the user now needs to define the parameters for the new function.
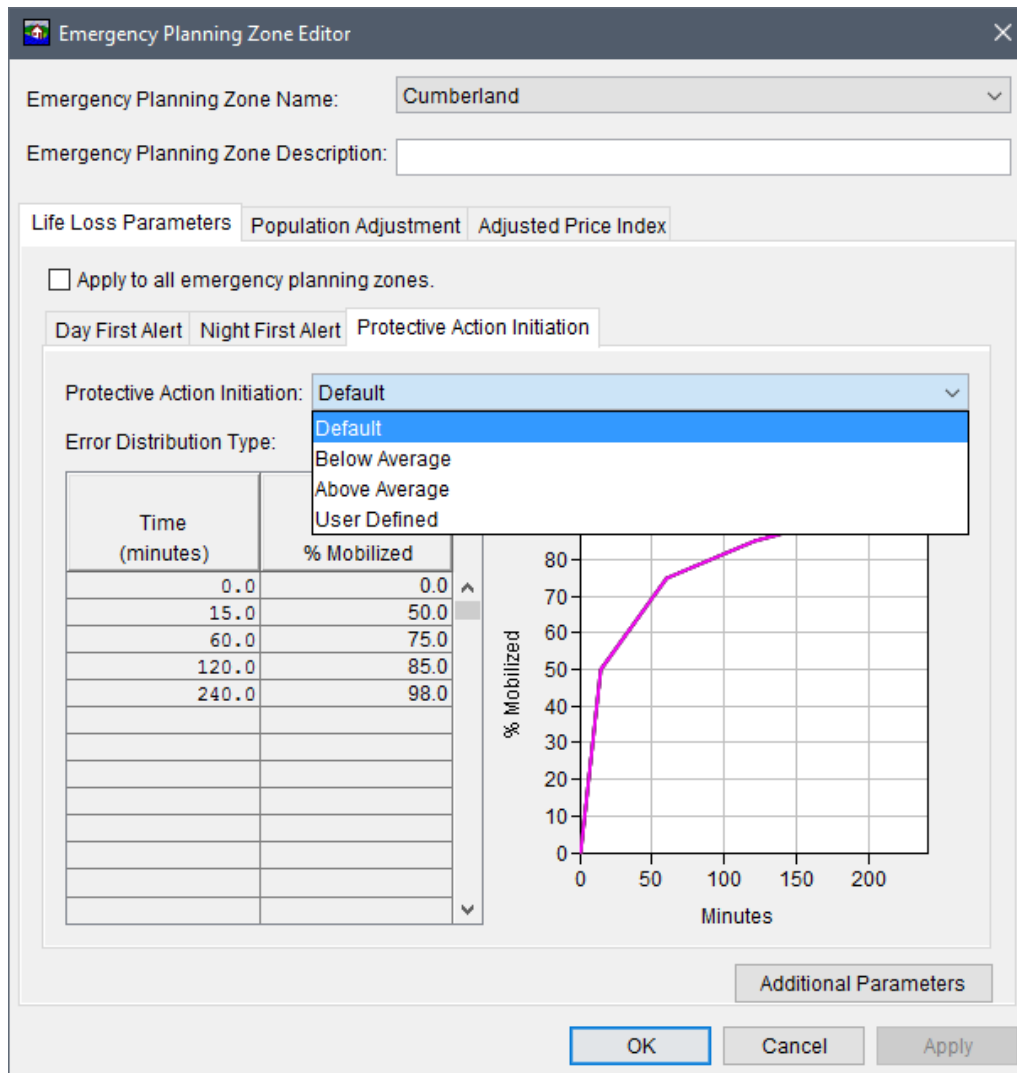
Figure 6.12 Protective Action Initiation (PAI) Tab – PAI Mobilization Curves
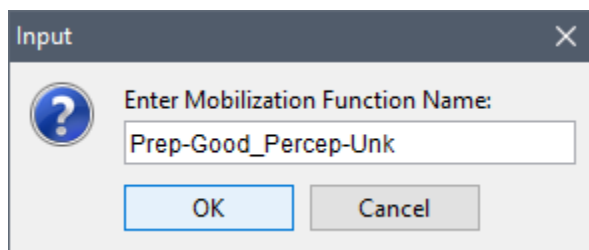
Figure 6.13 Mobilization Function – User Defined – Input Dialog

10.   The **User Defined** mobilization function enables the **Error Distribution Type** list (Figure 6.11). The error distribution type list for user-defined warning systems contains the following options: *None* (default), *Normal*, *Log Normal*, *Triangular*, and *Uniform*. From the **Error Distribution Type** list (Figure 6.11), the user can select a distribution type and define the proper uncertainty parameters for every ordinate in the curve.

Additional Parameters

11.   Additional parameters that influence life loss computations can be accessed and modified by clicking the **Additional Parameters** button (Figure 6.12). The **Additional Parameters** dialog box opens (Figure 6.14). Additional parameters include fatality rates and uncertainties, and non-evacuation depth thresholds.
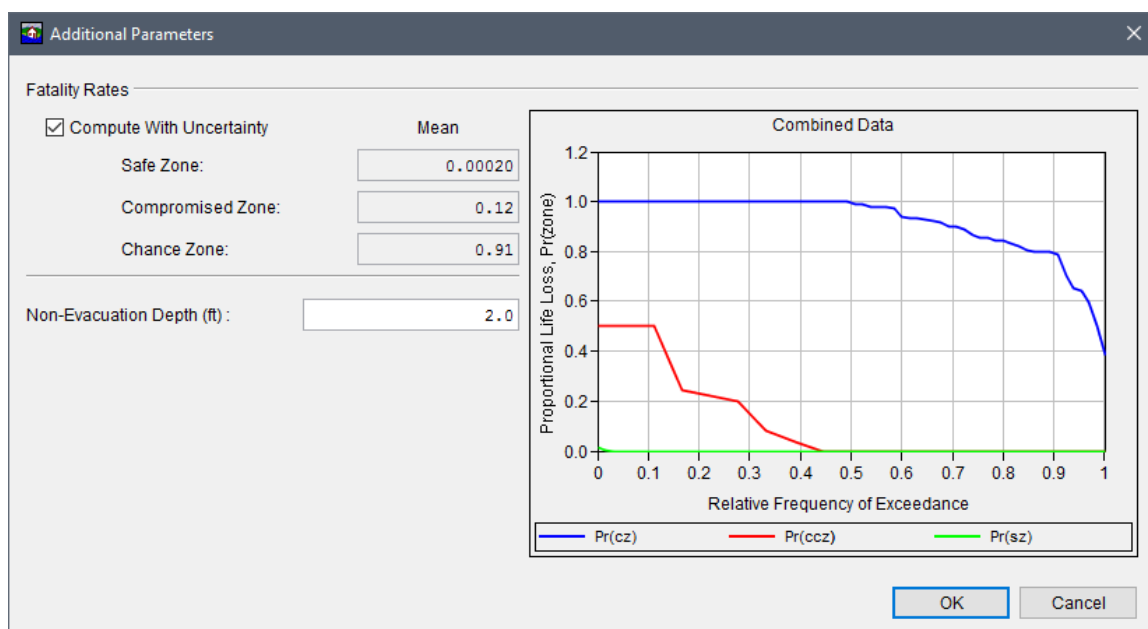
Figure 6.14 Additional Parameters Dialog Box

Fatality Rates

If the user wishes, uncertainty in the fatality rates can be turned on, by checking the ☑ checkbox to **Compute with Uncertainty** (Figure 6.14). However, the uncertainty (mean) for the following three zones, cannot be modified:

●   **Safe Zone – Pr(sz):** Zones which are typically dry, exposed to relatively quiescent floodwaters, or exposed to shallow flooding unlikely to sweep people off their feet. Depending on the nature of the flood, examples might include the second floor of residences and sheltered backwater regions. Fatality rate in Safe Zones is virtually zero and averages 0.02 percent.

●   **Compromised Zone – Pr(coz):**   Zones in which the available shelter has been severely damaged by the flood, increasing the exposure of flood victims to violent floodwaters. An example might be when the front of a house is torn away, exposing the rooms inside to

flooding. The historical fatality rate in Compromised Zones ranges from zero to about fifty percent, with an average rate near twelve percent.

- **Chance Zone – Pr(chz):** Zones in which flood victims are typically swept downstream or trapped underwater, and survival depends largely on chance; that is, the apparently random occurrence of floating debris that can be clung to, getting washed to shore, or otherwise finding refuge safely. The historical fatality rate in Chance Zones ranges from about thirty-eight percent to 100 percent, with an average rate over 91 percent.

Non-Evacuation Depth

In a gridded inundation configuration, the user can change the non-evacuation depth threshold from the default value of 2 feet. However, it is recommended that the threshold be set above the minimum foundation height of all structures in the structure inventory up to 3 feet. The user enters a value in the **Non-Evacuation Depth** box (Figure 6.14), remembering that the arrival time grids must be representative of the specified depth's arrival. In a hydrograph-based computation, the non-evacuation depth threshold is either 2 feet, or is retrieved for each structure from the foundation height of the structure, whichever value is greater. In other words, when the event depth is retrieved from a hydrograph then evacuation will not occur when the depth is greater than 2 feet or the structures foundation height if greater than 2 feet.

12.   Click **OK**, the **Additional Parameters** dialog box (Figure 6.14) will close. If finished defining or editing the life loss parameters for the emergency planning zones, click **OK**, and the **Emergency Planning Zone Editor** closes (Figure 6.8), and parameters for the life loss computation are set.

6.2.4   Population Adjustment

The population in each emergency planning zone (EPZ) can be indexed by the user. Adjustments to the population increase the number of people in each structure within the selected zone; this helps to describe future condition population. To adjust the population:

1.   From the **Study Tree**, from the **Geographic Data** folder, from the **Emergency Planning Zone** folder, right-click on a defined EPZ set (i.e., *Impact_Areas_EPZs*). Click **Edit**, from the shortcut menu (Figure 6.7); the **Emergency Planning Zone Editor** opens (Figure 6.8). From the **Emergency Planning Zone Editor** click the **Population Adjustment** tab (Figure 6.15).

2.   From the **Emergency Planning Zone Name**, select the zone of interest. In the **Population Adjustment** box (Figure 6.15), enter a value that adjusts the population. The values expected are decimal values expressed as a percentage relative to current population. A value of one would cause no change to the population, a value of 0.9 would be a ten percent reduction, and a value of 1.1 would be a ten percent increase.

3.   Click **OK**, the **Emergency Planning Zone Editor** closes (Figure 6.15). The population adjustment factor is set for the selected zone.

Figure 6.15 Emergency Planning Zone Editor – Population Adjustment Tab

6.2.5   Adjusted Price Index

Urban and agricultural price indexes in each emergency planning zone (EPZ) can be adjusted by the user to represent spatial price indexes for future conditions, to adjust prices:

1.   From the **Study Tree**, from the **Geographic Data** folder, from the **Emergency Planning Zone** folder, right-click on a defined EPZ set (i.e., *Impact_Areas_EPZs*). Click **Edit**, from the shortcut menu (Figure 6.7); the **Emergency Planning Zone Editor** opens (Figure 6.8). From the **Emergency Planning Zone Editor** click the **Adjusted Price Index** tab (Figure 6.16).

Figure 6.16 Emergency Planning Zone Editor – Adjusted Price Index Tab

2.   From the **Emergency Planning Zone Name**, select the zone of interest. To adjust the urban price index, from the **Urban Speficiations** box, in the **Base Data Year** box enter a year that represents the price index factor. In the **Price Index Factor** box enter the price index factor.

3.   To adjust the agricultural price index, from the **Agricultural Speficiations** box, in the **Base Data Year** box enter a year that represents the price index factor. In the **Price Index**

Factor box, enter the price index factor.

4.   Click **OK**, the **Emergency Planning Zone Editor** closes (Figure 6.16). The adjusted price factors are set for the selected zone.

CHAPTER 7

Inundation Data

Inundation data is required by HEC-FIA for computing consequences. Inundation data provides multiple ways to describe hydraulic characteristics within the study area. The user creates and defines inundation configurations which create a pattern for how the hydraulic characteristics are provided to the compute engine. In HEC-FIA a hydraulic event can be described in many ways, but the minimum requirement is that maximum depth is defined. The parameters that can be defined for an event are as follows:

- Maximum Depth
- Arrival Time (non-evacuation depth)
- Arrival Time (agriculture damage, typically zero depth)
- Duration (for agriculture threshold)
- Maximum Depth Times Velocity

Inundation configurations tell HEC-FIA how input hydraulic data are characterized throughout the floodplain. Five different types of inundation configurations are covered in this chapter:

- Common Computation Points only
- Cross Sections only
- Grids only
- Grids and Cross Sections
- Holdouts

Each configuration calculates hydraulic events differently; for more detail on the computational procedures and common issues consult the HEC-FIA Technical Reference Manual Chapter 3.

From an inundation configuration, the user can specify hydraulic events. Events are some combination of the previously described hydraulic event parameters. An event can be defined by an F-Part in a HEC-DSS file, or it could be a specific set of gridded data that describe the hydraulic event. One inundation configuration may have many events. Events are combined with time windows and alternatives to create simulations.

7.1   Creating New Inundation Configurations

To create new inundation configurations:

1. From the **Study Tree**, which is in the **Study Pane**, right-click on the **Inundation Data** folder. From the shortcut menu (Figure 7.1), click **New**; the **New Inundation Configuration** wizard opens (Figure 7.2).
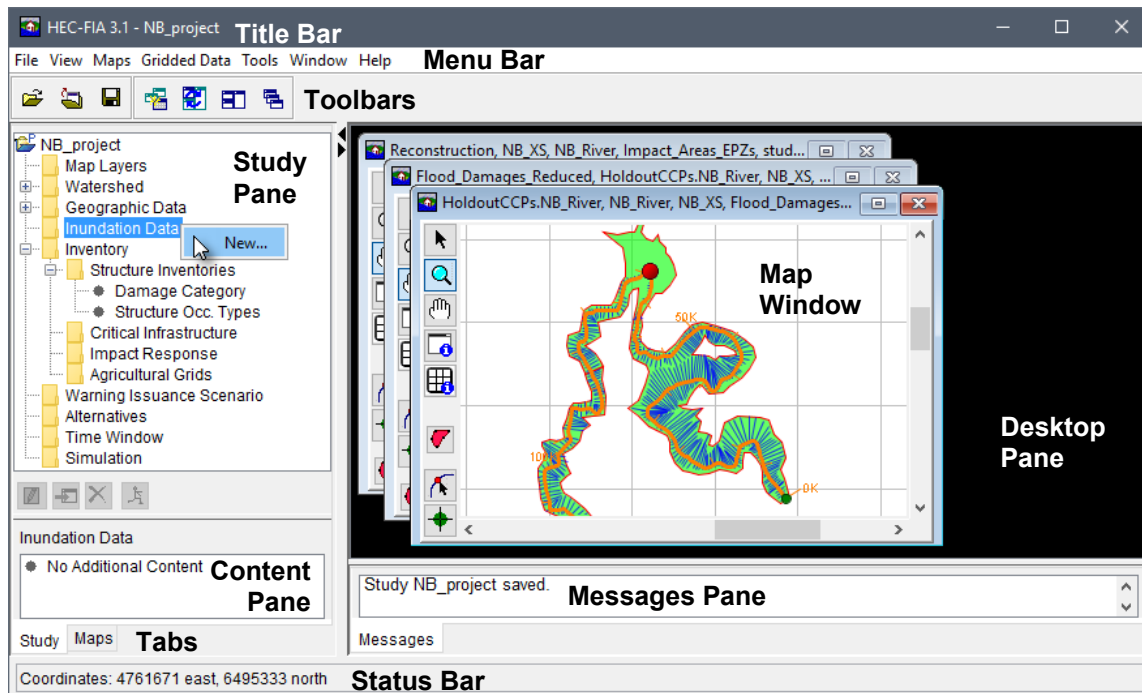
Figure 7.1 Inundation Data – Shortcut Menu Command

2. The first step in the **New Inundation Configuration** wizard (Figure 7.2) is to provide a name for the inundation configuration (**Name** box) and a description (**Description** box).

3. From the **Hydraulic Data Type** list (Figure 7.2), select the type of inundation configuration to create. Five types are available: **CCPs only**, **Cross Sections Only**, **Grids Only**, **Grids and Cross Sections**, and **Holdouts**. The holdouts hydraulic data type is a new option in HEC-FIA Version 3.1 for use with Flood Damages Reduced computes.
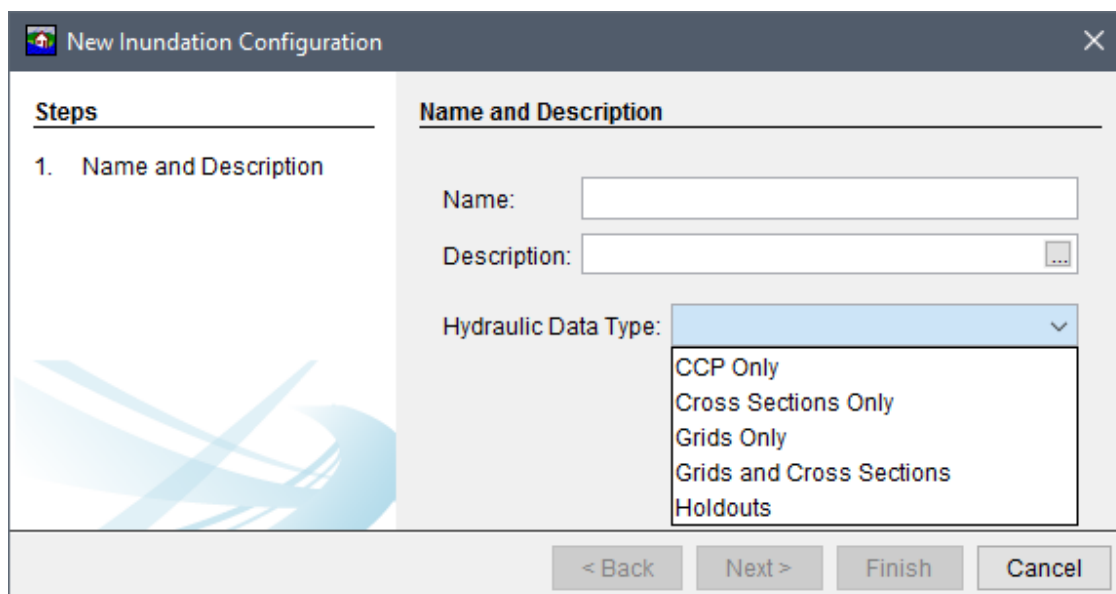
Figure 7.2 New Inundation Configuration Wizard – Step 1

4. Once a hydraulic data type is selected, the **New Inundation Configuration** wizard (Figure 7.2) asks for information specific to that hydraulic data type. The following sections describe the necessary steps and watershed configuration requirements for creating inundation configurations based on the type of hydraulic data used to describe the flood event(s).

7.1.1   CCP Only

CCP Only configurations are primarily used for setting up a simple watershed for evaluating a rough consequence analysis estimate. At minimum, to create a CCP only inundation configuration, the watershed configuration must contain a standard CCP set and a stream alignment. To create a **CCP Only** configuration:

1. From the **New Inundation Configuration Wizard** (Figure 7.2), enter a name in the **Name** box (e.g., *CCP_Only*). Enter a description in the **Description** box which is optional (but recommended). From the **Hydraulic Data Type** list, select **CCP Only** (Figure 7.3).

Figure 7.3 New Inundation Configuration Wizard – Step 1 – CCP Only

2. Click **Next**, the second page of the **New Inundation Configuration** wizard for **CCP Only** displays (Figure 7.4). From the **Watershed Configuration** list the user selects a defined watershed configuration. Note, the list only provides valid watershed configurations for the selected hydraulic data type. In the case of CCPs only, valid watershed configurations are those which contain (at minimum) a stream alignment and standard CCPs. The **Back** button returns the user to first page of the **New Inundation Configuration** wizard (Figure 7.4) for editing, if necessary.

3. Click **Finish**, the **New Inundation Configuration** wizard closes (Figure 7.4), and the new inundation configuration name (e.g., *CCP_Only*) appears under the **Inundation Data** folder on the **Study Tree**.
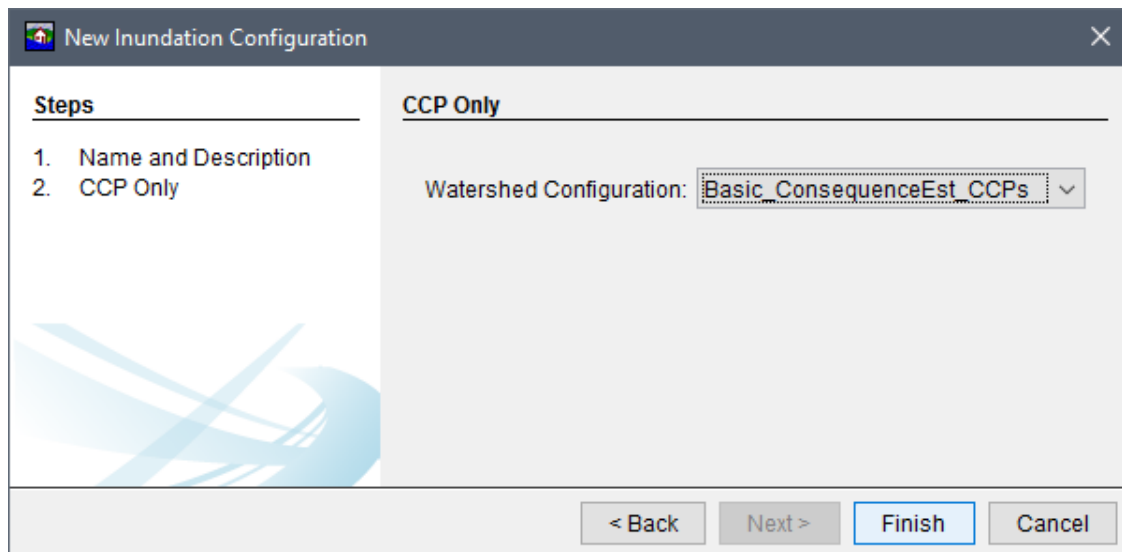
Figure 7.4 New Inundation Configuration Wizard – Step 2 – CCP Only

7.1.2   Cross Sections Only

Cross Sections Only configurations are typically used for a complex watershed for evaluating detailed consequence analysis estimates which can include all HEC-FIA estimate capabilities except Flood Damages Reduced (refer to Section 7.1.5). To create a cross sections only configuration a watershed configuration must contain a cross section set, a stream alignment and a terrain grid. Developing inundation configurations with cross section sets removes the need to have gridded data for each event, and relies on data out of a HEC-DSS file. Once the user has a watershed configuration setup created, the user can develop an inundation configuration and import events. To create a **Cross Sections Only** configuration:

1.   From the **New Inundation Configuration Wizard** (Figure 7.2), enter a name in the **Name** box (e.g., *CrossSectionsOnly*). Entering a description in the **Description** box is optional. From the **Hydraulic Data Type** list, select **Cross Sections Only** (Figure 7.5).
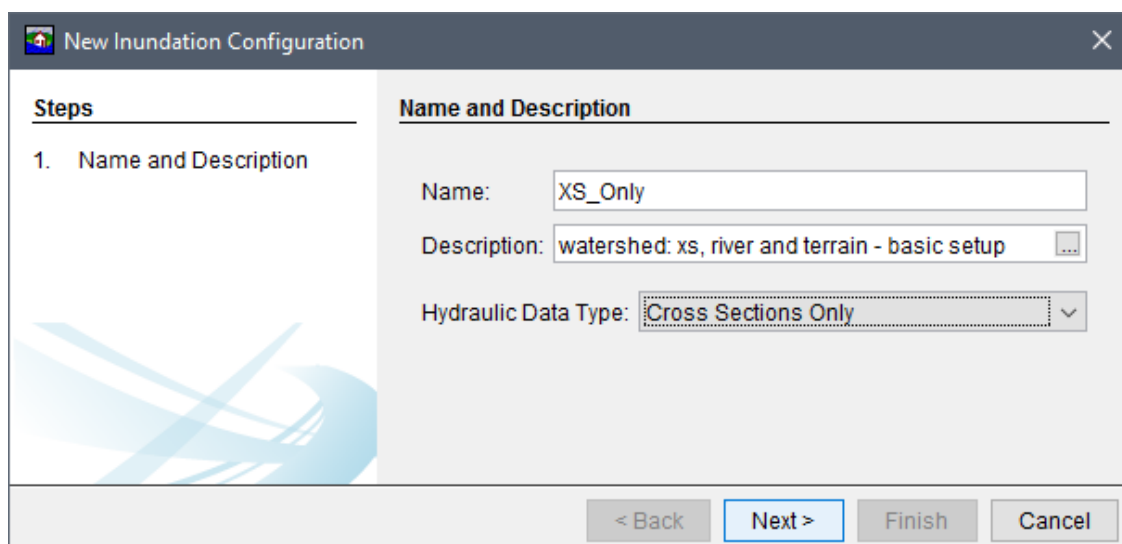
Figure 7.5 New Inundation Configuration Wizard – Step 1 – Cross Sections Only

2. Click **Next**, the second page of the **New Inundation Configuration** wizard for **Cross Sections Only** displays (Figure 7.6). From the **Watershed Configuration** list, the user selects a defined watershed configuration. Note, the list only provides valid watershed configurations for the selected hydraulic data type. In the case of cross sections only, valid watershed configurations are those which contain (at minimum) a stream alignment, a terrain grid and a cross section set. The **Back** button returns the user to first page of the **New Inundation Configuration** wizard (Figure 7.6) for editing, if necessary.
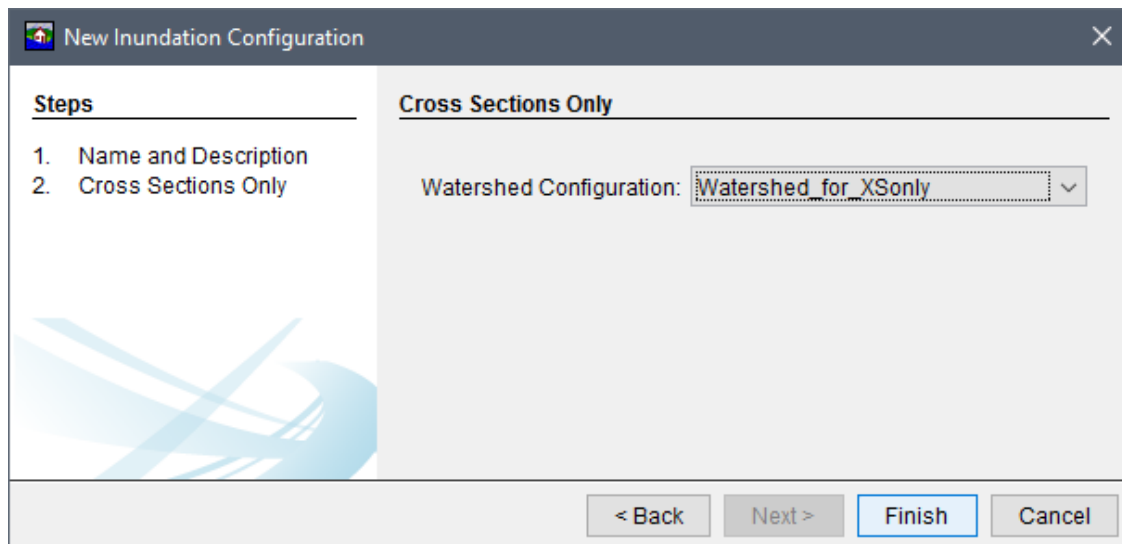
Figure 7.6 New Inundation Configuration Wizard – Step 2 – Cross Sections Only

3. Click **Finish**, the **New Inundation Configuration** wizard closes, and the new inundation configuration name (e.g., *XS_Only*) appears under the **Inundation Data** folder on the **Study Tree**.

7.1.3   Grids Only

Grids Only configurations are typically used for incorporating more complex hydraulics information (i.e., two-dimensional, 2D, gridded hydraulics) for evaluating detailed consequence analysis estimates which can include all HEC-FIA estimate capabilities except Flood Damages Reduced (refer to Section 7.1.5). However, the ability to use a grids only configuration depends on the hydraulic data included. For example, if a Reconstruction compute is desired then the user must provide hydraulic data that includes: arrival time, departure time, and the maximum depth of the flood. To create a grids only configuration a watershed configuration must (at minimum) contain a terrain grid. Once the user has a watershed configuration setup created, the user can develop an inundation configuration and import events. To create a **Grids Only** configuration:

1. From the **New Inundation Configuration Wizard** (Figure 7.2), enter a name in the **Name** box (e.g., *Grids_Only*). Entering a description is optional and is done in the **Description** box. From the **Hydraulic Data Type** list, select **Grids Only** (Figure 7.7).

2. Click **Next**, the second page of the **New Inundation Configuration** wizard for **Grids Only** displays (Figure 7.8). Select the types of grids that to be used (e.g., *Inundation Grid*,

Life Loss Arrival) by clicking on the appropriate grid type. Further, as noted in the wizard, for Reconstruction computes the required hydraulic data includes: arrival time, departure time, and the maximum depth of the flood. From the **Watershed Configuration** list, select a defined watershed configuration. Note, the list only provides valid watershed configurations for the selected hydraulic data type. The **Back** button returns the user to first page of the **New Inundation Configuration** wizard (Figure 7.7) for editing, if necessary.

Figure 7.7 New Inundation Configuration Wizard – Step 1 – Grids Only

Figure 7.8 New Inundation Configuration Wizard – Step 2 – Grids Only

3. Click **Finish**, the **New Inundation Configuration** wizard (Figure 7.8) closes and the new inundation configuration name (e.g., *Grids_Only*) appears under the **Inundation Data** folder on the **Study Tree**.

7.1.4   Grids and Cross Sections

The **Grids and Cross Sections** configuration allows users to use any grid combination to define the hydraulic event at a location, while still allowing the user to define warnings by evaluating a hydrograph at a cross section. The grids and cross sections configuration can be used for a complex watershed for evaluating detailed consequence analysis estimates which can include all HEC-FIA estimate capabilities except Flood Damages Reduced (refer to Section 7.1.5). However, the ability to use a grids and cross sections configuration depends on the hydraulic data included. For example, if a Reconstruction compute is desired then the user must provide hydraulic data (gridded or time series) that includes: arrival time, departure time, and the maximum depth of the flood. Note, gridded hydraulic data overrides times series information; for example, if a configuration is created using gridded maximum depth then HEC-FIA uses the hydrograph for the arrival time and event duration only. To create a **Grids and Cross Sections** configuration:

1. From the **New Inundation Configuration Wizard** (Figure 7.2), enter a name in the **Name** box (e.g., *Grids_and_XS*). Enter a description in the **Description** box is optional. From the **Hydraulic Data Type** list, select **Grids and Cross Sections** (Figure 7.9).

Figure 7.9 New Inundation Configuration Wizard – Step 1 – Grids and Cross Sections

2. Click **Next**, the second page of the **New Inundation Configuration** wizard for **Grids and Cross Sections** displays (Figure 7.10). The user selects which types of grids to be used (e.g., *Inundation Grid, Life Loss Arrival*). From the **Watershed Configuration** list, the user selects a defined watershed configuration. Note, the list only provides valid watershed configurations for the selected hydraulic data type. In the case of grids and cross sections, valid watershed configurations are those which contain (at minimum) a stream alignment, a terrain grid and a cross section set. The **Back** button returns the user to first page of the **New Inundation Configuration** wizard (Figure 7.9) for editing, if necessary.
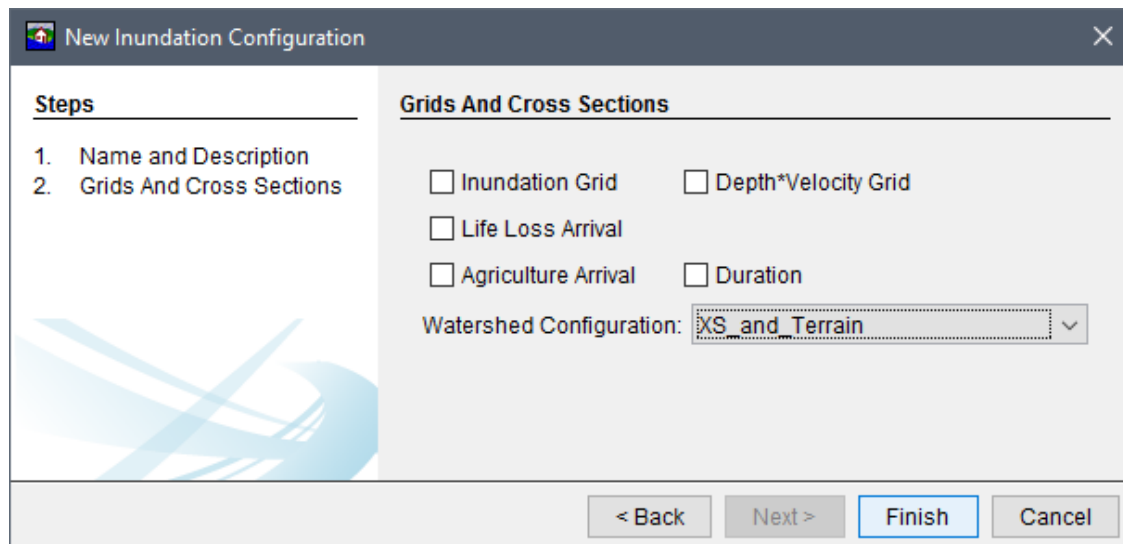
Figure 7.10 New Inundation Configuration Wizard – Step 2 – Grids and Cross Sections

3.   Click **Finish**, the **New Inundation Configuration** wizard closes and the new inundation configuration name (e.g., *Grids_and_XS*) appears under the **Inundation Data** folder on the **Study Tree**.

7.1.5   Holdouts

The **Holdouts** configuration allows users to complete only one type of impact analysis, Flood Damages Reduced. To create a holdouts configuration for a Flood Damages Reduced compute, at minimum the watershed configuration must contain a terrain grid, stream alignment, a cross section set, and elements representing at least one project (either storage areas with levees, or reservoirs with holdout CCPs). Once the user has a setup created, the user can develop an inundation configuration and import events. To create a **Holdouts** configuration:

1.   From the **New Inundation Configuration Wizard** (Figure 7.2), enter a name in the **Name** box (e.g., *FDRed_Holdouts*). Entering a description in the **Description** box is optional, but recommended. From the **Hydraulic Data Type** list, select **Holdouts** (Figure 7.11).

2.   Click **Next**, the second page of the **New Inundation Configuration** wizard for **Holdouts** displays (Figure 7.12). From the **Watershed Configuration** list the user selects a defined watershed configuration. Note, the list only provides valid watershed configurations for the selected hydraulic data type. In the case of Holdouts, valid watershed configurations are those which contain (at minimum) a terrain grid, a stream alignment and cross sections. The **Back** button returns the user to first page of the **New Inundation Configuration** wizard for editing, if necessary.

3.   Click **Finish**, the **New Inundation Configuration** wizard closes and the new inundation configuration name (e.g., *FDRed_Holdouts*) appears under the **Inundation Data** folder on the **Study Tree**.

Figure 7.11 New Inundation Configuration Wizard – Step 1 – Holdouts

Figure 7.12 New Inundation Configuration Wizard – Step 2 – Holdouts

7.2   Define Hydraulic Events

Once the inundation configuration is created, the hydraulic characteristics of an event must be defined. HEC-FIA accepts hydraulic data from HEC-DSS time-series and/or gridded files computed by a hydraulics model (e.g., HEC-HMS, HEC-RAS, HEC-ResSim, etc.). **Note:** Defining hydraulic events in HEC-FIA allows the user to map or set the path to the file but this step does not copy the file. Therefore, it is recommended to store HEC-DSS and/or gridded hydraulic data in the *shared* directory within the HEC-FIA study directory to ensure that the file(s) are stored with the project and shared between individuals.

7.2.1   Define HEC-DSS Time Series Events

When events are created using HEC-DSS files, HEC-FIA uses the watershed configuration that was associated with the inundation configuration to determine where the user has pre-defined output to be required. In a watershed configuration, the user has selected one or more of the following: a reservoir set, a cross section set, a storage area set, or a CCP set (standard of CCPs with holdout distribution areas).

During the import of those watershed elements, the user was required to define the mapping for A, B, and/or C parts for each element that was imported (review Chapter 5). HEC-FIA utilizes the A, B and C parts defined by the user at each location to compute a hydraulic event.

The user must select a HEC-DSS file path, and a computational output (E part) for inundation configurations (i.e., **CCP Only**, **Cross Sections Only**, and **Grids and Cross Sections**) which require mapping to **.dss* time series files. Further, the HEC-DSS file path must coordinate with the A, B, and C parts imported in the CCP, cross section, or storage area set used in the selected watershed configuration (step 2 of the **New Inundation Configuration** wizard, review Section 7.1). To define HEC-DSS time series events:

1. From the **Study Tree**, which is in the **Study Pane**, from the **Inundation Data** folder, right-click on the appropriate inundation configuration name. From the shortcut menu (Figure 7.13), click **Define Event**; a dialog box opens (based on the inundation configuration type).

2. For the **CCPs Only**, **Cross Sections Only** and **Grids and Cross Sections** inundation configurations, the **Define Event** dialog box opens (Figure 7.14). From the **Define Event** dialog box, from the **DSS File** box, click the ▢ button. The **Open** browser window opens for HEC-DSS files (Figure 7.15).

3. Navigate to an existing HEC-DSS dataset (**.dss*) for the hydraulic event of interest, select the HEC-DSS filename (e.g., *LeveeSimulation.dss*) and click **Open**. The **Open** browser window closes, and the path to the selected HEC-DSS file populates in the **Define Event** dialog box, in the **DSS File** box (Figure 7.14). In general, it is recommended to store HEC-DSS (and/or gridded) inundation data files in the *shared* HEC-FIA study directory.
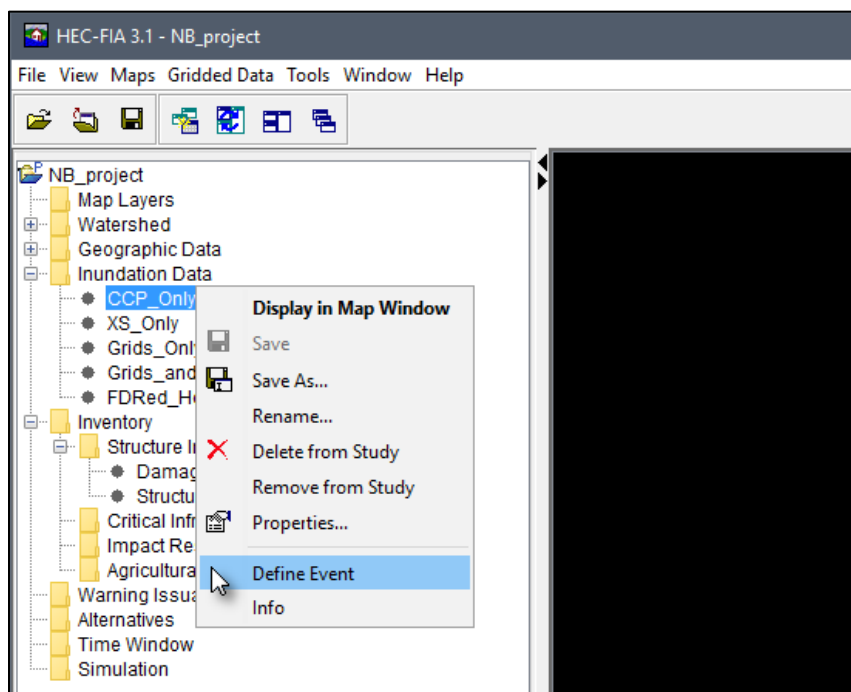
Figure 7.13 Inundation Data – Configuration Shortcut Commands
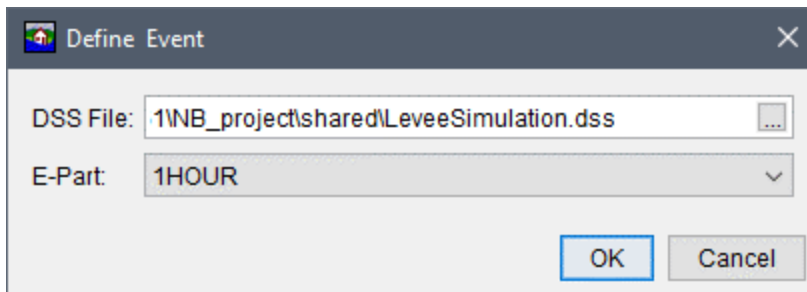
Figure 7.14 Define Event Dialog Box – HEC-DSS Time Series
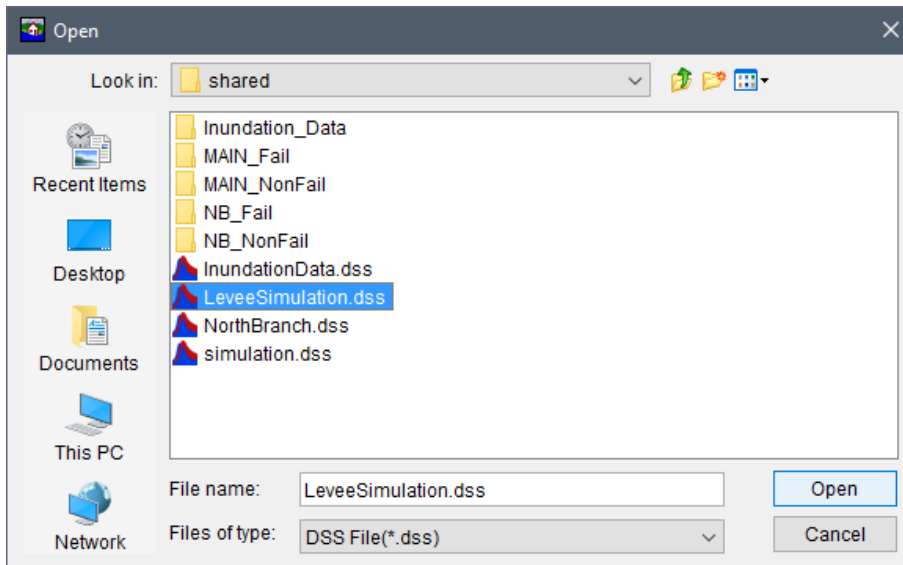
Figure 7.15 Open Browser Window – Select HEC-DSS File

4. Select the correct HEC-DSS time step for the hydraulic data, from the **E-Part** list (which expresses the output time step of the regular time series records; available types are MIN, 15 MIN, 30 MIN or 1 HOUR).

5. Click **OK**, the **Define Event** dialog box (Figure 7.14) closes and the defined event(s) display in the **Study Tree** below the selected inundation configuration. If the incorrect HEC-DSS record was linked then the user can repeat the above steps to set the path to the correct HEC-DSS file.

For **Cross Sections Only** and for **Grids And Cross Sections** inundation configurations the linked HEC-DSS time series data can be checked for missing data. To check if all of the connections are set up correctly for the HEC-DSS file path specified:

1. From the **Study Tree**, from the **Inundation Data** folder, from the inundation configuration name folder, right-click on the event (the F part) of interest (e.g., *NB_FAILED*); from the shortcut menu click **Check for missing data** (Figure 7.16). The **Missing DSS Data** dialog box opens (Figure 7.17).
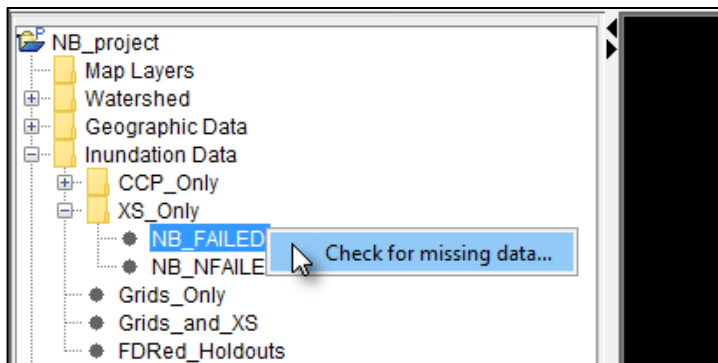
Figure 7.16 DSS Time Series Files – Check for missing data
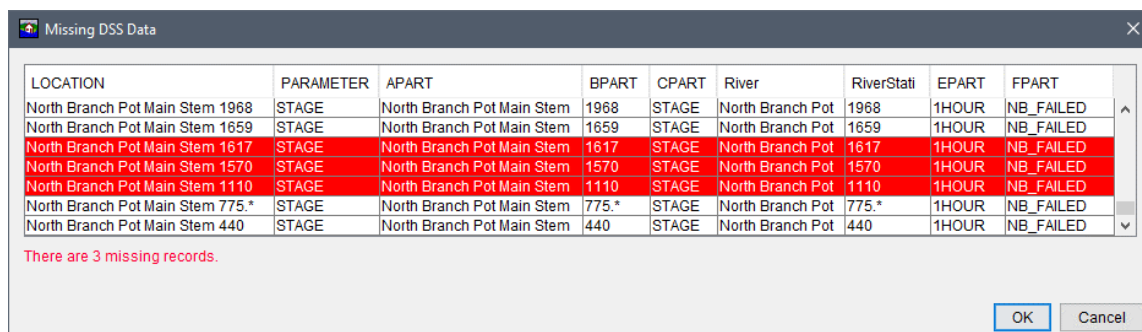
Figure 7.17 Missing DSS Data Dialog Box – Example

2. If an invalid path is found, the cross section, or CCP is highlighted in red. If this occurs, the user should look at the A, B, and C parts imported with the cross section or CCP set, and verify that pathname parts exist in the HEC-DSS path submitted for these events. If the pathname parts do not exist, it is possible that the pathname parts were not in the final HEC-RAS or HEC-ResSim model that produced the HEC-DSS output, or a naming convention issue in the shapefile that defined the pathname parts exists.

7.2.2   Define Gridded Hydraulic Events

Grids can be used to define hydraulic characteristics throughout a study area. The six hydraulic characteristics that can be represented by grids are maximum depth, maximum instantaneous depth-times-velocity, arrival time for life loss calculations, arrival time for agricultural calculations, and flood duration for agricultural calculations. Structures will be assigned hydraulic characteristics based on the value of the grid cell for each grid in which the structure point is contained.

Hydraulic gridded datasets can be imported into HEC-FIA in many formats, including GeoTiff (**.tif*), ASCII grid (**.asc*), floating point binary (**.flt*), Segmented Multi-Resolution Multi-Parameter (**.smrmp*), and virtual (**.vrt*) format. The GeoTiff (**.tif*) format is recommended for a more efficient operation of HEC-FIA once the file has been imported.

For the **Grids Only** inundation configuration only the following steps are required; however, for **Grids and Cross Sections** the user must first complete the steps in Section 7.2.1, prior to completing the steps described below.

For **Grids Only**:

1. From the **Study Tree**, which is in the **Study Pane**, from the **Inundation Data** folder, right-click on the appropriate inundation configuration name (e.g., *Grids_Only*). From the shortcut menu (Figure 7.13), click **Define Event**; the **Grids Only Event** dialog box opens (Figure 7.18).
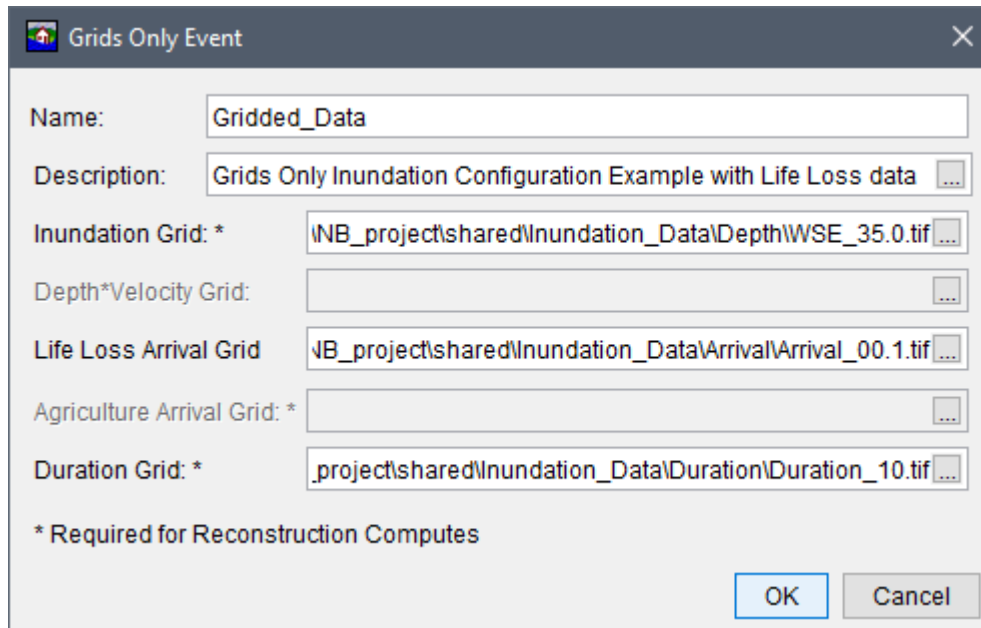
Figure 7.18 Grids Only Event Dialog Box – Example

2. From the **Grids Only Event** dialog box enter a name for the event in the **Name** box and provide a description in the **Description** box (Figure 7.18).

3. Depending on which grid types were selected for the **Grids Only** inundation configuration, a path to a grid for each grid type required. Be sure that all event grids come from the same HEC-RAS plan, or hydraulic model output. From an empty grid type box (e.g., **Inundation Grid**), click the ⬚ button. The **Open** browser window opens for selecting gridded files (Figure 7.19).

4. Navigate to an existing gridded dataset (**.tif, *.asc, *.flt, *.smrmp,* or **.vrt*) for the hydraulic event of interest, select the filename and click **Open**. The **Open** browser window closes (Figure 7.19), and the path to the selected gridded file populates in the **Grids Only Event** dialog box (Figure 7.18). In general, it is recommended to store gridded (and/or HEC-DSS) inundation data files in the *shared* HEC-FIA study directory.

5. Click **OK**, the **Grids Only Event** dialog box (Figure 7.18) closes and the defined event displays in the **Study Tree** below the selected **Grids Only** inundation configuration.
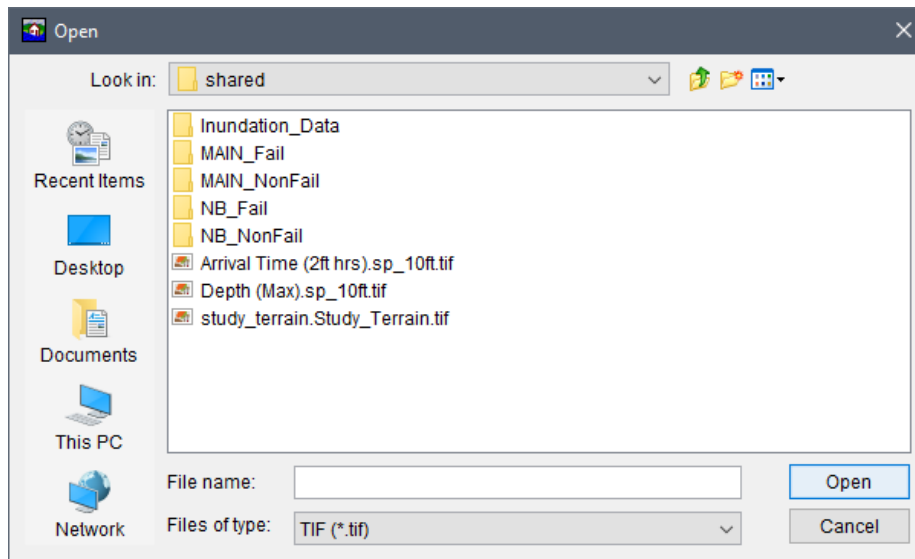
Figure 7.19 Open Browser Window – Select Gridded File

For **Grids and Cross Sections**:

1. Once the defined HEC-DSS time series event(s) is completed (review Section 7.2.1), from the **Study Tree**, from the **Inundation Data** folder, from the grids and cross sections inundation folder (e.g., *Grids_and_XS*), right-click on the appropriate event name (e.g., *NB_NOTFAILED*). From the event's shortcut menu (Figure 7.20), click **Edit**; and the **Grids and Cross Sections Event** dialog box opens (Figure 7.21).

2. From the **Grids and Cross Sections Event** dialog box enter a name for the event in the **Name** box and provide a description in the **Description** box (Figure 7.21).
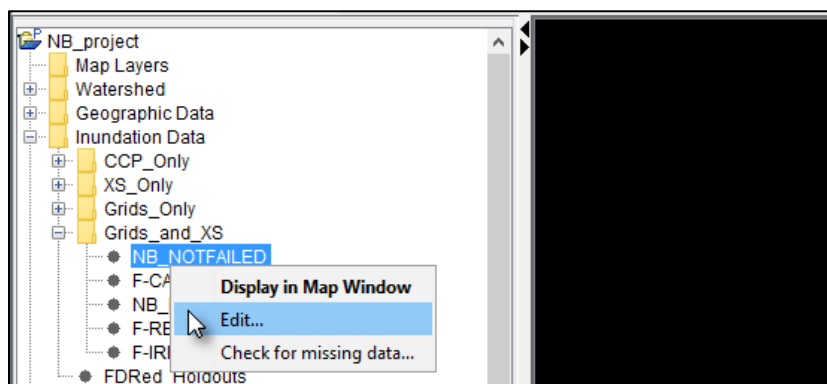
Figure 7.20 Grids and Cross Sections – Edit Event Shortcut Command

3. Depending on which grid types were selected for the **Grids and Cross Sections** inundation configuration a path to a grid for each grid type is required. Be sure that all event grids come from the same HEC-RAS plan, or hydraulic model output. From an enabled empty grid type box (e.g., **Inundation Grid**), click the [...] button.
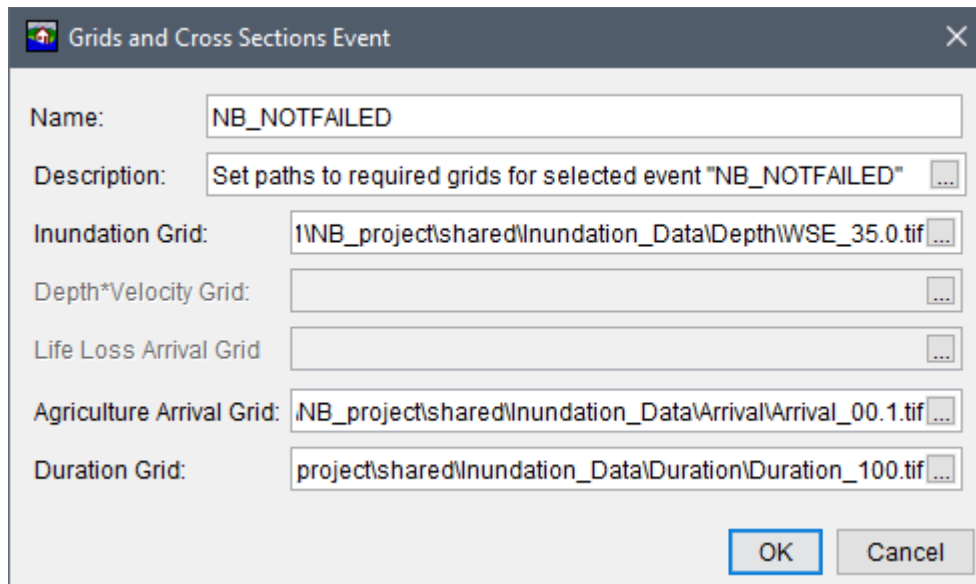
Figure 7.21 Grids and Cross Sections Event – Example

4. The **Open** browser window opens for selecting gridded files (Figure 7.19). Navigate to an existing gridded dataset (**.tif*, **.asc*, **.flt*, **.smrmp*, or **.vrt*) for the hydraulic event of interest, select the filename and click **Open**. The **Open** browser window closes (Figure 7.19), and the path to the selected gridded file populates in the **Grids and Cross Sections Event** dialog box (Figure 7.21). In general, it is recommended to store gridded (and/or HEC-DSS) inundation data files in the *shared* HEC-FIA study directory.

5. Click **OK**, the **Grids and Cross Sections Event** dialog box (Figure 7.21) closes.

6. Repeat Steps 1 through 5 until all HEC-DSS time series created events have the correct file paths to the gridded data specified from the **Grids and Cross Sections Event** dialog box.

7.2.3   Define Holdout Events

Holdout inundation configurations are used for setting up a watershed for computing Flood Damages Reduced. The Flood Damages Reduced compute requires the evaluation of stage throughout the entire study area for each event. To accommodate this evaluation requirement, the HEC-RAS software is required to convert the HEC-ResSim regulated and unregulated output flows to stages for HEC-FIA. Therefore, the **Holdout** inundation configuration is designed to link HEC-RAS output HEC-DSS time series files for at least one project (either storage areas with levees, or reservoirs with holdout CCPs). In other words, the HEC-RAS time series could be for a project with levees, a project with reservoirs (with converted HEC-ResSim regulated and unregulated flows to stages) or a project with both levees and reservoirs.

Additionally, if the **Holdout** inundation configuration is intended to include reservoirs, then there is an option to use HEC-ResSim calculated holdout HEC-DSS time series for a project with reservoirs. **NOTE:** To use this option the user must have associated a watershed configuration

which contains a reservoir set and a holdout CCPs set (review Chapter 5); otherwise, the option to use and set the path to the HEC-ResSim holdout HEC-DSS time series is inaccessible. HEC-FIA provides an additional option to enter holdout distributions in an override table (from the **New Alternative** dialog box as discussed in Chapter 10, Section 10.2.7) when including reservoirs for a flood damages reduced project when HEC-ResSim *.dss* data is not available. However, users can still use the holdout distributions override table even if the selected holdout configuration is linked to an HEC-ResSim HEC-DSS time series.

To define **Holdout** events:

1. From the **Study Tree**, from the **Inundation Data** folder, right-click on the appropriate inundation configuration name. From the shortcut menu (Figure 7.13), click **Define Event**; and the **Holdout Event** dialog box opens (Figure 7.22).

2. From the **Holdout Event** dialog box enter a name for the event in the **Event Name** box (Figure 7.22). Below the **Event Name** box there are two panels. From the top panel the user must select a HEC-DSS file path, and a computational output (E and F parts) for mapping the configuration to *.dss* time series output from HEC-RAS. From the bottom panel the user has the option link holdout HEC-DSS time series output from HEC-ResSim.
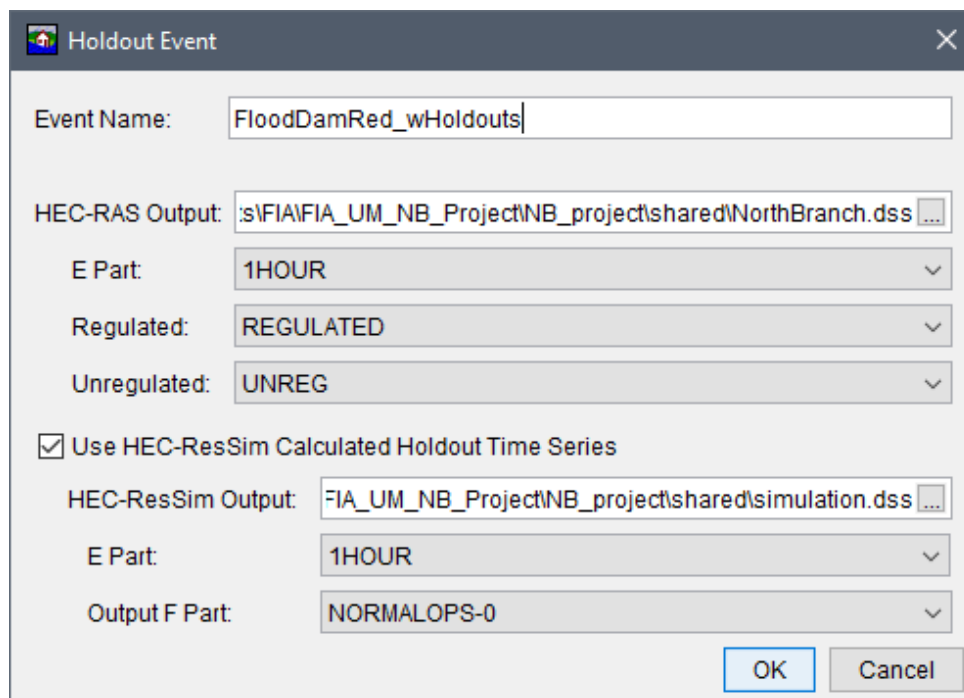
Figure 7.22 Holdout Event Dialog Box – Example

3. From the top panel of the **Holdout Event** dialog box, from the **HEC-RAS Output** box, click the ⬚ button. The **Open** browser window opens for HEC-DSS files (Figure 7.15). Navigate to an existing HEC-RAS output HEC-DSS dataset (*.dss*) for the hydraulic event of interest, select the HEC-DSS filename (e.g., *NorthBranch.dss*) and click **Open**. The **Open** browser window closes, and the path to the selected HEC-DSS file populates in the **Holdout Event** dialog box, in the **HEC-RAS Output** box (Figure 7.22). In general, it is

recommended to store HEC-DSS (and/or gridded) inundation data files in the *shared* HEC-FIA study directory.

4. Next, use the dropdown lists to complete the mapping to the linked *.dss* file by selecting the correct **E Part**, **Regulated** and **Unregulated** HEC-DSS identifier. From the **E Part** list select the correct *.dss* time step for the regular time series hydraulic data (available output types are MIN, 15 MIN, 30 MIN or 1 HOUR). From the **Regulated**, and **Unregulated** lists select the appropriate F part identifiers.

5. If the user desires to link holdout *.dss* time series output from HEC-ResSim, then from the bottom panel of the **Holdout Event** dialog box, check the **Use HEC-ResSim Calculated Holdout Time Series** checkbox ☑ (disabled, by default). If this option is not desired, then skip to Step 7.

    Selecting the checkbox enables the user to select a HEC-DSS file path and the computational output (E and F parts) for the HEC-ResSim holdout time series. From the **HEC-ResSim Output** box, click the ⊡ button, and the **Open** browser window for HEC-DSS files opens (Figure 7.15). From the **Open** browser window, navigate to an existing *.dss* dataset for the HEC-ResSim calculated holdout time series, select the HEC-DSS filename (e.g., *simulation.dss*) and click **Open**. The **Open** browser window closes, and the path to the selected *.dss* file populates in the **Holdout Event** dialog box, in the **HEC-ResSim Output** box (Figure 7.22).

6. Next, use the dropdown lists to complete the mapping to the linked *.dss* file by selecting the correct **E Part** and **Output F Part** HEC-DSS identifiers. From the **E Part** list, select the correct *.dss* time step for the hydraulic data. From the **Output F Part** list select the appropriate HEC-ResSim F part identifier.

7. Click **OK**, the **Holdout Event** dialog box (Figure 7.22) closes.

CHAPTER 8

Inventory Data

In HEC-FIA inventory data represents geospatial points or grids that represent damageable elements. HEC-FIA supports the evaluation of the following damageable elements:

- Structure Damages
- Structure Content Damages
- Vehicle Damages
- Agricultural Damages
- Direct Economic Damages (from ECAM model)
- Critical Infrastructure Impacts
- Loss of Life Estimations

In order to estimate damages for the elements listed above, specific key parameters must be defined. Such key parameters include the location of the element and its susceptibility to damage by the linked hydraulic event (review Chapter 7). This chapter provides instructions for importing and configuring the commonly used damageable elements in HEC-FIA.

8.1   Structure Inventories

As is mentioned above a damageable element is required to estimate flood damages or impacts in HEC-FIA. A variety of types of elements associated with HEC-FIA structure inventories are discussed below. In some cases the inventory must be augmented with additional information. For instance, to estimate loss of life risks the structure inventory must be supplied with population estimates.

Structure inventories are often generated specifically for a project. HEC-FIA supports the import Instructions for importing local parcel or point shapefiles is provides in Section 8.2. However, if no local structure inventory is readily available, users can access National Structure Inventory (NSI) database. HEC recommends that USACE users create structure inventories from the NSI database, as this source requires less GIS pre-processing and provides a valuable starting point for FIA modeling.

The NSI's database can be accessed <http://www.hec.usace.army.mil/fwlink/?linkid=7>, but only if the user is connected to the internet behind the USACE firewall.

8.2   Create a Structure Inventory

Structure inventories can be imported from a parcel shapefile or a point based shapefile. To create a structure inventory:

1. From the **Study Tree**, which is in the **Study Pane**, from **Inventory** folder, right-click on **Structure Inventories**. From the shortcut menu, point to **Generate From** and the submenu opens providing commands to import structure inventories (Figure 8.1).

2. In HEC-FIA, two options are available for creating a structures inventory – parcel shapefile, or point shapefile. The following sections describe each option for creating a structure inventory in HEC-FIA, which are accessed from the **Structure Inventories** shortcut submenu (Figure 8.1).
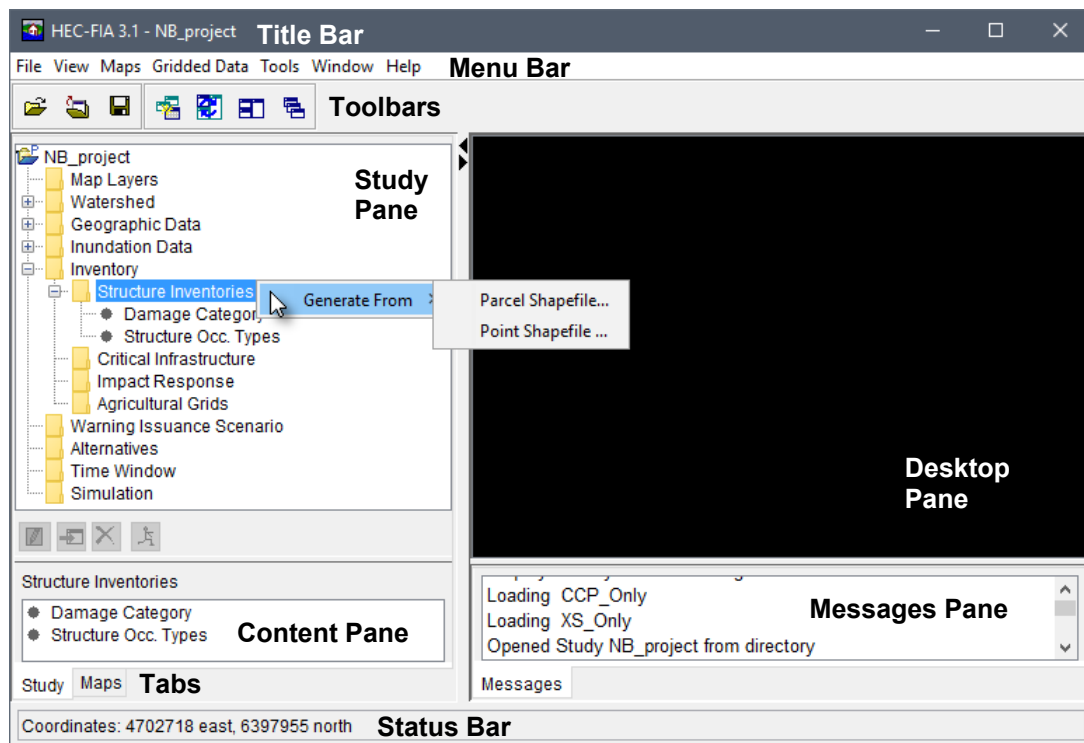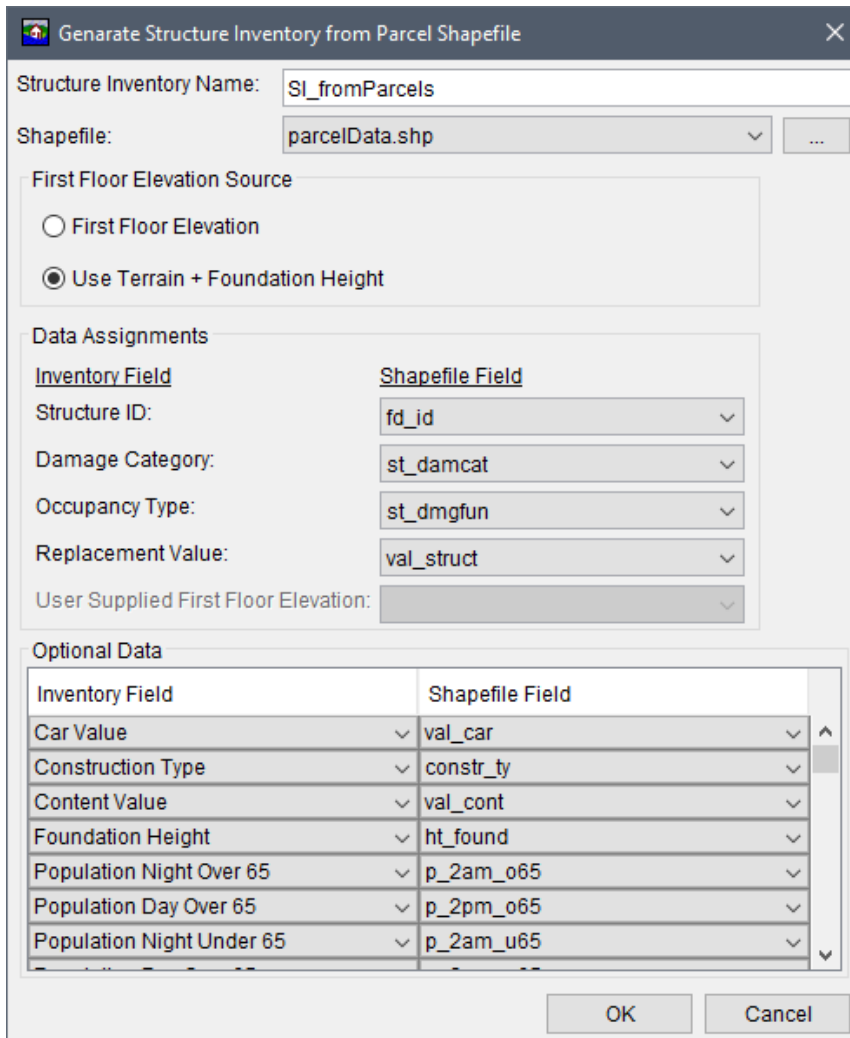
Figure 8.1 HEC-FIA Main Window – Structure Inventories – Shortcut Menu Commands

8.2.1   Generate Structures from a Parcel Shapefile

To import a structure inventory from a parcel shapefile, the requirements are the same as the point shapefile import. The only difference is that HEC-FIA calculates a centroid (center point) for each parcel record during the parcel shapefile import process; this center point is the defined location for each structure. To import from a parcel shapefile:

1. From the **Study Tree**, from the **Inventory** folder, right-click on **Structure Inventories**. From the shortcut menu (Figure 8.1), point to **Generate From**, and click **Parcel Shapefile**. The **Generate Structure Inventory from Parcel Shapefile** dialog box opens (Figure 8.2).

2. Enter a unique name for the structure inventory in the **Structure Inventory Name** text box (e.g., *SI_fromParcels* in Figure 8.2).

3. The **Shapefile** box lists the available shapefiles that have been added as map layers. If a map layer that represents the parcel structure inventory has not been added to the HEC-FIA project, click the ⬚ button. The **Open** browser window opens (Figure 8.3). Browse to the location of the shapefile that represents the parcel structure inventory shapefile (**.shp*), select the filename, and click **Open**. The **Open** browser window closes, and the **Shapefile** box lists the selected file (Figure 8.2).

4. Next, enter all of the information required to create a structure inventory from the parcel shapefile selected from the **Shapefile** list (e.g., *parcelData.shp*). Note, the Shapefile Field lists populate with the field names contained in the selected parcel shapefile.

Figure 8.2 Generate Structure Inventory from Parcel Shapefile Dialog Box – Example

From the **First Floor Elevation Source** panel, select the radio ⦿ button for either **First Floor Elevation**, or **Use Terrain + Foundation Height** (default selection) to set the elevation of the first floor for all structures in the inventory. If the **First Floor Elevation** option is clicked then the user must select the Shapefile Field from the **Data Assignments** panel. Alternatively, if the **Use Terrain + Foundation Height** option is selected then the user may select the Shapefile Field that represents the foundation height attribute

information from the **Optional Data** panel to define unique foundation heights for each structure. Note, the user may also add or edit the foundation height for individual structures or for structures within an occupancy type (refer to Section 8.3.1, for editing by structure; or Section 8.6.1, for editing by occupancy type).
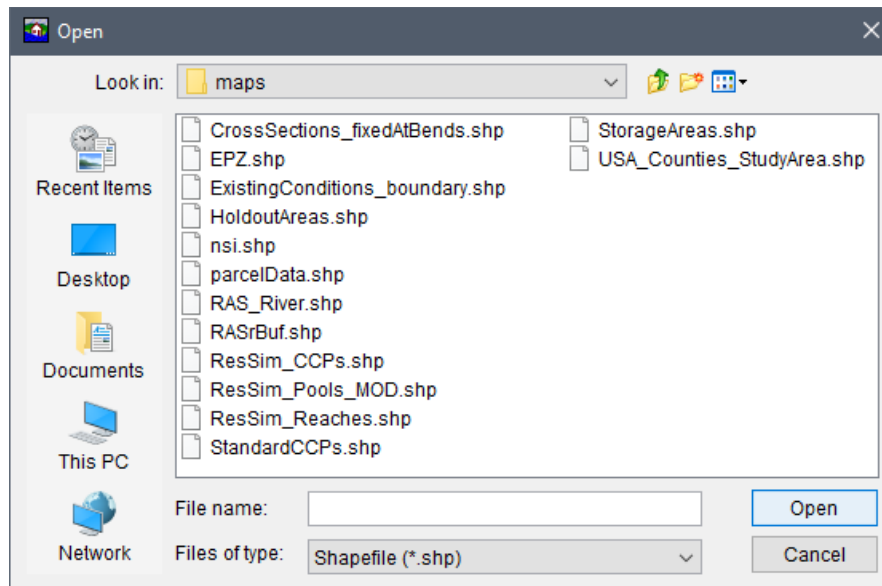
Figure 8.3 Open Browser Window – Open Parcel Structure Inventory Shapefile

From the **Data Assignments** panel, from the <u>Shapefile Field</u> lists, select the field which represents the <u>Inventory Field</u> attributes. For example, in Figure 8.2, for the **Replacement Value** the selected shapefile field name (e.g., *val_struct*) represents the structure value attribute in the selected parcel shapefile.

From the **Optional Data** panel, the user can select any field from the <u>Shapefile Field</u> list (e.g., *ht_found*) that corresponds to a field selected from the available <u>Inventory Field</u> list (i.e., *Foundation Height*).

5. Once all of the parcel structure information is entered, click **OK**, and the **Generate Structure Inventory from Parcel Shapefile** dialog box closes (Figure 8.2). A **Progress** message dialog opens providing the user with information on the importing of the structures.

6. Once the import is finished, the **Progress** message dialog closes, under the **Structure Inventories** folder in the **Study Tree** the new structure inventory name (e.g., *SI_fromParcels*) appears.

8.2.2   Generate Structures from a Point Shapefile

Users can create structure inventories using external software and import the inventory as a point structure inventory. A few required and optional fields are imported during creation of such an inventory. To generate a structure inventory using a point structure inventory (a point shapefile must be loaded for the HEC-FIA project):

1. From the **Study Tree**, from the **Inventory** folder, right-click on **Structure Inventories**. From the shortcut menu (Figure 8.1), point to **Generate From**, click **Point Shapefile**. The **Generate Structure Inventory from Point Shapefile** dialog box opens (Figure 8.4).

Figure 8.4 Generate Structure Inventory from Point Shapefile Dialog Box – Example

2. Enter a unique name for the structure inventory in the **Structure Inventory Name** text box (Figure 8.4).

3. The **Shapefile** box lists the available shapefiles that have been added as map layers. If a map layer that represents the point structure inventory has not been added to the HEC-FIA project, click the ⸱⸱⸱ button. The **Open** browser window opens (Figure 8.3). Browse to the location of the shapefile that represents the point structure inventory shapefile (**.shp*), select the filename, and click **Open**. The **Open** browser window closes, and the **Shapefile** box lists the selected file.

4. Next, enter all of the information required to create a structure inventory from the point shapefile selected from the **Shapefile** list. Note, the <u>Shapefile Field</u> lists populate with the

field names contained in the selected point shapefile. As explained in Step 4 of Section 8.2.1, the required fields that must be completed (from the **First Floor Elevation Source** and **Data Assignments** panels) are the source of the first floor elevation, the unique name of each structure, a damage category, an occupancy type, and the value of the structure. Further, from the **Optional Data** panel, the user can select any field from the lists provided; of particular note are the population fields and the number of stories, since those are used in the life loss compute process.

5.   Click **OK**, the **Generate Structure Inventory from Point Shapefile** dialog box closes. A **Progress** message dialog opens providing the user with a green import progress bar.

6.   Once the import is finished, the **Progress** message dialog closes, and under the **Structure Inventories** folder in the **Study Tree** the new structure inventory name appears.

8.3   Structure Inventory Shortcut Menu

Once a structure inventory has been created there are several ways to manipulate the inventory. From the **Study Tree**, from the **Inventory** folder, from the **Structure Inventories** folder, right-click on an imported structure inventory name (e.g., *NB_BaseNSI* in Figure 8.5). From the shortcut menu (Figure 8.5) the user may: display/remove the structure inventory from the active map window; edit the structure inventory; import additional structures; delete all structures; export structures to a shapefile; import population data; save as, rename, delete and/or remove the structure inventory from the study; and review properties of the structure inventory file.
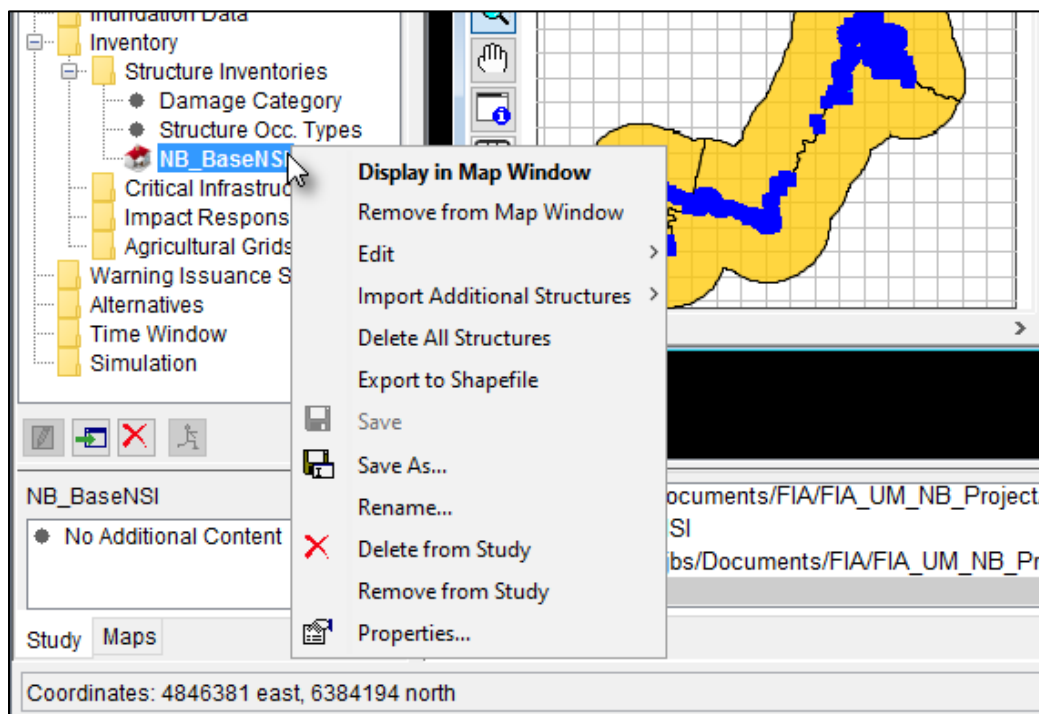
Figure 8.5 Structure Inventory – Study Tree – Shortcut Menu Options

8.3.1   Structure Inventory – Form Editor

From HEC-FIA the user may edit the structure inventory from the **Structure Editor** (table view), or from the **Structure Editor** (form view) on a structure by structure basis. From the structure inventory shortcut menu (Figure 8.5), point to **Edit**, click **Form Editor**, the **Structure Editor – {*Name of Structure Inventory*} (Form)** opens (Figure 8.6). Note: Click the **Apply** button to save changes and continue editing, or click **OK** to save changes and close the editor.

Figure 8.6 Structure Editor – Location Tab

Navigation Bar

A navigation bar is provided within the **Structure Editor (Form)** (Figure 8.7). The navigation bar allows users to move quickly between multiple structures.

Figure 8.7 Navigation Bar – Options

The navigation bar includes a list, which allows users to select a specific structure by **Name** (e.g., *RES1-2SNB 24001 00015389* in Figure 8.6). Alternatively, users can navigate through the list of structures by clicking the navigation buttons. Note, the text at the center of the navigation buttons (e.g., *1 of 5678* in Figure 8.7) indicates the total number of records in the list (e.g., *5678* total number of structures) and the structure currently being accessed (e.g., *1*, or the first structure in the alphabetized list). From left to right the navigator buttons are:

- **First Record** ⏮ button – moves directly to the top structure in the list.

- **Last Record** ⏭ button – moves directly to the bottom structure in the list.

- **Previous Record** ◀ button – moves forward through the list one structure at a time.

- **Next Record** ▶ button – moves backward through the list one structure at a time.

Location Tab

The **Structure Editor (Form)** automatically opens to the **Location** tab (Figure 8.6). This tab is informational only, and provides the user with the location of the structure, its ground elevation, and the coordinates of the structure. As the text at the bottom of the **Location** tab indicates, the user can determine the stream, stream station number, and ground elevation by selecting a **Watershed Configuration** from the list (e.g., *Reconstruction* in Figure 8.6) of created configurations and clicking the **Preview** button.

Classification Tab

From the **Classification** tab (Figure 8.8) of the **Structure Editor (Form)**, the user can view and/or edit the damage category, structure occupancy type, and the depth-damage functions (for the structure, content, other, and/or car) that have been assigned to the selected structure (e.g.,
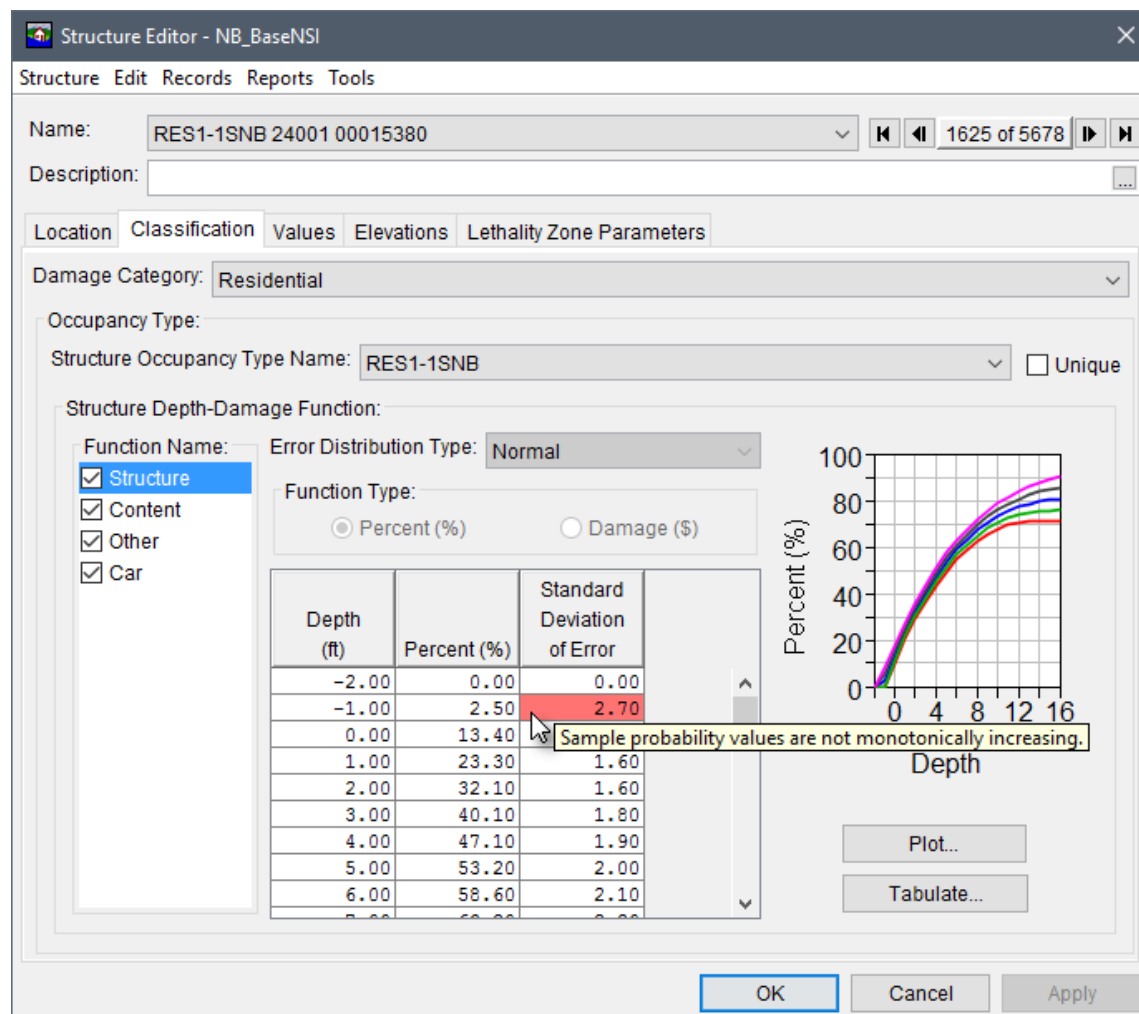
Figure 8.8 Structure Editor (Form) – Classification Tab

RES1-2SNB 24001 00015380 in Figure 8.8). To enter/modify depth-damage function curves, from the **Function Name** box, select the function of interest (e.g., ***Structure*** in Figure 8.8), and enter the values in the table. The provided depth-damage graph updates automatically. **Note:** If any depth-damage function values have associated errors then the value in error will be highlighted in red; further, if the user hovers over the highlighted error, a tooltip will appear providing an explanation (Figure 8.8).

Values Tab

From the **Values** tab (Figure 8.9) of the **Structure Editor (Form)**, for the selected structure (e.g., *RES1-2SNB 24001 00015380*) the user can view the structure/content/other/car values, the year the structure was put in service, number of stories the structure has, the number of cars at the structure and the number of people that can fit into the cars. From the **Values** tab, the user can also enter information about the people that use the structure such as the number of people at the structure at 2AM and 2PM. All other times of the day are interpolated between those two times and cannot be edited.
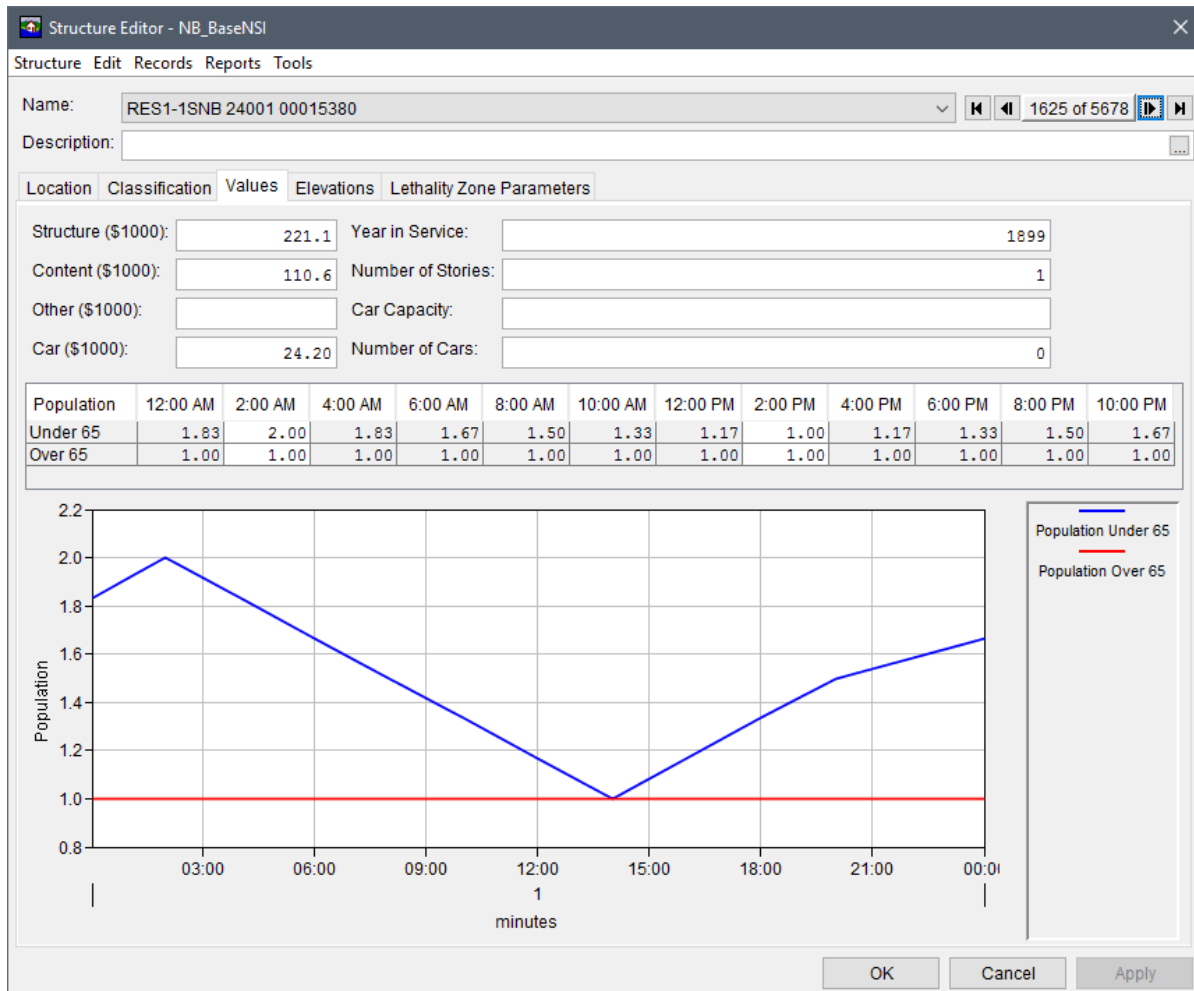
Figure 8.9 Structure Editor (Form) – Values Tab

Elevations Tab

From the **Elevations** tab (Figure 8.10) of the **Structure Editor (Form)**, users can view elevation information concerning a selected structure (e.g., *RES1-2SNB 24001 00015380*). The **First Floor Elevation** and the **Foundation Height** can be changed. The **Ground Elevation** is computed by HEC-FIA and is not editable. To select either the **First Floor Elevation** or the **Foundation Height** and click the radio ⦿ button next to the desired option; and enter the value in the box provided (in feet).

Figure 8.10 Structure Editor (Form) – Elevations Tab

Lethality Zone Parameters Tab

From the **Lethality Zone Parameters** tab (Figure 8.11) of the **Structure Editor (Form)**, users can view information about lethality zones concerning a structure. The Depth Thresholds panel includes the life loss thresholds for three zones (safe, compromised and chance), defined as the occupancy type level (review Section 6.2.3 and Section 8.6.1). Specifically, the user-defined thresholds set the start of the compromised zone (feet) and the start of the chance zone (feet) for occupants that are under 65 or over 65. For more detail on how lethality zone parameters work in HEC-FIA please review Chapter 4 of the HEC-FIA Technical Reference Manual.

From the Depth*Velocity Thresholds panel, the **Foundation Type** and the **Construction Type** lethality zone parameters can be modified by selecting any option from the lists provided. Once either item has been changed, click **Update**. The other values on the tab are updated automatically.

Note: The user cannot modify the lethality zone parameters from the **Structure Editor (Form)**. However, the depth thresholds or depth*velocity thresholds for each individual structure

occupancy type can be edited from the **Structure Occupancy Type Editor (Form)** dialog (review Section 8.6.1).

Figure 8.11 Structure Editor (Form) – Lethality Zone Parameters Tab

8.3.2   Structure Inventory – Table Editor

In the HEC-FIA interface, users can edit the structure inventory from the **Structure Editor (Table)** in a table form that allows users to edit the entire structure. From the structure inventory shortcut menu (Figure 8.5), point to **Edit**, click **Table Editor**, the **Structure Editor – {*Name of Structure Inventory*} (Table)** opens (Figure 8.12).

From the **Structure Editor (Table)** (Figure 8.12) users can edit the structure name, change the damage category, and/or change the occupancy type associated with the structure. From the table users can make changes easily to multiple structures, and filters are available that can make changing entire groups of structures easy. When finished, click **OK**, and all changes are automatically made to the selected structure inventory (e.g., *NB_BaseNSI* in Figure 8.12).

Figure 8.12 Structure Editor (Table)

8.3.3   Importing Additional Structures

Once the user has created a structure inventory, additional structures can be added to an existing inventory using the same methods that were used to create the original structure inventory (refer to Section 8.2). From the structure inventory shortcut menu (Figure 8.5), point to **Import Additional Structures**, and from the submenu click on the method to use for importing additional structures (parcel shapefile, National Structure Inventory, or point shapefile). These structures are added to the existing structure inventory; therefore, be sure not to import new structures in the same geographic location, as this could result in duplication of structures.

8.3.4   Delete All Structures

To delete all structures in a structure inventory, from the structure inventory shortcut menu (Figure 8.5), click **Delete All Structures**. A **Warning** dialog box opens (Figure 8.13). Click **Yes** if all structures are to be deleted from the selected structure inventory.
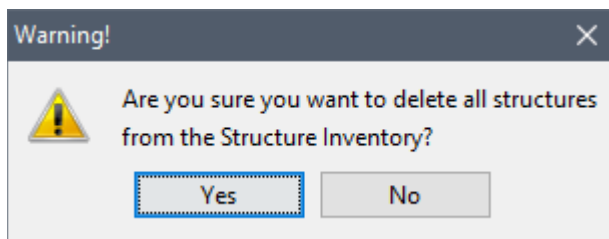
Figure 8.13 Warning Dialog Box – Delete All Structures

8.3.5   Export to Shapefile

HEC-FIA can create (export) a shapefile of the active structure inventory. From the structure inventory shortcut menu (Figure 8.5), click **Export to Shapefile**, the **Export Structure Inventory to Shapefile** dialog box opens (Figure 8.14).
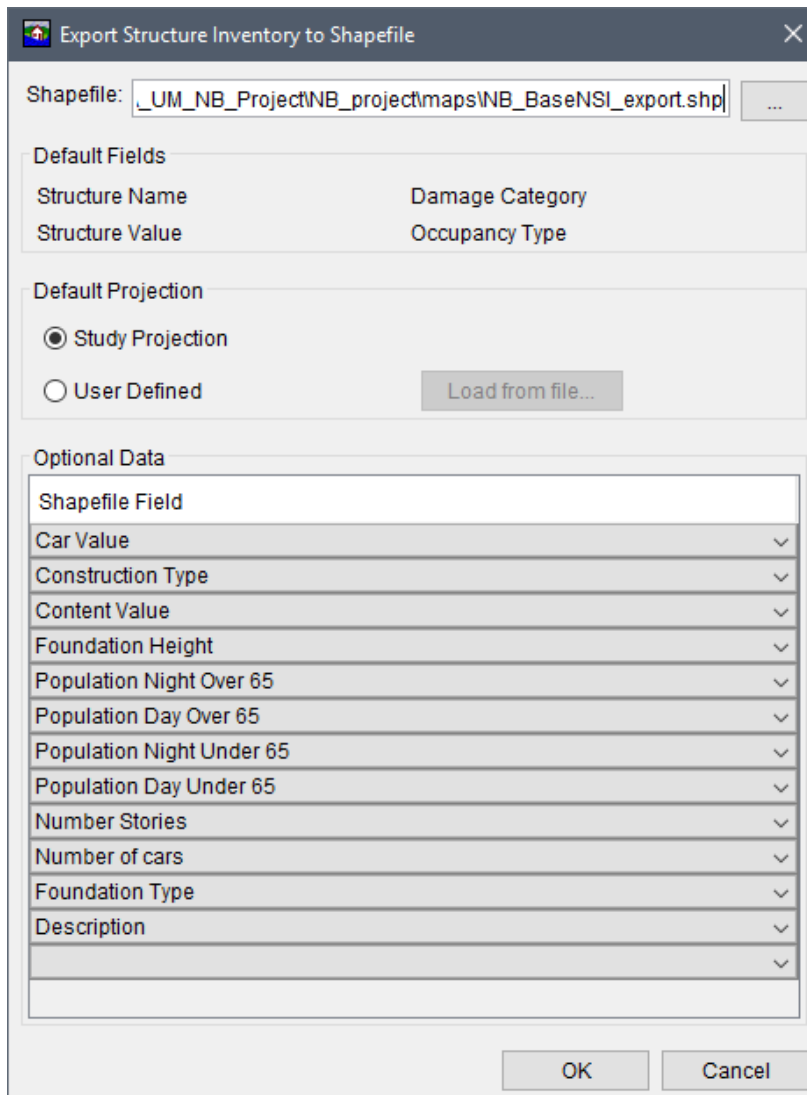
Figure 8.14 Export Structure Inventory to Shapefile Dialog Box – Example

1. Click ⬚⬚, a **Save** browser window (Figure 8.15) opens. Select the location where the shapefile is to be exported (created). Enter a name in the **File name** box, and click **Save**. The **Save** browser window closes and the name and path of the shapefile is displayed in the **Shapefile** box (Figure 8.14).

2. Define the projected coordinate system of the shapefile. From the **Default Projection** panel (Figure 8.14), select the radio ⊙ button to either **Study Projection** (which is the project of the current HEC-FIA project), or **User Defined** (which allows the user to set the projection from a projection **.prj* file). When **User Defined** is selected, the **Load from file** button becomes available. The **Load from file** button opens an **Open** browser window (similar to Figure 8.15). The file type is set to **.prj*, browse to the location of the shapefile that contains the correct projection. Click **Open**, the **Open** browser window closes.

3. Define the fields that the exported shapefile should contain from the **Optional Data** panel (Figure 8.14). The dropdown ⬚⬚ lists contain the fields that are available for

selection. From the **Optional Data** panel, the user can select any available field from the <u>Shapefile Field</u> list (e.g., *Foundation Height*).
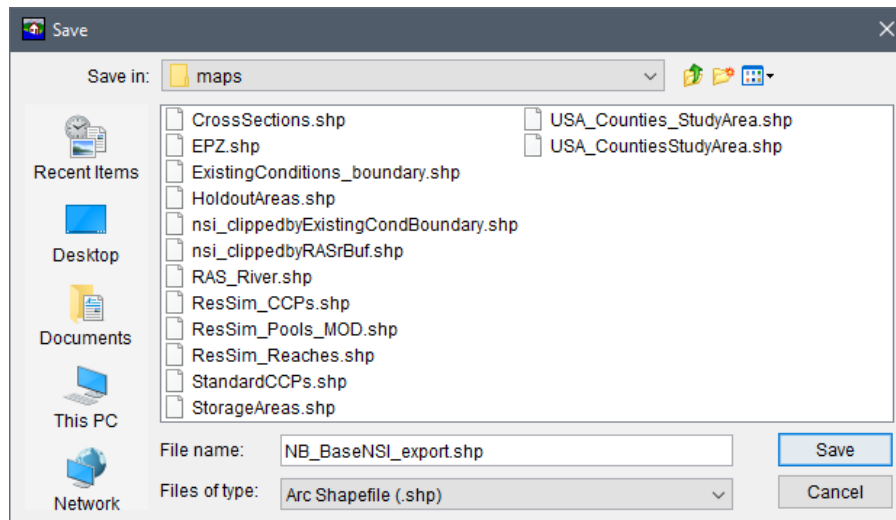
Figure 8.15 Save Browser Window – Export Structure Inventory to Shapefile

4.   Click **OK**, the **Export Structure Inventory to Shapefile** dialog box closes (Figure 8.14). A **Progress** message dialog opens providing the user with a green export progress bar, and once the export is finished, the **Progress** message dialog closes. The shapefile (i.e., *NB_BaseNSI_export.shp*) and all of the associated files are created at the specified location.

8.3.6   Save

From the structure inventory shortcut menu (Figure 8.5), click **Save** to save the structure inventory. The **Save** command updates the inventory's database (**.dbf*) file for the selected structure inventory in the study directory.

8.3.7   Save As

To create a copy of the structure inventory, from the structure inventory shortcut menu (Figure 8.5), click **Save As**, and the **Save Structure Inventories As** dialog box opens (Figure 8.16). In
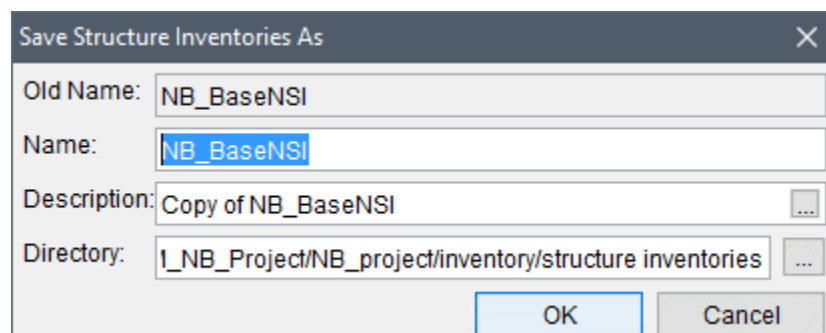
Figure 8.16 Save Structure Inventories As Dialog Box

the **Name** box enter the name of new structure inventory. A description of the structure inventory can be entered in the **Description** box. Click **OK**, the **Save Structure Inventories As** dialog box closes, and the new structure inventory is created and listed under the **Structure Inventories** folder in the **Study Tree**.

8.3.8   Rename

To rename the structure inventory, from the structure inventory shortcut menu (Figure 8.5), click **Rename**, the **Rename Structure Inventories** dialog box opens (Figure 8.17). In the **Name** box enter the name of new structure inventory. A description of the structure inventory can be entered in the **Description** box. Click **OK**, and the **Rename Structure Inventories** dialog box closes. The structure inventory listed under the **Structure Inventories** folder in the **Study Tree** is renamed.

Note: Caution should be taken when renaming structure inventories selected in exiting alternatives as the user must select the renamed structure inventory from the **Edit Alternative** dialog box (review Chapter 10).
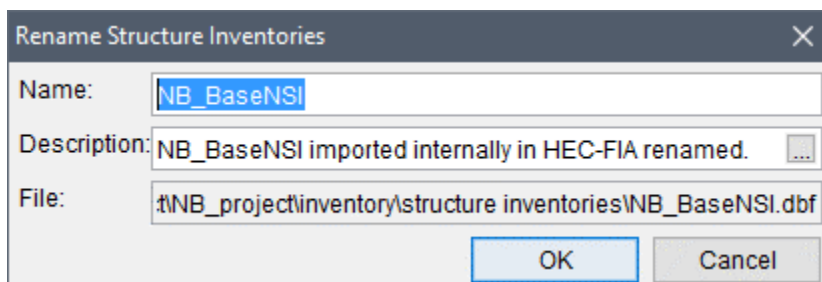
Figure 8.17 Rename Structure Inventories Dialog Box

8.3.9   Delete from Study

To delete a structure inventory and its associated files from the HEC-FIA project, from the structure inventory shortcut menu (Figure 8.5), click **Delete from Study**, a **Confirm Manager Delete** dialog box opens (Figure 8.18). By clicking **Yes**, the **Confirm Manager Delete** dialog box closes, and the selected structure inventory and associated (**.dbf* and **.mdx*) files are deleted from the HEC-FIA project and study directory.
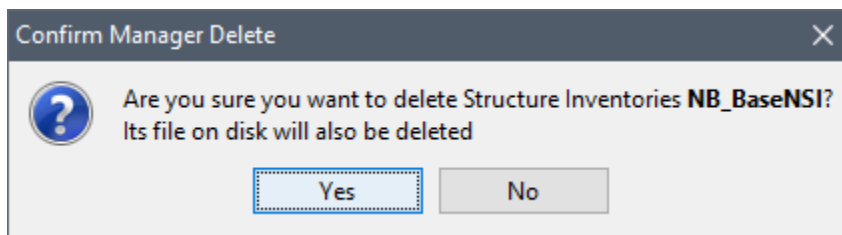
Figure 8.18 Confirm Manager Delete Dialog Box

8.3.10 Remove from Study

To remove the structure inventory from the HEC-FIA project (does not delete associated **.dbf* and **.mdx* files), from the structure inventory shortcut menu (Figure 8.5), click **Remove from Study**; a **Confirm Removal** dialog box opens (Figure 8.19). By clicking **Yes**, the **Confirm Removal** dialog box closes, and the structure inventory is removed from the HEC-FIA project.
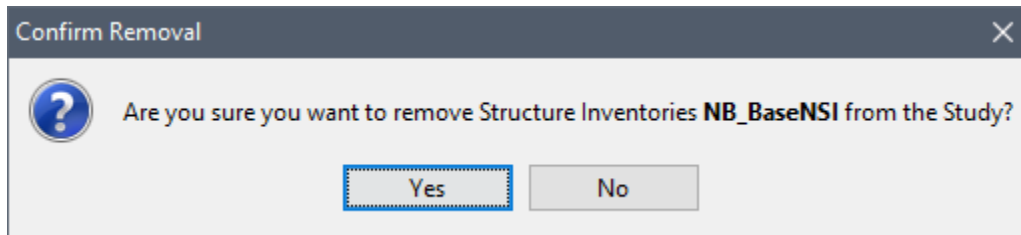
Figure 8.19 Confirm Removal Dialog Box

8.4   Structure Inventory – Map Window

The structure inventory can be manipulated from the active map window. To open a structure inventory in a map window, from the structure inventory shortcut menu (Figure 8.5), click **Display in Map Window**. From the map window tools, select the **Structure Tool** 🏠, right-click on a structure, and the structure's shortcut menu opens. From the structure's shortcut menu (Figure 8.20) the user can edit, copy, delete, and view information about the structure.
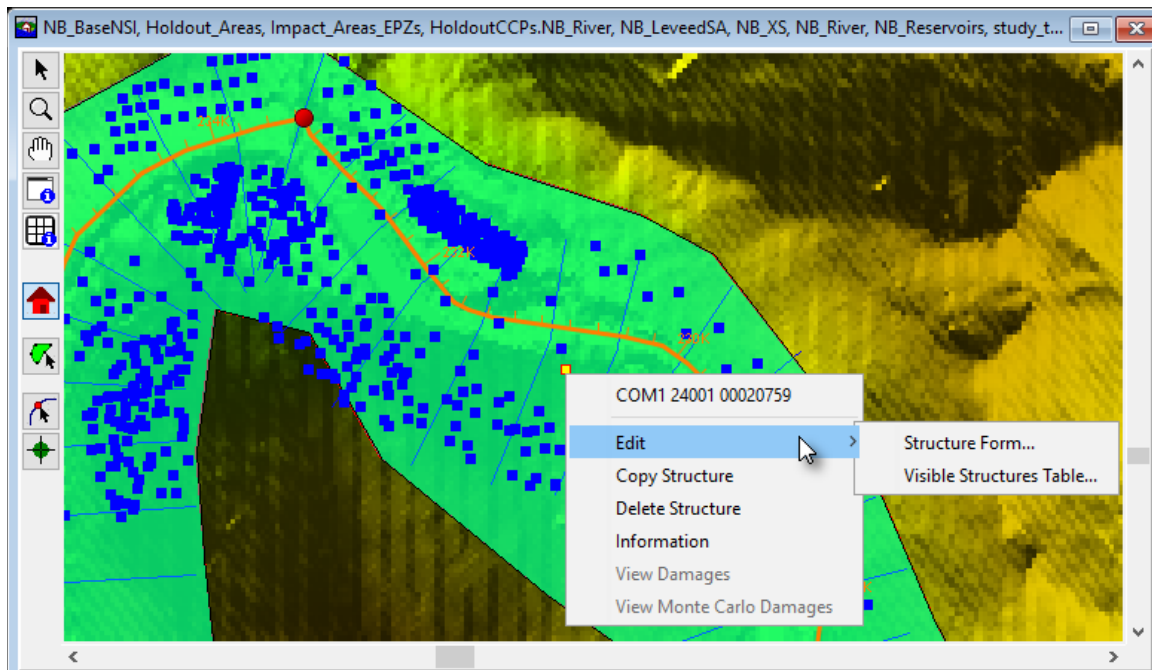
Figure 8.20 Map Window – Structure Tool – Structure Shortcut Menu Commands

To edit a structure selected from the map window, from the shortcut menu (Figure 8.20), point to **Edit** and click **Structure Form**. The **Structure Editor (Form)** will open for only the structures visible in the map window; further, the form will automatically open to the selected structure.

From the structure shortcut menu (Figure 8.20), point to **Edit**, and click **Visible Structure Table**, to open the **Structure Editor (Table)** for only the structures visible in the map window. Editing of structures in the **Structure Editor (Form)** has been covered in Section 8.3.1, and the rest of the editing structure inventory capabilities are covered in the following sections.

8.4.1 New/Copy/Paste/Delete Structure

To create a new structure in the map window, select the **Structure Tool** and while holding the **CTRL** key left-click in the map window at the location for the new structure. A structure is added with a default name. Note, the user can also create a new structure from the **Structure Editor (Form)** by clicking **New** from the **Structure** menu (Figure 8.6).

To copy a structure, right-click on a structure in the map window, from the structure shortcut menu (Figure 8.20), click **Copy Structure**. On the map window, find the location where the new structure belongs, right-click, from the shortcut menu click **Paste Structure** (Figure 8.21). The structure appears with a new name, but with all the same attributes as the original.
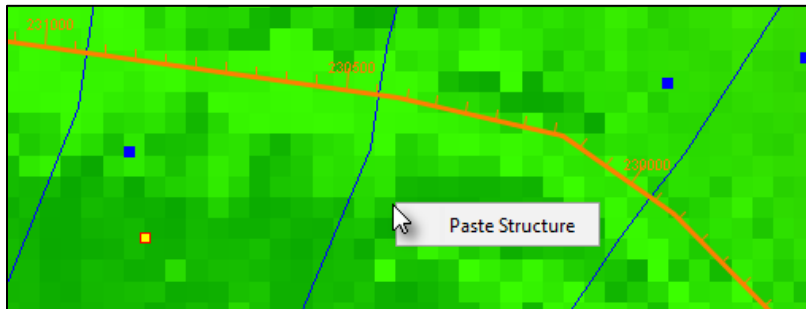
Figure 8.21 Map Window – Structure Tool – Paste Copied Structure

To delete a structure, right-click on a structure, from the structure shortcut menu (Figure 8.20), click **Delete Structure**. A **Warning** message dialog (Figure 8.22) opens. Click **Yes**, the structure is deleted from the structure inventory and is removed from the map window. Note, the user can also delete selected structures from the **Structure Editor (Form)** by clicking **Delete** from the **Structure** menu (Figure 8.6).
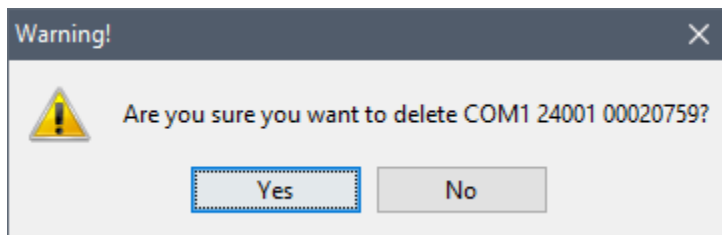
Figure 8.22 Warning Message Dialog – Delete Selected Structure

8.4.2 Information

To get general information about the selected structure inventory, from the structure shortcut menu (Figure 8.20), click **Information**; the **Individual Structure Information Report** dialog

box opens (Figure 8.23). The **Individual Structure Information Report** dialog box provides general information about the selected structure.
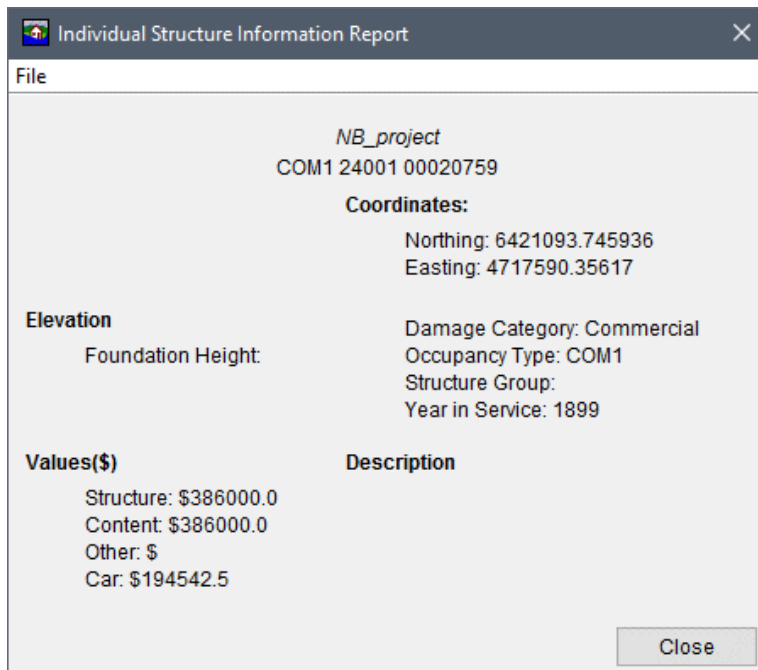
Figure 8.23 Individual Structure Information Report – Example

8.5   Damage Categories

Damage categories are the first aggregation level for flood damages. Damage categories represent a high level grouping for structures, and contain information which is used in the ECAM (Economic Consequence Assessment Model) process to determine loss ratio and capital loss ratio. ECAM requires that the damage categories are "Residential", "Commercial", "Industrial" and "Public". If structures are imported with damage category information included, then default damage categories are created during the structure import process. If the user desires to use the inventory for an ECAM compute, they must ensure the damage categories are consistent with the defaults in HEC-FIA.

8.5.1   Editing Damage Categories

To enter or modify damage categories:

1. From the **Study Tree**, which is in the **Study Pane**, from **Inventory** folder, right-click on **Damage Category**. From the shortcut menu (Figure 8.24) click **Edit**, the **Edit Damage Categories** dialog box (Figure 8.25) opens.

2. From the **Edit Damage Categories** dialog box (Figure 8.25), the user can enter or modify damage category names, enter or modify the reconstruction period (in days), and enter or modify the price index factor.
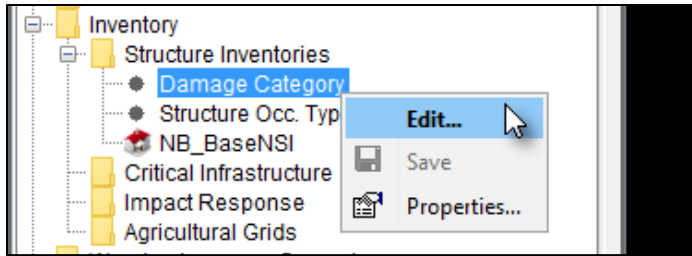
Figure 8.24 Damage Category – Study Tree – Shortcut Menu Options
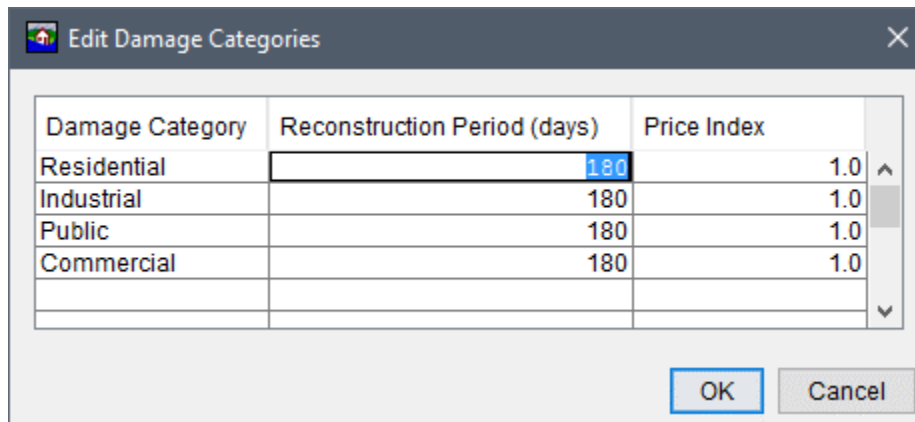
Figure 8.25 Edit Damage Categories Dialog Box

3. Once the user is finished, click **OK** and the **Edit Damage Categories** dialog box (Figure 8.25) closes.

8.5.2 Damage Categories for Reconstruction Computes

The reconstruction period values (editable from the **Edit Damage Categories** dialog box, e.g., Figure 8.25) are used in the new compute option, Reconstruction, added to HEC-FIA Version 3.1. The reconstruction period (e.g., *180* days in Figure 8.25) describes the number of days required to reconstruct structures, for a specific damage category type, from a value of zero back to the fully constructed value. During a reconstruction compute, HEC-FIA identifies structures damaged during subsequent events and uses the reconstruction period, time elapsed between flood events, and the total structure value to interpolate the value of the structure for each event. For more information regarding the Reconstruction compute option, review Section 10.2.4.

8.6 Structure Occupancy Types

Structure occupancy types are the next level of aggregation for structures in HEC-FIA, and are imperative for any consequence calculation. Each structure is required to have an occupancy type. The occupancy types describe a class of structures (e.g., single family, no basement, raised foundation, one story). Data entered for an occupancy type is applied to all the structures assigned to that occupancy type. Several occupancy types can be assigned to a single damage category. For example, single-story structures with no basements, single-story structures with basements, mobile homes, and duplex apartments are different structure occupancy types assigned to a residential damage category.

Data describing an occupancy type include: the depth-percent damage functions (structure, content, and other); the content-to-structure value ratio (used to estimate the value of contents based on a percentage of the value of the structure); the uncertainties in the foundation height, value ratios (content to structure, and other to structure); and the damage in the depth-damage functions.

8.6.1   Entering or Editing Structure Occupancy Types

When importing an inventory from a point or parcel shapefile, default (or existing) functions must be imported through a table name mapping process after the structure inventory has been imported. The table name mapping process pre-populates inventories with either the standard default curves or existing curves and general information (refer to Section 8.6.3 for an example). Users can also input depth-damage functions by hand from the **Structure Occupancy Type Editor** (Figure 8.27).

Open the **Structure Occupancy Type Editor** (form view) from the **Study Tree**, from the **Inventory** folder, from the **Structure Inventories** folder, right-click on **Structure Occ. Types**. From the shortcut menu (Figure 8.26) point to **Edit**, click **Form Editor**. The **Structure Occupancy Type Editor (Form)** (Figure 8.27) opens.
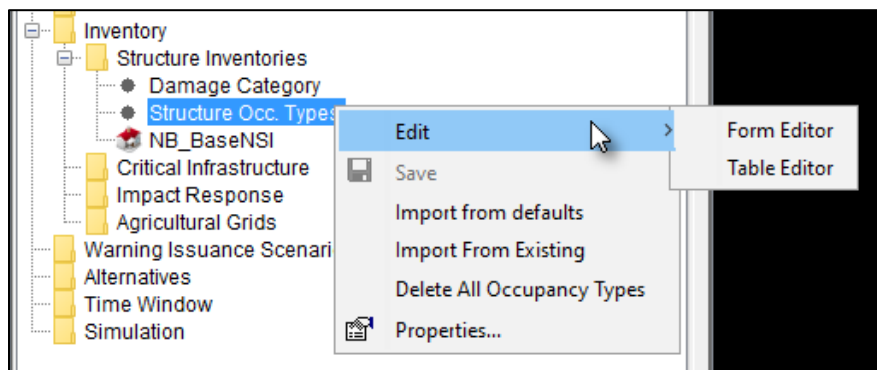
Figure 8.26 Structure Occupancy Type – Study Tree – Shortcut Menu Options

From the **Structure Occupancy Type Editor (Form)** (Figure 8.27), the user may enter new or edit existing occupancy types. Note, click the **Apply** button to save changes and continue editing, or click **OK** to save changes and close the editor.

Navigation Bar

A navigation bar (Figure 8.7) is provided in the **Structure Occupancy Type Editor (Form)** (Figure 8.27). The navigation bar allows users to move quickly between multiple occupancy types. The navigation bar includes a dropdown [   ] list, which allows users to select a specific occupancy type by **Name** (e.g., *AGR1* in Figure 8.27). Alternatively, users can navigate through the list of occupancy types by clicking the navigation buttons (review Section 8.3.1).

Figure 8.27 Structure Occupancy Type Editor

Depth-Damage Functions Tab

The **Structure Occupancy Type Editor (Form)** automatically opens to the **Depth-Damage Functions** tab (Figure 8.27). From this tab the user can enter or modify the depth-damage functions for structure, content, other, or car. The depth-damage function can either be in percent or damage (dollars). Also, the user can select the uncertainty distribution for the function. Editing the occupancy type information updates all structures in all structure inventories of that occupancy type classification. If the user wishes to update a single structure's depth-damage functions, the edits can happen at the **Structure Editor (Form)** level (review Section 8.3.1).

Safe Zones Tab

When calcuating life loss, for each structure occupancy type the user can define life loss thresholds. To modify these thresholds (which is generally discouraged), from the **Structure Occupancy Type Editor (Form)**, click the **Safe Zones** tab (Figure 8.28). In the **Number of Stories** box (Figure 8.28) the user provides the structure height information for that particular structure occupancy type. From the **Structure Zone Height Information** area (Figure 8.28) the user sets each zone for occupants that are under 65 or over 65 (review Section 6.2.3 and Section 8.6.1). Specifically, the user-defined thresholds set the start of the compromized zone (feet) and the start of the chance zone (feet) for occupants that are under 65 or over 65, the start of the safe zone is automatically set to the foundation height (feet). Finally, in the **Depth * Velocity Thresholds** area (Figure 8.28), the user describes the partial damage or total damage that could

occur for the three types of foundations. For more detail on how safe zones work in HEC-FIA please review Chapter 4 of the HEC-FIA Technical Reference Manual.

Figure 8.28 Structure Occupancy Type Editor (Form) – Safe Zones Tab

General Info/Uncertainty Parameters Tab

For certain parameters in HEC-FIA, the user can describe the uncertainty about those parameters. From the **Structure Occupancy Type Editor (Form)**, click the **General Info/Uncertainty Parameters** tab (Figure 8.29). From the available table the user can describe

the uncertainty. Additionally the foundation height is defined at the structure occupancy type level. The foundation height is utilized in the life loss compute, and if uncertainty about the foundation height is to be evaluated as a part of the overall risk analysis process the user can edit that uncertainty at the occupancy type level. Also, from this tab, the user can describe information about cars from the **Automobile Data** area (Figure 8.29).

Note: When a simulation is computed with uncertainty turned on (refer to Section 10.2.3) then the parameters entered in the **General Info/Uncertainty Parameters** tab (Figure 8.29) are used for all structures in all structure inventoires of that occupancy type classificaiton. For example, in Figure 8.29, the other and car to structure value ratios are empty which HEC-FIA considers zero during an uncertainty compute; therefore, all structures classified as AGR1 will be computed for other and car values set to zero with no uncertainty.

Figure 8.29 Structure Occupancy Type Editor (Form) – General Info/Uncertainty Parameters Tab

8.6.2 Incorporating Uncertainty

The majority of the uncertainties pertaining to the consequences computations in HEC-FIA are defined at the level of the occupancy type. In other words, uncertainty parameters are typically constant across all structures within a particular occupancy type classification. Thus economic uncertainty is typically entered through the **Structure Occupancy Type Editor - General Info/Uncertainty Parameters** tab (Figure 8.29). Five major uncertainty parameters, and four major tabular relationships with uncertainty are available.

The five parameters with uncertainty are:

- Foundation Height
- Structure Value (expressed as a percentage of the mean)
- Content to Structure Value Ratio
- Other to Structure Value Ratio
- Car to Structure Value Ratio

When defining these parameters there are two ways the information is input. Either uncertainty is defined as a percentage of the mean, or as a fully specified distribution. In the case of the percentage of the mean, the value of the parameter at an individual structure is used as the mean value for the structure and the standard deviation is defined as a percentage of the mean. This coefficient of variation is multiplied by the value of the parameter at the structure, and sampled using the selected distribution; the resulting value is used for the structure. In this case, all structures have different results, but the distance from the mean is the same relative distance. In the case where parameters are defined as distributions, there is one sampled value for all structures of that occupancy type; the sampled value is enforced at the structure level.

The four major tabular relationships are:

- Structure Depth-Damage Relationship
- Content Depth-Damage Relationship
- Car Depth-Damage Relationship
- Other Depth-Damage Relationship

The depth-damage relationships are all computed using curve sampling; for more detail on how this works please review the Chapter 9 in the HEC-FIA Technical Reference Manual.

8.6.3   Import from Defaults

In order to make it easier to populate the depth-damage curve information for each occupancy type, the ability to import from defaults has been added to the software. In HEC-FIA default depth-damage curves were taken from EGM 04-01 and the HAZUS database. **Note:** If the structure inventory occupancy types are not given the <u>same name</u> as the forty default based occupancy types, the software has the ability to perform name mapping whereby the occupancy names in the structure inventory are mapped to the equivalent occupancy types. This ability allows depth-damage relationships and other occupancy type parameters to be quickly imported. The imported information can then be reviewed and modified to meet user needs.

To import structure occupancy types from defaults:

1. From the **Study Tree**, from the **Inventory** folder, from the **Structure Inventories** folder, right-click on **Structure Occ. Types**. From the shortcut menu (Figure 8.26) click **Import from Defaults**, and a **Warning** message dialog opens (Figure 8.30). Click **Yes**, to import the default structure occupancy types. The **Warning** message dialog closes and the defaults import.
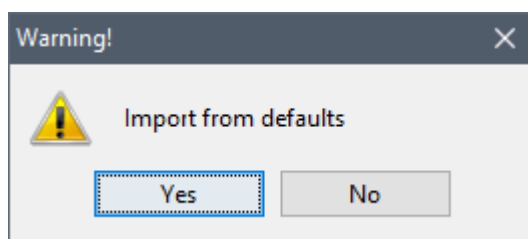
Figure 8.30 Warning Message Dialog – Import from Defaults

2.   However, if structure occupancy types already exist then from the **Warning** message dialog, click **Yes**, and the **Generate Occupancy Types from Default Database** dialog box opens (Figure 8.31).

3.   From the **Generate Occupancy Types from Default Database** dialog box select the radio ⦿ button to either **ADD** the defaults to existing occupancy types, or **REPLACE** existing occupancy types with defaults.
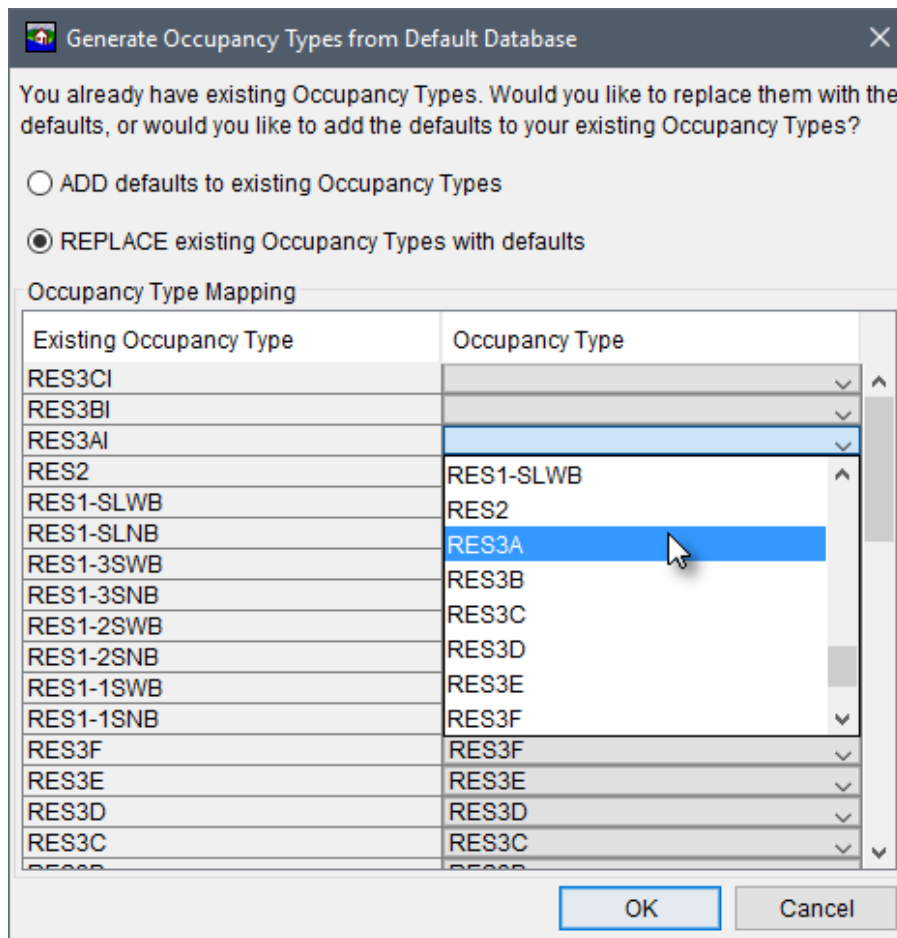
Figure 8.31 Generate Occupancy Types from Default Database Dialog Box

Select the option to **ADD defaults to existing Occupancy Types**, to add the defaults without performing the name mapping function. The imported information can then be reviewed and modified as needed.

Select the option to **REPLACE existing Occupancy Types with defaults** to perform the name mapping function whereby the occupancy names in the structure inventory are mapped to the equivalent occupancy types. When necessary for this option, from the **Occupancy Type Mapping** panel, utilize the provided dropdown lists to select the default occupancy type name (e.g., *RES3A* in Figure 8.31) to replace the existing equivalent occupancy type name in the structure inventory (e.g., *RES3AI* in Figure 8.31).

4.   Click **OK**, and the **Generate Occupancy Types from Default Database** dialog box closes (Figure 8.31). A **Progress** message dialog opens providing the user with

information on the either the import of the default occupancy types or the replacement of existing occupancy types (Figure 8.32). Once the occupancy types update is finished, the **Progress** message dialog closes.
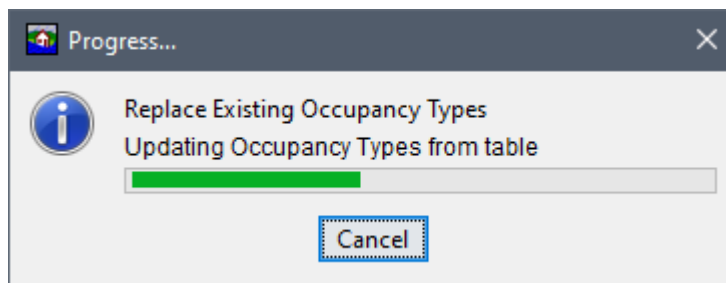
Figure 8.32 Progress Message Dialog – Replace Existing Occupancy Types

8.6.4   Import from Existing

The user can also import structure occupancy types from an existing structure occupancy type file. When this option is utilized after a structure inventory has been imported, then a name mapping process is performed whereby the occupancy names in the structure inventory are mapped to the equivalent occupancy types in the select file. This capability allows depth-damage relationships and other occupancy type parameters to be quickly imported and mapped to imported structure inventories. The imported information can then be reviewed and modified to meet user needs.

From the **Study Tree**, from the **Inventory** folder, from the **Structure Inventories** folder, right-click on **Structure Occ. Types**. From the shortcut menu (Figure 8.26) click **Import from Existing**, and an **Open** browser window opens (Figure 8.3). Browse to the location of the occupancy type file (*occtype.dbf*) that represents the structure occupancy types, select the filename, and click **Open**. The **Open** browser window closes, and a **Progress** message dialog opens providing a green progress bar for mapping the occupancy types to imported structure inventories (Figure 8.33). The **Progress** message dialog closes once the mapping is complete.
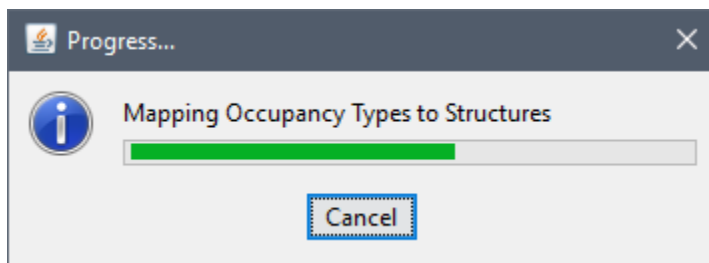
Figure 8.33 Progress Message Dialog – Mapping Occupancy Types

8.6.5   Delete All Occupancy Types

To delete all occupancy types, from the occupancy type shortcut menu (Figure 8.26), click **Delete All Occupancy Types**, a **Warning** message dialog opens (Figure 8.34). By clicking **Yes** occupancy types are deleted from the imported structure inventories and the HEC-FIA project.
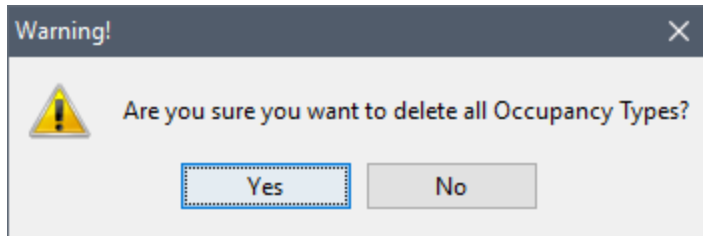
Figure 8.34 Warning Message Dialog – Delete All Occupancy Types

8.7   Critical Infrastructure

Critical infrastructure includes structures in the floodplain that are critical to the nation or a particular region, but are not part of a traditional structure inventory. These critical infrastructure elements may be elements that have tremendous service value such as utilities or bridges, or they may also pose risks to the population due to the presence of hazardous materials such as chemical facilities. It can be difficult to assign a dollar value to these structures or describe the impacts to the economy based on inundation. However, it is critical to describe when these locations are inundation and duration of flooding. HEC-FIA does not evaluate economic losses at critical infrastructure elements. Instead it tracks and reports hydraulic event parameters using a shapefile format. This capability allows the user to identify timing, depth and durations of flooding at the critical infrastructure. The import process via point shapefile is similar to the structure inventory import process.

To create a critical infrastructure inventory:

1.   From the **Study Tree**, from the **Inventory** folder, right-click on the **Critical Infrastructure** folder. From the shortcut menu, click **Import**; the **Import Critical Infrastructure** dialog box opens (Figure 8.35).

2.   Provide a name for the critical infrastructre in the **Name** box on the **Import Critical Infrastructure** dialog box (Figure 8.35).

3.   The **Shapefile** box lists the available shapefiles that have been added as map layers. If a map layer that represents the critical structure inventory has not been added to the HEC-FIA project, click the [⋯] button. The **Open** browser window opens (Figure 8.3). Browse to the location of the shapefile that represents the critical structure inventory shapefile (**.shp*), select the filename, and click **Open**. The **Open** browser window closes, and the **Shapefile** box lists the selected file (Figure 8.35).

4.   In the **Required Fields** panel, the user needs to provide information from the shapefile fields for **Name**, **Sector** (damage category), and **Sub Sector** (structure occupancy type).

5.   From the **Ground Elevation** subpanel, click the radio ◉ button to either have HEC-FIA calculate the ground elevation from the terrain grid (**Let FIA add ground elevation column**) or to select the attribute (**Select Attribute**) from the selected shapefile that best describes the ground elevation.

Note: Some elements (i.e., bridges) do not provide good values from the terrain grid if the terrain represents the river surface rather than the bridge surface, so if HEC-FIA adds the ground elevation, make sure to enter an override elevation for elevations that describe when damages would begin to occur.

6. Optional information can be provided from the **Optional Fields** panel. Suggested optional fields are *Description*, *Street Address*, *City*, *State*, *Zip Code*, and *Telephone Number*. To include optional information select any field from the <u>Fields in the Shape</u> list (e.g., *DESC1_F*) that corresponds to a field selected from the available <u>Fields in HEC-FIA</u> list (i.e., *Description*).

7. Once everything is defined, click **OK**. The **Import Critical Infrastructure** dialog box (Figure 8.35) closes, under the **Critical Infrastructure** folder in the **Study Tree**, the name of the imported critical infrastructure (*NB_CI*) appears.

Figure 8.35 Import Critical Infrastructure Dialog Box – Example

8.7.1   Critical Infrastructure Shortcut Menu

Once a critical infrastructure inventory has been created there are several ways a user can manipulate the critical infrastructure from a shortcut menu. From the **Study Tree**, under the **Critical Infrastructure** folder, right-click on the created critical infrastructure (e.g., *NB_CI*). From the shortcut menu (Figure 8.36) the user can display/remove the critical infrastructure from the active map window, edit the critical infrastructure, save/save as, rename, delete/remove the critical infrastructure from the HEC-FIA project, and review properties of the critical infrastructure file.
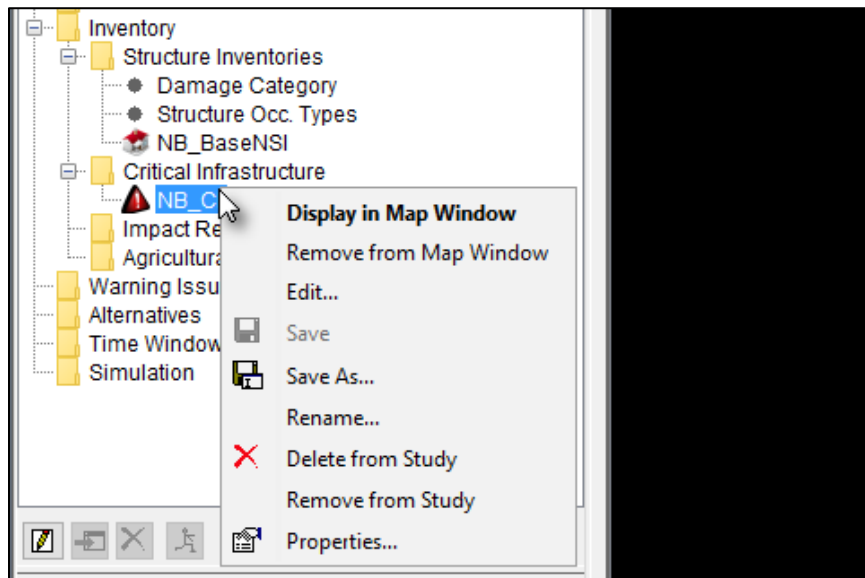
Figure 8.36 Critical Infrastructure – Study Tree – Shortcut Menu Options

Display in Map Window

To display the critical infrastructure locations in the HEC-FIA project, from the critical infrastructure shortcut menu (Figure 8.36), click **Display in Map Window**. The map window now includes the critical infrastructure locations (Figure 8.37). To turn off the critical infrastructure locations in the HEC-FIA project, from the critical infrastructure shortcut menu (Figure 8.36) click **Remove from Map Window**.
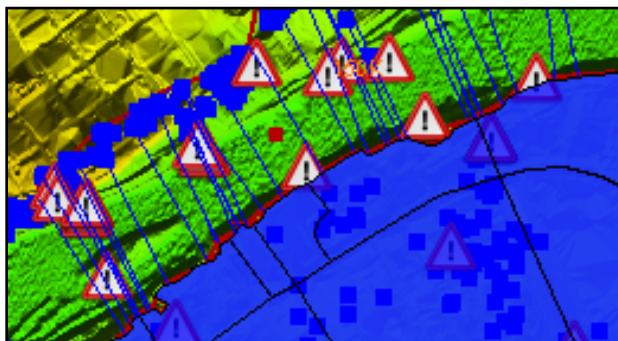
Figure 8.37 Map Window – Critical Infrastructure Locations

Edit

To edit a defined critical infrastructure, from the critical infrastructure shortcut menu (Figure 8.36), click **Edit**, the **Edit Critical Infrastructure** dialog box opens (Figure 8.38). If the user wants to override the terrain model elevation for the critical infrastructure element, uncheck the **Use Terrain Model** checkbox and define the ground elevation in the appropriate text box. Click the **Apply** button to save changes and continue editing, or click **Ok** to save changes and close the editor.

Within the **Edit Critical Infrastructure** (Figure 8.38), there is a navigation bar (Figure 8.7). The navigation bar allows users to move quickly between multiple critical structures. The navigation bar includes a dropdown [   ] list, which allows users to select a specific critical structure by **Name** (e.g., *Public Library* in Figure 8.38). Alternatively, users can navigate through the list by clicking the navigation buttons (review Section 8.3.1).

Figure 8.38 Edit Critical Infrastructure Dialog Box – General Info Tab

Save As

To create a copy of a critical infrastructure, from the critical infrastructure shortcut menu (Figure 8.36), click **Save As**, the **Save Critical Infrastructure As** dialog box opens (similar to Figure 8.16). In the **Name** box enter the name of new critical infrastructure. The user can enter a

description of the critical infrastructure in the **Description** box. Click **OK**, the **Save Critical Infrastructure As** dialog box closes, and the new critical infrastructure is created.

Rename

To rename the critical infrastructure, from the critical infrastructure shortcut menu (Figure 8.36), click **Rename**, the **Rename Critical Infrastructure** dialog box opens (similar to Figure 8.17). In the **Name** box enter the new name of critical infrastructure. The user can enter a description of the critical infrastructure in the **Description** box. Click **OK**, the **Rename Critical Infrastructure** dialog box closes, and the critical infrastructure has been renamed.

Delete from Study

To delete the critical infrastructure and its associated files from the HEC-FIA project, from the critical infrastructure shortcut menu (Figure 8.36), click **Delete from Study**, a **Confirm Manager Delete** message dialog opens (similar to Figure 8.18). By clicking **Yes**, the **Confirm Manager Delete** message dialog closes, and the critical infrastructure and its associated files are deleted from the HEC-FIA project.

Remove from Study

To remove the critical infrastructure from the HEC-FIA project (does not delete files), from the critical infrastructure shortcut menu (Figure 8.36), click **Remove from Study**; a **Confirm Removal** message dialog opens (similar to Figure 8.19). By clicking **Yes**, the **Confirm Removal** message dialog closes, and the critical infrastructure is from the HEC-FIA project.

8.8   Impact Response

Impact response tables allow the user to define an impact and associate it with a stage or flow threshold at a specific hydrograph location. The user can define a threshold using either a ">" (greater than) sign or a "<" (less than) sign. The greater than sign evaluates when the HEC-DSS hydrograph becomes greater than the threshold, thus it is a flood stage threshold. The less than sign evaluates when the HEC-DSS hydrograph is less than the threshold, thus it is a low stage threshold (i.e., navigation can no longer occur). In HEC-FIA, the date and time is recorded each time the flood stage/flow exceeds or drops below a set threshold within the same event.

To create an impact response:

1. From the **Study Tree**, from the **Inventory** folder, right-click on the **Impact Response** folder. From the shortcut menu, click **New**; the **New Impact Response** dialog box opens (Figure 8.39).

2. Provide a name for the impact response rule set in the **Name** box on the **New Impact Response** dialog box (Figure 8.39).
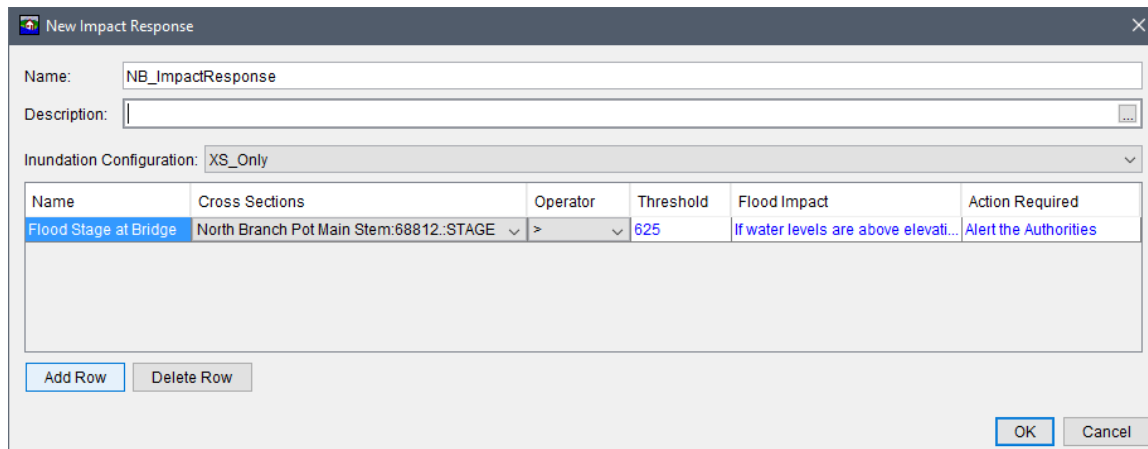
Figure 8.39 New Impact Response Dialog Box

3. Select a defined inundation configuration from the **Inundation Configuration** list. **Important:** The only inundation configurations which can be utilized are ones which are linked to HEC-DSS hydrograph time series: CCPs only, cross sections only, or grids and cross sections (review Chapter 7). The inundation configuration selection sets the second column of the table to either: *CCP*, *Cross Sections*, or *Grids and Cross Sections*.

4. To generate the rules that define the impact response, click **Add Row**. A blank row appears in the table on the **New Impact Response** dialog box (Figure 8.39). Enter a name for the rule (*Flood Stage at Bridge*) in the **Name** column. From the second column (e.g., **Cross Sections** column in Figure 8.39), select the cross section location where the impact is measured. From the **Operator** column, select the operator for the rule. Enter the threshold in the **Threshold** column. Enter the impacts and actions in the **Flood Impact** and **Action Required** columns.

5. Once everything is defined, click **OK**. **New Impact Response** dialog box (Figure 8.39) closes. Under the **Impact Response** folder in the **Study Tree**, the name of the impact response (*NB_ImpactResponse*) appears.

8.8.1   Impact Response Shortcut Menu

Once an impact response has been created several ways are available to manipulate the impact response from a shortcut menu. From the **Study Tree**, under the **Impact Response** folder, right-click on the created impact response name (e.g., *NB_ImpactResponse*). From the shortcut menu (Figure 8.40) the user can edit the impact response; save/save as, rename, delete/remove the impact response from the HEC-FIA study; or review the properties of the impact response file.
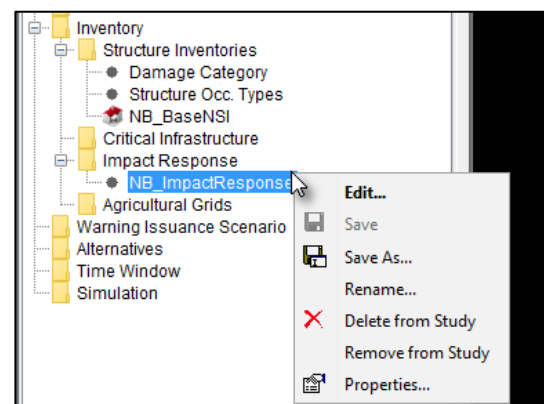
Figure 8.40 Impact Response – Study Tree – Shortcut Menu Options

Edit

To edit a defined impact response, from the impact response shortcut menu (Figure 8.40), click **Edit**, the **Edit Impact Response** dialog box opens (Figure 8.41).

Figure 8.41 Edit Impact Response Dialog Box

Save As

To create a copy of a defined impact response, from the impact response shortcut menu (Figure 8.40), click **Save As**, the **Save Impact Response As** dialog box opens (similar to Figure 8.16). In the **Name** box enter the name of new impact response. The user can enter a description of the impact response in the **Description** box. From the **Directory** box the user can specify the location of the new impact response. Click **OK**, the **Save Impact Response As** dialog box closed, and the new impact response is created.

Rename

To rename the impact response, from the impact response shortcut menu (Figure 8.40), click **Rename**, the **Rename Impact Response** dialog box opens (similar to Figure 8.17). In the **Name** box enter the new name of the impact response. The user can enter a description of the impact response in the **Description** box. Click **OK**, the **Rename Impact Rsponse** dialog box closes, and the impact response is renamed.

Delete from Study

To delete a defined impact response and its associated files from the HEC-FIA project, from the impact response shortcut menu (Figure 8.40), click **Delete from Study**. A **Confirm Manager Delete** message dialog opens (similar to Figure 8.18). By clicking **Yes**, the **Confirm Manager Delete** message dialog closed, and the impact response and its associated files are deleted from the HEC-FIA project.

Remove from Study

To remove the impact response from the HEC-FIA project (does not delete files), from the impact response shortcut menu (Figure 8.40), click **Remove from Study**. A **Confirm Removal** message dialog opens (similar to Figure 8.19). By clicking **Yes**, the **Confirm Removal** message dialog closed, and the impact response is removed from the HEC-FIA project.

8.9   Agricultural Grids

Agricultural data is not typically used in a consequence assessment; however, it may assist the user in understanding the amount and type of agriculture in the floodplain and potential flood impacts to it. Additionally, users may find it beneficial to download the urban areas and open water to utilize them to verify structure locations. Agriculture data can be downloaded from the U. S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). Access and download the NASS Cropland Data Layer (CDL) from the following website: https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php. NASS provides the CDL in GeoTiff (*.tif*) format, where each cell represents a crop type (review Appendix B of this manual for tips preparing NASS data for import into HEC-FIA).

8.9.1   Create an Agricultural Grid

Agricultural grids are generated from NASS CDL grids. To create an agricultural grid, from the **Study Tree** from the **Inventory** folder, right-click on **Agricultural Grids**. Point to **Generate From NASS**, click **Load NASS CDL Grid**, the **Import Crop Data From NASS** dialog box opens (Figure 8.42).
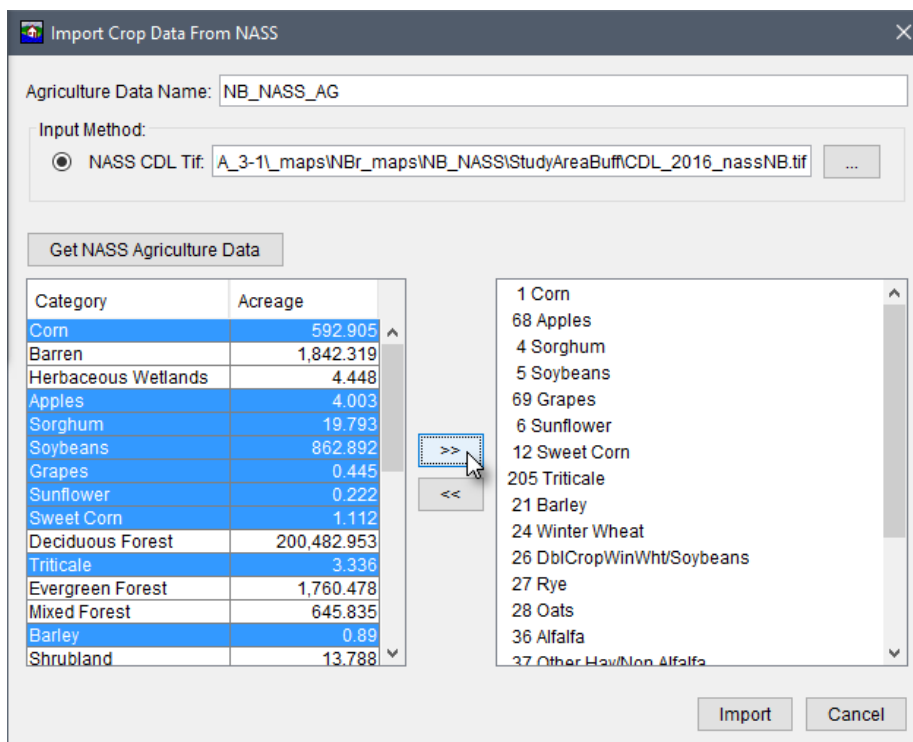
Figure 8.42 Import Crop Data From NASS Dialog Box

1.   Provide a name for the agricultural grid in the **Agriculture Data Name** box on the **Import Crop Data From NASS** dialog box (Figure 8.42).

2.   From the **Input Method** panel, click the ⬚ button. The **Select** browser window opens for NASS CDL (**.tif*) file types. Browse to the location of the shapefile that represents the NASS dataset, select the filename, and click **Select**. The **Select** browser window closes, and the **NASS CDL Tif** box lists the selected file (Figure 8.42).

3.   Click the **Get NASS Agriculture Data** button, this retrieves the category and acreage information contained in the selected NASS CDL (**.tif*) file.

4.   Once the data has been retrieved, the *Category* (category name) and *Acreage* table populates the crop information (crop name, acreage). From the table, select the crops/categories of interest and click the add category ⬚ >> button to add the categorization code (e.g., *1*) and land cover name (e.g., *Corn*) to the import selection box (box at the right of the data table in Figure 8.42). Use the remove category ⬚ << button to select and remove crops/categories from the import selection box.

5.   Now that everything is defined, click **Import**. The **Import Crop Data From NASS** dialog box (Figure 8.42) closes. HEC-FIA then filters the NASS CDL (**.tif*) to only include cells with the crop/category types that were selected for import (e.g., *Corn*). Under the **Agricultural Grids** folder in the **Study Tree**, the name of the agricultural grid (*NB_NASS_AG*) appears.

8.9.2   Agricultural Grid Shortcut Menu

Once an agricultural grid has been created there are several ways the grid can be manipulated from a shortcut menu. From the **Study Tree**, under the **Structure Inventories** folder, under the **Agricultural Grids** folder, right-click on the created agricultural grid name (e.g., *NB_NASS_AG*). From the shortcut menu (Figure 8.43), the user can display/remove the agricultural grid from the active map window, edit the agricultural grid, save/save as, rename, delete/remove the agricultural grid from the study, and review properties of the agricultural grid file.
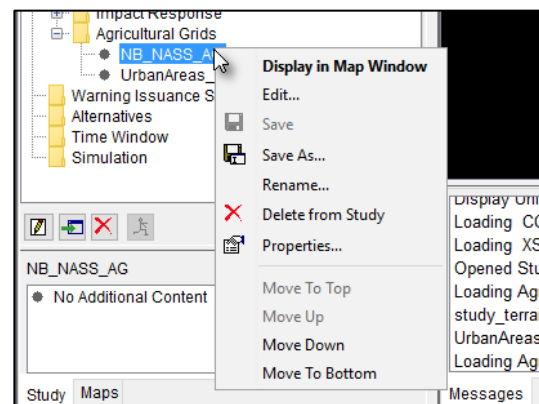
Figure 8.43 Agricultural Grids – Study Tree – Shortcut Menu Options

Edit

When completing an Agricultural Economic Loss assessment in HEC-FIA, Economic Guidance Memorandum (EGM) 14-02 states that current normalized agricultural prices can be found at the U.S. Department of Agriculture (USDA) website (Appendix A). The EGM also states that the USACE website will no longer disseminate this data but its location will be provided as a memorandum. Each crop category in the imported agricultural grid needs the planting date

information filled out, in addition to how much production costs are spent on the crop on a monthly basis. This information typically comes from a local land-grant university through an agricultural extension agency. For example, the USDA National Institute of Food and Agriculture's land-grant University directory. Additionally, price, yield, and harvest cost/date information needs to be populated. This information typically comes from the agriculture extension service or from the NASS website.

To edit a defined agricultural grid, from the agricultural grid shortcut menu (Figure 8.43), click **Edit**, and the **Crop Loss Editor** opens (Figure 8.44). From the **Crop Loss Editor**, the user can select and edit specific crops via the navigation bar (Figure 8.7). The navigation bar allows users to move quickly between multiple crops in the selected agricultural grid. The navigation bar includes a dropdown [   ] list, which allows users to select a specific **Crop** (e.g., *Alfalfa* in Figure 8.44). Alternatively, users can navigate through the list of crops by clicking the navigation buttons (review Section 8.3.1).
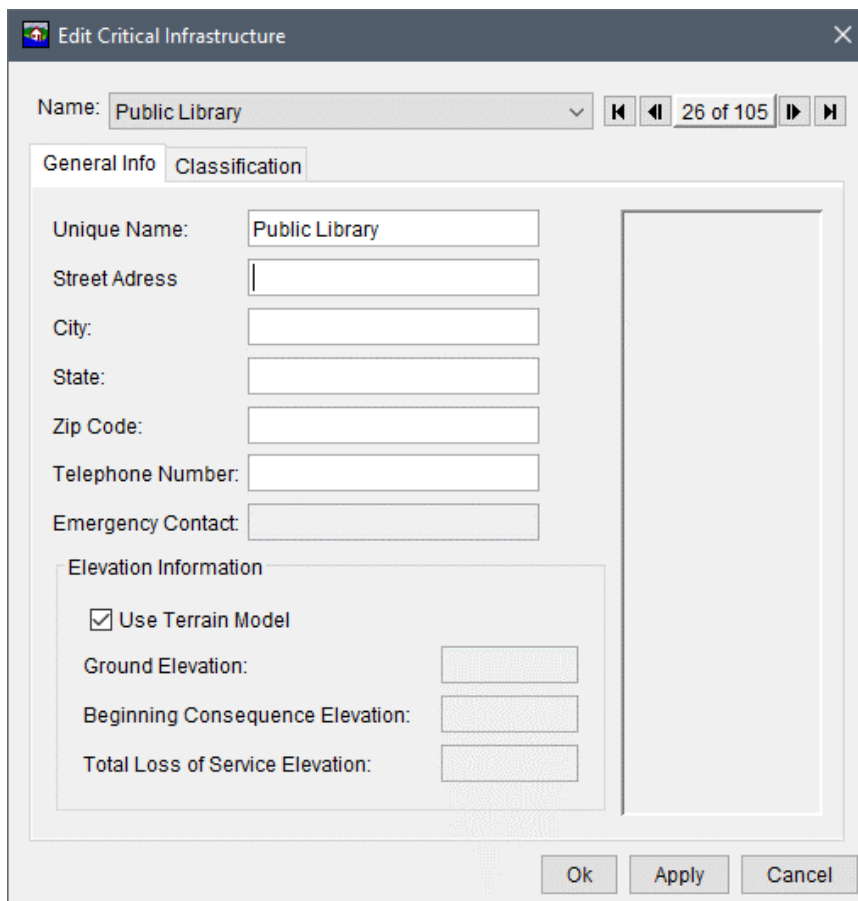

Figure 8.44 Crop Loss Editor – Example

Three tables are available in the **Crop Loss Editor** dialog. The top table defines the cost to produce the crop, which is split into fixed costs and variable costs for the first and second planting. Each month can be assigned a different cost. The middle table contains information for harvest cost and the bottom table defines a damage curve. The damage curve defines the percentage of crop loss per month per flood duration (in days). The user can add damage curves by clicking the **Add Duration** button.

Save As

To create a copy of the agricultural grid, from the agricultural grid shortcut menu (Figure 8.43), click **Save As**, the **Save Agricultural Grids As** dialog box opens (similar to Figure 8.16). In the **Name** box enter the name of new agricultural grid. The user can enter a description of the agricultural grid in the **Description** box. From the **Directory** box specify the location of the new agricultural grid. Click **OK**, the **Save Agricultural Grids As** dialog box closes, and the new agricultural grid is created.

Rename

To rename the agricultural grid, from the agricultural grid shortcut menu (Figure 8.43), click **Rename**, the **Rename Agricultural Grids** dialog box opens (similar to Figure 8.17). In the **Name** box enter the new name of the agricultural grid. The user can enter a description of the agricultural grid in the **Description** box. Click **OK**, the **Rename Agricultural Grids** dialog box closes. The agricultural grid listed under the **Structure Inventories** folder, under the **Agricultural Grids** folder, in the **Study Tree** is renamed.

Delete from Study

To delete the agricultural grid and its associated files from the HEC-FIA project, from the agricultural grid shortcut menu (Figure 8.43), click **Delete from Study**, a **Confirm Manager Delete** message dialog opens (similar to Figure 8.18). By clicking **Yes**, the **Confirm Manager Delete** message dialog closes, and the agricultural grid and its associated files are deleted from the HEC-FIA project.

Remove from Study

To remove the agricultural grid from the HEC-FIA project (does not delete files), from the agricultural grid shortcut menu (Figure 8.43), click **Remove from Study**; a **Confirm Removal** message dialog opens (similar to Figure 8.19). By clicking **Yes**, the **Confirm Removal** message dialog closes, and the agricultural grid is removed from the HEC-FIA project.

CHAPTER 9

Warning Issuance Scenario

In HEC-FIA the warning issuance defines the moment a warning is issued to the population at risk. The issuance of warning can be generated as the result of a hydraulic event (e.g. the exceedance of a specified stage at a particular location or appearance of water on the interior side of a levee) or the passage of an amount of time in the model simulation (e.g. thirty minutes after the start of the simulation). A lag can be specified to simulate the time between the physical occurrence of the event and the human response of issuing a warning in response to that event. If the user defines a warning issuance relative to a rule that uses a specific location and threshold, the warning issuance is dependent upon a particular inundation configuration and hydraulic event. If the user defines a warning issuance relative to start time, the warning issuance works with any alternative, and is dependent upon the start time of the time window used in the simulation.

Warning issuance times are a critical component of the life loss computation, and can be a major source of uncertainty in the life loss results. For instance, if a house is located close to the river near a dam, inundation can occur quickly and the warning issuance may drive loss of life estimations. On the other hand, when inundation occurs hours after the occurrence of a particular event, warning issuance may not be the most important factor in the computation of loss of life risks.

Warning issuance times also impact economic losses through the evacuation of cars during loss of life computation. Each occupancy type has a car carrying capacity, and each structure has a number of cars and people associated with it. The number of people that evacuate safely determines how many cars are left in the floodplain to be damaged.

9.1   Create a Warning Issuance Scenario

To create a warning issuance scenario:

1. From the **Study Tree**, which is in the **Study Pane**, right-click **Warning Issuance Scenario**, from the shortcut menu click **New**. The **New Warning Issuance Scenario** dialog box opens (Figure 9.1).

2. Enter a name in the **Name** box (Figure 9.1), an optional description can be provided in the **Description** box.

3. Click the radio button to select the warning type. Warnings can be issued either by **Warn Relative to Start Time** (default) or **Warn By Rule**. The **New Warning Issuance Scenario** dialog box changes dependent upon which warning type is selected.

4. Once a selection is made for how the warning is triggered, a selection has to be made for where the warning is broadcast. In the **Define Time By** dropdown ⌄ menu one of two options can be selected **All Structures** (default), or by **Warning Region**.
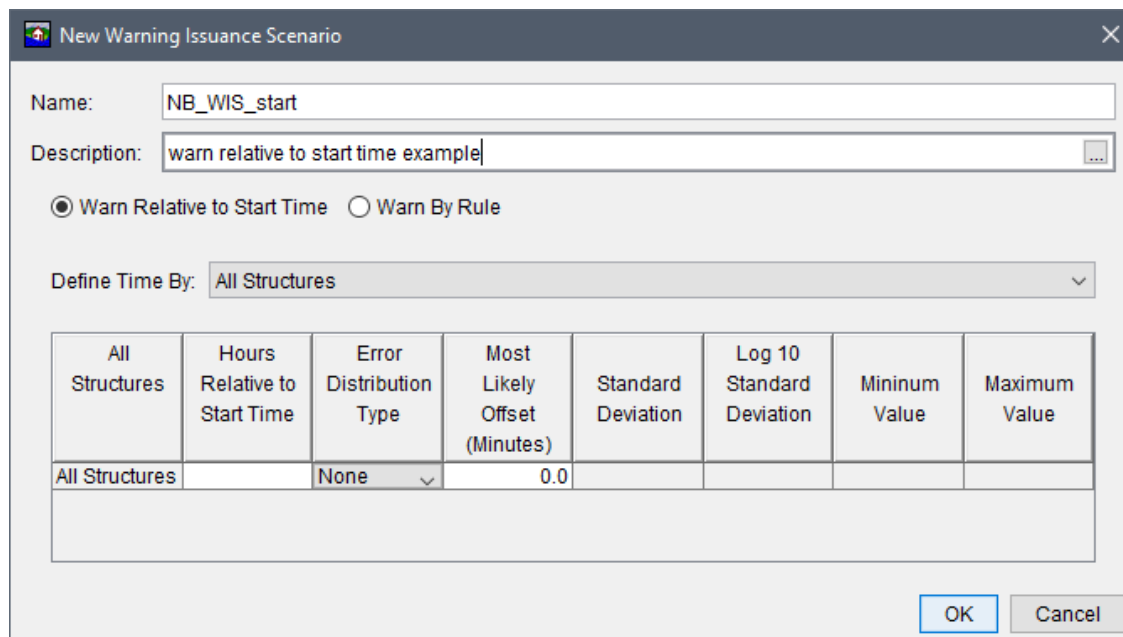
Figure 9.1 New Warning Issuance Scenario Dialog Box

5. Once the warning issuance scenario has been defined, click **OK**. The **New Warning Issuance Scenario** dialog box (Figure 9.1) closes, and the newly defined warning issuance scenario appears in the **Study Tree**, under the **Warning Issuance Scenario** folder.

9.1.1   Warn Relative to Start Time

Warning relative to start time issues a warning that is a fixed number of hours relative to the start time of the simulation regardless of the event being modeled, or the type of inundation configuration. This option is designed to support **Grids Only** inundation configurations (review Chapter 7), where no logical physical trigger exists in the data. Typically, warning occurs relative to the initiation of a breach condition in the hydraulic model. Through coordination between an HEC-FIA modeler and a hydraulic modeler, a breach condition can be defined relative to the start of the simulation. Arrival time grids are defined relative to the start time. Thus an arrival time of zero signifies arrival of water at the beginning of the specified time window. If the hydraulic modeler generates an arrival grid such that the first time in the grid is the breach time, every cell that was wet before the breach maps to zero.

Note: Warning time can cause issues if a significant number of structures are in the floodplain that are in the cells that were wet before breach. Therefore, it is very important that the hydraulic modeler and the HEC-FIA modeler coordinate. However, if the warning issuance relative to start time is also set at zero, the warning goes out on the first time step of the HEC-FIA simulation. If the user sets the warning issuance to be -30, the warning goes out 30 minutes before the simulation start, which would be equivalent to 30 minutes before breach.

When using gridded hydraulic data, the time in the HEC-FIA time window does not have to be the same as the simulation time in HEC-RAS, but the relative timing must be preserved. When using HEC-DSS time series hydraulic data, the times in the time window must be within the times in the HEC-DSS time series.

Define Time By: All Structures

When the warning issuance time is defined by **All Structures** (Figure 9.1), the same warning time is applied to all structures. Applying the same warning time to all structures is useful when a rough estimate is desired but this scenario is also generally a poor representation of reality.

In the **Hours Relative to Start Time** (Figure 9.1) column, the user defines the hours between the **Start Time** identified in the **Time Window** (review Chapter 11) and the issuance of the warning. Numbers for hours relative to start time can be entered in decimals such that 1.5 is equivalent to 1 hour and 30 minutes after the start time and -0.25 would be 15 minutes before the start of the simulation.

From the **Error Distribution Type** list there are five choices: **None**, **Normal**, **Log Normal**, **Triangular**, and **Uniform** (Figure 9.2). The choice of the error distribution makes the last four columns in the table editable or non-editable for the following columns: **Standard Deviation**, **Log10 Stand Deviation**, **Minimum Value**, and **Maximum Value** (Figure 9.2). An offset (in minutes) is entered in the **Most Likely Offset** column.

Define Time By: Warning Region

Defining the warning issuance time by **Warning Region** (Figure 9.2) allows the user to use a polygon shapefile to define which rule or what time the warning issuance occurs within each polygon in the polygon shapefile.

1.   From the **New Warning Issuance Scenario** dialog box (Figure 9.1), from the **Define Time By** list, select **Warning Region** and the **New Warning Issuance Scenario** dialog box updates (Figure 9.2).

2.   From the **Warning Region** list select the appropriate polygon shapefile (e.g., *EPZ.shp* in Figure 9.2). Note, if the list of shapefiles in the dropdown menu does not contain the desired shapefile, then the user must add the shapefile to the HEC-FIA project as map layer (review Section 4.3).

3.   The selected shapefile contains a unique name field that contains the warning regions. From the **Attribute** list, select the appropriate field name (e.g., *Name* in Figure 9.2), and the table updates. The table on the **New Warning Issuance Scenario** dialog box (Figure 9.2) now has a row for each polygon contained in the shapefile (a multi-part polygon should only have one record in the table). As described in the **All Structures** section, the user provides information for the remainder of the table.

Figure 9.2 New Warning Issuance Scenario Dialog Box – Define Time By Warning Region Option

9.1.2   Warn By Rule

Warning by rule is an option that allows users to input stage based warning issuance rules. For instance, the user may specify that a warning is issued whenever the river stage exceeds a flood stage at a gage of interest in the study area. The specified rules depend upon the dynamics of the study area and its hydraulic characteristics. This option can only be utilized for inundation configurations that are either **Cross Sections Only** or **Grids and Cross Sections** (review Chapter 7).

From the **New Warning Issuance Scenario** dialog box (Figure 9.1) select **Warn by Rule**, the **New Warning Issuance Scenario** dialog box changes (Figure 9.3). To define rules proceed with the following steps:

1. From the **Inundation Configuration** list (Figure 9.3), select the inundation configuration that is intended to be used for this warning issuance scenario. Rules can only be defined at locations where a HEC-DSS time series hydrograph is present, so only inundation configurations that contain cross sections can be used for rule based warnings.
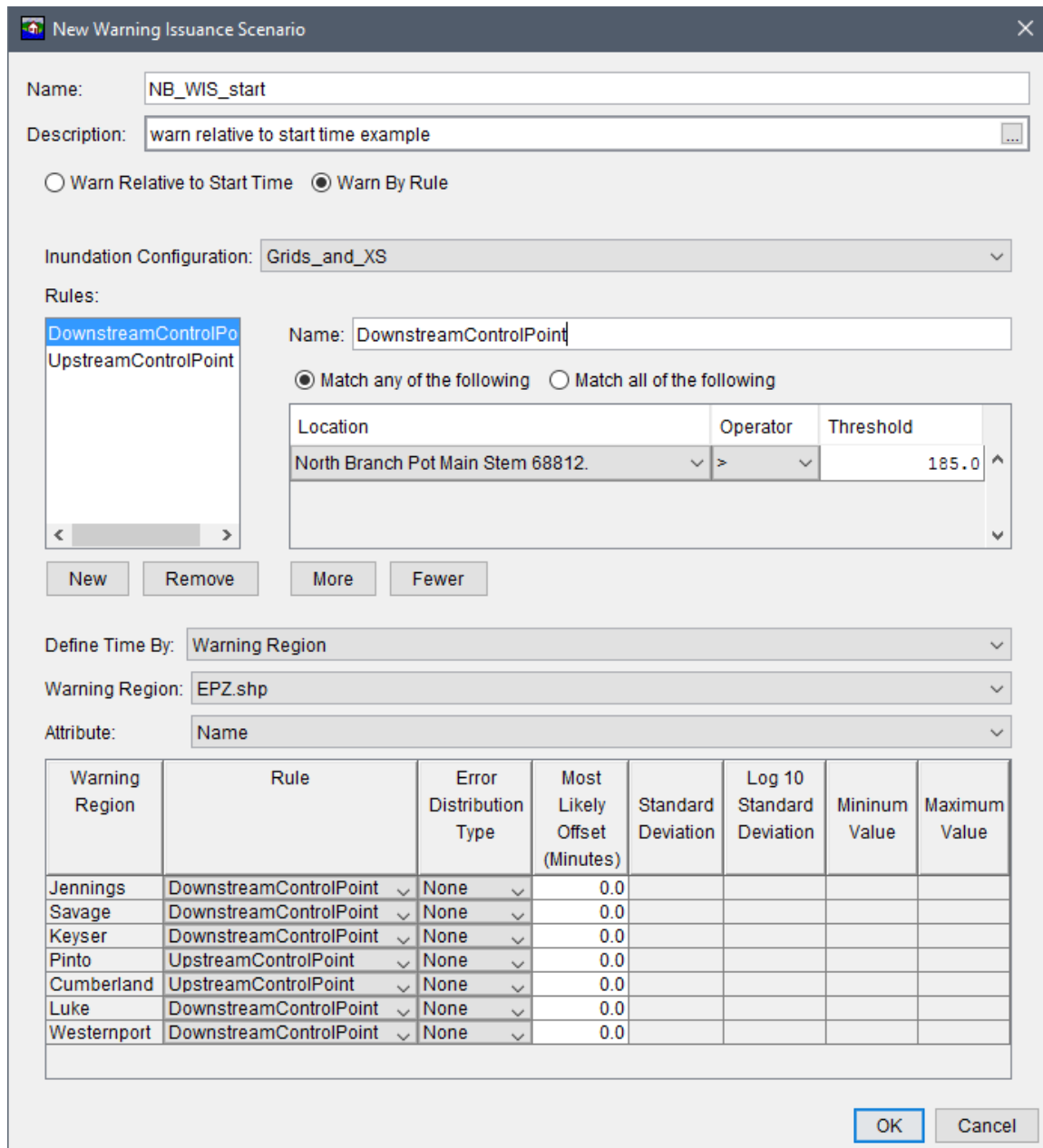
Figure 9.3 New Warning Issuance Scenario Dialog Box – Warn By Rule

2. Click the **New** button, this creates a new rule and provides a default name in the **Name** box. The **Name** box is editable so the user can change the name to a more meaningful name (e.g., *DownstreamControlPoint* in Figure 9.3).

3. Two options are available for how the rule is executed, click the radio ⊙ button to select:

- **Match any of the following** is an OR logical statement. An example would be: "if condition one is met OR condition two is met, then the warning has been triggered".

- **Match all of the following** is an AND logical statement. An example would be: "if condition one is met AND condition two is met, then the warning has been triggered".

4. Once the user has made a selection on how the rule is executed, click the **More** button to add a **Location**, **Operator** and **Threshold** to the table (Figure 9.3). A **Location** is a specific cross section. This rule creation provides HEC-FIA with information to know which hydrograph to use (a record in a HEC-DSS file), so that the condition can be tracked.

    An **Operator** is an expression symbol which defines how to evaluate the condition. For instance if the user chooses the "=" operator, the warning is only initiated when stage is exactly equal to the threshold. If the user uses the operator ">", the warning is issued as soon as the hydrograph exceeds the threshold value; if the first time step of the hydrograph is greater than the threshold, the warning goes out on the first time step.

    A **Threshold** is a value that is used to compare to the hydrograph based on the operator symbol. Be sure to define the threshold in the same units and type as the hydrograph data supplied at the location.

5. Create and define additional rules by repeating Steps 2 through 4. Once the rules are defined, specify the geographic extent and the offset time using the **Define Time By** options outlined in Section 9.1.1.

9.1.3   Incorporating Uncertainty

Many factors may influence when a warning is actually issued. In HEC-FIA, the user is able to define uncertainty about the warning issuance. However, the components of this uncertainty are lumped into a single distribution. Example scenarios contributing to this lumped sum uncertainty distribution include: the chance that a warning is issued in anticipation of a particular condition being met; the chance that a warning is not issued because it occurs without anyone being aware; or the chance that the warning is delayed due to decision making processes at the Emergency Management Agency; or delays due to the time between identification of the natural event and notifying the Emergency Management Agency of disaster potential.

To define uncertainty on a warning issuance:

1. Following the **Define Time By** selection (which can be either option), the first step is to select a distribution type, from the **New Warning Issuance Scenario** dialog box (Figure 9.2). From the **Error Distribution Type** column in the table (Figure 9.4), select the error distribution type from the available list. The available types are **Normal**, **Log Normal**, **Triangular**, and **Uniform**.

2. Each **Error Distribution Type** has different values which are required to define the entire distribution (as displayed in Figure 9.4), but there are a few things to note when filling out the parameters:

    - The values of the uncertainty distribution parameters are in minutes, not hours.

    - The values of the uncertainty distribution parameters are relative to the time defined in the second column of the table. (Hours relative to start, or relative to when the rule is executed for the specific event.)

- The uncertainty values are added to the value in the second column of the table, thus negative values make the warning go out earlier, and positive values make the warning issuance happen later.

Warning Region	Hours Relative to Start Time	Error Distribution Type	Most Likely Offset (Minutes)	Standard Deviation	Log 10 Standard Deviation	Mininum Value	Maximum Value
Jennings	-0.25	Normal	0.0				
Savage	1.5	None	0.0				
Keyser	0.5	Log Normal	0.0				
Pinto	5.0	None	0.0				
Cumberland	1.0	Triangular	0.0				
Luke	0.0	None	0.0				
Westernport	2.5	Uniform	0.0				

Figure 9.4 New Warning Issuance Scenario Dialog Box – Warning Uncertainty

During a Monte Carlo compute (if this option is selected for an HEC-FIA alternative as described in Section 10.2.3), a random number is selected for each row in the table (Figure 9.4), and a warning issuance time is calculated for each structure depending on the geo-location of the structure for **Warning Region** or **All Structures**.

9.2 Warning Issuance Scenario Shortcut Menu

Once a warning issuance scenario has been created, the user can perform various functions on the created warning issuance scenario using the shortcut menu. From the **Study Tree**, under the **Warning Issuance Scenario** folder, right-click on the created warning issuance scenario name (e.g., *NB_WIS_Rule*). From the shortcut menu (Figure 9.5) the user can edit the warning issuance scenario, save/save as, rename, delete from the HEC-FIA project, remove from the HEC-FIA project, and review properties of the warning issuance scenario file.
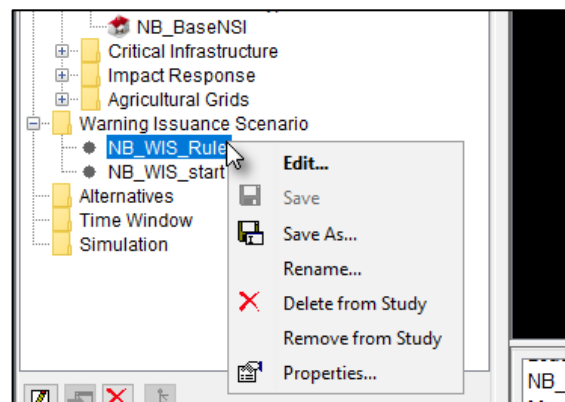
Figure 9.5 Warning Issuance Scenario – Study Tree – Shortcut Menu Commands

9.2.1 Edit

To edit a warning issuance scenario, from the warning issuance scenario shortcut menu (Figure 9.5), click **Edit**, the **Edit Warning Issuance Scenario** dialog box opens (similar to Figure 9.2 or

Figure 9.3). The user can edit the selected warning issuance scenario following the instructions provided in Section 9.1.

9.2.2   Save As

To create a copy of the warning issuance scenario, from the warning issuance scenario shortcut menu (Figure 9.5), click **Save As**, the **Save Warning Issuance Scenario As** dialog box opens (Figure 9.6). In the **Name** box enter the name of new warning issuance scenario. The user can enter a description of the warning issuance scenario in the **Description** box. Click **OK**, the **Save Warning Issuance Scenario As** dialog box closes, and the new warning issuance scenario is created.
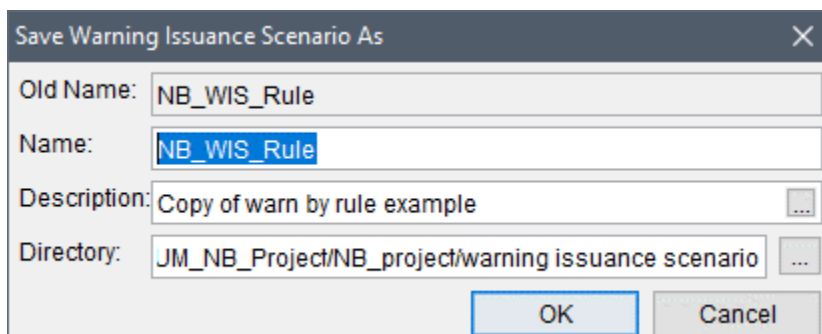
Figure 9.6 Save Warning Issuance Scenario As Dialog Box

9.2.3   Rename

To rename the warning issuance scenario, from the warning issuance scenario menu (Figure 9.5), click **Rename**, the **Rename Warning Issuance Scenario** dialog box opens (Figure 9.7). In the **Name** box enter the new name of the warning issuance scenario. The user can enter a description of the warning issuance scenario in the **Description** box. Click **OK**, the **Rename Warning Issuance Scenario** dialog box closes, and the warning issuance scenario has been renamed.
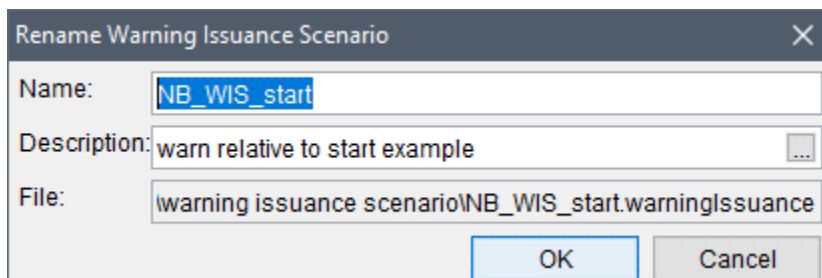
Figure 9.7 Rename Warning Issuance Scenario Dialog Box

9.2.4   Delete from Study

To delete the warning issuance scenario and its associated files from the HEC-FIA project, from the warning issuance scenario shortcut menu (Figure 9.5), click **Delete from Study**, a **Confirm Manager Delete** message window opens (Figure 9.8). By clicking **Yes**, the **Confirm Manager**

Delete message window closes, and the warning issuance scenario and its associated files are deleted from the HEC-FIA project.
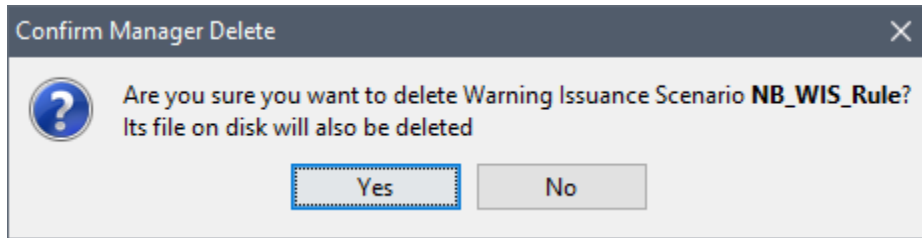
Figure 9.8 Confirm Manager Delete Message Window – Example

9.2.5   Remove from Study

To remove the warning issuance scenario from the HEC-FIA project (does not delete files), from the warning issuance scenario shortcut menu (Figure 9.5), click **Remove from Study**; a **Confirm Removal** window opens (Figure 9.9). By clicking **Yes**, the **Confirm Removal** window closes, and the warning issuance scenario is removed from the HEC-FIA project.
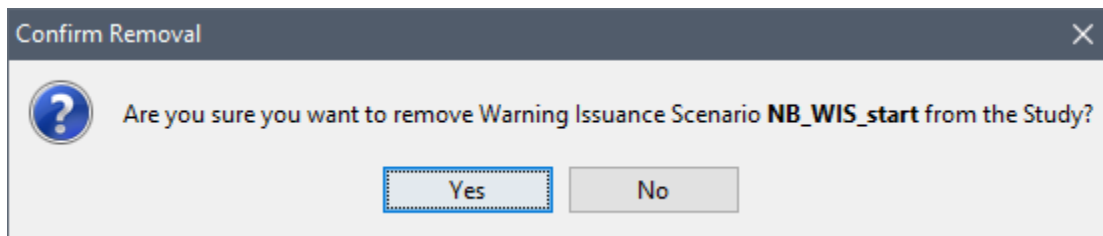
Figure 9.9 Confirm Removal Message Window – Example

CHAPTER 10

Alternatives

In HEC-FIA an alternative is a combination of an inundation configuration (includes watershed configurations), emergency planning zones, structure inventory, critical infrastructure, impact response curves, agricultural data, and computation settings. An alternative describes the data used during an HEC-FIA compute and the computations HEC-FIA performs. In addition to defining the internal data HEC-FIA needs, an alternative is also a mechanism for defining the external data elements that are required to fully define a hydraulic event. HEC-FIA alternatives are important for linking HEC-FIA to other models through the HEC-WAT (Watershed Analysis Tool) software and the CWMS (Corps Water Management System) software.

10.1   Create an Alternative

1.   From the **Study Tree**, which is in the **Study Pane**, right-click on **Alternatives** from the shortcut menu, click **New** (Figure 10.1); and the **New Alternative** dialog box opens (Figure 10.2).
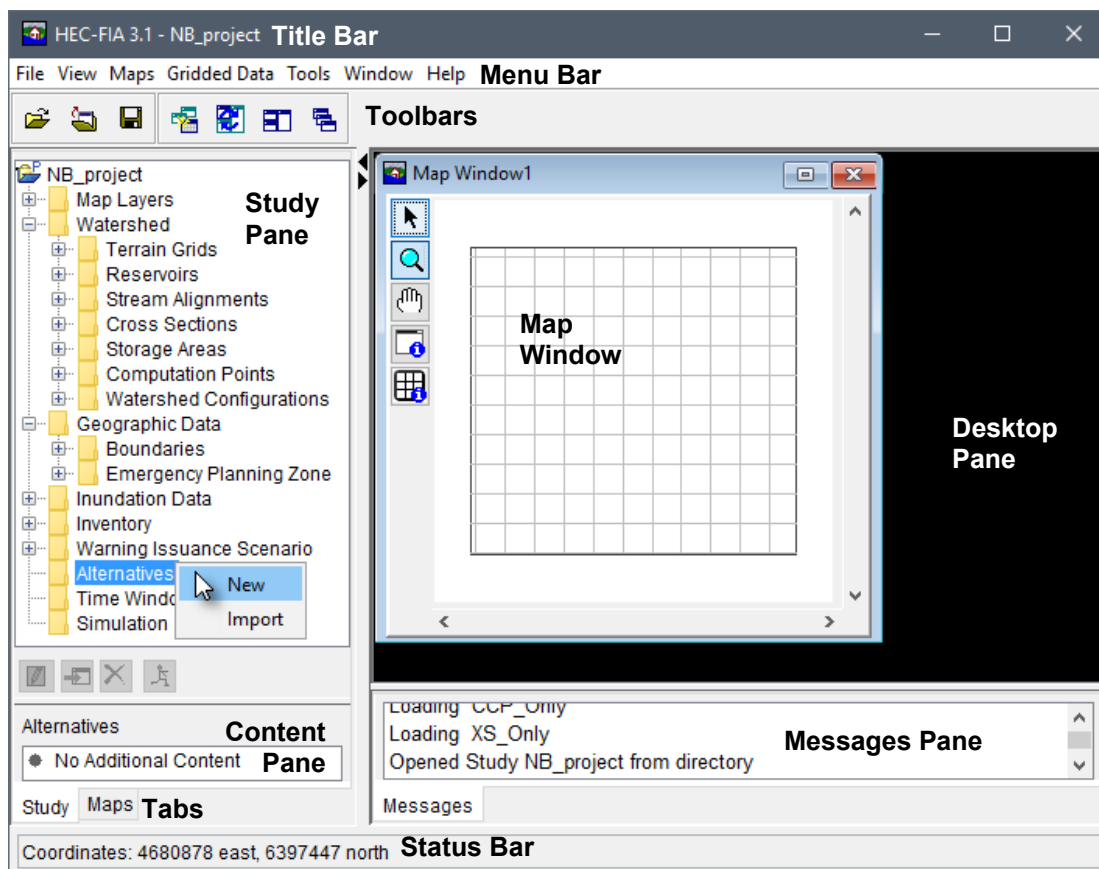
Figure 10.1 Alternatives – Study Tree – Shortcut Menu Commands

Figure 10.2 New Alternative Dialog Box – Default View

2. In the **Name** box (Figure 10.2), enter a name for the alternative. Enter a **Description** for the alternative (optional, but recommended). Beneath the **Name** and **Description**, the top half of the dialog provides dropdown [ ] lists for selecting the data to use during an HEC-FIA computation. The lists only include data created by the user (e.g., inundation configurations).

3. In the **Emergency Planning Zones** list select an emergency planning zones set (formerly called impact area). This selection defines the warning systems being used across the study area.

4. From the **Inundation Configuration** list (Figure 10.2), select an inundation configuration. By selecting an inundation configuration, the alternative now has knowledge of the watershed configuration (terrain grid, stream alignment, reservoirs, cross section geometry, storage areas, and/or common computations points), and the hydraulic information.

5. From the **Structure Inventory** list, select a structure inventory.

6. If a critical infrastructure has been defined, select one from the **Critical Infrastructure** list (Figure 10.2).

7. If an impact response has been defined, select one from the **Impact Response** list (Figure 10.2). The elements available from this list are contingent upon the **Inundation Configuration** selected in Step 4, for these elements must match the inundation configuration selected when the impact response was created (review Chapter 8, Section 8.8).

8. If the HEC-FIA project includes agricultural economics, and agricultural grids have been defined, from the **Agriculture Inventory** list (Figure 10.2), select the appropriate grid.

9. If a warning issuance scenario has been defined and required for the alternative, select one from the **Warning Issuance** list (Figure 10.2). The elements available from this list are contingent upon the **Inundation Configuration** selected in Step 4, for the warn by rule scenarios must match the inundation configuration selected when the scenario was created (review Chapter 9, Section 9.1.2).

10. In the bottom half of the **New Alternative** dialog box (Figure 10.2), the available HEC-FIA compute options are available for selection from seven tabs: **Life Loss**, **Agriculture**, **Uncertainty**, **Reconstruction**, **ECAM**, **Output**, and **Holdout**. Depending on what the user selected in Steps 3 thru 9, certain compute options might not be available. Only the economic loss calculation occurs when the lower half of the alternative window is left blank. Section 10.2 describes the input for each compute option.

11. Click **OK**, the **New Alternative** dialog box closes (Figure 10.2). The alternative has been created and the name appears in the **Study Tree** under the **Alternatives** folder.

10.2   Compute Options for an Alternative

HEC-FIA can analyze a variety of flood damages and impacts through a range of computational methods. For instance, damage to structures can be computed using grids, cross sections, grids and cross sections, or from common computation points. Flood damages and impacts as well as the methods used to estimate them are selected as part of an alternative definition. The selection of elements in the top half of the **New Alternative** dialog box (Figure 10.2) govern which options are available in the lower half of the **New Alternative** dialog box (Figure 10.2).

10.2.1 Life Loss Compute Tab

For a life loss compute, the top half of the **New Alternative** (or **Edit Alternative**) dialog box at minimum must contain a structure inventory with population (e.g., *NB_BaseNSI* in Figure 10.3), an inundation configuration that includes the maximum depth and arrival time for the flood event (e.g., *XS_Only* in Figure 10.3), an emergency planning zone set (e.g., *EPZ* in Figure 10.3), and a warning issuance scenario (e.g., *NB_WIS_start* in Figure 10.3). In addition to the list of required

information, a life loss compute can also contain impact response information (e.g., *NB_ImpactResponse* in Figure 10.3).

From the **Life Loss** tab (Figure 10.3), the user can select several options. For instance, the user can compute life loss for relative times, which allows the user to select time of day other than 2 AM and 2 PM. If the user checks the ☑ checkbox to **Compute Life Loss** (Figure 10.3), HEC-FIA only computes for 2 AM and 2 PM.

Figure 10.3 Edit Alternative Dialog Box – Life Loss Compute Option – Example

The user can also select options impacting the evacuation time at the structures in the floodplain. These options and their data inputs are described below.

Compute Life Loss for Relative Times

The **Compute Life Loss for Relative Times** option (Figure 10.3) allows users to define relative times for the loss of life computations and results. To define the relative time, click the ☑ checkbox next to **Compute Life Loss for Relative Times**, click **Choose Time**, and the **Life Loss Computation Time** dialog box opens (Figure 10.4). Users can select up to twelve times per event. Note, while all HEC-FIA life loss computations are based on relative times, this option allows the user to increase the number of relative times from the 2 AM and 2 PM default times to any other two-hour increment.
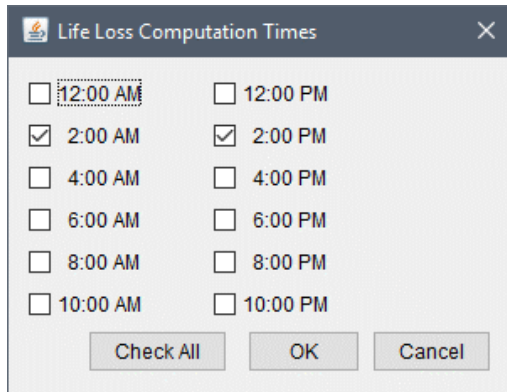
Figure 10.4 Life Loss Computation Times Dialog Box

Let HEC-FIA Compute

From the **Evacuation Information** panel, the **Define Time By** option to **Let HEC-FIA Compute** (Figure 10.5) allows the user to define a hazard area shapefile during the compute that represents the areas that are hazardous. HEC-FIA computes a shortest straight line distance from the structures in the selected hazard area to the edge of the polygon boundary, and divides that distance by the nominal evacuation speed (velocity in miles per hour) to determine an amount of time required to evacuate each structure.
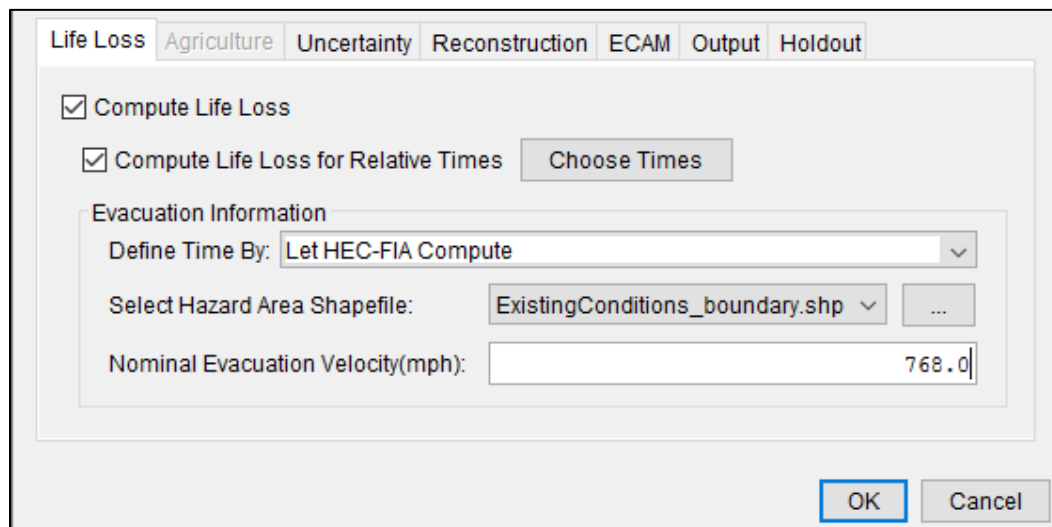
Figure 10.5 Life Loss Compute Option – Let HEC-FIA Compute Option – Example

All Structures

From the **Evacuation Information** panel, the **Define Time By** option set to **All Structures** (Figure 10.6) allows the user to define the time in minutes that the evacuation takes. The same value is used for every structure in the study area.

Figure 10.6 Life Loss Compute Option – All Structures Option – Example

Emergency Planning Zone

From the **Evacuation Information** panel, the **Define Time By** option set to **Emergency Planning Zone** (Figure 10.7) allows the user to define the evacuation time (in minutes) based on the names of polygons in the EPZ set (formerly impact areas) selected from the **Emergency Planning Zones** list, in the top half of the **Create Alternative** dialog box (e.g., *EPZ* in Figure 10.3). HEC-FIA uses the time defined for evacuation for every structure within the zone.

Figure 10.7 Life Loss Compute Option – Emergency Planning Zone Option – Example

10.2.2 Agriculture Compute Tab

For an agriculture compute, the top half of the **New Alternative** (or **Edit Alternative**) dialog box (Figure 10.8) at minimum must contain an inundation configuration for hydraulic data that includes the flood duration and arrival time for the event (e.g., *Grids_and_XS*), and the gridded agriculture inventory (e.g., *NB_NASS_AG*). In addition to the list of required information, it is useful to include an emergency planning zone set (e.g., *EPZ*) for grouping output results.

In HEC-FIA, the agriculture compute is based on the selected agricultural grid and associated budget/duration information for each crop in the grid (review Section 8.9), the hydraulic event, and the time window. In order to compute agricultural damages the user must enable the compute option. From the bottom half of the **New Alternative** (or **Edit Alternative**) dialog box, click the **Agriculture** tab (Figure 10.8), and check the **Compute Agriculture** ☑ checkbox.

Figure 10.8 New Alternative Dialog Box – Agriculture Compute Option – Example

10.2.3 Uncertainty Tab

HEC-FIA uses Monte Carlo simulation methods to incorporate uncertainty into its calculations. Incorporating parameters that consider uncertainty allows for the evaluation of consequences, yielding results that span the range of possible outcomes for a modeled event. Furthermore, policy requires all calculations that contribute to a benefit-to-cost ratio for U.S. Army Corps of Engineers projects be evaluated with a risk-based analysis (see Appendix A, ER1105-2-101). For more details on the specifics of the application of Monte Carlo in HEC-FIA and the input parameters, please review Chapter 9 of the HEC-FIA Technical Reference Guide.

From the **New Alternative** dialog box (Figure 10.2), from the **Uncertainty** tab (Figure 10.9), the user can turn the uncertainty compute option on or off. Check the ☑ checkbox for **Compute With Uncertainty** to turn on this option (Figure 10.9).

Figure 10.9 New Alternative Dialog Box – Uncertainty Compute Option

Uncertainty settings are available at the parameter level. For instance, if the user wishes to sample the foundation height for single family residences with no basement, this uncertainty parameter is set where the foundation height for this occupancy type is defined (accessed from the **Structure Occupancy Type Editor** or the **Structure Editor**, as described in Chapter 9 of this manual). Thus only alternative level uncertainty options are found in the **Uncertainty** tab (Figure 10.9). For instance, from the **Iteration Controls** panel, users can select an option by clicking the radio ⦿ button and specifying that either the computations run **Until Convergence** is reached (selected by default), or **Until Max Iterations** for the simulation is reached for a fixed number of iterations. If compute "Until Convergence" is selected, the parameter to define convergence must be selected; the options are **Loss of Life** or **Total Damage** (economic loss).

From the **Monte Carlo Controls** panel, the users may also select an initial input seed; this ensures the reproducibility of the results. Finally, the parameters **Convergence Tolerance** and **Convergence Confidence Interval** (Figure 10.9) define the necessary parameters to establish that a convergence criterion has been met. For more details on the specifics of these settings please review Chapter 9 of the HEC-FIA Technical Reference Guide.

10.2.4 Reconstruction Tab

The reconstruction compute option is new in HEC-FIA Version 3.1, and facilitates estimates of damages from multiple single events. This new analysis capability provides the ability to incorporate reconstruction of previously damaged structures when estimating structure damages from a second event. For a reconstruction compute, the top half of the **New Alternative** (or **Edit Alternative**) dialog box at minimum must contain a structure inventory (e.g., *NB_BaseNSI* in Figure 10.10), an inundation configuration with hydraulic data for at least two events that includes the flood duration and arrival time for each event (e.g., *XS_Only* in Figure 10.10), and an emergency planning zone set (e.g., *EPZ* in Figure 10.10). In addition to the list of the basic required information, a reconstruction compute that includes life loss and/or ECAM should contain a structure inventory with the population at each structure, and a warning issuance scenario.

To include life loss estimates in the reconstruction compute, complete the **Life Loss** tab as described in Section 10.2.1. To include the Economic Consequences Assessment Model (ECAM), complete the ECAM tab as described in Section 10.2.5. To create the reconstruction compute alternative, select the **Reconstruction** tab and check the ☑ checkbox for **Output Reconstruction Information** (Figure 10.10) to enable the creation of a reconstruction simulation. Note, if there are no alternatives in the HEC-FIA project with the **Output Reconstruction Information** turned on, then the **New Reconstruction Simulation** shortcut command will not be enabled. Next, from the **Reconstruction Controls** (Figure 10.10) the user can select options impacting the reconstruction compute for all structures or a subset of structures in the floodplain. These options and their data inputs are described below.

Define No Reconstruction Zones

From the **Reconstruction Controls**, check the ☑ checkbox for **Define No Reconstruction Zones** (Figure 10.10) to enable the dropdown list and ⬚ button. With this option enabled the user can either select a polygon shapefile from the dropdown list, which contains all valid

shapefiles added as map layers to the project, or click the [...] button to browse to and open the appropriate shapefile. HEC-FIA utilizes the selected polygon shapefile to define the geographic extent of the no reconstruction zone; thus, all structures within the provided zone can only be damaged once, and then the structures are ignored in damage computations for all subsequent events. For example, this option could be useful for identifying structures within a flood zone that lose flood insurance after incurring damages from an event.

Figure 10.10 New Alternative Dialog Box – Reconstruction Compute Option

Define Maximum Reconstruction Events

From the **Reconstruction Controls**, check the ☑ checkbox for **Define Maximum Reconstruction Events** (Figure 10.10) to enable this option. Next, enter an integer value in the box to define the maximum number of reconstruction events for all structures assessed

individually. The integer represents the maximum times a structure can be damaged from an event and be reconstructed before being removed from the structure inventory. For example:

- If a value of 0 is entered, then a structure damaged for the first time will be immediately removed from the structure inventory.

- By default, a value of 1 is entered. A value of 1 will allow a damaged structure to be rebuilt one time; therefore, if a subsequent event damages the structure a second time, the structure will be removed from the structure inventory.

- A value of 2 allows a structure to be flooded twice, reconstructing after both events; however, a third event will damage the structure and remove it from the structure inventory.

Define Maximum Reconstruction Percent

From the **Reconstruction Controls**, check the ☑ checkbox for **Define Maximum Reconstruction Percent** (Figure 10.10) to enable this option. Next, enter a value between 0 and 100 in the box provided. The value entered is used to define the maximum damage a structure can receive as a percentage of the total structure before reconstruction is not allowed. All structures in the structure inventory are assessed individually. Therefore, if a damaged structure requires more reconstruction (as a percent of the total structure) than the user-defined value, reconstruction will not be allowed. For example, if the maximum reconstruction percent value is set to 75, then structures will be removed from the structure inventory if the damage received from any single event is greater than 75 percent of the total structure value.

10.2.5 ECAM Tab

Economic Consequences Assessment Model (ECAM) is a computable general equilibrium model used to evaluate the impact of shocks to the economy in terms of reductions in labor and/or capital. HEC-FIA allows users to access the ECAM model through the internet during simulations. To use ECAM during an HEC-FIA simulation, an internet connection is required. In the context of HEC-FIA, the model is used to evaluate the indirect economic damages associated with a flood event.

As stated above, the ECAM model requires estimates of the reductions in labor and capital due to flood events. Since labor reduction calculations take life loss risks into account, ECAM cannot be run unless the life loss compute option is turned on (review Section 10.2.1). The labor reductions are based on the number of work hours reduced due to people being displaced from their homes due to flooding and life loss. Capital reductions are based on the damages to commercial, industrial, and public structures and their contents. To convert these to ratios, a total supply of available labor and capital must be provided.

Because ECAM runs each county independently, values for labor and capital must be provided for each county in the study area. The total labor and capital must represent the total for the whole county, not the portion of the county in the study area. Available capital is entered as the total value of commercial, industrial and public structures. Labor should be entered as the total

under 65 years of age population at all structures at 2AM. For more detail on the assumptions, please refer to the paper titled "Using HEC-FIA to Identify the Consequences of Flood Events" (Lehman, W.P. et. al. 2014).

For the ECAM compute, the top half of the **New Alternative** (or **Edit Alternative**) dialog box at minimum must contain a structure inventory with population (e.g., *NB_BaseNSI* in Figure 10.11), an inundation configuration that includes the maximum depth and arrival time for the flood event (e.g., *XS_Only* in Figure 10.11), an emergency planning zone set (e.g., *EPZ* in Figure 10.11), and a warning issuance scenario (e.g., *NB_WIS_Rule* in Figure 10.11). In addition to the list of required information, an ECAM with a life loss compute can also contain an impact response (e.g., *NB_ImpactResponse* in Figure 10.3).

Figure 10.11 New Alternative Dialog Box – ECAM Compute Option

Setup the life loss compute from the **Life Loss** tab as described in Section 10.2.1. Enable the ECAM compute option, from the ECAM tab, by checking the ☑ checkbox for **Compute ECAM** (Figure 10.11). Next, from the **County Data Source** panel, select the polygon shapefile from the

County Shapefile list (Figure 10.11) that represents the counties in the study area. Select the polygon shapefile from the dropdown [   ] list, which contains all valid shapefiles added as map layers to the project; alternatively, click the [...] button to browse to and open the appropriate shapefile. Following the county shapefile selection from the **5 Digit FIPS** list (Figure 10.11), select the appropriate field name (e.g., *GEOID*) that contains the county's 5 digit Federal Information Processing Standard (FIPS) code ("SSCCC", where SS is a two digit state code and CCC is a three digit county code). The county data table (located at the bottom of the ECAM tab) updates with the County FIPS and County Name attributes contained in the selected shapefile. Enter the Total Capital and Total Labor values for each county in the study area.

10.2.6 Output Tab

The **New Alternative** (or **Edit Alternative**) dialog box contains an **Output** tab (Figure 10.12). For alternatives that include uncertainty (review Section 10.2.3), from the **Output** tab, from the **Monte Carlo Intermediate Values** panel (Figure 10.12), the user can turn on (check the ☑ checkbox) additional Monte Carlo output options (**Store All Randoms**, **Store All Sampled Values**, **Fatality Rate Randoms** and **Fatality Rate Samples**). By default HEC-FIA turns off (☐ unchecked) most output options during Monte Carlo runs due to the size of those outputs.

In addition to the Monte Carlo output options, from the **Output** panel, HEC-FIA allows users to turn on the option (check the ☑ checkbox), to include **Hydraulic Inputs By Structure** output data for quality assurance or quality control purposes (Figure 10.12).
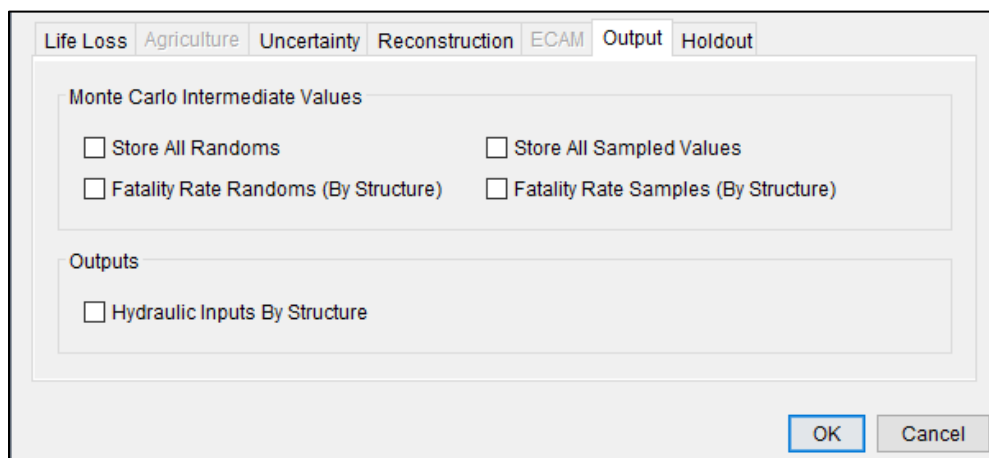
Figure 10.12 New Alternative Dialog Box – Additional Output Compute Options

10.2.7 Holdout Tab

The flood damages reduced compute option is new in HEC-FIA Version 3.1, and is the comparative evaluation of at least one project (e.g., storage areas with levees, reservoirs with holdouts) to the hypothetical condition of no project. For a flood damages reduced compute, the top half of the **New Alternative** (or **Edit Alternative**) dialog box at minimum must contain a structure inventory with population (e.g., *NB_BaseNSI* in Figure 10.13), the inundation configuration must be a holdouts configuration (e.g., *FloodDamagesReduced* in Figure 10.13), and an emergency planning zone set (e.g., *EPZ* in Figure 10.13).

In the case that the project includes reservoirs with holdouts and an HEC-ResSim *.dss* time series data is not provided (review Chapter 7, Section 7.1.5), users can turn on the option to use the holdout override table, from the **Holdout** tab (Figure 10.13). The override table option allows the user to manually enter the reservoir contribution to each holdout distribution area for apportioning the influence of reservoirs on the change in damage estimates throughout the study area. To use this override table, check the ☑ checkbox for **Use Alternative Holdout Distribution Table Override** to turn on this option (Figure 10.13).

The override table lists the reservoir names across the top of the table, and each row lists the name of the holdout distribution area (contained in the watershed configuration). To complete the override table, enter a value in the cell (between 0.0 and 100.0) that represents the reservoir contribution (in percent of the total allocation) to the holdout area. The total contribution for all reservoirs (e.g., *Jennings Randolph* and *Savage* reservoirs in Figure 10.13) for each holdout area (e.g., *Jennings* holdout area) must sum to 100 percent. As displayed in Figure 10.14, each row (holdout area) sums to 100.0 between the two reservoirs.

Figure 10.13 New Alternative Dialog Box – Flood Damages Reduced – Holdouts Tab
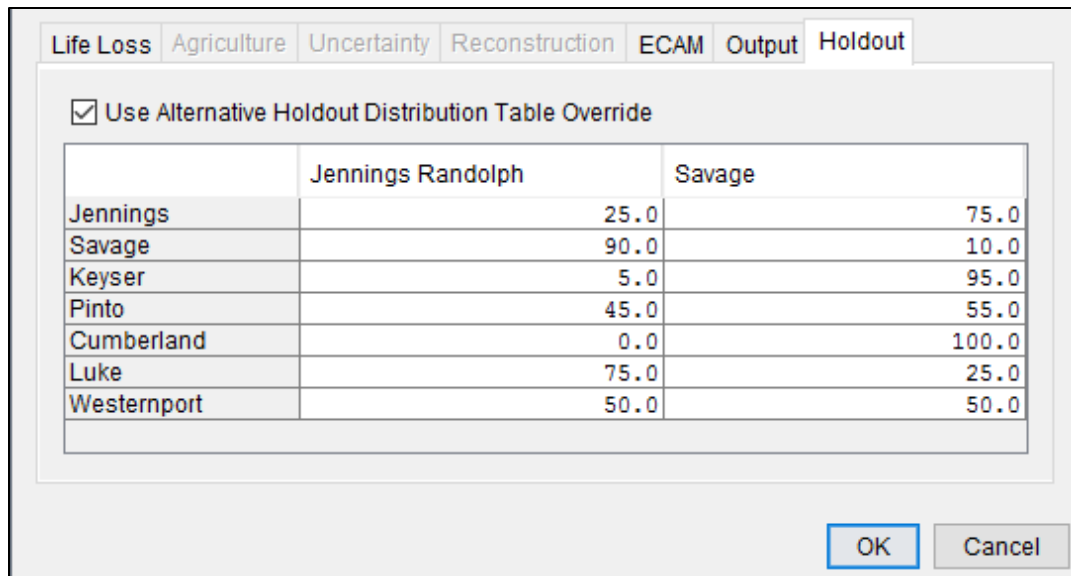
Figure 10.14 Flood Damages Reduced – Holdout Override Table Option – Example

Note, if the user sets the holdout inundation configuration to use HEC-ResSim DSS data, but later decides to override the DSS data, then the user can just turn on the option to use the override table to set the reservoir contribution without needing to modify the inundation configuration. In other words, if the flood damages reduced holdout inundation configuration has an HEC-ResSim *.dss* time series data provided, then HEC-FIA calculates the reservoir contributions based on the provided time series data. However, if the user provides both, the override table overrides the HEC-ResSim data.

10.3   Import Existing Alternative

1.   From the **Study Tree**, right-click on **Alternatives** from the shortcut menu, click **Import** (Figure 10.1), and the **Import Alternatives** dialog box opens (Figure 10.15).
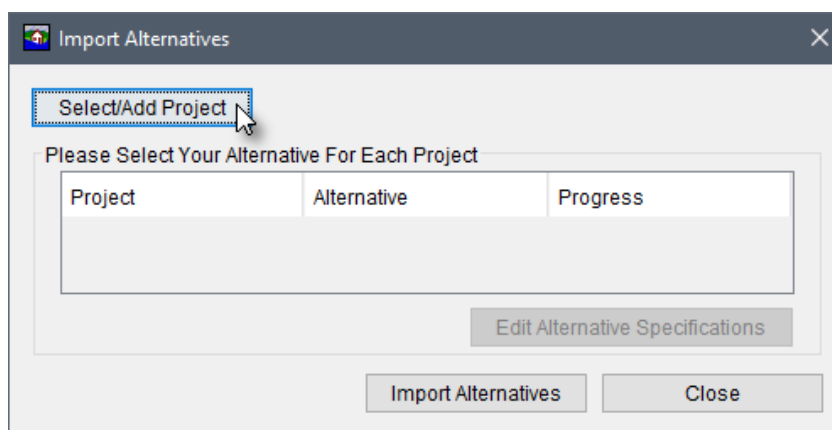
Figure 10.15 Import Alternatives Dialog Box

2.   From the **Import Alternatives** dialog box, click the **Select/Add Project** button, an **Open** browser window opens (Figure 10.16). Navigate to the folder that contains the HEC-FIA model alternative(s) to be imported. Select the HEC-FIA project filename (*.prj*) of interest, which is not the same as a shapefile projection file (*.prj*). The HEC-FIA project

filename (e.g., *NB_project.prj*) appears in the **File name** box, click **Open**. The **Open** browser window closes, and the **Import Alternatives** dialog box updates (Figure 10.17).
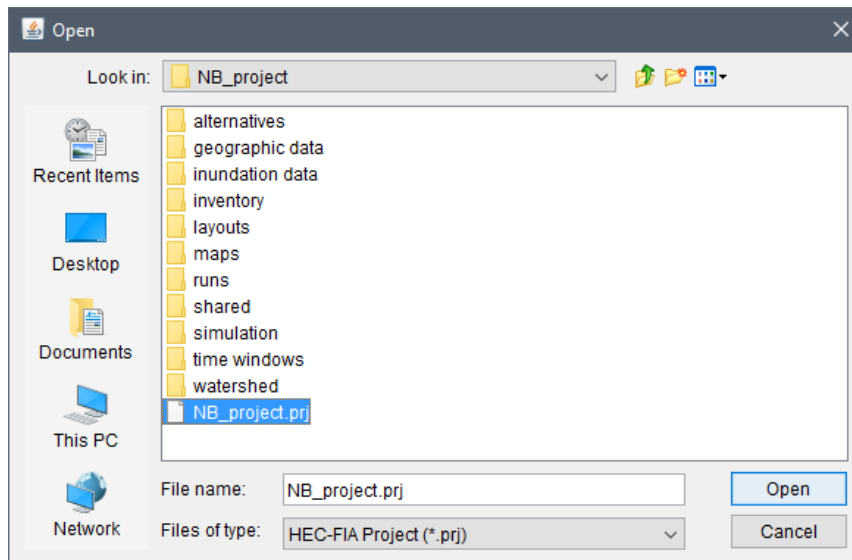
Figure 10.16 Open Browser Window
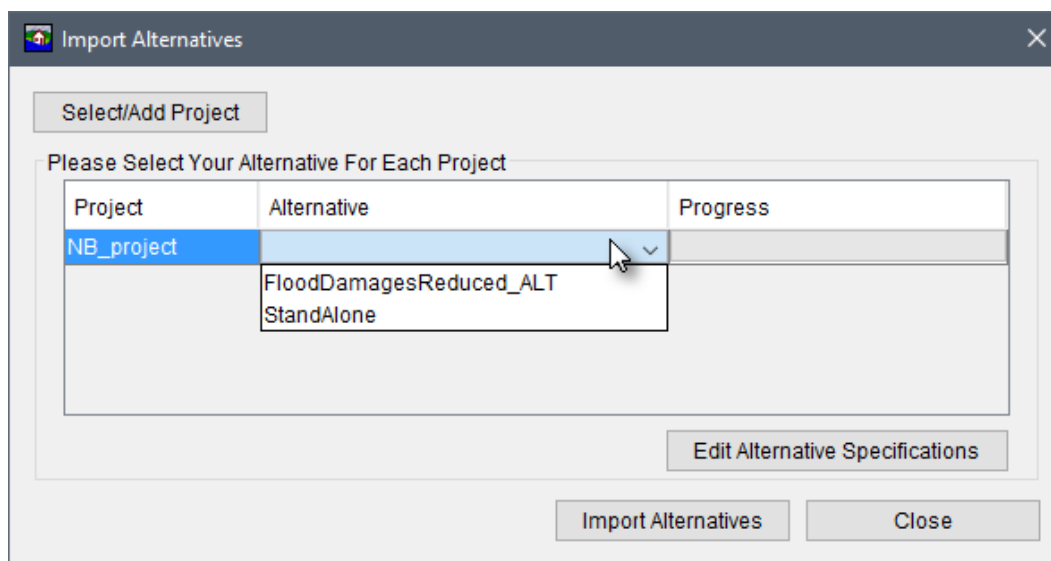
Figure 10.17 Import Alternatives Dialog Box – Example Import

3. The table now contains the name of the **Project** (e.g., *NB_project*). From the Alternatives column select the alternative to import (e.g., *FloodDamagesReduced_ALT*) from the dropdown list (Figure 10.17).

4. Repeat Steps 2 through 3 to select additional alternatives to import either from the same project or from a different HEC-FIA project.

5. From the **Import Alternatives** dialog box, click the **Edit Alternative Specifications** button, the **Alternative Specification** dialog box opens (Figure 10.18). The checkbox to **Copy Projection from project** should be checked ☑ by default, click **OK**.
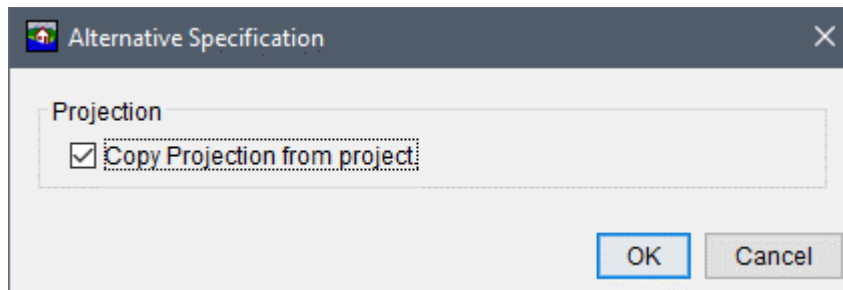
Figure 10.18 Alternative Specification Dialog Box

6. From the **Import Alternatives** dialog box, click the **Import Alternatives** button (Figure 10.17), in the **Progress** column of the table the cell provides a green progress bar displaying the import for the selected alternative(s). An **Information** message window opens when the import is complete, click **OK**.

7. From the **Import Alternatives** dialog box, click **Close** (Figure 10.17). The HEC-FIA alternative(s) appear in the **Study Tree** under the **Alternatives** folder.

10.4   Alternative Shortcut Menu

Once an alternative has been created (or imported) the user can perform various functions on the alternative from a shortcut menu. From the **Study Tree**, under the **Alternatives** folder, right-click on a defined alternative (e.g., *FloodDamagesReduced*). From the shortcut menu (Figure 10.19), the user can display the alternative in the active map window, edit the alternative, save/save as, rename, delete from the HEC-FIA project, remove from the HEC-FIA project, and review properties of the alternative file.
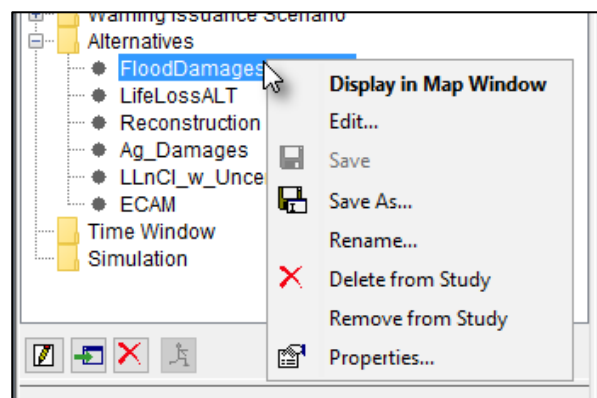
Figure 10.19 Alternative – Study Tree – Shortcut Menu Commands

10.4.1 Edit Alternative

To edit an alternative, from the alternative shortcut menu (Figure 10.19), click **Edit**, the **Edit Alternative** dialog box opens (Figure 10.20). From the top half of the **Edit Alternative** dialog box, the user can edit the various elements that define the alternative, and from the bottom half of the dialog the user can select specific tabs to edit any of the available compute options.

Figure 10.20 Edit Alternative Dialog Box – Example Flood Damages Reduced Alternative

10.4.2 Save As

To create a copy of an alternative, from the alternative shortcut menu (Figure 10.19), click **Save As**, the **Save Alternative As** dialog box opens (Figure 10.21). In the **Name** box enter the name of the new alternative. The user can enter a description for the alternative in the **Description** box. Click **OK**, the **Save Alternatives As** dialog box closes, and the new alternative is created.
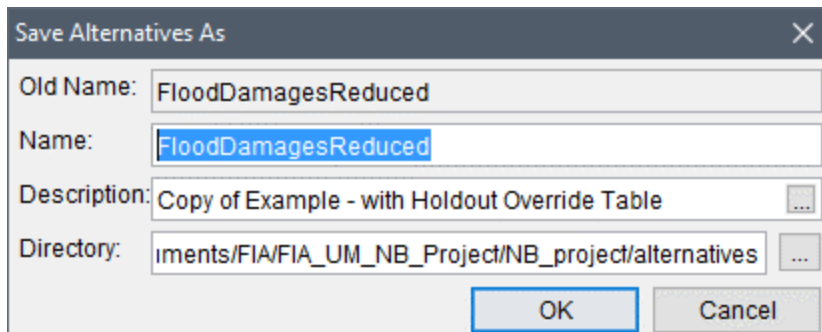
Figure 10.21 Save Alternatives As Dialog Box

10.4.3 Rename

To rename an alternative, from the alternative shortcut menu (Figure 10.19), click **Rename**, the **Rename Alternatives** dialog box opens (Figure 10.22). In the **Name** box enter the new name of the alternative. The user can enter a description for the alternative in the **Description** box. Click **OK**, and the **Rename Alternatives** dialog box closes. The alternative listed under the **Alternatives** folder in the **Study Tree** is renamed.
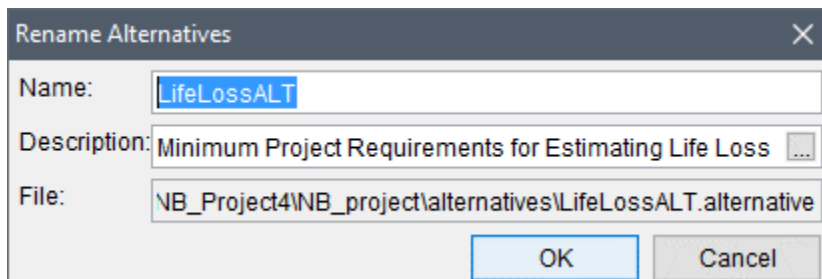
Figure 10.22 Rename Alternatives Dialog Box

10.4.4 Delete from Study

To delete the alternative and its associated files from the HEC-FIA project, from the alternative shortcut menu (Figure 10.19), click **Delete from Study**, a **Confirm Manager Delete** message window opens (Figure 10.23). By clicking **Yes**, the **Confirm Manager Delete** message window closes, and the alternative and its associated files are deleted from the HEC-FIA project.
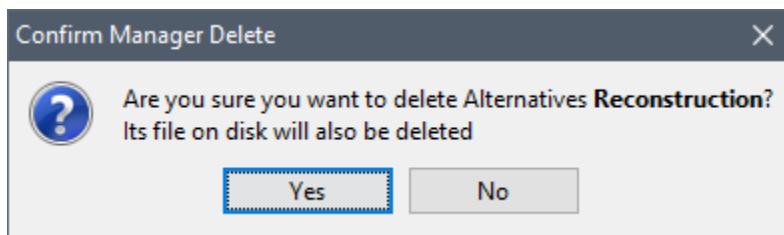
Figure 10.23 Confirm Manager Delete Message Window – Example

10.4.5 Remove from Study

To remove the alternative from the HEC-FIA project (does not delete files), from the alternative shortcut menu (Figure 10.19), click **Remove from Study**; a **Confirm Removal** message window opens (Figure 10.24). By clicking **Yes**, the **Confirm Removal** message window closes, and the alternative is removed from the HEC-FIA project.
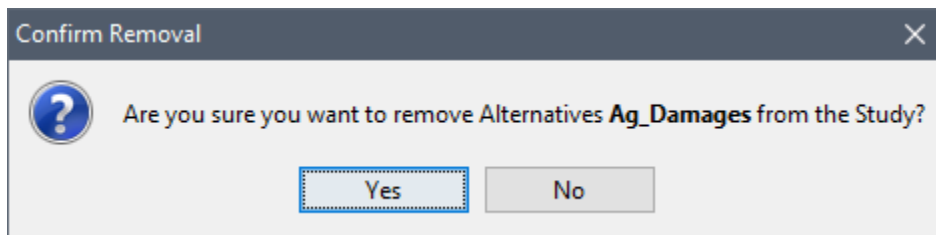
Figure 10.24 Confirm Removal Message Window – Example

CHAPTER 11

Time Windows

A time window defines the simulation start and end dates and times for a simulation. When creating time windows for cross section based simulations, the time window has to be set to match the time series time window of the data in the HEC-DSS file. For HEC-DSS time series data, the time window can be set to a subset of the length of the time series, but it cannot be extended on either end of the time series. When creating time windows for gridded data everything is set relative to the start time of the time window since the gridded data does not contain date time information. However, the simulation time window should contain the full length of time used by the hydraulic simulation to compute arrival time grids, if life loss is being computed by the HEC-FIA project.

When creating time window(s) for reconstruction computes, two options are available. The first option is to create a time window for each individual event, following the time window requirements for HEC-DSS time series data described above. The second option is to use the same time window for a subsequent event, but from the **Simulation Manager** dialog box set a simulation start offset (in days) for different events utilizing the same time window (refer to Section 12.1.2). The start offset option is only offered for reconstruction computes using a gridded inundation configuration and is available regardless of using the same or different time windows for each event.

11.1   Create a Time Window

1.   From the **Study Tree**, which is in the **Study Pane**, right-click on **Time Window** from the shortcut menu, click **New**. The **Create New Time Window** dialog box opens (Figure 11.1).
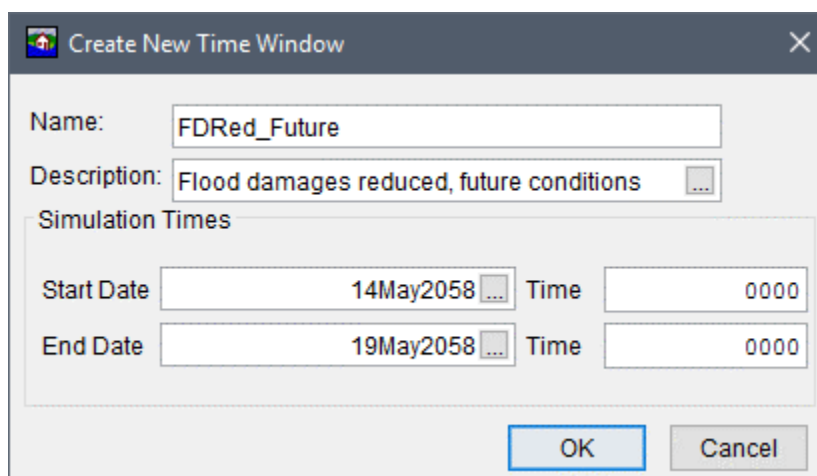
Figure 11.1 Create New Time Window Dialog Box – Example

2. In the **Name** box (Figure 11.1) enter a name for the time window.

3. For the start date enter a date using the format *ddmmmyyyy* in the **Start Date** box (Figure 11.1). The start time must be entered in twenty-four hour clock time in the **Time** box and this time needs to occur after or at the start of the data referenced in the HEC-DSS record.

4. For the end date, enter a date using the format *ddmmmyyyy* in the **End Date** box (Figure 11.1). The **End Date** must be later than the **Start Date**; the simulation ends when the end date occurs, so it must include all of the hydrographs that are to be modeled. The end time is entered in twenty-four hour clock time in the **Time** box.

5. Click **OK**, the **Create New Time Window** dialog box (Figure 11.1) closes. The time window has been created and the name appears in the **Study Tree** under the **Time Window** folder.

11.2   Time Window Shortcut Menu

Once a time window has been created, the user can manipulate the time window from a shortcut menu. From the **Study Tree**, from **Time Window** folder, right-click on a defined time window (e.g., *FDRed_Future*). From the shortcut menu (Figure 11.2) the user can edit, save/save as, rename, delete from the HEC-FIA project, and review properties of the selected time window. If more than one time window has been defined, the user can adjust the order of the time windows under the **Time Window** folder.
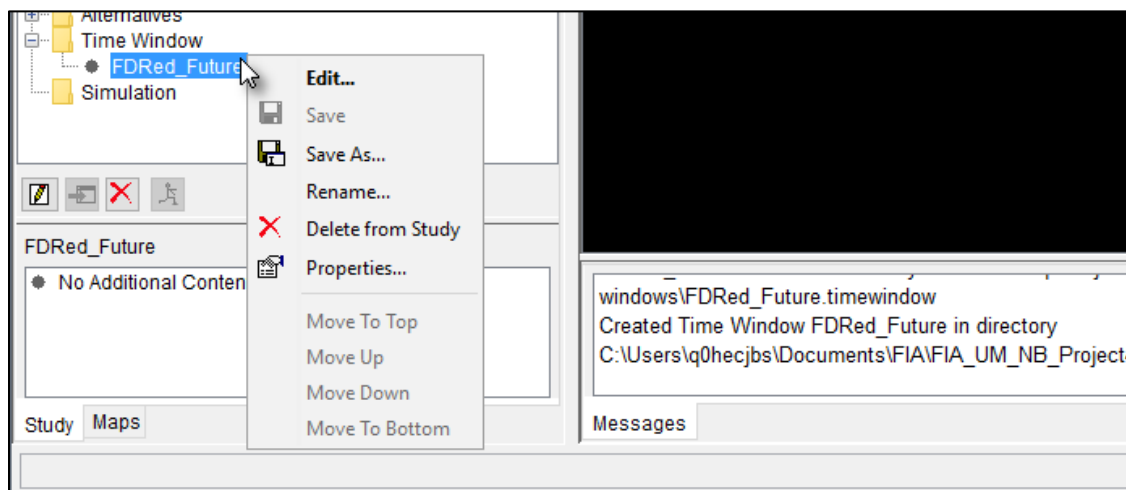
Figure 11.2 Time Window – Study Tree – Shortcut Menu Commands

11.2.1 Edit

To edit a time window, from the time window shortcut menu (Figure 11.2), click **Edit** and the **Time Window** dialog box opens (Figure 11.3). The user can edit the **Start Date** and time and the **End Date** and time.
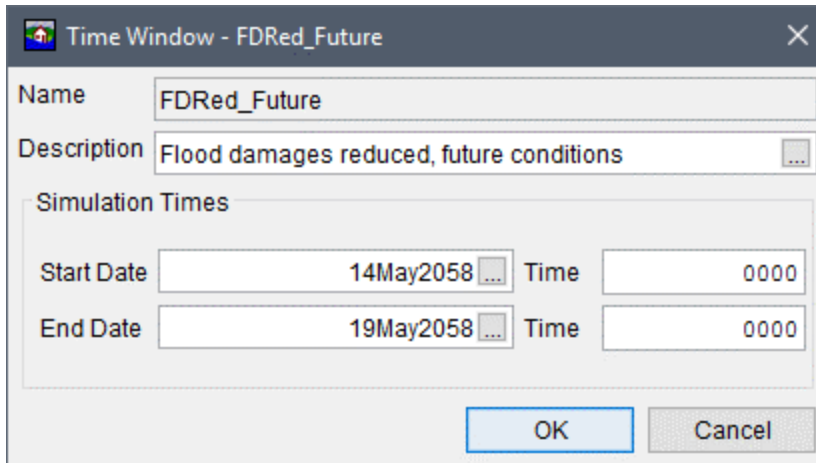
Figure 11.3 Time Window Dialog Box – Edit Selected Time Window

11.2.2 Save As

To create a copy of the time window, from the time window shortcut menu (Figure 11.2), click **Save As**, the **Save Time Window As** dialog box opens (Figure 11.4). In the **Name** box enter the name of the new time window. The user can enter a description for the time window in the **Description** box. Click **OK**, the **Save Time Window As** dialog box closes, and the new time window is created.
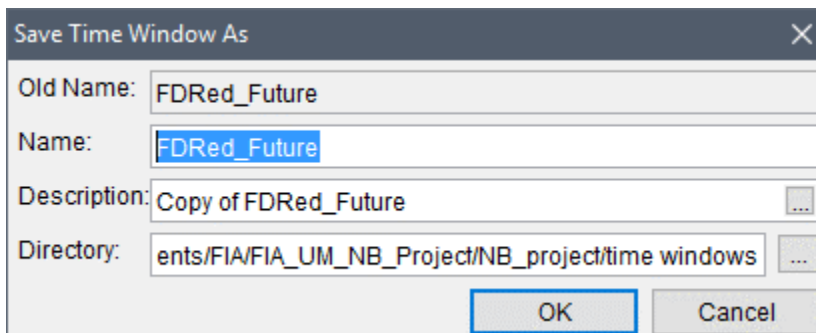
Figure 11.4 Save Time Window As Dialog Box

11.2.3 Rename

To rename a time window, from the time window shortcut menu (Figure 11.2), click **Rename**, the **Rename Time Window** dialog box opens (Figure 11.5). In the **Name** box enter the new
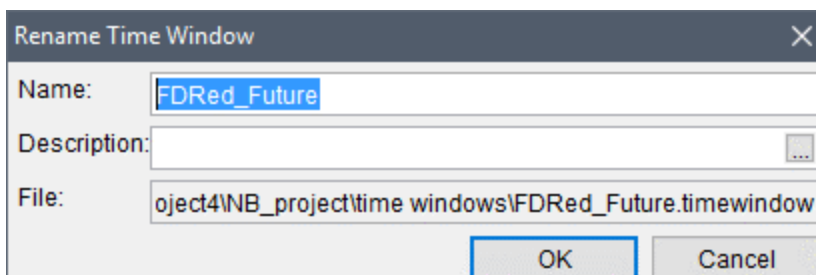
Figure 11.5 Rename Time Window Dialog Box

name of the time window. The user can enter a description for the time window in the **Description** box. Click **OK** and the **Rename Time Window** dialog box closes. From the **Study Tree**, under the **Time Window** folder, the time window is renamed.

11.2.4 Delete from Study

To delete a time window and its associated files from the HEC-FIA project, from the time window shortcut menu (Figure 11.2), click **Delete from Study**, a **Confirm Manager Delete** message window opens (Figure 11.6). By clicking **Yes**, the **Confirm Manager Delete** message window closes, and the time window and its associated files are deleted from the HEC-FIA project.

Figure 11.6 Confirm Manager Delete Message Window

11.2.5 Move Up/Move Down, Move To Top/Move To Bottom

The time window order can be adjusted when more the one time window is defined in an HEC-FIA project. From the time window shortcut menu (Figure 11.2), the **Move To Top**, **Move Up**, **Move Down**, and **Move To Bottom** items are available. By clicking on one of those menu items the user can adjust the order of the time windows under the **Time Window** folder in the **Study Tree**.

CHAPTER 12

Simulations and Results

A simulation manager in HEC-FIA is a combination of individual simulations. A simulation connects an alternative with an event and a time window. The user can add the same alternative for multiple events, allowing the events to be run in the same simulation group. Alternatively, multiple alternatives can be matched to the same event, allowing the evaluation of damages to be based on changes in the floodplain (such as structural and nonstructural measures) identified in the alternative, through the watershed configuration or other changes in the alternative.

When computing damages for a single event in HEC-FIA, all structures are assumed to be fully valued. However, under some conditions, it could be the case that structures had been recently flooded by a separate event. HEC-FIA Version 3.1 added the new reconstruction compute option to facilitate in the analysis of computing an estimate of damages for the second event (or multiple subsequent events) where structures are in the process of being reconstructed from the first (or previous) event.

12.1   Creating Simulations

Two options are now available for creating simulations. The first option is the original option to create a simulation for one or more alternative, event, and time window. The second option, new to HEC-FIA Version 3.1, is the reconstruction simulation. The reconstruction simulation can only be used for alternatives that have the reconstruction compute option turned on (review Section 10.2.4). Instructions for creating simulations from these two options are described below.

12.1.1 Create a Simulation

To create a standard simulation:

1. From the **Study Tree**, which is in the **Study Pane**, right-click on **Simulation**, from the shortcut menu, click **New Simulation** (Figure 12.1). The **Simulation Manager** dialog box opens (Figure 12.2).

2. Enter a name in the **Name** box for the simulation. A description for the simulation group can be added in the **Description** box.

3. Next the user must add an alternative (or multiple alternatives) to the simulation group. Click **Add**, a row is added to the table. The user can add the same alternative for multiple events, allowing them to be run in the same simulation group. Alternatively, multiple alternatives can be matched to the same event, allowing the evaluation of damages to be

based on changes in the floodplain (such as structural and nonstructural measures) identified in the alternative, through the watershed configuration or other changes in the alternative. To do this, from the **Alternative** column the user selects the defined alternative from a list; from the **Event** column, selects events that have been defined for the selected alternative; and, from the **Time Window** column select defined time windows.
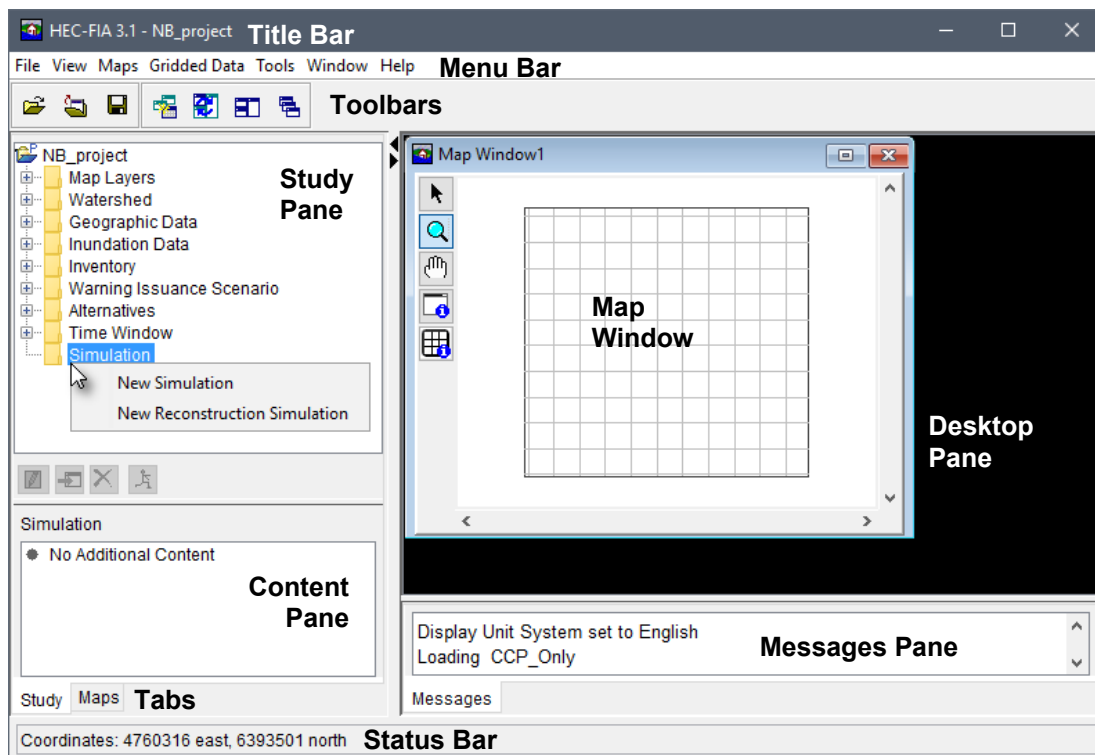
Figure 12.1 Simulation – Study Tree – Shortcut Menu Commands
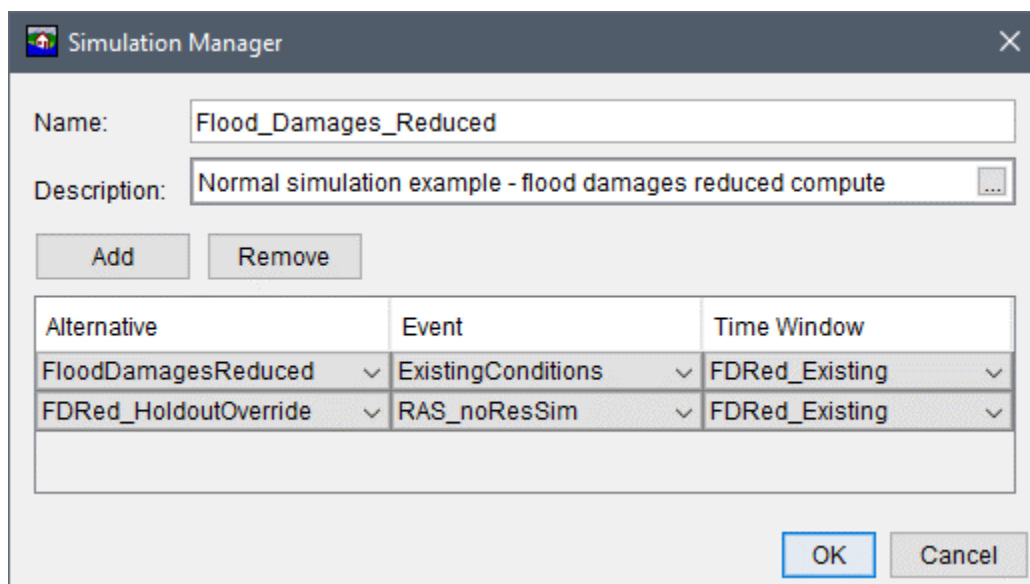
Figure 12.2 Simulation Manager Dialog Box – Example Simulation

4.   Once the simulation is defined, click **OK**. The **Simulation Manager** dialog box closes (Figure 12.2). The name of the simulation (i.e., *Flood_Damages_Reduced*) appears in the **Study Tree** below the **Simulation** folder.

12.1.2 Create a Reconstruction Simulation

To create a reconstruction simulation:

1.   From the **Study Tree**, which is in the **Study Pane**, right-click on **Simulation**, from the shortcut menu, click **New Reconstruction Simulation** (Figure 12.1). The **Simulation Manager** dialog box opens (Figure 12.3). Note, an alternative must exist with the reconstruction option turned on in order for this shortcut menu option to be enabled (review Section 10.2.4).

Figure 12.3 Simulation Manager Dialog Box – Example Reconstruction Simulation

2.   Enter a name in the **Name** box for the simulation. A description for the simulation group can be added in the **Description** box.

3.   Next the user must select an alternative from the **Alternative** list. The selected alternative enables the **Event** column to list all events contained in the inundation configuration selected for the alternative.

4.   To select any event from the inundation configuration (for the selected alternative) click the **Add** button, and a row is added to the table. Next, from the **Event** column, select the first event in the series of events for the first row. Add additional events by clicking the **Add** button as required. **Important:** The events are computed by HEC-FIA in order from the top of the table to the bottom.

To reorder events in the **Simulation Editor** click ⬆, to move the selected event up one row; or click ⬇, to move the selected event down one row.

5. Next, for each event select the appropriate time window for the event from the **Time Window** column. Note, for hydraulic data from HEC-DSS time series records, the time window must match the data in the HEC-DSS file (time window start and end date and time cannot extend beyond the data in the HEC-DSS file).

6. The **Start Offset (Days)** column allows the user to move the start of the selected **Event** (the arrival time of the flood) by a set number of integer days. Entering a negative number of days will push the entire flood backward in time, and entering a positive integer will push the flood forward in time, from the start of the selected **Time Window**. For example, if all events in the inundation configuration use the same time window, then the events can be staggered by simply putting increasing numbers into the **Start Offset (Days)** column. As displayed in Figure 12.4, another use of the start offset is the ability to move an event around in time to put one event in front of another.

    Note: The start offset only works for a grids only inundation configuration.
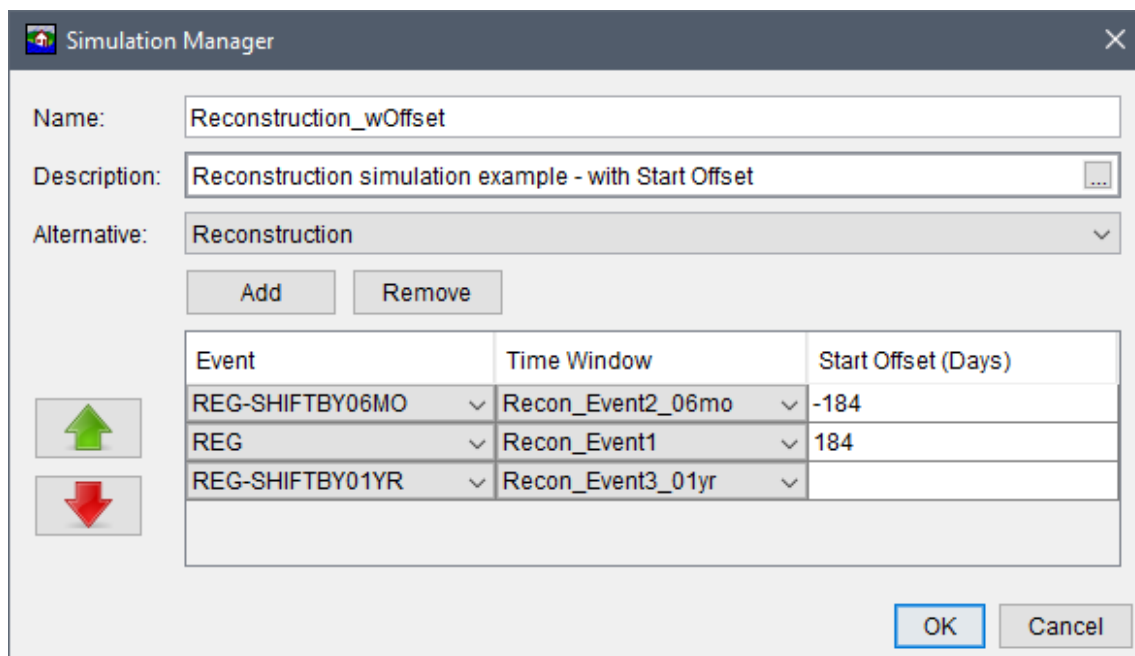
Figure 12.4 Simulation Manager Dialog Box – Reconstruction Simulation – Start Offset Example

7. Once the reconstruction simulation is defined, click **OK**. The **Simulation Manager** dialog box closes (Figure 12.4). The name of the simulation (i.e., *Reconstruction*) appears in the **Study Tree** below the **Simulation** folder.

12.2   Simulation Shortcut Menu

Once a simulation has been created the user can perform various functions on the simulation from a shortcut menu. From the **Study Tree**, under the **Simulation** folder, right-click on the created simulation (e.g., *Basic_LifeLoss_Sim*). From the shortcut menu (Figure 12.5) the user can edit the simulation, compute the simulation, save as, rename, delete from the HEC-FIA project, remove from the HEC-FIA project, and review properties of the simulation file.
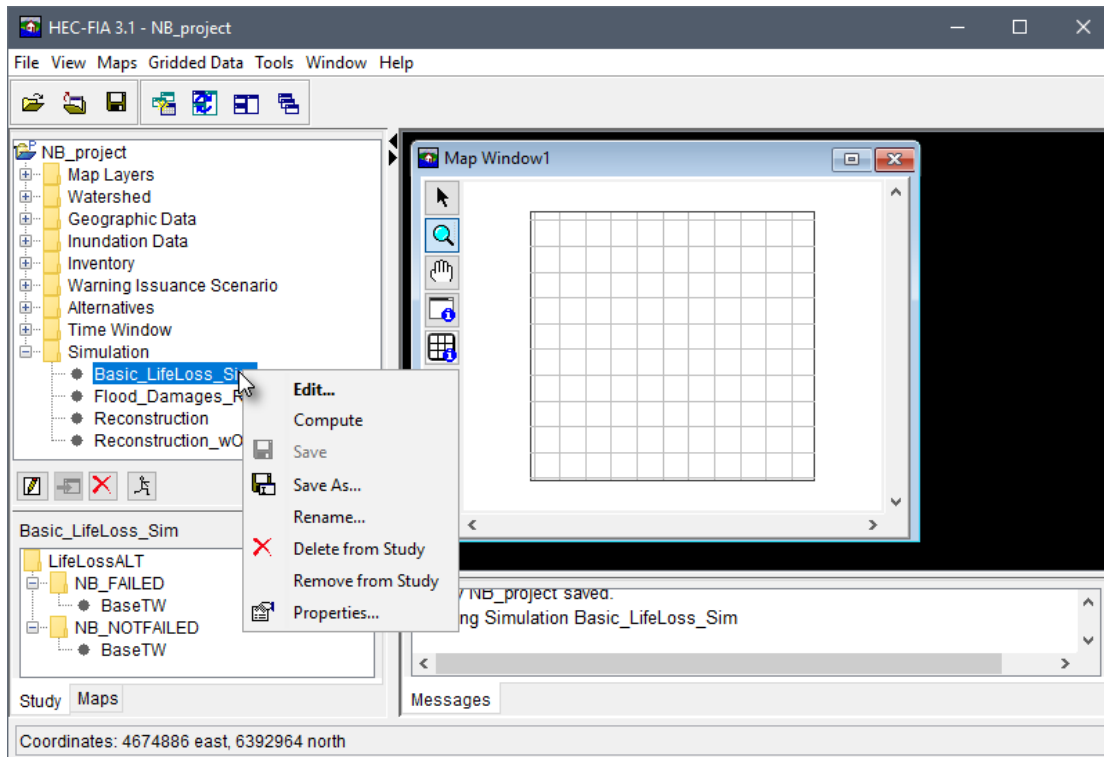
Figure 12.5 Simulation – Study Tree – Shortcut Menu Options

12.2.1 Edit

To edit a simulation, from the simulation shortcut menu (Figure 12.5), click **Edit**, the **Simulation Manager** dialog box opens for the selected simulation (Figure 12.2).

12.2.2 Compute

Run a simulation group:

1. From the **Study Tree**, from the **Simulation** folder, right-click on a defined simulation (i.e., *Basic_LifeLoss_Sim*). From the simulation shortcut menu (Figure 12.5) click **Compute**. Alternatively, from the **Study Pane Action Toolbar**, the user can click the **Compute** action button.

2. The **Compute Progress** dialog box opens (Figure 12.6). This dialog provides the user with information on the progress of the selected simulation. Error and warning messages are color-coded. Specifically, red text indicates an error in the simulation setup (e.g., "*Undefined Night Warning System Function defined for…*"), and yellow-orange text indicates a warning message. Note, some compute warning messages appear in the **Messages Pane** instead of the **Compute Progress** dialog box.

3. When the compute is finished click **Close**, the **Compute Progress** dialog box closes (Figure 12.6). The user can now review the results for the simulation (review Section 12.3).
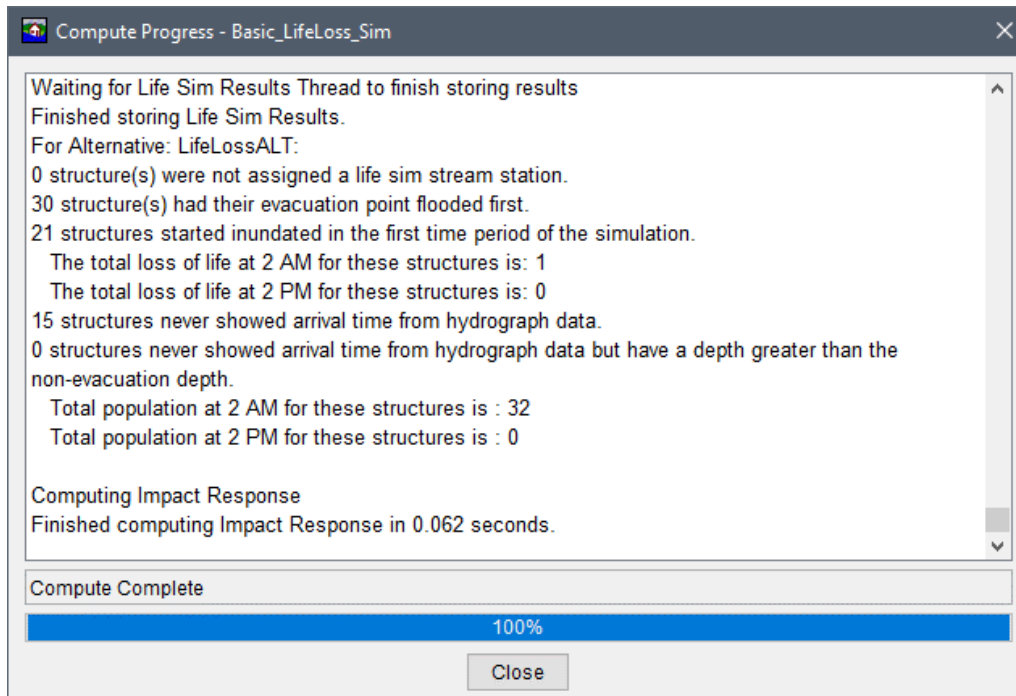
Figure 12.6 Compute Progress Dialog Box – Example

12.2.3 Save As

To create a copy of a simulation, from the simulation shortcut menu (Figure 12.5), click **Save As**, the **Save Simulation As** dialog box opens (Figure 12.7). In the **Name** box enter the name of the new simulation. The user can enter a description for the simulation in the **Description** box. Click **OK**, the **Save Simulation As** dialog box closes, and the new simulation is created.
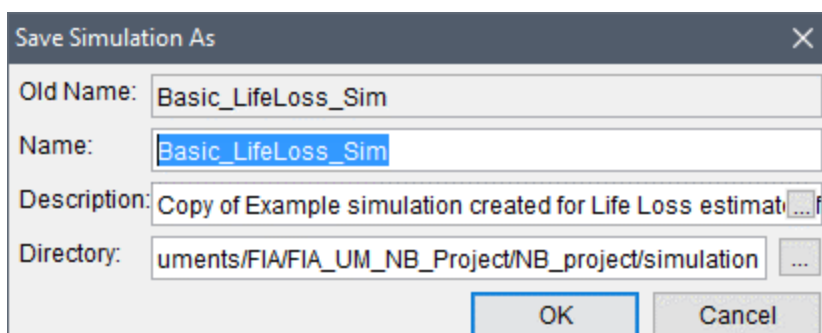

Figure 12.7 Save Simulation As Dialog Box

12.2.4 Rename

To rename a simulation, from the simulation shortcut menu (Figure 12.5), click **Rename**, the **Rename Simulation** dialog box opens (Figure 12.8). In the **Name** box enter the new name of the simulation. The user can enter a description for the simulation in the **Description** box. Click **OK**, the **Rename Simulation** dialog box closes, and the simulation has been renamed.
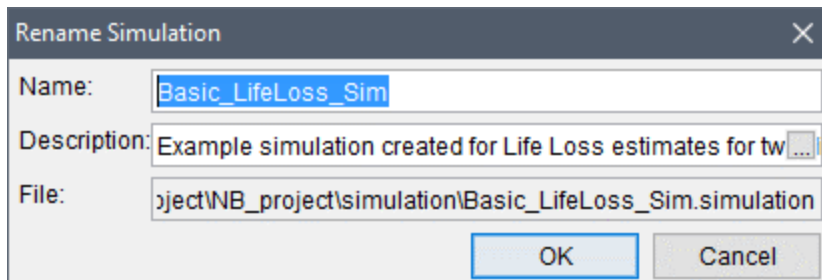
Figure 12.8 Rename Simulation Dialog Box

12.2.5 Delete from Study

To delete a simulation and its associated files from the HEC-FIA project, from the simulation shortcut menu (Figure 12.5), click **Delete from Study**, a **Confirm Manager Delete** message window opens (Figure 12.9). By clicking **Yes**, the **Confirm Manager Delete** message window closes, and the simulation and its associated files are deleted from the HEC-FIA project.
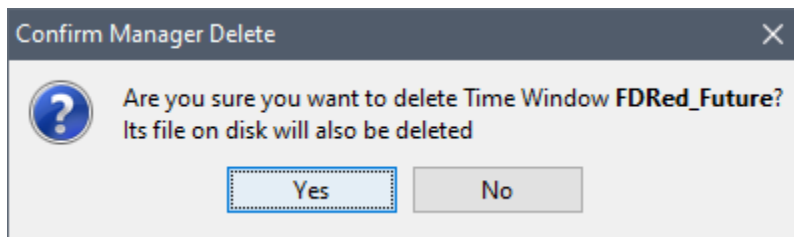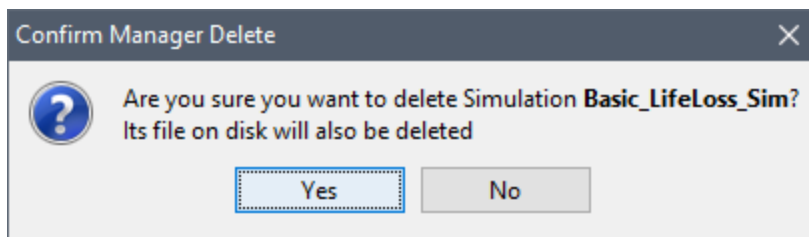

Figure 12.9 Confirm Manager Delete Message Window

12.2.6 Remove from Study

To remove a simulation from the HEC-FIA project (does not delete files), from the simulation shortcut menu (Figure 12.5), click **Remove from Study**; a **Confirm Removal** message window opens (Figure 12.10). By clicking **Yes**, the **Confirm Removal** message window closes, and the simulation is removed from the HEC-FIA project.
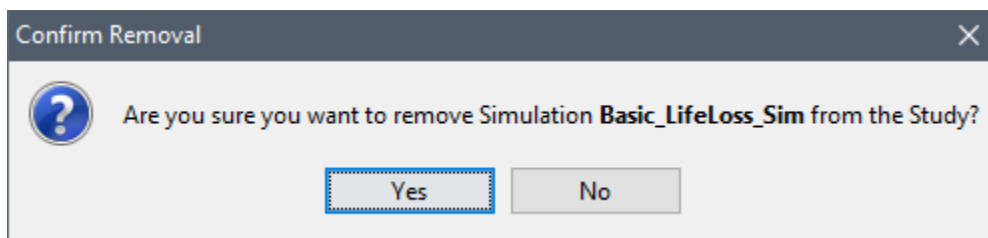
Figure 12.10 Confirm Removal Message Window

12.3   Viewing Results

Simulation results can be viewed in several internally generated reports. The next few sections outline the general properties of the available reports. When a simulation is run in HEC-FIA, a file structure is developed to store the results (review Section 3.2 for project directory structure). The file structure begins in the root directory with the *runs* sub-directory, the next folder in the

sub-directory is the alternative name, followed by a subfolder with the event name, and finally a subfolder with the time window name. Inside of the last folder are the results from that simulation. The **Content Pane** displays this general folder structure when the simulation is selected in the study window. When the node named by the time window is right-clicked (e.g., *BaseTW* in Figure 12.11), the user receives the options for results reporting available based on the selections in the alternative.
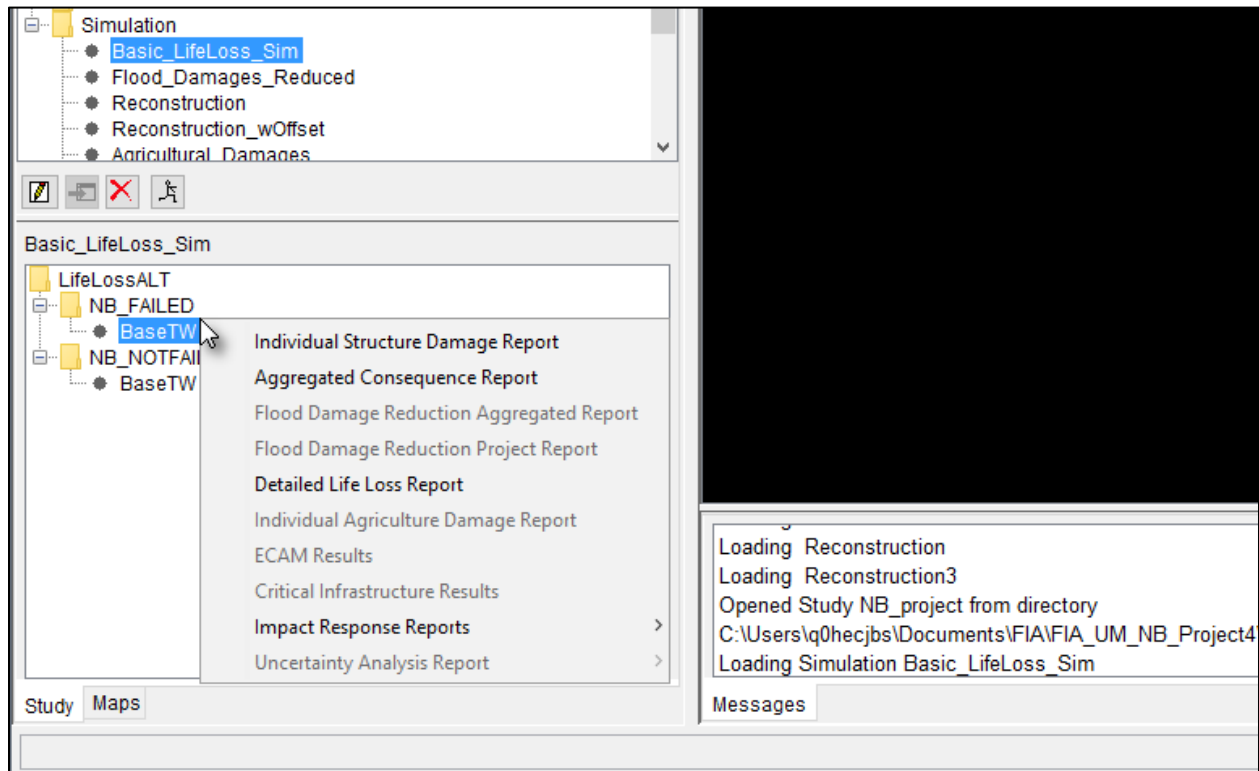
Figure 12.11 Simulation – Content Pane – Event Results Shortcut Menu Options

12.3.1 Individual Structure Damage Report

To view individual structure damage results:

1. From the **Content Pane** (Figure 12.11), information about the simulations that have been computed is available. Under each alternative name (e.g., *LifeLossALT* in Figure 12.11), is a list of associated events (e.g., *NB_FAILED* and *NB_NOTFAILED* in Figure 12.11). Under each event is a list of time windows. By right-clicking on a time window name (e.g., *BaseTW* in Figure 12.11), the **Results** shortcut menu appears (Figure 12.11) displaying the available reports.

2. The **Individual Structure Damage Report** dialog box opens (Figure 12.12).

3. This report contains a row for each structure damaged by the event. Notice that there are more columns available than are shown in the default window (Figure 12.12). To access the additional rows the user can expand the width of the report, or scroll using the horizontal scroll bar (Figure 12.13).

Structure Damage Results for LifeLossALT\NB_FAILED\BaseTW ☒

File View

Individual Structure Damage Report

for alternative **LifeLossALT**
for event **NB_FAILED**
for time window **BaseTW**

Structure Name	Damage				Total Damage	Depth of Flooding	Population At Risk (Day)
	Struct Damage	Cont Damage	Car Damage	Other Damage			
RES2 54057 00002349	0.0	0.0	0.0	0.0	0.0	-2.09	2.0
RES3CI 54057 00002357	0.0	0.0	0.0	0.0	0.0	-1.48	8.0
IND3 24001 00002567	303054.53	1327255.0	0.0	0.0	1630309.5	2.03	15.0
RES1-1SWB 54057 00002310	15540.37	6740.0	0.0	0.0	22280.36	-2.88	2.0
RES1-1SWB 54057 00002311	25908.86	9373.2	0.0	0.0	35282.06	-1.62	2.0
RES1-1SNB 54057 00002319	74473.21	20338.58	30957.81	0.0	125769.61	3.82	0.0
RES1-1SNB 54057 00002321	49072.82	13738.3	0.0	0.0	62811.12	1.78	1.0
RES1-1SNB 54057 00002322	64382.3	17677.75	0.0	0.0	82060.05	2.94	1.0
RES1-1SNB 54057 00002330	31905.0	9243.12	2921.57	0.0	44069.68	0.63	0.0
RES1-2SNB 54057 00002333	45081.44	13284.92	0.0	0.0	58366.36	3.28	1.0
RES1-2SNB 54057 00002334	10668.32	2651.81	0.0	0.0	13320.12	-0.43	0.0
RES1-2SNB 54057 00002335	54496.84	16046.05	0.0	0.0	70542.89	4.44	1.0
RES1-2SNB 54057 00002338	16270.23	4425.93	0.0	0.0	20696.16	0.12	1.0
RES1-2SNB 54057 00002339	29751.91	8620.79	0.0	0.0	38372.7	1.54	0.0
RES1-2SNB 54057 00002346	9630.79	2322.39	0.0	0.0	11953.18	-0.54	1.0
IND1 24001 00002551	1825358.75	3717904.0	0.0	0.0	5543263.0	12.31	15.0
RES1-2SNB 54057 00001801	52625.01	15447.67	0.0	0.0	68072.68	2.54	3.0
RES1-2SNB 54057 00001803	85154.67	25025.57	0.0	0.0	110180.23	5.52	3.0

Figure 12.12 Example – Individual Structure Damage Report – Default View

Structure Damage Results for LifeLossALT\NB_FAILED\BaseTW ☒

File View

Individual Structure Damage Report

for alternative **LifeLossALT**
for event **NB_FAILED**
for time window **BaseTW**

Population At Risk (Night)	Warning Time	% Not Mobilized (Day)	% Caught Evacuating (Day)	% Clear (Day)	% Not Mobilized (Night)	% Caught Evacuating (Night)	% Clear (Night)	Loss of Life (Day)	Loss of Life (Night)
2.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0	3535	10.0	0.0	90.0	10.0	0.0	90.0	0.0	0.0
2.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	3397	10.21	0.0	89.79	10.21	0.0	89.79	0.0	0.0
1.0	3551	9.95	0.0	90.05	9.95	0.0	90.05	0.0	0.0
1.0	3472	10.08	0.0	89.92	10.08	0.0	89.92	0.0	0.0
0.0	3661	10.74	0.0	89.26	10.74	0.0	89.26	0.0	0.0
1.0	3442	10.13	0.0	89.87	10.13	0.0	89.87	0.0	0.0
1.0	3883	8.55	0.0	91.45	8.55	0.0	91.45	0.0	0.0
1.0	3288	10.4	0.0	89.6	10.4	0.0	89.6	0.0	0.0
1.0	3738	9.63	0.0	90.37	9.63	0.0	90.37	0.0	0.0
1.0	3578	9.9	0.0	90.1	9.9	0.0	90.1	0.0	0.0
1.0	3879	9.38	0.0	90.62	9.38	0.0	90.62	0.0	0.0
1.0	-90	8.55	0.0	91.45	8.55	0.0	91.45	0.0	0.026
3.0	3685	9.72	0.0	90.28	9.72	0.0	90.28	0.0	0.0
3.0	3497	10.04	0.0	89.96	10.04	0.0	89.96	0.0	0.0

Figure 12.13 Example – Individual Structure Damage Report – Scrolled View

4. If the user selects the row of a structure of interest (or group of structures), the option to zoom to those structures in the map window is possible by right-clicking on one of the selected rows and clicking **Zoom to Structures** from the shortcut menu.

5. The columns can be sorted in descending order by clicking on the header of the column. To reverse the sorting order, click the header a second time.

6. Unless the table is sorted in descending order, the final row in the table provides the total values in each column.

12.3.2 Aggregated Consequence Report

The **Aggregated Consequence Report** (Figure 12.14) sorts the computed impacts by emergency planning zone, damage category, occupancy type, or any boundary polygon (e.g., counties in the study area or holdout areas) the user wishes to aggregate the results (if the polygon has been added as boundary data).

Aggregated Consequence Report for LifeLossALT\BaseTW

View By: Damage Category

Emergency Planning Zones
Damage Category
Occupancy Type
Holdout_Areas
Counties_in_StudyArea

Economic   Structure   Agriculture   Life Loss   Summary

Urban Damage Summary
by Damage Category

for alternative **LifeLossALT**
for event **NB_FAILED**
for time window **BaseTW**

Damage Category	Struct Damage ($1000)	Content Damage ($1000)	Car Damage ($1000)	Other Damage ($1000)	Total ($1000)
Commercial	144.46	231.41	4.26	0.00	380.13
Industrial	2,128.41	5,045.16	0.00	0.00	7,173.57
Public	0.00	9.44	0.00	0.00	9.44
Residential	10,170.45	3,044.43	33.88	0.00	13,248.76
Total	12,443.32	8,330.44	38.14	0.00	20,811.90

Print...   Save To File   Close

Figure 12.14 Example – Aggregated Consequence Report

To view the consequences of the modeled event as an aggregated report summarized in tabular format:

1. With a simulation selected from the **Study Tree**, from the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu, click **Aggregated Consequence Report** (Figure 12.11).

2.   The **Aggregated Consequence Report** opens (Figure 12.14).

3.   The report has a title block explaining what is being reported. The first line in the title block is a description of the type of data, and is based on which tab (**Economic**, **Structure**, **Agriculture**, **Life Loss**, or **Summary**) has been selected. The second line is based on the option selected from the **View By** list (e.g., *Damage Category* in Figure 12.13), which governs how the data is aggregated. The remaining lines define the alternative, event and time window used to produce these specific results.

4.   To aggregate the results based on any polygon shapefile, the shapefile must be added to the HEC-FIA study as boundary data (review Section 6.1), the boundary appears in the **View By** list. If the user selects the boundary, the data is processed to represent all points within the polygons that make up the polygon shapefile. Additionally, the report can be displayed using attributes available in the results shapefile such as *Emergency Planning Zone*, *Damage Category* or *Occupancy Type*.

12.3.3 Flood Damage Reduction Reports

To view the flood damage reduction reports, the simulation must contain the proper alternative, event, time window combination for a Flood Damages Reduced compute. This feature requires the event to have the necessary hydraulic data (review holdout inundation configuration described in Chapter 7), and the alternative to be set to use the holdout inundation configuration (see Section 10.2.7). If the alternative is not set up properly then the flood damage reduction reports are not enabled.

Flood Damage Reduction Aggregated Report

Two report options are available for the flood damages reduced simulation. The first option is to view the damage reduction estimates as an aggregated report. The aggregated report sorts the computed impacts by holdout distribution area (when included), damage category, occupancy type, or any boundary polygon (e.g., counties in the study area) the user wishes to aggregate the results (if the polygon has been added as boundary data).

To view the flood damage reduction estimates as an aggregated report:

1.   From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu, click **Flood Damage Reduction Aggregated Report** (Figure 12.11).

2.   The **Flood Damage Reduction Aggregated Report** opens (Figure 12.15).

3.   The **View By** list governs how the damage reduction is aggregated in the report (by default *Holdout Distribution Area* is selected). To aggregate the results based on any polygon shapefile, the shapefile must be added to the HEC-FIA study as boundary data (review Section 6.1), and the boundary appears in the **View By** list.

Figure 12.15 Example – Flood Damage Reduction Aggregated Report – Default View

If the user selects the boundary, the data is processed to represent all points within the polygons that make up the polygon shapefile. Additionally, the report can be displayed using attributes available in the results shapefile such as *Holdout Distribution Area*, *Damage Category* or *Occupancy Type*.

4. The next level of the report provides the **Precedence** in the structure damage reduction allocation by *Levees* or by *Reservoirs* (default selection). The precedence selection updates the Levee Benefit and Reservoir Benefit columns.

Flood Damage Reduction Project Report

The second report option for the Flood Damages Reduced simulation is to view the damage reduction estimates by project. The project report sorts the computed impacts by project, which can be further apportioned by any boundary polygon (e.g., counties in the study area, holdout areas) the user wishes to apportion the results (if the polygon has been added as boundary data).

To view the flood damage reduction estimates reported by project:

1. From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu, click **Flood Damage Reduction Aggregated Report** (Figure 12.11).

2. The **Flood Damage Reduction Project Report** opens (Figure 12.16).
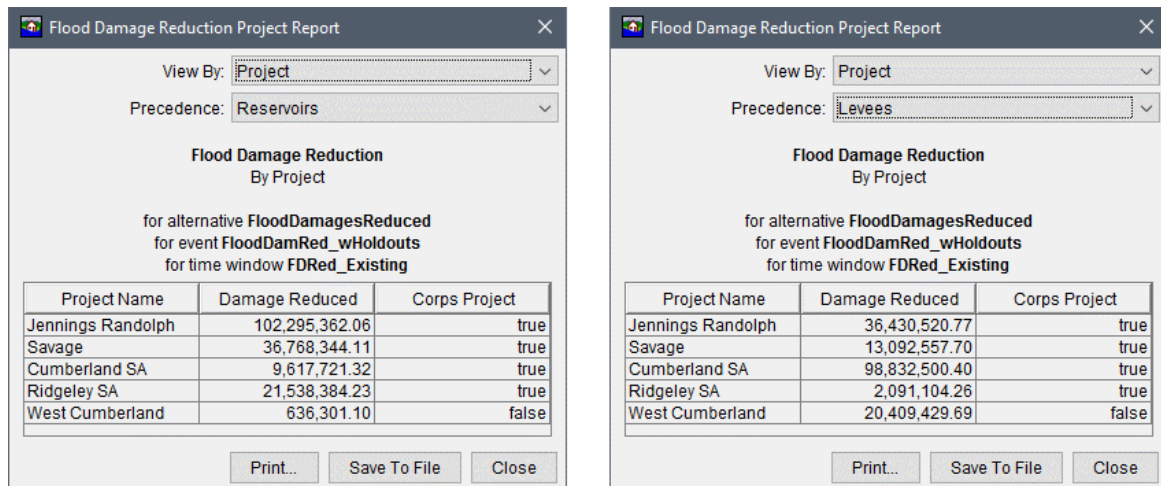
Figure 12.16 Example – Flood Damage Reduction Project Report – Reservoirs (*left*) – Levees (*right*)

3. The **View By** selection list governs how the damage reduction is grouped in the report (e.g., *Project*, selected by default). To apportion the results based on any polygon shapefile (e.g., counties), the shapefile must be added to the HEC-FIA study as boundary data (review Chapter 6, Section 6.1), and the boundary appears in the **View By** list. If the user selects the boundary, the data is processed to represent all points within the polygons that make up the polygon shapefile. The report table updates with an additional column for the selected boundary attributes.

4. The next level of the report provides the **Precedence** in the structure damage reduction allocation by *Levees* or by *Reservoirs* (default selection). The Damage Reduced column updates based on the **Precedence** dropdown list selection.

12.3.4 Detailed Life Loss Report

To view the detailed life loss report, the alternative, event, time window combination must be set up to run life loss. This capability requires the event to have the necessary hydraulic data, and the alternative to be set to compute life loss. If the alternative is not set to compute life loss, this report is not enabled. To view the detailed life loss report:

1. From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu (Figure 12.11) click **Detailed Life Loss Report**.

2. The **Detailed Life Loss Report** opens (Figure 12.17).

3. The **Detailed Life Loss Report** provides information about how HEC-FIA calculated life loss for the study area (Figure 12.17). The report aggregates data to explain how life loss was computed. When computing deterministic runs, the results are deterministic, when computing Monte Carlo runs, the results represent averages.

Figure 12.17 Example – Detailed Life Loss Report

4.   The **View By** selection list governs the category grouping for the life loss report (e.g., *Total*, selected by default). Additionally, the report can be displayed using attributes available in the results shapefile such as *Emergency Planning Zone*, *Damage Category* or *Occupancy Type*; or by a polygon shapefile (e.g., counties).

   To group the results based on any polygon shapefile, the shapefile must be added to the HEC-FIA study as boundary data (review Section 6.1), the boundary appears in the **View By** list. If the user selects the boundary, the data is processed to represent all points within the polygons that make up the polygon shapefile.

12.3.5 Individual Agriculture Damage Report

To view the individual agriculture damage report, the alternative, event, time window combination must be set up to run an agriculture compute. This report requires the event to have the necessary hydraulic data, and the alternative to be set to compute agricultural damages (as described in Section 10.2.2). If the alternative is not set to compute agricultural damages, this report is not enabled. To view the report:

1.   From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu (Figure 12.11) click **Individual Agriculture Damage Report**.

2.   The **Individual Agriculture Damage Report** opens (Figure 12.18). The final row in the table provides the total damage and acreage values.

Figure 12.18 Example – Individual Agriculture Damage Report

12.3.6 ECAM Results

The ECAM report is only enabled if the alternative, event, time window combination has been set to run life loss and ECAM. If those conditions are met, the output for ECAM is written during the compute, and the report is enabled. This report has two tabs, one representing the changes in the output of the economy, the other representing the changes in labor employed by the sectors for the county. Each tab reports at the sector level for the selected county.

1.   From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu (Figure 12.11) click **ECAM Results**.

2.   The **ECAM Indirect Economics Output Report** opens (Figure 12.19).
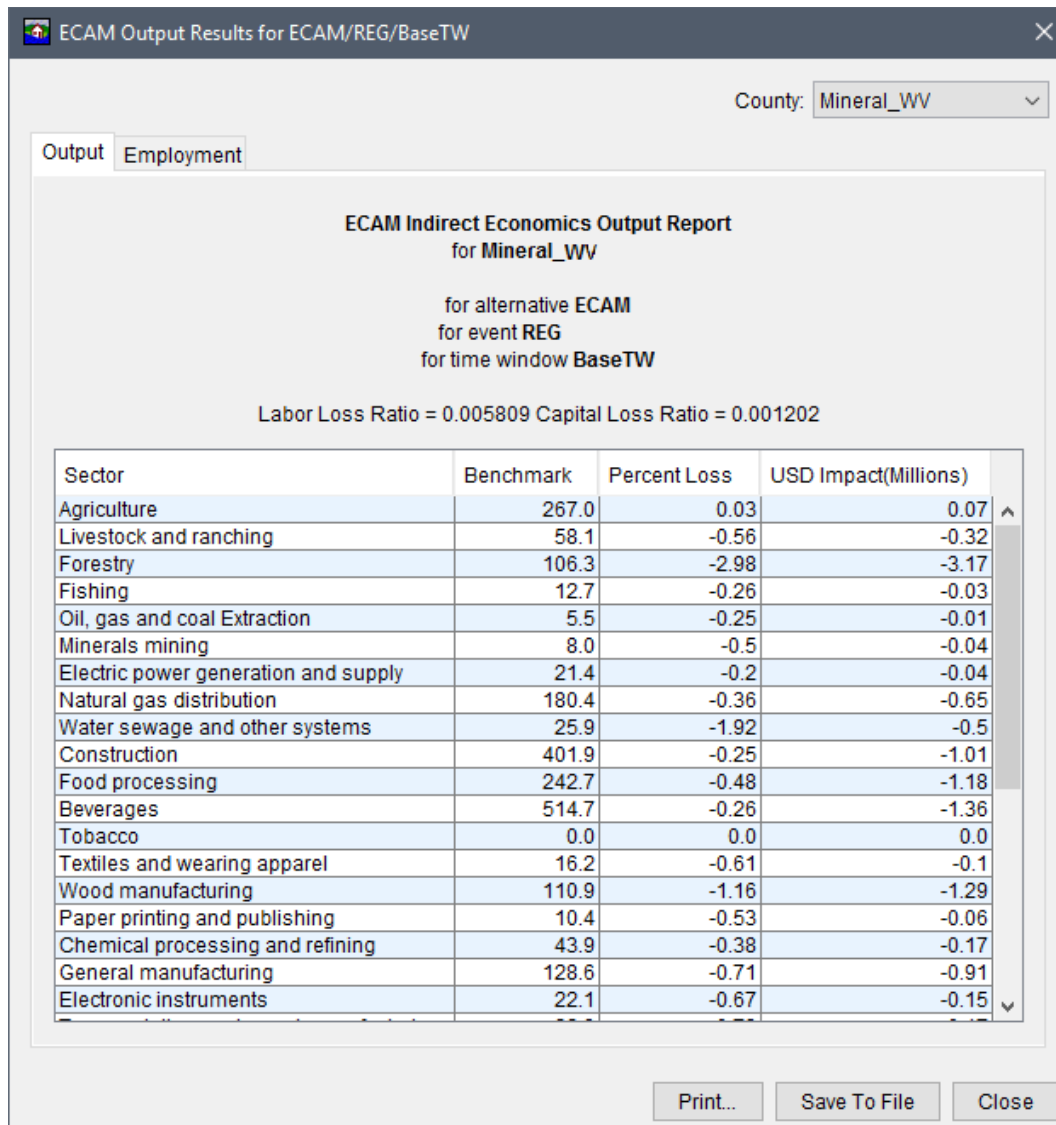
Figure 12.19 Example – ECAM Indirect Economics Output Report

3. The report has a title block explaining what is being reported. The first line in the title block is a description of the type of data, and is based on which tab (**Output** or **Employment**) has been selected. The second line is based on the county selected in the **County** list (Figure 12.19). The next three lines define the alternative, event and time window used to produce these specific results. The final line in the title block contains the labor loss and capital loss ratios.

4. The columns can be sorted in descending order by clicking on the header of the column. To reverse the sorting order, click the header a second time.

5. Unless the table is sorted in descending order, the final row in the table provides the total values in each column.

12.3.7 Critical Infrastructure

Critical infrastructure results are available if the alternative, event, time window combination has a critical infrastructure inventory defined in the alternative (review Chapter 10). The report only includes critical infrastructure elements which were inundated by the event based on the user defined elevation, or the elevation of the terrain grid.

1. From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu (Figure 12.11) click **Critical Infrastructure Results**.

2. The **Critical Infrastructure Report** opens (Figure 12.20).

Critical Infrastructure Report

Critical Infrastructure Report

for alternative **CI_compute**
for event **REG**
for time window **BaseTW**

CI Name	Ground	WSE	Depth	Arrival	DV	Duration
CHEM_PHARM_PREP_MAN_0000	597.53	602.88	5.35	55.53	na	1234.88
CHEM_CHEM_INDUSTR_0000	597.41	602.72	5.31	55.58	na	1230.59
CHEM_CHEM_INDUSTR_0001	596.34	602.09	5.75	54.13	na	1401.88
CHEM_CHEM_INDUSTR_0002	590.12	598.55	8.42	50.05	na	2064.43
CHEM_CHEM_INDUSTR_0003	593.88	597.57	3.69	58.92	na	903.83
CHEM_CHEM_INDUSTR_0004	591.72	596.74	5.02	55.78	na	1348.10
EDUC_PUB_SCH_0000	588.47	598.60	10.13	49.05	na	2447.74
EDUC_PUB_SCH_0001	596.53	598.62	2.08	64.85	na	142.02
EDUC_PUB_SCH_0002	590.47	598.65	8.19	50.22	na	2023.04
ENRG_ELEC_POW_GEN_PLT_00...	589.31	598.69	9.38	49.55	na	2231.56
ENRG_SUBSTN_0000	596.81	598.75	1.93	na	na	na
MAIL_USPS_PO_0000	596.19	598.77	2.58	61.60	na	485.33

Print...   Save To File   Close

Figure 12.20 Example – Critical Infrastructure Report

3. The report has a title block explaining what is being reported. The remaining lines in the title block define the alternative, event and time window used to produce these specific results. The columns can be sorted in descending order by clicking on the header of the column. To reverse the sorting order, click the header a second time.

12.3.8 Impact Response Reports

If an impact response element is defined in the alternative, an impact response report is available whether or not the thresholds were exceeded. Three ways are provided to view the impact response reports: by rule, by location, and summary. The option to view the impact response **By Rule** and **By Location** displays the hydrograph at the location of the rule, and the threshold elevation relative to the hydrograph, if no threshold is exceeded, the summary will declare that the criteria was not met.

Impact Response Rules Report

The **By Rule** report (Figure 12.21) displays each rule independently. To view the impact response reports, by rule, with a simulation selected from the **Study Tree**, from the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu, point to **Impact Response Reports** (Figure 12.11) and click **By Rule**.

The **Impact Response Report** opens for rules (e.g., *Flood Stage at Bridge* in Figure 12.21). The report has a dropdown list and navigation buttons at the top to allow users to select different rules. The plot, impact and response panels update based on the selected rule.
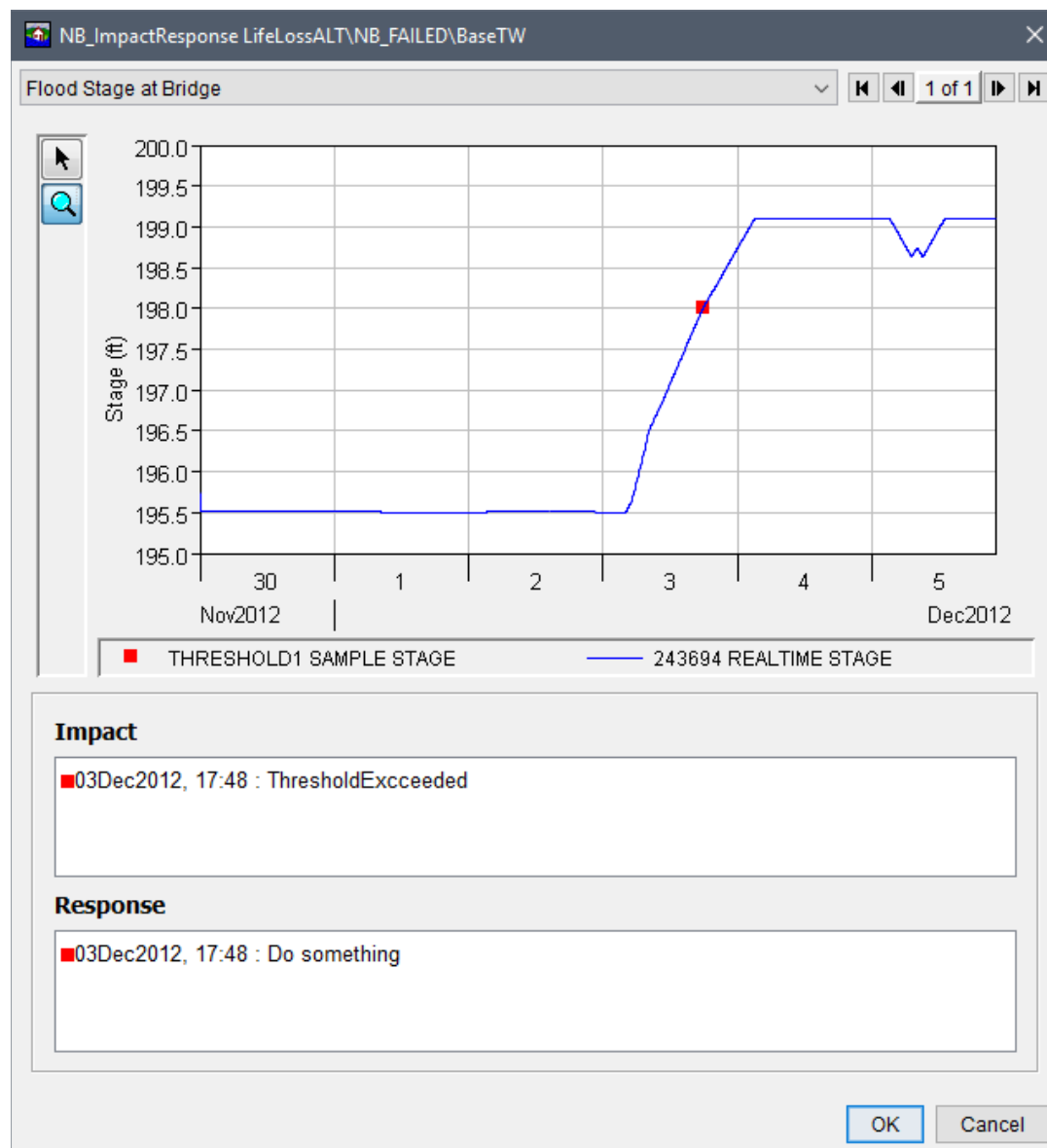
Figure 12.21 Example – Impact Response Report – By Rule

Impact Response Location Report

To view the impact response reports, by location, with a simulation selected from the **Study Tree**, from the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu, point to **Impact Response Reports** (Figure 12.11) and click **By Location**. The **Impact Response Report** opens for locations (Figure 12.22). This report option displays impact response information by each location that has been defined in the impact response rules set; if there are many rules for one location, then the rules are displayed together. (e.g., *Flood Stage at Bridge* in Figure 12.22).
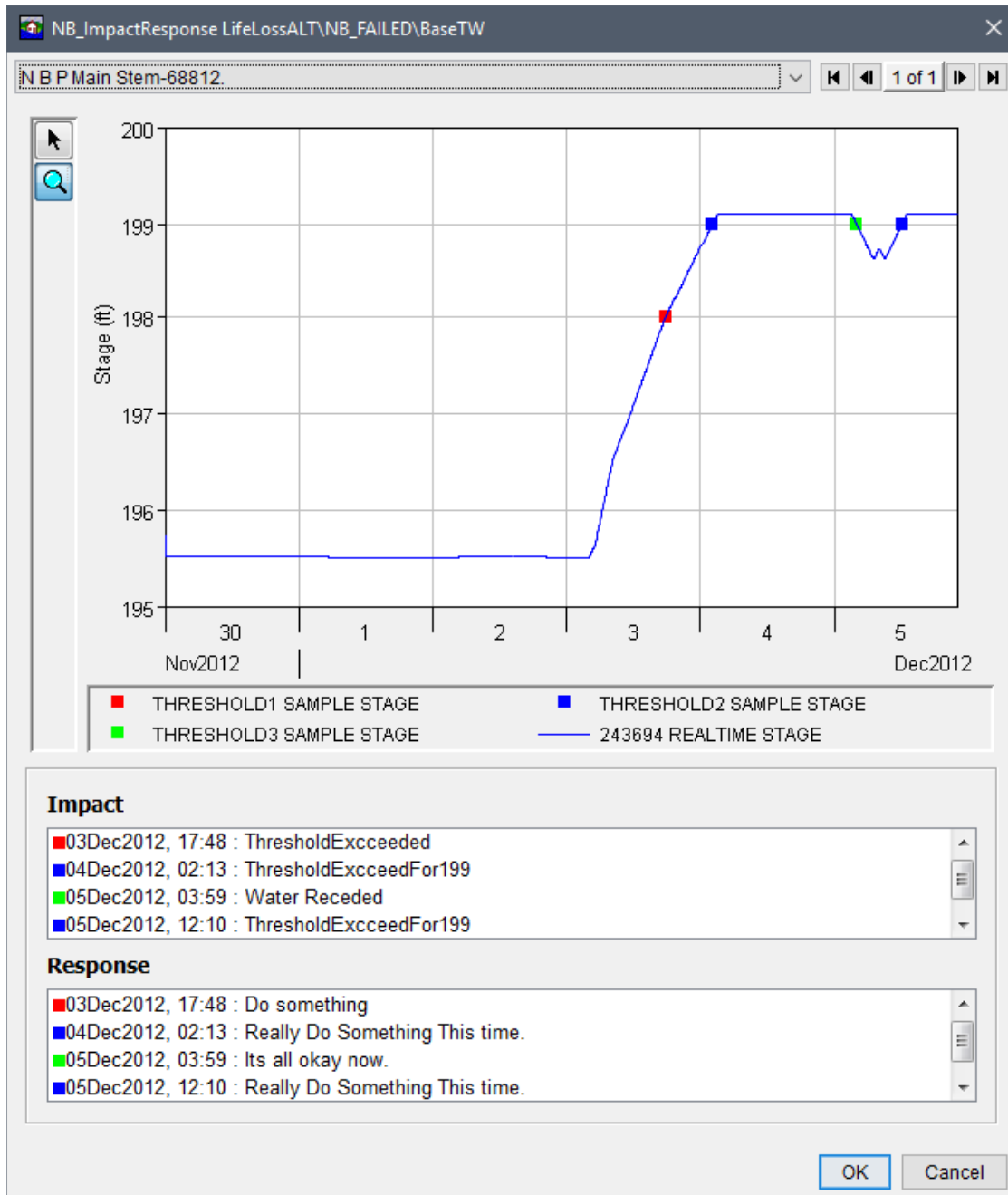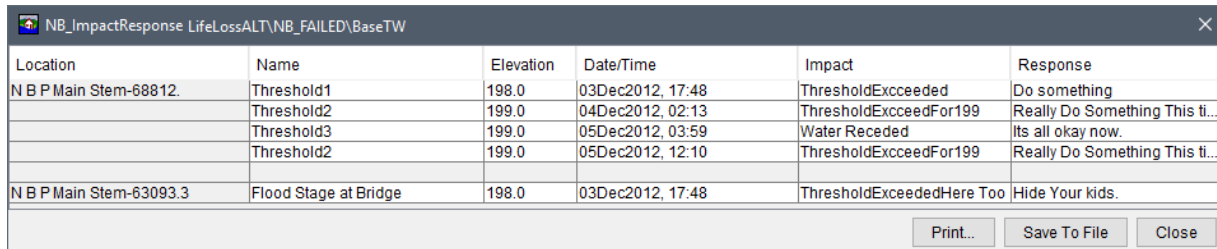
Figure 12.22 Example – Impact Response Report – By Location

Impact Response Summary Report

To view the impact response summary report, with a simulation selected from the **Study Tree**, from the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu, point to **Impact Response Reports** (Figure 12.11) and click **Summary**. The summary report opens (Figure 12.23) and displays all rules that were applied and the number of times the threshold conditions were met. The appropriate impact and response is defined each time a threshold is met.

Location	Name	Elevation	Date/Time	Impact	Response
N B P Main Stem-68812.	Threshold1	198.0	03Dec2012, 17:48	ThresholdExcceeded	Do something
	Threshold2	199.0	04Dec2012, 02:13	ThresholdExcceedFor199	Really Do Something This ti...
	Threshold3	199.0	05Dec2012, 03:59	Water Receded	Its all okay now.
	Threshold2	199.0	05Dec2012, 12:10	ThresholdExcceedFor199	Really Do Something This ti...
N B P Main Stem-63093.3	Flood Stage at Bridge	198.0	03Dec2012, 17:48	ThresholdExceededHere Too	Hide Your kids.

NB_ImpactResponse LifeLossALT\NB_FAILED\BaseTW

Print... | Save To File | Close

Figure 12.23 Example – Impact Response Report – Summary

12.3.9 Uncertainty Analysis Reports

The uncertainty analysis reports can be viewed two different ways: through **Results by Iteration**, or **Life Loss By Warning Issuance** plots. These plots provide the results by iteration; therefore, the number of iterations computed is dictated by the Monte Carlo iteration controls set by the user in the alternative editor (review Chapter 10, Section 10.2.3).

Uncertainty Analysis Results By Iteration

To view the uncertainty analysis results by iteration:

1. From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu (Figure 12.11), point to **Uncertainty Analysis Report**, and click **Results by Iteration**.

2. The **Results by Iteration** report (Figure 12.24) opens.

3. The report displays a paired data record with an output variable for each iteration in the Monte Carlo compute. To view values that were sampled to produce the output, the user must first check the option in the **Uncertainty** tab of the alternative editor (see Section 10.2.3), and then view the output HEC-DSS file using HEC-DSSVue. The output variable displayed in the plot can be changed by selecting a different item from the **Variable** list (e.g., *Total-2 AM-Over 65* in Figure 12.24).
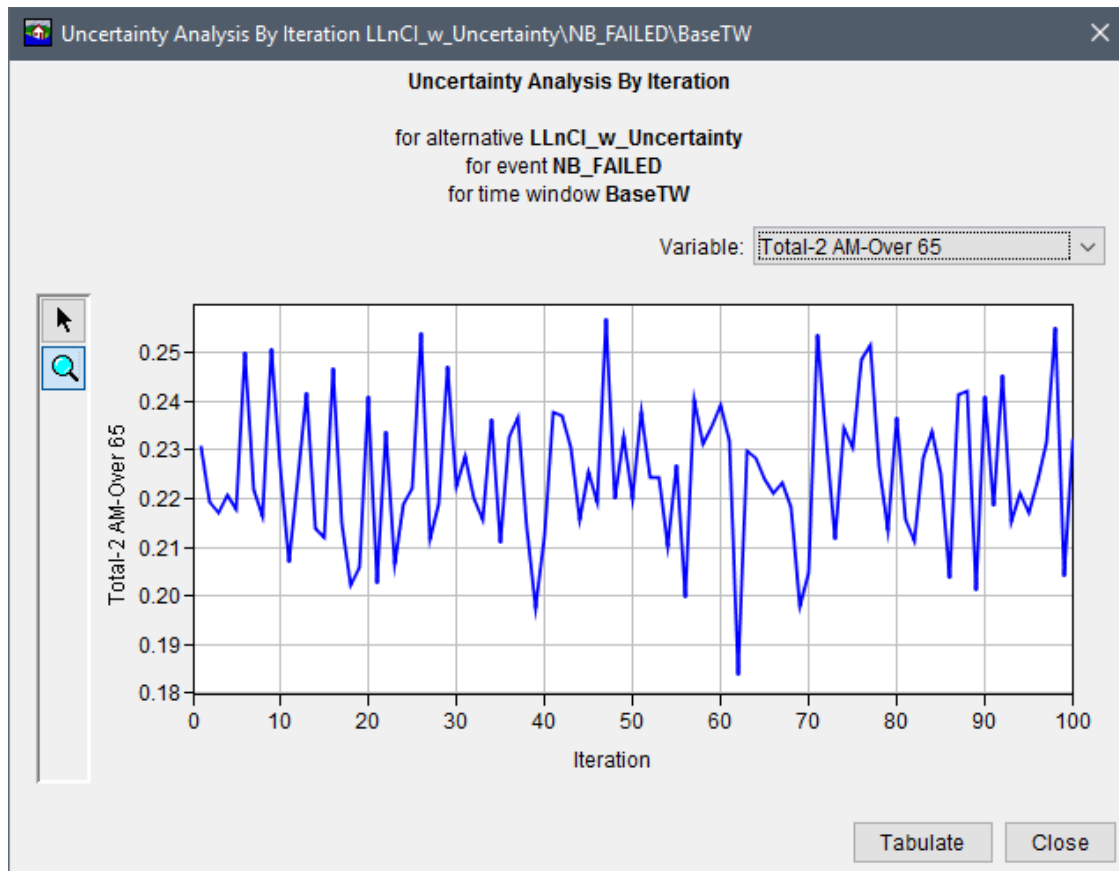
Figure 12.24 Example – Uncertainty Analysis By Iteration Report

Uncertainty Analysis Results By Warning Issuance

To view the uncertainty analysis results for life loss by warning issuance (when uncertainty is included in the warning issuance scenario as described in Section 9.1.3):

1. From the **Content Pane** (Figure 12.11), right-click on a time window, from the shortcut menu (Figure 12.11), point to **Uncertainty Analysis Report**, click **Life Loss By Warning Issuance**.

2. The **Life Loss by Warning Issuance** report (Figure 12.25) opens.

3. This report displays a point graph which plots warning issuance time on the x-axis, and life loss on the y-axis for each iteration Monte Carlo output. The time of day displayed in the plot can be changed by selecting a different time from the **Time Of Day** list (e.g., *All Structures 2AM* in Figure 12.25). Note, the available items in the **Time Of Day** list is dependent on the computation times set by the user from the alternative editor (review Section 10.2.1).
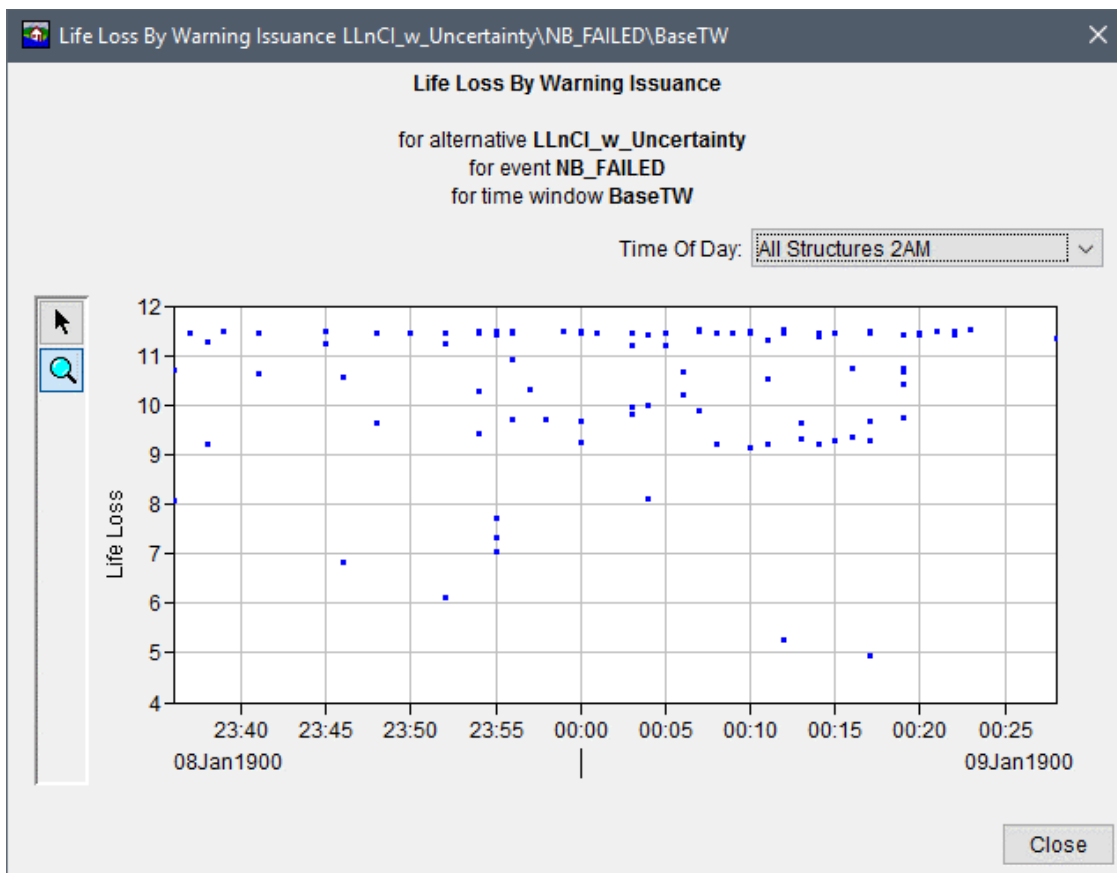
Figure 12.25 Example – Uncertainty Analysis By Warning Issuance Report

Appendix A

References

FEMA, Federal Emergency Management Agency HAZUS (Hazards U.S.), 2008, *data and software*, FEMA Department of Homeland Security, Washington D.C.

Hydrologic Engineering Center, 2009. *HEC-DSSVue, HEC Data Storage System Visual Utility Engine User's Manual, Version 2.0, CPD-79*, U. S. Army Corps of Engineers, Davis, CA.
http://www.hec.usace.army.mil/software/hec-dssvue/documentation/User'sManual_2.0/HEC-DSSVue_20_Users_Manual.pdf

Hydrologic Engineering Center, 2016. *HEC-RAS, River Analysis System User's Manual, Version 5.0, CPD-68*, U.S. Army Corps of Engineers, Davis, CA.
http://www.hec.usace.army.mil/software/hec-ras/documentation/HEC-RAS%205.0%20Users%20Manual.pdf

Hydrologic Engineering Center, 1995. *HEC-PBA Project Benefit Accomplishment Package User's Manual, CPD-67*, U.S. Army Corps of Engineers, Davis, CA.

Hydrologic Engineering Center, 2013. *HEC-ResSim, Reservoir System Simulation User's Manual, Version 3.1,* U.S. Army Corps of Engineers, Davis, CA.
http://www.hec.usace.army.mil/software/hec-ressim/documentation/HEC-ResSim_31_UsersManual.pdf

Lehman, W.P., Dunn, C.N., and Light, Dr. Miles, 2014. *Using HEC-FIA to Identify the Consequences of Flood Events*. 6th International Conference on Flood Management (ICFM6), Sao Paulo, Brazil.

NSI, National Structure Inventory Database. Currently only USACE employees have access.
http://www.hec.usace.army.mil/fwlink/?linkid=7

NIFA, National Institute of Food and Agriculture, Cooperative Extension System (CES), *Land Grant University Website Directory*, U.S. Department of Agriculture (USDA), Washington, D.C. Accessed: January 25th, 2018.
https://nifa.usda.gov/land-grant-colleges-and-universities-partner-website-directory?state=All&type=Extension

Rogers, G. O. and J. H. Sorensen, 1991. "Diffusion of Emergency Warning: Comparing Empirical and Simulation Results," in *Risk Analysis Prospects and Opportunities*, C. Zerros et al. (eds.), Plenum Press, New York, p. 117 - 134.

Sorensen, J.; Mileti, D. 2014a. *First Alert and/or Warning Issuance Time Estimation for Dam Breaches, Controlled Dam Releases, and Levee Breaches or Overtopping*. Draft paper prepared for U.S. Army Corps of Engineers. Institute for Water Resources, Risk Management Center. Davis, CA.

Sorensen, J.; Mileti, D. 2014b. *First Alert or Warning Diffusion Time Estimation for Dam Breaches, Controlled Dam Releases and Levee Breaches or Overtopping*. Draft paper prepared for U.S. Army Corps of Engineers. Institute for Water Resources, Risk Management Center. Davis, CA.

Sorensen, J.; Mileti, D. 2014c. *Protective Action Initiation Time Estimation for Dam Breaches, Controlled Dam Releases, and Levee Breaches or Overtopping*. Draft paper prepared for U.S. Army Corps of Engineers. Institute for Water Resources, Risk Management Center. Davis, CA.

Sorensen, J.; Mileti, D. 2015. *A Guide to Public Alerts and Warnings for Dam and Levee Emergencies*. Prepared for U.S. Army Corps of Engineers. Institute for Water Resources, Risk Management Center. Davis, CA.
https://silverjackets.nfrmp.us/Portals/0/doc/WarningGuidebook_USACE.pdf?ver=2015-08-10-213008-520

USACE, November 2013. EGM 14-02, *Current Normalized Prices*, Planning and Policy Division of the Directorate of Civil Works, U.S. Army Corps of Engineers.
https://planning.erdc.dren.mil/toolbox/library/EGMs/EGM04-01.pdf

USACE, November 2013. EGM 14-02, *Current Normalized Prices*, Planning and Policy Division of the Directorate of Civil Works, U.S. Army Corps of Engineers.
https://planning.erdc.dren.mil/toolbox/library/EGMs/EGM14-02.pdf

USACE, July 2017. ER 1105-2-101, *Planning – Risk analysis for Flood Damage Reduction Studies*, U.S. Department of the Army, Washington, DC 20314-1000.
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1105-2-101.pdf

USDA, U.S. Department of Agriculture, *National Agricultural Statistics Service* (NASS), U.S. Department of Agriculture, Washington, D.C. Accessed: January 25th, 2018.
https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php

Appendix B

Data Preparation

This appendix is written to explain steps for converting data to input types that are supported by HEC-FIA; it is for users who have not upgraded to the latest version of HEC-RAS 5.0. To see the steps for getting the correct data for input to HEC-FIA from HEC-RAS 5.0, go to Appendix G.

The geographic information system (GIS) pre-processing that is required for an HEC-FIA study can be handled through the use of the ESRI ArcGIS® Desktop software. Information and availability about the ArcGIS® Desktop software is available from ESRI (www.esri.com). The software should include ArcMap®, the ArcGIS® 3D Analyst extension, and the ArcGIS® Spatial Analyst extension. Optionally, users can use other GIS platforms like GRASS (http://grass.osgeo.org/) or QGIS (http://www.qgis.org/en/site/)

Several GIS pre-processing steps need to be completed before creating a study in HEC-FIA. Depending on the level of detail in the study, not all of the following need to be utilized:

1. Preparation of maximum inundation depth grids
2. Preparation of duration and arrival time grids
3. Creation of maximum inundation area polygon
4. Generation of the hazard area boundary
5. Preparation of a digital terrain model
6. Preparation of arrival time grid for depths two feet and greater
7. Preparation of various items developed by HEC-GeoRAS (Hydrologic Engineering Center's ArcGIS extension for processing geospatial data for HEC-RAS)
8. Preparation of emergency planning zone (formerly defined as impact area in HEC-FIA Version 3.0) polygons
9. Preparation of double warning time polygon
10. Agricultural grid preparation

Each of these steps is explained in the following sections.

B.1   Preparing Maximum Inundation Depth Grids

For rapid consequence assessment, flood inundation information for a specific flood scenario is supplied to HEC-FIA in the form of depth grids. Depth grids used for the assessment are typically generated by a hydraulic engineer using HEC-GeoRAS, RAS Mapper (a tool that is part of the HEC-RAS software) or another hydraulic model. The maximum inundated depth grid is required for each flood scenario to be analyzed. The GeoRAS maximum inundation depth grid is located in the "Max WS" folder of the RAS Mapper results directory.

If the depth grid(s) are in binary formation (.flt), the user can convert the .flt file to a .tif file outside of HEC-FIA. However, HEC-FIA automatically converts the .flt to a .tif file. When HEC-FIA converts .flt to .tif, the software tiles, pyramids, and compresses the .tif file, which can be very beneficial in terms of data storage:

1. Start **ArcCatalog**, the **ArcCatalog** window opens (Figure B.1).

Figure B.1 ArcCatalog Window

2. If the **ArcToolbox Pane** is not present, click **ArcToolbox** on the **Standard Toolbar** (Figure B.2) and the **ArcToolbox Pane** displays in the **ArcCatalog** window (Figure B.1).

Figure B.2 ArcCatalog Window - Standard Toolbar

3. From the **ArcToolbox Tree**, double-click **Conversion Tools**, double-click **From Raster**, and then double-click **Raster to Float** (Figure B.3).

4. The **Raster to Float** dialog box opens (Figure B.4). Click ☛ next to the **Input raster** box to select a grid.

5. The **Input raster** browser opens (Figure B.5). Browse to the location of the depth grid file select it. Click **Add**, the **Input raster** browser closes, and the path and the name of the selected depth grid file is displayed in the **Input raster** box on the **Raster to Float** dialog box (Figure B.4).

Figure B.3 ArcToolbox Tree
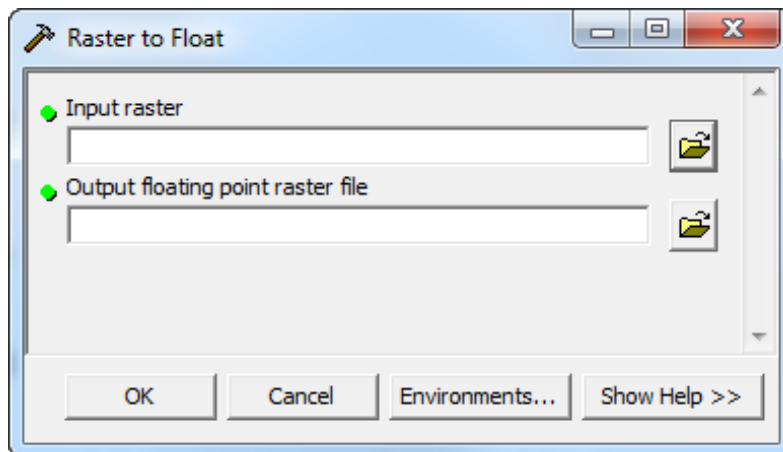
Figure B.4 Raster to Float Dialog Box

6. By default the output floating raster file is stored to the same directory as the selected
    depth grid file. In the **Output floating point raster file** box (Figure B.6) the path and the
    default name for the binary file appears. The default name is the depth grid filename with
    *RasterT_* appended to the front, and appended to the end if *1.FLT* (i.e., *RasterT_
    dp001.FLT*). Modify this to represent flood scenario represented by the depth grid (i.e.,
    FP_Fail.flt).
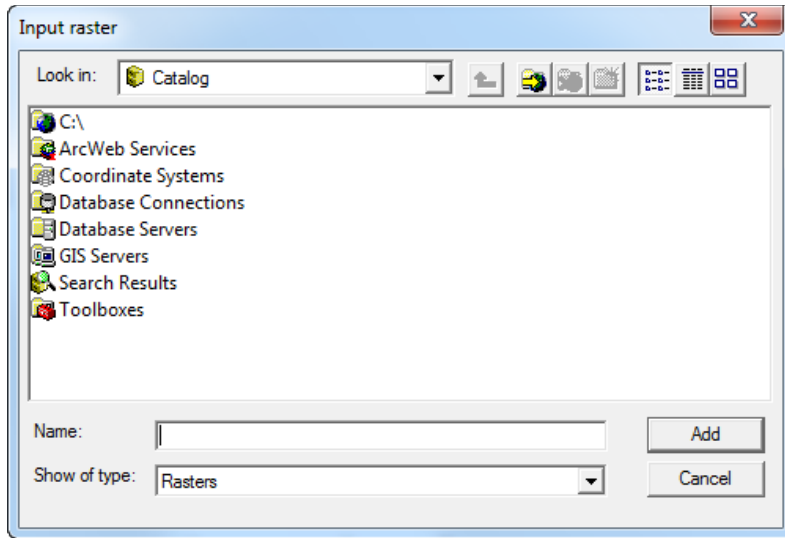
Figure B.5 Input Raster Browser
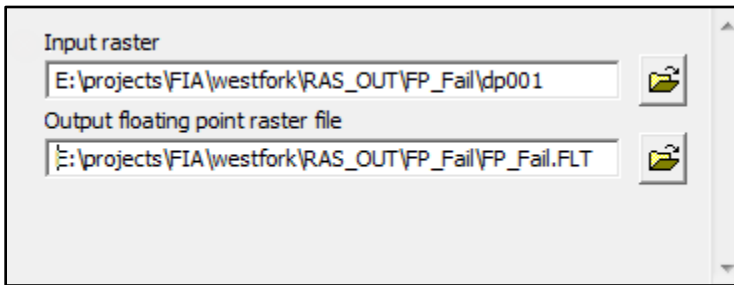
Figure B.6 Output Floating Point Raster File Default Name

7.   Click **OK**. The **Raster to Float** dialog box closes and the **Raster to Float Compute** dialog box opens (Figure B.7). This dialog box notifies the user of the status of the compute and how long it took to create the binary file. When finished viewing information, click **Close** to close the **Raster to Float Compute** dialog box.
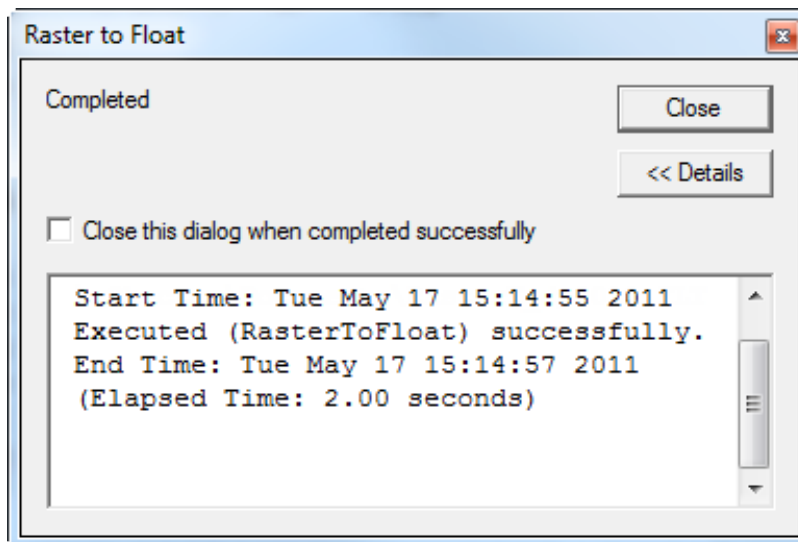
Figure B.7 Raster to Float Dialog Box

8. Now in the selected directory, there are two files, *.flt and *.hdr. The depth grid has been successfully converted to a binary format.

B.2   Preparing Duration and Arrival Time Grids

This step is only required if using duration and arrival time grids in place of hydrograph data. Duration grids are only required for agricultural damages. If agricultural damage is not part of the assessment then duration grids do not need to be prepared. Arrival time grids are required for both agricultural and life loss calculations.

Duration grids and arrival time grids are generally produced from either ArcGIS® plug-ins or RAS Mapper. The duration grid is defined as the duration of time a grid cell is wet. The arrival time grid contains the amount of time it takes for water stage to reach a predefined threshold at each cell. Typically the arrival time threshold is two (2) feet. If life loss calculations are to be computed with arrival time grids, make sure the threshold for arrival time (default of two feet) is the same threshold used to define the hazard boundary for each scenario.

For an agricultural damage assessment, the arrival time threshold is typically zero (0) feet.

B.2.1   Duration Grid Preparation

To convert the duration grid to binary format (.flt):

1. Start **ArcCatalog**. The **ArcCatalog** window opens (Figure B.1).

2. If the **ArcToolbox Pane** is not present, click **ArcToolbox** on the **Standard Toolbar** (Figure B.2) and the **ArcToolbox Pane** displays in the **ArcCatalog** window.

3. From the **ArcToolbox Tree**, double-click **Conversion Tools**, double-click **From Raster**, and then double-click **Raster to Float** (Figure B.3).

4. The **Raster to Float** dialog box opens (Figure B.4). Browse to the location of the duration grid file by clicking next to the **Input raster** box.

5. The **Input raster** browser opens (see Figure B.5). Browse to the location of the duration grid file, click on the duration grid filename. Click **Add**, the **Input raster** browser closes (Figure B.5), and the path and the name of the selected duration grid file (i.e., *E:\projects\FIA\westfork\Duration\FP_Fail \FP_F_Duration*) appears in the **Input raster** box on the **Raster to Float** dialog box (Figure B.4).

6. By default the software creates the output floating point raster file to the same directory as the selected duration grid file. In the **Output floating point raster file** box (Figure B.6) the path and the default name for the binary file (i.e., *E:\projects\FIA\westfork\Duration\ FP_Fail\RasterT_FP_F1.FLT*) appears. Modify the float filename to represent the flood scenario represented by the duration grid (i.e., *FP_Fail_Duration.FLT*).

7. Click **OK**, the **Raster to Float** dialog box closes. The **Raster to Float Compute** dialog box opens (Figure B.7). This dialog box notifies the user of the status of the compute and how long it took to create the binary file. When finished viewing information, click **Close**. The **Raster to Float Compute** dialog box closes.

8. Now in the selected directory, there are two files, *.flt and *.hdr. The duration grid has been successfully converted to a binary format.

B.2.2   Arrival Time Grid Preparation

To convert the arrival time grid to binary format (.flt):

1. Start **ArcCatalog**. The **ArcCatalog** window opens (Figure B.1).
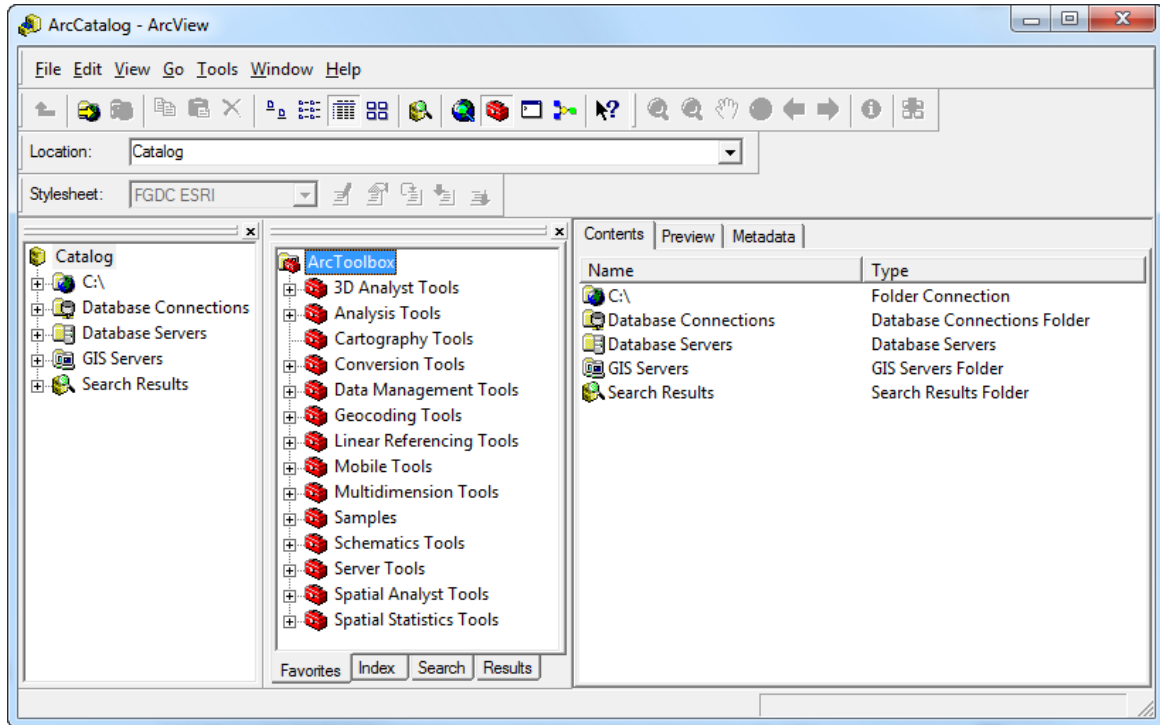
2. If the **ArcToolbox Pane** is not present, click **ArcToolbox** on the **Standard Toolbar** (Figure B.2) and the **ArcToolbox Pane** displays in the **ArcCatalog** window.

3. From the **ArcToolbox Tree**, double-click **Conversion Tools**, double-click **From Raster**, and then double-click **Raster to Float** (Figure B.3).

4. The **Raster to Float** dialog box opens (Figure B.4). Browse to the location of the arrival time grid file by clicking 📂 next to the **Input raster** box.

5. The **Input raster** browser opens (Figure B.5). Browse to the location of the arrival time grid file, click on the grid filename. Click **Add**, the **Input raster** browser closes, and the path and the name of the selected arrival time grid file appears in the **Input raster** box on the **Raster to Float** dialog box.

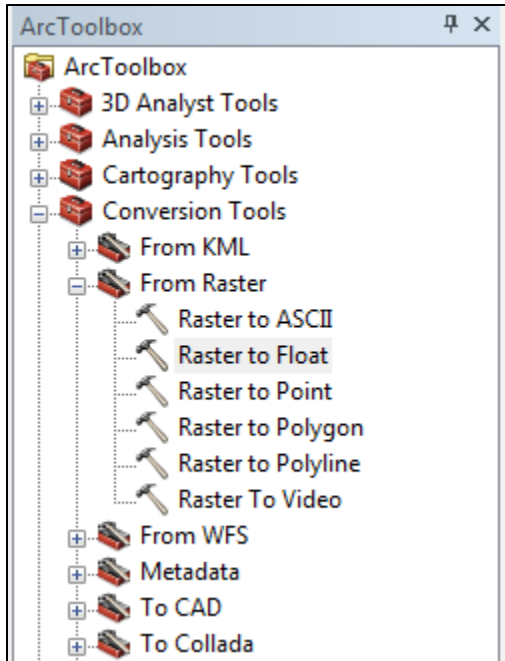6. By default the software creates the output floating point raster file to the same directory as the selected arrival time grid file. In the **Output floating point raster file** box (Figure B.6) the path and the default name for the binary file (i.e., *E:\projects\FIA\westfork\ ArrivalTime\FP_Fail\RasterT_FP_F1.FLT*) appears. Modify the float filename to represent the flood scenario represented by the arrival time grid (i.e., *FP_Fail_ Arrival.FLT*).

7. Click **OK**. The **Raster to Float** dialog box closes and the **Raster to Float Compute** dialog box opens (Figure B.7). This dialog box notifies the user of the status of the compute and how long it took to create the binary file. When finished viewing information, click **Close**. The **Raster to Float Compute** dialog box closes.

8. Now in the selected directory, there are two files, *.flt and *.hdr. The arrival time grid has been successfully converted to a binary format.

B.3   Maximum Inundated Area Polygon

A polygon that represents the maximum inundated area for the largest flood scenario is necessary to trim other required data down to a manageable size. The inundated area polygon for the

maximum flood inundation scenario is typically generated by the hydraulic engineer while performing inundation mapping in HEC-GeoRAS (bounding polygons). These bounding polygons are stored in the HEC-GeoRAS geodatabase for a given study. This maximum inundated area needs to be converted to a shapefile for later use.

To convert the maximum inundated area bounding polygon to a shapefile:

1. Start **ArcCatalog**. The **ArcCatalog** window opens (Figure B.1).

2. From the first pane (the **Catalog Tree),** browse to the folder that contains the geodatabase file for the study.

3. Once the geodatabase file appears in the **Contents** tab of the main window (Figure B.8), double-click on the geodatabase filename (i.e., *Truman_SDF.mdb*). Next, double-click on the geodatabase feature dataset (i.e., *RasResults*).
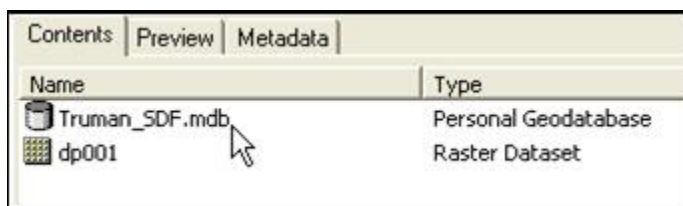
Figure B.8 Contents Tab - Geodatabase File

4. The bounding polygon file created by HEC-GeoRAS should appear in the list (i.e., *bP001*). Right-click on the bounding polygon filename (Figure B.9). From the shortcut menu, point to **Export** and select **To Shapefile (single)**.
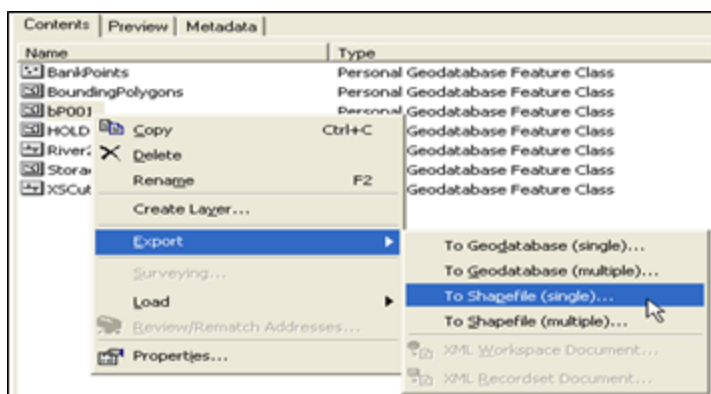
Figure B.9 Export Shortcut Menu

5. The **Feature Class to Feature Class** dialog box opens (Figure B.10).

6. The **Input Features** box should contain the name of the selected bounding polygon file. Choose the location to store the shapefile by clicking 📂 next to the **Output Location** dialog box. The **Output Location** browser opens (Figure B.11). Browse to the folder to store the shapefile, click **Add**. The **Output Location** browser closes, and the pathname with the selected folder appears in the **Output Location** box of the **Feature Class to Feature Class** dialog box.
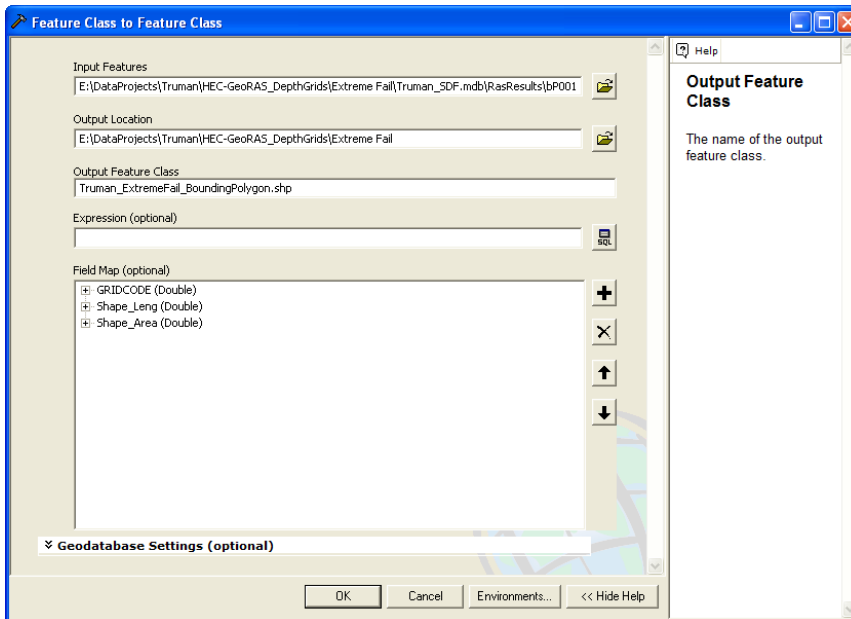
Figure B.10 Feature Class to Feature Class Dialog Box
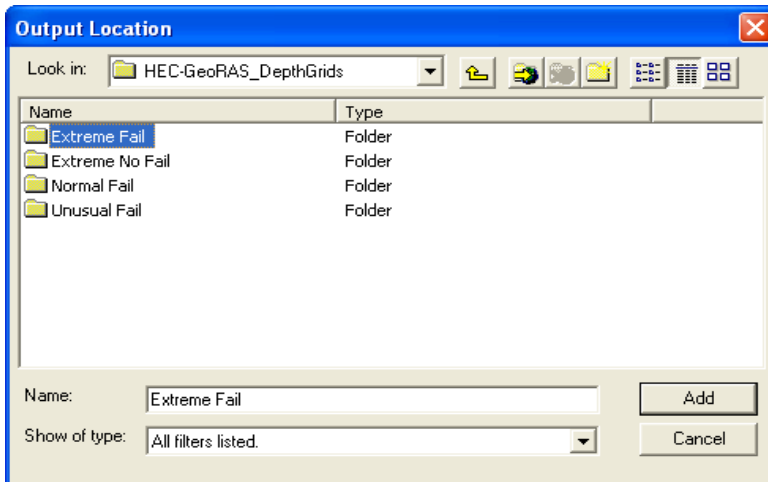
Figure B.11 Output Location Browser

7. In the **Output Feature Class** box, provide a name for the shapefile (i.e., *Truman_ ExtremeFail_BoundingPolygon*).

8. Click **OK.** The **Feature Class to Feature Class** dialog box closes, and the **Feature Class to Feature Class Compute** dialog box opens (Figure B.12). This dialog box contains information on if the creation of the float file was successful and how long it took to create the binary file. Click **Close**. The **Feature Class to Feature Class Compute** dialog box closes and the shapefile appears in the location selected.
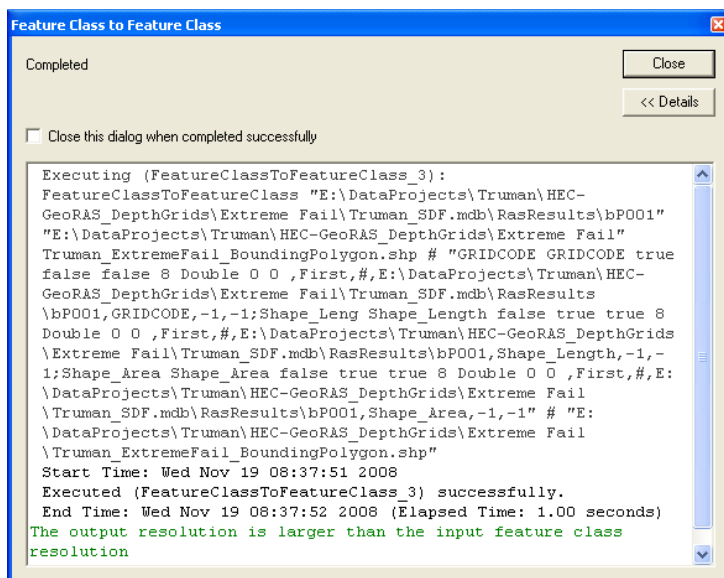
Figure B.12 Feature Class to Feature Class Compute Dialog Box

B.4   Generate Hazard Area Boundary

During the evacuation portion of the life loss computation in HEC-FIA, the time it takes for people in a given structure to evacuate safely (defined as the time from leaving a structure to reaching a safe location) can be defined by either:

- Entering the exact time (minutes) it takes for the inhabitants of each structure to reach a safe location, or

- Providing a hazard area boundary and nominal evacuation velocity (mph) and letting HEC-FIA compute the time required for the inhabitants of each structure to evacuate to safety.

Typically, a hazard area boundary and nominal velocity is entered in HEC-FIA to estimate the evacuation times for a given event. The hazard area boundary should be determined by creating a polygon that represents the extents of flooding where depth is greater than two feet. Each flood event being simulated has a separate hazard area boundary. To create a hazard area boundary, follow the steps in the following sections.

B.4.1   Reclassify Depth Grid Cells

The following steps assist the user in creating a polygon representing the Hazard Boundary, which represents everything with two feet of flooding or greater. This polygon can be utilized for evaluating where structures evacuate in an HEC-FIA simplified LifeSim computation. Reclassify depth grid cells for the maximum depth grid to values of one (1) if greater than two feet deep and two (2) if less than or equal to two feet deep:

1. Start **ArcMap**. The **ArcMap** window opens (Figure B.13). By default, a **new empty map** is selected, click **OK**.
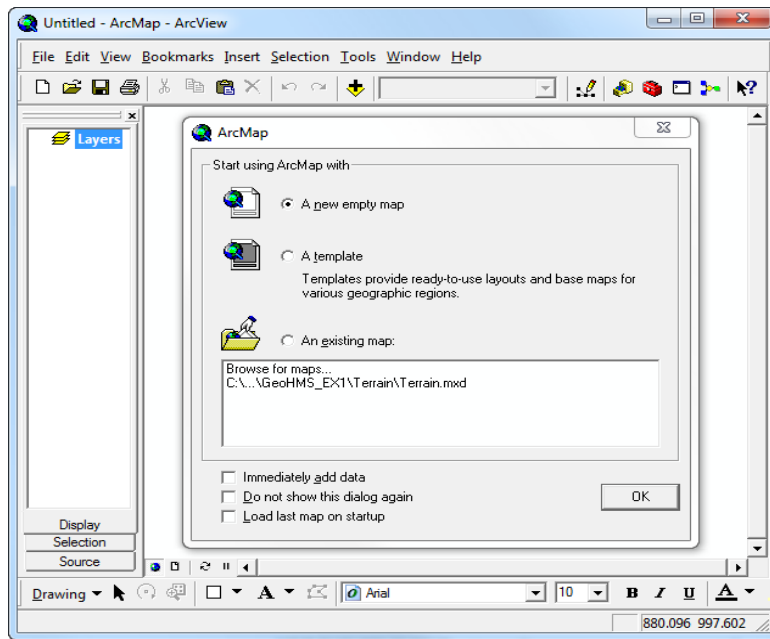
Figure B.13 ArcMap® Window

2. If the **Spatial Analyst Toolbar** is not available from the **ArcMap** window, right-click on the empty area next to the **Menu Bar** (Figure B.14). From the shortcut menu, click **Spatial Analyst**, the **Spatial Analyst Toolbar** (Figure B.15) appears in the **ArcMap** window in the toolbar area.

3. From the **Spatial Analyst Toolbar**, click **Spatial Analysis** and then select **Reclassify** from the shortcut menu. The **Reclassify** dialog box opens (Figure B.16).

4. Input raster is the maximum depth grid (*depth0*) for the flood scenario being assessed. From the **Input raster** list, select the depth grid file or by clicking 📂 next to the **Input raster** list.

5. A **Choose an input raster** browser opens. Browse to the location of the depth grid file, click on the depth grid filename and then click **Add**. The **Choose an input raster** browser closes, and the filename of the grid appears in the **Input raster** box on the **Reclassify** dialog box.

6. Leave the **Reclass field** box blank.

7. Default values appear in the **Set values to reclassify** box (Figure B.17). These values (both old and new) need to be reset. Set all values less than or equal to two (2) feet to a new value of two (2) and values from two (2) feet up to the highest value in the depth grid to a new value of one (1). For an example, see Figure B.16. Note that when entering the old value range a space is required on both sides of the dash (enter 0 - 2, not 0-2).
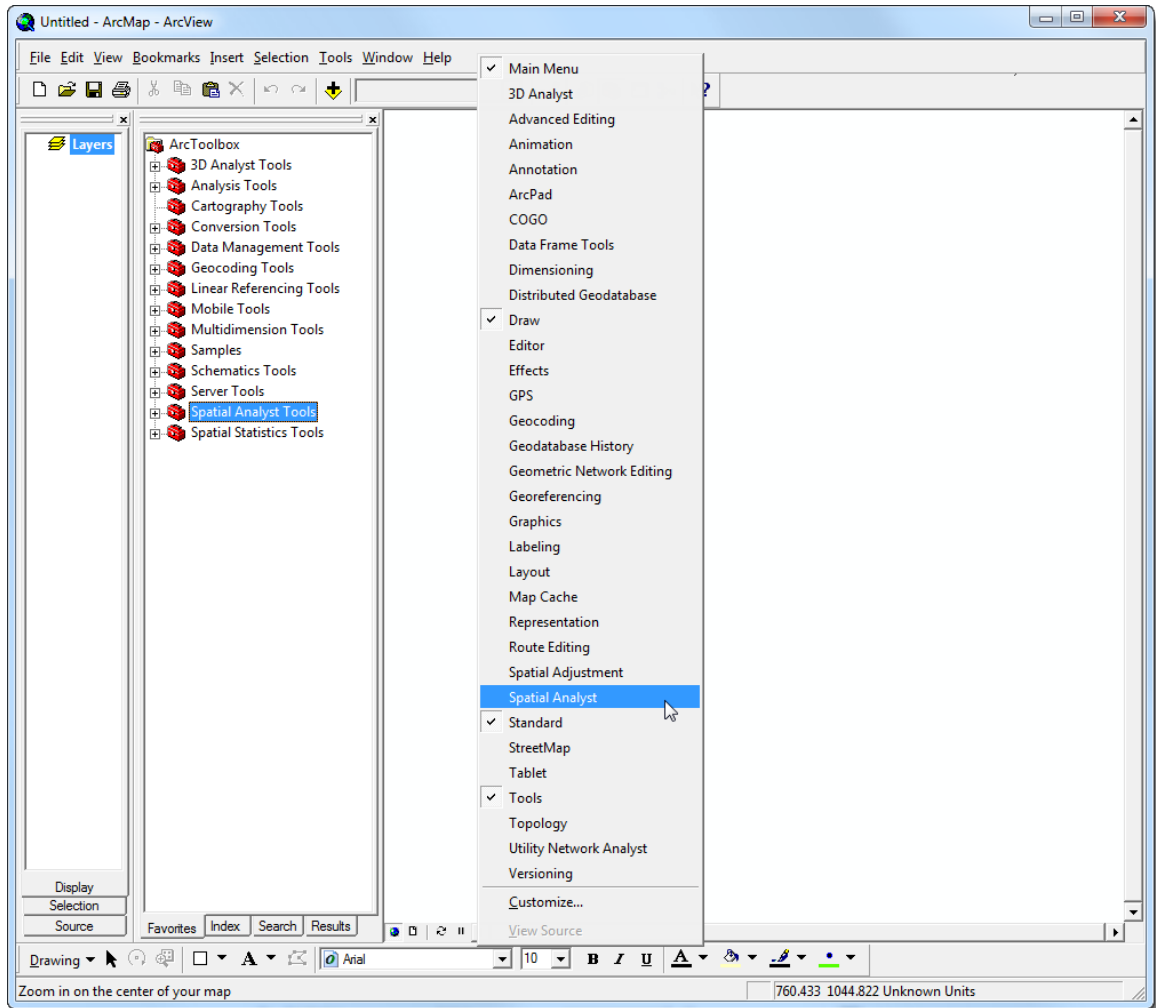
Figure B.14 Toolbar Setup Shortcut Menu
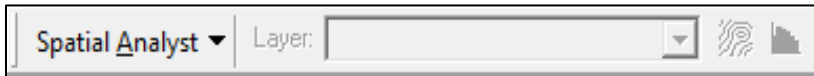
Figure B.15 Spatial Analyst Toolbar
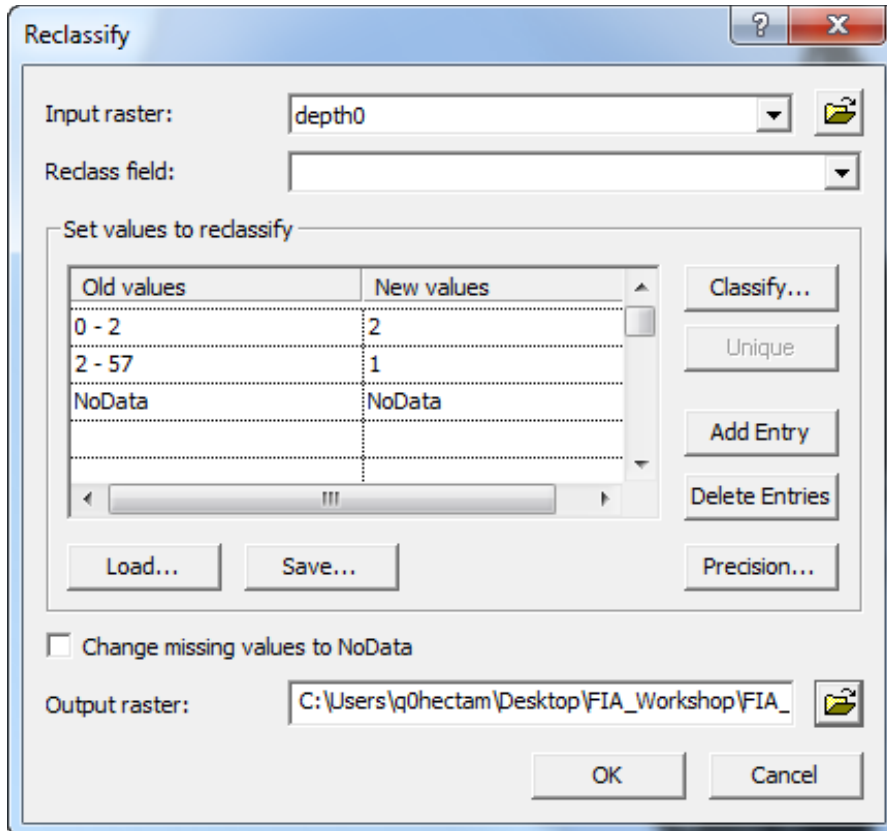
Figure B.16 Reclassify Dialog Box
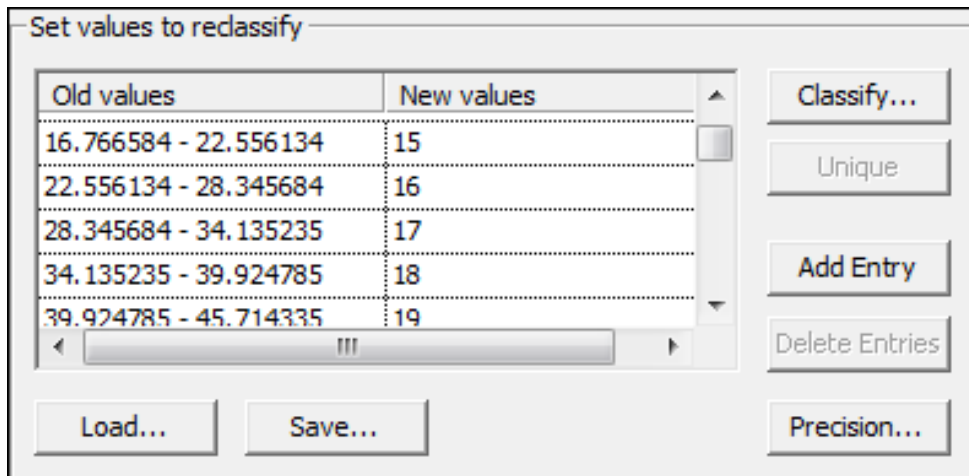
Figure B.17 Set Values to Reclassify

8. In the **Output raster** box, type the desired pathname for the depth grid or click 📂 to browse to the place where the grid is to be saved.

9. Click **OK**. The hazard area grid is created. When that is finished, the **Reclassify** dialog box closes and the hazard area boundary grid displays in the ArcMap® window.

B.4.2 Generate a Polygon Shapefile of the Hazard Area Boundary

Generate a polygon shapefile that represents the hazard area boundary (can be done in ArcMap or ArcCatalog):

1. If the **ArcToolbox Pane** is not present, click **ArcToolbox** 🔴 on the **Standard Toolbar** (Figure B.1) and the **ArcToolbox Pane** displays in the ArcMap or ArcCatalog window.

2. From the **ArcToolbox Tree**, double-click **Conversion Tools**, double-click **From Raster**, and then double-click **Raster to Polygon** (Figure B.3). The **Raster to Polygon** dialog box opens (Figure B.18).
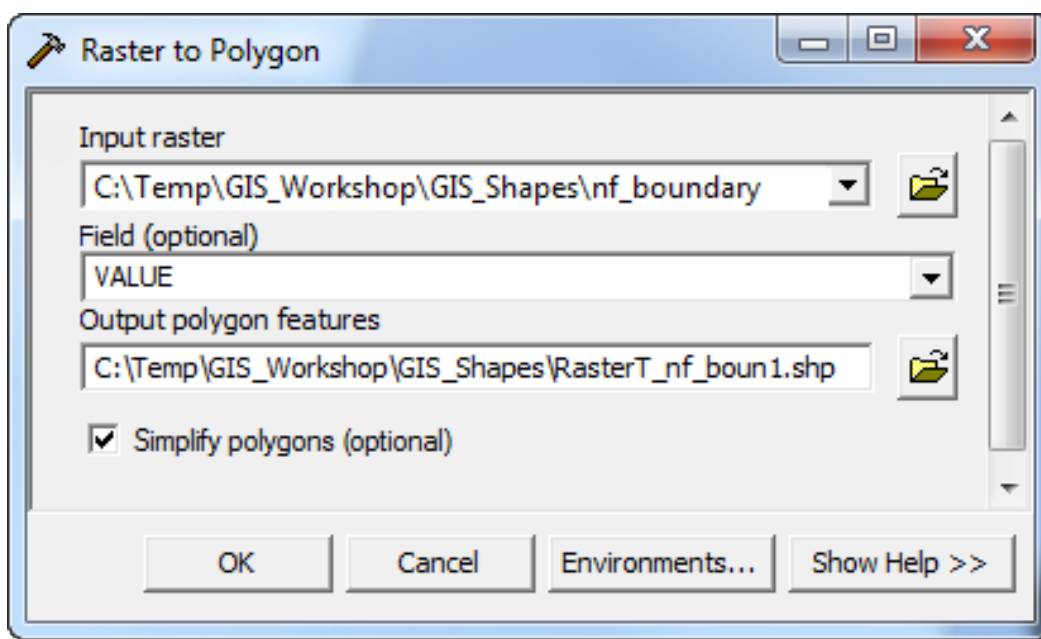
Figure B.18 Raster to Polygon Dialog Box

3. The input raster file is the hazard area boundary grid that was created in the previous section. Select the location of the hazard area boundary grid by clicking 📂 next to the **Input raster** box (Figure B.18). Browse to the location of the hazard area boundary grid, and select it. Click **Add**, the **Input raster** browser closed, and the path and the name of the selected hazard area boundary file appears in the **Input raster** box on the **Raster to Polygon** dialog box.

4. The **Field** box should be set to **VALUE**; this option is used to assign values from the cells in the hazard area boundary file to the polygons in the shapefile.

5. By default the software stores the output shapefile to the same directory as the selected hazard area boundary grid. In the **Output polygon features** box, the path and the default name for the shapefile appears. Change this name to symbolize the depth grid it represents (i.e., *normal_fail_hazardarea.shp*).

6. Select **Simplify polygons** so that the software smooths the polygons into simpler shapes.

7. Click **OK**. The **Raster to Polygon** dialog box closes and the **Raster to Polygon Compute** dialog opens. This dialog box notifies the user of the status of the compute and how long it took to create the binary file. When finished viewing information, click **Close**. The **Raster to Polygon Compute** dialog box closes.

B.4.3   Editing the Hazard Area Boundary Shapefile

All polygons with a value of one (1) in the output polygon dataset represent the hazard area boundary. Edit the polygon shapefile and select all polygons with a value of two (2) and delete them. To edit the hazard area boundary shapefile:

1. From the **Editor Toolbar** click **Editor** (Figure B.19), from the shortcut menu click **Start Editing**.
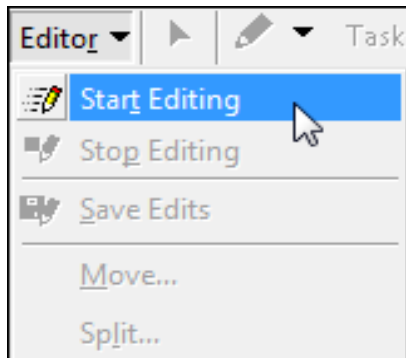
Figure B.19 Start Editing

2. Right-click on the shapefile that was created in the previous section. From the shortcut menu (Figure B.20), click **Open Attribute Table**. The attribute table for the hazard area polygon file opens (Figure B.21).

3. Click **Options** (Figure B.21). From the shortcut menu, click **Select by Attributes**. The **Select by Attributes** dialog box opens (Figure B.22).

4. Double-click on **"GRIDCODE"**, in the **SELECT * FROM** *shapefile name* **WHERE** box "GRIDCODE" appears. Click the equals sign button and then enter 2.
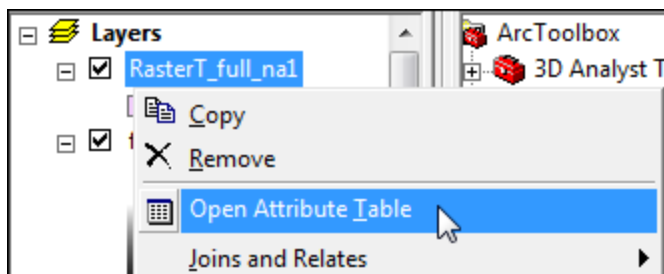
Figure B.20 Open Attribute Table Menu Item
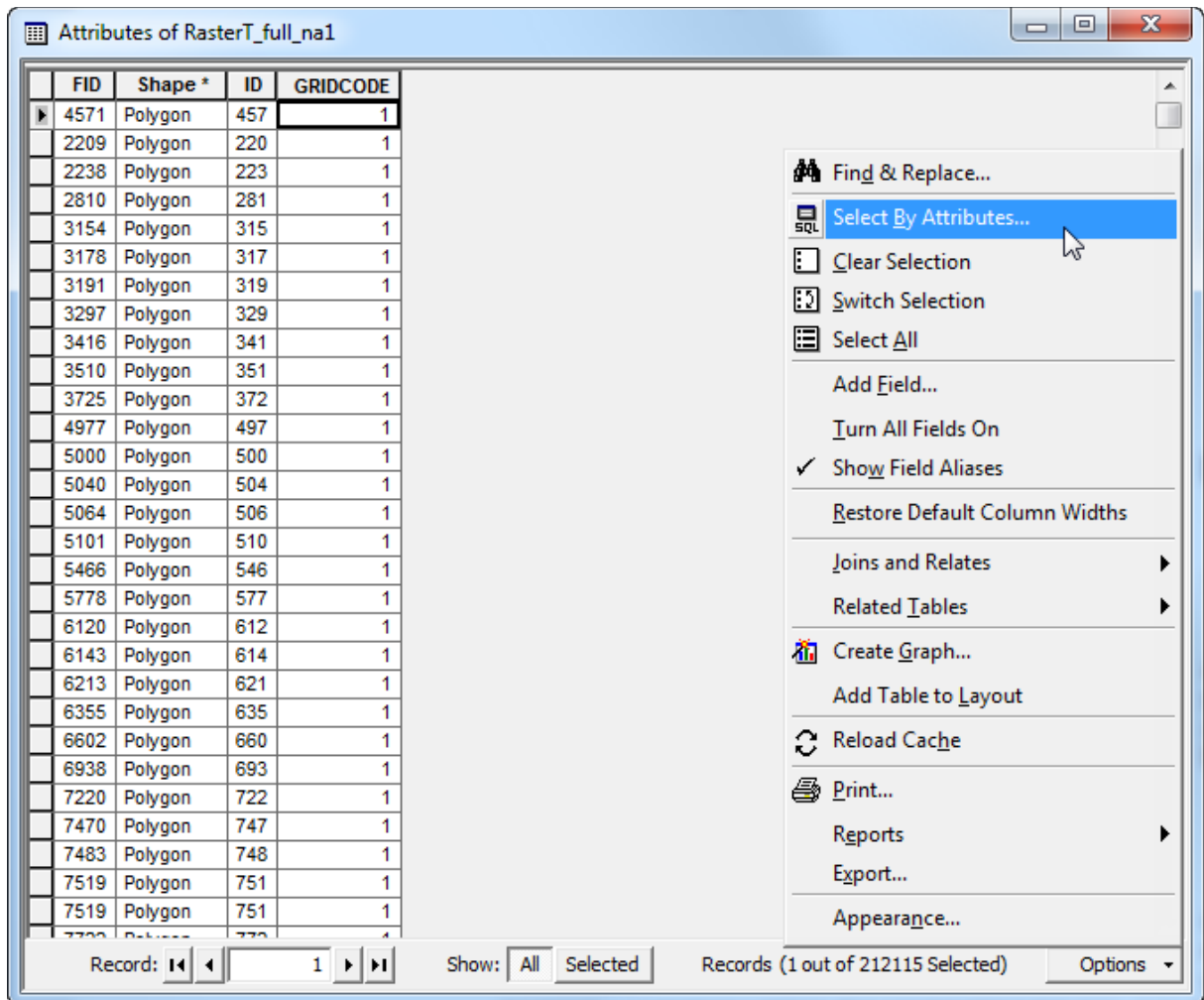
Figure B.21 Attribute Table

5. Click **Apply**, in the attribute table all the rows with a *GRIDCODE* equal to two (2) are highlighted in a cyan color. If the shapefile is displayed in the ArcMap window, the same items are highlighted in cyan.

6. Click **Close**, the **Select by Attributes** dialog box closes.

7. From the attribute table dialog box click the **Delete** key. All of the highlighted rows are deleted. Click ☒ to close the attribute table.

8. From the **Editor Toolbar** click **Editor** (Figure B.19). From the shortcut menu click **Save Edits**. Now the hazard area boundary shapefile has been edited to contain only the polygons that delineate areas where the maximum depth is greater than two feet.

9. Repeat all steps in this section for each depth grid in the study.
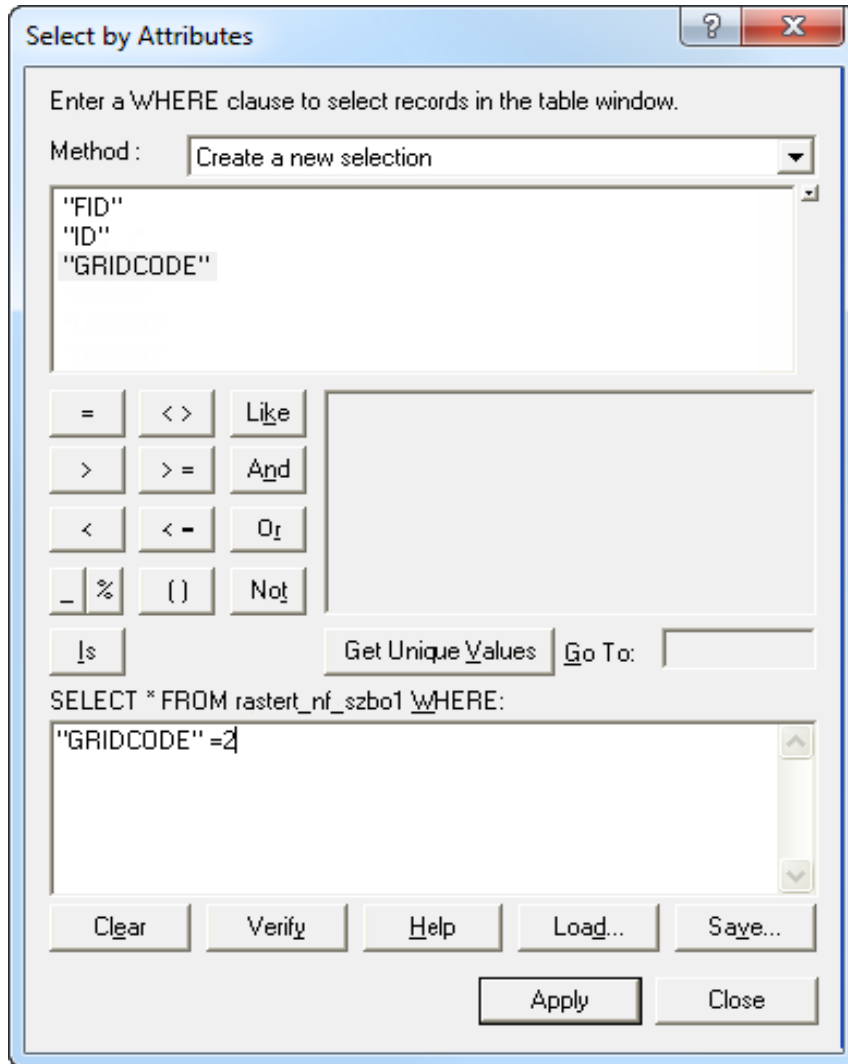
Figure B.22 Select by Attributes Dialog Box

B.5   Preparing Digital Terrain Model

Terrain data can be in binary grid format for use in HEC-FIA, or in the .tif format. HEC-FIA and HEC-RAS 5.0 utilize .tif files; this section explains the steps to convert from ESRI Raster to .flt so that the file can be imported into HEC-FIA 3.0. HEC-FIA converts the file to .tif for the user. Terrain information is required to assign ground elevations to a structure inventory generated in HEC-FIA, to update ground elevations in an existing structure inventory, and to determine the arrival time at the hazard boundary during the evacuation stage of the life loss compute. To prepare a terrain grid for importing into HEC-FIA, follow the steps in this section.

B.5.1   Clip the Original Digital Terrain Grid

If an existing terrain grid extends far beyond the limits of the study, the terrain grid can be clipped to the same area that is covered by the maximum inundated depth grid. This action allows HEC-FIA to use the terrain grid in a more efficient manner. If the terrain grid is of manageable size (less than 1GB in size), then skip to Section B.5.2.

To clip the digital terrain grid:

1. Start **ArcMap**. The **ArcMap** window opens (Figure B.13).

2. If the **ArcToolbox Pane** is not present, click **ArcToolbox** 🔴 on the **Standard Toolbar** (Figure B.1) and the **ArcToolbox Pane** displays in the **ArcMap** window.

3. From the **ArcToolbox Tree**, double-click **Spatial Analyst Tools**, double-click **Extraction**, and then double-click **Extraction by Mask** (Figure B.23).
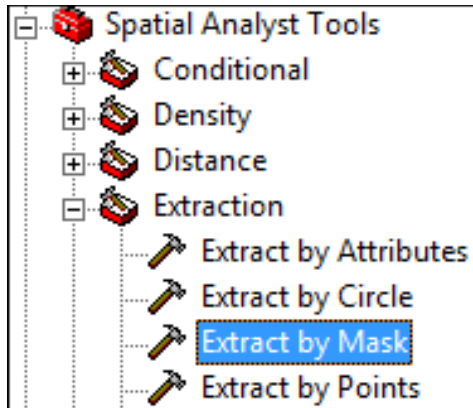
Figure B.23 Spatial Analyst Tools

4. The **Extract by Mask** dialog box opens (Figure B.24). Browse to the location of the digital terrain grid file by clicking 📂 next to the **Input raster** list.
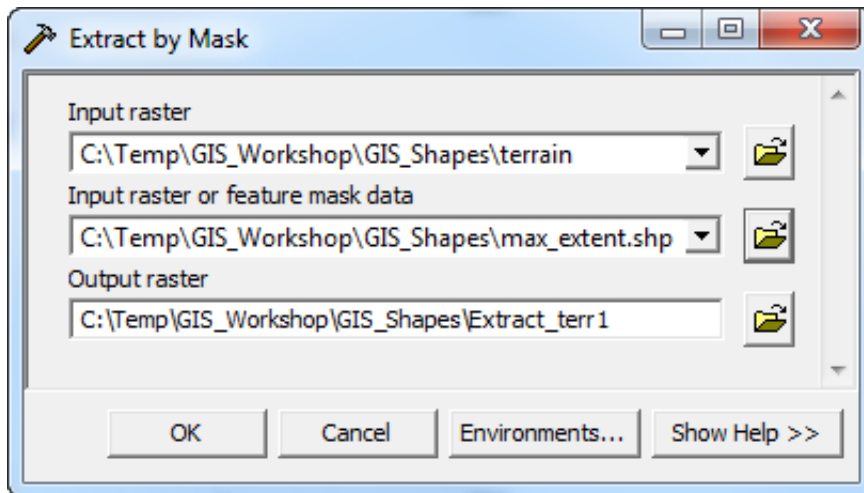
Figure B.24 Extract by Mask Dialog Box

5. The **Input Raster** browser opens (see Figure B.25). Browse to the location of the digital terrain grid file, click on the digital terrain grid filename. Click **Add**, the **Input raster** browser closes, and the pathname of the selected digital terrain grid file (i.e., *C:\Temp\ GIS_Workshop\GIS_Shapes\terrain*) appears in the **Input raster** list on the **Extract by Mask** dialog box (Figure B.24).
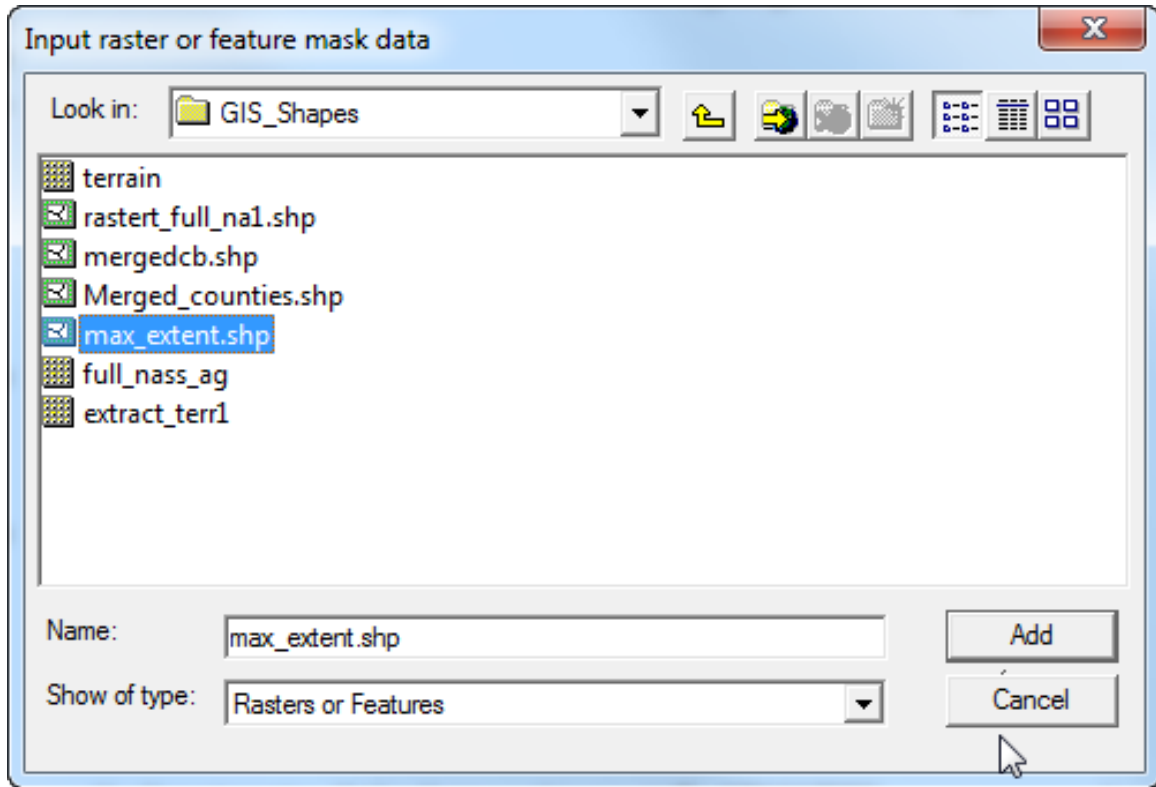
Figure B.25 Input Raster or Feature Mask Data Browser

6.   Browse to the location of the maximum inundated area bounding polygon shapefile (created in Section B.3) by clicking 📂 next to the **Input raster or feature mask data** list (Figure B.24). The **Input raster or feature mask data** browser opens (Figure B.25).

7.   Browse to the location of the maximum inundated area bounding polygon shapefile, click on the shapefile filename. Click **Add**, the **Input raster or feature mask data** dialog box closes, and the path and the name of the selected maximum inundated area bounding polygon shapefile appears in the **Input raster or feature mask data** list on the **Extract by Mask** dialog box (Figure B.24).

8.   By default the software creates the masked terrain digital grid in the same location as the original terrain digital grid.

9.   Click **OK**, the **Extract by Mask** dialog box closes and the **Extract by Mask Compute** dialog box opens (Figure B.26). This dialog box notifies the user of the status of the compute and how long it took to create the masked digital terrain grid file. When finished viewing information, click **Close**, the **Extract by Mask Compute** dialog box closes and the shapefile appears in the selected location.
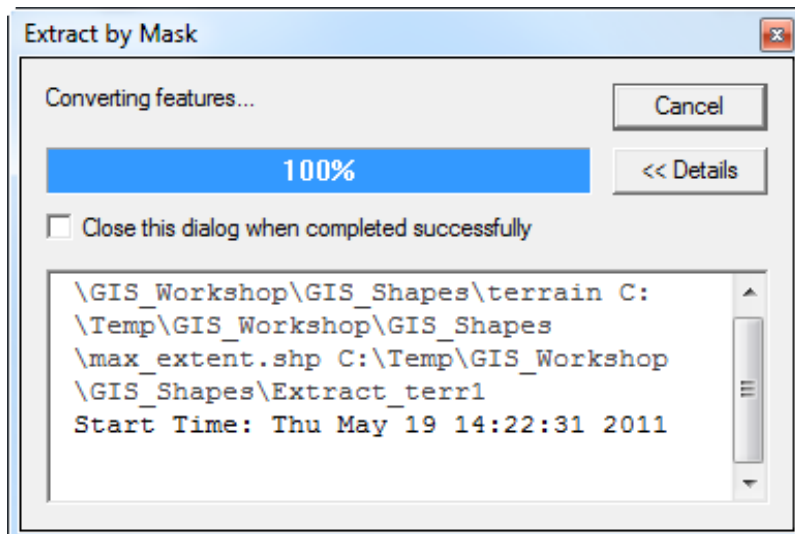
Figure B.26 Extract by Mask Dialog Box

Now in the selected directory, the masked terrain digital grid file appears.

B.5.2   Convert Terrain Grid to a Binary Format

1. Start **ArcMap**. The **ArcMap** window opens (Figure B.13).

2. If the **ArcToolbox Pane** is not present, click **ArcToolbox** 🐞 on the **Standard Toolbar** (Figure B.1) and the **ArcToolbox Pane** displays in the **ArcMap** window.

3. From the **ArcToolbox Tree**, double-click **Conversion Tools**, double-click **From Raster**, and then double-click **Raster to Float** (Figure B.3).

4. The **Raster to Float** dialog box opens (Figure B.4). Browse to the location of the clipped digital terrain grid file by clicking 📂 next to the **Input raster** box.

5. The **Input raster** browser opens (Figure B.5). Browse to the location of the clipped digital terrain grid file, click on the clipped digital terrain grid filename. Click **Add**, the **Input raster** browser closes, and the pathname of the selected clipped digital terrain grid file appears in the **Input raster** box on the **Raster to Float** dialog box.

6. By default the software creates the output floating point raster file to the same directory as the selected clipped digital terrain grid file. In the **Output floating point raster file** box (Figure B.6) the path and the default name for the binary file appears.

7. Click **OK**, the **Raster to Float** dialog box closes. The **Raster to Float Compute** dialog box opens (Figure B.7). This dialog box notifies the user of the status of the compute and how long it took to create the binary file. When finished viewing information, click **Close**, the **Raster to Float Compute** dialog box closes.

8. Now in the selected directory, there are two files, *.flt and *.hdr. The clipped digital terrain grid has been successfully converted to a binary format.

The grid can also be converted to ASCII file format for importing into HEC-FIA using **Raster to ASCII**. However, binary format is preferred due to smaller file sizes and faster processing time.

B.6   Preparing HEC-RAS Data

HEC-FIA requires a stream centerline for all consequence computations. The life loss computation in HEC-FIA also requires a cross section shapefile, storage area shapefile, and associated HEC-DSS database with stage-hydrograph output at each cross section and storage area for the flood scenarios being assessed.

B.6.1   Stream Centerline, Cross Section, Storage Area

The stream centerline, cross section, and storage area feature classes are stored in the HEC-GeoRAS geodatabase. To create a shapefile of the stream centerline:

1. Start **ArcCatalog**. The **ArcCatalog** window opens (Figure B.1).

2. From the first pane, from the **Catalog Tree**, browse to the folder that contains the HEC-GeoRAS geodatabase for the HEC-FIA project.

3. Once the geodatabase file appears in the **Contents** tab of the main window, double-click on the geodatabase filename (i.e., *Truman_SDF.mdb*). Now double-click on the geodatabase feature dataset (i.e., *RasResults*).

4. The stream centerline file created by HEC-GeoRAS should appear in the list (i.e., *River2D*). Right-click on the stream centerline filename from the shortcut menu point to **Export**, click **To Shapefile (single)**.

5. The **Feature Class to Feature Class** dialog box opens (Figure B.10).

6. The **Input Features** box (Figure B.10) should contain the name of the selected stream centerline file. Browse to location where the shapefile is to be stored by clicking 📂 next to the **Output Location** box (Figure B.10). The **Output Location** browser opens (Figure B.11). Browse to the folder where the shapefile is to be stored, click **Add**. The **Output Location** browser closes, and the pathname with the selected folder appears in the **Output Location** box of the **Feature Class to Feature Class** dialog box.

7. In the **Output Feature Class** box (Figure B.10), provide a name for the shapefile.

8. Click **OK**. The **Feature Class to Feature Class** dialog box closes and the **Feature Class to Feature Class Compute** dialog box opens (Figure B.12). This dialog box contains information on start time, if creation was successful, end time, and how long it took to create the binary file. Click **Close**, the **Feature Class to Feature Class Compute** dialog box closes and the shapefile appears in the selected location.

9. Now in the selected directory, the shapefile appears. The stream centerline has been successfully exported to a shapefile.

10. Repeat Steps 1-10 for the storage area (i.e., *StorageAreas*) shapefile (i.e., *Truman_StorageAreas*) and the cross sections (i.e., XSCutlines) shapefile (i.e., *Truman_XSections*).

If HEC-GeoRAS and HEC-RAS were not used to develop the hydraulic results for the study, the stream alignment in HEC-FIA can be imported from an existing line shapefile or digitized using tools in HEC-FIA. Clip the stream centerline to the extents of the study area using the steps described below. Economic consequence can be computed in HEC-FIA using any stream alignment and depth grid as input. However, HEC-FIA cannot compute loss of life consequences unless a cross section shapefile, storage area shapefile, and associated HEC-DSS database are provided as input, which are output from HEC-RAS and HEC-GeoRAS.

B.6.2   HEC-DSS File

For life loss computation, HEC-FIA can obtain flood wave arrival times for individual structures from arrival time grids or from stage-hydrographs stored by HEC-RAS in a HEC-DSS (Hydrologic Engineering Center's Data Storage System) file. The hydraulic engineer needs to configure HEC-RAS to generate stage-hydrographs at all cross section and storage area locations before simulating an event. If the HEC-DSS file already contains hydrograph data for each cross section, skip this section.

1. Start **HEC-RAS**. The **HEC-RAS** window opens Figure B.27.
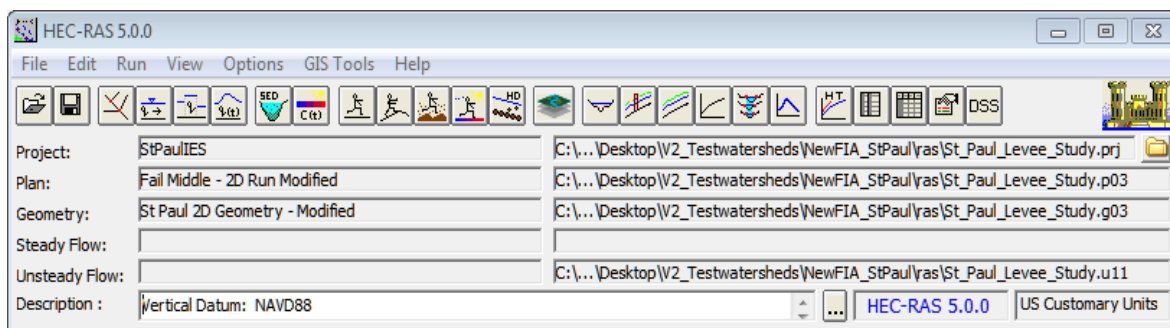
Figure B.27 HEC-RAS Main Window

2. From the toolbar click ⚡, the **Unsteady Flow Analysis** dialog box opens (Figure B.28).

3. From the **Options** menu, click **Stage and Flow Output Locations**, the **Stage and Flow Output Locations** dialog box opens (Figure B.29).

4. From the **River** list, select **(All Rivers)**.

5. From the **RS** box, select **(All Rivers)**.

6. Click the arrow to select all the cross section locations to the **Selected Locations** box.

7. Click **OK**, the **Stage and Flow Output Locations** dialog box closes.
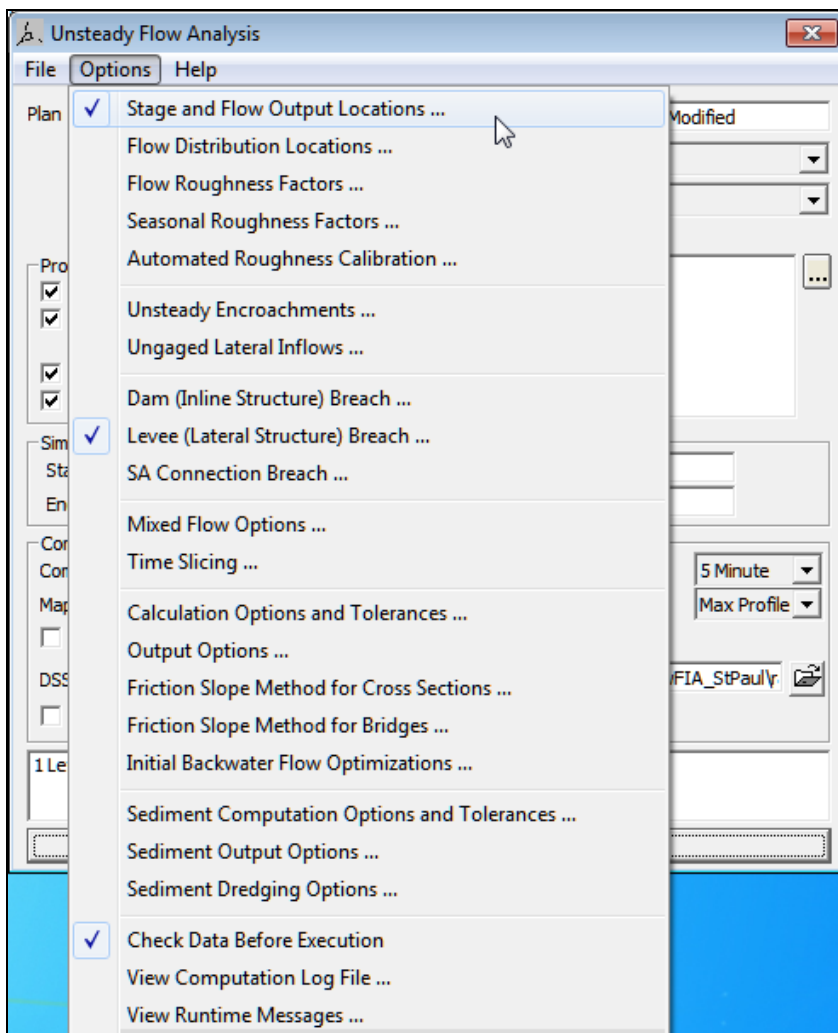
Figure B.28 Unsteady Flow Analysis Dialog Box

8. From the **Unsteady Flow Analysis** dialog box (see Figure B.28), in the **DSS Output Filename** box, enter the path and the filename of the HEC-DSS file that contains the stage-hydrographs created by HEC-RAS.

9. Click **Compute** and the **HEC-RAS Computations** dialog box opens. When computations are finished, click **Close**, the **HEC-RAS Computations** dialog box closes.

10. The HEC-DSS file is created in the selected location.
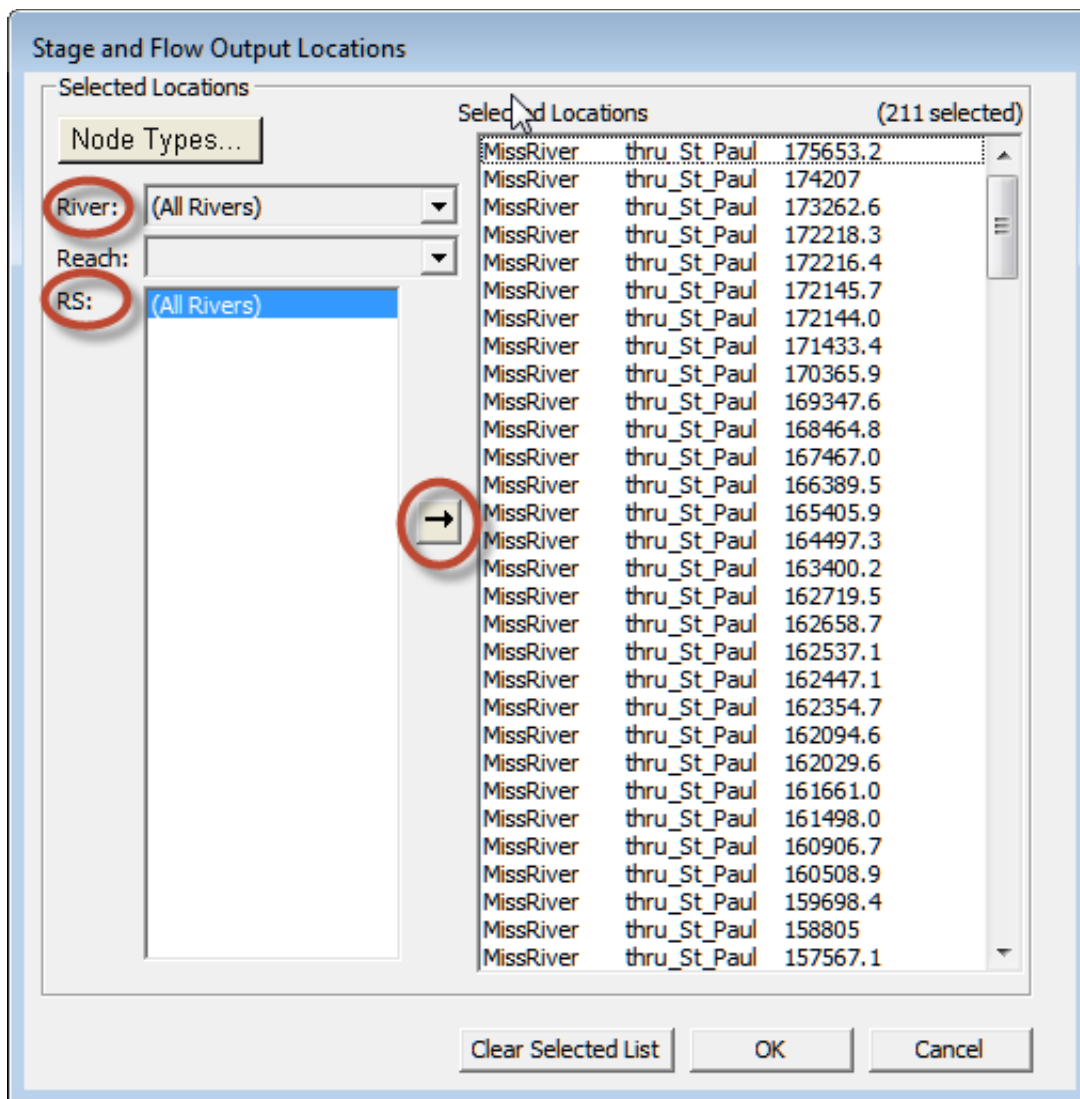
Figure B.29 Stage and Flow Output Locations Dialog Box

B.7   Emergency Planning Zones

Emergency planning zones (formerly defined as impact areas in HEC-FIA Version 3.0) are required by HEC-FIA. Emergency planning zones (EPZs) are used for defining common input parameters for groups of structures as well as for aggregating consequence results. A county dataset (shapefile) is often the most readily available dataset for defining impact areas. When county boundaries are used as EPZs, damages can be reported by individual structure, county, or larger area.

Emergency planning zones (EPZs) are polygons and the polygon shapefile can contain several discrete polygons, but HEC-FIA cannot import multi-part polygons. So each individual polygon must have a different name.

If a geo-referenced polygon shapefile is not available for use as EPZs, or if some polygons do not import because the EPZs are multi-part polygons, the EPZs can be digitized in HEC-FIA.

B.8   Double Warning Data

For flood scenarios where warnings would go out to different parts of the inundated area at different times, the double-warning approach may be necessary. For example, for any dam failure flood scenario where the non-fail releases from the dam would cause significant damage (i.e., most PMF events), the double-warning approach is required. The double-warning approach in this example would allow HEC-FIA to warn those people impacted by the non-fail inundation at a different time (earlier) than those impacted by the dam failure inundation.

Follow these steps to prepare the data necessary for the double-warning procedure. The example uses full pool failure (*FP_Fail*) and full pool non-fail (*FP_NonFail*) inundations.

1. Open **ArcMap** (Figure B.13), and add the *FP_Fail* and *FP_NonFail* shapefiles by clicking ⬇ **Add Data**. If the **ArcToolbox Pane** is not present, click **ArcToolbox** 🔴 on the **Standard Toolbar** (Figure B.2).

2. From the **ArcToolbox Tree**, double-click **Analysis Tools**, double-click **Overlay**, and then double-click **Union** (Figure B.30). The **Union** dialog box opens (Figure B.39).

3. From the **Input Features** list (Figure B.31), select the *FP_Fail* and *FP_NonFail* shapefiles. The selected shapefiles appear in the table below the **Input Features** list.

4. Change the default name in the **Output Feature Class** (Figure B.31) to reflect that it is a union of the two files.

5. Leave all other options as default and press **OK**. The **Union** dialog box closed and the **Union Dialog Compute** box opens indicating when the union tool has completed its task.
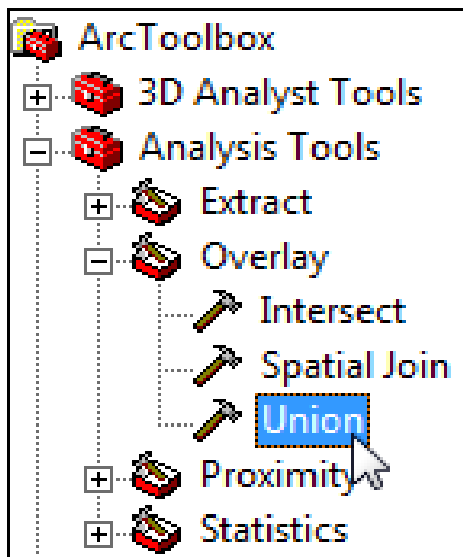
Figure B.30 ArcToolbox Tree
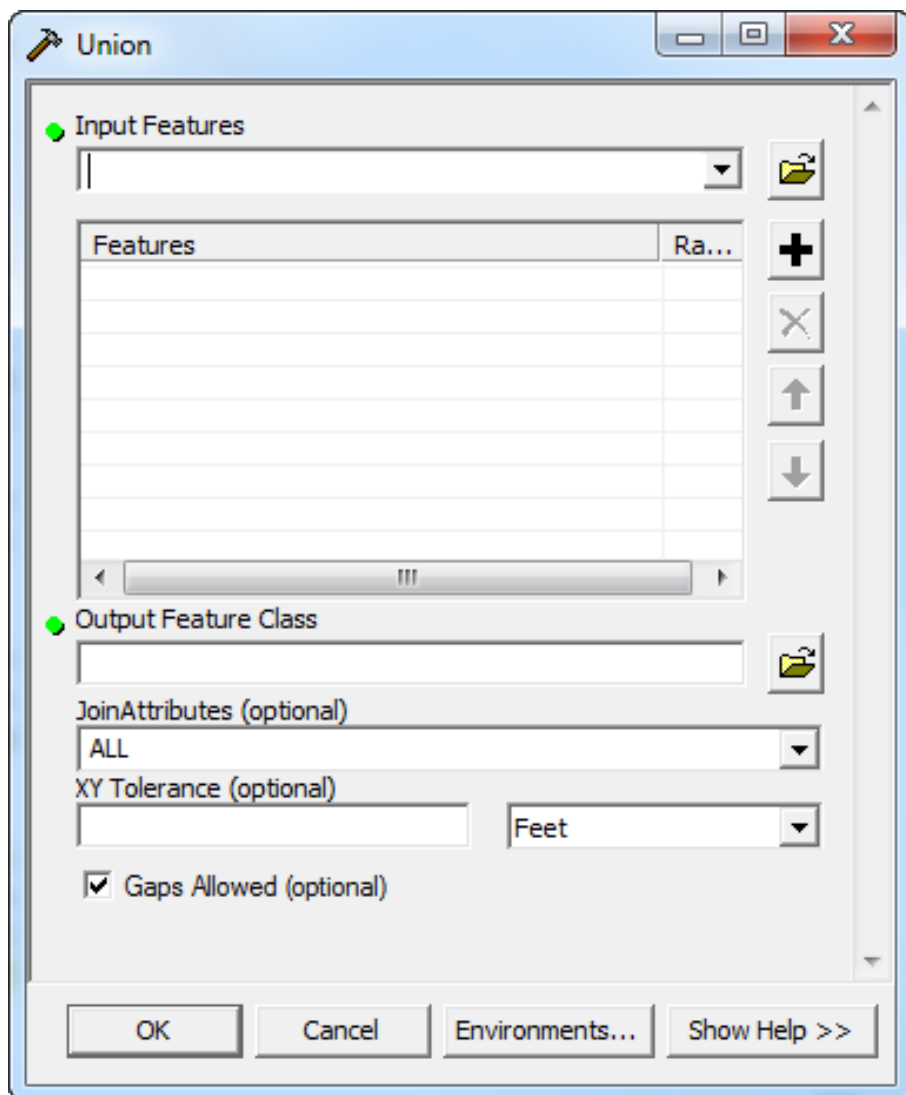
Figure B.31 Union Dialog Box

6. Open the attribute table of the new shapefile by right-clicking on the shapefile in the table of contents pane. Add a new field to the table by clicking **Options** and then clicking on **Add Field**. The **Add Field** dialog box appears (Figure B.32). In the **Name** box enter "Name", in the **Type** list select "Text", and in the **Field Properties** box enter 20 for the **Length** (Figure B.32). Click **OK**.

7. Next, enter the appropriate name for each polygon feature (*FP_NonFail, FP_Fail*). From the **Editor** toolbar, select **Start Editing** (Figure B.19).

8. Double-click in the appropriate cell of the attribute table and enter the correct name for each polygon in the table (Figure B.33).

9. From the editor toolbar, select **Stop Editing**. Save the edits. The double warning time polygon shapefile (*westfork_FP_BP_Union.shp*) is now ready for use in HEC-FIA.
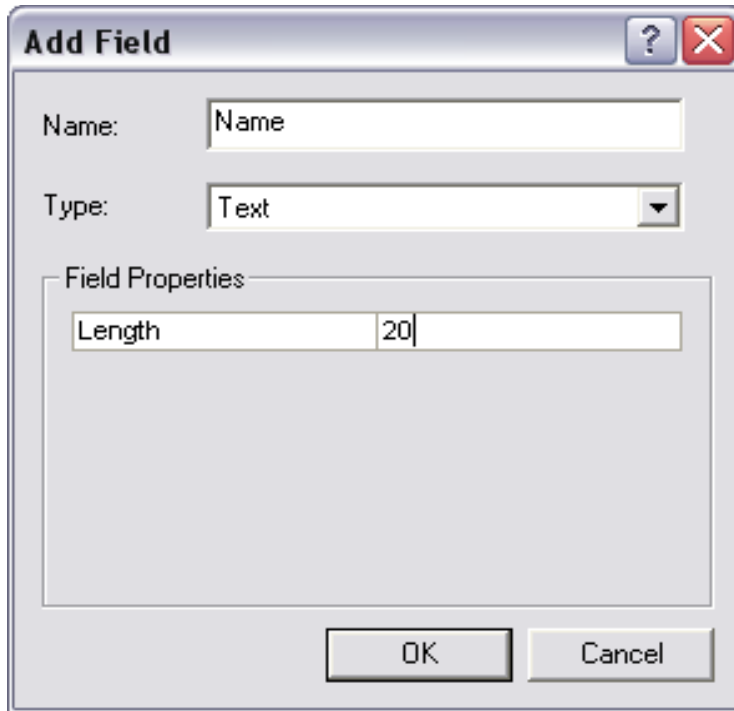
Figure B.32 Add Field Dialog Box
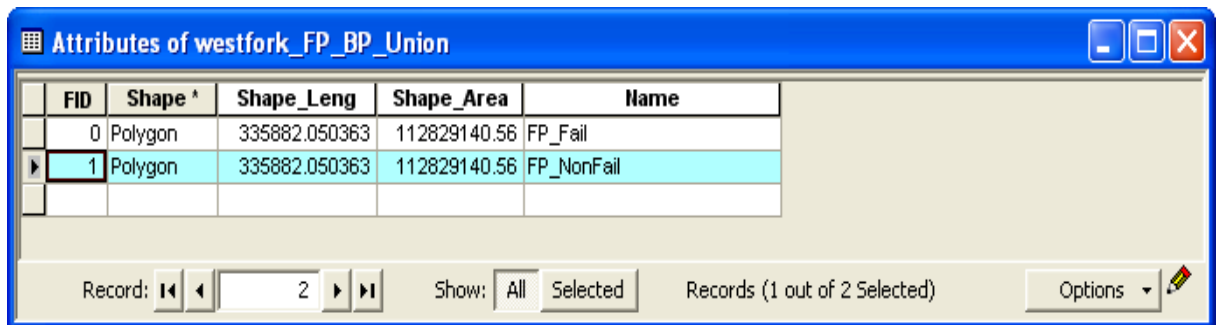
Figure B.33 Entering Names into the Attribute Table

B.9   Agricultural Grid Preparation

NASS CDL grids are generally the preferred data source for quick assessments of agricultural damage. The NASS CDL agricultural data is available online for the continental United States at the following website:
https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php.

The NASS agricultural grids are in .tif file format. The projection information is contained within a world file (.tfw). Follow these steps to prepare the agricultural data for use in HEC-FIA:

1.   Open **ArcMap** (Figure B.13), add the maximum inundation shapefile (i.e., *max_extent.shp*) obtained in Section 0 by clicking ⬇ **Add Data**.

2.   Next, add the NASS agricultural grid file.

3. Not all data in the NASS CDL layer are required; only those within the study area should be selected. Right-click on the shapefile in the table of contents and click **Zoom To Layer** (Figure B.34). This selection zooms the map window to the shapefile extent.
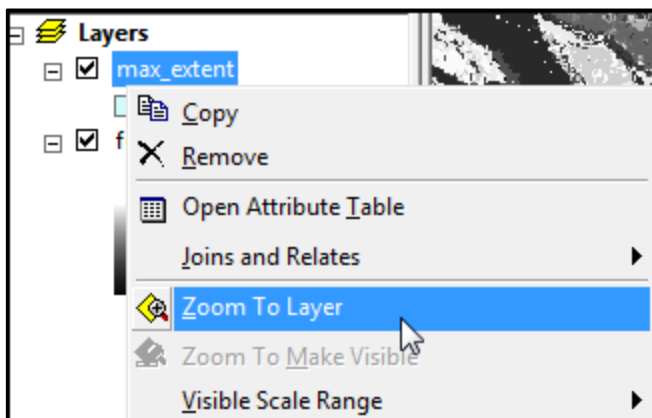
Figure B.34 Zoom to Layer Menu Option

4. Next, right-click on the NASS CDL grid in the table of contents and point to **Data**, click **Export Data** (Figure B.35).

5. The **Export Raster Data** dialog box appears (Figure B.36).

6. Choose **Data Frame (Current)** for the Extent. This selection exports data to the current frame extent, which is based on the maximum inundation shapefile set in Step 3.

7.   Since the shapefile was added first, the data frame should be using the required spatial reference. Choose **Data Frame (Current)** for the spatial reference. This selection projects the NASS CDL data into the same projection as the maximum inundation shapefile, which should be the projection system used for all FIA GIS data.

8. Leave the middle portion of the dialog with the default values. The **Cell Size(cx, cy)** is automatically adjusted to meet the selected spatial reference.

9. Browse to the location where the shapefile is to be stored by clicking 📂 next to the **Location** box (Figure B.36).

10. Next select **TIFF** from the **Format** list (Figure B.36). In the **Name** box, enter the name of the grid that is to be exported.

11. Click **Save**. The **Export Data Dialog** box closes and the user is prompted to add the new data to the ArcMap project. Select **No**, the prompt closes, and the exported data is not added to the ArcMap project.

12. Finally, create a world file for the exported data.
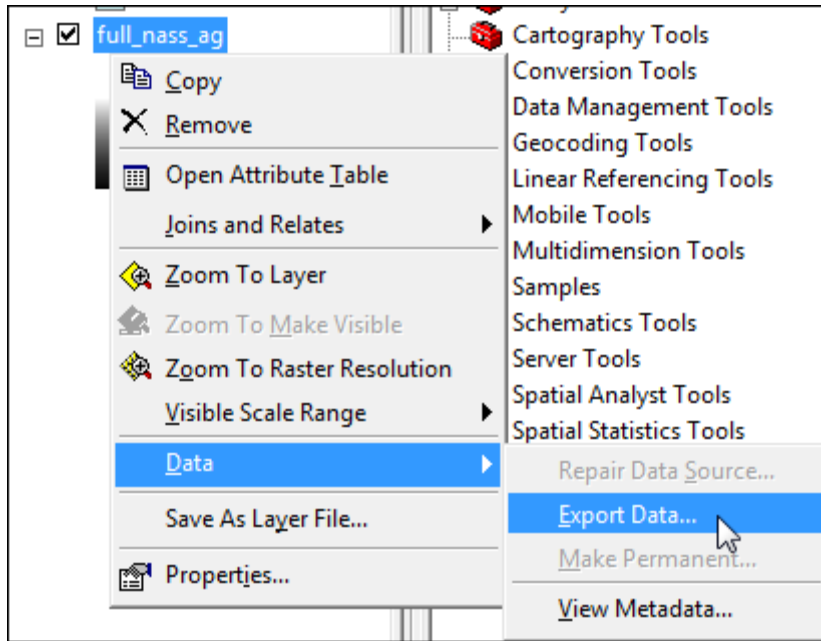
Figure B.35 Export Data Layer Menu Option
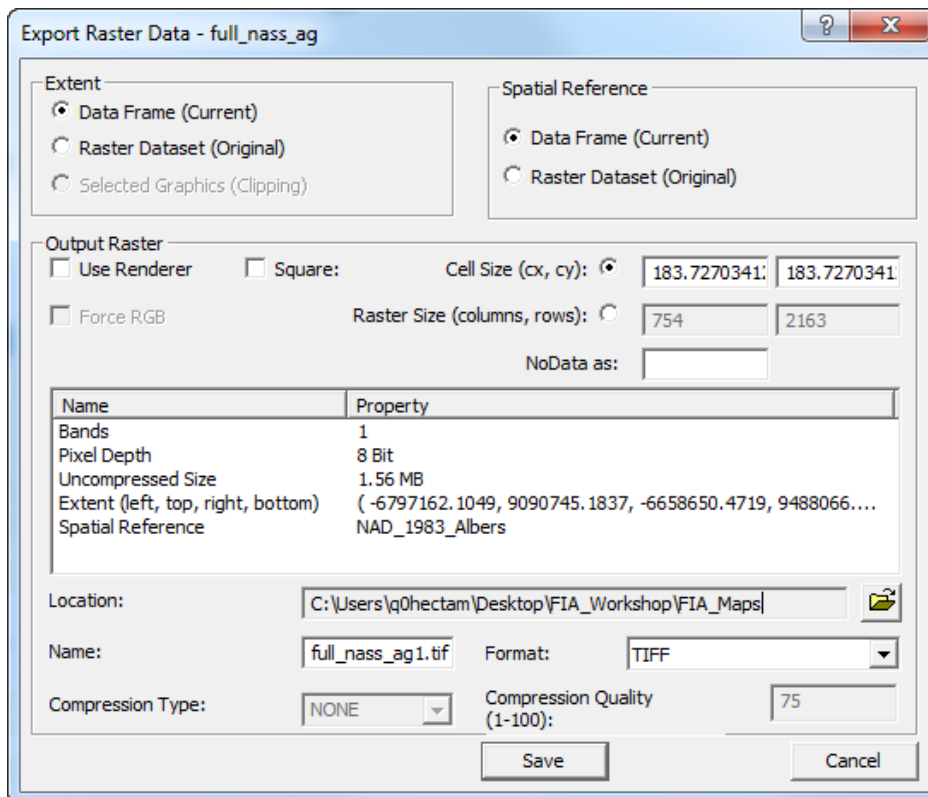
Figure B.36 Export Raster Data Dialog Box

13. From the **ArcToolbox Tree** (Figure B.3), double-click **Data Management Tools**, double-click **Raster**, then **Raster Properties**, and then double-click **Export Raster World File** (Figure B.37). The **Export Raster World File** dialog box opens (Figure B.38).
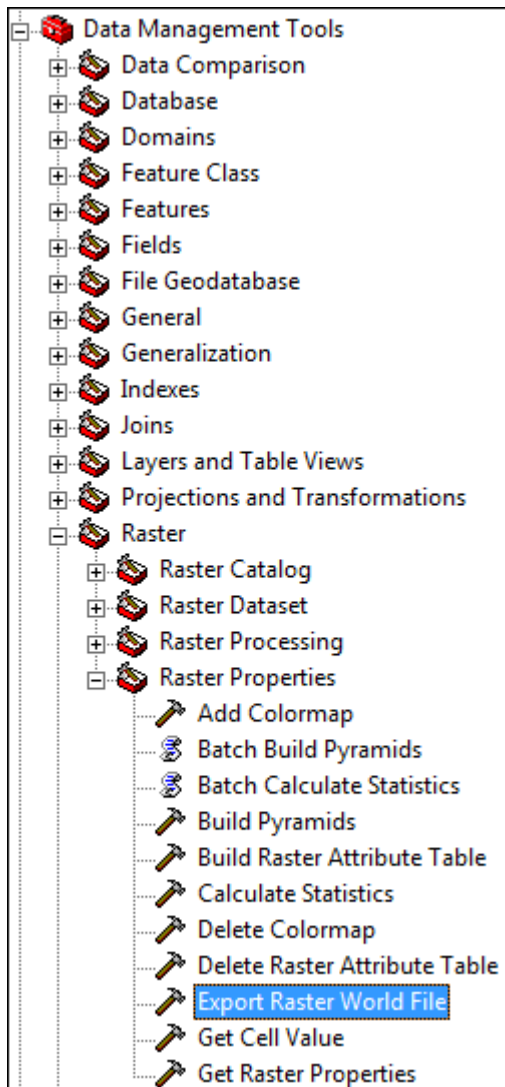
Figure B.37 Export Raster World File

14.   Browse to the location of the masked digital terrain grid file by clicking 📂 next to the **Input raster** box.

15.   Once the exported .tif file is selected (i.e., *westfork_NASS_ag.tif*), click **OK.** The associated world file (.tfw) is created in the same directory as the .tif file. The Agricultural grid is now ready to be imported in HEC-FIA.
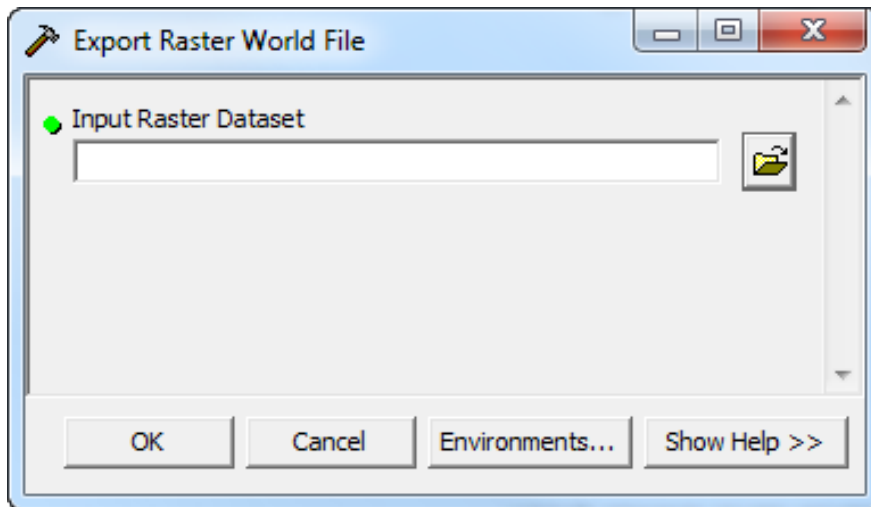
Figure B.38 Export Raster World File Dialog Box

Appendix C

Coordinate System Setup

To maintain a geographic reference (also called a geo-reference), HEC-FIA uses a user-selected **coordinate system**. This system allows HEC-FIA to establish x- and y-coordinates in World Coordinate System (WCS) for each point on the layer, regardless of their actual projected coordinate system. The x-coordinate is referred to as "easting" and the y-coordinate is referred to as "northing" following customary use in surveying and mapping. This appendix focuses on how to setup and edit different coordinate systems.

C.1   Geographic Referencing

To maintain a geographic reference, the user must specify a coordinate system for each HEC-FIA project. To establish the grid size and coordinate system:

1. From the **Maps** menu**,** click **Default Map Properties** (Figure C.1).

2. The **Default Map Properties** for dialog box opens (Figure C.2).
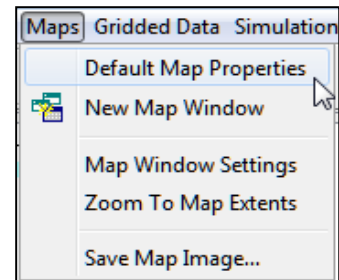
Figure C.1 Maps Menu
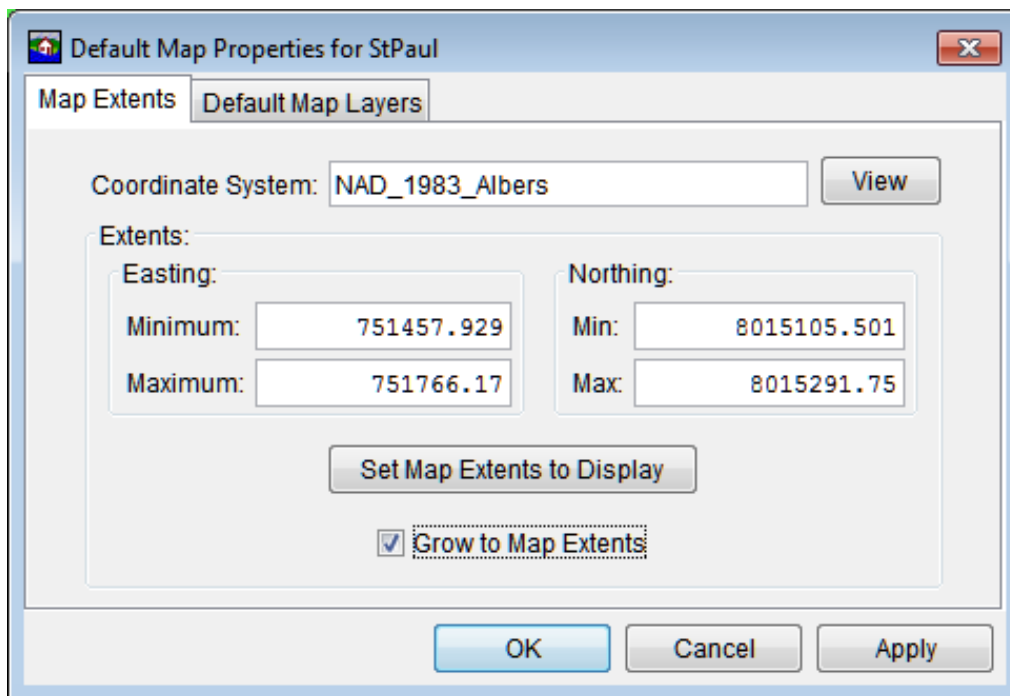
Figure C.2 Default Map Properties for Dialog Box

3. The information in the **Map Default Properties for** dialog box (Figure C.2) includes:
    Coordinate System: this box identifies the established coordinate system for a watershed. To edit the coordinate system, click **View** (Figure C.2).

    Extents – Easting Min, Max, Northing Min, and Max. These values indicate the location of the left, top, right, and bottom borders of the grid in the display area.

    Grow to Map Extents. When this checkbox is selected, HEC-FIA automatically sets the geographic extents to define the smallest rectangle that encompasses all the objects in the workspace.

C.2   Coordinate System Types

A **coordinate system** is a method of representing points in a space of given dimensions by coordinates. Two coordinate system types of interest to FIA are the geographic coordinate system, which is based on latitude and longitude coordinates, and the project coordinate system, which represents the projection of a geographic coordinate system on a plane.

The simplest way to add a coordinate system to an HEC-FIA project is to import a projected shapefile into the map window. The coordinates are set based on the *.prj file of the first map added to the map window.

Another way to add a coordinate system to an HEC-FIA project is from the **Default Map Properties for** dialog box (Figure C.2), click **View**. The **Map Coordinate Information** dialog box opens (Figure C.3).
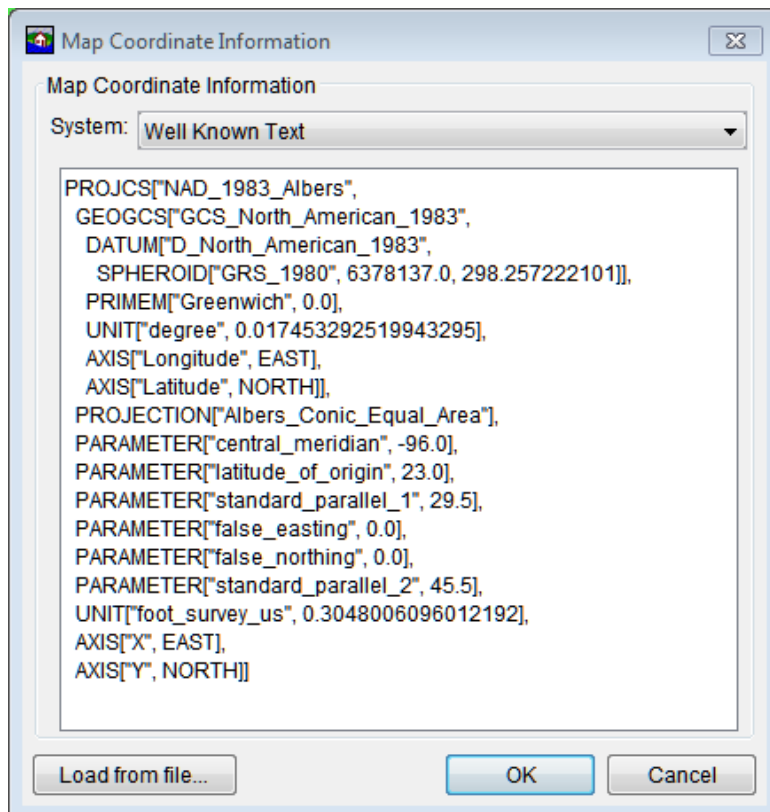
Figure C.3 Coordinate Information Dialog Box

Click **Load from file,** an **Open Browser** opens (Figure C.4), browse to a .prj that contains the correct projection for the HEC-FIA project.
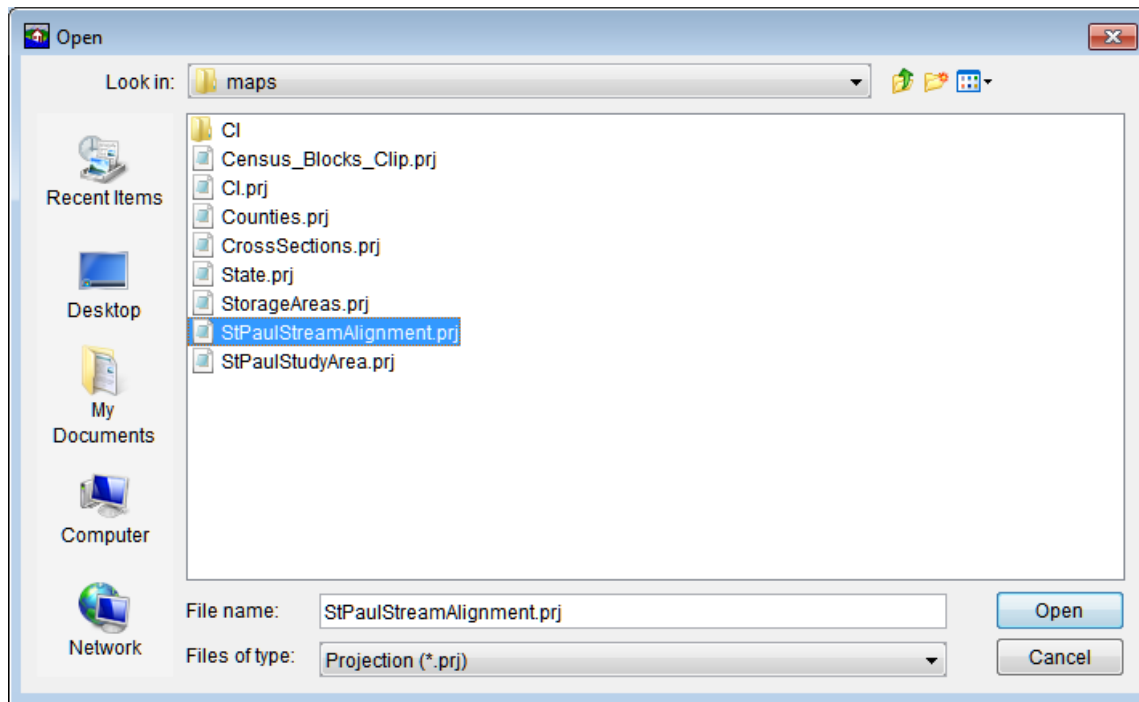
Figure C.4 Open Browser

A few notes on performance, if a background image file or an internet map file is being used, it is best to set the projection to that of the background image map, this speeds up the zooming by re-projecting the data on the fly rather than the background image. Also, the background imagery is better when viewed in the native projection.

The coordinate systems available in HEC-FIA are shown in Table C.1. This table also shows the units and spheroid type for each coordinate system. A **spheroid** (ellipsoid) is the shape of the earth that used in the calculations that transform positions on the curved surface of the earth to positions on a flat map. It is part of the horizontal datum, which approximates the curved surface of the earth over part of the globe.

Table C.1 Coordinate Systems Available in HEC-FIA

Coordinate Systems	Units	Spheroid
X-Y	U.S. feet	N/A
Google/Bing Web Mercator		WGS 84
Geographic	radians	WGS 72
Universal Transverse Mercator	meters	GRS 1980(NAD83)
State Plane Coordinates	meters	GRS 1980(NAD83)
Albers Equal-Area Conic	Degrees of Arc	Sphere of Radius 6370997 meters
Lambert Conformal Conic	International Feet	
Transverse Mercator	U.S. feet	Clarke 1866(NAD27)
Albers Equal-Area Conic (SHG)	meters	GRS 1980(NAD83)
Polar Stereographic (HRAP)	meters	Sphere of Radius 6371200 meters

C.2.1   X-Y Coordinate System

The X-Y coordinate system is also known as the World Coordinate System (WCS). This coordinate system superimposes a grid on layer features to establish x- and y-coordinates for each point on the layer. The origin point (0,0) can be located anywhere, but every object is located in relation to the origin point. The X-Y coordinate system has no spheroid specification. To set parameters for the X-Y Coordinate System:

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2. The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.5).
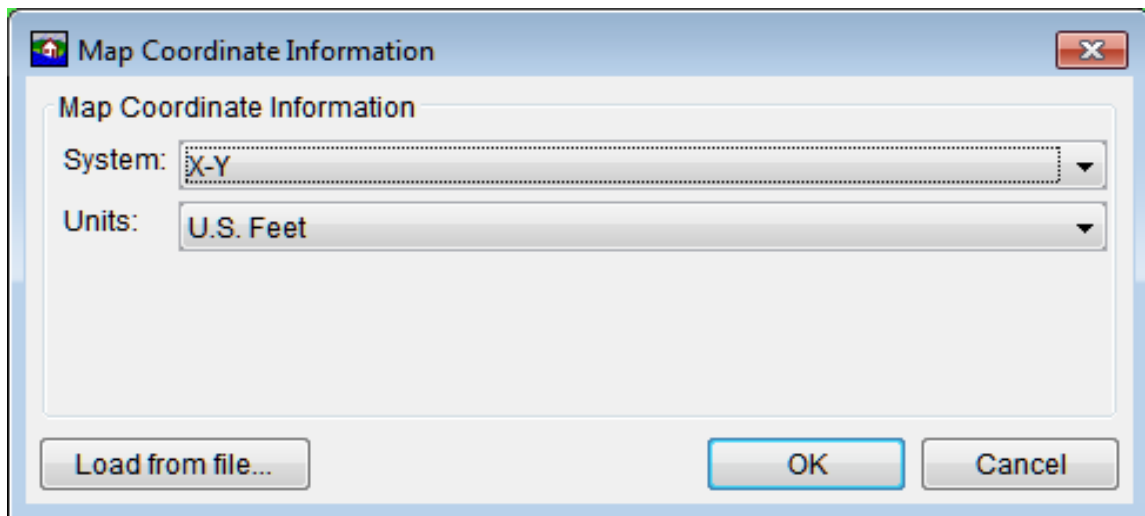
Figure C.5 Map Coordinate Information Dialog Box - X-Y Coordinate System

3. From the **System** list, select *X-Y*.

4. From the **Units** list, select the units for the X-Y coordinate system.

5. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.5). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *X-Y* is displayed.

C.2.2   Google/Bing Web Mercator Coordinate System

The Google/Bing Web Mercator coordinate system (Figure C.6) is a variation of the Mercator projection and is the standard for most web mapping applications. Also, used by Bing and OpenStreet.

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

Figure C.6 Map Coordinate Information Dialog Box - Google/Bing Web Mercator Coordinate System

2. The **Coordinate System** box displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.6).

3. From the **System** list, select *Google/Bing Web Mercator*.

4. The **Map Coordinate Information** dialog box (Figure C.6) displays information about the coordinate system.

5. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.6). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Google/Bing Web Mercator* should be displayed.

C.2.3   Geographic Coordinate System

Each of the different coordinate systems has their own set of options editable in the **Map Coordinate Information** dialog box (Figure C.7). For a **Geographic Coordinate System**, users can define **units** and **spheroid**.
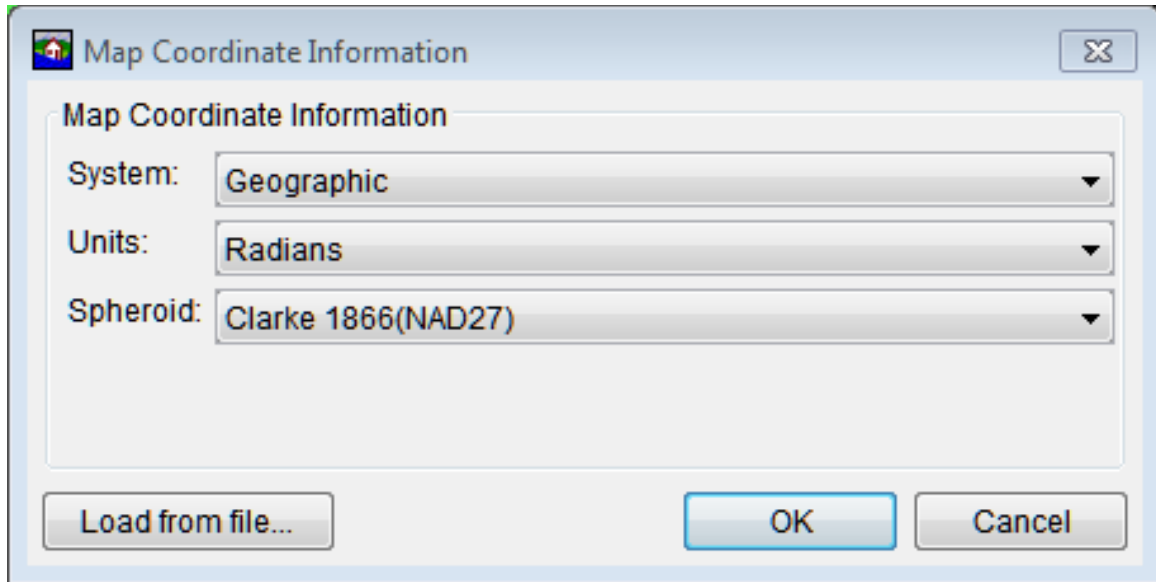
Figure C.7 Map Coordinate Information Dialog Box - Geographic Coordinate System

To set parameters for the Geographic Coordinate System:

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2. The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.7).

3. From the **System** list, select *Geographic*.

4. From the **Units** list, select the units for the *Geographic* coordinate system. The only units available should be **Radians, Degrees of Arc**, and **Seconds of Arc**.

5. From the **Spheroid** list, select a spheroid type for the *Geographic* coordinate system.

6. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.7). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Geographic* should be displayed.

C.2.4   Universal Transverse Mercator Coordinate System

The Universal Transverse Mercator (UTM) coordinate system is a projection coordinate system. UTM is used to define horizontal positions throughout the world by dividing the surface of the Earth into six-degree zones, with a central meridian in the center of each zone.

To set parameters for the Universal Transverse Mercator Coordinate System:

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2. The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.8).

Figure C.8   Map Coordinate Information Dialog Box - Universal Transverse Mercator Coordinate System

3. From the **System** list, select *Universal Transverse Mercator*.

4. From the **Units** list, select the units for the *Universal Transverse Mercator* coordinate system.

5. From the **Spheroid** list, select a spheroid type for the *Universal Transverse Mercator* coordinate system.

6. In the **UTM Zone** box, enter the UTM zone number.

7. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.8). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Universal Transverse Mercator* should be displayed.

C.2.5   State Plane Coordinate System

The State Plane Coordinate System (SPCS) was established in the 1930's and now covers all fifty states. Zones were established for each state using either the Lambert Conformal or Traverse Mercator projections. Units are generally in feet (NAD27) or meters (NAD83).

To set parameters for the State Plane Coordinate System:

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2.   The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.9).

Figure C.9   Map Coordinate Information Dialog Box - State Plane Coordinates Coordinate System

3.   From the **System** list, select *State Plane Coordinates*.

4.   In the **Zone** box, enter the zone for the state. These codes are FIPS codes.

5.   Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.9). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *State Plane* Coordinates should be displayed.

C.2.6   Albers Equal-Area Conic Coordinate System

The Albers Equal-Area Conic projection was established for mapping large areas. The projection is an equivalent projection, where areas are proportional and directions are true in limited areas.

To set parameters for the Albers Equal-Area Conic Coordinate System:

1.   From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2.   The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.10).

3.   From the **System** list, select *Albers Equal-Area Conic*.

Figure C.10   Map Coordinate Information Dialog Box - Albers Equal-Area Conic Coordinate System

4.   From the **Units** list, select the units for the Albers Equal-Area Conic coordinate system.

5.   From the **Spheroid** list (Figure C.10), select a spheroid type for the Albers Equal-Area Conic coordinate system.

6.   The remaining items to be entered are the angular parameters that are required to fine-tune the projection. When specifying latitudes enter **N** or **S**, and for longitudes, enter **E** or **W**. Use the **SPACEBAR** to toggle between the entries.

7.   Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.10). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Albers Equal-Area Conic* should be displayed.

C.2.7   Lambert Conformal Conic Coordinate System

The Lambert Conformal Conic projection is used extensively for mapping areas of the world with predominantly east-west orientation. Similar to the Albers Equal-Conic projection, however the projection is not done in an equal-area.

To set parameters for the Lambert Conformal Conic Coordinate System:

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

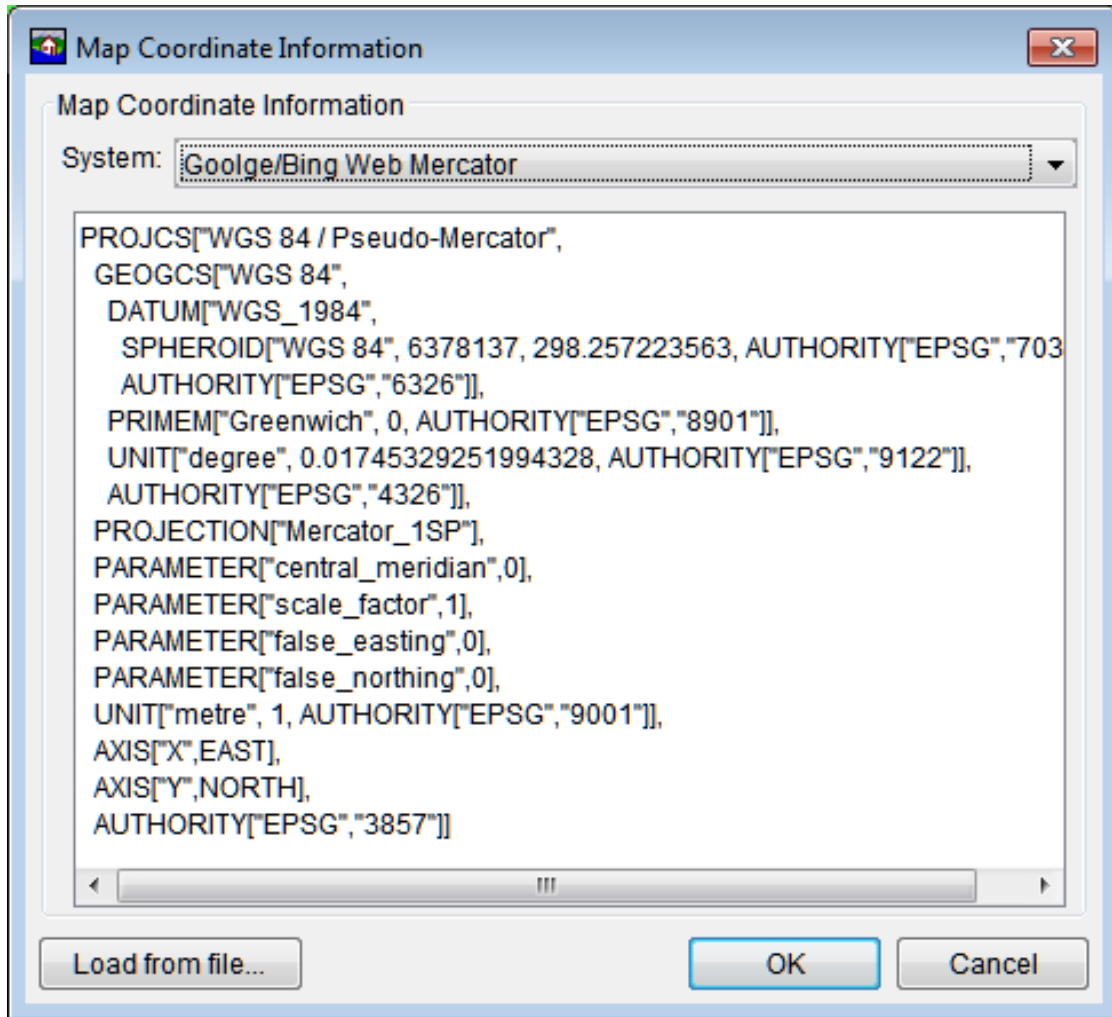2. The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.11).
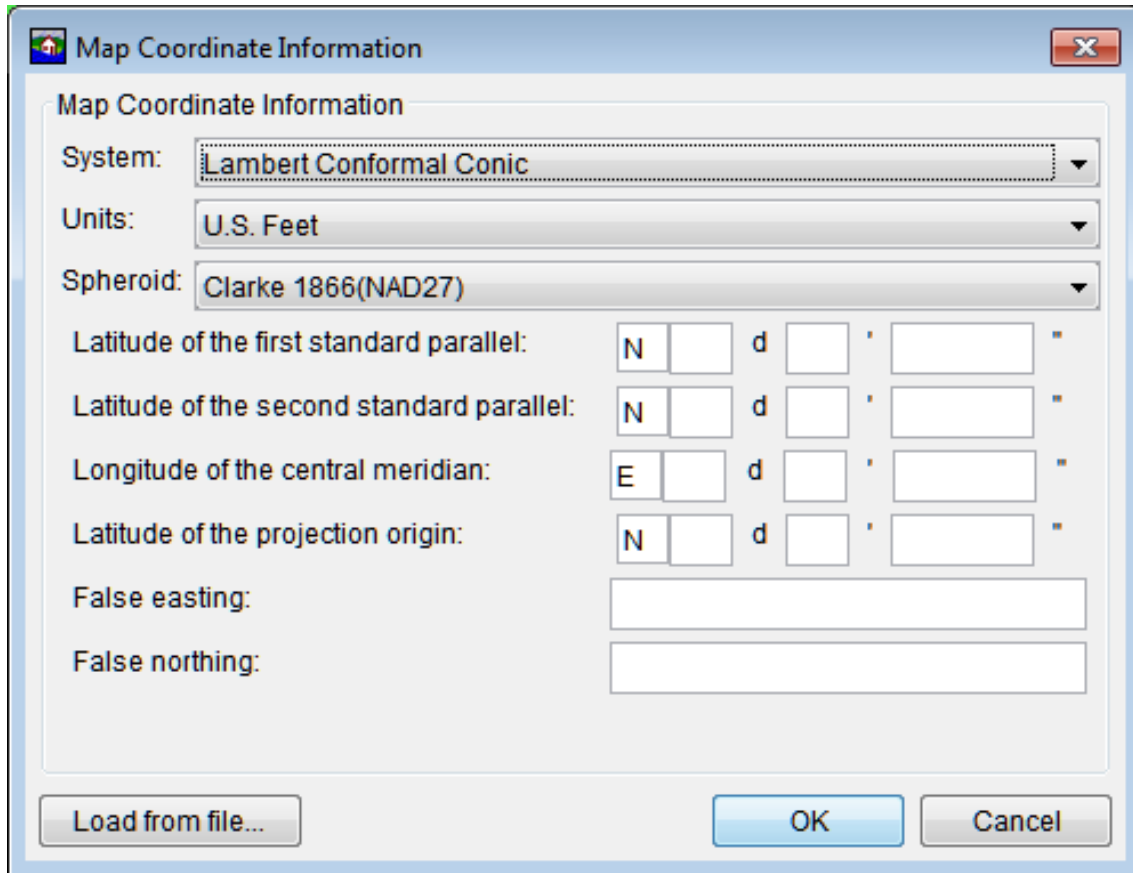
Figure C.11　Map Coordinate Information Dialog Box - Lambert Conformal Conic Coordinate System

3. From the **System** list, select *Lambert Conformal Conic*.

4. From the **Units** list, select the units for the Lambert Conformal Conic coordinate system.

5. From the **Spheroid** list (Figure C.11), select a spheroid type for the Lambert Conformal Conic coordinate system.

6. When specifying latitudes enter **N** or **S**, and for longitudes, enter **E** or **W**. Use the **SPACEBAR** to toggle between the entries.

7. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.11). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Lambert Conformal Conic* should be displayed.

C.2.8   Transverse Mercator Coordinate System

In the Transverse Mercator projection, a sphere is projected onto a cylinder tangent to a central meridian. It is similar to the Lambert Conformal Conic project, but used to portray large areas in a north-south orientation. Many national grid systems are based on the Transverse Mercator projection.

To set parameters for the Transverse Mercator Coordinate System:

1.   From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2.   The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.12).
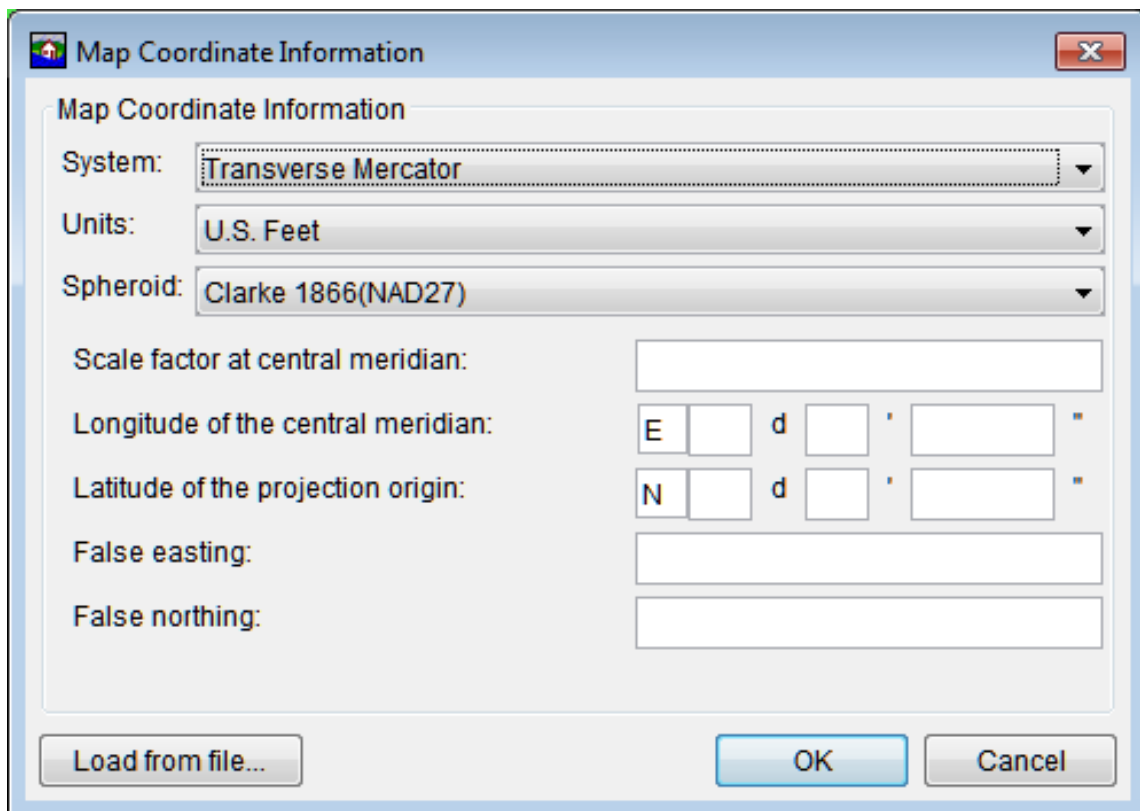
Figure C.12   Map Coordinate Information Dialog Box - Transverse Mercator Coordinate System

3.   From the **System** list, select *Transverse Mercator*.

4.   From the **Units** list, select the units for the Transverse Mercator coordinate system.

5.   From the **Spheroid** list (Figure C.12), select a spheroid type for the Transverse Mercator coordinate system.

6.   Enter a scaling factor for central meridian, in the **Scale factor at central meridian** box.

7.   When specifying latitudes enter **N** or **S**, and for longitudes, enter **E** or **W**. Use the **SPACEBAR** to toggle between the entries.

8.   Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.12). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Transverse Mercator* should be displayed.

C.2.9   Albers Equal-Area Conic (SHG) Coordinate System

The standard hydrologic grid (SHG) is a variable-resolution square-celled map grid defined for the conterminous United States, based on the Albers Equal-Area Conic projection system. The parameters are set to match USACE map coordinates for SHG.

To view the parameters for the **Albers Equal-Area Conic (SHG) Coordinate System**:

1.   From the **Maps** menu, select **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2.   The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.13).
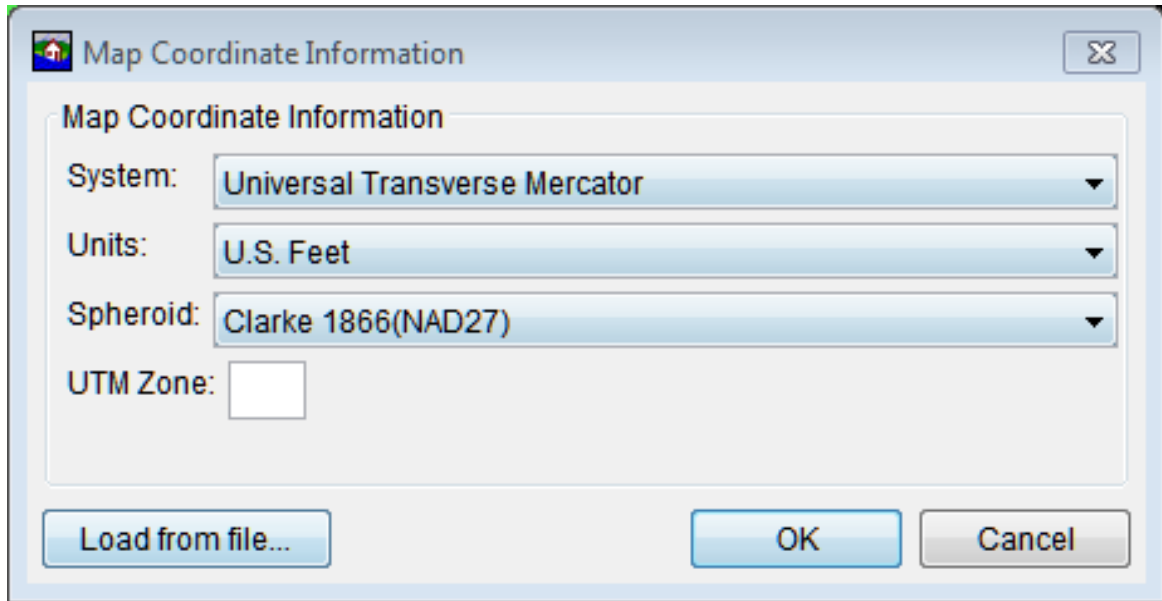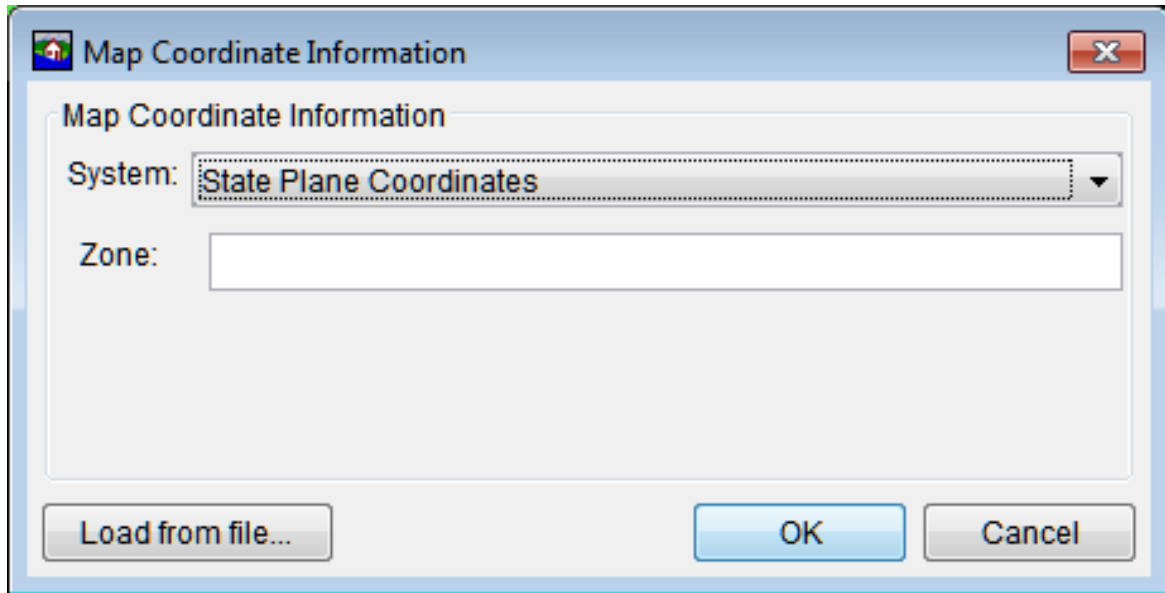

Figure C.13   Map Coordinate Information Dialog Box - Albers Equal-Area Conic (SHG) Coordinate System

3. From the **System** list, select *Albers Equal-Area Conic (SHG)*.

4. From the **Units** list, select the units for the Albers Equal-Area Conic (SHG) coordinate system.

5. From the **Spheroid** list (Figure C.13), select a spheroid type for the Albers Equal-Area Conic (SHG) coordinate system.

6. The remaining parameters are informational and are not editable.

7. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.13). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Albers Equal-Area Conic (SHG)* should be displayed.

C.2.10 Polar Stereographic (HRAP) Coordinate System

The Hydrologic Rainfall Analysis Project (HRAP) projection system, is a type of polar stereographic coordinate system. The parameters are set to match NWS map coordinates used for radar grids.

To view the parameters for the Polar Stereographic (HRAP) Coordinate System:

1. From the **Maps** menu, click **Default Map Properties**. The **Default Map Properties for** dialog box opens (Figure C.2).

2. The **Coordinate System** field displays the name of the selected coordinate system (X-Y is default). Click **View**. The **Map Coordinate Information** dialog box opens (Figure C.14).

3. From the **System** list, select *Polar Stereographic (HRAP)*.
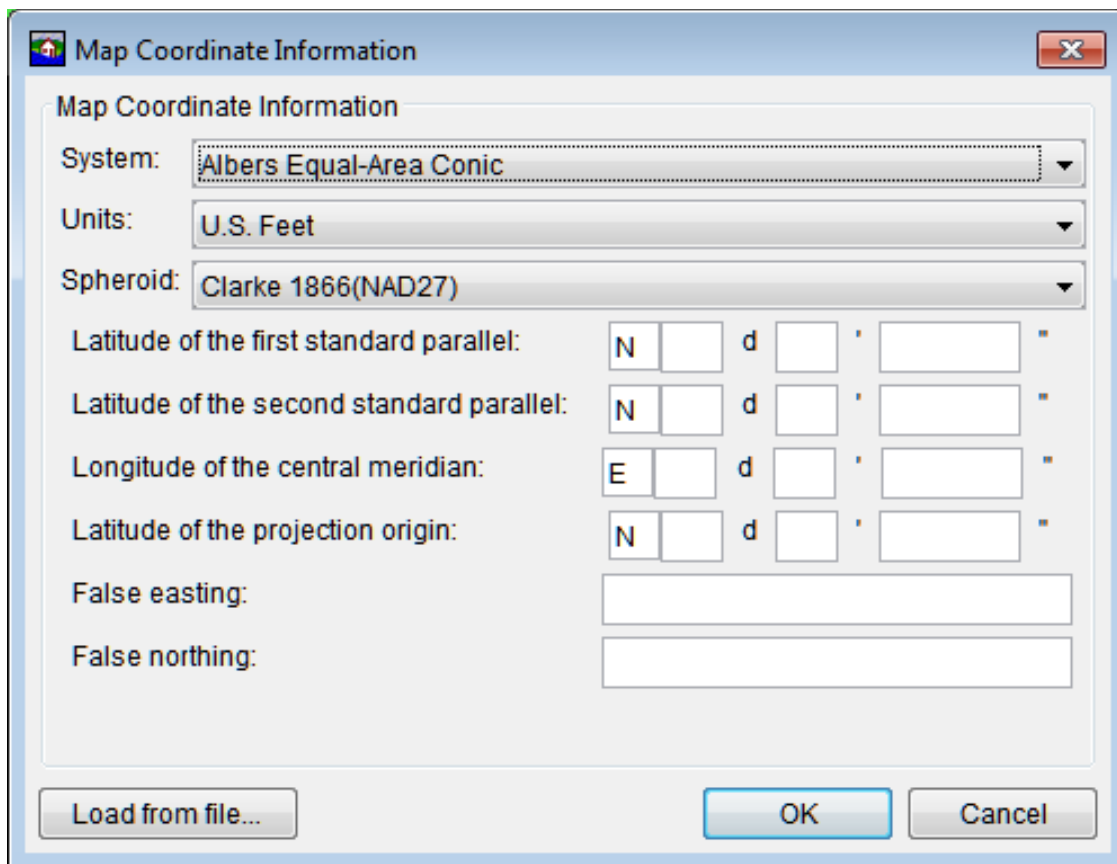
4. From the **Units** list, select the units for the Polar Stereographic (HRAP) coordinate system.

5. From the **Spheroid** list (Figure C.14), select a spheroid type for the Polar Stereographic (HRAP) coordinate system.

6. The values entered in the **Semi-major** and **Semi-minor** boxes (Figure C.14) reflect the length of the axes of an ellipse and change according to spheroid selection. In Figure C.14, *Sphere of Radius 6371200 Meters* is selected as the spheroid, and the lengths of the axes have been automatically entered to reflect a sphere of radius 6371200 feet.

7. The remaining parameters are informational and are not editable.

8. Click **OK**. The **Map Coordinate Information** dialog box closes (Figure C.14). In the **Coordinate System** box of the **Default Map Properties for** dialog box (Figure C.2), *Polar Stereographic (HRAP)* should be displayed.
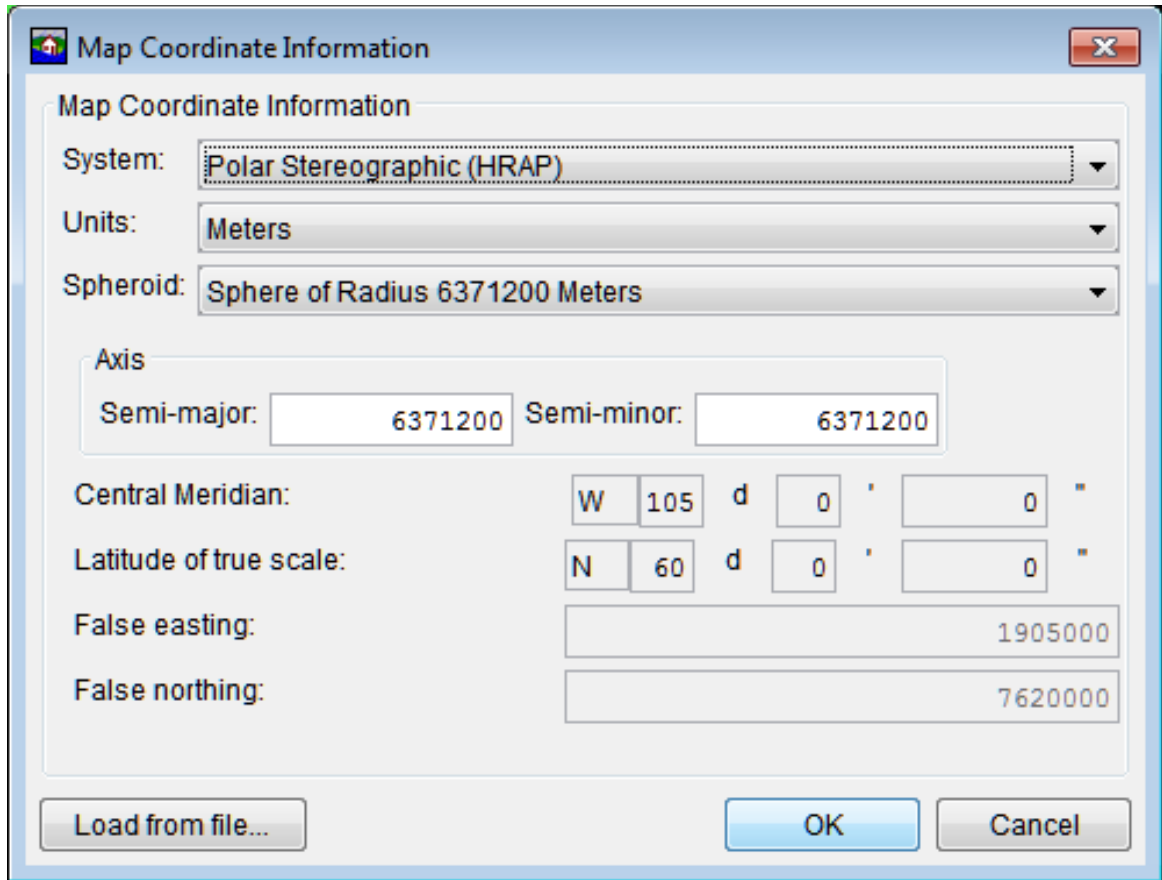
Figure C.14   Map Coordinate Information Dialog Box - Polar Stereographic (HRAP) Coordinate System

Appendix D

Layer Display Properties

Many map layers are supported by HEC-FIA. The different map layers are described in Section 4.2 of this manual. Users can edit several display properties for each of these layers, and the different editor dialog boxes are layer-specific to polygon shapefiles, line shapefiles, and gridded data. This appendix outlines the functions of each of the editors for the different layers in HEC-FIA.

To access the map layer editors, beneath the **Content Pane**, select the **Maps** tab. The **Content Pane** displays all of the study elements that are represented in the map window. Select the map layer to be edited and right-click. From the shortcut menu (Figure D.1) click **Properties**. An editor specific to the selected map layer opens.
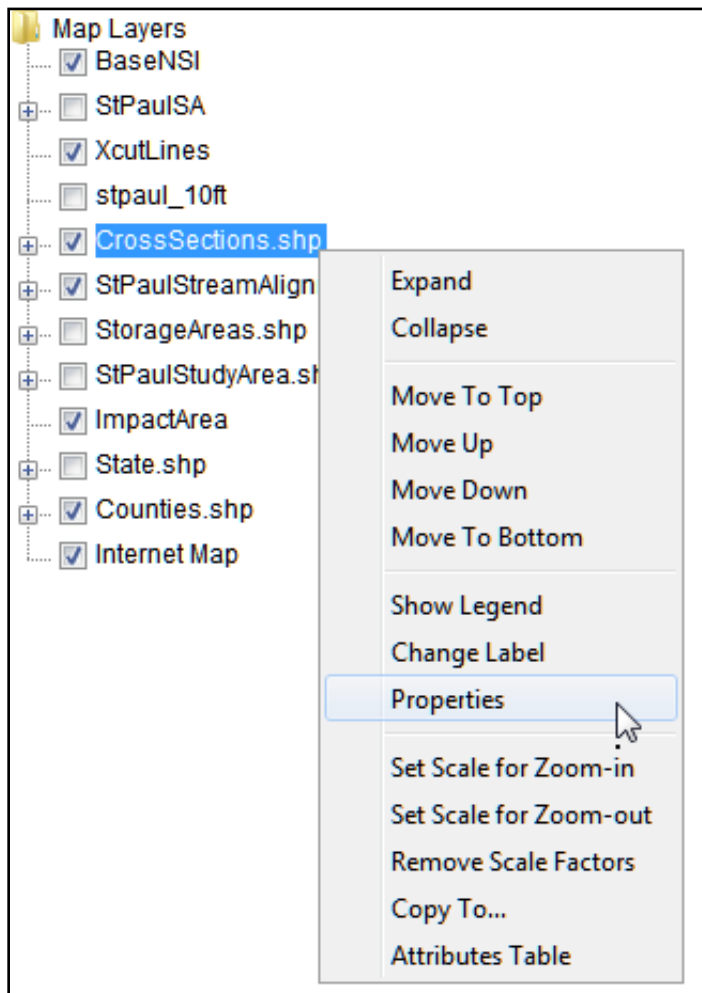
Figure D.1 Map Layer Shortcut Menu

D.1   Polygon Shapefile Display Properties

Shapefiles store non-topological geometry and attribute information for the spatial features of a data set. Three types of shapefiles are possible: polygon, line, and point. Each of these has a different set of display options.

User-editable polygon shapefile display properties include **Fill**, **Borders**, and **Labels**.

To edit polygon shapefile fill properties:

1. From the **Content Pane** with the **Maps** tab selected, right-click on the name of a polygon shapefile (**.shp*).

2. From the shortcut menu, click **Properties** (see Figure D.1). The **Edit Polygon Properties** dialog box appears (Figure D.2).
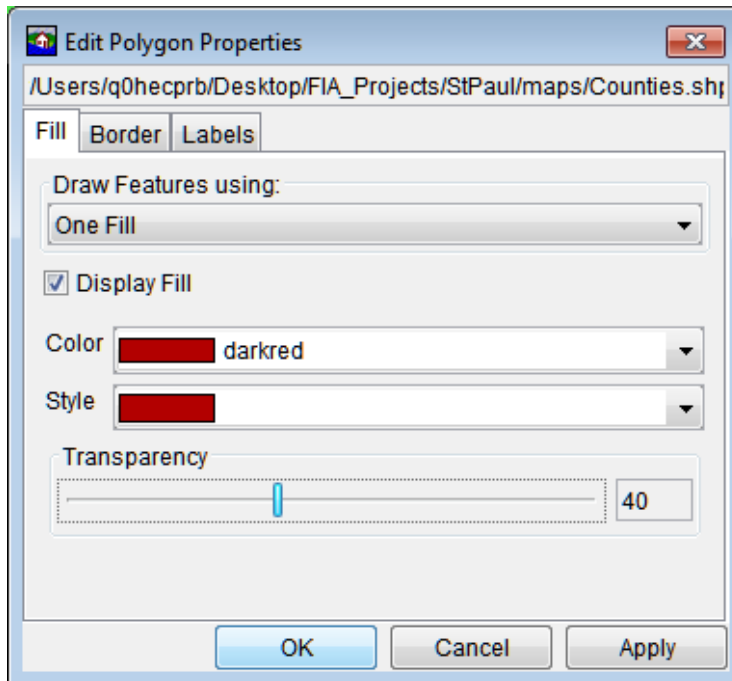
Figure D.2 Edit Polygon Properties Dialog Box

3. Under the **Fill** tab, check the **Display Fill** box to fill the selected shapefile.

4. By default, HEC-FIA draws fill features using **One Fill** for the selected shapefile. To set fill properties for a single fill:

    a. From the **Color** list, select the fill color. In the example in Figure D.2, dark red has been selected.

    b. From the **Style** list**,** select the fill style (e.g., solid color, diagonal lines, etc.).

    c. Use the **Transparency** slider to select the level of transparency fill.

5.   Users can also establish separate fill colors by shapefile attribute:

    a.   From the **Draw Features using** list (Figure D.2), select **Attribute Values**.

    b.   From the **Field for values** list, select the name of the shapefile attribute that represents the separate polygons. In Figure D.3, *Name* has been selected for the shapefile *Counties.shp*.
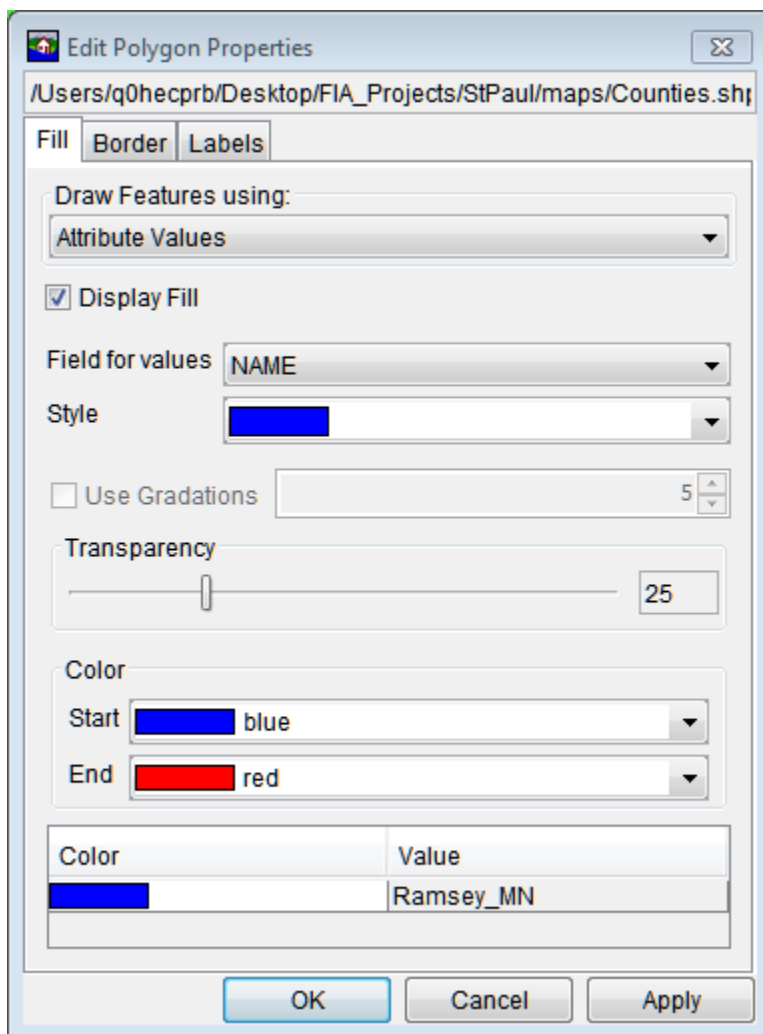
Figure D.3 Fill Polygon by Shapefile Attribute

    c.   From the **Style** list, select the desired fill style.

    d.   Use the **Transparency** slider to select the level of transparency for the fill.

    e.   From the **Color** box (Figure D.3), select the start and end of the color range for the shapefile. HEC-FIA fills in the colors in between. In Figure D.4, the shapefile has been filled according to the properties entered in Figure D.3.

6.   Once fill properties have been edited, click **Apply** to apply the display properties to the layer. When finished editing, click **OK**.
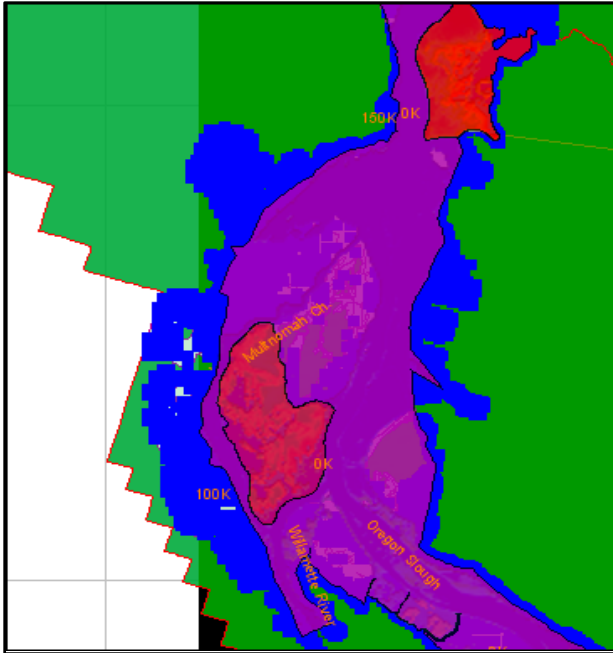
Figure D.4 Shapefile Polygon Filled by Attribute

To edit shapefile border properties:

1. From the **Content Pane** with the **Maps** tab selected, right-click on the name of a polygon shapefile (**.shp*).

2. From the shortcut menu, click **Properties** (Figure D.1). The **Edit Polygon Properties** dialog box appears (Figure D.2).

3. Click the **Border** tab and select **Display Border** to create a border (Figure D.5).
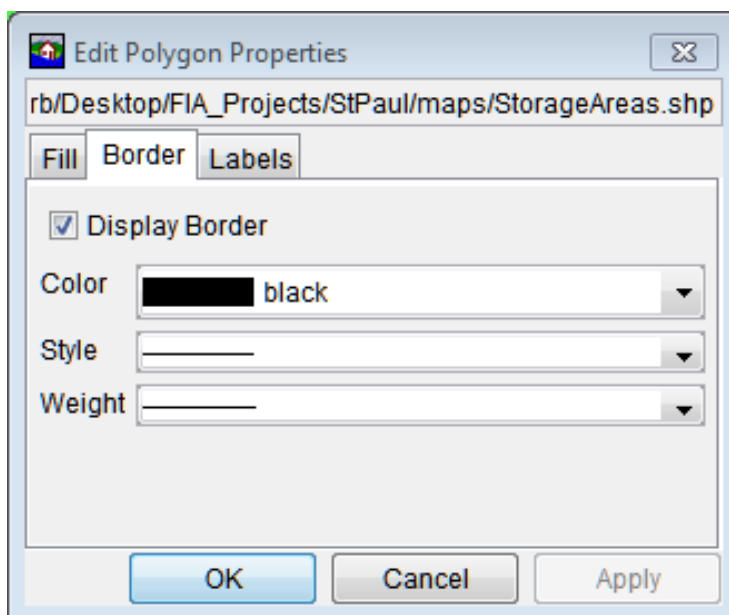
Figure D.5 Edit Polygon Properties Dialog Box - Border Tab

4.   From the **Color, Style**, and **Weight** lists (Figure D.5), edit the border color, style (e.g. solid, dashed, etc.), and weight as desired.

5.   Click **Apply** to display changes in the map window and continue editing.

6.   When finished editing, click **OK** to close the dialog.

To edit labels for shapefile attributes:

1.   From the **Content Pane** with the **Maps** tab selected, right-click on the name of a polygon shapefile (**.shp*).

2.   From the shortcut menu, click **Properties** (Figure D.1). The **Edit Polygon Properties** dialog box appears (Figure D.2).

3.   Select the **Labels** tab (Figure D.6).
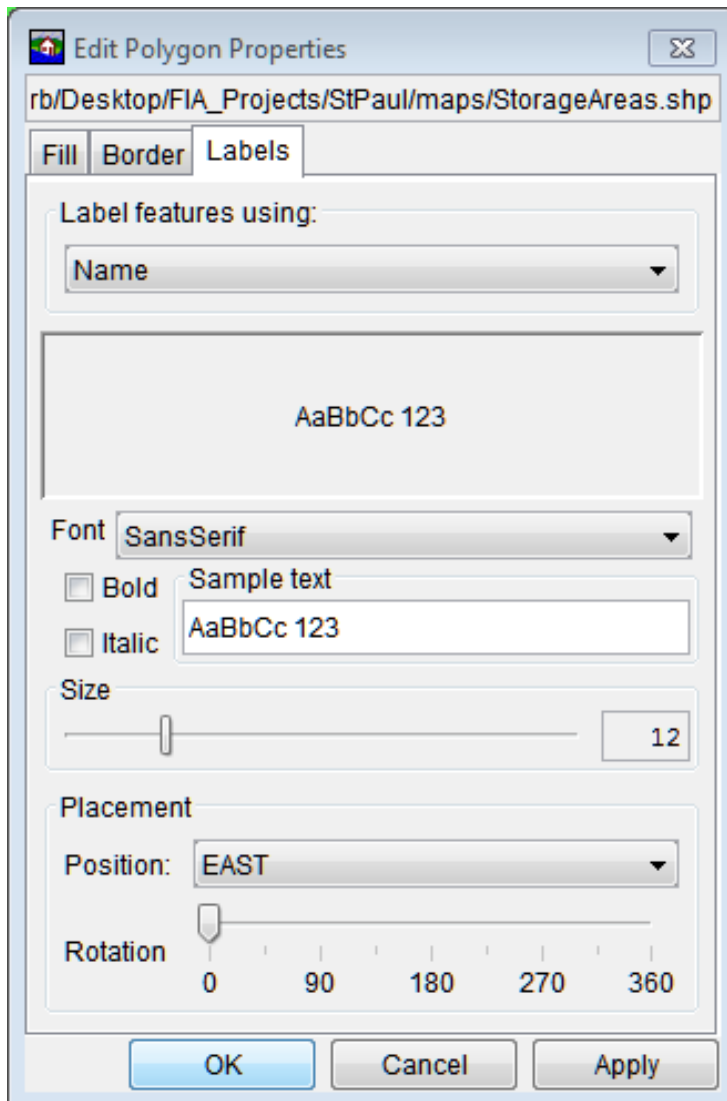
Figure D.6 Edit Polygon Properties Dialog Box - Labels Tab

4. From the **Label features using** list (Figure D.6), select the name of the shapefile attribute that represents the labels for separate polygons. *Name* has been selected for the shapefile *StorageAreas.shp*.

5. From the **Font** list (Figure D.6) select the desired font for labels, select whether to make the labels bold or italicized, and the **Size** slider adjusts the font size for labels. From the **Placement** box, the user can adjust the placement of labels and rotate labeled.

6. Click **Apply** to display changes in the map window and keep editing.

7. When finished editing, click **OK** to close the dialog.

D.2   Line Shapefile Display Properties

Line shapefiles are usually uploaded to studies as centerlines that represent a stream system for a study (see Chapter 5, Section 5.3). User-editable line shapefile display properties include **Style** and **Labels**.

To edit line shapefile style properties:

1. From the **Content Pane** with the **Maps** tab selected, right-click on the name of a line shapefile (**.shp*).

2. From the shortcut menu, click **Properties** (Figure D.1). The **Edit Line Properties** dialog box appears (Figure D.7).
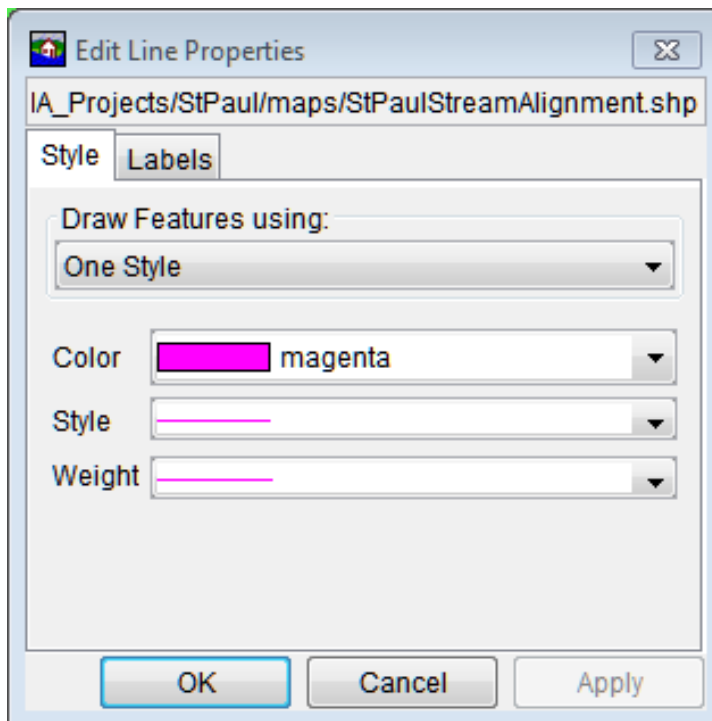
Figure D.7 Edit Line Properties Dialog Box

3. From the **Draw Features using** list, **One Style** is the default. This option applies style properties to all of selected shapefile.

    a. From the **Color** list, select the display color of the line shapefile

.

    b. From the **Style** list, select the line style of the shapefile.

    c. From the **Weight**, select the desired weight (thickness) of the line.

4. Users can also edit features of a line shapefile by attribute:

    a. From the **Draw Features using** list (Figure D.7), select **Attribute Values** (Figure D.8).
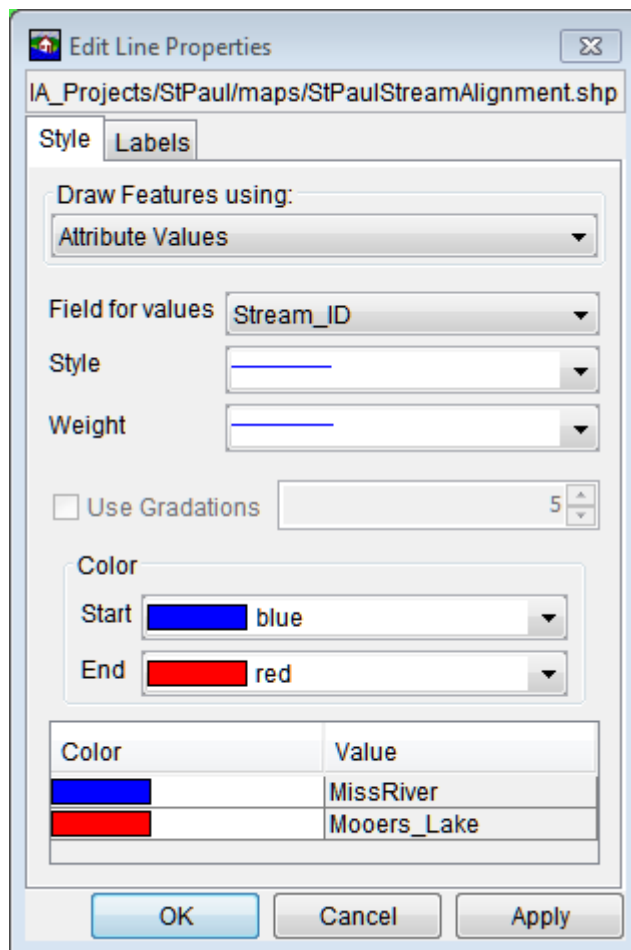
Figure D.8 Features Using Shapefile Attribute

    c. From the **Field for values** list, select the name of the shapefile attribute that represents separate lines. *Stream_ID* has been selected for the shapefile *StPaulStreamAlignment.shp*.

    d. Select the desired line style from the **Style** list**.**

e. Select desired line weight (thickness) from the **Weight** list (Figure D.8).

f. Select a **Start** color and an **End** color. HEC-FIA automatically fills in a gradation in between the two colors.

5. When the desired changes have been made, click **Apply** and the changes display in the map window. When finished editing, click **OK** to close the dialog box.

Users can display labels for attributes of line shapefiles and edit the way they display in the map window.

To edit label properties for line shapefiles:

1. From the **Content Pane** with the **Maps** tab selected, right-click on the name of a line shapefile (**.shp*).

2. From the shortcut menu, click **Properties** (Figure D.1). The **Edit Line Properties** dialog box appears (Figure D.7).

3. Select the **Labels** tab (Figure D.9).
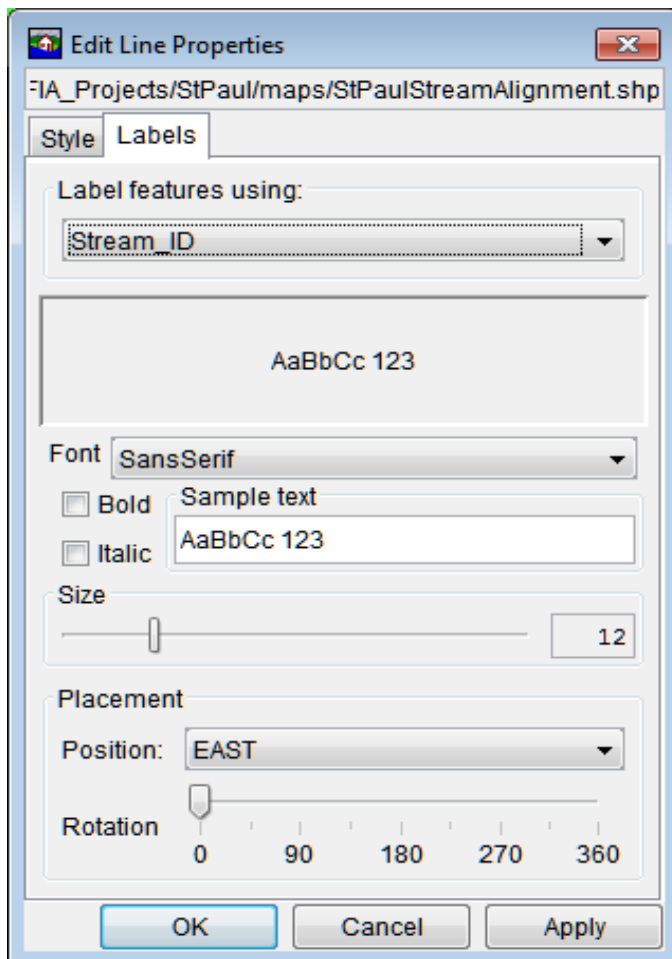
Figure D.9 Edit Line Properties Dialog Box - Labels Tab

4. From the **Label features using** list (Figure D.9), select the name of the shapefile attribute that represents the labels for separate lines. *Stream_ID* has been selected for the shapefile *StPaulStreamAlignment.shp*.

5. From the **Font** list (Figure D.9) select the desired font for labels, select whether to make the labels bold or italicized, and the **Size** slider adjusts the font size for labels. From the **Placement** box, the user can adjust the placement of labels and rotate labeled.

6. Click **Apply** to display changes in the map window and keep editing.

7. When finished editing, click **OK** to close the **Edit Line Properties** dialog box (Figure D.9).

D.3   Gridded Data Display Properties

For gridded data (.tif), users can adjust display properties for color by elevation as well as toggle at which scales the layer are displayed in the map window.

To adjust display properties for data grids:

1. From the **Content Pane** with the **Maps** tab selected, right-click on the name of a gridded data file (**.tif*).

2. From the shortcut menu, click **Properties**. The **Elevation Options** dialog box appears (Figure D.10).

3. From the list box (Figure D.10), there are available color contour schemes – **Aspect Shading, Grayscale, Linear, Precipitation, Red-Green-Blue, Terrain** (default), and **Water Depth**.

4. The **Draw Edges** (Figure D.10) option is specifically for ASCII NetTin files. If selected, the edges of the triangles that make up an ASCII NetTin file are drawn.

5. The contour tic interval can be set by entering a value in the **Tic Interval** box (Figure D.10).

6. HEC-FIA sets the maximum and minimum limits of the contours automatically. To override the maximum and minimum limits, clear **System Specified Min/Max Values** (Figure D.10) and enter new values in the **Maximum** and **Minimum** boxes.

7. Adjust the brightness (amount of white), saturation (amount of black), and transparency (level of opacity or alpha) for the colors using the **Brightness**, **Saturation**, and **Transparency** slider bars or boxes (Figure D.10).
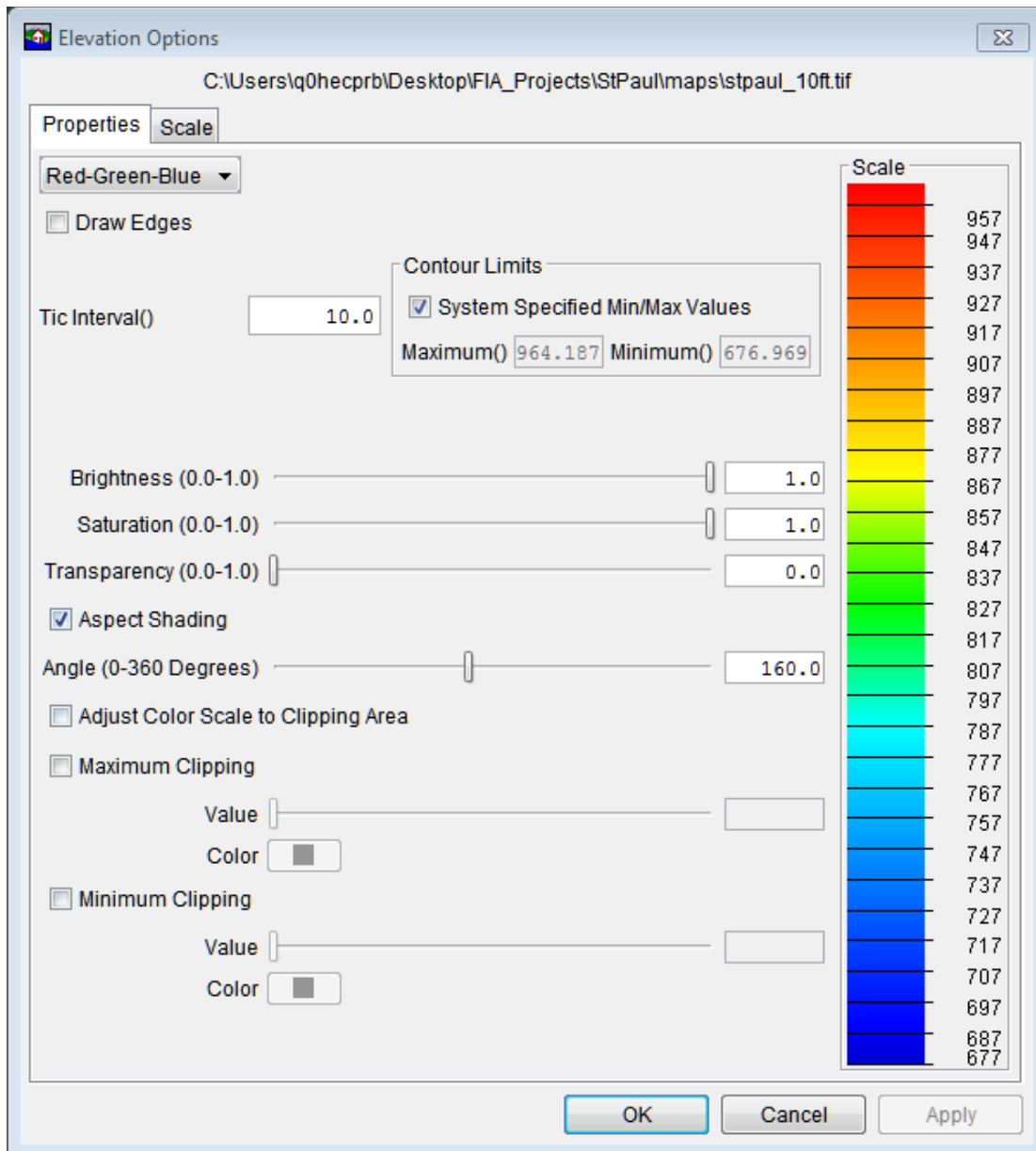
Figure D.10 Elevation Options Dialog Box

8. By default the **Aspect Shading** option is on. Aspect shading displays the map layer in relief by placing an imaginary light source above the map and shading the contours. The user can adjust the angle of the light source by using the **Angle** slider bar or by entering a value in the box. If aspect shading is not desired, clear **Aspect Shading** (Figure D.10).

9. Clipping allows users to highlight an area using user-definable color choices and values. For maximum clipping, fill the contour with the clip color from the maximum value of the map to the value entered for **Maximum Clipping**. For example, maximum clipping could be used to highlight smog levels, cloud cover, or snow level at a particular elevation. By default, maximum clipping is turned off. To enable, click **Maximum Clipping** (Figure D.10), then choose a color by clicking **Color**, and either enter a maximum clipping value by using the **Value** slider bar or enter a value in the box.

10. Minimum clipping fills the contour with the clip color from the minimum value of the map to the value entered for **Minimum Clipping**. For example, minimum clipping could be used to see where a water level would be if it flooded to a particular elevation. By default, minimum clipping is turned off. To enable, click **Minimum Clipping** (Figure D.10), then choose a color by clicking **Color**, and either enter a minimum clipping value by using the **Value** slider bar or by entering a value in the box.

11. Click **Apply** to display changes in the map window and keep editing.

12. When finished editing, click **OK** to close the dialog (Figure D.10).

Users may also set the zoom scales at which they would like layers to display in the map window. For example, a user might not want to see their counties shapefile below a particular scale. To toggle these settings:

1. From the **Content Pane** with the **Maps** tab selected, right-click on the name of a gridded data file (**.tif*).

2. From the shortcut menu, click **Properties**. The **Elevation Options** dialog box appears (Figure D.10).

3. Select the **Scale** tab (Figure D.11).
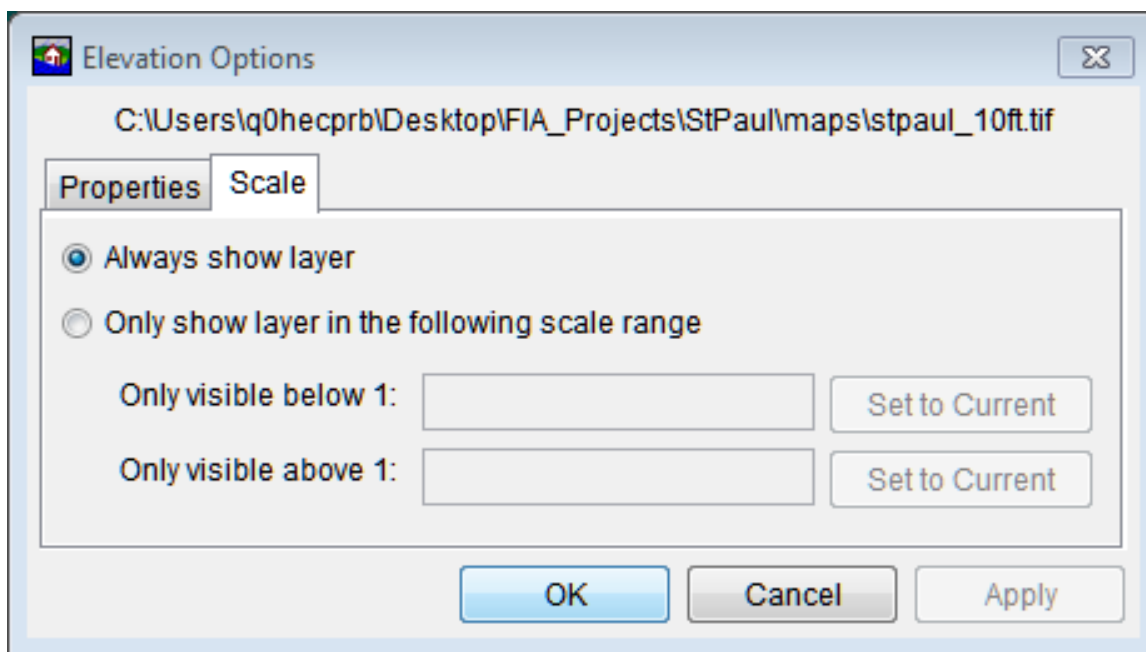
Figure D.11 Elevation Options Dialog Box - Scale Tab

4. Select **Always Show Layer** (Figure D.11) to display the layer in the map window at all scales.

5. To make the layer visible only below a certain scale level, select **Only show layer in the following scale range** (Figure D.11). Zoom to the desired scale level, click **Set to**

Current for **Only visible below 1**. The layer now appears only when the zoom scale is below this level.

6.   To make the layer visible only above a certain scale level, select **Only show layer in the following scale range** (Figure D.11). Zoom to the desired scale level, click **Set to Current** for **Only visible above 1**. The layer now appears only when the zoom scale is higher than this level.

7.   Click **Apply** to display changes in the map window and keep editing.

8.   When finished editing, click **OK** to close the dialog.

Appendix E

Using the Color Chooser

The **Color Chooser** (Figure E.1) provides flexibility in the selection of colors for map layers, labels, and background colors. The **Color Chooser** has three tabs: **Swatches**, **HSB**, and **RGB**, offering three methods for choosing a color. Under each method, the preview area allows the user to preview color choices before applying changes.
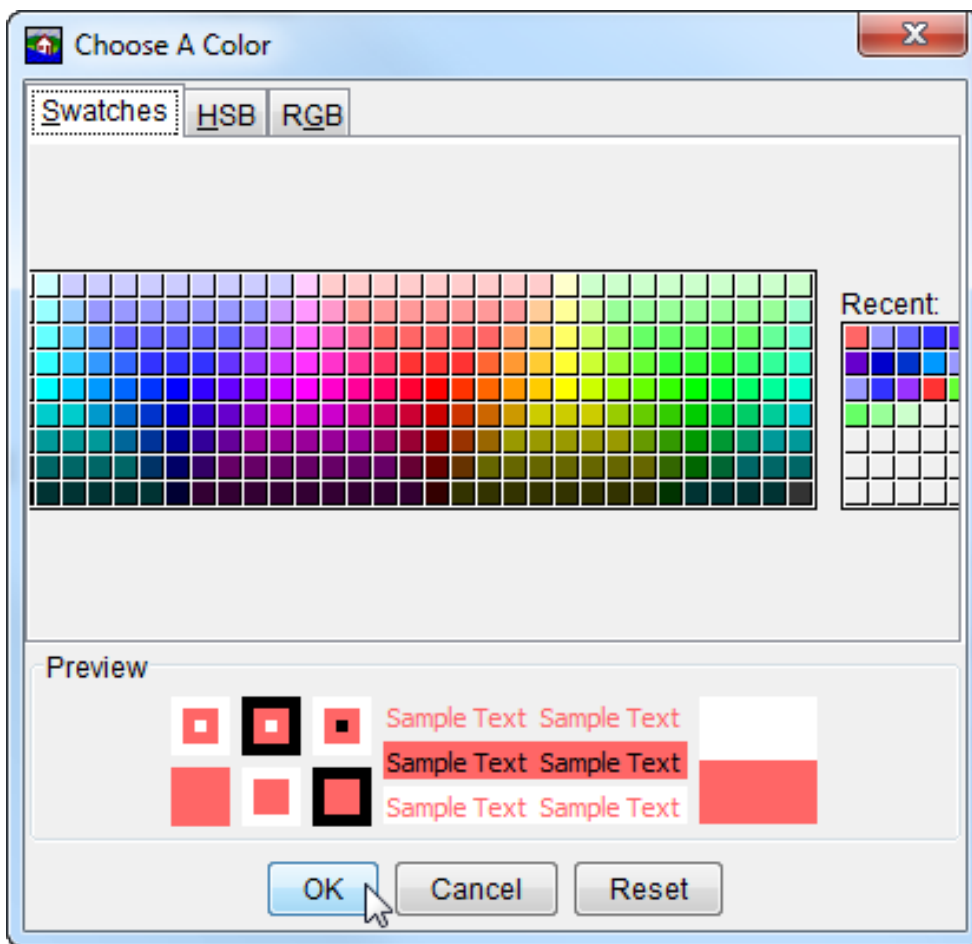
Figure E.1 Color Chooser - Swatches Worksheet

E.1   Swatches Worksheet

The **Swatches** worksheet provides a palette of pre-defined colors. From the palette, select a color. Once a color has been selected, the **Recent** and **Preview** boxes display that color. Click **OK** and the **Color Chooser** closes (Figure E.1). Depending on where the **Color Chooser** was accessed, the user clicks either **Apply** or **OK** and the color change appears in the display area.

E.2   HSB Worksheet

HSB is the Hue, Saturation, and Brightness color model, which allows the user to set the hue, saturation, and brightness of colors. From the **Color Chooser**, select the **HSB** tab; the **HSB Worksheet** (Figure E.2) becomes available.
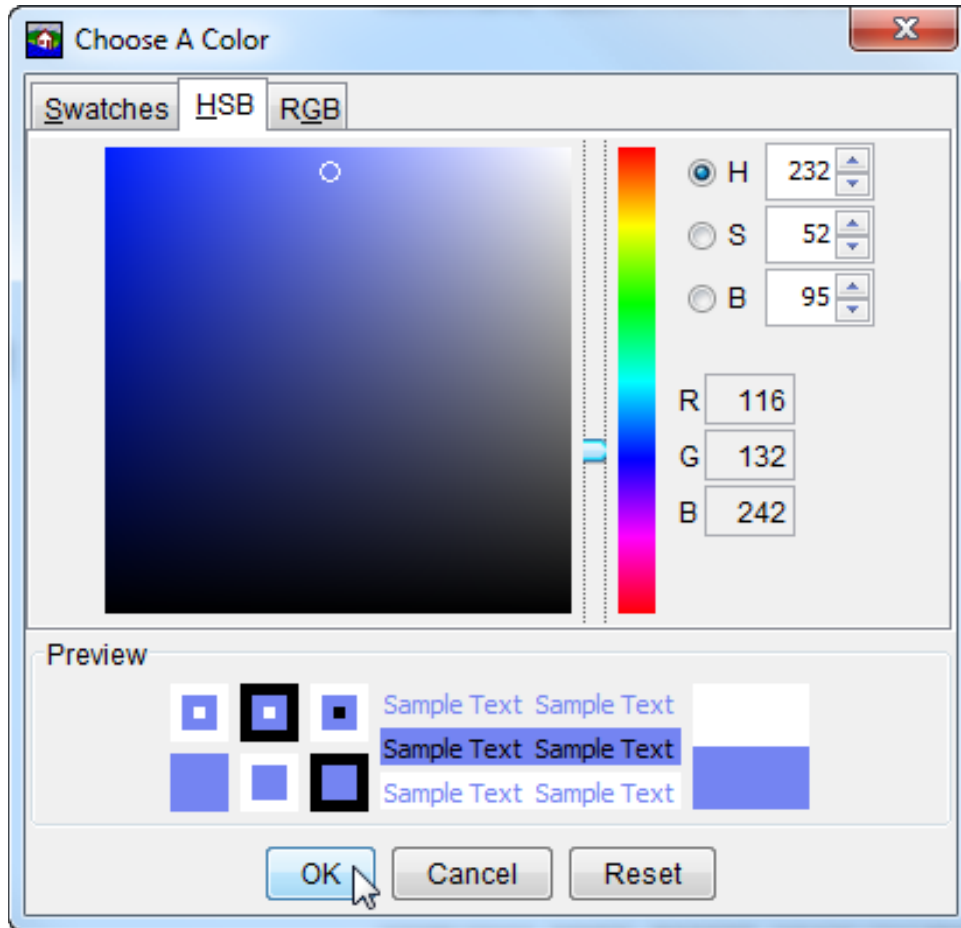
Figure E.2 Color Chooser - Hue, Saturation, and Brightness Worksheet

Several ways are available to adjust the hue, saturation, and brightness of the colors. The slider bar in conjunction with the **H**, **S**, and **B** options changes the color, if the user selects *red* with the **H** option selected, then when the user switches to the **S** and **B** options, the user is changing the saturation and brightness of *red*. Another way to affect the colors is in the **H**, **S**, and **B** boxes, the user can directly enter a value for hue, saturation, and brightness. The following rules apply to the values that can be entered for each box:

H Box: Hue is measured in a circle from zero (0) to 359 degrees.
            0 = red, 60 = yellow, 120 = green, 180 = cyan
            240 = blue, 300 = magenta
S Box: Saturation is the amount of black, measured from zero (0) to one hundred (100) percent.
B Box: Brightness is the amount of white, measured from zero (0) to one hundred (100) percent.

A final method for setting the color on the HSB worksheet is from the color palette, click and drag the little white circle. As the little white circles is dragged, the hue, saturation, and brightness values, along with the red, green and blue color values area atomically changed. The red, green, and blue values in the **R**, **G**, and **B** boxes are not editable and informational only.

Click **OK**, the **Color Chooser** closes (Figure E.2). Depending on where the **Color Chooser** was accessed, the user clicks either **Apply** or **OK** and the color change appears in the display area.

E.3   RGB Worksheet

RGB is the Red, Green, and Blue color model, which allows the user to set the red, green, and blue values colors. From the **Color Chooser**, select the **RGB** tab; the **RBB Worksheet** (Figure E.3) becomes available.
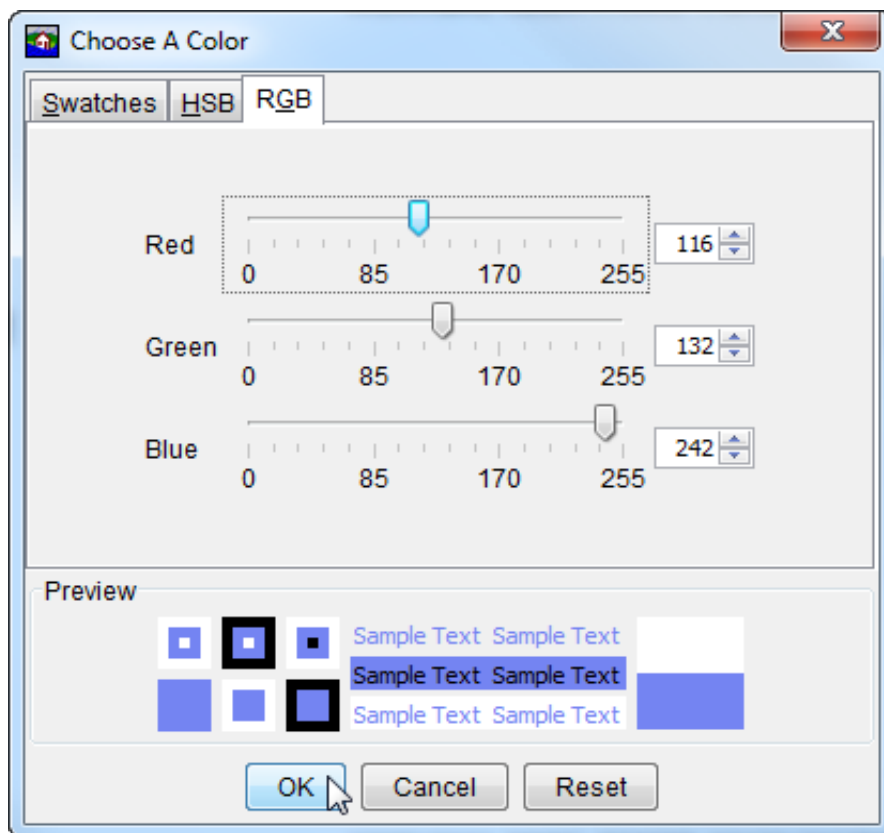
Figure E.3 Color Chooser - RGB Worksheet

The user has two ways to adjust the red, green, and blue value of colors. A slider bar is available for **Red**, **Green**, and **Blue**. As the user changes the slider bar for each one, in the **Preview** box, the color being produced is displayed. Another way to affect colors is in the **Red**, **Green**, and **Blue** boxes the user can directly enter a value. Click **OK**, the **Color Chooser** closes (Figure E.3). Depending on where the **Color Chooser** was accessed, the user clicks either **Apply** or **OK** and the color change appears in the display area.

Appendix F

Using HEC-DSSVue

HEC-DSSVue (Hydrologic Engineering Center Data Storage System Visual Utility Engine) is a graphical user interface software for viewing, editing, and manipulating data in HEC-DSS database files. With HEC-DSSVue, data may be plotted, tabulated, edited, and manipulated with over fifty mathematical functions. Along with these functions, HEC-DSSVue provides several utility functions, such as entering data sets into a database, renaming data set names, copying data sets to other HEC-DSS database files, and deleting data sets.

In HEC-FIA, HEC-DSSVue is used mainly as a viewing tool for HEC-DSS data. This appendix reviews some of the general functions in HEC-DSSVue. For further detail, see the HEC-DSSVue User's Manual.

F.1   HEC Data Storage System Concepts

HEC-DSS is a database system designed to efficiently store and retrieve typically sequential, scientific data. Such data types include, but are not limited to, time series data, curve data, spatial-oriented gridded data, textual data (such as this manual), and others. The system facilitates users and application programs retrieval and storage of data.

The data are arranged into blocks. For example, one year of daily-interval data is stored in a single **record** in the HEC-DSS. Each record is given a unique name called a pathname. The **pathname** is formulated in a way that makes it easy to group related data together. Software from HEC has the ability to read from and write to HEC-DSS. This capability facilitates data exchange among applications. For example, HEC-ResSim can be used to generate the time series input for HEC-FIA.

F.2   Overview of HEC-DSSVue in HEC-FIA

From the **Tools** menu, click **HEC-DSSVue**. The **HEC-DSSVue** main window opens (Figure F.1).

The **Menu Bar** contains the menus for the main window of HEC-DSSVue.

The **Toolbar** contains shortcut buttons to the most-used features of HEC-DSSVue:

   Open File Button - opens an **Open File Browser** to select a HEC-DSS file to open.

   Plot Button - plots the data of the selected pathname(s).
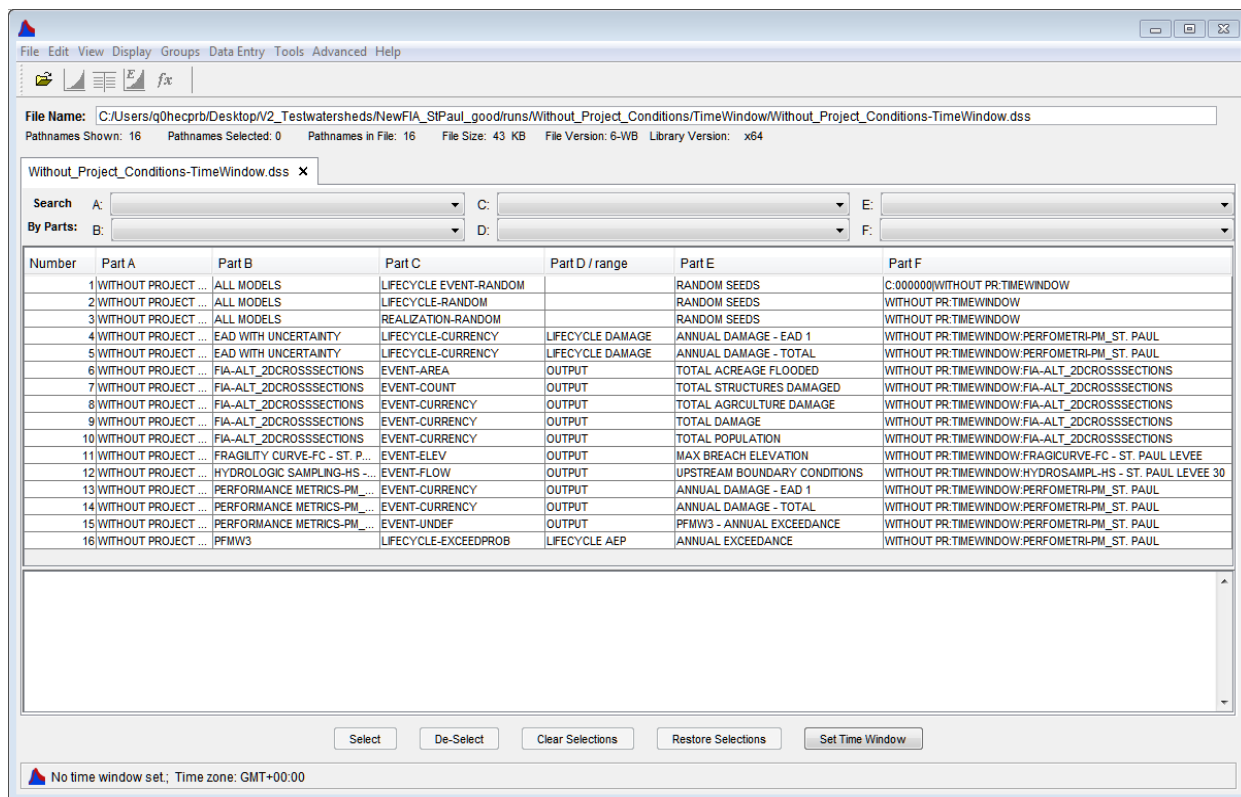
Figure F.1 HEC-DSSVue Main Window

 Tabulate Button - displays the data of the selected pathname(s) in a tabular form.

 Graphical Edit Button – provides a shortcut to an editor for data manipulation.

 Function Button - provides a shortcut to the mathematical function tools for editing HEC-DSS data.

The **HEC-DSS File Information** (Figure F.1) box displays the filename of the HEC-DSS file, and statistics about the pathnames in the HEC-DSS file and the size of the HEC-DSS file.

The **Filter Lists** are used to sort HEC-DSS pathnames by parts. A filter list for each individual part, A through F is available. The **Pathname Table** displays the filtered pathnames contained in the HEC-DSS file. The pathnames are displayed by the individual parts. The **Selected Pathname List** displays the pathnames that have been selected from the **Pathname Table**.

The **Select Commands** are available after pathnames have been selected. Available commands are **Select, De-Select, Clear Selections, Restore Selections**, and **Set Time Window**.

F.3   Opening a HEC-DSS File

Several ways are available to open a HEC-DSS file from HEC-DSSVue. One way is to type in the location and filename of the HEC-DSS file in the **File Name** box of the **HEC-DSSVue** main window (Figure F.1). After entering the correct information, press **ENTER**. The **Pathname**

Table displays the pathnames of the selected HEC-DSS file, and the **HEC-DSS File Information** box displays statistics about the HEC-DSS file.

Alternatively, select **Open** from the **File** menu or click **Open File** 📂 from the **Toolbar**. Either method opens the **Open HEC-DSS File** browser (Figure F.2).
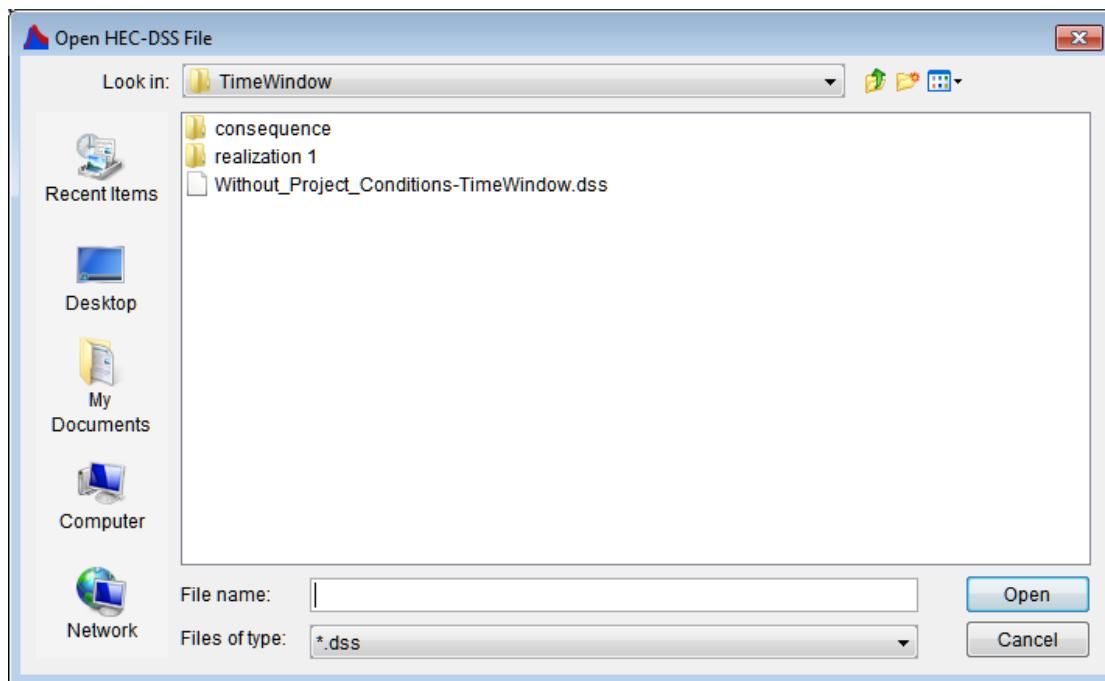
Figure F.2 Open HEC-DSS File Browser

Locate the HEC-DSS file to open, click **OK**. The **Open HEC-DSS File** browser closes, and the HEC-DSSVue main window displays the name of the HEC-DSS file and all of the pathnames associated with that HEC-DSS file appear in the **Pathname Table** (Figure F.1).

F.4   Set Time Window

To view data for a particular block of time, users can define a time window. Users can define a time window by specific start and end dates and times, time relative to the current date, or individual water years.

1.   Click **Set Time Window**, the **Set Time Window** dialog box opens (Figure F.3). By default, **No Time Window** is selected.

2.   To enter specific start date and time:

     a.   Select **Specific Time Window**.

     b.   In the **Start Date** box type a date in the format ddmmmyyyy (i.e., *26Nov1993*), and in the **Start Time** box type a time in the format hhmm (i.e., *0630*).

     c.   Enter an **End Date** and **Time** in the provided fields.

d. If the user wants to use the current date and time, click **Set Current Time**. All time window boxes are filled, the ending date and times need to be reviewed and edited.

Figure F.3 Set Time Window Dialog Box

3. To set a time window relative to current time:

    a. Select **Relative to Current Time**.

    b. From the dropdown list, select time units (days, hours, months, or years).

    c. In the **Go Back** field, enter the number of days/hours/months/years the user would like HEC-DSSVue to show prior to the current time.

    d. In the **Go Forward** field, enter the number of days/hours/months/years the user would like HEC-DSSVue to display after the current time.

4. To set a time window by individual water year, in the **Start Date of Water Year** field select the date that represents the start of each water year.

5. To retain time window settings for all data viewing in HEC-DSSVue, select **Retain Between Sessions**.

6. Click **OK**, the **Set Time Window** dialog box closes (Figure F.3), the time window is set, and the time window is displayed in the **Status Bar** of the **HEC-DSSVue** main window (Figure F.1).

F.5   HEC-DSS Pathnames

HEC-DSS data is stored in blocks, or records, within a file each record is identified by a unique name called a **pathname**. Each time that data is stored or retrieved from the file, its pathname must be given. The pathname is the key to the data's location within a database. A pathname is analyzed by HEC-DSS to determine an index number. This index determines where the data set is stored within the database. This design ensures that very few disk accesses are made to retrieve or store data sets. One data set is not directly related to another, so updating other areas of the database when a new data set is stored is not required.

HEC-DSS references records (data sets) by a pathname. The pathname of a HEC-DSS record can be three hundred and ninety-one (391) characters or less, and is, by convention, separated into **six parts**. The parts can be sixty-four (64) characters or less and are delimited by slashes in the pathname. The pathname parts are designated **A** through **F**. Table F.1 provides an example naming convention for regular-interval time series:

Table F.1 HEC-DSS Pathname Parts

A	project, river, or basin name
B	
C	data parameter (e.g., FLOW, PRECIP)
D	starting block data; format ddmmyyyy
E	time interval
F	additional user-defined descriptive information

F.5.1   Viewing of HEC-DSS Pathnames

The **Pathname Table** displays all of the pathnames by their different parts (Figure F.1). Users can toggle display options from the **View** menu. Available commands are **Pathname List**, **Pathname Parts**, **Condensed Catalog**, **No Pathnames**, and **Unsorted List**. The **Pathname List** command (Figure F.4) displays the pathnames in the **Pathname Table**, while **No Pathnames** displays nothing.

Number	Pathname
1	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/ALL MODELS/LIFECYCLE EVENT-RANDOM//RANDOM SEEDS/C:000000|WITHOUT PR:TIMEWINDOW/
2	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/ALL MODELS/LIFECYCLE-RANDOM//RANDOM SEEDS/WITHOUT PR:TIMEWINDOW/
3	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/ALL MODELS/REALIZATION-RANDOM//RANDOM SEEDS/WITHOUT PR:TIMEWINDOW/
4	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/EAD WITH UNCERTAINTY/LIFECYCLE-CURRENCY/LIFECYCLE DAMAGE/ANNUAL DAMAGE - EAD 1/WITHOUT PR:TIM...
5	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/EAD WITH UNCERTAINTY/LIFECYCLE-CURRENCY/LIFECYCLE DAMAGE/ANNUAL DAMAGE - TOTAL/WITHOUT PR:TI...
6	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/FIA-ALT_2DCROSSSECTIONS/EVENT-AREA/OUTPUT/TOTAL ACREAGE FLOODED/WITHOUT PR:TIMEWINDOW:FIA-A...
7	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/FIA-ALT_2DCROSSSECTIONS/EVENT-COUNT/OUTPUT/TOTAL STRUCTURES DAMAGED/WITHOUT PR:TIMEWINDOW:...
8	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/FIA-ALT_2DCROSSSECTIONS/EVENT-CURRENCY/OUTPUT/TOTAL AGRCULTURE DAMAGE/WITHOUT PR:TIMEWINDO...
9	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/FIA-ALT_2DCROSSSECTIONS/EVENT-CURRENCY/OUTPUT/TOTAL DAMAGE/WITHOUT PR:TIMEWINDOW:FIA-ALT_2D...
10	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/FIA-ALT_2DCROSSSECTIONS/EVENT-CURRENCY/OUTPUT/TOTAL POPULATION/WITHOUT PR:TIMEWINDOW:FIA-ALT...
11	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/FRAGILITY CURVE-FC - ST. PAUL LEVEE/EVENT-ELEV/OUTPUT/MAX BREACH ELEVATION/WITHOUT PR:TIMEWINDO...
12	/WITHOUT PROJECT CONDITIONS-TIMEWINDOW/HYDROLOGIC SAMPLING-HS - ST. PAUL LEVEE 30YEARS/EVENT-FLOW/OUTPUT/UPSTREAM BOUNDARY CONDITIO...

Figure F.4 Pathname List

F.5.2   Sorting HEC-DSS Pathnames by Parts

Users can also filter the display by pathname parts. Sorting the HEC-DSS pathnames by parts is the command **Search pathnames by part** (default). However, another way to sort the pathnames is available from the **View** menu, choose **Search pathnames by string**. The details for this method are described in the HEC-DSSVue User's Manual.

To filter by pathname parts, from the **Filter Lists** (Figure F.5) decide which pathname parts are to be used to sort the pathname list; a **Filter List** for each individual pathname part exists. In the example in Figure F.5, the **D Part** *Output* has been selected to show all pathnames with that **D Part**.

Number	Part A	Part B	Part C	Part D	Part E	Part F
1	WITHOUT PROJECT CONDI...	FIA-ALT_2DCROSSSECTIONS	EVENT-AREA	OUTPUT	TOTAL ACREAGE FLOODED	WITHOUT PR:TIMEWINDOW:FI...
2	WITHOUT PROJECT CONDI...	FIA-ALT_2DCROSSSECTIONS	EVENT-COUNT	OUTPUT	TOTAL STRUCTURES DAMAG...	WITHOUT PR:TIMEWINDOW:FI...
3	WITHOUT PROJECT CONDI...	FIA-ALT_2DCROSSSECTIONS	EVENT-CURRENCY	OUTPUT	TOTAL AGRCULTURE DAMAGE	WITHOUT PR:TIMEWINDOW:FI...
4	WITHOUT PROJECT CONDI...	FIA-ALT_2DCROSSSECTIONS	EVENT-CURRENCY	OUTPUT	TOTAL DAMAGE	WITHOUT PR:TIMEWINDOW:FI...
5	WITHOUT PROJECT CONDI...	FIA-ALT_2DCROSSSECTIONS	EVENT-CURRENCY	OUTPUT	TOTAL POPULATION	WITHOUT PR:TIMEWINDOW:FI...
6	WITHOUT PROJECT CONDI...	FRAGILITY CURVE-FC - ST. P...	EVENT-ELEV	OUTPUT	MAX BREACH ELEVATION	WITHOUT PR:TIMEWINDOW:FR.
7	WITHOUT PROJECT CONDI...	HYDROLOGIC SAMPLING-HS -...	EVENT-FLOW	OUTPUT	UPSTREAM BOUNDARY CON...	WITHOUT PR:TIMEWINDOW:H...
8	WITHOUT PROJECT CONDI...	PERFORMANCE METRICS-PM_...	EVENT-CURRENCY	OUTPUT	ANNUAL DAMAGE - EAD 1	WITHOUT PR:TIMEWINDOW:PE.
9	WITHOUT PROJECT CONDI...	PERFORMANCE METRICS-PM_...	EVENT-CURRENCY	OUTPUT	ANNUAL DAMAGE - TOTAL	WITHOUT PR:TIMEWINDOW:PE.
10	WITHOUT PROJECT CONDI...	PERFORMANCE METRICS-PM_...	EVENT-UNDEF	OUTPUT	PFMW3 - ANNUAL EXCEEDAN...	WITHOUT PR:TIMEWINDOW:PE.

Figure F.5 Sort HEC-DSS Pathnames by Parts

F.5.3   Selecting Pathnames

Once the **Pathname Table** is sorted, users can select the pathnames to view or manipulate. To select a pathname, double-click on a pathname in the **Pathname Table,** the selected pathname appears in the **Selected Pathname List** (Figure F.6). The user can also click on a pathname in the **Pathname Table**, and then click the **Select** button.

19		AG RESOR
20		AG RESOR
21		AG RESOR

//AG RESORT/FLOW/01FEB2014/15MIN/M0H0/
//AG RESORT/PRECIP-CUM/01FEB2014/15MIN/M0H0/

Figure F.6 Selected Pathname List

To select multiple consecutive pathnames, in the **Pathname Table**, click on the first pathname in the consecutive series. Find the last pathname in the series and click on it while holding down the **SHIFT** key. The block of pathnames highlights. Click **Select**, and all the pathnames within that block are added to the **Selected Pathname List**.

Users can also select multiple pathnames by selecting them while holding down the **CTRL** key. Once all of the appropriate pathnames are selected, release the **CTRL** key and click **Select**. All the pathnames that have been selected are added to the **Selected Pathname List**.

Users can select all of the pathnames displayed in the **Pathname Table**. From the **Edit** menu, choose **Select All**. All of the pathnames now appear in the **Selected Pathname List**.

F.5.4   Clearing Selected Pathnames

To clear a pathname from the **Selected Pathname List**, select a pathname and click **De-Select**. The pathname is cleared from the **Selected Pathname List**. To clear all pathnames from the **Selected Pathname List**, click **Clear Selections**, and the **Selected Pathname Box** is empty. Groups of pathnames can also be cleared using the same concepts described in the previous section and selecting pathnames by using the **SHIFT** and **CTRL** keys. Once pathnames have been cleared from the **Selected Pathname Box**, the pathnames can be restored to the **Selected Pathname Box** by clicking **Restore Selections**.

F.6   Visualizing Data

Once pathname(s) are selected, users can visualize pathnames in graphical form (plots) or in tabular form. Further details on plots and tables are discussed in the HEC-DSSVue User's Manual.

F.6.1   Plots

To view a plot of the pathnames in the **Selected Pathname List** (see Figure F.1), either click the **Plot** button from the **Toolbar** or choose **Plot** from the **Display** menu. Both of these options open the **Plot Window** (Figure F.7).
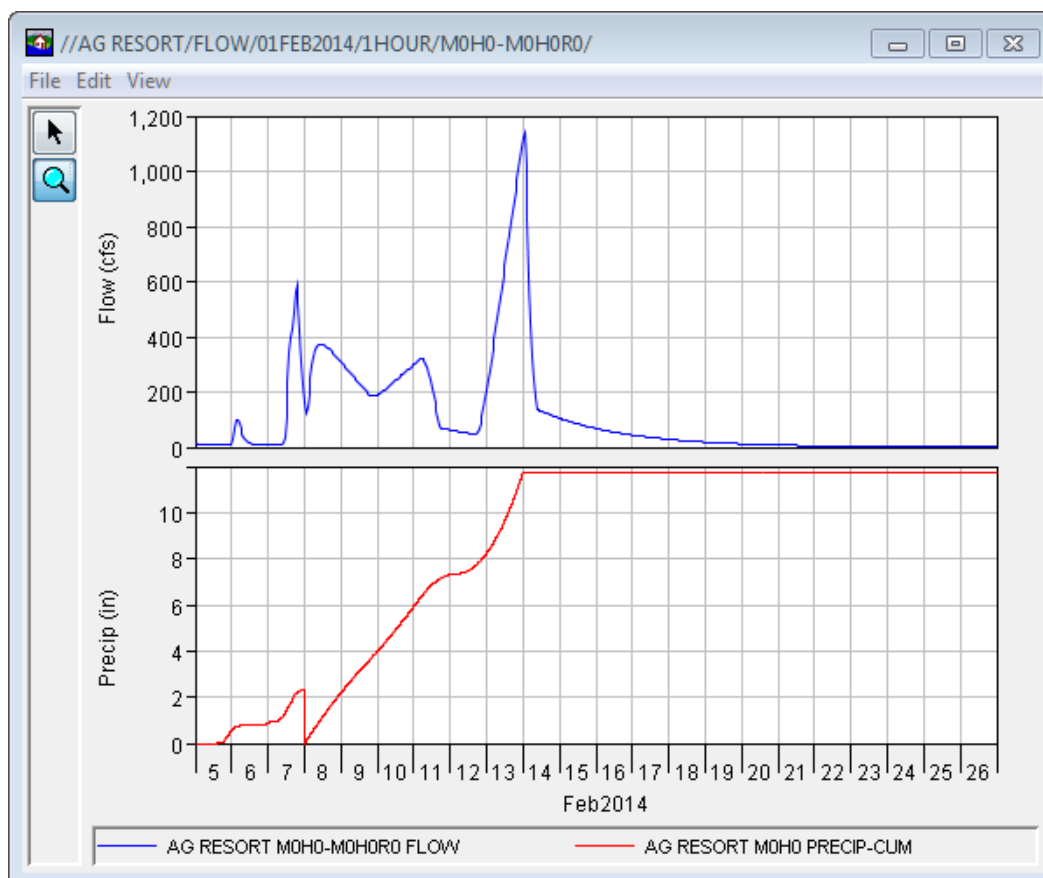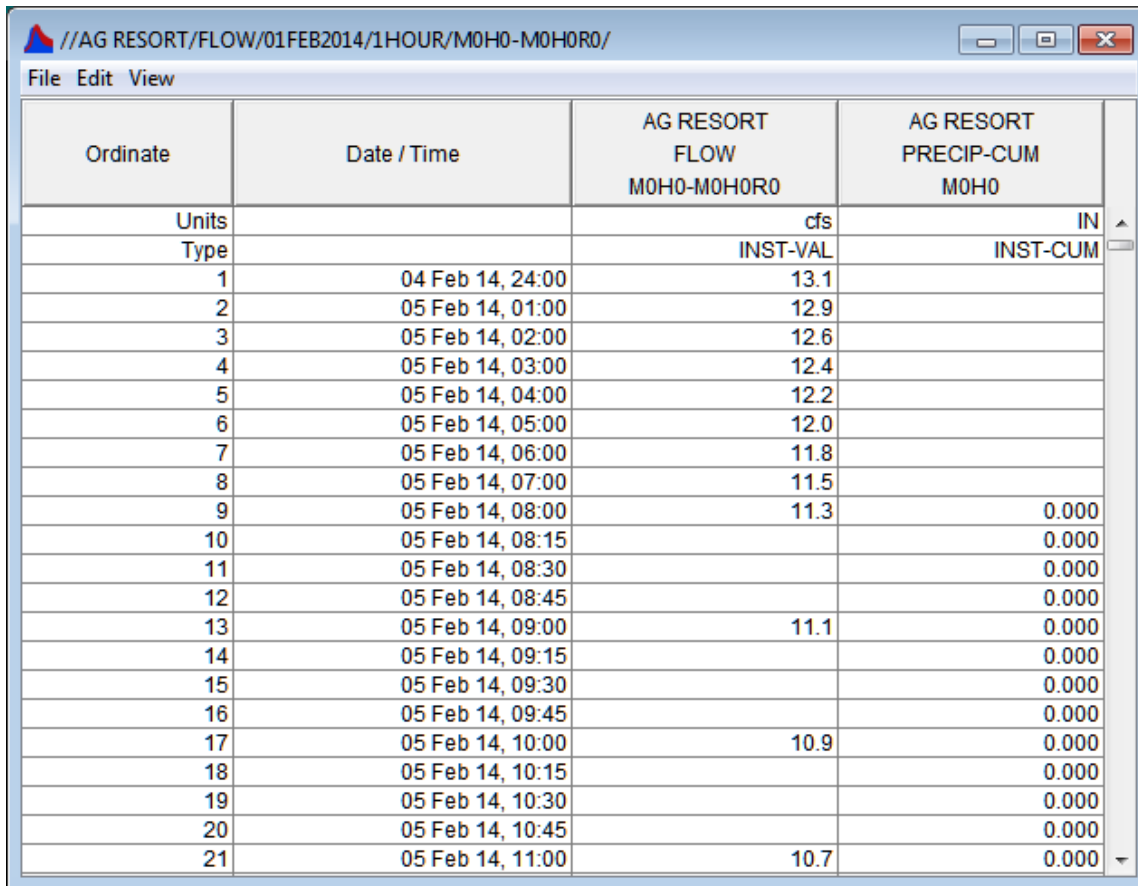

Figure F.7 HEC-DSSVue Plot Dialog Box

The parameters for the plots are labeled and color-coded. Date ranges are specified along one axis, and the units of measure are specified along the other axis. The **Plot Window** can be resized by clicking on the corner of the window and dragging it to the desired size. Using the **Zoom Tool** also zooms in and out on areas of the plot.

F.6.2 Tables

To view a table of the pathnames in the **Selected Pathname List** (Figure F.6), either click the **Tabulate** button ☰ from the **Toolbar** or choose **Tabulate** from the **Display** menu. The **Tabulate Window** (Figure F.8) opens.

Ordinate	Date / Time	AG RESORT FLOW M0H0-M0H0R0	AG RESORT PRECIP-CUM M0H0
Units		cfs	IN
Type		INST-VAL	INST-CUM
1	04 Feb 14, 24:00	13.1	
2	05 Feb 14, 01:00	12.9	
3	05 Feb 14, 02:00	12.6	
4	05 Feb 14, 03:00	12.4	
5	05 Feb 14, 04:00	12.2	
6	05 Feb 14, 05:00	12.0	
7	05 Feb 14, 06:00	11.8	
8	05 Feb 14, 07:00	11.5	
9	05 Feb 14, 08:00	11.3	0.000
10	05 Feb 14, 08:15		0.000
11	05 Feb 14, 08:30		0.000
12	05 Feb 14, 08:45		0.000
13	05 Feb 14, 09:00	11.1	0.000
14	05 Feb 14, 09:15		0.000
15	05 Feb 14, 09:30		0.000
16	05 Feb 14, 09:45		0.000
17	05 Feb 14, 10:00	10.9	0.000
18	05 Feb 14, 10:15		0.000
19	05 Feb 14, 10:30		0.000
20	05 Feb 14, 10:45		0.000
21	05 Feb 14, 11:00	10.7	0.000

Figure F.8 Tabulate Dialog Box

The **Tabulate Window** displays the ordinate (starting from the start date/time), the date and time stamp, and the values for the selected data sets. From the **Tabulate Window**, users have several options for displaying the tabular data (e.g. displaying commas in the number formatting, setting the precision of decimal places for data).

F.7   HEC-DSS Records

HEC-DSS uses a block of sequential data as the basic unit of storage. Each block contains a series of values of a single variable over a time span appropriate for most applications. The basic purpose of HEC-DSS is the organization of data into records of continuous, applications-related

elements, as opposed to individually addressable data items. This approach is more efficient for scientific applications than that of a conventional database system because it avoids the processing and storage overhead required for assembling an equivalent record from a conventional system. Data is stored in blocks, or records, within a file, and each record is identified by a unique name called a **pathname**.

F.7.1   Renaming Records

To change the pathname parts of a pathname:

1.   One or more pathnames must be selected for this command to be available (see Section F.5.3, page F-6 for pathname selection).

2.   From the **Edit** menu, click **Rename Records**. The **Rename Records to:** dialog box (Figure F.9) opens.
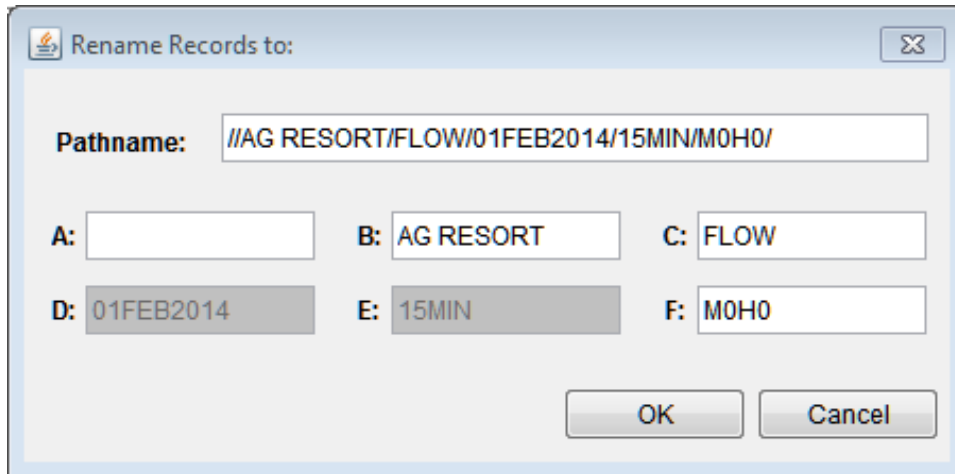
Figure F.9 Rename Records to Dialog Box

3.   Each of the boxes (**A** - **F**) represents the different pathname parts. Users can change the parts by typing the new information in the appropriate box.

4.   Click **OK**. The **Rename Records to:** dialog box closes (Figure F.9) and a message appears displaying the number of records renamed. The selected pathname is no longer displayed in the **Selected Pathname Box** and the pathname displays in the **Pathname Table** (Figure F.1) with the new pathname parts.

F.7.2   Duplicating Records

Users can duplicate records to make a copy of a record with an altered pathname part. To duplicate records:

1.   One or more pathnames must be selected (see Section F.5.3, page F-6) for this command to be available.

2.   From the **Edit** menu, choose **Duplicate**. The **New pathname parts for duplicate records:** dialog box opens (similar to Figure F.8).

3.   Each of the boxes (**A** - **F**) represents the different pathname parts. Users can enter new names for each of the parts in the fields.

4.   Click **OK**, the **New pathname parts for duplicate records:** dialog box closes, a message appears informing the user of the number of records that were duplicated. A new pathname is displayed in the **Pathname Table** (Figure F.1).

F.7.3   Deleting Records

To delete records:

1.   One or more pathnames must be selected (see Section F.5.3, page F-6) for this command to be available.

2.   A warning message dialog box appears, stating that records are going to be deleted .

3.   To delete, click **Yes**. The warning message dialog box closes. A message appears displaying the number of records deleted.

4.   The deleted records no longer appear in the **Pathname Table**.

F.7.4   Editing Data Associated with Records

Users can edit the data associated with a pathname, if the users have the appropriate permissions. To edit, from the **Edit** menu click **Tabular Edit**. Users can edit data directly, enter new time-series data or paired data, or use math functions to manipulate the data. All of these features are detailed in the HEC-DSSVue User's Manual.

Appendix G

Export Data from HEC-RAS

The HEC-RAS software is an integral part of the process for running HEC-FIA. HEC-FIA relies on data from HEC-RAS in the form of Storage Area and Cross Section shapefiles; Terrain grids, Inundation grids, Arrival Time grids, and HEC-DSS output. This appendix shows the basic steps in HEC-RAS to export data for use by HEC-FIA.

G.1   Preparing HEC-RAS Data

The consequence computation in HEC-FIA can be done using a cross section shapefile, storage area shapefile, and associated HEC-DSS database with stage-hydrograph output at each cross section and storage area for the flood scenarios being assessed. Another way to compute consequences is to use gridded data containing the various hydraulic parameters that HEC-FIA needs. This appendix covers the steps to prepare that data in HEC-RAS for HEC-FIA.

G.2   Opening a Project

To run HEC-RAS, make sure the software has been installed; if it is installed there should be a shortcut on a user's desktop. Double-click the shortcut; the main window of the HEC-RAS software opens (Figure G.1).
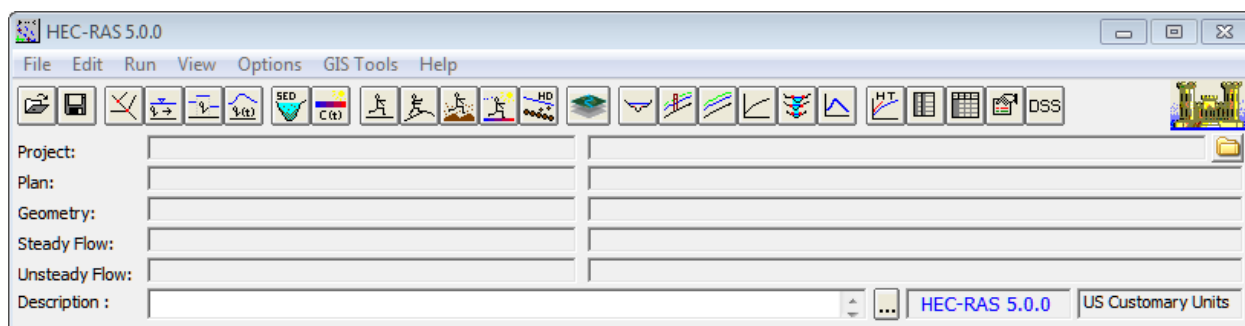

Figure G.1 HEC-RAS Main Window

From the **File** menu, click **Open Project**. The **Open Project Browser** (Figure G.2) opens. Browse to the file location of the "ras.prj" file, select the file from the table on the browser, click **OK**. The **Open Project Browser** closes, and the information about the selected project appears in the HEC-RAS main window (Figure G.1).
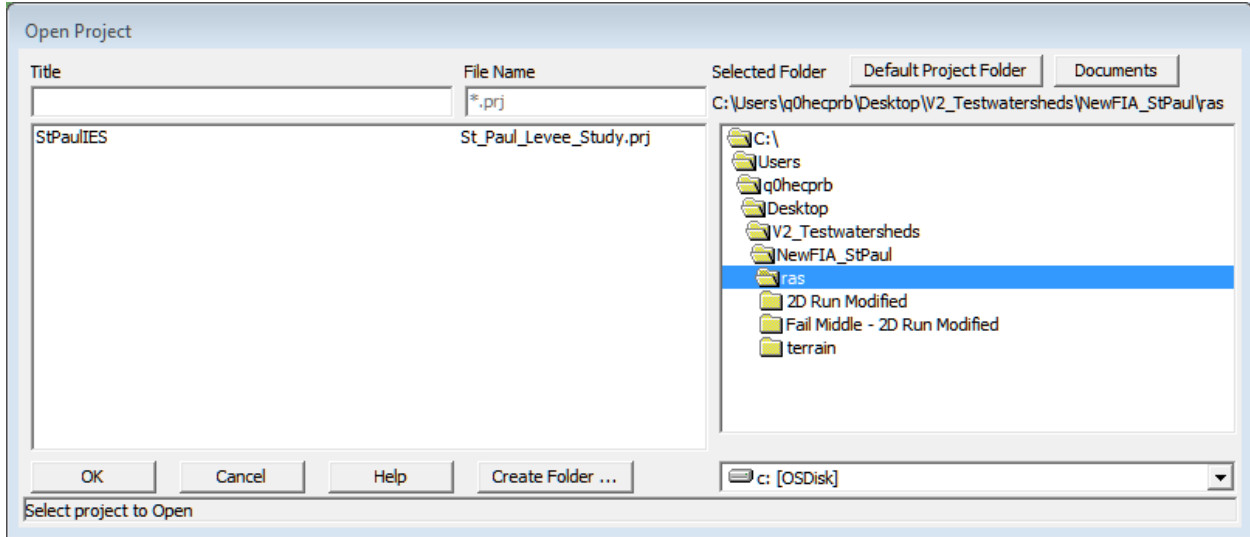
Figure G.2 Open Project Dialog Box

G.3 Exporting Cross Sections and Storage Areas

HEC-FIA can utilize HEC-RAS cross section and storage area shapefiles to calculate depth, arrival time, and duration at points in the floodplain. HEC-FIA doesn't need the geometry of the cross sections; it only requires the line that represents the cross section. HEC-FIA also needs to be able to identify the HEC-DSS A B C parts as attributes on the shapefile.

To export the cross sections and storage area shapefiles follow these steps:

1. To start the RAS Mapper toll, click RAS Mapper from the HEC-RAS toolbar (Figure G.3). The **RAS Mapper** main window opens (Figure G.4)
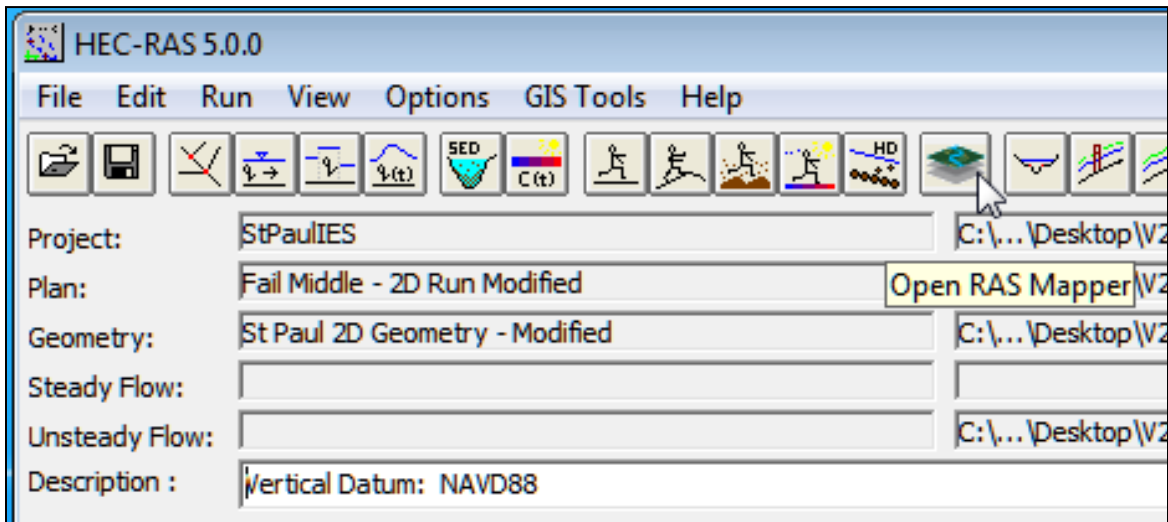
Figure G.3 Open RAS Mapper

2. The geometry associated with the selected HEC-RAS project is loaded. This geometry includes storage areas and cross sections (XS).
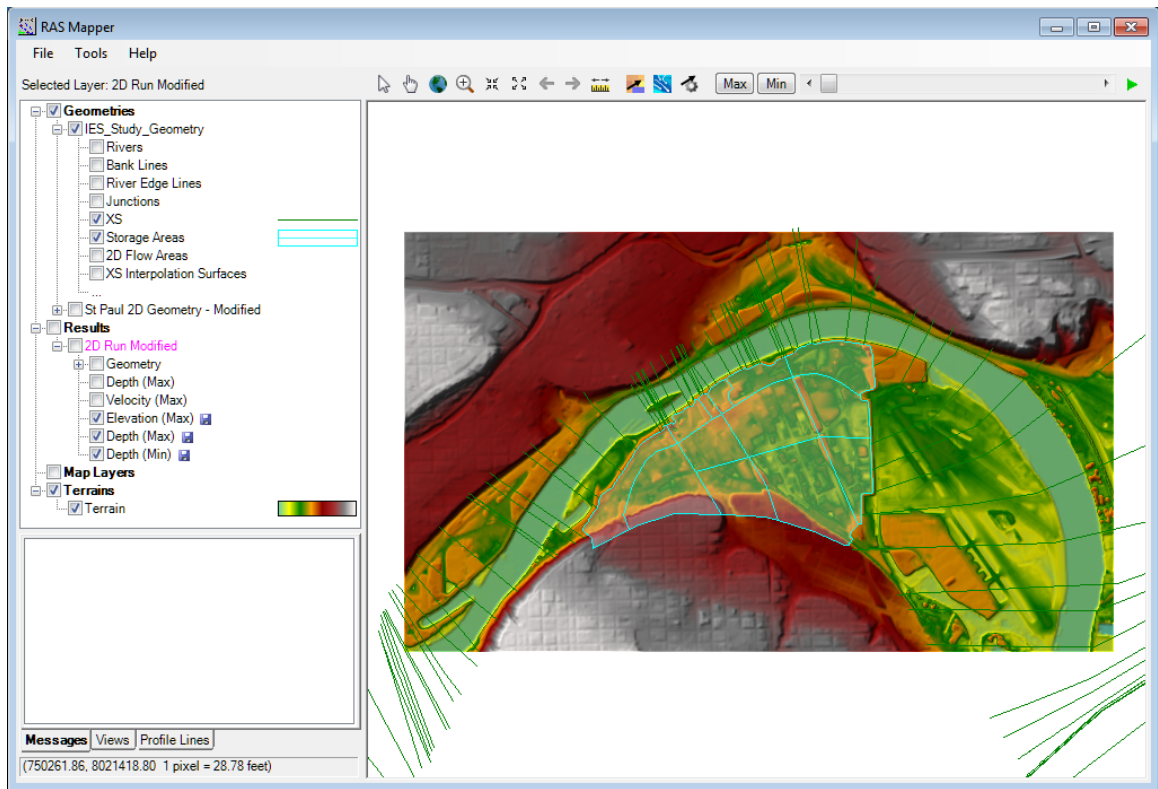
Figure G.4 RAS Mapper Main Window

3. Right-click **Storage Areas**, from the shortcut menu point to **Export Layer**, click **Save features to Shapefile** (Figure G.5). The **Enter Shapefile Name** browser opens (Figure G.6).

Figure G.5 RAS Mapper - Storage Areas - Export Layer

4. Browse to the location where the shapefile is to be stored, in the **File name** list (Figure G.6) enter a name for the shapefile. Click **Save**, the **Enter Shapefile Name** browser closes (Figure G.6), and the shapefile is created.

Figure G.6 Save Layer As Browser

5. Right-click **XS** (cross sections), from the shortcut menu point to **Export Layer,** click **Save features to Shapefile** (Figure G.5). The **Enter Shapefile Name** browser opens (Figure G.6).
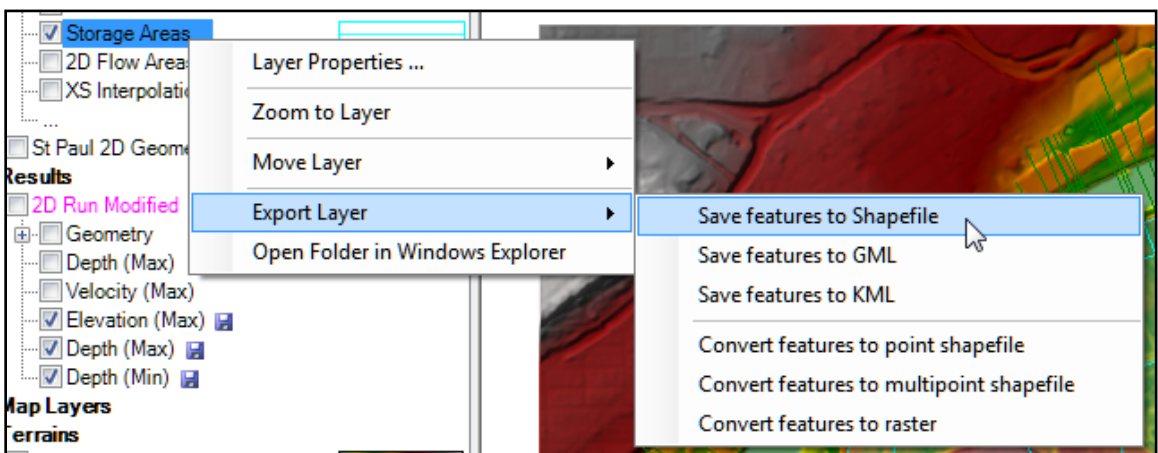
6. Browse to the location where the shapefile is to be stored, in the **File name** list (Figure G.6) enter a name for the shapefile. Click **Save**, the **Enter Shapefile Name** browser closes (Figure G.6), and the shapefile is created.
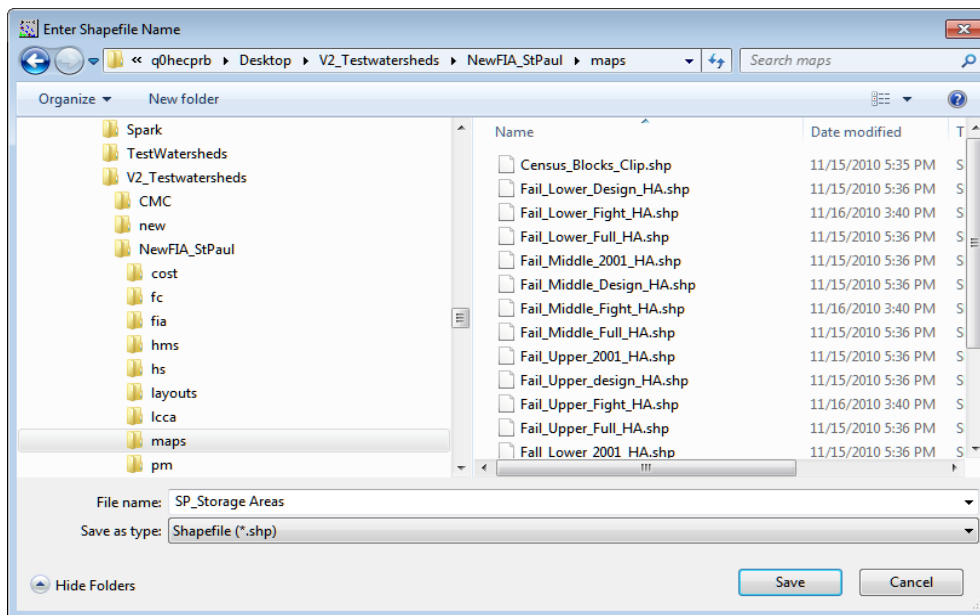
7. Shapefiles for the storage areas and cross sections have been created.

G.4   Preparing Digital Terrain Model

Terrain data can be in binary grid format, or in the tiled image format (*.tif) for use in HEC-FIA. The tiled image format is the suggested file type in HEC-FIA. HEC-FIA converts the file to .tif if it is not already in that format. HEC-RAS also uses the .tif format, so if the HEC-RAS model has a terrain, the user should use the terrain in .tif format as created by HEC-RAS. Terrain information is required to assign ground elevations to a structure inventory generated in HEC-FIA or to update ground elevations in an existing structure inventory. To prepare a terrain grid through RAS Mapper, follow the steps below:

1.   Open RAS Mapper (Figure G.3).

2. The node at the bottom of the map tree is titled "Terrains", and should have a sub node which represents the terrain for the RAS Mapper Project.

3.   It is possible for there to be many terrains in the RAS Mapper project. To make sure that the proper terrain is being used, the user should check which terrain is associated with the geometry that is producing the results being provided to HEC-FIA. To do this, right-click on the appropriate **Geometry in the Results Node** of the **Map** tree, and select

Associate Terrain Layer. The **Manage Geometry Associations** dialog box opens (Figure G.7) and the user should be able to identify the terrain for the results in question in the third column of the form.
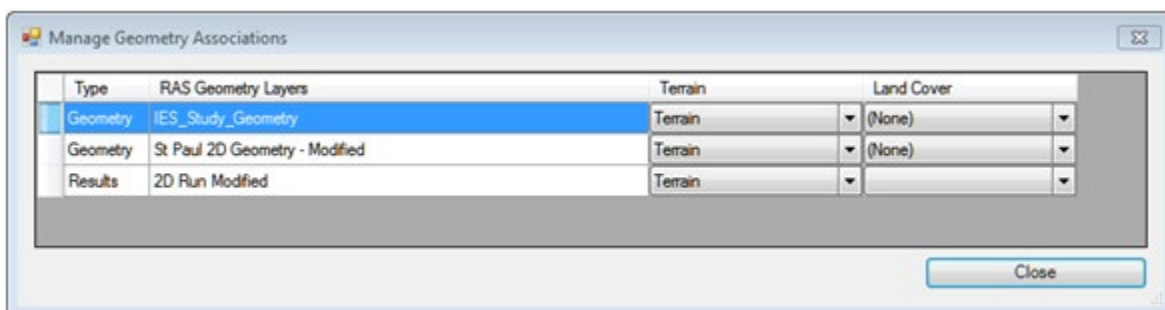
Figure G.7 Manage Geometry Associations Dialog Box

4. Now that the name of the terrain file is known, go to the root directory of the HEC-RAS project directory, and find a terrain titled "Terrain.tif", or "Terrain.vrt". A terrain grid can be represented by more than one "Terrain.tif", or "Terrain.vrt".

5. To check a .vrt file, open the file in a text editor, (Figure G.8, using Notepad++®) there is an xml node <ComplexSource> which contains at least one xml node <SourceFilename>. The file path in the SourceFilename is the path to the data file for the terrain .vrt, The path is relative to the .vrt file. If there are many files, make sure to grab all of the referenced files and the .vrt file to send to the HEC-FIA modeler. HEC-FIA can import .vrt files as well.

Figure G.8 Editing the XML File Associated with a .vrt File

G.4.1   Creating Gridded Output

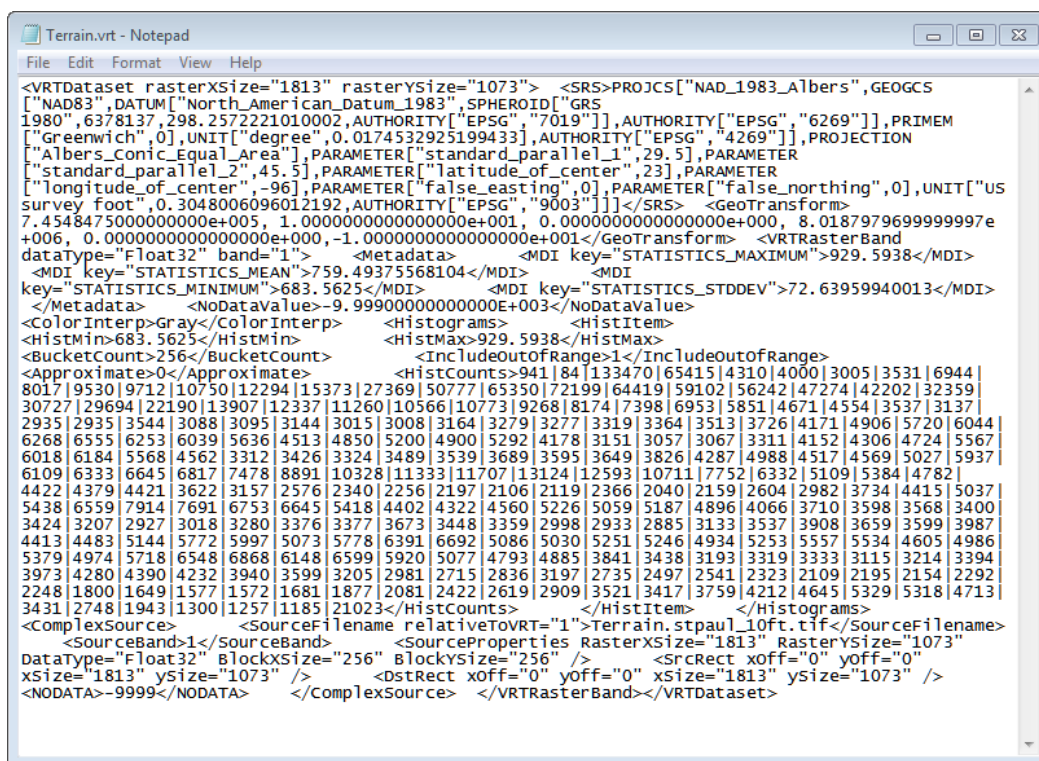Flood inundation information for a specific flood scenario is supplied to HEC-FIA in the form of depth grids, when the consequence assessment uses gridded data. Depth grids used for the assessment are typically generated by a hydraulic engineer using RAS Mapper. The typical output format is a GeoTif *.tif for HEC-RAS 5.0 with RAS Mapper. This section describes how to output data to grids. The procedure works for unsteady one-dimensional hydraulics modeling, modeling with two-dimensional flow areas, or plans with combinations of both.

HEC-FIA uses two main grids, the maximum depth grid, and the arrival time grid. The maximum depth grid describes the highest depth in a grid cell throughout the entire simulation. The arrival time grid defines when a grid cell had depth that exceeds some user defined threshold. HEC-FIA can also use a duration grid for agriculture computations describing how long a grid cell is wet, starting with the first time the threshold is crossed on the rising limb, until the last time the threshold is exceeded on the falling limb.

To create a stored grid in RAS Mapper:

1. From the **RAS Mapper** main window (Figure G.4), from the **Tools** menu, click **Manage Map Results**.

2. The **Manage Results Maps** dialog box opens (Figure G.9). From the table, click **Add New Map**, the **Results Map Parameters** dialog box opens (Figure G.10).
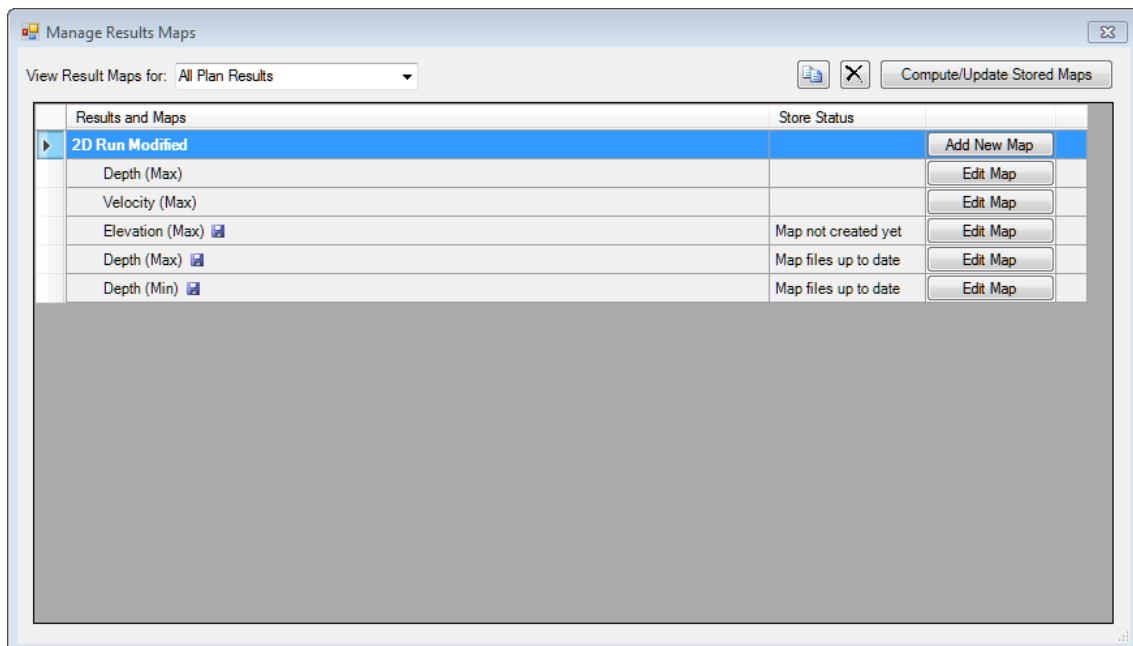

Figure G.9 Manage Results Maps Dialog Box

3. To create a *maximum depth grid*, from the **Map Type** list box, select **depth**. From the **Unsteady Profile** box, select **Maximum**. From the **Map Output Mode** box, select **Stored Raster (using current terrain as layout)**. To create a *maximum depth grid*, click **Create this map**.
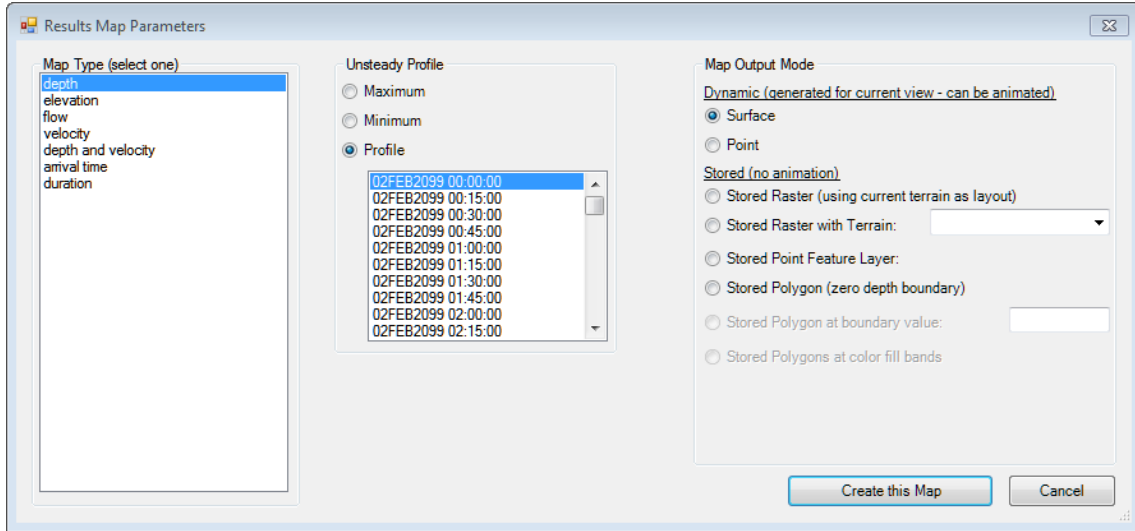
Figure G.10 Results Map Parameters Dialog Box

4. The **Manage Results Maps** dialog box (Figure G.9); now has an added row for the *maximum depth grid* that was just created (Figure G.11). From the **Store Status** column, the status for the *maximum depth grid* is **Map not created yet**. To actually write the file to disk, click **Compute/Update Stored Maps**, status is now **Map files up to date**.

Figure G.11 New Maximum Depth Grid

5. To add an *arrival time grid*, from the **Manage Results Maps** dialog box (Figure G.9), click **Add New Map**, the **Results Map Parameters** dialog box opens (Figure G.10).

6. From the **Map Type** list, select **arrival time**, from the **Unsteady Profile** box, select **Hours.** HEC-FIA expects the arrival time grid to be in decimal hours not decimal days.

7. If the *arrival time grid* being created includes loss of life, from the **Depth Threshold Parameters** box (Figure G.12) in the **Threshold depth** box enter a value if the study team decides this is an important threshold to evaluate (sensitivity). When creating any *arrival time grid*, it is important to communicate the start time of the *arrival time grid* to HEC-FIA.
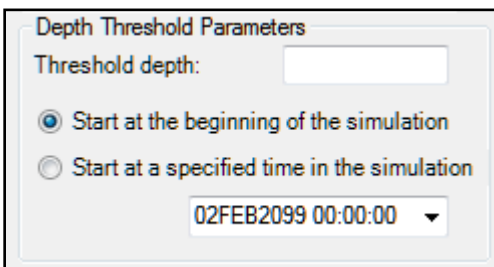

Figure G.12 Depth Threshold Parameters

If an agriculture arrival time grid is being created, the **Threshold depth** needs to be reviewed by the PDT, which hopefully includes an economist. Once the PDT has come to an agreement on the parameters for the *arrival time grid*, from the **Map Output Mode** box, click **Stored Raster (using current terrain as layout)**. From the **Results Map Parameters** dialog box (Figure G.10) click **Create this Map**, and the *arrival time grid* has been created.

8. From the **Manage Results Maps** dialog box (Figure G.9), on the table a row has been added for the *arrival time grid* that was just created. From the **Store Status** column, the status for the *arrival time grid* is **Map not created yet**. To actually write the file to disk, click **Compute/Update Stored Maps**, status is now **Map files up to date**.

9. Commonly in dam failure studies, *depth and velocity grids* are important for life loss analysis. *Depth and velocity grids* are used by HEC-FIA to compute building stability criteria, and can have large impacts on the life loss computes. To create a *depth and velocity grid*, from the **Results Map Parameters** dialog box (Figure G.10), from the **Map Type** list, select **depth and velocity**. From the **Unsteady Profile** box, the default is **Maximum**. From the **Map Output Mode** box, select **Stored Raster (using current terrain as layout)**.

10. To create the *depth and velocity grid*, from the **Results Map Parameters** dialog box (Figure G.10) click **Create this Map**, and the *depth and velocity grid* has been created.

11. From the **Manage Results Maps** dialog box (Figure G.9), on the table a row has been added for the *depth and velocity grid* that was just created. From the **Store Status** column, the status for the *depth and velocity grid* is **Map not created yet**. To actually write the file to disk, click **Compute/Update Stored Maps**, status is now **Map files up to date**.

12. Finally, for *duration* grids, from the **Results Map Parameters** dialog box (Figure G.10), from the **Map Type** list, select **duration** (Figure G.12).

13. From the **Unsteady Profile** box (Figure G.13) select **Hours**. From the **Depth Threshold Parameters** box (Figure G.14) in the **Threshold depth** box enter 0 (zero). From the **Map Output Mode** box select **Stored Raster (using current terrain as layout)**.

14. To create the *duration grid*, from the **Results Map Parameters** dialog box (Figure G.10) click **Create this Map**, and the *duration grid* has been created.

15. From the **Manage Results Maps** dialog box (Figure G.9), on the table a row has been added for the *duration grid* that was just created. From the **Store Status** column, the status for the *duration grid* is **Map not created yet**. To actually write the file to disk, click **Compute/Update Stored Maps**, status is now **Map files up to date**.

For more information on these grids and how they are created, consult the documentation for HEC-RAS Version 5.0 and RAS Mapper.

G.4.2   HEC-DSS File

HEC-FIA obtains flood wave arrival times for individual structures for life loss computations from stage-hydrographs stored by HEC-RAS in a HEC-DSS (Hydrologic Engineering Center's Data Storage System) file. For this information to be useful to HEC-FIA, the hydraulic engineer must configure HEC-RAS to generate stage-hydrographs at all cross section and storage area locations before simulating an event. Since HEC-FIA interpolates the stage between cross sections, and minutely information is important, it is advised that the output time step be set to a relatively small time step. Typically fifteen- to five-minutes are used.

1. From the main **HEC-RAS** window (see Figure G.1).

2. Click **Unsteady Flow Analysis**, the **Unsteady Flow Analysis** dialog box (Figure G.13) opens.
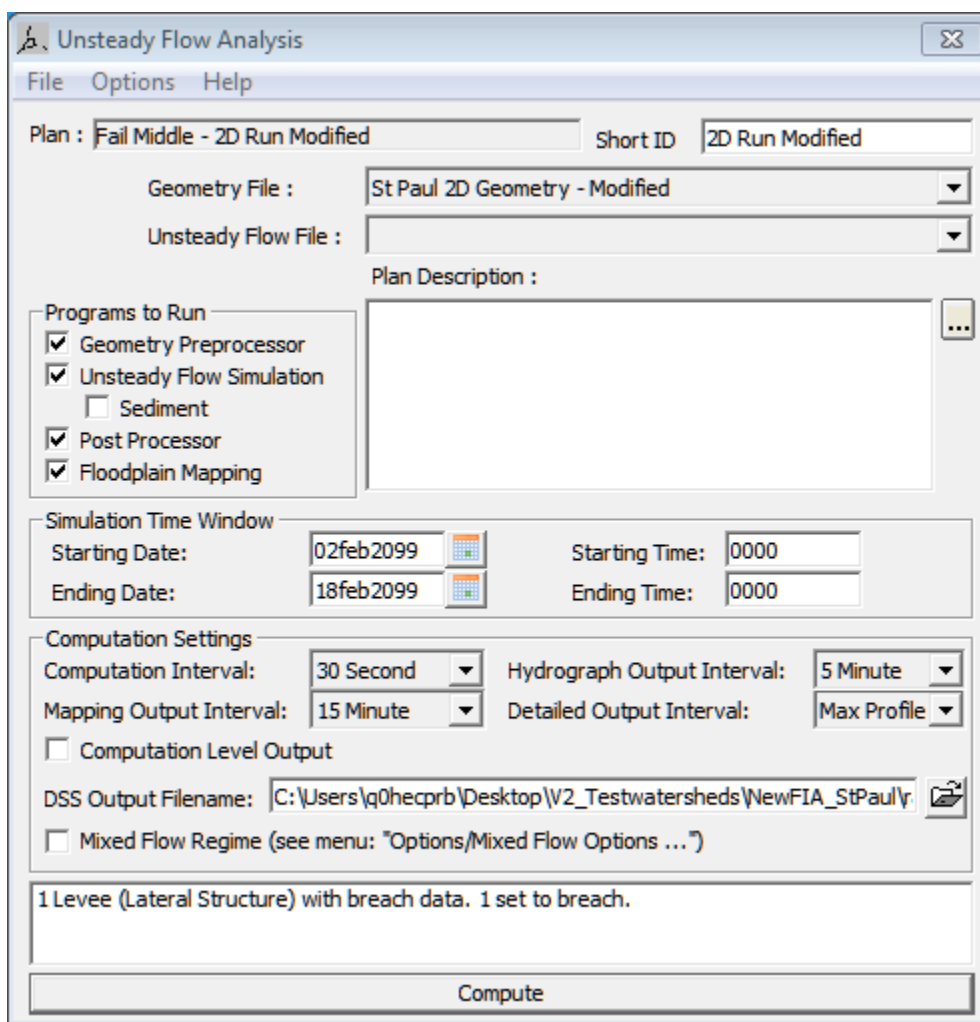
Figure G.13 Unsteady Flow Analysis Dialog Box

3. From the **Options** menu, (Figure G.14) click **Stage and Flow Output Locations**, the **Stage and Flow Output Locations** dialog box opens (Figure G.15).

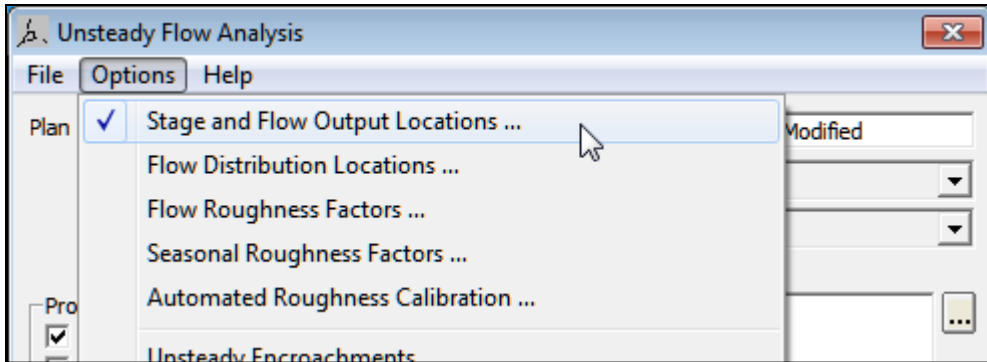**Figure G.14** Options Menu - Stage and Flow Out Locations
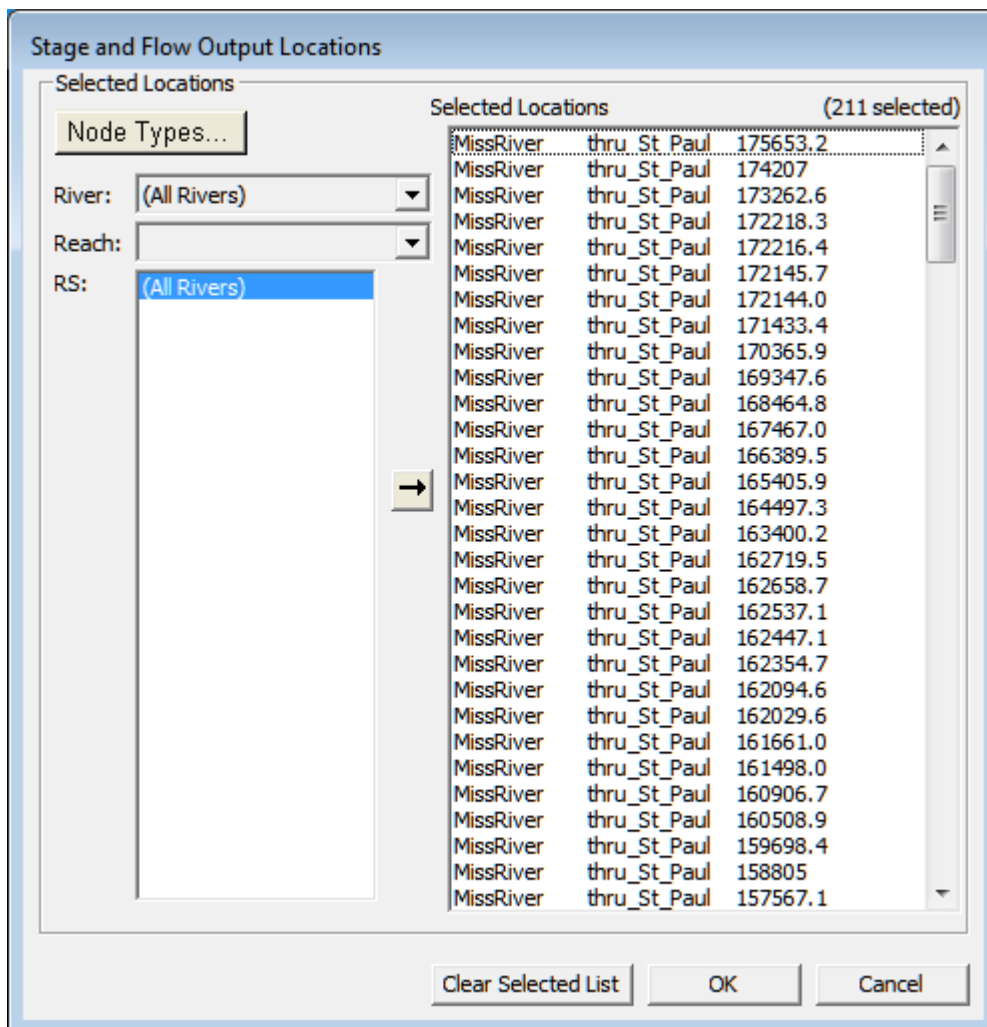

Figure G.15 Stage and Flow Output Locations Selector

4. From the **River** list (Figure G.15), select **(All Rivers)**.

5. From the **RS** box (Figure G.15), select **(All Rivers)**.

6. Click the right-arrow button to select all the cross section locations to the **Selected Locations** box (Figure G.10).

7. Click **OK**; the **Stage and Flow Output Locations** dialog box closes (Figure G.15).

8. From the **Unsteady Flow Analysis** dialog box (Figure G.13), in the **HEC-DSS Output Filename** box, enter the path and the filename of the HEC-DSS file that contains the stage-hydrographs created by HEC-RAS.

9. Click **Compute**, the **Unsteady Flow Analysis** dialog box closes (Figure G.16), and the **HEC-RAS Computations** dialog box opens. When computations are finished, click **Close**, the **HEC-RAS Computations** dialog box closes.

10. The HEC-DSS file is created during the HEC-RAS simulation in the location that the user selected.

Appendix H

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