HEC-LifeSim
Life Loss Estimation

User's Manual

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HEC-LifeSim, USACE, life loss, spatially; dynamic, simulation, modeling, economic, damages, levee failure, floods, population at risk, PAR, loss, shelter; software; risk assessment; dam; levee safety, analysis, hazard; emergency; hydraulic data; HEC-RAS, grid set; structure inventories; damage category; occupancy type; construction type; stability criteria; submergence criteria, emergency planning zone, EPZ, road network data, shapefile, destination data, alternatives, simulations, results, animation, uncertainty, arrival, attribute, feature, properties, gridded map, vertex
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CHAPTER 1

Introduction

The U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's (HEC) Life Loss Estimation (HEC-LifeSim) software is a spatially-distributed dynamic simulation modeling system for estimating potential life loss and direct economic damages from natural and dam and levee failure floods. HEC-LifeSim accounts explicitly for the impact of warning issuance time; warning diffusion; the population at risk's (PAR's) protective action initiation; the PAR's evacuation potential; detailed flood dynamics; and, loss of shelter on loss of life. An agent-based approach has been developed to track individuals throughout the warning and evacuation process. The software can be used to provide inputs for risk assessment and to explore options for improving the effectiveness of a dam owner's emergency plans or a local authority's response plans. While HEC-LifeSim was developed for dam and levee safety analyses, the software is not just limited to flood hazards. HEC-LifeSim can be applied to any type of hazard that can be converted into a time series of gridded data including fires, toxic gas, and hurricanes.

Monte Carlo sampling techniques are used in HEC-LifeSim to capture the natural variability of temporal uncertainty in the warning and evacuation process as well as the potential for life loss when put in threatening flood situations. Many model parameters can be defined with uncertainty in HEC-LifeSim, providing a means of capturing knowledge uncertainty. The natural variability and knowledge uncertainty parameters will vary offering a range of potential life loss and economic damage results.

- Knowledge uncertainty (epistemic uncertainty) random variables are not known exactly and exist when it is not possible to make an accurate estimate of value of an input. A few examples are flood likelihood, hydraulic coefficients, and channel capacities.

- Natural variability (aleatoric uncertainty) random variables vary spatially or event-to-event and exist when the outcome of a natural process is random, or the natural process is so complex it seems random when viewed in isolation. A few examples are flood magnitude and forecasts.

A better understanding of the factors driving consequences are gained by reviewing the distribution of results as opposed to a single deterministic result. HEC-LifeSim can be used to provide inputs for risk assessment and to explore options for improving the effectiveness of a dam owner's emergency plans or a local authority's response plans.

1.1 Purpose

The main purpose of the HEC-LifeSim software is to help USACE study teams better understand the consequences of a flood event. Although flooding can lead to many types of severe consequences, the primary objective of the USACE Dam and Levee Safety program is to manage
risk to the public who rely on those structures to keep them reasonably safe from flooding. Thus, reducing the risk associated with life loss is paramount.

HEC-LifeSim was developed to:

- Effectively support reduction of life-safety risks associated with flooding,
- Evaluate existing and residual risks against tolerable risk guidelines,
- Understand life-loss dynamics associated with floods, and
- Create or improve existing emergency action plans.

HEC-LifeSim provides a practical life loss estimation approach. The software is designed to facilitate:

- Entry of appropriate data into each of the individual simulation required components,
- The flexibility to apply new research as data inputs to the model,
- Review simulation results from a high level down to individual details, and
- View simulation results as map animations to help facilitate review of results and discussion with emergency managers.

1.2 Organization of Manual

The organization of this manual by chapter is as follows:

Chapter 2  Installation process, getting started with HEC-LifeSim, and creating an HEC-LifeSim study.
Chapter 3  Overview of the HEC-LifeSim interface.
Chapter 4  Overview of hydraulic datasets
Chapter 5  Overview of structure inventories
Chapter 6  Overview of emergency planning datasets
Chapter 7  Overview of road network datasets
Chapter 8  Overview of destination datasets
Chapter 9  Overview of alternatives
Chapter 10  Overview of simulations
Chapter 11  Provides the user with a thorough understanding of the results that are generated
Appendix A  Details the Map Window and the map layer editing tools
Appendix B  Provides tips and tricks for preparing a road network
Appendix C  References
Appendix D  Terms and Conditions of Use
CHAPTER 2

Installing and Starting HEC-LifeSim

This chapter describes the recommended computer system requirements for installing and running HEC-LifeSim. The software includes a graphical user interface (GUI), designed to increase the usability and efficiency of the software. The HEC-LifeSim GUI provides for file management, data entry and editing, and viewing output results.

2.1 Requirements

- Installation – about 180MB (megabytes) of hard disk space
- Memory – 1GB (gigabytes) RAM (random access memory); recommended 4GB RAM
- Microsoft .NET Framework Version 4.0

2.2 Installation

- Install HEC-LifeSim using the self-extracting setup package file downloaded from the Hydrologic Engineering Center (HEC) website (http://www.hec.usace.army.mil/).

- The installer (with administrative privileges) will run through a series of steps regarding terms and conditions, install location (e.g., C:\Program Files), and shortcut icons.

- Install the HEC-LifeSim example dataset from the HEC website (http://www.hec.usace.army.mil/).

2.3 Starting HEC-LifeSim

When starting the HEC-LifeSim, double-click the HEC-LifeSim icon (shortcut) on the desktop. The main window of the HEC-LifeSim will appear (Figure 2-1). If the desktop shortcut icon is not available, the user can start HEC-LifeSim from the Start menu, click All Programs, click HEC, and click HEC-LifeSim.

2.4 Creating a Study

A study in HEC-LifeSim is a combination of the data, models, or events required to analyze a specific geographical area. The study represents all of the input data and simulation output required to adequately answer the question of estimating consequences from a hazard. There are two ways to create a study.
To create a HEC-LifeSim study:

1. From the HEC-LifeSim main window (Figure 2-1), from the File menu, click **Create New**. Another way is from the Study Tree, right-click **New Study**, from the shortcut menu, click **Create New**. Either way, the **Save As** browser will open (Figure 2-2).

2. From the **Save As** browser, navigate to the location (directory) where the HEC-LifeSim study will be created. Enter a name (required) in the **File name** box.
3. Click **Save**, the **Save As** browser (Figure 2-2) will close. The HEC-LifeSim main window (Figure 2-1) will now have the name of the study in the **Study Tree** and the **Title Bar**.

4. A directory with the study name and associated files will be created for the study.

### 2.5 Opening a Study

To open an existing HEC-LifeSim study:

1. From the HEC-LifeSim main window (Figure 2-1), from the **File** menu, click **Open Existing**. Another way is from the **Study Tree**, right-click **New Study**, from the shortcut menu, click **Open Existing**. Either way, an **Open** browser will open (Figure 2-3).

![Open Browser](image)

**Figure 2-3. Open Browser**

2. Browse to the location of the HEC-LifeSim study file (*.sim). Click on the *sim* file and the **File name** box will now contain the filename (e.g., *LifeSim_Example_Study.sim*).

3. Click **Open**, the **Open** browser (Figure 2-3) will close and the HEC-LifeSim main window (Figure 2-1) will now display the selected study in the **Study Tree** and the study name will display in the **Title Bar**.

### 2.6 Study Directories and Files

Directories and files are automatically created by HEC-LifeSim to store information. Figure 2-4 displays an example of how HEC-LifeSim organizes the directories and files in the study directory. As data is entered, subsequent files and subdirectories are created. A description of the created directories is also provided in Table 2-1.
Figure 2-4. Example HEC-LifeSim Study Directory Structure
Table 2-1. Example HEC-LifeSim Directories and Files

<table>
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<th>File or Directory Name</th>
<th>Contents</th>
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<td>Study folder that is created when a user creates a new study (Section 4.1.1).</td>
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</tr>
<tr>
<td>Files created by HEC-LifeSim when a study is created. Contains the name and description of the study, map properties, and references to the HEC-LifeSim study elements. The *.sim.bak file is an automatic backup file of the *.sim file.</td>
<td></td>
</tr>
<tr>
<td>Sub-directory created by HEC-LifeSim when hydraulic data is imported. Contains files that define data items for imported hydraulic data. Also, sub-directories are created when hydraulic data is defined and are dependent on the hydraulic data import option utilized.</td>
<td></td>
</tr>
<tr>
<td>Sub-directory created by HEC-LifeSim when a study is created. Contains all of the information about the imported and defined structure inventory, damage categories and structure occupancy types.</td>
<td></td>
</tr>
<tr>
<td>Sub-directory created by HEC-LifeSim when Emergency Planning Zones (EPZ) data is imported. Contains all of the information about the imported and defined EPZ data.</td>
<td></td>
</tr>
<tr>
<td>Sub-directory created by HEC-LifeSim when the road network is imported. Contains all of the information about the imported and defined road network.</td>
<td></td>
</tr>
<tr>
<td>Sub-directory created by HEC-LifeSim when destination data is imported. Contains the created destination data shapefile.</td>
<td></td>
</tr>
<tr>
<td>Sub-directory created by HEC-LifeSim when an alternative is created. The created alternative is saved as an XML file.</td>
<td></td>
</tr>
<tr>
<td>A sub-directory created by HEC-LifeSim when a simulation is created. Also, sub-directories are created to contain the simulation Results.sqlite files when the simulation is defined, and the subdirectories are dependent on the options selected.</td>
<td></td>
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CHAPTER 3

HEC-LifeSim Interface

The HEC-LifeSim main window (Figure 3-1) displays the framework for the HEC-LifeSim software. The interface allows users to enter data, review data, create alternatives, run simulations, and review results. The Title Bar (Figure 3-1) displays the name of the HEC-LifeSim study, once a study is opened or has been created.

![Figure 3-1. HEC-LifeSim Main Window – Interface](image)

### 3.1 Main Window

The main window is organized with a **Menu Bar**; two tabs (Study and Map Layers); a **Map Window** with an associated toolbox; and, the **Status Bar**. The following describes basic elements of the main window:

- **Title Bar**: Displays the name of the active HEC-LifeSim study.
- **Menu Bar**: Contains the HEC-LifeSim menus.
- **Study and Map Layers Tabs**: The **Study** tab contains a **Study Tree** that guides users the building blocks on an HEC-LifeSim study. The **Map Layers** tab contains a list of all map layers that are currently part of the active study. Clicking a tab opens the tab specific information and commands.
Map Window  Used to graphically display the HEC-LifeSim study components, which is geographically-referenced (geo-referenced).

Map Window Toolbox Contains tools used to setup, navigate, and edit within the HEC-LifeSim Map Window.

Status Bar Displays messages related to incoming data, status of the HEC-LifeSim software for informational purposes.

### 3.2 Menu Bar

The menu bar of HEC-LifeSim provides the user with many commands to perform various functions. An overview for each menu in HEC-LifeSim software is provided.

**File** The File menu allows the user to perform study management functions such as creating, opening, closing, and saving an HEC-LifeSim study. Available commands are: Create New, Open Existing, Save, Save As, and Exit.

**Mapping** From the Mapping menu users can add or remove map layers from the Map Layers tab and Map Window. Map layers that can be added to an HEC-LifeSim study are - *.shp, *.flt, *.tif, *.vrt, or web layers. Other available functions from the Mapping menu are creating vector layers (*.shp), and modifying or importing map projections. Available commands are: Add Map Layer, Add Web Layer, Create New Vector Layer, Remove Map Layer, and Map Properties.

**Study** From the Study menu, users can import, create, modify, and edit the building blocks of an HEC-LifeSim study. Commands include Hydraulic Data, Structure Inventories, Emergency Planning Data, Road Network Data; Destinations Data, Alternatives, and Simulations.

**Help** Displays a copy of the HEC-LifeSim User's Manual current version; and information about HEC-LifeSim.

### 3.3 Tabs –

The HEC-LifeSim main window (Figure 3-1) is organized into two tabs that allow the user to view, enter, and edit HEC-LifeSim study data or to view and manipulate any map layer geographically in the Map Window.

**Study Tab** Allows a user to view, add, and edit data; and add/remove map layers for an HEC-LifeSim study. The Study tab is the default tab and provides a view of the study data in a tree (Study Tree). Also, from the Study Tree a user can create, edit, and delete datasets, alternatives and simulations. The Study Tree lists datasets, alternatives and simulations that have been created. Refer to Chapters 4 and 5 for additional details on the Study tab.
Map Layers Tab

The Map Layers tab provides a list of the map layers displayed in the Map Window. However, only selected layers in the Map Layers tab will display in the Map Window. The user can turn map layers on or off, adjust the properties of the layers, modify the order of the layers for viewing in the Map Window. Appendix A provides greater detail on the Map Layers tab and associated Map Window.

3.4 Map Window

The Map Window (Figure 3-1) in HEC-LifeSim provides a way to graphically display HEC-LifeSim components. This section is designed to give a brief overview of what is available in the Map Window and map layers. For more detail on the mapping functionality in HEC-LifeSim, refer to Appendix A.

The Map Window Toolbox (Figure 3-1) contains three toolbars. The first toolbar is the General Toolbar, second is the Selectable Layers Toolbar, and third is the Editor Toolbar. If a tool has a parentheses after the tooltip, the letter in the parentheses represents a hot key that allows a user to access the tool through the keyboard. For example, to access the Query tool (Q) through keyboard selections, the user will click the Shift-Q keys over the Map Window. This will activate the Query tool. A list of all of the hot keys is located in Appendix.

3.4.1 General Toolbar –

The General Toolbar includes the Select Tool (B), Pan Tool (P), Zoom In Tool (Z), Zoom to full extents, Add Data, Query Features Tool (Q), and Measure Distance Tool (M). These tools change the appearance of the cursor, as well as the functionality of the mouse cursor in the Map Window.

Select Tool (B)
The Select tool allows the user to select elements displayed in the Map Window that are currently selected in the Selectable Layers. More details on Selectable Layers can be found in the next section. To select features click on a feature or click, hold, and drag a rectangle around features to select them in the Map Window. Additionally, the Select tool allows users to access shortcut menus which can be used to customize features when in editing mode. Refer Appendix A for more information regarding editing mode.

Pan Tool (P)
The Pan tool allows the user to pan the Map Window; click the Pan tool and click, hold and move the mouse around the Map Window. Also, if the mouse has a wheel then the user can pan the Map Window by using the wheel (click and hold the wheel to pan).

Zoom In Tool (Z)
The Zoom In tool allows the user to zoom in to areas of the Map Window. To zoom in, hold the mouse button down and outline the area of interest to enlarge. Also, if the mouse has a wheel then the user can zoom in or out using the wheel (wheel up zooms in and wheel down zooms out).
Chapter 3 – HEC-LifeSim Interface

3.4.2 Selectable Layers Toolbar –

Selectable Layers Toolbar allows the user to turn on and off map layers of a study using the Select tool from the Selectable Layers Toolbar. The list of options depends on the maps layers located in the Map Layers tab, except Internet (web) layers. For further explanation on the use of Selectable Layers, refer to Appendix A, Section A.13.1.
3.4.3 Editor Toolbar –

The set of tools located in the Editor Toolbar initiate an editing session for the selected layer. When a user right-clicks on a map layer in the Map Layers tab, from the shortcut menu (Figure 3-2), click Edit, and the tools in the Editor Toolbar become active. Only one map layer can be edited at one time. For lines and polygons, there are two editing modes: feature edit and vertex edit. Clicking on a selected feature puts the user into the feature edit mode (move, delete, reverse), double-clicking on a selected feature puts the user in the vertex edit mode (add, delete, edit vertex points).

There are some tools available during an edit session which are not available from the shortcut menu (Figure 3-2) or the Editor Toolbar. Clicking Delete will delete all currently selected features or currently selected vertices depending on which mode the user is in. Clicking the R key will reverse the direction of a currently selected line feature. Also, right-clicking during an edit session allows the user to do multiple tasks depending on what is clicked. Detailed information on all of the functionality of the editing tools is available in Appendix A.

Add new features Tool (A)
The Add new features tool allows the user to add a new feature to the editable map layer by left-clicking to add feature data. Selected features can be deleted by either clicking the Delete key, or right-click on the selected feature(s) and from the shortcut menu click Delete Selected Features.

Insert vertex Tool (I)
The Insert vertex tool allows the user to add a vertex to an existing line or polygon map layer. The Insert vertex tool becomes available when the selected feature is in the vertex edit mode. As the cursor gets close to the line or polygon edge the Map Window will display what the updated feature will look like if a vertex is added at the cursor. Left-click to insert the new vertex.

Break line feature into two line features at a defined location Tool (K)
The Break line feature tool will split a line feature into two features at the point the user clicked on the line. The user needs to be in the feature edit mode for this tool to be enabled.

Continue from end Tool (lines only)
The Continue from end (lines only) tool will continue a line feature from the end point of the line feature to the point to a second point clicked in the Map Window. Double-
click to finish the line continuation edits or right-click and choose **Finish Editing Vertices**, or choose a different tool to finish the line continuation. The user needs to be in the vertex edit mode for this tool to be enabled.

**Add new line or polygon to existing feature Tool**
The **Add new line or polygon to existing feature** tool will allow the user to add a polygon or line to an existing selected polygon or line feature. For example, to add a hole to a polygon, click to add points defining the hole and double-click to finish. The user needs to be in the vertex edit mode for this tool to be enabled.

**Feature Snapping Settings Tool**
The **Feature Snapping Settings** tool allows the user to define snapping rules when editing. Snapping will automatically move the desired action to the nearest snap point when the cursor is close. This can be very useful when trying to line up endpoints of line features or place points directly on top of other features. Enable snapping by clicking **Enable Snapping**. From the **Snap to Feature** list, select the desired feature to snap to, then select how snapping will be applied (all points, end points, or edges).

**Undo Tool (Ctrl + Z)**
The **Undo** tool allows the user to undo changes made during an edit session. Only enabled if there are edits that can be undone.

**Redo Tool (Ctrl + Y)**
The **Redo** tool allows the user to redo changes made. Only enabled if there are edits to redo.

**Save Edits Tool (Ctrl + S)**
The **Save Edits** tool will save all edits made during the editing session. Only enabled if edits have been made.

**Stop Editing Tool**
The **Stop Editing** tool will stop the edit session. At this point a new map layer can be selected for editing. If edits have been made then the user will be prompted to save them before stopping the edit session.

### 3.5 Help

**Help** is available from several HEC-LifeSim dialog boxes. By clicking ☰️, help information about the individual dialog box will be revealed. Detailed information on how to utilize and
complete the specific dialog is usually provided will appear in a window. The help window can be closed by clicking the close window button, or the help window will automatically close when the dialog box that was open closes.
CHAPTER 4

Hydraulic Data

Hydraulic data is a critical component to computing life loss in HEC-LifeSim. Hydraulic data sources in HEC-LifeSim generally come from a two-dimensional hydraulic model, such as HEC-RAS (Hydrologic Engineering Center's (HEC) River Analysis System software), FLO-2D (FLO-2D Software, Inc., Nutrioso, AZ), or MIKE 21 (Danish Hydraulic Institute, Denmark (DHI), see Appendix C). However, at a minimum a time series of depth and velocity is required. HEC-LifeSim will interpolate the depths and velocities between hydraulic time steps. A shorter hydraulic time step will generally provide more hydraulically accurate computations.

In addition to providing the time series of depth and velocity, a hydrograph representing the hydraulic event must be provided as well. The hydrograph is critical in developing the warning issuance timing relative to a specific condition (e.g., dam or levee breach). This chapter covers the various ways to import, edit, and view hydraulic data.

4.1 Import from HEC-RAS

HEC-LifeSim has the ability to import hydraulic results directly from an HEC-RAS study as long as the HEC-RAS results were produced with HEC-RAS Version 5.0 or later. The ability to link directly with the hydraulic results, and convert the hydraulic information, is an efficient step in creating hydraulic data for an HEC-LifeSim study. HEC-LifeSim uses the HEC-RAS tool RAS Mapper to sample hydraulic information and then create a layer that can be viewed in the Map Window (Figure 4-1).
Creating hydraulic data from an HEC-RAS study:

1. From the HEC-LifeSim main window (Figure 4-1), from the Study tab, from the Study Tree, right-click on Hydraulic Data, from the shortcut menu click Import From HEC-RAS (Figure 4-2). Another way is from the HEC-LifeSim main window, from the Study menu, point to Hydraulic Data, click Import From HEC-RAS.

![Figure 4-2. Hydraulic Data Shortcut Menu](image)

2. Either way, the Import From HEC-RAS (5.0 and later) dialog box (Figure 4-3) will open.

![Figure 4-3. Import From HEC-RAS (5.0 and later) Dialog Box](image)
3. To select the HEC-RAS output file, from the **HEC-RAS Output File (.pxx.hdf)** box click **open**, an **Open** browser (Figure 4-4) will open. Navigate to the location of an HEC-RAS plan output file; select the correct HEC-RAS plan output file, which should have the file extension *.*.pxx.hdf* (e.g., *.p01.hdf, or *.p47.hdf). Click **Open**, the **Open** browser will close (Figure 4-4) and the user will be returned to the **Import From HEC-RAS (5.0 and later)** dialog box (Figure 4-5).

![Figure 4-4. Open Browser](image)

![Figure 4-5. Import From HEC-RAS (5.0 and later) Dialog Box – Hydraulic Dataset Information](image)

The **HEC-RAS Output File** box (Figure 4-5) will now contain the location and the name of the HEC-RAS plan output file. By default, the name of the HEC-RAS plan output file is used as the name of the hydraulic dataset. The name appears in the **Name** box (Figure 4-5), the user can change this name. Also, if there is an associated terrain file in the same location, then the **HEC-RAS Terrain File (*.hdf)** box will be automatically populated.

4. If the HEC-RAS terrain file is not located in the same place as the HEC-RAS plan output file, to the right of the **HEC-RAS Terrain File (*.hdf)** box click **open**. An **Open** browser (Figure 4-4) will open, navigate to the directory where the terrain file is located. Select the correct terrain file (e.g., *.*.hdf), click **Open**, the **Open** browser will close (Figure 4-4) and the user will be returned to the **Import From HEC-RAS (5.0 and later)** dialog box (Figure 4-5).
5. Next, the user can import the representative hydrograph (time series), Section 4.1.1 provides further details on how to create the representative hydrograph.

6. The Imminent Hazard and the First Hydraulic Timestep information needs to be defined, Section 4.1.1 provides further details.

7. Once all the data required to build a hydraulic dataset from HEC-RAS has been completed, from the Import From HEC-RAS (5.0 and later) dialog box (Figure 4-5), click OK.

8. The Import From HEC-RAS (5.0 and later) dialog box (Figure 4-5) will close, and in the Study Tree, under the Hydraulic Data node, is the name of the hydraulic dataset based on the HEC-RAS plan name.

### 4.1.1 Representative Hydrograph (From HEC-RAS)

The representative hydrograph can be created by importing the hydrograph from HEC-RAS data or import from a map (created from the HEC-RAS hydraulic data that has been imported).

**Create from RAS Data**

From the Import From RAS dialog box (Figure 4-5), click Import from RAS. The RAS Results Selector (Figure 4-6) will open. The representative hydrograph can be created from a cross section location or a storage area location.

![RAS Results Selector Dialog Box](image-url)
To create the representative hydrograph from an HEC-RAS cross section location:

1. From the **RAS Results Selector** (Figure 4-6), expand **Cross Sections** (Figure 4-7). From the expanded list, select the HEC-RAS cross section that contains the representative hydrograph.

![RAS Results Selector Dialog – Hydrograph from a Cross Section](image)

2. In the **RAS Unsteady Results Plot** area (Figure 4-7) of the **RAS Results Selector**, the hydrograph for the selected cross section will display (Figure 4-8). In the section to the right on the **RAS Results Selector**, the data for the representative hydrograph is displayed (Figure 4-7).

To create the representative hydrograph from an HEC-RAS storage area location:

1. From the **RAS Results Selector** (Figure 4-6), expand **Storage Areas** (Figure 4-8). From the expanded list, select the HEC-RAS storage area that contains the representative hydrograph.

2. In the **RAS Unsteady Results Plot** area (Figure 4-5) of the **RAS Results Selector**, the hydrograph for the selected storage will display (Figure 4-7). In the section to the right on the **RAS Results Selector**, the data for the representative hydrograph is displayed (Figure 4-7).

Once the desired representative hydrograph is displayed, click **OK**, the **RAS Results Selector** will close (Figure 4-8) and the selected representative hydrograph will be used for the hydraulic import.
From the **Import From HEC-RAS (5.0 and later)** dialog box (Figure 4-9) the user can view the **First Hydraulic Timestep** and view and adjust the **Imminent Hazard** start time (Section 4.1.2).
For HEC-RAS imported hydrographs the **First Hydraulic Timestep** cannot be modified (note the date and time box is gray and inaccessible as well as the slider triangle). Instead, when the representative hydrograph is set using the **Import From RAS** option the first hydraulic timestep is defined by the model output. All other hydraulic data import options allow the **First Hydraulic Timestep** and the **Imminent Hazard** start time to be adjusted by the user.

**RAS Results Selector Tools**

There are two sets of tools in the **RAS Results Selector** dialog. The first set of tools is located in the **RAS Results Plot** (Figure 4-10), and the second set of tools is located in the **RAS Results Table** (Figure 4-11). These tools are as follows:

![RAS Unsteady Results Plot](image)

*Figure 4-10. RAS Results Plot Tools*

![RAS Results Table](image)

*Figure 4-11. RAS Results Table Tools*
**RAS Results Plot Tools**

**Select Values Tool**
Using the **Select Values** tool, click and hold inside the **RAS Unsteady Results Plot** (Figure 4-10), a yellow callout box will display that provides the **Time of Day** and corresponding **Value** for the specified location along the hydrograph (Figure 4-10). Click and drag to get information in a yellow callout box anywhere along the hydrograph.

**Zoom In Tool**
The **Zoom In** tool (Figure 4-10) allows the user to select an area to zoom in on. Click and drag a box to zoom in on a specific area of the plot. At any time the user can also zoom in or out using the mouse wheel (if the mouse has a mouse wheel), by rotating the wheel up to zoom in or down to zoom out.

**Pan Tool**
The **Pan** tool (Figure 4-10) allows the user to pan the **RAS Unsteady Results Plot**. Click the **Pan** tool, in the plot area, click and hold while moving the mouse to pan. Panning in the plot can also be achieved, at any time, by pressing down on the scroll wheel (middle mouse button) of the mouse (if the mouse has a scroll wheel).

**Zoom To Full Tool**
The **Zoom To Full** tool (Figure 4-10) is a quick way to re-center the **RAS Unsteady Results Plot** by zooming out to the full extent of the hydrograph plot.

**RAS Results Table Tools**

**Select By Attribute Tool**
The **Select By Attribute** tool (Figure 4-11) opens the **Select By Attribute** dialog box (Figure 4-12), which allows the user to perform queries, make selections, and locate features in the RAS results data table. Refer to Section 5.1 for further help with using this option.

**Show All Records Tool**
The **Show All Records** tool (Figure 4-11) allows the user to display all records (selected or unselected) in the **RAS Results Table**. Refer to Section 5.1 for further help with using this option.

**Show Selected Records Only Tool**
The **Show Selected Records Only** tool (Figure 4-11) allows the user to only display features in the **RAS Results Table** which were selected in the **Select By Attribute** dialog box (Figure 4-12). Refer to Section 5.1 for further help with using this option.
Deselect All Records

The Deselect All Records tool (Figure 4-11) will unselect all records which were selected in the Select By Attribute dialog box (Figure 4-12). All records will be viewable and none with be highlighted in the RAS Results Table. Refer to Section 5.1 for further help with using this option.

Create from RAS Data in a Map View

Another way to import the representative hydrograph from HEC-RAS data, is from a "map" view of the data. Import From Map opens the RAS Map Data Selector (Figure 4-13).
The **RAS Map Data Selector** allows the user to specify a time series of depth at any point in the HEC-RAS study area. This method is generally used when no detailed information is given regarding imminent hazard timing relative to an HEC-RAS geometric feature. Using the **Select Hydrograph** tool, the user can select a cross section or storage area on the map and the data for the hydrograph from that selection area will appear (Figure 4-13). The map tools for the **RAS Map Data Selector** are described in the following list:

- **Pan Tool (P)**
  The Pan tool allows the user to pan the **RAS Map Window** (Figure 4-13). To pan, select the Pan tool, click and hold while moving the mouse to pan. Another way to pan, is press down on the scroll wheel (middle mouse button) of the mouse (if the mouse has a scroll wheel). The letter (P) refers to the hot key which can be used to select the Pan tool immediately in the **RAS Map Window**.

- **Zoom In Tool (Z)**
  The Zoom In tool allows the user to select an area to zoom in, by clicking and dragging a box to zoom in to a specific area of the **RAS Map Window** on the **RAS Map Data Selector** (Figure 4-13). The user can also zoom in or out by using the mouse wheel (if the mouse has a mouse wheel). The letter (Z) refers to the hot key which can be used to select the Zoom In tool immediately in the **RAS Map Window**.

- **Fixed Zoom Out Tool (O)**
  The Fixed Zoom Out tool zoom outs a fixed distance in the **RAS Map Window** (Figure 4-13). Click the Fixed Zoom Out tool once, the **RAS Map Window** on the **RAS Map Data Selector** (Figure 4-13) will zoom out a fixed distance. Double-click on the tool icon and the **RAS Map Window** will zoom out twice the fixed distance. The letter (O) refers to the hot key which can be used to select the Fixed Zoom Out Tool immediately in the **RAS Map Window**.

- **Zoom to full extents Tool**
  The Zoom to full extents tool is a quick way to re-center the **RAS Map Window** (Figure 4-13) by zooming out to the full extent of the HEC-RAS study area.

- **Select Hydrograph Tool**
  The Select Hydrograph tool is the default selection upon opening the **RAS Map Data Selector** dialog box (Figure 4-13). This tool is what allows the user to specify a time series of depth at any point in the HEC-RAS study area. From the **RAS Map Window**, the user will click on a location in the study area, a **Progress Window** will open. The **Progress Window** will show the collection of depth time series data for that selected point.

From the **Animation Bar** at the bottom of the **RAS Map Data Selector** (Figure 4-14), the user can view (animated) the HEC-RAS depth simulation for the specified plan. The controls for the animation bar function the same as the controls to a video player. Use the slider bars to modify
the speed (faster or slower) and position of the animation playback. To modify the animation settings, click 
, the Animation Settings dialog box (Figure 4-15) will open.

The user can export a copy of the animation, click 
, the Export Animation Wizard (Figure 4-16) will open.

Once the desired representative hydrograph is displayed, click OK, the RAS Map Data Selector will close (Figure 4-13) and the selected representative hydrograph will be used for the hydraulic import. From the Import From HEC-RAS (5.0 and later) dialog box (Figure 4-9) the user can adjust the First Hydraulic Timestep and/or the Imminent Hazard start time (Section 4.1.2).

4.1.2 First Hydraulic Timestep and Imminent Hazard

The First Hydraulic Timestep and time of Imminent Hazard (e.g., dam breach) are important for HEC-LifeSim to correctly calculate hydraulic timing in relation to warning and evacuation information during the simulation (Figure 4-17).
Figure 4-17. Import From HEC-RAS (5.0 and later) Dialog Box – First Hydraulic Timestep and Imminent Hazard

Once a hydrograph has been selected, define the first hydraulic timestep (for the Import From HEC-FLO2D and Import From Grids hydraulic data import options, but not for the Import From HEC-RAS import option) and imminent hazard by:

1. Once a hydrograph has been defined, the **Imminent Hazard** date and time should be set in the **Imminent Hazard** box (Figure 4-17). The imminent hazard time defines the time that the hazard (e.g., dam breach) becomes unavoidable. The user can adjust the imminent hazard date and time by using the red slider triangle (Figure 4-17). Moving the red slider will adjust the imminent hazard red dotted line on the time series data graph, which will modify the date and time in the **Imminent Hazard** box (Figure 4-17). The user can also adjust the date and time from **Imminent Hazard** box by clicking which opens a calendar and time adjustment window (Figure 4-18).

Figure 4-18. Calendar and Time Adjustment Window
2. The **First Hydraulic Timestep** can also be set or modified (when imported from FLO-2D or Grids) the same way as the **Imminent Hazard**, except by using the green slider triangle (Figure 4-17). When importing hydraulic data from HEC-RAS, the first hydraulic time step cannot be edited (as noted by the disabled date and time box and slider triangle) because it is defined by the model output.

3. Setting the **Imminent Hazard** and the **First Hydraulic Timestep** (when applicable) are the final steps for importing HEC-RAS hydraulic data. Once all of the appropriate information has been entered click **OK**, the Import From HEC-RAS (5.0 and later), dialog box will close (Figure 4-17). From the HEC-LifeSim main window, from the Study Tree, the Hydraulic Data node will now display the name of the created hydraulics dataset.

### 4.2 Import from FLO-2D

HEC-LifeSim has the ability to import hydraulic results directly from FLO-2D output files. The required FLO-2D output files are DEPTH.OUT and TIMDEP.OUT which can be generated automatically from a FLO-2D simulation. HEC-LifeSim will take the FLO-2D results files and convert them into a time series of depth and velocity compressed geotiff files. The geotiff files are stored in the hydraulics directory of the HEC-LifeSim study. The ability to link directly with the hydraulic results saves a huge step in converting hydraulic information to a software specific format.

To import hydraulic data, from FLO-2D, to an existing HEC-LifeSim study:

1. From the HEC-LifeSim main window (Figure 4-1), from the **Study** tab, from the Study Tree, right-click on Hydraulic Data, from the shortcut menu click Import From FLO2D. Another way is from the HEC-LifeSim main window, from the Study menu, point to Hydraulic Data, click Import From HEC-FLO2D.

2. From either way, the **Import From FLO2D** dialog box (Figure 4-19) will open.

3. In the Name box (Figure 4-19), enter a name for the hydraulic data.

4. In the DEPTH.OUT File box click ![open](image), an Open browser (Figure 4-4) will open. Navigate to the directory where the hydraulic data (DEPTH.OUT) for the FLO-2D model is located. Select the correct FLO-2D output file (e.g., *.OUT). Click Open, the Open browser will close (Figure 4-4), the Import From FLO2D dialog box (Figure 4-19) will now display the selected file location in the DEPTH.OUT File box.

5. If the FLO-2D depth file (DEPTH.OUT) is not located in the same directory as the time of depth file (TIMDEP.OUT), to right of the TIMDEP.OUT File box click ![open](image), an Open browser will open (Figure 4-4). Navigate to the directory where the hydraulic file (TIMDEP.OUT) is located, select the file (*,OUT). Click Open, the Open browser will close (Figure 4-4), the Import From FLO2D dialog box (Figure 4-19) will now display the selected file location in the TIMDEP.OUT File box.
6. The **Projection (Optional)** box is available for selecting the geographic projection for the FLO-2D hydraulic data to be imported using an ESRI®'s projection file format. The user may add the geographic projection by clicking ![Open](image) an **Open** browser will open (Figure 4-4). Navigate to the location of the projection file (*.prj), click **Open**, the **Open** browser will close (Figure 4-4). The **Import From FLO2D** dialog box (Figure 4-19) will now display the selected projection file in the **Projection (Optional)** box.

7. Set the vertical units for the hydraulic data (either **Feet** or **Meters**) from the **Vertical Units** list (Figure 4-19).

8. Next, the user can import the representative hydrograph (time series), refer to Section 4.1.1 for details on how to import or add the representative hydrograph.

9. The **Imminent Hazard** and the **First Hydraulic Timestep** information needs to be defined next, refer to Section 4.1.1 for further details.

10. Once all of the data has been entered the dialog will look similar to Figure 4-20.

11. Click **OK**, the **Import From FLO2D** dialog box (Figure 4-20) will close. The HEC-LifeSim main window **Study** tab will now list the name of the **Hydraulic Data** imported.
The Status Bar on the HEC-LifeSim main window, will display the progress of converting the FLO2D output into a time series of depth and velocity grids. The user can continue working and it will not affect the FLO2D import process.

### 4.2.1 Representative Hydrograph (From DSS)

The representative hydrograph can be created from HEC-RAS data (created from the HEC-RAS hydraulic data that has been imported) or created from a DSS (HEC’s Data Storage System) file. Section 4.1.1 details creating the representative hydrograph from HEC-RAS data in the Create from RAS Data section. The following section will detail how to import a representative hydrograph from DSS data.

**Create from DSS Data**

A FLO-2D model typically gets its hydrograph data from a DSS file that contains output from other sources such as HEC-RAS, HEC-ResSim, or HEC-HMS. The DSS file can be used to generate the representative hydrograph.

1. From the Import From FLO2D dialog box (Figure 4-20), click Import From DSS, the DSS Selector (Figure 4-21) will open. The DSS Selector allows the user to select time
series hydrograph data from DSS records. DSS is a database system that was designed by HEC to efficiently store and retrieve scientific data that is typically sequential (Appendix C).

2. To select a DSS file, to the right of the DSS File box, click , and an Open browser will open (Figure 4-4). Navigate to the directory where the DSS file is located; select the appropriate DSS file (*dss). Click Open, the Open browser will close (Figure 4-4) and the user will be returned to the DSS Selector (Figure 4-21).

3. The DSS Selector will display all of the available records contained in the selected DSS file (Figure 4-22).

4. If several records (pathnames) are available, for easier display of DSS records, the DSS records can be filtered by the specific parts of a record's pathname. From the Search By Parts box (Figure 4-22), there is a list for each part (e.g., A, B ,C, etc.) where the user can choose how to filter the records. This filtering changes the content displayed in the Results Table (Figure 4-22). This table is similar to the RAS Results Table discussed in Section 4.1.1.

5. When the desired hydrograph data has been selected click OK, the DSS Selector will close (Figure 4-22), and the Import From FLO2D dialog box (Figure 4-20) will now contain the DSS selected time series graph and tabulated data.
The tools for the plot and table areas on the **Import From FLO2D** dialog box (Figure 4-20) are the same tools described in Section 4.1.1 for the **Import From HEC-RAS (5.0 and later)** dialog box (Figure 4-9).

### 4.2.2 First Hydraulic Timestep and Imminent Hazard

Refer to Section 4.1.2 for information on defining the first hydraulic timestep and imminent hazard. Section 4.1.2 provides information on setting up the **First Hydraulic Timestep** and time of **Imminent Hazard** (e.g., dam breach) data which is very important for HEC-LifeSim to correctly calculate hydraulic timing in relation to warning and evacuation information during the simulation.

### 4.3 Import from Grid Set

HEC-LifeSim has the ability to import hydraulic results (e.g., MIKE.21, DHI) directly from a time series of gridded files (grid set). Most hydraulic simulations store depth and velocity grids as time series, which is an easy and convenient way to transfer hydraulic simulation data among various groups that may not have the hydraulic modeling software. HEC-LifeSim can import depth and velocity grids in several formats: *.flt, *.tif, and binary ESRI® grids. When importing a grid set, HEC-LifeSim converts the gridded data into geotiff files which are stored in the hydraulics study directory.
To import hydraulic data, in a gridded format, to an existing HEC-LifeSim study:

1. From the HEC-LifeSim main window (Figure 4-1), from the Study tab, from the Study Tree, right-click on Hydraulic Data, from the shortcut menu click Import From Grids. Another way is from the HEC-LifeSim main window, from the Study menu, point to Hydraulic Data, click Import From HEC-Grids.

2. Either way, the Import From Grid Set dialog box (Figure 4-23) will open.

![Image](image.png)

Figure 4-23. Import From Grid Set Dialog Box

3. In the Name box (Figure 4-23), enter a name for the hydraulic gridded data.

4. To the right of the Grid Set Files Directory box click ![Open Directory](image.png), an Open Directory Containing grids browser will open (Figure 4-24). Navigate to the folder where the hydraulic grid data is located, select the correct folder, click Select Folder. The Open Directory Containing grids browser will close (Figure 4-24), the Import From Grid Set dialog box (Figure 4-23) will now display the selected folder in the Grid Set Files Directory box.

5. Next, if the depth grids are in a specific naming convention and numerical order, click Grids are in numeric order with first depth grid = dp1 or dp001 and velocity = vp1 or vp001. Only select this option, if the Grid Set Timestep (minutes) is the same between each grid and the grids follow the specified naming convention of "depth grids being dp# and velocity grids being vp#" where # is 1 or 001 for the first grid and incrementing by one for each subsequent timestep.
6. If the gridded files do not satisfy the regular interval naming format, do not select **Grids** are in numeric order with the first depth grid = dp1 or dp001 and velocity = vp1 or vp001 and the **Grid Set Timestep (minutes)** box will remain disabled (grayed out). The user then must enter the **Depth**, **Velocity** and **Time (hours)** in the table. The **Add Row** and **Remove Row** buttons can be used to add a row or remove a row in the **Depth**, **Velocity**, and **Time (hours)** table. Rows will always be either added or removed from the bottom of the table.

7. Set the vertical units for the hydraulic data (either **Feet** or **Meters**) from the **Vertical Units** list (Figure 4-23).

8. Next, the representative hydrograph will either be created from a DSS file, **Import From DSS** (Section 4.1.2) or HEC-RAS hydraulic data, **Import From RAS** (refer to Section 4.1.1).

9. The **Imminent Hazard** and the **First Hydraulic Timestep** information needs to be defined next, refer to Section 4.1.1 for further details.

10. Once all of the data has been entered the **Import From Grid Set** dialog box will look similar to Figure 4-25.

11. Click **OK**, the **Import From Grid Set** dialog box (Figure 4-25) will close. The HEC-LifeSim main window **Study** tab will now have the name of the **Hydraulic Data** listed.

### 4.4 Editing, Viewing, and Removing Hydraulic Datasets

Once hydraulic data has been added to the HEC-LifeSim study, a hydraulic dataset can be edited, deleted, viewed, or moved.
4.4.1 Edit a Hydraulic Dataset

To edit a hydraulic dataset:

1. From the HEC-LifeSim main window (Figure 4-1), from the Study tab, from the Hydraulic Data folder, right-click on a hydraulic dataset. From the shortcut menu (Figure 4-26), click Edit Hydrograph Data and Timing. Another way is from the HEC-LifeSim main window (Figure 4-1), from the Study menu, point to Hydraulic Data, point to Edit, and select the appropriate hydraulic dataset.
2. Either way, the Select Hydrograph and Timing Information For "hydraulic dataset" dialog box will open (Figure 4-27).

![Select Hydrograph and Timing Information For "hydraulic dataset" Dialog Box](image)

3. From the Select Hydrograph and Timing Information For "hydraulic dataset" dialog box (Figure 4-27) users can replace existing representative hydrographs. Depending on the hydraulic data source, the user can click Import From RAS (Section 4.1.1), Import From Map (Section 4.1.1), or Import From DSS (Section 4.1.1).

4. The Time Series Data table, First Hydraulic Timestep (when enabled), and Imminent Hazard can be modified (Section 4.1.1).

5. Once editing of the hydraulic data is complete click, OK, and the Select Hydrograph and Timing Information For "hydraulic dataset" dialog box will close (Figure 4-27).

### 4.4.2 Delete a Hydraulic Dataset

To delete a hydraulic dataset:

1. From the HEC-LifeSim main window (Figure 4-1), from the Study tab, from the Hydraulic Data folder, right-click on a hydraulic dataset. From the shortcut menu (Figure 4-26), click Delete. Another way is from the HEC-LifeSim main window (Figure 4-1), from the Study menu, point to Hydraulic Data, point to Delete, and select the appropriate hydraulic dataset.

2. The selected dataset will be removed from the study and the study directory.
4.4.3 View a Hydraulic Dataset

Depending on which method was chosen to import hydraulic datasets for an HEC-LifeSim study, the user can view hydraulic datasets.

Import from HEC-RAS

If the hydraulic dataset was imported from HEC-RAS, the hydraulic cross sections, storage areas, and two-dimensional flow areas can be displayed in the Map Window of the HEC-LifeSim main window (Figure 4-1). From the Study Tree, from the Hydraulic Data folder, right-click on a hydraulic dataset. From the shortcut menu (Figure 4-26) click either Display Cross Sections, Display Storage Areas, or Display 2D Flow Areas. As the user selects the feature desired, the feature will be displayed in the Map Window of the HEC-LifeSim main window (Figure 4-1).

Import from FLO-2D or a Grid Set

If the hydraulic dataset was imported from FLO-2D or gridsets, the hydraulic data can be displayed in the Map Window (acceptable data formats are: *.shp, *.flt, *.tif, or *.vrt):

1. From the HEC-LifeSim main window (Figure 4-1), from the Mapping menu, click Add Map Layer. The Browse for files browser will open (Figure 4-28).

   ![Figure 4-28. Browse for files Browser](image)

2. Navigate to where the desired hydraulic data file is located, and click Open. The Browse for files browser will close (Figure 4-28) and the selected hydraulic data file will be added to the Map Window. More information on adding map layers to the Map Window can be found in Appendix A.
4.4.4 Move a Hydraulic Dataset

To move specific hydraulic datasets up or down in the Study Tree:

1. From the Study Tree of the HEC-LifeSim main window (Figure 4-1), from the Hydraulic Data folder, right-click on a hydraulic dataset of interest. From the shortcut menu (Figure 4-26), click Move Up, the selected dataset will move up one layer in the Study Tree.

2. To move the selected dataset down, from the shortcut menu (Figure 4-25), click Move Down.

3. Datasets can also be moved in the Study tab by utilizing the drag and drop method. From the Study Tree on the HEC-LifeSim main window (Figure 4-1), click and hold on the dataset of interest. The user can move the dataset up or down the list by moving the mouse. A bar will show the new location where selected dataset will be moved.
CHAPTER 5

Structure Inventories

The next step after adding hydraulic data to the study is to add structure inventories. A structure inventory represents geospatial points that contain damageable elements (typically a structure such as a home). Structure inventories are required and allow HEC-LifeSim to estimate direct economic damage for a flood event. To estimate life loss for an event, a structure inventory must be supplied with population data. HEC-LifeSim can accept structure inventories in the form of point shapefiles, HAZUS databases, and the National Structure Inventory database (NSI). This chapter describe the ways structure inventories in different formats can be added to an HEC-LifeSim study.

5.1 Import from Shapefile

The point shapefile that represents a structure inventory for an area, will contain information on structure occupancy types (Appendix C), population, structure values, foundation height, construction type, and other information.

To create a structure inventory from a point shapefile:

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, right-click on Structure Inventories, from the shortcut menu click Import Structures From Shapefile (Figure 5-2). Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, click Import Structures From Shapefile.

Figure 5-1. HEC-LifeSim Main Window
2. Either way, the **Import From Point Shapefile** dialog box (Figure 5-3) will open.

3. In the **Name** box (Figure 5-3), enter a name for the structure inventory.

4. To select the shapefile that contains information about the structure inventory, to the right of the **Structure Inventory Shapefile** box (Figure 5-3), click ▼. An **Open** browser
(Figure 5-4) will open, navigate to the directory where the point shapefile is located. Select the correct point shapefile (e.g., *.shp), click Open, the Open browser will close (Figure 5-4) and the user will be returned to the Import From Point Shapefile dialog box (Figure 5-3).

Figure 5-4. Open Browser

5. The Structure Inventory Shapefile box (Figure 5-3) will now contain the name and location of the selected point shapefile.

6. A structure inventory has required attributes that will be used in an HEC-LifeSim study, so the user must provide information about those attributes in the selected point shapefile. From the Import Attributes column (Figure 5-3), for each listed Required Attribute, the user must select from a list the field name of the attribute in the selected point shapefile.

7. For example, in Figure 5-5, for Damage Category (required attribute), from the Import Attributes list for Damage Category, possible field names are presented for the user. The user will select a field name – DamCat.

Figure 5-5. Define Structure Attribute Information – Damage Category
8. Another example, in Figure 5-6, for **2AM Population Under 65** (required attribute), from the **Import Attributes** list for **2AM Population Under 65**, possible field names are presented for the user. The user will select a field name – **Pop2amU65**.

![Figure 5-6. Example – Define Structure Attribute Information – 2AM Population Under 65 and Other Value](image)

9. If the point shapefile does not contain a required attribute, the user should click the **Missing** checkbox (Figure 5-6) for that required attribute (e.g., **Other Value**). In the **Default Value** column (Figure 5-6) for that required attribute, the box become active and the user must enter a value for the required attribute (e.g., **10000**).

10. Once all of the structure attribute information has been completed, from the **Import From Point Shapefile** dialog box, click **Next** (Figure 5-3).

### 5.1.1 Default Damage Category Assignments

Next the user must confirm the damage category names associated with the seven default damage category IDs (Appendix C). Damage categories are the first aggregation level for structures.
1. From the point shapefile, HEC-LifeSim tries to match up the damage category names to the default damage category ID (Figure 5-7). For example, in Figure 5-7, for damage category ID *IND*, HEC-LifeSim selected *Industrial*. If the selection is not correct, from the list the user can change the assignment.

![Default Damage Category Assignments](image)

Figure 5-7. Default Damage Category Assignments

2. Once the user has reviewed the default damage category assignments, from the **Import From Point Shapefile** dialog box, click **Next** (Figure 5-7).

### 5.1.2 Default Occupancy Type Assignments

Next the user must confirm the occupancy type names associated with the default occupancy type IDs (Appendix C). Occupancy types are another level of aggregation for structures. Occupancy types are imperative for the consequence calculations. Refer to Section 5.4.1 for more information on occupancy types.

1. From the point shapefile, HEC-LifeSim tries to match up the occupancy type names to the default occupancy type IDs (Figure 5-8). For example, in Figure 5-8, for occupancy type ID *COM5*, HEC-LifeSim selected *COM5*. If the selection is not correct, from the list the user can change the assignment.

2. Once the user has reviewed the default occupancy type assignments, from the **Import From Point Shapefile** dialog box, click **Next** (Figure 5-8).
5.1.3 Default Construction Type Assignments

Next the user must confirm the construction type names associated with the default construction type IDs. Construction types are used to define stability criteria for a structure. A reinforced concrete structure will generally be more resilient to a flood than a wood structure.

1. From the point shapefile, HEC-LifeSim tries to match up the construction type names to the default construction type IDs (Figure 5-9). For example, in Figure 5-9, for
construction type ID *Wood*, HEC-LifeSim selected *Wood Attached Frame*. If the selection is not correct, from the list the user can change the assignment.

2. Once the user has reviewed the default construction assignments, from the **Import From Point Shapefile** dialog box, click **Finish** (Figure 5-9).

3. The **Import From Point Shapefile** dialog box will close (Figure 5-9). From the HEC-LifeSim main window (Figure 5-1), from the **Study** tab, from the **Study Tree**, under the **Structure Inventories** folder, the name of the imported **Structure Inventory** data set is listed.

### 5.2 Import from HAZard United States (HAZUS) Database

The HAZard United States (HAZUS) database contains information on structure counts, occupancy types, population, structure values, foundation height, build type, and other information. The database was developed to support FEMA’s HAZUS-MH software which is a multi-hazard estimation tool. The data in the database can be used to generate structure inventories for use in HEC-LifeSim.

To create a structure inventory from a HAZUS database:

1. From the HEC-LifeSim main window (Figure 5-1), from the **Study** tab, from the **Study Tree**, right-click on **Structure Inventories**, from the shortcut menu click **Import Structures From HAZUS** (Figure 5-2). Another way is from the HEC-LifeSim main window, from the **Study** menu, point to **Structure Inventories**, click **Import Structures From HAZUS**.

2. Either way, the **Import From HAZUS** dialog box (Figure 5-10) will open.

![Figure 5-10. Import From HAZUS Dialog Box](image)

3. In the **Name** box (Figure 5-10), enter a name for the structure inventory.

4. To select the bounding polygon shapefile that defines the boundaries of the structure inventory, to the right of the **Bounding Polygon Shapefile** box (Figure 5-10), click **...**. An **Open** browser will open (Figure 5-4), navigate to the directory where the bounding polygon shapefile is located. The bounding polygon shapefile must have a projection in order to properly access the HAZUS database. Select the correct bounding polygon.
shapefile (e.g., *.shp), click **Open**, the **Open** browser will close (Figure 5-4), and the user will be returned to the **Import From HAZUS** dialog box (Figure 5-10).

HAZUS creates several different files that the user needs to define before a structure inventory can be built from HAZUS.

5. HAZUS population data is gathered and stored in `bndrygbs.mdb` (required). From the **Import From HAZUS** dialog box (Figure 5-10), to the right of the HAZUS Population (`bndrygbs.mdb`) box click \[\text{Open}\], an **Open** browser will open (Figure 5-4), navigate to the directory where the HAZUS population data (`bndrygbs.mdb`) is located. Select the correct HAZUS population data (`bndrygbs.mdb`) file, click **Open**, the **Open** browser will close (Figure 5-4), and the user will be returned to the **Import From HAZUS** dialog box (Figure 5-10).

6. HAZUS vehicle data is gathered and stored in `flVeh.mdb` (required). From the **Import From HAZUS** dialog box (Figure 5-10), to the right of the HAZUS Vehicles (`flVeh.mdb`) box click \[\text{Open}\], an **Open** browser will open (Figure 5-4), navigate to the directory where the HAZUS vehicle data (`flVeh.mdb`) is located. Select the correct HAZUS vehicle data (`flVeh.mdb`) file and click **Open**, the **Open** browser will close (Figure 5-4), and the user will be returned to the **Import From HAZUS** dialog box (Figure 5-10).

7. HAZUS construction data is gathered from the HAZUS database file `MSH.mdb` (required). From the **Import From HAZUS** dialog box (Figure 5-10), to the right of the HAZUS Construction (`MSH.mdb`) box click \[\text{Open}\], an **Open** browser will open (Figure 5-4), navigate to the directory where the HAZUS construction data (`MSH.mdb`) is located. Select the correct HAZUS construction data (`MSH.mdb`) file, click **Open** the **Open** browser will close (Figure 5-4), and the user will be returned to the **Import From HAZUS** dialog box (Figure 5-10).

8. In the **Foundation Height (ft)** box (Figure 5-10), enter a default height (in feet) of the structures foundation (required).

9. Once all of the required information has been entered the **Import From HAZUS** dialog box will look similar to Figure 5-11.

![Import From HAZUS Dialog Box - Completed](image)

Figure 5-11. **Import From HAZUS** Dialog Box - Completed
10. Click OK the **Import From HAZUS** dialog box (Figure 5-11) will close. From the HEC-LifeSim main window (Figure 5-1), from **Study** tab, from the **Study Tree**, under the **Structure Inventories** folder, the name of the imported **Structure Inventory** dataset is listed.

### 5.3 Import from National Structure Inventory (NSI)

The National Structure Inventory (NSI) for an area, will contain information on structure occupancy types, population, structure values, foundation height, build type, and other information. The NSI is currently only available to U.S. Army Corps of Engineer (USACE) users. The NSI is a database of structure locations and attributes, and was developed using information from the HAZUS database and other sources including the Longitudinal Employer-Household Dynamics database ([https://lehd.ces.census.gov/](https://lehd.ces.census.gov/)).

To create a structure inventory from the NSI:

1. From the HEC-LifeSim main window (Figure 5-1), from the **Study** tab, from the **Study Tree**, right-click on **Structure Inventories**, from the shortcut menu click **Import Structures From NSI** (Figure 5-2). Another way is from the HEC-LifeSim main window, from the **Study** menu, point to **Structure Inventories**, click **Import Structures From NSI**.

2. Either way, the **Import Structures From NSI** dialog box (Figure 5-12) will open.

![Figure 5-12. Import Structures From NSI Dialog Box](image)

3. In the **Structure Inventory Name** box (Figure 5-12), enter a name for the structure inventory.

4. To select the bounding polygon shapefile that defines the boundaries of the structure inventory, to the right of the **Bounding Polygon Shapefile** box (Figure 5-12), click ![Open](image). An **Open** browser will open (Figure 5-4), navigate to the directory where the bounding polygon shapefile is located. The bounding polygon shapefile must have a projection in order to properly access the NSI database. Select the correct bounding polygon shapefile (e.g., *.shp), click **Open**, the **Open** browser will close (Figure 5-4), and the user will be returned to the **Import Structures From NSI** dialog box (Figure 5-12).

5. In the **Default Foundation Height (ft)** box, enter a default height (in feet) for the structures foundation (required). The NSI does not contain foundation height information and must be supplied by the user for HEC-LifeSim (Figure 5-12).
6. Click **OK**, the **Import Structures From NSI** dialog box will close (Figure 5-12). The HEC-LifeSim **Status Bar** will display the progress for the NSI structures download.

7. Once the download is complete the **Status Bar** will display the message, "Structure Inventory successfully imported from NSI". From the HEC-LifeSim main window (Figure 5-1), from Study tab, from the **Study Tree**, under the **Structure Inventories** folder, the name of the imported **Structure Inventory** dataset is listed.

### 5.4 Edit a Structure Inventory

When a structure inventory is imported, default criteria for damage, stability, and submergence are assigned to structures based on attribute information. The criteria for structure damage, stability, and submergence can be edited, created, and assigned. The following sections describe how to edit the structure inventory criteria.

#### 5.4.1 Occupancy Type Editor

**Occupancy types** are a subcategory of the damage categories assigned to a study and 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); and the uncertainties in the first floor elevation, value ratios (content to structure, and other to structure), and the damage in the depth-damage functions.

The **Occupancy Type Editor** (Figure 5-13) allows the user to revise and create the warning and protective action response, depth-damage functions, value uncertainty, and foundation height uncertainty associated with structures that share common attributes. Also, from the editor, a user can assign damage criteria based on any combination of structure damage category, occupancy class, number of stories, basement information and construction type.

#### Occupancy Type Editor Buttons

The **Occupancy Type Editor** (Figure 5-13) has buttons that allow for creating, deleting, and copying of items that are available for a structure occupancy type. Also, there is a **Help** button available specific to the **Occupancy Type Editor**. The functions of the buttons is listed below:

- **Add New**
  
  **Add New** allows a user to create a new occupancy types. From the **Occupancy Type Editor** (Figure 5-13) click **Add New**, the **New Occupancy Type Name** dialog box will open (Figure 5-14). In the **Name** box, enter a name for the new occupancy type.
Click **OK**, the **New Occupancy Type Name** dialog box will close (Figure 5-14). Users will return to the **Occupancy Type Editor** (Figure 5-13), with the new occupancy type displayed.

**Delete**

**Delete** allows the user to delete selected occupancy types. From the **Occupancy Type Editor** (Figure 5-13) select an occupancy type from the **Name** list. Click **Delete**, a **Confirm Delete** window (Figure 5-15) will open asking for confirmation to delete the selected item. Click **Yes**, the **Confirm Delete** message window will close (Figure 5-15), and the selected occupancy type is deleted.
Copy

Copy allows the user to copy an existing occupancy type with a new name. From the Occupancy Type Editor (Figure 5-13) select an occupancy type from the Name list. Click Copy, the Save Occupancy Type As dialog will open (Figure 5-16). Enter a new name in the Name box. Click OK, the Save Occupancy Type As dialog box will close (Figure 5-16). Users will return to the Occupancy Type Editor (Figure 5-13) with the new occupancy type displayed.

Help

Help provides context sensitive help about the Occupancy Type Editor (Figure 5-13). Click Help, a help window (Figure 5-17) opens providing information about the Occupancy Type Editor.
Create an Occupancy Type

To create a new occupancy type:

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, right-click on Structure Inventories, from the shortcut menu click Edit Occupancy Types (Figure 5-2). Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, click Edit Occupancy Types.

2. Either way the Occupancy Type Editor (Figure 5-13) will open.

3. From the Occupancy Type Editor (Figure 5-13), from the Edit menu, click Add New, or click the Add New button. Either way the New Occupancy Type Name dialog box will open (Figure 5-14).

4. Enter a name (required) in the Name box, and a description (optional) about the occupancy type, click OK. The New Occupancy Type Name dialog box will close (Figure 5-14), and the Occupancy Type Editor (Figure 5-13) will open.

5. The user can set or modify the uncertainty around the foundation height (as a percentage). The user needs to define the uncertainty about foundation heights at the occupancy type level using the structure's foundation height attribute. The default is none, from the Variation in Foundation Height as % list (Figure 5-18), the user can chose Triangular, Normal (standard deviation), and Uniform (minimum, maximum). For example, in Figure 5-18, the user has selected Triangular and needs to enter Minimum and Maximum values.

6. The user can set warning and protective action behavior for the selected occupancy type. If the Population in structure warned at the same time box is selected (Figure 5-18) then the warning will reach all people in the structure at once instead of at different times. For example, in an apartment building residents could receive a warning at different times but for a single family residential structure the warning will reach all people in the structure at the same time. The user can also select Population in structure takes protective action at the same time (Figure 5-18), this is where all of the people within the structure will try to evacuate at the same time. For example, in a single family residential structure everyone will try to evacuate at the same time but in a commercial structure everyone might try to evacuate at different times.
7. From the **Depth-Damage Functions** box (Figure 5-19) of the **Occupancy Type Editor** (Figure 5-13), the user can enter depth-damage functions for structure, contents, vehicle, or other, and define uncertainty about the depth-damage function.

8. From the **Depth-Damage Functions** box (Figure 5-19) the user selects which depth-damage functions will be created for the selected occupancy type. As the user makes a selection, the tabs become available. For example, if the user selected **Structure** and **Vehicle**, then the **Structure** and **Vehicle** tabs become active.

### Figure 5-19. Depth-Damage Functions Box

9. **Structure Depth-Damage Function.** The user can set the **Variation in Structure Value as %** (Figure 5-19) by defining the uncertainty about the **Structure Value** associated with a structure based on the selected occupancy type. Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum). The user can also set the uncertainty associated with how much damage can occur from depths of water at the structure for the **Structure Depth-Damage Function** (Figure 5-19). Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum).

10. **Content Depth-Damage Function.** The user can set the **Variation in content Value as %** (Figure 5-19) by defining the uncertainty about the **Content Value** associated with a structure based on the selected occupancy type. Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum). The user can also set the uncertainty associated with how much damage can occur from depths of water at the structure for the **Content Depth-Damage Function** (Figure 5-19). Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum).
11. **Vehicle Depth-Damage Function.** The user can set the **Variation in Vehicle Value as %** (Figure 5-19) by defining the uncertainty about the **Vehicle Value** associated with a structure based on the selected occupancy type. Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum). The user can also set the uncertainty associated with how much damage can occur from depths of water at the structure for the **Vehicle Depth-Damage Function** (Figure 5-19). Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum).

12. **Other Depth-Damage Function.** The user can set the **Variation in Other Value as %** (Figure 5-19) by defining the uncertainty about the **Other Value** associated with a structure based on the selected occupancy type. Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum). The user can also set the uncertainty associated with how much damage can occur from depths of water at the structure for the **Other Depth-Damage Function** (Figure 5-19). Uncertainty types available are the **Triangular** (minimum, maximum), **Normal** (standard deviation), and **Uniform** (minimum, maximum).

13. From the **Depth-Damage Function Table** (Figure 5-20) right-click, from the shortcut menu (Figure 5-20), the user can enter the depth-damage function, copy/paste values into the table, and add/delete rows to the table.

14. Once information about the selected occupancy type is entered, from the **Occupancy Type Editor** (Figure 5-13), click **OK**. The **Occupancy Type Editor** will close and the information for the selected occupancy type is saved.

### Delete an Occupancy Type

To delete an existing occupancy type:

1. From the **Occupancy Type Editor** (Figure 5-13), select an occupancy type from the **Name** list.
2. From the Edit menu, click Delete, or click the Delete button. Either way, a Confirm Delete window (Figure 5-15) will open asking for confirmation to delete the selected item. Click Yes, the Confirm Delete message window will close (Figure 5-15), and the selected occupancy type is deleted.

### Rename an Occupancy Type

To rename an existing occupancy type:

1. From the Occupancy Type Editor (Figure 5-13), select an occupancy type from the Name list.

2. From the Edit menu, click Rename, the Rename Occupancy Type dialog box will open (Figure 5-21). Enter a new name in the Name box, click OK. The Rename Occupancy Type dialog box will close (Figure 5-21), and users will return to the Occupancy Type Editor (Figure 5-13) with the new name of the occupancy type displayed.

![Rename Occupancy Type Dialog Box](image)

### Copy an Occupancy Type

To copy an existing occupancy type:

1. From the Occupancy Type Editor (Figure 5-13), select an occupancy type from the Name list.

2. From the Edit menu, click Save As, or click the Copy button. Either way, the Save Occupancy Type As dialog will open (Figure 5-16). Enter a new name in the Name box. Click OK, the Save Occupancy Type As dialog box will close (Figure 5-16). Users will return to the Occupancy Type Editor (Figure 5-13) with the new occupancy type displayed.

### 5.4.2 Stability Criteria Editor

**Stability criteria** defines the depth and velocity threshold for total structure collapse due to a hazard. The threshold is defined by a depth – velocity curve. If at any time during a simulation the depth and velocity are at a point above the velocity curve then the structure is assumed to be collapsed which can have significant impacts on estimated life loss. The stability criteria is
generally based on the construction type. The user can add, edit, and assign stability criteria based on the structure attributes: construction type, number of stories, occupancy type. The Stability Criteria Editor (Figure 5-22) allows the user to define stability criteria for the structure inventory.

Figure 5-22. Stability Criteria Editor

### Stability Criteria Editor Buttons

The Stability Criteria Editor (Figure 5-22) has buttons that allow for creating, deleting, and copying of stability criteria. Also, there is a Help button available specific to the Stability Criteria Editor. The functions of the buttons are listed:

- **Add New**
  - Add New allows a user to create a stability criteria. Click Add New, the Building Stability Curve Editor will open (Figure 5-23). In Name box, enter a name for the new stability criteria and enter the function that represents the stability criteria. Click OK, the Building Stability Curve Editor will close (Figure 5-23). The Stability Criteria Editor (Figure 5-22) will display the new stability criteria.

- **Delete**
  - Delete allows the user to delete selected stability criteria. From the Stability Criteria Editor (Figure 5-22) select a stability criteria from the Name list. Click Delete, a Confirm Delete window (Figure 5-15) will open asking for confirmation to delete the selected item. Click Yes, the Confirm Delete message window will close (Figure 5-15), and the selected stability criteria is deleted.

- **Copy**
  - Copy allows the user to copy an existing stability criteria with a new name. From the Stability Criteria Editor (Figure 5-22) select a stability criteria from the Name list. Click Copy, the Building Stability Curve Editor will open (Figure 5-23). Enter a new name in
the Name box. Click OK, the Building Stability Curve Editor will close (Figure 5-23). The Stability Criteria Editor will display (Figure 5-22) the copied stability criteria.

Help
Help provides context sensitive help about the Stability Criteria Editor (Figure 5-22). Click Help, a help window (Figure 5-24) opens providing information about the Stability Criteria Editor.

Figure 5-23. Building Stability Curve Editor

Figure 5-24. Stability Criteria Editor - Help
Create Stability Criteria

To create a new stability criteria:

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, from the Structure Inventories folder, right-click on a structure inventory. From the shortcut menu (Figure 5-25) click Edit Stability Criteria. Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, point to Edit Stability Criteria, click on a structure inventory.

![Figure 5-25. Individual Structure Inventory – Shortcut Menu](image)

2. Either way, the Stability Criteria Editor will open (Figure 5-22).

3. From the Stability Criteria Editor (Figure 5-22), from the Edit Criteria menu, click Add New, or click the Add New button. Either way the Building Stability Curve Editor will open (Figure 5-23).

4. Enter a name (required) in the Name box for the new stability criteria.

5. Enter the structural stability criteria function in the table on the Building Stability Curve Editor (Figure 5-23). From the table right-click, from the shortcut menu (e.g., Figure 5-20), the user can enter the structural stability criteria function, copy/paste values into the table, and add/delete rows to the table.

6. Click OK, the Stability Criteria Editor (Figure 5-22) will display the new stability criteria.

Edit Stability Criteria

The user can add the information that will be discussed in this section when creating or editing a stability criteria.
1. The left side of the Stability Criteria Editor (Figure 5-22) provides a nested tree structure for assigning Structural Collapse Criteria to structures based on specific attributes (Construction Type, Number of Stories, Occupancy Type). An example, if the Construction Type is Wood, then the Number of Stories column will populate with all numbers of stories for structures that are wood construction. If the Number of Stories is 2, then the Occupancy Type column will populate with all the unique occupancy types that are of Wood construction and that are also 2 stories. If an item in one of the columns is bold then it indicates that it shares the same collapse criteria as the selected item to the left. If an item is not bold then it indicates that it shares the same collapse criteria as the selected item to the left. Figure 5-22 provides an example for visualizing and assigning the Criteria:

- For example, in Figure 5-22, the nested information is as follows: Construction Type is Wood; Number of Stories is 2; and, in the Occupancy Type the available occupancy types are: COM4, COM8, RES1-2SNB, RES1-2SWB, RES3A, RES3BI, RES3B, and RES3A.

- Specifically, in Figure 5-22, the information in the Stability Criteria Editor is telling the user that all Wood structures that are 2 stories tall, could be one of eight occupancy types (COM4, COM8, RES1-2SNB, RES1-2SWB, RES3AI, RES3BI, RES3B, and RES3A). Which means that all of those structures have the same structural stability criteria.

- To assign a different collapse criteria to Wood, 2 stories, RES3B structures, the user would select RES3B and choose a different stability criteria from the Criteria list on the Stability Criteria Editor (Figure 5-22). The occupancy type RES3B will now be bold, since it would no longer be the same as the Wood, 2 stories stability criteria.

- If the collapse criteria is changed for a tree item that has child elements (e.g., 2 stories has 8 occupancy types) then when a different item is selected or OK is clicked, a Propagate Changes To Children message window (Figure 5-26) will appear asking for authorization to make the changes to the parent and propagate to its child elements (e.g., all Occupancy Types listed for Number of Stories = "2"). Click Yes, the Propagate Changes To Children message window will close (Figure 5-26) and all child elements will be assigned with the new stability criteria.

![Propagate Changes To Children Message Window](image-url)
2. To edit the stability criteria function, from the Stability Criteria Editor (Figure 5-22), from the Edit Criteria menu, click Edit. The Building Stability Curve Editor will open (Figure 5-23), which will allow the user to edit the stability criteria function.

3. From the stability criteria function table, the user can right-click, from the shortcut menu (Figure 5-20), the user can copy, paste, and insert/delete rows in the table.

4. Once the stability criteria function has been entered, click OK, the Building Stability Curve Editor will close (Figure 5-23). The stability criteria function will display on the Stability Criteria Editor (Figure 5-22), if all of the stability criteria data has been entered, click OK, and the Stability Criteria Editor will close.

Delete a Stability Criteria

To delete an existing stability criteria:

1. From the Stability Criteria Editor (Figure 5-22), select a stability criteria from the Name list.

2. From the Edit Criteria menu, click Delete, or click the Delete button. Either way, a Confirm Delete window (Figure 5-15) will open asking for confirmation to delete the selected item. Click Yes, the Confirm Delete message window will close (Figure 5-15), and the selected stability criteria is deleted.

Rename a Stability Criteria

To rename an existing stability criteria:

1. From the Stability Criteria Editor (Figure 5-22), select a stability criteria from the Name list.

2. From the Edit Criteria menu, click Rename, the Rename Stability Criteria Data dialog box will open (Figure 5-27). Enter a new name in the Name box, click OK. The Rename Stability Criteria Data dialog box will close (Figure 5-27), and the Stability Criteria Editor will open (Figure 5-22) with the new name of the stability criteria displayed.

Figure 5-27. Rename Stability Criteria Data Dialog Box
Copy a Stability Criteria

To copy an existing stability criteria:

1. From the Stability Criteria Editor (Figure 5-22), select a stability criteria from the Name list.

2. From the Edit Criteria menu, click Save As, or click the Copy button. Either way, the Building Stability Curve Editor will open (Figure 5-23). Enter a new name in the Name box. Click OK, the Building Stability Curve Editor will close (Figure 5-23). The Stability Criteria Editor will display (Figure 5-22) the new stability criteria.

5.4.3 Submergence Criteria Editor

Submergence is defined as a water level at a structure that can affect probability of survival. The submergence criteria in HEC-LifeSim is split into three zones: chance, compromised, and safe for population over and under 65 years of age. The structural submergence criteria is defined based on attributes such as number of stories and occupancy class and can be altered utilizing this editor. For example, a one-story residential home with roof access may have different submergence criteria than a structure without roof access.

The Submergence Criteria Editor (Figure 5-28) is used to define how the depths at structures can affect life loss by placing the population in submergence zones (Safe, Compromised, and Chance). The Safe zone represents a zone of very low probability of life loss, the Compromised zone represents an area with a moderate probability of life loss, and the Chance zone represents an area where probability of life loss is high.

![Submergence Criteria Editor](image)

Figure 5-28. Submergence Criteria Editor

Submergence Criteria Editor – Help Button

Help

Help provides context sensitive help about the Submergence Criteria Editor (Figure 5-28). Click Help, a help window (Figure 5-29) opens providing information about the Submergence Criteria Editor.
Based on information entered under stability criteria (Section 5.4.2), information for submergence criteria can be added and/or edited.

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, from the Structure Inventories folder, right-click on a structure inventory. From the shortcut menu (Figure 5-25) click Edit Structural Submergence Criteria. Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, point to Edit Submergence Criteria, click on a structure inventory.

2. Either way, the Submergence Criteria Editor will open (Figure 5-28).

3. The left side of the Submergence Criteria Editor (Figure 5-28) provides a nested tree structure for assigning Structural Submergence Criteria (Number of Stories and Occupancy Type) which is very similar to how stability criteria is assigned (Section 5.4.2). For example, in Figure 5-28, if the Number of Stories is 2, then the Occupancy Type list will populate with all the unique occupancy types that are also two stories. If an item in one of the columns is bold then it has a different submergence criteria than the parent item.

- For the example, in (Figure 5-28) for structures that are 2-stories tall, available occupancy types are: COM4, COM8, RES1-2SNB, RES1-2SWB, RES3AI, RES3BI, RES3B, and RES3A. All of these occupancy types share the same submergence criteria for a two-story structure.
• To assign a different submergence criteria, for example, for a 2-story RES3B, the user will select RES3B and define the submergence criteria for the selected occupancy type. The submergence criteria for the occupancy type RES3B will now be bold, and will no longer be the same as the other two-story structures submergence criteria.

• If the submergence criteria is changed for a tree item that has child elements (e.g., two-story structures have eight child elements) then when a different item is selected a message window (Figure 5-26) will appear asking for authorization to propagate the changes to the child elements. Click Yes, child elements (e.g., COM4, COM8, etc.) will be assigned to the new submergence criteria.

4. Submergence criteria data is defined for three zones that are entered by the user. The three zones are – Safe, Compromised, and Chance. For each zone the user will enter population number for Under 65 and Over 65. The Safe Zone is between zero and two feet, and is where structure submergence will not place people in a life loss zone. The Comprised Zone is between two and 22 feet, and is where the structure is submerged but safe for people under 65 (assuming there is roof access). The Chance Zone is between two and thirteen feet, and is where the structure is submerged but safe for people over 65 (assumes no access to the roof).

5. Once the submergence criteria has been entered, click OK, the Submergence Criteria Editor will close (Figure 5-28) and the submergence criteria is saved.

5.5 Copy a Structure Inventory

To copy an existing structure inventory:

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, from the Structure Inventories folder, right-click on a structure inventory. From the shortcut menu (Figure 5-25) click Copy. Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, point to Copy, and click on a structure inventory.

2. Either way, the Name of New Structure Inventory dialog box will open (Figure 5-30). Enter a new name in the Name box. Click OK, the Name of New Structure Inventory dialog box will close (Figure 5-30). The new structure inventory will display on the Study Tree under the Structure Inventories folder.

Figure 5-30. Name of New Structure Inventory Dialog Box
5.6 Delete a Structure Inventory

To delete an existing structure inventory from an HEC-LifeSim study and study directory:

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, from the Structure Inventories folder, right-click on a structure inventory. From the shortcut menu (Figure 5-25) click Delete. Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, point to Delete, click on a structure inventory.

2. Either way, a Confirm Delete window (Figure 5-15) will open asking for confirmation to delete the selected structure inventory. Click Yes, the Confirm Delete message window will close (Figure 5-15), and the selected structure inventory is deleted, and no longer displays in the Study Tree under the Structure Inventories folder. The selected structure inventory is also deleted from the structure inventory study directory.

5.7 Display a Structure Inventory

From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, from the Structure Inventories folder, right-click on a structure inventory. From the shortcut menu (Figure 5-25) click Show in Map Window. The selected structure inventory will display in the Map Window of the HEC-LifeSim main window (Figure 5-1).

5.8 Generate Structure Hydraulic Summary

The user can create an output shapefile based on the structure inventory for a selected hydraulic scenario. The output shapefile will contain hydraulic information based on the selected scenario such as maximum depth, velocity, and key hydraulic threshold arrival times at each structure.

1. From the HEC-LifeSim main window (Figure 5-1), from the Study tab, from the Study Tree, from the Structure Inventories folder, right-click on a structure inventory. From the shortcut menu (Figure 5-25) click Generate Summary Hydraulics at Structures. Another way is from the HEC-LifeSim main window, from the Study menu, point to Structure Inventories, point to Generate Summary Hydraulics, and click on a structure inventory.

2. Either way, The Generate Structure Hydraulic Summary dialog box will open (Figure 5-31).

3. The user needs to provide a location where the output shapefile will be saved. To the right of the Output Shapefile box click , a Save As browser will open (Figure 5-32). Navigate to the directory where the output shapefile will be saved. Enter a name for the output shapefile in the File name box (*.shp). Click Save, the Save As browser will close (Figure 5-32) and the user will be returned to the Generate Structure Hydraulic Summary dialog box (Figure 5-31), the Output Shapefile box will now display the pathname and shapefile name of the output shapefile.
4. From the **Hydraulic** list (Figure 5-31) select the appropriate hydraulic dataset. If no hydraulic dataset exists, then the list will be empty and summary hydraulics cannot be generated.
5. In the **Hydraulic Output** box (Figure 5-31), the hydraulic output options have been selected – **Compute Maximum Depth**, **Computer Maximum Velocity**, and **Compute Maximum Depth Times Velocity**. These options are all selected by default, if the user does not want an option, unselect.

6. From the **Depth and Velocity Arrival Time (Minutes)** box (Figure 5-31), default values for **Depth Arrival Times** and **Velocity Arrival Times** have been set. Units are either in feet or meters, and depend on the units in the selected hydraulic dataset. The default values can be modified, but no more than six boxes per arrival time type can be identified per output shapefile. Not all six boxes require data.

7. Once all of the necessary and desired parameters have been set, click **OK**, a **Progress Window** will open (Figure 5-33) showing the progress of the hydraulic summary output shapefile creation. When processing of the output shapefile is complete the **Progress Window** will close (Figure 5-33). The output shapefile will automatically be added to the **Map Window** of the HEC-LifeSim main window (Figure 5-1) and the output shapefile will be saved in the appropriate location.

![Progress Window](image)

Figure 5-33. Progress Window
CHAPTER 6

Emergency Planning Data

The next step in building an HEC-LifeSim study is to add emergency planning data which represents an area (or areas) with potentially unique overall evacuation effectiveness such as evacuation preparedness, community awareness, and the types of flood warning systems available. Refer to Sorensen et. al. (2014a; 2014b; and 2014c) for examples of how to define an emergency planning zone (EPZ) or area (Appendix C). The effectiveness of the warning systems available and the anticipated community responses are captured in community diffusion curves for first warning alert and protective action initiation (sometimes called mobilization).

Central to the evacuation process in HEC-LifeSim are the first alert and Protective Action Initiation (PAI) community diffusion curves (Figure 6-1). The first alert curves represent the percentage of the population that receives a notification of the warning over time (e.g., fifty percent of the population will receive a warning alert within forty minutes of warning issuance). First alert curves are entered for daytime and nighttime scenarios because the speed at which a first alert can be received can vary significantly between daytime and nighttime. The PAI curves represent the percent of population that takes protective action over time. For example, fifty percent of the population will have taken protective action within eight minutes of a first alert (Sorensen et. al., 2014c; Appendix C). The diffusion curves can be entered with uncertainty and HEC-LifeSim performs curve sampling on an iteration basis in the Monte Carlo simulation.

![Figure 6-1. Conceptual diagram illustrating the flood warning and evacuation timeline. Highlighted sections relevant to emergency planning zone input data are, warning diffusion time from warning issuance (light red) and protective action initiation delay from first alert (light green)](image)

6.1 Emergency Planning Zone (EPZ) Editor

The Emergency Planning Zone Editor (Figure 6-2) allows the user to enter information defining separate emergency planning zones (EPZ). In most cases, separate emergency management agency areas within the study area are modeled as unique emergency planning zones since the warning issuance efficiency, message content, and public response can vary.
These emergency planning zones are provided in the form of a polygon shapefile where each polygon feature in the shapefile represents an emergency planning zone.

(Figure 6-1). The tabs on the Emergency Planning Zone Editor (Figure 6-2) represent the first alert and PAI diffusion curves that need to be created for the emergency planning zones.

### 6.1.1 EPZ Editor Tabs

The Warning Issuance Delay tab (Figure 6-2) allows the user to set the warning issuance delay, which is the time it takes from when the emergency managers receive the notification of the imminent hazard to when an evacuation order is issued to the public. For example, if the emergency manager for an EPZ took anywhere between 15 to 30 minutes to verify the hazard and initiate a public evacuation order, then the user would enter a warning issuance delay function with a uniform distribution (Figure 6-1).

### Warning Issuance Delay

The Warning Issuance Delay tab (Figure 6-2) allows the user to set the warning issuance delay, which is the time it takes from when the emergency managers receive the notification of the imminent hazard to when an evacuation order is issued to the public. For example, if the emergency manager for an EPZ took anywhere between 15 to 30 minutes to verify the hazard and initiate a public evacuation order, then the user would enter a warning issuance delay function with a uniform distribution (Figure 6-1).

### Daytime First Alert

The Daytime First Alert tab (Figure 6-2) allows the user to set a unique (for multiple zones, when present) warning system with uncertainty to define the diffusion curve. The diffusion curve
represents the percentage of the population which will receive a first alert warning over time during daytime hours from when the warning was issued and can be described with uncertainty (Figure 6-1).

**Nighttime First Alert**

Nighttime First Alert tab (Figure 6-2) allows the user to set a unique (for multiple zones, when present) warning system with uncertainty to define the diffusion curve. The diffusion curve represents the percentage of the population which will receive a first alert warning over time during nighttime hours from when the warning was issued and can be described with uncertainty. The default curves take into account the challenges with sending out a warning at night (Figure 6-1).

**Protective Action Initiation**

The Protective Action Initiation tab (Figure 6-2) allows the user to set a unique (for multiple zones, when present) mobilization PAI system with uncertainty to define the diffusion curve. The protective action initiation delay represents the percentage of the population which will take protective action over time from when the first alert is received (Figure 6-1).

### 6.1.2 EPZ Editor Buttons

**Add New**

Add New allows the user to create a new first alert or PAI diffusion curve. Click Add New, a Name of New Curve Type dialog box opens (Figure 6-3). The Curve Type name will change depending on the selected tab. For example, in Figure 6-3, the Curve Type is Warning Issuance Delay. Enter a name in the Name box, click OK. The Name of New Curve Type dialog box will close, and a new blank diffusion curve will be added to the Curve Type list (e.g., Warning Issuance Delay list) of the Emergency Planning Zone Editor.

![Figure 6-3. Name of New Curve Type Dialog Box](image)

**Delete**

Delete allows users to remove user created first alert or PAI diffusion curves. The default curves cannot be deleted. Select a user created diffusion curve, click Delete, a Confirm Delete message window will open (Figure 6-4). Click Yes, the Confirm Delete message window will close, and the selected diffusion curve will be deleted.
Copy

Copy allows users to copy user created first alert or PAI diffusion curve. The default curves cannot be copied. Select a user created diffusion curve, click Copy, the Name of New Curve Type dialog box will open (Figure 6-3). The name of the selected curve will display in the Name box, enter a new name in the Name box for the copy of the selected curve. Click OK, the Name of New Curve Type dialog box will close (Figure 6-3), and the copy will display in the Curve Type list of the Emergency Planning Zone Editor (Figure 6-2).

6.2 Create an Emergency Planning Zone Dataset

In most cases, separate emergency management agency areas within the study area are modeled as unique emergency planning zones since the warning issuance efficiency, message content, and public response can vary.

To create emergency planning zones from a point shapefile:

1. From the HEC-LifeSim main window (Figure 6-5), from the Study tab, from the Study Tree, right-click on Emergency Planning Zones, from the shortcut menu click Import Emergency Planning Zones From Shapefile. Another way is from the HEC-LifeSim
main window, from the **Study** menu, point to **Emergency Planning Data**, click **Import From Shapefile**.

2. Either way, the **Import Emergency Planning Zone** dialog box (Figure 6-6) will open.

![Figure 6-6. Import Emergency Planning Zone Dialog Box](image)

3. Enter a name for the emergency planning zone in the **Name** box (Figure 6-6).

4. To select the shapefile that contains information about the emergency planning zone, to the right of the **Emergency Planning Zone Polygon Shapefile** box (Figure 6-6), click ![Open](image). An **Open** browser (Figure 6-7) will open, navigate to the directory where the point

![Figure 6-7. Open Browser](image)
shapefile is located. Select the correct point shapefile (e.g., *.shp), click Open, the Open browser will close (Figure 6-7) and the user will be returned to the Import Emergency Planning Zone dialog box (Figure 6-6).

5. From the Emergency Planning Zone Name Field (Figure 6-6) list select the shapefile attribute that is representative of the unique emergency planning zone (e.g., county names). The Emergency Planning Zone list (Figure 6-6) now displays the selected information. The items available in the list are generated from the selected emergency planning zone shapefile.

6. From the Warning Issuance Delay tab (Section 6.1.1) the user will provide parameters that define the amount of time it could take for emergency managers to issue a warning to the public. From the Warning Issuance Delay list (Figure 6-6) a user can select the default warning issuance delay curves (information from the imported EPZ shapefile). The user can also create, delete, and add user defined curves through use of the Import Emergency Planning Zone dialog box (Figure 6-6). To view all of the default warning issuance delay curves, from the Import Emergency Planning Zone dialog box (Figure 6-6), click Display default Warning Issuance Delay Curves, the curves will display in the plot area of the Import Emergency Planning Zone dialog box (Figure 6-6).

7. When the user creates a new warning issuance delay curve, uncertainty about that curve can be added. When a user defined warning issuance delay curve has been created, uncertainty types become available on the green area of the Import Emergency Planning Zone dialog box (Figure 6-8). The different available uncertainty types are listed below with the required parameters that the user will need to input:

- **None** (default) – Enter a Most Likely value
- **Lindell** – Requires the user to set an A and B value
- **Triangular** – Enter a Minimum and Maximum value
- **Normal** – Enter a Standard Deviation value
- **Uniform** – Requires the user to set the Minimum and Maximum value

8. From the Daytime First Alert tab (Section 6.1.1) the user will provide parameters that define the warning diffusion curves for daytime conditions. From the Warning Diffusion list (Figure 6-9) a user can select the default warning diffusion curves (information from the imported EPZ shapefile). The user can also create, delete, and add user defined
curves through use of the Import Emergency Planning Zone dialog box (Figure 6-6) buttons (Section 6.1.2).

9. When the user creates a new warning diffusion curve, uncertainty about that curve can be added. When a user defined warning diffusion curve has been created, the Uncertainty Type list (Figure 6-9) becomes available. When the user selects an uncertainty type, the table below the Uncertainty Type list changes according to the selected uncertainty type.

![Image of Emergency Planning Zone with warning diffusion curves and uncertainty type list.]

The different available uncertainty types are listed below with the required parameters that the user will need to input:

- **None** (default)
- **Triangular** – Enter a **Minimum** and **Maximum** value (percentage)
- **Normal** – Enter a **Standard Deviation** value
- **Uniform** – Enter a **Minimum** and **Maximum** value (percentage)

10. From the Nighttime First Alert tab (Section 6.1.1) the user will provide parameters that define the warning diffusion curves for nighttime conditions. From the Warning Diffusion list (similar to Figure 6-9) a user can select the default warning diffusion curves (information from the imported EPZ shapefile). The user can also create, delete, and add user defined curves through use of the Import Emergency Planning Zone dialog box (Figure 6-6) buttons (Section 6.1.2). Step 9 is exactly the same for the Nighttime First Alert tab.

11. From the Protective Action Initiation tab (Section 6.1.1) the user will provide parameters that define the PAI response curves. From the Mobilization (PAI) Response list (Figure 6-10) a user can select the default PAI response curves (information from the imported EPZ shapefile). The user can also create, delete, and add user defined curves through use of the Import Emergency Planning Zone dialog box (Figure 6-6). Step 9 is exactly the same for the Protective Action Initiation tab.

12. Once all of the correct information for the EPZ dataset has been entered (Figure 6-6), click **OK**. The Import Emergency Planning Zone dialog box will close (Figure 6-6). From the HEC-LifeSim main window (Figure 6-5), from the Study Tree, under the Emergency Planning Zones folder, the name of the EPZ dataset will display.
6.3 Edit an EPZ Dataset

Once an EPZ dataset has been created, the user can edit that EPZ dataset from the Emergency Planning Zone Editor (Figure 6-2). From the HEC-LifeSim main window (Figure 6-5), from the Study tab, from the Study Tree, from the Emergency Planning Zones folder, right-click on an EPZ dataset, from the shortcut menu (Figure 6-11), click Edit. Another way is from the HEC-LifeSim main window, from the Study menu, point to Emergency Planning Data, point to Edit, click an EPZ dataset. Either way, the Emergency Planning Zone Editor (Figure 6-2) will open. Section 6.1 and Section 6.2 (Steps 6 thru 11) provide information on the editor.

6.4 Display an EPZ Dataset

To copy an EPZ dataset from an existing dataset:

To display an EPZ dataset, from the HEC-LifeSim main window (Figure 6-5), from the Study tab, from the Study Tree, from the Emergency Planning Zones folder, right-click on an EPZ dataset, from the shortcut menu (Figure 6-11), click Show in Map Window. The selected EPZ dataset will display in the Map Window of the HEC-LifeSim main window (Figure 6-5).
6.5 Copy an EPZ Dataset

1. From the HEC-LifeSim main window (Figure 6-5), from the Study tab, from the Study Tree, from the Emergency Planning Zones folder, right-click on an EPZ dataset, from the shortcut menu (Figure 6-11), click Copy. Another way is from the HEC-LifeSim main window, from the Study menu, point to Emergency Planning Data, point to Copy, and click an EPZ dataset.

2. Either way, the Name of New Emergency Planning Zones (Figure 6-12) will open. Enter a new name in the Name box. Click OK, the Name of New Emergency Planning Zones dialog box will close (Figure 6-12). The new EPZ dataset will display on the Study Tree under the Emergency Planning Zones folder.

![Name of New Emergency Planning Zones Dialog Box](Image)

Figure 6-12. Name of New Emergency Planning Zones Dialog Box

6.6 Delete an EPZ Dataset

To delete an EPZ dataset from the HEC-LifeSim study and study directory files:

1. From the HEC-LifeSim main window (Figure 6-5), from the Study tab, from the Study Tree, from the Emergency Planning Zones folder, right-click on an EPZ dataset, from the shortcut menu (Figure 6-11), click Delete. Another way is from the HEC-LifeSim main window, from the Study menu, point to Emergency Planning Data, point to Delete, click an EPZ dataset.

2. Either way, a Confirm Delete window (Figure 6-4) will open asking for confirmation to delete the selected EPZ dataset. Click Yes, the Confirm Delete message window will close (Figure 6-4), and the selected EPZ dataset is deleted, and no longer displays in the Study Tree under the Emergency Planning Zones folder. The selected EPZ dataset is also deleted from the EPZ study directory.
CHAPTER 7

Road Network Data

Road network data is required in a HEC-LifeSim study to represent possible evacuation routes that people can take during an evacuation. The road network features can be categorized into multiple road types with attributes defining their census feature class classification (CFCC), flow direction, and vertical offset (Appendix C).

- The CFCC classification is a three-character system that is used to define feature data. The first character *A* denotes roads, the second character is an integer that denotes road type (e.g., Primary Highway), and the third character further classifies within the road type (e.g., underpass). The CFCC codes are used in HEC-LifeSim to define attributes about the road that affect transportation (e.g., free flow speed). Further information on CFCC classification is available in Appendix C.

- Roads can be defined as one-way directional in HEC-LifeSim. If roads are defined in this way, care must be taken to make sure that the direction and links are set up correctly.

- The vertical offset attribute is designed for roads that are elevated above the ground such as a bridge that would actually have water running under the road instead of on the road.

Appendix B is designed to help users prepare and edit road networks for use in HEC-LifeSim. There are two ways to add road network data to an HEC-LifeSim study and only one format is supported (polygon shapefiles) to be utilized in HEC-LifeSim simulations.

### 7.1 Create Road Network Datasets

Road network datasets can be created by importing information from a polyline shapefile that represents a road network. Another way to import a road network dataset is using a bounding polygon shapefile to generate a road network using all available data within the bounding polygon from the OpenStreetMap database (Appendix C).

#### 7.1.1 Import from a Shapefile

To create a road network dataset from a polygon shapefile:

1. From the HEC-LifeSim main window (Figure 7-1), from the Study tab, from the Study Tree, right-click on Road Networks, from the shortcut menu (Figure 7-2), click Import Road Network From Shapefile. Another way is from the HEC-LifeSim main window, from the Study menu, point to Road Network Data, click Import From Shapefile.

2. Either way, the Import Road Network dialog box (Figure 7-3) will open.
3. Enter a name for the road network dataset in the Name box (Figure 7-3).

4. To select the shapefile that contains information about the road network, to the right of the Road Network Shapefile box (Figure 7-3), click Open. An Open browser (Figure 7-4) will open, navigate to the directory where the polygon shapefile is located. Select the correct point shapefile (e.g., *.shp), click Open, the Open browser will close (Figure 7-4) and the user will be returned to the Import Road Network dialog box (Figure 7-3). The location and name of the selected polygon shapefile will display in the Road Network Shapefile box (Figure 7-3).

5. The Import Road Network dialog box (Figure 7-3) already has CFCC default parameters. From the CFCC Name Field list (Figure 7-3), select CFCC. The CFCC parameters is used to identify the most noticeable characteristic of a road.
Figure 7-3. Import Road Network Dialog Box

Figure 7-4. Open Browser
If this information is not known (CFFC is not available from the CFCC Name Field list), then the user could access the shapefile attribute table (see Appendix A, Section A.4 for details on accessing the attribute table) to determine which column header contains the CFCC road identifications (e.g., A73, A15, A63, etc.). Road classification parameters can be defined differently for each CFCC. For example, a primary highway defined as A11 can have a different free flow speed than another primary highway defined as A12. The road classification parameters can be edited in the Road Classification (CFCC) Parameters table (Figure 7-3).

6. If the road network shapefile contains data classifying one-way streets and the attribute identification (e.g., True or False), then user can set the information for one-way streets (optional). From the One-Way Field list (Figure 7-3), select One_Way. From the Identifier list, select True.

7. Another optional field which depends on the road networks shapefile attributes is the Vertical Offset list (Figure 7-3), which sets the vertical offset.

8. Once all of the information has been entered click OK, the Import Road Network dialog will close (Figure 7-3). If the road network CFCC Name Field list (Figure 7-3) has values that are not in the classification parameters table then a message box will appear asking to define attributes for the missing CFCC values. From the HEC-LifeSim main window (Figure 7-1), from the Study Tree, under the Road Networks folder, the name of the road network dataset is displayed.

7.1.2 Import from OpenStreetMap

OpenStreetMap is a collaborative project to create a free editable map of the world (Appendix C). It is supported by a large community of dedicated members to provide global GIS data. HEC-LifeSim can take the road network information stored within the OpenStreetMap database to create a road network for use in the software.

To create a road network dataset from a bounding polygon shapefile:

1. From the HEC-LifeSim main window (Figure 7-1), from the Study tab, from the Study Tree, right-click on Road Networks, from the shortcut menu (Figure 7-2), click Import Road Network From OpenStreetMap. Another way is from the HEC-LifeSim main window, from the Study menu, point to Road Network Data, click Import From OpenStreetMap.

2. Either way, the Import Road Network From OpenStreetMap dialog box (Figure 7-5) will open.

3. To select the bounding polygon shapefile, to the right of the Bounding Polygon Shapefile box (Figure 7-5), click . An Open browser (Figure 7-4) will open, navigate to the directory where the bounding polygon shapefile is located. Select the correct point shapefile (e.g., *.shp), click Open, the Open browser will close (Figure 7-4).
4. Click **OK**, and the **Import Road Network From OpenStreetMap** dialog box will close and a **Progress Window** will open (Figure 7-6). The **Progress Window** displays the import process where HEC-LifeSim goes out to the OpenStreetMap Data Server to collect data based on the selected bounding polygon shapefile. Once the import is completed the **Progress Window** will close (Figure 7-6).

5. From the HEC-LifeSim main window (Figure 7-1), from the **Study Tree**, under the **Road Networks** folder, the name of the road network dataset is displayed.

### 7.2 Edit a Road Network Dataset

Once a road network dataset has been created, the user can edit that road network dataset from the **Edit Road Network** dialog box (Figure 7-7). From the HEC-LifeSim main window (Figure 7-1), from the **Study** tab, from the **Study Tree**, from the **Road Networks** folder, right-click on a road network dataset, from the shortcut menu (Figure 7-8), click **Edit**. Another way is from the HEC-LifeSim main window, from the **Study** menu, point to **Road Network Data**, point to **Edit**, click a road network dataset. Either way, the **Edit Road Network** dialog box (Figure 7-7) will open. Section 7.1.1 provides information on the editor.

### 7.3 Display a Road Network Dataset

To display a road network dataset, from the HEC-LifeSim main window (Figure 7-1), from the **Study** tab, from the **Study Tree**, from the **Road Networks** folder, right-click on a road network dataset, from the shortcut menu (Figure 7-8), click **Show In Map Window**. The selected road network dataset will display in the **Map Window** of the HEC-LifeSim main window (Figure 7-1).
Chapter 7 – Road Network Data

Figure 7-7. Edit Road Network Dialog Box

<table>
<thead>
<tr>
<th>CFCC</th>
<th># Lanes</th>
<th>Free Flow Speed (mph)</th>
<th>Jam Density (Vehicles/Mile)</th>
<th>Break Away Density (Vehicles/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10</td>
<td>3</td>
<td>65</td>
<td>160</td>
<td>28</td>
</tr>
<tr>
<td>A11</td>
<td>3</td>
<td>65</td>
<td>160</td>
<td>28</td>
</tr>
<tr>
<td>A12</td>
<td>3</td>
<td>65</td>
<td>160</td>
<td>28</td>
</tr>
<tr>
<td>A13</td>
<td>3</td>
<td>65</td>
<td>160</td>
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<td>A14</td>
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<td>A15</td>
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<td>28</td>
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<td>A16</td>
<td>3</td>
<td>65</td>
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<td>A19</td>
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<td>A20</td>
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<td>A24</td>
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</tr>
<tr>
<td>A25</td>
<td>2</td>
<td>50</td>
<td>160</td>
<td>23</td>
</tr>
</tbody>
</table>

Figure 7-8. Individual Road Network Dataset – Shortcut Menu
Also, road network dangles (or line ends that do not share an endpoint with any other line) can be displayed. Dangles are useful for determining incomplete road networks by being able to quickly identify locations where roads are disconnected when they should be connected (refer to Appendix B for details on modifying road networks using dangles). From the HEC-LifeSim main window (Figure 7-1), from the Study tab, from the Study Tree, from the Road Networks folder, right-click on a road network dataset, from the shortcut menu (Figure 7-8), click Show Dangles in Map Window. The selected road network dataset's dangles will display in the Map Window of the HEC-LifeSim main window (Figure 7-1).

### 7.4 Copy a Road Network Dataset

To copy a road network dataset from an existing dataset:

1. From the HEC-LifeSim main window (Figure 7-1), from the Study tab, from the Study Tree, from the Road Networks folder, right-click on a road network dataset, from the shortcut menu (Figure 7-8), click Copy. Another way is from the HEC-LifeSim main window, from the Study menu, point to Road Network Data, point to Copy, and click a road network dataset.

2. Either way, the Name of New Road Network (Figure 7-9) will open. Enter a new name in the Name box. Click OK, the Name of New Road Network dialog box will close (Figure 7-9). The new road network dataset will display on the Study Tree under the Road Networks folder.

![Figure 7-9. Name of New Road Network Dialog Box](image)

### 7.5 Delete a Road Network Dataset

To delete a road network dataset from the HEC-LifeSim study and study directory files:

1. From the HEC-LifeSim main window (Figure 7-1), from the Study tab, from the Study Tree, from the Road Networks folder, right-click on a road network dataset, from the shortcut menu (Figure 7-8), click Delete. Another way is from the HEC-LifeSim main window, from the Study menu, point to Road Network Data, point to Delete, click a road network dataset.

2. Either way, a Confirm Delete window (Figure 7-10) will open asking for confirmation to delete the selected road network dataset. Click Yes, the Confirm Delete message window will close (Figure 7-10), and the selected road network dataset is deleted, and no
longer displays in the **Study Tree** under the **Road Networks** folder. The deleted road network is also removed from the road network study directory.

![Confirm Delete Window](image)

Figure 7-10. Confirm Delete Window
CHAPTER 8

Destination Data

Destination data is required in a HEC-LifeSim study to represent possible evacuation locations during flooding events. The destination can either be a location within the flooded area that is considered a safe haven for evacuees or locations outside the flooding extents. The local Emergency Management Agency (EMA) can be a helpful resource for locating safe havens and for information on defining these types of locations. The Federal Emergency Management Agency (FEMA) provides contact information for EMAs (https://www.fema.gov/emergency-management-agencies). The destination data is represented as points in space, HEC-LifeSim will find the nearest road from a destination point and consider that the evacuation location. The destinations do not have to be directly on a road. A method to create destinations and define their location is detailed in Appendix A, Section A.9.5.

8.1 Create Destination Datasets

To create a destination dataset from a shapefile:

1. From the HEC-LifeSim main window (Figure 8-1), from the Study tab, from the Study Tree, right-click on Destinations, from the shortcut menu, click Import Destinations From Shapefile. Another way is from the HEC-LifeSim main window, from the Study menu, point to Destinations Data, click Import From Shapefile.

Figure 8-1. HEC-LifeSim Main Window
2. Either way, the **Import Destinations From Point Shapefile** dialog box (Figure 8-2) will open.

3. Enter a name for the destination dataset in the **Name** box (Figure 8-2).

![Figure 8-2. Import Destinations From Point Shapefile Dialog Box](image)

4. To select the shapefile that contains information about destinations, to the right of the **Destinations Shapefile** box (Figure 8-2), click ![Open](image). An **Open** browser (Figure 8-3) will open, navigate to the directory where the polygon shapefile is located. Select the correct point shapefile (e.g., *.shp), click **Open**, the **Open** browser will close (Figure 8-3) and the user will be returned to the **Import Destinations From Point Shapefile** (Figure 8-2). The location and name of the selected polygon shapefile will display in the **Destinations Shapefile** box (Figure 8-2).

![Figure 8-3. Open Browser](image)

5. Click **OK**, the **Import Destinations From Point Shapefile** dialog will close (Figure 8-2). From the HEC-LifeSim main window (Figure 8-1), from the **Study Tree**, under the **Destinations** folder, the name of the destination dataset is displayed.

### 8.2 Display a Destination Dataset

To display a destination dataset, from the HEC-LifeSim main window (Figure 8-1), from the **Study** tab, from the **Study Tree**, from the **Destinations** folder, right-click on a destination
dataset, from the shortcut menu (Figure 8-4), click Show in Map Window. The selected destination dataset will display in the Map Window of the HEC-LifeSim main window (Figure 8-1).

Figure 8-4. Individual Destination Dataset – Shortcut Menu

### 8.3 Copy a Destination Dataset

To copy a destination dataset from an existing dataset:

1. From the HEC-LifeSim main window (Figure 8-1), from the Study tab, from the Study Tree, from the Destinations folder, right-click on a destination dataset, from the shortcut menu (Figure 8-4), click Copy. Another way is from the HEC-LifeSim main window, from the Study menu, point to Destinations Data, point to Copy, and click a destination dataset.

2. Either way, the Name of New Destinations (Figure 8-5) will open. Enter a new name in the Name box. Click OK, the Name of New Destinations dialog box will close (Figure 8-5). The new destination dataset will display on the Study Tree under the Destinations folder.

Figure 8-5. Name of New Destinations Dialog Box
8.4 Delete a Destination Dataset

To delete a destination dataset from the HEC-LifeSim study and study directory files:

1. From the HEC-LifeSim main window (Figure 8-1), from the Study tab, from the Study Tree, from the Destinations folder, right-click on a destination dataset, from the shortcut menu (Figure 8-4), click Delete. Another way is from the HEC-LifeSim main window, from the Study menu, point to Destinations Data, point to Delete, click a destination dataset.

2. Either way, a Verify Deletion of Destination Data message window (Figure 8-6) will open asking for confirmation to delete the selected destination dataset. Click Yes, the Verify Deletion of Destination Data message window will close (Figure 8-6), and the selected destination dataset is deleted, and no longer displays in the Study Tree under the Destinations folder. The selected destinations dataset is also deleted from the destinations study directory.

Figure 8-6. Verify Deletion of Destination Data Message Window
CHAPTER 9

Alternatives

An alternative in HEC-LifeSim allows the user to define what input data sources and parameters will make up the simulation computations. Any combination of input data sources can be used to define an alternative. For example, one alternative may use a road network that allows for contra-flow and another may use a different hydraulic event or different warning issuance times. Setting up multiple alternatives allows the user to quantify and compare the effects of operational changes on the hazard analysis. Alternatives in HEC-LifeSim represent the parameters that define a simulation and include defining:

- Input data sources (e.g., hydraulics, structure inventory),
- Warning issuance times,
- Destination locations by Emergency Planning Zone (EPZ), and
- Various other parameters (e.g., fatality rates, stop and go speed).

9.1 Create an Alternative

To create an alternative in HEC-LifeSim the user will provide a name, define the input data sources, and provide information for warning issuance scenarios (Public Warning Issuance) and destinations for emergency planning zones (Destination Zone Assignments).

1. From the HEC-LifeSim main window (Figure 9-1), from the Study tab, from the Study Tree, right-click on Alternatives, from the shortcut menu, click Create New Alternative. Another way is from the HEC-LifeSim main window, from the Study menu, point to Alternatives, click Create New.
2. Either way, the **Create New Alternative** dialog box (Figure 9-2) will open.

3. Enter a name for the alternative in the **Name** box (Figure 9-2).

![Create New Alternative Dialog Box](image)

**Figure 9-2. Create New Alternative Dialog Box**

4. By default, HEC-LifeSim will create a traffic simulation of the evacuation. If the user does not want a traffic simulation click **Simulate Evacuation** (Figure 9-3). Also, if the user chooses not to create a traffic simulation, then a road network and destinations datasets do not need to be defined.

![Create New Alternative Dialog Box – Input Data Sources](image)

**Figure 9-3. Create New Alternative Dialog Box – Input Data Sources**

5. From the **Input Data Sources** box (Figure 9-3), from the **Hydraulic Event** list, the user needs to select a Hydraulic Data dataset. If the user needs to edit the selected Hydraulic Data dataset, from the **Create New Alternative** dialog box (Figure 9-2), the user will
click , and the **Select Hydrograph and Timing Information** dialog box will open (see Chapter 4 for further information).

6. From the **Input Data Sources** box (Figure 9-3), from the **Structure Inventory** list, the user needs to select a structure inventory.

7. From the **Input Data Sources** box (Figure 9-3), from the **Emergency Planning Zone** list, the user needs to select an EPZ dataset. If the user needs to edit the selected EPZ dataset, from the **Create New Alternative** dialog box (Figure 9-2), the user will click , and the **Emergency Planning Zone Editor** will open (see Chapter 6 for further information).

8. If the user has selected to create a traffic simulation, from the **Input Data Sources** box (Figure 9-3), from the **Road Network** list, the user needs to select a road network dataset. If the user needs to edit the selected road network dataset, from the **Create New Alternative** dialog box (Figure 9-2), the user will click , and the **Edit Road Network** dialog box will open (see Chapter 7 for further information).

9. If the user has selected to create a traffic simulation, from the **Input Data Sources** box (Figure 9-3), from the **Destinations** list, the user needs to select a destinations dataset.

10. Now the user needs to define warning issuance scenarios; from the **Create New Alternative** dialog box (Figure 9-2), click the **Public Warning Issuance** tab (Figure 9-4). The public warning issuance scenario has three parameters. Each parameter can be defined with uncertainty and is used to define when warnings are issued to the population (Figure 9-5).

![Study Hydrograph](image)

Figure 9-4. Create New Alternative Dialog Box – Public Warning Issuance Tab
Figure 9-5. Conceptual diagram illustrating the flood warning and evacuation timeline. Highlighted sections relevant to warning issuance time are: Hazard Identified Relative Time (blue); Hazard Communication Delay (light yellow); and, Warning Issuance Delay (light grey).

a. The **Emergency Planning Zone** list is a list of all the emergency planning zones in the selected EPZ dataset (Figure 9-3). Therefore, if a selected EPZ dataset has multiple zones then the list will contain the names of the multiple zones.

b. The **Hazard Identified Relative Time** parameter (Figure 9-4) is the time, in hours, from the imminent hazard defined by the selected hydraulic data. From the **Uncertainty Type** list, the user will select – None, Triangular, Normal, or Uniform. Based on the selected uncertainty the user will enter information that defines that uncertainty.

c. The **Hazard Communication Delay** parameter (Figure 9-4) is the time that it would take from when the hazard is identified to when the EPZ representatives would be notified. From the **Uncertainty Type** list, the user will select – None, Triangular, Normal, or Uniform. Based on the selected uncertainty the user will enter information that defines that uncertainty.

d. The **Warning Issuance Delay** parameter (Figure 9-4) is the time it takes from when the emergency managers receive the notification of the imminent hazard to when they issue an evacuation order to the public. The **Warning Issuance Delay** is part of the warning issuance process but it is defined in the emergency planning zone dataset (see Chapter 6 for further information).

e. The **Study Hydrograph** (Figure 9-4), which was defined in the hydraulic dataset (see Chapter 4 for further information), visually displays the overall Warning Issuance.

11. Now the user needs to define the destinations for the emergency planning zones; from the **Create New Alternative** dialog box (Figure 9-2), click the **Destination Zone Assignment** tab (Figure 9-6). The user can define unique (for multiple zones, when present) destinations for selected EPZs. For example, if the warning message content for a particular EPZ dictates specific destination locations those locations can be defined and people within the EPZ will attempt to evacuate to one of the specified destination locations.
a. The **Emergency Planning Zone** list (Figure 9-6), is a list of all the emergency planning zones contained in the selected EPZ dataset (Figure 9-3). Therefore, if a selected EPZ dataset has multiple zones then the list will contain the names of the multiple zones.

b. The **Destination Field Name** list (Figure 9-6) is a list of available field names from the selected EPZ dataset. Once a field name has been selected, in the box on the right (Figure 9-6) the name of the destinations will appear. To select individual destinations click the checkbox. To select all of the destinations, click **Select All**.

12. Once all of the information for the alternative has been entered, click **OK**, the **Create New Alternative** dialog box (Figure 9-2) will close. From the HEC-LifeSim main window (Figure 9-1), from the **Study Tree**, under the **Alternatives** folder, the name of the alternative is displayed.

### 9.2 Alternative – Evacuation Parameters

Evacuation parameters allow the user to adjust the default traffic simulation parameters in HEC-LifeSim. From the **Create New Alternative** dialog box (Figure 9-2) or from the **Alternative Editor** (similar to Figure 9-2), from the **Options** menu, click **Evacuation Parameters**. The **Evacuation Parameters** dialog box (Figure 9-7) will open. All available evacuation parameters are set with defaults, the user can adjust the parameters. To restore the default values click **Restore Defaults**. Once all adjustments have been made, click **Save**, the **Evacuation Parameters** dialog box will close (Figure 9-7).

- **Stop and Go Speed (mph)**: The stop and go speed (default 3 mph) represents the speed that vehicles will go in miles per hour in traffic jam conditions. It is the minimum speed that a vehicle can go.
• **Greenshield Power Term**: Parameter used to help define the relationship between speed and density of vehicles on the road network (default 1.5).

• **Pedestrian Speed (mph)**: The speed in miles per hour that people evacuating on foot will travel (default 4 mph).

• **Fraction in Vehicles (0-1)**: The fraction of population that will be evacuating in vehicles vs. on foot (default of 1, all in vehicles).

• **Fraction in Cars vs. SUVs/Trucks (0-1)**: Of the population evacuating in vehicles, the fraction that will be in cars vs. the fraction in SUVs/Trucks (default of 0.5, half in cars).

• **Vehicle Occupancy Rate**: Defines the maximum number of people per vehicle (default 3).

• **Fraction Who Re-Route in Jam (0-1)**: The fraction of population that have the option to re-route if a traffic jam is reached (default of 0.8, or 80 percent will reroute).

• **Vehicle Look-Forward Distance (feet)**: The distance in front of a vehicle along its path that defines the density of vehicles which affect its speed (default 1320 feet).

• **Road Segment Assessment Interval**: The number of sections that a road is broken into when binning vehicle counts on roads (default 4).

• **Impassable Road Flood Depths (feet)**: The depth threshold on roads in which vehicles will not attempt to re-route around the inundated road (default 2 feet).
• **Evacuation Time Step (seconds)**: The time step of the traffic simulation. Smaller time steps will give better vehicle interactions but take longer to run (default 10 seconds).

• **Live Traffic update interval (minutes)**: The time step between traffic update intervals or time between life traffic updates (default 5 minutes).

### 9.3 Alternative – Life Loss Parameters

Life loss parameters allow the user to adjust the default fatality rate curves that are used to define probability of life loss for the chance, compromised, and safe zones. Default values are based on research done by McClelland and Bowles (2002).

1. From the **Create New Alternative** dialog box (Figure 9-2) or from the **Alternative Editor** (similar to Figure 9-2), from the **Options** menu, click **Life Loss Parameters**. The **Life Loss Parameters** dialog box (Figure 9-8) will open.

![Life Loss Parameters Dialog Box](image)

2. All available life loss parameters are set with defaults, the user can adjust the parameters. To restore the default values click **Restore Defaults** (Figure 9-8).

3. Users can select a zone (**Chance**, **Compromised**, or **Safe**) from the **Zone** list (Figure 9-8) to view or modify the curve data. The **Relative Exceedance** (X-Axis) represents the probability of a receiving a particular fatality rate. The **Proportional Life Loss** (Y-Axis) represents the fatality rate. Using the default chance zone data, if 100 people were in the chance zone fifty of them would have a 100 percent fatality rate. In HEC-LifeSim, if a vehicle with three people, is placed in the **Chance** zone, then the frequency exceedance is
sampled to get the fatality rate and then a random sample is defined for each person to
determine life loss based on the sampled fatality rate.

4. The table (Figure 9-8) provides the Proportional Life Loss and Frequency Exceedance
data for the chosen zone. The user can modify the data by entering values into the fields
manually. The curves must be monotonically decreasing, any changes made to the table
that results in an unexpected value (increasing values instead of decreasing) will be
outlined in red. Any changes made to the table will be displayed in the plot.

5. When done evaluating/modifying the life loss parameters, click Save. The Life Loss
Parameters dialog box (Figure 9-8) will close.

9.4 Alternative – Stability Criteria

The user can adjust the default stability criteria in terms of depth (ft), velocity (ft/sec), and depth
multiplied by velocity (ft²/sec) for people, cars, and SUVs/trucks. Default values are based on
research done by Aboelata and Bowles (2005).

1. From the Create New Alternative dialog box (Figure 9-2) or from the Alternative
Editor (similar to Figure 9-2), from the Options menu, click Stability Criteria. The
Stability Criteria dialog box (Figure 9-9) will open.

![Stability Criteria Dialog Box](image-url)
2. All available stability criteria parameters are set with defaults, the user can adjust the parameters. To restore the default values click Restore Defaults (Figure 9-9).

3. Modify the listed stability criteria parameters (Figure 9-9) by entering values into the fields manually. The stability criteria represent the depth, velocity, and depth multiplied by velocity thresholds for stability in the hazard. If any of the thresholds are surpassed during a simulation for a given vehicle or group evacuating on foot, the group will automatically be assigned to the chance zone (refer to Section 9.3).

4. When done evaluating/modifying the stability criteria parameters, click Save. The Stability Criteria dialog box (Figure 9-9) will close.

### 9.5 Edit an Alternative

To edit an alternative, from the HEC-LifeSim main window (Figure 9-1), from the Study tab, from the Study Tree, from the Alternatives folder, right-click on an alternative name. From the shortcut menu (Figure 9-10), click Edit. Another way is from the HEC-LifeSim main window, from the Study menu, point to Alternatives, point to Edit, click on an alternative name. Either way the Alternative Editor will open (similar to Figure 9-2). Sections 9.1 through 9.4 cover all of the data items that can be edited by the user.

![Figure 9-10. Individual Alternative Shortcut Menu](image)

### 9.6 Copy an Alternative

To copy an alternative, from the HEC-LifeSim main window (Figure 9-1), from the Study tab, from the Study Tree, from the Alternatives folder, right-click on an alternative name. From the shortcut menu (Figure 9-10), click Copy. Another way is from the HEC-LifeSim main window, from the Study menu, point to Alternatives, point to Copy, click on an alternative name. Either way the Name of New Alternative dialog box (Figure 9-11) will open. Enter a new name in the
Name box, click OK, the Name of New Alternative dialog box (Figure 9-11) will close. From the HEC-LifeSim main window (Figure 9-1), from the Study Tree, under the Alternatives folder, the name of the alternative is displayed.

### 9.7 Delete an Alternative

To delete an alternative, from the HEC-LifeSim main window (Figure 9-1), from the Study tab, from the Study Tree, from the Alternatives folder, right-click on an alternative name. From the shortcut menu (Figure 9-10), click Delete. Another way is from the HEC-LifeSim main window, from the Study menu, point to Alternatives, point to Delete, click on an alternative name. Either way a Confirm Delete window (Figure 9-12) will open. The window will ask the user, “Are you sure you want to delete [the selected] alternative […] from the study”, click Yes to confirm the deletion. The Confirm Delete window (Figure 9-12) will close, and from the HEC-LifeSim main window (Figure 9-1), from the Study Tree, under the Alternatives folder, the name of the alternative no longer appears. The selected alternative is also deleted from the alternatives study directory.
CHAPTER 10

Simulations

An HEC-LifeSim simulation is a mathematical representation of the behavior of a system, given inputs and initial conditions. It applies the various study inputs (e.g., hydraulic scenario) to simulate the evacuation process and calculates consequence results based on the inputs. HEC-LifeSim simulations are created for the purpose of running and viewing life loss and damage estimation results for multiple alternatives. A common application for HEC-LifeSim would be to inform a risk analysis where consequence estimates will be developed for multiple hypothetical events for current and future conditions. Other applications include planning alternatives to reduce consequences (e.g., non-structural measures).

10.1 Create a Simulation

Now that all of the building blocks have been added and configured (imported datasets, configured alternatives), the user can create an HEC-LifeSim simulation.

1. From the HEC-LifeSim main window (Figure 10-1), from the Study tab, from the Study Tree, right-click on Simulations, from the shortcut menu, click Create New Simulation. Another way is from the HEC-LifeSim main window, from the Study menu, point to Simulations, click Create New.

![Figure 10-1. HEC-LifeSim Main Window](image)

2. Either way, the Create New Simulation dialog box (Figure 10-2) will open.
3. Enter a name for the simulation in the **Name** box (Figure 10-2).

4. In the **Imminent Hazard Time(s) of Day** box (Figure 10-2) select the imminent hazard times for the day (click each time that is required). The user must select at least one time of day. For each time of day selected, a new simulation will be calculated using the selected alternatives. For example, if **2 AM** is selected then the selected alternatives will be simulated for the selected number of iterations with the imminent hazard occurring at **2 AM**.

5. In the **Number of Iterations** box (Figure 10-2) enter the number of iterations for the simulation. The number of iterations cannot be greater than 1,000,000 (one million).

6. The results in HEC-LifeSim are summarized into zones. The zones are represented by polygons. Emergency planning zones are commonly used but the user can use any polygon shapefile (e.g., river mile from dam breach). To change the polygon for summarizing results, to the right of the **Summarize Results By** box (Figure 10-2), click **...**. An **Open** browser will open, navigate to the directory where the desired polygon shapefile is located, select it, and click **Open**. The **Open** browser will close and the desired summary results polygon path will be shown in the box.

7. From the **Alternatives** box (Figure 10-2), select the alternatives to use in the simulation by clicking on the alternative name. The user must select at least one alternative. Multiple alternatives can be selected.
8. Once all of the information for the simulation has been entered, click **OK**, the **Create New Simulation** dialog box (Figure 10-2) will close. From the HEC-LifeSim main window (Figure 10-1), from the **Study Tree**, under the **Simulations** folder, the name of the simulation is displayed.

### 10.2 Simulation – Computation Engine Options

Compute engine options allow the user to set the number of threads for the simulation. HEC-LifeSim is designed to take advantage of multiple processors, often called parallel processing. The number of threads for the simulation defaults to the maximum number of available processors on a user's computer. The user has the option of modifying the number of threads between one and the maximum number. Sometimes with very large datasets memory limits will be exceeded when a large number of threads are defined. It is recommended for very large datasets to reduce the number of threads if memory limits are reached.

1. From the **Create New Simulation** dialog box (Figure 10-2), or from the **Simulation Editor** (similar to Figure 10-2), from the **Options** menu, click **Computation Engine Options**. The **Computation Engine Options** dialog box (Figure 10-3) will open.

![Computation Engine Options Dialog Box](image)

Figure 10-3. Computation Engine Options Dialog Box

2. From the **Number of Threads for Simulation** list, select the number of threads that will be available for the simulation (e.g., 8).

3. Click **Save**, the **Computation Engine Options** dialog box will close (Figure 10-3).

### 10.3 Edit a Simulation

To edit a simulation, from the HEC-LifeSim main window (Figure 10-1), from the **Study** tab, from the **Study Tree**, from the **Simulations** folder, right-click on a simulation name. From the shortcut menu, click **Edit** (Figure 10-4). Another way is from the HEC-LifeSim main window, from the **Study** menu, point to **Simulations**, point to **Edit**, click on a simulation name. Either way the **Simulation Editor** will open (similar to Figure 10-2). Sections 10.1 and 10.2 cover all of the data items that can be edited by the user.

### 10.4 Delete a Simulation

To delete a simulation, from the HEC-LifeSim main window (Figure 10-1), from the **Study** tab, from the **Study Tree**, from the **Simulations** folder, right-click on a simulation name. From the shortcut menu (Figure 10-4), click **Delete**. Another way is from the HEC-LifeSim main window, from the **Study** menu, point to **Simulations**, point to **Delete**, click on a simulation name. Either way a **Confirm Delete Simulation** message window (Figure 10-5) will open. The
window will ask the user, "Are you sure you want to delete [the selected simulation] and all of its results" from the study, click Yes. The Confirm Delete message window (Figure 10-5) will close, and from the HEC-LifeSim main window (Figure 10-1), from the Study Tree, under the Simulations folder, the name of the simulation no longer appears. The simulation and associated results files will also be deleted from the simulations study directory.

10.5 Compute a Simulation

To compute a simulation, from the HEC-LifeSim main window (Figure 10-1), from the Study tab, from the Study Tree, from the Simulations folder, right-click on a simulation name. From the shortcut menu (Figure 10-4), click Run Simulation. Another way is from the HEC-LifeSim main window, from the Study menu, point to Simulations, point to Run, click on a simulation name.

The computation of the simulation will begin, from the HEC-LifeSim main window (Figure 10-1), a progress bar will appear (Figure 10-6) in the Status Bar, detailing the progress of the compute. Once the compute is complete, the Status Bar will detail information.
CHAPTER 11

Viewing HEC-LifeSim Results

When a simulation has been created for an HEC-LifeSim study the simulation should be computed (Chapter 10) and the results reviewed. During a simulation compute, summary results for each iteration are written out to a database, the user can then generate detailed iteration results to view agent level simulation data such as animations and evacuation timing. Agent level refers to viewing results down to the vehicle or evacuating group level. The detailed iteration results are computed per iteration to save both storage space and computation time. Results include summary tabulated results by iteration, summary box and whisker plots, plot by iteration and plot by uncertainty. In addition, detailed output can be generated by iteration allowing the user to animate the simulation in the Map Window and view detailed iteration plot results.

11.1 Simulation Results Table

Once the simulation has been create and computed, the results can be reviewed by iteration in table format. To view the simulation results tabulated:

1. From the HEC-LifeSim main window (Figure 11-1), from the Study tab, from the Study Tree, from the Simulations folder, right-click on a simulation, from the shortcut menu, point to View Results Table, click on an alternative. Another way is from the HEC-LifeSim main window, from the Study menu, point to Simulations, point to View Results Table, point to a simulation, click on an alternative.

![Figure 11-1. HEC-LifeSim Main Window](image-url)
2. Either way, the Simulation Results Table dialog box (Figure 11-2) will open for the alternative associated with the simulation.

![Simulation Results Table Dialog Box](image)

Figure 11-2. Simulation Results Table Dialog Box

3. The Simulation Results Table (Figure 11-2) can be summarized either by emergency planning zone (EPZ) or by time of day. To summarize results by an EPZ, from the Summary Zone list (Figure 11-2), select a different EPZ (if the simulation alternative includes multiple EPZs). To summarize results by a different time of day (when more than one time of day option is included in the simulation), from the Time Of Day Scenario list (Figure 11-2) select a time of day.

4. Click , the Select By Attribute dialog box (Figure 11-3) will open, from this dialog box the user can define equations to select results. The Available Fields box (Figure 11-3) provides a list of all of the result fields the user can select. The Functions box (Figure 11-3) provides the scripting commands and functions the user can use to filter results.

   For example, in Figure 11-3, the user wants to display the results where the number of people over sixty-five that survived in structures is between 500 and 10,000. To create the expression that represents these criteria, from the Functions box (Figure 11-3), under Booleans, the user double-clicked AND (Figure 11-3). In the Select from Results where box (Figure 11-3), what appears is AND(). From the Available Functions box, the user double-clicks Survived_In_StructuresO65, which now appears in the expression in the Select from Results where box. The user continues to add items to the expression, until the expression is complete. The note that appears below the Select from Results where box - Example: First data record (row id =0) would be equal to ‘True ’ - is explaining that the first row in the Simulation Iteration Results Table (Figure 11-2) is true for the defined expression.
5. Data in the Simulation Iteration Results Table (Figure 11-2) can be copied (i.e., entire table, individual cells, columns, rows). Select the range of data to copy, right-click, and from the shortcut menu click Copy. The information is copied to the clipboard and needs to be pasted to another application (e.g., Microsoft Excel®) for saving. Instead of using the shortcut menu the user can also use Ctrl + C.

11.2 Simulation Results Plot

The simulation results plot provides a way to summarize the HEC-LifeSim iteration results for an alternative and compare them across different times of day. The results are summarized in the form of box and whisker plots to allow the user to quickly gain an understanding of the distribution of various results from the Monte Carlo simulation. Users can access simulation result plots by:

1. From the HEC-LifeSim main window (Figure 11-1), from the Study tab, from the Study Tree, from the Simulations folder, right-click on a simulation, from the shortcut menu, point to View Results Plot, click on an alternative. Another way is from the HEC-LifeSim main window, from the Study menu, point to Simulations, point to View Results Plot, point to a simulation, click on an alternative.

2. Either way, the Simulation Results Plot dialog box (Figure 11-4) will open for the alternative associated with the simulation.

The following sections detail the available options from the Simulation Results Plot dialog box (Figure 11-4).
11.2.1 View by Summary Zone

The Simulation Results Plot (Figure 11-4) can be summarized by each summary zone polygon defined when creating the simulation. To view the summarized results by output summary polygon, click View By Summary Zone (Figure 11-4), and select a different zone from the list.

11.2.2 View by Summary Data

From the Simulation Results Plot dialog box (Figure 11-4) the user can summarize results by three categories - Life Loss, Percentage and Economic Damage. From the Plot Summary Data By list (Figure 11-5), for each category the user can select different options for viewing data in the Simulation Results Plot dialog box (Figure 11-4).
11.2.3 View Results by Iteration

Viewing results by iteration allows the user to visualize each iteration result in a scatter plot and helps the user identify which iterations calculated outlying values. These outlying values, or any iteration of interest, can then be selected to generate detailed output for that specific iteration.

1. From the Simulation Results Plot dialog box (Figure 11-4), from the View Results by box (Figure 11-6), click an available View Results by Iteration button. Another way is from the Simulation Results Plot dialog box (Figure 11-4), by right-clicking on a box and whisker plot, a shortcut menu will appear (Figure 11-7), from the shortcut menu click View Results by Iteration.

![Figure 11-6. Simulation Results Plot Dialog Box – View Results by Box](image1)

2. Either way, the Iteration Results Plot dialog box (Figure 11-8) will open.

![Figure 11-8. Iteration Results Plot Dialog Box](image2)
View by Summary Zone

The **Iteration Results Plot** (Figure 11-8) can show results by summary zone polygon. To view results by summary zone polygon, click **View By Summary Zone** (Figure 11-8), and select a different zone from the list.

View by Summary Data

From the **Iteration Results Plot** dialog box (Figure 11-8) the user can summarize results by two categories - **Life Loss** and **Economic Damage**. From the **Plot Summary Data By** list (Figure 11-9), for each category the user can select different options for viewing data in the **Iteration Results Plot** dialog box (Figure 11-8).

![Figure 11-9. Iteration Results Plot Dialog Box – Plot Summary Data By](image)

**11.2.4 View Detailed Output by Iteration**

When more information is desired for a specific iteration, detailed output can be generated. If detailed output is generated, HEC-LifeSim re-runs the specified iteration with the same random number sequence but this time much more information is saved. The detailed output generated contains information down to the evacuating group level regarding group size, location, and timing information during the simulation. The detailed output generated includes a database containing evacuation information for groups and their evacuation paths, structure inventory results shapefile, and a road network results shapefile. There is no limit to the number of iterations that HEC-LifeSim can generate a detailed output for, however physical memory could become an issue at some point. Detailed outputs cannot be generated concurrently.

From the **Iteration Results Plot** dialog box (Figure 11-8), from the **Detailed Output** box (Figure 11-10) enter the number of the iteration of interest in the **Iteration** box. Another way is from the plot, select a point and the iteration number will appear in the **Iteration** box (Figure 11-8). Click **Generate Detailed Output** from the **Detailed Output** box, or from the plot, right-click on a point of interest, and from the shortcut menu click **Generate Detailed Output**.

Once the generation of the detailed output is complete for the iteration, the point on the graph becomes red and the other options in the **Detailed Output** box (Figure 11-10) and the shortcut
menu (Figure 11-11) become available. The following sections provide detailed information about the other options.

<table>
<thead>
<tr>
<th>Iteration:</th>
<th>Re-Generate Detailed Output</th>
<th>Detailed Output Table</th>
<th>Structure Detail to Map Window</th>
<th>Time Evacuating</th>
<th>Evacuation Outflow</th>
<th>Animate Evacuation</th>
<th>Destination Arrival</th>
</tr>
</thead>
<tbody>
<tr>
<td>145</td>
<td>G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 11-10. Iteration Results Plot Dialog Box – Detailed Output Box

Figure 11-11. Iteration Results Plot Dialog Box – Detailed Output Shortcut Menu

**Re-Generate Detailed Output**

This option will only appear after detailed output has been generated for a selected iteration, this option will re-generate the specified iteration's detailed output. The **Re-Generate Detailed Output** option is best used when the simulation has been altered and a detailed output had already been created for specific iteration(s), and would need to be re-generated for the new simulation.

**Detailed Output Table**

After generating detailed output for an iteration, the detailed output can be displayed in tabular format (Figure 11-12) by clicking in the **Detailed Output Box** (Figure 11-10) or by clicking **Open Detailed Output Table** from the shortcut menu (Figure 11-11). The functionality of the table is the same as the summary results table (Section 11.1). The detailed output table contains information about each evacuating group’s behaviors during the iteration such as their origin, when they received the warning, when they mobilized, and where they evacuated to. This table can be very useful for finding specific information (e.g., the number of groups or people that did not get warned prior to getting trapped in their structure). The timing values for warning, mobilized, and ended are all relative to the imminent hazard time.

For every group that was defined for the iteration the detailed output table (Figure 11-12) contains the number of people, their origin (coincides with row number in structure attribute table), their destination (-1 means no destination was reached), warning information, mobilization information, and if they were caught evacuating.

When row(s) are selected, the user can generate a KMZ (Keyhole Markup Language Zipped) animation file. To generate the file, click **Generate KMZ Animation**, a **Save As** browser will
open (Figure 11-13). The user will find the location where to save the file, enter a name in the **File name** box, and click **Save**. The **Save As** browser will close, and the file will be created in the selected location. The KMZ file can be opened in Google Earth® and easily shared to show animation results. In most cases, HEC-LifeSim's animation system will be the preferred choice for viewing animation results.

---

**Structure Detail to Map Window**

After generating detailed output for an iteration, the structure detail can be added to the **Map Window** (Figure 11-14) of the HEC-LifeSim main window. The structure information added to the **Map Window** for the detailed output displays life loss total (i.e., **LL_Total**) that occurred
inside each structure and is color-coded and changes by size. For an increasing loss of life in a structure there is an increasing icon size and gray to red coloration. This output can be very useful for viewing the entire study area and highlight areas with the greatest risk for life loss in structures and which require supplementary investigation.

The user can make changes to how the structure detail layer displays in the Map Window through the Properties dialog box (Figure 11-15). Further detail on the properties of the structure detail layer can be found in Appendix A, Section A.8.

**Time Evacuating**

After generating detailed output for an iteration, an evacuation time histogram can be displayed (Figure 11-16) by clicking in the Detailed Output Box (Figure 11-10) or by clicking Time Evacuating Histogram from the shortcut menu (Figure 11-11). The time evacuating histogram,
for the results of the iteration selected, gives the user an indication for how long it takes groups
to evacuate to a destination. This data is gathered from the detailed output table as the difference
between TimeEnded and TimeMobilized.

Evacuation Outflow

After generating a detailed output for an iteration, a plot showing total outflow of evacuation can
be viewed (Figure 11-17) by clicking in the Detailed Output Box (Figure 11-10) or by
clicking View Evacuation Outflow from the shortcut menu (Figure 11-11). The evacuation
outflow plot displays the cumulative flow of people that mobilize and reach safety over time.
The plot can act as a good indicator of traffic congestion occurring during the evacuation. If the
"Safety" curve deviates from the "Mobilized" curve, this is an indication that traffic congestion is
occurring.

Animate Evacuation

After generating a detailed output for an iteration the detailed output results can be reviewed as
an animation in the Map Window. The detailed output animation provides a dynamic view for
the results of the iteration number selected. The animation results can be used to review
evacuation routes, warning issuance times, hydraulic data, and other simulation items. The
animations can also be exported as video files to share.

Click , the Evacuation Symbol Selection Wizard will open (Figure 11-18). From the wizard
the user can setup the different options for the animation. Information regarding modifying the
symbols for map layers can be found in Appendix A, Section A.8. Click Animate, the
Evacuation Symbol Selection Wizard will close (Figure 11-18) and the animation will display
in the Map Window (Figure 11-19) of the HEC-LifeSim main window.
To view the specific information for results displayed in a plot, left-click on the point of interest and a yellow callout box will open (e.g., Figure 11-20).
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Figure 11-19. Evacuation Animation Displayed in Map Window

The **Map Window** will now display an animation playback control and two new map layers will be added for the evacuation animation and the hydraulic animation. The animation toolbar controls function similarly to video controls for viewing the animation results in the **Map Window**.

**Destination Arrival**

After generating the detailed output for a specific iteration the cumulative destination arrival plot for that iteration can be viewed by clicking ▶️ in the **Detailed Output Box** (Figure 11-10) or by clicking **Cumulative Destination Arrival** from the shortcut menu (Figure 11-11). The **Cumulative Destination Arrival** plot (Figure 11-20) shows cumulative curves for the arrival of vehicles to each destination in the study. The plot can be very useful in checking the validity of the traffic simulation results. If a destination is showing significantly more outflow than historical department of transportation data would indicate then the user should question the validity of the results and consider adjustments. If a destination that should be getting significant through traffic is getting none then the user should check the road network to make sure the roads are connected correctly (refer to Appendix B for tips on how to refine road network...
connectivity). Another way to check would be to animate the evacuation process to see the area of concern.

Figure 11-20. Cumulative Destination Arrival Plot

11.2.5 View Results by Uncertainty

The user can visualize the results of the sampled uncertainty to quickly identify parameters that are driving the consequences. For example, plotting by warning issuance could show a strong trend between when the warning is issued and the total life loss. These results can be extremely helpful in identifying alternatives for risk reduction measures.

1. From the Simulation Results Plot dialog box (Figure 11-4), from the View Results by box (Figure 11-6), click an available View Results by Uncertainty button. Another way is from the Simulation Results Plot dialog box (Figure 11-4), by right-clicking on a box and whisker plot, a shortcut menu will appear (Figure 11-7), from the shortcut menu click View by Uncertainty.

2. Either way, the Uncertainty Results Plot dialog box (Figure 11-21) will open.

View by Emergency Planning Zone (EPZ)

Uncertainty results are stored by emergency planning zone for an alternative simulation since the uncertain parameters being viewed are reliant on the warning issuance, warning dissemination, and protective action initiation of the simulation. The Uncertainty Results Plot (Figure 11-21) can be displayed to only show results for individual emergency planning zones. To view results by emergency planning zone, click View By Emergency Planning Zone (Figure 11-21), and select a different zone from the list.
View by Summary Data

From the **Uncertainty Results Plot** dialog box (Figure 11-21); the user can summarize results by various parameters. From the **Sampled Parameter** list (Figure 11-22); the user can select different parameters for viewing data in the **Uncertainty Results Plot** dialog box (Figure 11-21).

For the **Mobilization** and **Warning Dissemination Curve** options, the X-axis represents the sample that was used to define the curve. A value of zero would mean the curve was sampled at the lower bound of the uncertainty and a value of one would mean that the curve was sampled at the upper bound. For example, if the PAI curve maximum % initiated for an EPZ ranged between 85 and 95 percent and the X-axis value was zero, then the iteration had a maximum % initiated of 85 percent of the population for the EPZ.
Appendix A

Map Preferences

To help the user visualize the study and results, HEC-LifeSim has the capability to display map layers that represent the features of a study. The map layers, displayed in the Map Window are also listed in the Map Layers tab (Figure A-1). Map layers provide a geographical reference for the study area. The HEC-LifeSim GUI (Figure A-1) describes the formats of the map layers, and provides commands that allow the user to configure, manage, and edit map layers.

Map layers are optional and not necessary for computing and reviewing results (Chapter 1). However, to view the results of simulation animations (Chapter 11) the Map Window is useful for helping to facilitate the review of simulation results and discussion with emergency managers. Furthermore, viewing map layers in the Map Window is a useful way to examine the validity of imported datasets. For example, a road network with missing connectivity or incorrect directions on one-way roads can lead to erroneous results. Therefore, editing the road network dataset can provide a reliable foundation for traffic simulation (Appendix B provides an example of editing an imported road network dataset in the Map Window).

A.1 Map Window

The Map Window (Figure A-1) provides a way to graphically display HEC-LifeSim components. The rendering engine takes advantage of the computer's graphics processing using Open Graphics Library - OpenGL (https://www.opengl.org/) to draw the map layers. All geographic information system (GIS) data is re-projected on the fly using GDAL (Geospatial Data Abstraction Library) (http://www.gdal.org/).
A.1.1 Map Window Toolbars

There are three toolbars located in the HEC-LifeSim main window Map Window Toolbox (Figure A-1). The first is the General Toolbar, second is the Selectable Layers Toolbar, and third is the Editor Toolbar. Details about each toolbar are detailed in the following sections.

**General Toolbar**

The General Toolbar includes the Select Tool (B), Pan Tool (P), Zoom In Tool (Z), Zoom to full extents, Add Data, Query Features Tool (Q), and Measure Distance Tool (M). These tools change the appearance of the cursor, as well as the functionality of the mouse cursor in the Map Window.

**Select Tool (B)**

The Select tool allows the user to select elements displayed in the Map Window that are currently selected in the Selectable Layers. More details on Selectable Layers can be found in the next section. To select features click on a feature or click, hold, and drag a rectangle around features to select them in the Map Window. Additionally, the Select Tool allows users to access shortcut menus which can be used to customize features when in editing mode.

**Pan Tool (P)**

The Pan tool allows the user to pan the Map Window; click the Pan tool and click, hold and move the mouse around the Map Window. Also, if the mouse has a wheel, then the user can pan the Map Window by using the wheel (click and hold the wheel to pan).

**Zoom In Tool (Z)**

The Zoom In tool allows the user to zoom in to areas of the Map Window. To zoom in, hold the mouse button down and outline the area of interest to enlarge. Also, if the mouse has a wheel then the user can zoom in or out using the wheel (wheel up zooms in and wheel down zooms out).

**Fixed Zoom Out Tool (O)**

The Fixed Zoom Out tool zooms out a fixed distance. Click the Fixed Zoom Out tool once and the HEC-LifeSim Map Window view will zoom out a fixed distance. Double-click on the Fixed Zoom Out tool and the Map Window view will zoom out twice the fixed distance.

Additionally the user can utilize the shortcut menu option, right-click anywhere in the Map Window, to zoom in or out a fixed distance.

**Zoom to full extents Tool**

The Zoom to full extents tool is a quick way to re-center the map by zooming out to the full geo-graphical extent of the map layers in the Map Window. Web layers do not affect the map extents.
Add Data Tool
Click the Add Data tool, the Browse for files browser will open. This browser allows users to navigate to layers (including *.shp, *.flt, *.tif, and *.vrt) of interest and add the layer(s) to the Map Window.

If the user clicks the down arrow next to the Add Data tool a shortcut menu will appear which allows the user to add data, add web imagery, or create new data that is added to the Map Window.

Query Features Tool (Q)
The Query Features tool identifies the geographic feature or place currently selected in the Map Window. Alternatively, multiple features can be identified by dragging a box over the desired area. Once a selection is made the Feature Query dialog box will open with the information presented in table format separated by Feature type. Only visible layers in the Map Window will be queried and the Selectable Layers option does not modify the Query Features tool.

Measure Distance Tool (M)
The Measure Distance tool allows the user to measure the distance along a specified line. With the tool selected, click to initiate the measure line. Each subsequent click will add a new point to the measure line. When finished, double-click on the location of the final point. The Measure Results dialog box will open and display the distance in the units the user has chosen (feet, miles, meters, or kilometers).

Selectable Layers Toolbar –
Selectable Layers Toolbar allows the user to turn on and off map layers of a study using the Select tool from the Selectable Layers Toolbar. The list of options depends on the maps layers located in the Map Layers tab, except Internet (web) layers. For further explanation on the use of Selectable Layers, refer to Section A.13.1.

Editor Toolbar –
The set of tools located in the Editor Toolbar become active after users initiate an editing session for a map layer. When a user right-clicks on a map layer in the Map Layers tab, from the shortcut menu (Figure A-2), click Edit, and the tools in the Editor Toolbar become active. Only one map layer can be edited at one time. For lines and polygons, there are two editing modes: feature edit and vertex edit. Clicking on a selected feature puts the user into the feature edit mode (move, delete, reverse), double-clicking on a selected feature puts the user in the vertex edit mode (add, delete, edit vertex points).

There are some tools available during an edit session which are not available from the shortcut menu (Figure A-2) or the Editor Toolbar. Clicking Delete will delete all currently selected features or currently selected vertices depending on which mode the user is in. Clicking the R key will reverse the direction of a currently selected line feature. Also, right-clicking during an edit session allows the user to do multiple tasks depending on what is clicked.
**Add new features Tool (A)**

The **Add new features** tool allows the user to add a new feature to the editable map layer by left-clicking to add feature data. Selected features can be deleted by either clicking the **Delete** key, or right-click on the selected feature(s) and from the shortcut menu click **Delete Selected Features**.

**Insert vertex Tool (I)**

The **Insert vertex** tool allows the user to add a vertex to an existing line or polygon map layer. The **Insert vertex Tool** becomes available when the selected feature is in the vertex edit mode. As the cursor gets close to the line or polygon edge the **Map Window** will display what the updated feature will look like if a vertex is added at the cursor. Left-click to insert the new vertex.

**Break line feature into two line features at a defined location Tool (K)**

The **Break line feature** tool will split a line feature into two features at the point the user clicked on the line. The user needs to be in the feature edit mode for this tool to be enabled.

**Continue from end (lines only) Tool**

The **Continue from end (lines only)** tool will continue a line feature from the end point of the line feature to the point to a second point clicked in the **Map Window**. Double-click to finish the line continuation edits or right-click and choose **Finish Editing Vertices**, or choose a different tool to finish the line continuation. The user needs to be in the vertex edit mode for this tool to be enabled.

**Add new line or polygon to existing feature Tool**

The **Add new line or polygon to existing feature** tool will allow the user to add a polygon or line to an existing selected polygon or line feature. For example, to add a hole to a polygon, click to add points defining the hole and double-click to finish. The user needs to be in the vertex edit mode for this tool to be enabled.
Feature Snapping Settings Tool
The Feature Snapping Settings tool allows the user to define snapping rules when editing. Snapping will automatically move the desired action to the nearest snap point when the cursor is close. This can be very useful when trying to line up endpoints of line features or place points directly on top of other features. Enable snapping by clicking Enable Snapping. From the Snap to Feature list, select the desired feature to snap to, then select how snapping will be applied (all points, end points, or edges).

Undo Tool (Ctrl + Z)
The Undo tool allows the user to undo changes made during an edit session. Only enabled if there are edits that can be undone.

Redo Tool (Ctrl + Y)
The Redo tool allows the user to redo changes made. Only enabled if there are edits to redo.

Save Edits Tool (Ctrl + S)
The Save Edits tool will save all edits made during the editing session. Only enabled if edits have been made.

Stop Editing Tool
The Stop Editing tool will stop the edit session. At this point a new map layer can be selected for editing. If edits have been made then the user will be prompted to save them before stopping the edit session.

Hot Keys
If a tool has a parentheses after the tooltip the letter in the parentheses represents a hot key (Table A-1) to call on the tool without clicking on it. For example, for the Query tool if the user clicks Shift-Q over the Map Window the Query tool will be active. Note, for the hot keys to work for tools located in the Editor Toolbar users must first initiate an editing session for a map layer.

A.1.2 Map Window Properties
To set the projection (coordinate system) associated with the HEC-LifeSim study, from the HEC-LifeSim main window (Figure A-1), from the Mapping menu (Figure A-3), click Map Properties. The Map Properties dialog box will open (Figure A-4), from this dialog box the user can setup the projection for the HEC-LifeSim study.

1. From the Map Properties dialog box (Figure A-4), click Import New Projection, an Open browser will open (Figure A-5).

2. From the Open browser (Figure A-5), navigate to the projection file of interest (usually any shapefile associated with the study area) and select a projection File (*.prj) and click Open.
Table A-1. Map Window Toolbars – Hot Keys

<table>
<thead>
<tr>
<th>Icon</th>
<th>Tool Name</th>
<th>Hot Key(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Select Tool</td>
<td>(Shift + B)</td>
</tr>
<tr>
<td></td>
<td>Pan Tool</td>
<td>(Shift + P)</td>
</tr>
<tr>
<td></td>
<td>Zoom In Tool</td>
<td>(Shift + Z)</td>
</tr>
<tr>
<td></td>
<td>Fixed Zoom Out Tool</td>
<td>(Shift + O)</td>
</tr>
<tr>
<td></td>
<td>Query Features Tool</td>
<td>(Shift + Q)</td>
</tr>
<tr>
<td></td>
<td>Measure Distance Tool</td>
<td>(Shift + M)</td>
</tr>
<tr>
<td></td>
<td>Add new features</td>
<td>(Shift + A)</td>
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<td></td>
<td>Insert vertex</td>
<td>(Shift + I)</td>
</tr>
<tr>
<td></td>
<td>Break Line Feature</td>
<td>(Shift + K)</td>
</tr>
<tr>
<td></td>
<td>Undo</td>
<td>(Ctrl + Z)</td>
</tr>
<tr>
<td></td>
<td>Redo</td>
<td>(Ctrl + Y)</td>
</tr>
<tr>
<td></td>
<td>Save Edits</td>
<td>(Ctrl + S)</td>
</tr>
</tbody>
</table>

Figure A-3. Mapping Menu

Figure A-4. Map Properties Dialog Box
3. The Open browser will close (Figure A-5) and the projection for the study will now be displayed in the Map Properties dialog box (Figure A-6). Click OK, and the Map Properties dialog box will close (Figure A-4).

A.2 Map Layers Tab

The Map Layers menu (Figure A-7) provides a tree view for the map layers that have been added to an HEC-LifeSim study. However, only selected (✓) layers in the Map Layers tab will display in the Map Window (Figure A-1). The user can turn map layers on or off, adjust the properties of the layers, and, modify the order of the layers for viewing in the Map Window.

A.3 Map Layers

Geographic Information System (GIS) files are the map layer formats supported by HEC-LifeSim and include: *.shp, *.flt, *.tif, and *.vrt. The user can add map layers, add background map layers, remove map layers, adjust a map layer's position in the view, edit a map layer's properties, zoom into a layer, and many other functions. The ability to manipulate the different map layers is specific for that map layer format.
A.3.1 Adding Map Layers

To add a map layer:

1. From the HEC-LifeSim main window (Figure A-1), from the Mapping menu (Figure A-3), click Add Map Layer. Also, from the General Toolbar (Section A.1.1), click . Either way, the Browse for files browser (Figure A-8) will open.

2. From the Browse for files browser (Figure A-8), navigate to the GIS file of interest that will be added as a map layer. Select the appropriate GIS file (*.shp, *.flt, *.tif, or *.vrt) and the File name box (Figure A-8) will now display the selected filename.

![Figure A-8. Browse for files Browser](image)

3. Click Open, the Browse for files browser (Figure A-8) will close, the selected dataset will now be displayed in the Map Window, and selected map layer name will appear in the Map Layer Tree.

Another way to add map layers, is to drag and drop the desired GIS files directly onto the either the Map Window or the Map Layers Tree (Figure A-9) from a folder. Desired GIS files can be dropped in between map layers in the Map Layers Tree to define the layer position when displaying to the Map Window.

![Figure A-9. Drag and Drop Map Layers](image)
Note: When shapefiles are added utilizing the drag and drop method from a folder to the Map Window, the default settings for specific data types may not appear correctly. For example, in Figure A-9, when adding Example_Destinations in Map Window, the destinations should appear as yellow stars (★), instead destinations appear as the default general point layer symbol. Refer to Section A.8 for details on changing map layer symbology.

### A.3.2 Adding Background Internet Maps

Knowing where the study is located in reference to known geographic positions can be quite helpful with communication. There are two types of internet background maps, OpenStreetMap and ESRI World Imagery map and there are two ways to add these background internet maps.

To add a background internet map to the HEC-LifeSim study, from the Mapping menu on the HEC-LifeSim main window (Figure A-3), point to Add Web Layer, and select the internet map from the available list which would be a good background map for the study area. Also, from the General Toolbar (Section A.1.1), click from the shortcut menu (Figure A-10), point to Add Web Imagery, and select the internet map from the available list which would be a good background map for the study area. Either way, the selected background map will display in the Map Window (Figure A-11).

![Figure A-10. General Toolbar - Add Data Shortcut Menu](image)

### A.3.3 Map Layer Position in the Map Layer Tree

Once a map layer is added to an HEC-LifeSim study, the user can adjust the position of a map layer. Within the HEC-LifeSim framework, some map layers represent a particular HEC-LifeSim dataset (i.e., hydraulic data, structure inventories, emergency planning zones), while other map layers provide information.

The Map Layer Tree (Figure A-11) displays the map layers from top to bottom, where the topmost layer overlays the next one down in the list and continues to the bottom layer. In other words, if a background internet map is added, that map layer will automatically be added to the bottom of the Map Layers Tree (Figure A-11), and will be underneath all layers listed above it. At times it may be desirable to have various map layers drawn in a different order in the Map Window.

To move map layers:

1. From the Map Layers Tree (Figure A-7), right-click on the map layer of interest, from the shortcut menu (Figure A-2), either select Move Up or Move Down.
2. To move the map layer of interest below other map layers listed in the Map Layers Tree, click Move Down. The selected map layer will move one step below its current position. Repeat until the map layer of interest is at the desired location within the Map Layers Tree.

![Background Internet Map](image1)

Figure A-11. Background Internet Map

3. To move the map layer of interest above other map layers listed in the Map Layers Tree, click Move Up. The selected map layer will move one step above its current position. Repeat until the map layer of interest is at the desired location within the Map Layers Tree.

Another way to move map layers in the Map Layers Tree is to drag and drop a map layer to the desired location in the Map Layers Tree. From the Map Layers Tree, click and hold the map layer of interest, move the cursor up or down the Map Layer Tree (the selected map layer will move in conjunction with the mouse). A bar will show the new location where the selected map layer will be moved (Figure A-12), release the mouse, and the selected map layer will be in a new position on the Map Layer Tree.

![Moving a Selected Map Layer in the Map Layers Tree](image2)

Figure A-12. Moving a Selected Map Layer in the Map Layers Tree
A.3.4 Zoom to Layer

This option, will set the zoom of the Map Window (Figure A-11) based on the extents of the selected map layer. From the Map Layers Tree (Figure A-12), right-click on the map layer of interest, from the shortcut menu (Figure A-2), click Zoom to Layer, the Map Window view will change to include the entire extent for the selected map layer.

A.3.5 Map Layer Select Options

There are three options (Select All, Select by Polygon, or Reverse Selection) for selecting map layer features from the Individual Map Layer shortcut menu (Figure A-13).

![Figure A-13. Individual Map Layer Shortcut Menu - Select](image)

- **Note**: If the Map Window tool, Selectable Layers (Section A.1.1), has been modified from All Layers, the Select commands might not be accessible. If the Select shortcut commands are unavailable for a specific map layer, make certain the map layer is selected (✓) in the Selectable Layers dropdown list, and try the Select shortcut commands again.

The following describes the Select sub-menu commands:

- **Select All**: The Select All command will select all of the features within the map layer.
- **Select by Polygon**: The Select by Polygon command will open the Select by Polygon dialog box (Figure A-14).
- **Reverse Selection**: The Reverse Selection command will select the opposite. For example, if all of the features are selected in the map layer then choosing Reverse Selection will de-select all of the features.
Select By Polygon

1. From the Map Layers tab, right-click on a map layer of interest (Figure A-13), from the shortcut menu point to Select, click Select by Polygon. The Select by Polygon dialog box will open (Figure A-14).

2. From the Selection Polygon box (Figure A-14), the user must select either Polygon from map or Polygon from file.

   - Polygon from map (default): The user will need to select a polygon map layer that is part of the HEC-LifeSim study from the Polygon map layer list (Figure A-14), which contains a list of the polygon map layers (e.g., the Emergency Planning Zone(s) map layer) currently in the Map Layers tab. Notice, there is an option in the Polygon from map section to Use selected polygons (Figure A-14). The Use selected polygons option will only be available when the identified Polygon map layer has features selected or if a subset of a layer has been selected (using the Select By Attribute option is explained in Section A.4; or the map layer Select options are explained in Section A.3.5).

   - Polygon from file: This allows the user to select a polygon shapefile. When selected (Figure A-15), from the Polygon Shapefile box (Figure A-15), click , the Select a Polygon Shapefile browser will open. The user will need to navigate to the file of choice and select the desired polygon shapefile (*.shp). Click, Open, the Select a Polygon Shapefile browser will close, and the name of the selected polygon shapefile will display in the Polygon Shapefile box (Figure A-15).
3. Next, from the **Selection Options** box (Figure A-14), the user needs to set the selection type. The choices are **Contains** and **Intersects**:

   - **Contains** (default) – this option (Figure A-14) will select features that are completely within a polygon that has been selected. In other words, this option will not select any features which intersected with the border of the selecting polygon.

   - **Intersects** – this option (Figure A-14) will only select features which intersects the polygon that has been selected. This includes features that are completely contained in the selection polygon in addition to intersecting with the border of the selecting polygon. Note, this option will is not available for point shapefiles.

4. The last step, is the selections method, available options are **Append**, **New Selection**, and **Select from Selection**:

   - **Append** – this option (Figure A-14) adds the selection to the already selected features. This option will only be available if there are selected features within the input map layer.

   - **New Selection** (default) – this option (Figure A-14) will clear any previous selection made to the input map layer.

   - **Select from Selection** – this option (Figure A-14) will only select features that are currently selected in the input map layer.

5. Click, **OK**, the **Select by Polygon** dialog box will close (Figure A-14). Now, the selected map layer will have features selected in the **Map Window** corresponding to the preferences set in the **Select by Polygon** dialog box (Figure A-14).

### A.4 Map Layer Attributes Dialog Box

Map layer attributes can be accessed for each map layer and provides a table for the dataset referenced by the map layer. To access a specific map layer **Attribute** table:

- From the **Map Layers** tab, right-click on a map layer of interest, from the shortcut menu (Figure A-2), click **Open Attribute Table**. The **Map Layer Attributes** dialog box will
open (Figure A-16). Editing of the map layer attributes is detailed in Section A.10 of this appendix.

- **Note**: From the table, when a single cell is selected (e.g., row 1, column 1) the keyboard arrow keys (and the tab and enter keys) can be utilized to step through the table one cell at a time.

### A.4.1 Attribute Selection Tools

**Select By Attribute Tool**
Opens the Select By Attribute dialog box (Figure A-17), which allows the user to perform queries, make selections, and locate features in the Map Window. When a feature is selected in the attribute table, that same feature will also be selected in the Map Window (and vice versa).

**Show All Records Tool**
Allows the user to show all records (selected or unselected) in the attribute table for the map layer of interest.

**Show Selected Records Only Tool**
Allows the user to only show features in the attribute table which were selected in the Select By Attribute dialog box (Figure A-17).
Deselect All Records Tool

Unselects all records which were selected in the Select By Attribute dialog box (Figure A-17). When the tool is selected all records will be viewable and none will be highlighted in the attribute table (and in the Map Window).

A.4.2 Selecting Features/Rows by Attribute

To access and select specific attributes for a map layer:

1. From the Map Layers tab of the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest. From the shortcut menu (Figure A-2), click Open Attribute Table, the Map Layer Attributes dialog box will open (Figure A-16).

2. Click , the Select By Attribute dialog box will open (Figure A-17). The user by selecting certain attributes and using expressions can manipulate the selected map layer. The Available Fields box (Figure A-17) provides a list of all of the attributes of the selected map layer. Double-click on an attribute in the Available Fields box, this will add the attribute to the Select from Map Layer Name where box (Figure A-18). The Functions box contains the commands and functions that the user can select for creating expressions.

3. Figure A-18 provides an example expression. From Booleans (Figure A-17), the user has selected AND, selected the attribute N_Stories from the Available Field box (Figure A-17). N_Stories has been set to equal to 1, and the attributes Pop2pmU65 is set to greater than 100.
A message appears below the Select from Map Layer Name where box (Figure A-18) – Example: First data record (row id = 0) would be equal to ‘False’. The word False is explaining that the first row in the table on the Map Layer Attributes dialog box (Figure A-16) is false for the example expression and will not become selected when the Execute button is clicked. If the word True was displayed in the message, then the first row in the table on the Map Layer Attributes dialog box (Figure A-16) would have been selected by the example expression.

4. If the entered expression contains errors the message section below the Select from Map Layer Name where box (Figure A-18) will display the issues with the expression. The message will say Tree contains errors until the expression is completed correctly.

5. Another resource providing help to complete an expression is the ErrorLog which is available when an expression is incorrect. Click ErrorLog, the Errors Encountered in Expression dialog box will open (Figure A-19). Information is provided on what the possible issues are with the defined expression.

6. Once the expression is correct, run the expression, click Execute. The Select By Attribute dialog box will close (Figure A-17) and the rows in the table on the Map Layer Attributes dialog box (Figure A-20) where the expression is True will be highlighted in dark teal. Show Selected Records Only ( ) and Deselect All Records ( ) are now active.

7. After a selection is made in the table (Figure A-20), the feature is not only highlighted in the table, but is also highlighted in the Map Window (Figure A-1) for the selected map layer. For example, in Figure A-21, features are highlighted in the Map Window following the successful execution of the defined expression. The highlighted features will be differentiated in bright teal (as opposed to the original blue color). Double-
clicking in the Map Window will deselect the features in the Map Window and in the Map Layer Attributes dialog box (Figure A-20).

8. **Show Selected Records Only** ([ ] ) will only display the highlighted features in the table on the Map Layer Attributes dialog box (Figure A-20). Clicking ([ ] (Show All Records), will bring back all of the records for the selected map layer.

![Figure A-21. Map Window – Displaying Features Selected in Map Layer Attributes Dialog Box](image)

**A.4.3 Attribute Table Shortcut Menu**

Other functions and commands are available from the Map Layer Attributes dialog box (Figure A-20). If the user right-clicks on a selected row in the table, a shortcut menu will display, with one option - **Zoom to Selected**. **Zoom to Selected** will zoom to the selected row(s) in the table (Figure A-20) on the Map Window.
When the user right-clicks on selected column(s) in the table, a shortcut menu will display (Figure A-22) with several available options - Sort Ascending, Sort Descending, Remove Sort, Calc. Statistics, Find, Field Calculator, and Delete Column. Other options are available when the user is in edit mode (described in Section A.10.1).

![Figure A-22. Attributes Table – Selected Columns Shortcut Menu](image)

**Sort Ascending**  
Sorts the selected column in ascending (i.e., low to high; A – F) order. After clicking **Sort Ascending**, an up arrow (↑) will appear in the column header to show the sorting of the selected column. Double-clicking on a selected column will reverse the current sort.

**Sort Descending**  
Sorts the selected column in descending (i.e., high to low; F – A) order. After clicking **Sort Descending**, a down arrow (↓) will appear in the column header to show the sorting of the selected column. Double-clicking on a selected column will reverse the current sort.

**Remove Sort**  
Remove Sort does not become active until either Sort Ascending or Sort Descending has been clicked. Remove Sort will revert the selected column back to its original state.

**Calc. Statistics**  
When clicked the Attribute Summary Statistics dialog box will open (Figure A-23), providing the summary statistics for the selected columns (default) in the table (Figure A-20). If the selected columns have numeric values then the summary statistics will include indicative statistics of the data and a histogram. If the selected columns have text data then the summary statistics will have a list of all the unique text values and the frequency of those text values along with a pie chart of the most frequent text values. When rows in the table on the Map Layer Attributes dialog box (Figure A-20) are selected, the Selected Rows Only option (Figure A-23) becomes available in the Attribute Summary Statistics dialog box (Figure A-23). If the user clicks this option, the summary statistics displayed are only for the selected rows in the Map Layer Attributes Table (Figure A-20). The pie chart (Figure A-23) will lump smaller counts into a new unique value and count entitled Other if there are more than four unique items associated with the selected column.
The **Find** option is only available when the entire table on the Map Layer Attributes dialog box (Figure A-20) is available. If the user has selected **Show Selected Records Only** (Figure A-20), then the **Find** option will not be available. When **Find** is clicked, the **Find In: Attribute** dialog box (Figure A-24) will open. The user can search for specific attributes by entering the attribute name in the **Find** box (Figure A-24).

### A.5 Create New Map Layers

New map layers can be created in HEC-LifeSim using the **Create New Vector Features File** dialog box (Figure A-25). The new map layers created are shapefiles (*.shp), which store non-topological geometry and attribute information for the spatial features of a dataset.
To create a new map layer:

1. From the HEC-LifeSim main window (Figure A-1), from the Mapping menu (Figure A-26), click Create New Vector Layer. Another way is from the General Toolbar (Figure A-1), from Add Data ( ); from the shortcut menu (Figure A-27), click Create New. Either way, the Create New Vector Features File dialog box (Figure A-25) will open.

2. From the File Output Location box (Figure A-25) click , a Save As browser will open (Figure A-28), navigate to the desired directory for storing the shapefile (*.shp). Enter a name (required) in the File name box (Figure A-28) for the new map layer. Click Save, the Save As browser will close (Figure A-28) and pathname and filename of the new map layer will display in the File Output Location box (Figure A-25).

3. From the Feature Type list (Figure A-25) select the geographic features of the shapefile which can be represented as points, polylines (lines), or polygons (areas).
4. Users have the option to select a projection for the new map layer from another map layer. To add a reference map coordinate system (create a projection), from the Projection box (Figure A-25), click Open, an Open browser will open (Figure A-5). Navigate to the location of the projection file that contains the projection that will be used for the new map layer (*.prj), select the file and click Open. The Open browser will close (Figure A-5), the Create New Vector Features File dialog box (Figure A-25), Projection box will now contain the file location of the selected projection file.

5. Click OK, the Create New Vector Features File dialog box will close (Figure A-25). The HEC-LifeSim Map Layers tab (Figure A-1) will now contain the newly created map layer (at the bottom of the Map Layers tab).
6. The next step after creating a new map layer is to add new features. Adding new features to the map layer will be discussed in detail in Section A.10.

### A.6 Map Layer Tools

In HEC-LifeSim there are tools available to perform operations on map layers that can be useful in preparing data and analyzing results (e.g., exporting shapefiles, clipping features, or creating buffer polygons). Currently tools are only available for points, lines, and polygons shapefiles but will be expanded in the future to include gridded data. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer of interest. From the shortcut menu, point on **Tools**, from the submenu (Figure A-29) are several commands that are available for editing map layers. These commands change according to the feature type (points, polylines, or polygons). The following is an overview of each command:

![Individual Map Layer Shortcut Menu – Tools](image)

**Export to New Shape** Exports the selected map layer as a new shapefile (i.e., output shapefile), saved with a name provided by the user. There are options to save the new shapefile with the Map Window projected coordinate system or the original coordinate system set for the selected map layer. Another alternative is to export only selected features for the map layer, when a subset of the map layer's features has been selected. This command is available for points, polylines, and polygon feature types. See Section A.6.1 for further details on the use of this command.

**Create Centroids Shapefile** Calculates the center point for the polygon(s) in the selected map layer and creates a centroids shapefile. An additional option allows the user to only include selected features in the centroids shapefile. This command is only available for polygon feature types. See Section A.6.2 for further details on the use of this command.
**Buffer**

Creates polygons around features within the selected map layer, for a set distance around the object called a buffer (Figure A-30). There is an option to merge the buffered features in the created polygon shapefile. If the merge option is selected all overlapping buffer polygons will be merged into one features and all attribute information will be removed from all of the new buffered features of the created polygon shapefile. This command is available for points, polylines, and polygon feature types. See Section A.6.3 for further details on the use of this command.

![Buffer Tool Options – Illustration by Feature Type](image)

**Simplify**

This tool is utilized for simplifying the source polyline or polygon map feature by eliminating points based on the Simplification Method chosen. There are three methods to choose from (Visalingam Whyatt, Lang, and Douglas Peucker). Based on the Simplification Method chosen the dialog box will change to accommodate the parameters for the method of choice. This command is available for polylines and polygon feature types. See Section A.6.5 for further details on the use of this command.

**Clip**

Clip can be utilized to extract features from the selected map layer, using a polygon map layer or polygon shapefile to clip the input map layer features to within the polygon boundaries (Figure A-31). This command is available for polylines and polygon feature types. See Section A.6.4 for further details on the use of this command.
A.6.1 Export to New Shapefile

To export a selected map layer to a new shapefile:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-29), click Export to New Shape. The Export To Shapefile dialog box will open (Figure A-32).

2. From the Output Shapefile box (Figure A-32), click , a Save As browser will open (Figure A-28). Navigate to the desired location for storing the new shapefile (*.shp), enter a name (required) in the File name box (Figure A-28) for the new shapefile.

3. Click Save, the Save As browser will close (Figure A-28), the Export To Shapefile dialog box (Figure A-32) will now display the path and name for the new shapefile to be saved in the Output Shapefile box.
4. Next, the user needs to select the projection for the new shapefile. From the **Output Projection** box (Figure A-32) the available options: **Use Map Projection** or **Use Source Projection**.

   - **Use Map Projection** – this will set the new shapefile's projected coordinate system to that of the HEC-LifeSim study.
   - **Use Source Projection** – this will set the new shapefile's projected coordinate system to that of the selected map layer.

5. An optional step, **Export Selected Features** (Figure A-32) allows the user to save the new shapefile with only features that have been selected for the selected map layer (i.e., using the **Select By Attribute** option explained in Section A.4; or the **Select** options explained in Section A.3.5).

6. Click **OK**, the **Verify Add Results** message window will open (Figure A-33) asking the user if the newly created shapefile should be added to the **Map Window** (Figure A-1). Click **Yes**, to add the new shapefile to the **Map Window**, and the **Verify Add Results** message window will close (Figure A-33).

![Verify Add Results Message Window](image)

**A.6.2 Create Centroids Shapefile**

To create a centroids shapefile from a selected map layer (polygon shapefile):

1. From the **Map Layers** tab, on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-29), click **Create Centroids Shapefile**. The **Create Centroids** dialog box will open (Figure A-34).

![Create Centroids Dialog Box](image)
2. From the **Output Shapefile** box (Figure A-34), click ![Save As](.), a **Save As** browser will open (Figure A-28). Navigate to the desired location for storing the new centroids shapefile (*shp*), enter a name (required) in the **File name** box (Figure A-28) for the new centroids shapefile.

3. Click **Save**, the **Save As** browser will close (Figure A-28), the **Create Centroids** dialog box (Figure A-34) will now display the path and shapefile name for the new centroids shapefile to be saved in the **Output Shapefile** box.

4. Next, the user needs to select the projection for the new centroids shapefile. From the **Output Projection** box (Figure A-34) the available options: **Use Map Projection** or **Use Source Projection**.

   - **Use Map Projection** – this will set the new centroids shapefile's projected coordinate system to that of the HEC-LifeSim study.

   - **Use Source Projection** – this will set the new centroids shapefile's projected coordinate system to that of the selected map layer.

5. An optional step, **Only for Selected Features** (Figure A-34) allows the user to save the new shapefile with only features that have been selected for the selected map layer (i.e., using the **Select By Attribute** option explained in Section A.4; or the **Select** options explained in Section A.3.5).

6. Click **OK**, the **Verify Add Results** message window will open (Figure A-33) asking the user if the newly created shapefile should be added to the **Map Window** (Figure A-35). Click **Yes**, to add the new shapefile to the **Map Window**, and the **Verify Add Results** message window will close (Figure A-33).

### A.6.3 Buffer

To create a new shapefile that is based on one set distance of a selected map layer:

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-29), click **Buffer**. The **Create Buffer Polygon(s)** dialog box will open (Figure A-36).

2. From the **Output Shapefile** box (Figure A-36), click ![Save As](.), a **Save As** browser will open (Figure A-28). Navigate to the desired location for storing the new shapefile (*shp*), enter a name (required) in the **File name** box (Figure A-28) for the new shapefile.

3. Click **Save**, the **Save As** browser will close (Figure A-28), the **Create Buffer Polygon(s)** dialog box (Figure A-36) will now display the path and shapefile name for the new shapefile to be saved in the **Output Shapefile** box.
4. Next, the user needs to select the projection for the new centroids shapefile. From the Output Projection box (Figure A-36) the available options: **Use Map Projection** or **Use Source Projection**.

   - **Use Map Projection** – this will set the new shapefile's projected coordinate system to that of the HEC-LifeSim study.
• **Use Source Projection** – this will set the new shapefile's projected coordinate system to that of the selected map layer.

5. The user will need to enter the buffer distance for the new shapefile. In the **Buffer Options** box (Figure A-36), in the **Buffer Distance** box enter the buffer distance in feet (e.g., 50).

6. An optional step, **Only Buffer Selected Features** (Figure A-36) allows the user to save the new shapefile with only features that have been selected for the selected map layer (i.e., using the **Select By Attribute** option explained in Section A.4; or the **Select** options explained in Section A.3.5).

7. Click **OK**, a **Verify Add Results** message window will open (Figure A-33) asking the user if the newly created shapefile should be added to the **Map Window** (Figure A-1). Click, **Yes**, to add the new shapefile to the **Map Window**, and the **Verify Add Results** message window will close (Figure A-33).

**A.6.4 Clip Tool**

To create a shapefile of a selected map layer that has been clipped (points and polygons):

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-29), click **Clip**. The **Clip by Polygon** dialog box will open (Figure A-37).

![Figure A-37. Clip by Polygon Dialog Box](image)

2. From the **Output Shapefile** box (Figure A-37), click **[ ]**, a **Save As** browser will open (Figure A-28). Navigate to the desired location for storing the new shapefile (*.shp), enter a name (required) in the **File name** box (Figure A-28) for the new shapefile.
3. Click **Save**, the **Save As** browser will close (Figure A-28), the **Clip by Polygon** dialog box (Figure A-37) will now display the path and shapefile name for the new shapefile to be saved in the **Output Shapefile** box.

4. Next, the user needs to clip the selected map layer based on polygon shapefiles that are part of the HEC-LifeSim study or from other polygon shapefiles. The available options are: **Polygon From Map** or **Polygon From File**.

   - **Polygon From Map**: From the **Clip Polygon** box (Figure A-37), from the **Clip Polygon Shapefile** list (Figure A-37), all polygon map layers (e.g., the *Emergency Planning Zone(s)* map layer) associated with the current HEC-LifeSim study will be available. The user will need to select the desired polygon map layer that will be used to clip the selected map layer. An optional feature is **Use Selected Features for clip** (Figure A-37) which is only available when the selected map layer has features selected (i.e., using the **Select By Attribute** option explained in Section A.4, or the **Select** options explained in Section A.3.5).

   - **Polygon From File**: From the **Clip Polygon** box (Figure A-38), from the **Clip Polygon Shapefile** box, click ![browse_icon](image), the **Please select a clip polygon shapefile** browser will open. The user will need to navigate to the file of choice and select the desired polygon shapefile (*.shp). Click **Open**, if the selected file is a polygon shapefile, the **Please select a clip polygon shapefile** browser will close. On the **Clip by Polygon** dialog box (Figure A-38), the selected file's path and name will display in the **Clip Polygon Shapefile** box (Figure A-38). If the file selected is not a polygon shapefile, then, a warning message window will open (Figure A-39).

![Clip by Polygon Dialog Box – Polygon From File Option](image)

![OpenGLMapping Warning Message](image)

5. Next, the user needs to select the projection for the new centroids shapefile. From the **Output Projection** box (Figure A-37) the available options: **Use Map Projection** or **Use Source Projection**.
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- **Use Map Projection** – this will set the new shapefile's projected coordinate system to that of the HEC-LifeSim study.

- **Use Source Projection** – this will set the new shapefile's projected coordinate system to that of the selected map layer.

6. An optional step, **Only Clip Selected Features** (Figure A-37) allows the user to save the new shapefile with only features that have been selected for the selected map layer (i.e., using the **Select By Attribute** option explained in Section A.4; or the **Select** options explained in Section A.3.5).

7. Click **OK**, a **Verify Add Results** message window will open (Figure A-33) asking the user if the newly created shapefile should be added to the **Map Window** (Figure A-1). Click **Yes**, to add the new shapefile to the **Map Window**, and the **Verify Add Results** message window will close (Figure A-33).

A.6.5 **Simplify – Polygon Map Layer**

To create a shapefile of a selected polygon map layer that has been simplified (polylines and polygons):

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-29), click **Simplify**. Based on the feature type of the selected map layer, either the **Simplify Polygon(s)** dialog box (Figure A-40) or the **Simplify Line(s)** dialog box (similar to Figure A-40) will open.

![Figure A-40. Simplify Polygon(s) Dialog Box](image)
2. From the **Output Shapefile** box (Figure A-40), click ➔, a **Save As** browser will open (Figure A-28). Navigate to the desired location for storing the new shapefile (*.shp), enter a name (required) in the **File name** box (Figure A-28) for the new shapefile.

3. Click **Save**, the **Save As** browser will close (Figure A-28), the **Simplify Polygon(s)** dialog box (Figure A-40) will now display the path and shapefile name for the new shapefile to be saved in the **Output Shapefile** box.

4. Next, the user needs to select the projection for the new centroids shapefile. From the **Output Projection** box (Figure A-40) the available options: **Use Map Projection** or **Use Source Projection**.
   - **Use Map Projection** – this will set the new shapefile's projected coordinate system to that of the HEC-LifeSim study.
   - **Use Source Projection** – this will set the new shapefile's projected coordinate system to that of the selected map layer.

5. The user must select method for simplifying the selected map layer. From the **Simplify Options** box (Figure A-40), from the **Simplification Method** list (Figure A-40), select the appropriate simplification method. Each method has its own set of inputs. The simplification methods are briefly described:
   - **Visalingam Whyatt** – An area based algorithm to eliminate points based on each individual points effective area (area within the polygon the point affects). The point(s) which affect the polygon the least will be removed first. The user must enter the maximum number of points (greater than four and less than two points than the total number of points in the polygon) to be eliminated (**Number of Points** box, Figure A-40). If the number of points entered is greater than the total number of points in the polygon then an identical copy of the polygon will be made.
   - **Lang** – A perpendicular distance based algorithm to eliminate points based on the perpendicular distance of the points. The perpendicular distance is compared to a user entered tolerance limit for intermediate points between the end point and the entered number of look ahead points. The algorithm works based on the simplify inputs (**Number of Points** box, Figure A-40), tolerance and look ahead points that the user enters. The **Tolerance** value must be greater than zero and the **Look Ahead Points** number must be less than or equal to the total number of points in the polyline or polygon shapefile. The point(s) which have a perpendicular distance less than the **Tolerance** limit for a set number of **Look Ahead Points** will be eliminated until there are no more intermediate points. If the number of **Look Ahead Points** entered is greater than the total number of points in the polygon or polyline shapefile then an identical copy of the selected shapefile will be made.
   - **Douglas Peucker** – Similar to the **Lang** method, in that the points are eliminated based on the points distance from a simplification line. The simplification line is a
straight line between key points. Key points are set for points greater than the **Tolerance** level defined by the user. The **Tolerance** level is the **Simplify Inputs** for the **Douglas Peucker** method, and the value must be greater than zero. In the end only the key points will remain after this simplification method is used.

6. An optional step, **Simplify Only Selected Features** (Figure A-40) allows the user to save the new shapefile with only features that have been selected for the selected map layer (i.e., using the **Select By Attribute** option explained in Section A.4; or the **Select** options explained in Section A.3.5).

7. Click **OK**, a **Verify Add Results** message window will open (Figure A-33) asking the user if the newly created shapefile should be added to the **Map Window** (Figure A-1). Click **Yes**, to add the new shapefile to the **Map Window**, and the **Verify Add Results** message window will close (Figure A-33).

### A.7 Remove Map Layers

Removing map layers for an HEC-LifeSim study:

1. From the HEC-LifeSim main window (Figure A-1), from the **Mapping** menu, point to **Remove Map Layer** (Figure A-41), from the list of map layers click on the map layer that is to be removed from the HEC-LifeSim study. The map layer is removed.

![Figure A-41. Mapping Menu – Remove Map Layer](image)

2. Another option is, from the HEC-LifeSim main window, from the **Map Layers** tab (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-2), click **Remove**. The selected map layer will be removed from the HEC-LifeSim study. **Remove** will allow the user to select multiple map layers for removal.

### A.8 Map Layers Properties

The properties of map layers can be viewed or edited in the **Map Layer Properties** dialog box (Figure A-42) of the selected map layer. Depending on the map layer feature type (point,
polyline, polygon, or gridded data) the options available in the Map Layer Properties dialog box (Figure A-42) will vary accordingly. The Map Layer Properties dialog box (Figure A-42) is organized into two tabs which allow the user to view and modify Map Window (Figure A-1) display features (Render Properties tab) and to view the map layer source information (Source Info tab).

A.8.1 Render Properties Tab

The Render Properties tab (Figure A-42) provides the user with the ability to edit map layer symbology (type, color, size, and other options).

<table>
<thead>
<tr>
<th>Draw By:</th>
<th>Single Symbol</th>
<th>Only the symbol can be modified directly. In other words all features will be drawn with the same symbology.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td></td>
<td>The symbol(s) can be edited by unique attribute names or values. For example, one-way roads can be drawn differently than two-way roads.</td>
</tr>
<tr>
<td>Value</td>
<td></td>
<td>The symbol(s) can be modified for a range of Attribute values. For example, structures can be drawn differently for larger populations than smaller populations.</td>
</tr>
</tbody>
</table>
Line/Fill Color: The user can modify the color for Line or Fill color setting. For example, to change line color, click on Line Color, the Select a Color dialog box will open (Figure A-43). Properties are:

![Select a Color Dialog Box](image)

**Selected Color** This display box provides a preview of the selected color.

**Color Pallet** This display area (Figure A-43) provides saturation (amount of black) options for the chosen color in the Color Bar. Notice the white circle in the Color Bar display area, this circle shows the location of the selected color. Click anywhere inside the Color Pallet area and the white circle will be moved to the new location, and the Color Properties (Figure A-43) values will change automatically.

**Color Bar** This slider bar (Figure A-43) allows the user to choose the color from the options available (ROYGBIVR).

**Opacity** The Opacity slider bar (Figure A-43) changes the transparency of the color (also known as Alpha). For maximum color (zero transparency of the color) slide the bar completely to the left (Alpha will change to 255). For zero color (or maximum transparency of the color) slide the bar completely to the right (Alpha will change to 0).
**Color Properties**

Provides value boxes (Figure A-43) for *Alpha* (measure of opacity), *Red*, *Green* and *Blue*. Each box is a measure (from 0 to 255) of opacity or color. The maximum value is 255 and minimum value is zero. Modifying these numbers also affects the saturation (amount of black, lower the value more black).

Example *Color Properties* values (for all examples the Alpha value = 255):
- Bright Red – Red 255, Green 0, Blue 0
- White – Red 255, Green 255, Blue 255
- Bright Yellow – Red 255, Green 255, Blue 0
- Bright Teal – Red 0, Green 255, Blue 255

**Common Colors**

Provides twelve commonly used colors; click on a color and the *Select a Color* dialog box (Figure A-43) will update with the color chosen.

**Symbol Size**

The *Symbol Size* (for point map layers) or *Line Width* (for polyline of polygon map layers) is a number representing the size/width (Figure A-42) of the symbol/line being displayed. The numerical value of size/width ranges from 1 to 50 and the smaller the number the smaller/thinner the symbol/line will be.

Default *Symbol Size* or *Line Width* examples:
- *Structure Inventories*, Symbol = 4
- *Destinations*, Symbol = 11
- *Road Networks*, Line Width = 1
- *Emergency Planning Zones*, Line Width = 2

**Draw by Single Symbol**

To adjust symbol type, symbol size, and the symbol line and fill color for a point map layer:

1. From the *Map Layers* tab on the HEC-LifeSim main window (Figure A-1), right-click on the point map layer of interest, from the shortcut menu (Figure A-2), click *Properties*. The *Map Layer Properties* dialog box for the selected map layer will open (Figure A-42).

2. The first option available to the user to modify the point map layer is to change the *Draw By* definitions. For example, the default setting for point (as well as polygon, and polyline) map layer properties is *Draw By, Single Symbol* (Figure A-42). At this point keep the default *Draw By, Single Symbol* setting.

3. To change the symbol type from the default blue house (Blueprint) select a new symbol from the available *Symbols* box (Figure A-44). Selecting a new symbol will automatically adjust the symbol preview (symbol in the top-right box of the *Properties* dialog box).
4. Click **Apply**, all of the features in the map layer will be updated to the newly selected symbol (once **Apply** is clicked this change cannot be undone).

5. To adjust the map symbol line color, select **Line Color** (Figure A-42), click the **Line Color** preview box. The **Select a Color** dialog box will open (Figure A-45).
6. For example, in Figure A-45, the Select a Color dialog box has a large checkered box, and other items that are similar to the Map Layer Properties dialog box (Figure A-42). For the default Line Color setting the Opacity is set to maximum and that is why the Selected Color is empty (transparent).

7. Modify the Selected Color in the Select a Color dialog box (Figure A-45) until the desired color is achieved. Click OK, the Select a Color dialog box will close (Figure A-45). The user will be returned to the Map Layer Properties dialog box (Figure A-42) where the new color will be displayed in the Line Color box and displayed in the symbol preview box.

8. Repeat Steps 5 through 7, for the Fill Color (Figure A-42) if the Fill Color needs to be modified.

9. To modify the size of the symbol to be displayed in the Map Window, from the Size box (Figure A-42) enter the new size.

   • For polylines and polygon shapefile the Size box is call Line Width and modifies the line (or polygon outline) width.

   • An extra option for a polyline Map Layer Properties dialog box (Figure A-42) is the option for adding an arrow at the end of lines. To add an arrow at the end of the lines select the Draw End Arrow option located under the Line Width box.

10. Once editing of the symbol type, symbol size, and the symbol line and fill color for a point map layer is complete, click Apply the Map Layer Properties dialog box will close (Figure A-42).

**Draw by Category**

To adjust Draw By, Category map layer properties options for a point map layer:

1. From the Map Layers tab, from the HEC-LifeSim main window (Figure A-1), right-click on the point map layer of interest, from the shortcut menu (Figure A-2), click Properties. The Map Layer Properties dialog box for the selected map layer will open (Figure A-42).

2. The first option available to the user to modify the point map layer is to change Draw By. From the Draw By list (Figure A-42), the default value is Single Symbol (Figure A-42). From the list the user can select other options.

3. From the Draw By list (Figure A-42), select Category, now the Attribute list (Figure A-46) is available. The Attribute list (Figure A-46) contains all of the attributes contained in the selected map layer.
4. From the **Attribute** list (Figure A-46) select the attribute of interest to draw the map layer by.

5. For the attribute that is selected, from the **Value** and **Symbol** table (Figure A-47), the table will update with the range of values (text or numerical) for the selected attribute. Figure A-47 provides an example for the *BldgType* attribute selection with the range of values equal to *Steel*, *Wood*, *Masonry*, *Concrete*, and *Manufactured*.

![Figure A-46. Map Layer Properties Dialog Box – Attribute List - Category](image)

![Figure A-47. Map Layer Properties Dialog Box – Value and Symbol Table](image)

The example shown in Figure A-47 also displays the default symbol assignment for the range of values present. These defaults can be modified by the user, and must be edited individually.

6. To change a symbol, select a **Value/Symbol** row in the table (Figure A-47), and the selected symbol will be displayed in the **Preview** box (Figure A-48). From the **Symbols** box (Figure A-48) click on the desired new symbol. The **Preview** box and the symbol in the **Value/Symbol** table (Figure A-47) will automatically update with the newly selected symbol.
7. To adjust the map symbol line color, select **Line Color** (Figure A-42), click **Line Color** preview box. The **Select a Color** dialog box will open (Figure A-45).

8. For details on the **Select a Color** dialog box see Section A.8.1. For example, in Figure A-45, the **Select a Color** dialog box has a large checkered box, and other items that are similar to the **Map Layer Properties** dialog box (Figure A-42). For the default **Line Color** setting the **Opacity** is set to maximum and that is why the **Selected Color** is empty (transparent).

9. Modify **Selected Color** in the **Select a Color** dialog box (Figure A-45) until the desired color is achieved. Click **OK**, the **Select a Color** dialog box will close. The user will be returned to the **Map Layer Properties** dialog box (Figure A-42) where the new color will be displayed in the **Line Color** box and displayed in the symbol preview box.

10. Repeat Steps 6 through 9 for all of the values listed in the **Values/Symbol** table (Figure A-47), which need to be changed.

11. Once editing of the **Draw By Category** for a point map layer is complete, click **Apply** the **Map Layer Properties** dialog box will close (Figure A-42).

12. Editing the **Draw By Category** for polyline and polygon shapefiles is mainly the same as point shapefiles. The only difference in the previously mentioned options is that users can change the **Line Width** (polylines and polygons) instead of **Size** (points), and there is an added option to **Draw End Arrow** (polylines only).
Draw by Value

Another option for modifying a map layer's properties is to adjust the Draw By option to Value for a specific attribute.

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on the point map layer of interest, from the shortcut menu (Figure A-2), click Properties. The Map Layer Properties dialog box (Figure A-42) for the selected map layer will open.

2. The first option available to the user to modify the point map layer is to change Draw By option. From the Draw By list, the default value is Single Symbol (Figure A-42). From the list the user can select other options.

   From the Draw By list, select Value, now the Attribute list (Figure A-49) is available. The Attribute list contains all of the attributes contained in the selected map layer.

   ![Map Layer Properties Dialog Box – Attribute List – Value](image)

3. From the Attribute list (Figure A-49) select the attribute of interest to draw the map layer by. Notice that the list of Attributes for Draw By Value (Figure A-49) is limited to only the ones with numerical values.

4. For the attribute that is selected, the parameters in the Draw By Value Bin Definitions box (Figure A-50) become available and will update with the range of quantitative values for the selected attribute.

5. The values entered for Number, Minimum and Maximum are used to define bins in equal intervals between the Minimum and Maximum values for the selected Attribute. The total number of breaks (set at equal intervals by default) are used to determine the
range of values (in the Value/Symbol table) by the value entered in the Number box (Figure A-50). The Excluded Values row (Figure A-50) in the Value/Symbol table represents all values that are less than the Minimum or greater than the Maximum values. By default the Minimum and Maximum values are set as the data minimum and maximum values so no features are excluded.

Figure A-50 provides an example with the default, and three examples that modify the Number and the Maximum value fields and how those changes modify the bins displayed in the Value/Symbol table.

6. Individual bin ranges can be adjusted in the Value/Symbol table (Figure A-50) by entering the maximum value for each range, manually. To enter the maximum value manually, double-click a Value/Symbol row, the row is now editable. Then over-write the current value and the range will update (maximum value for the over-written value and the minimum value for the next row in the Value/Symbol table).

- A hint for users is that sometimes the best way to determine the Draw By Value Bin Definitions is to review the summary statistics from the Map Layer Attributes dialog box (Figure A-16), from the shortcut menu (Figure A-22), click Cal. Statistics. For the selected attribute (i.e., Pop2amU65), the Attribute Summary Statistics dialog box will open (Figure A-51). Section A.4.3 provides a detailed description.
7. Also, the examples shown in Figure A-50 present the default symbol assignments for the range of values. These defaults can be modified by the user, for the selected **Value/Symbol** in the table. Each **Value/Symbol** the user wishes to modify from the default must be edited individually.

8. To change a symbol, select a **Value/Symbol** row in the table (Figure A-50), and the selected symbol will be displayed in the **Preview** box (Figure A-48). From the **Symbols** box (Figure A-44) click on the desired new symbol. The **Preview** box (Figure A-48) and the symbol in the **Value/Symbol** table (Figure A-50) will automatically update with the newly selected symbol.

9. To adjust the map symbol line color, select **Line Color** (Figure A-44), click **Line Color** preview box. The **Select a Color** dialog box will open (Figure A-45).

10. For details on the **Select a Color** dialog box see Section A.8.1. For example, in Figure A-45, the **Select a Color** dialog box has a large checkered box, and other items that are similar to the **Map Layer Properties** dialog box (Figure A-42). For the default **Line Color** setting the **Opacity** is set to maximum and that is why the **Selected Color** is empty (transparent).

11. Modify **Selected Color** in the **Select a Color** dialog box (Figure A-45) until the desired color is achieved. Click **OK**, the **Select a Color** dialog box will close. The user will be returned to the **Map Layer Properties** dialog box (Figure A-42) where the new color will be displayed in the **Line Color** box and displayed in the symbol preview box.

12. Repeat Steps 8 through 11 for all of the values listed in the **Values/Symbol** table (Figure A-50), which need to be changed.
13. Once editing of the **Draw By Value** for a point map layer is complete, click **Apply** and the **Map Layer Properties** dialog box will close (Figure A-42).

### A.8.2 Source Info Tab

The **Source Info** tab (Figure A-52) provides the:

- **Projection** coordinate system associated with the map layer,
- **Horizontal Units** of the map layer, and
- **Extent** of the map layer.

![Figure A-52. Map Layer Properties Dialog Box – Source Information Tab](image)

### A.9 Gridded Map Layer Properties

The properties of gridded map layers (*.tif) can be viewed or edited in the **Map Layer Properties** dialog box (Figure A-53) of a selected gridded map layer. The **Map Layer Properties** dialog box (Figure A-53) is organized into two tabs which allow the user to view and modify **Map Window** (Figure A-1) display features (**Render Properties** tab) and to view the map layer source information (**Source Info** tab).

#### A.9.1 Render Properties Tab

The **Render Properties** tab (Figure A-53) provides the user with the ability to edit gridded map layer symbology (type, color or color ramp, and other options). There are three sections in the **Render Properties** tab which are:
Continuous Ramp

- None
- Minimum Maximum
- Standard Deviations
- Histogram-Equalization

Depending on the selection the Min and Max or Deviations boxes (Figure A-53) will become active.

Color Ramp

The Color Ramp list (Figure A-54) contains nine options for the user to select for the color ramp of the gridded map layer.

There are two additional options for modifying the Color Ramp. The first is Invert Colors, which when selected will invert the selected color ramp scheme. The second is Transparency, the user will enter a transparency value (percentage) to modify the translucency of the selected color scheme. Lower numbers are higher opacity and higher numbers are more transparent (one hundred effectively removes the map layer from view).
Specified Values

Specified Values allow the user to set the number of Bins which updates the Value and Symbol table (Figure A-53).

The preset Symbol color scheme ranges from black to white (low to high values). To change the preset symbol color click on the color box and the Select a Color dialog will open (Figure A-43). The available options for the Select a Color dialog box (Figure A-43) are very similar to what is described in Section A.8.1.

Continuous Ramp Rendering

The Continuous Ramp rendering options for gridded map layers and allows the user to adjust the symbology (type, color or color ramp, and other options) for a selected gridded map layer:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on the point map layer of interest, from the shortcut menu (Figure A-2), click Properties. The Map Layer Properties dialog box for the selected gridded map layer will open (Figure A-53).

2. Users must decide which stretch type to select from the Stretch Type list (Figure A-53):
   - None – The colors in the selected color ramp will be linearly distributed based on the cell values relation to the minimum and maximum data values.
   - Minimum Maximum – This option activates the Min and Max boxes (Figure A-53). The selected color ramp will be stretched between the defined minimum and maximum values. This can be useful when the user wants data to be stretched over a very small data range. The user must use the default values or input different values. If the default minimum and maximum data values are chosen the gridded data will render the same as the None option.
• **Standard Deviations** (default) – This option activates the **Deviations** box (Figure A-53). The default **Deviations** value is 2, users can delete and enter different deviations in the box. The ramp is stretched by the number of deviations from the mean data value.

• **Histogram-Equalization** – If the user selects this option and no histogram information exists for the gridded data, a **Histogram Does Not Exist** message window will open (Figure A-55) asking the user for confirmation to create a histogram for the selected raster/gridded map layer.

![Figure A-55. Histogram Does Not Exist Message Window](image)

3. The default color ramp is black fading to white, the user can change this from the **Color Ramp** list (Figure A-53). To determine if the color ramp scheme is correct, click **Apply** (Figure A-53) and view the updated gridded map layer in the **Map Window** (Figure A-1). Once **Apply** is clicked this change cannot be undone.

4. If the **Color Ramp** selection is not correct (e.g., higher water velocity with green colors and lower flow velocity with red colors) then select **Invert Colors** (Figure A-53). Click **Apply**, and view the updated gridded map layer in the **Map Window** (Figure A-1) to confirm the color scheme selection.

5. The transparency of the entire gridded/raster map layer can be changed (from the default value of fully opaque). In the **Transparency** box (Figure A-53), the user can enter a value from zero to 100 (percent) to increase the transparency of the map layer (the maximum value of 100 percent is maximum translucency).

6. Once editing of the symbology (type, color or color ramp, and other options) for a gridded map layer is complete, click **Apply**, and the selected gridded map layer is updated.

### Rendering with Specified Values

To use **Specified Values** for rendering gridded map layers and adjust the symbology (type, color or color ramp, and other options) for a selected map layer:

1. From the **Map Layers** tab, on the HEC-LifeSim main window (Figure A-1), right-click on the point map layer of interest, from the shortcut menu (Figure A-2), click **Properties**.
The *Map Layer Properties* dialog box for the selected gridded map layer will open (Figure A-53).

2. Select *Specified Values* (Figure A-56), the *Continuous Ramp* selection (Figure A-53) is no longer available, while the *Specified Values* parameters becomes available.

![Map Layer Properties Dialog Box – Gridded Map Layer – Specified Values](image)

3. For *Specified Values*, the user needs to enter the number of bins. The default number of bins is five. Values entered in the *Bins* box (Figure A-56) cannot be less than one or greater than fifty. When the number of bins is entered, the *Value* and *Symbol* table (Figure A-56) is modified with a range of quantitative values (set at equal numbers) based on the number of bins specified and the total range of values in the map layer.

4. Individual bin ranges can be adjusted in the *Value/Symbol* table (Figure A-56) by entering the maximum value for each range, manually. To enter the maximum value manually, double-click a *Value/Symbol* row, the row is now editable. Then over-write the current value and the range will update (maximum value for the over-written value and the minimum value for the next row in the *Value/Symbol* table).

5. The default color ramp is black fading to white, the user can change this from the *Color Ramp* list (Figure A-54). To determine if the color ramp scheme correct, click *Apply* (Figure A-53) and view the updated gridded map layer in the *Map Window* (Figure A-1). Once *Apply* is clicked this change cannot be undone.

6. If the *Color Ramp* selection turns not to be correct (e.g., higher water velocity with green colors and lower flow velocity with red colors) then select *Invert Colors* (Figure A-53). Click *Apply*, and view the updated gridded map layer in the *Map Window* (Figure A-1) to confirm the color scheme selection.

7. To adjust the color for a range of values, in the *Value* and *Symbol* table (Figure A-56) click on a specific color in the table. The *Select a Color* dialog box will open (Figure A-45).
For details on the Select a Color dialog box see Section A.8.1. For example, in Figure A-45, the Select a Color dialog box has a large checkered box, and other items that are similar to the Map Layer Properties dialog box (Figure A-42). For the default Line Color setting the Opacity is set to maximum and that is why the Selected Color is empty (transparent).

8. Modify Selected Color in the Select a Color dialog box (Figure A-45) until the desired color is achieved. Click OK, the Select a Color dialog box will close. The user will be returned to the Map Layer Properties dialog box (Figure A-53) where the new color will be displayed in the Value and Symbol table (Figure A-56).

9. Repeat Steps 4 through 8 for all of the values listed in the Values/Symbol table (Figure A-56), which need to be changed.

10. The transparency of the entire gridded/raster map layer can be changed (from the default value of fully opaque). In the Transparency box (Figure A-53), the user can enter a value from zero to 100 (percent) to increase the transparency of the map layer (the maximum value of 100% is maximum translucency).

11. Once editing of the symbology (type, color or color ramp, and other options) for a gridded map layer is complete, click Apply, selected gridded map layer is updated.

A.9.2 Source Info Tab

The Source Info tab for gridded map layers (Figure A-52) provides the:

- Projection coordinate system associated with the map layer,
- Horizontal Units of the map layer, and
- Extent of the map layer.

A.10 Editing Map Layer Features and Attributes

As explained in Section A.1.1, there are several Map Window editing tools in the Editor Toolbar. Additional map layer editing can be accomplished from the Map Layer Attribute dialog box (Figure A-57). The Map Window (Figure A-1) and Map Layer Attribute dialog box (Figure A-57) editing tools are designed to facilitate in adjusting the geometric and attribute data directly within the software to increase overall productivity. For example, moving structures or editing roads for use in the simulation can be done quickly and easily from the HEC-LifeSim software interface.

It is important to note, only one map layer can be edited at a time. Also, it is beneficial to save often while editing a map layer.
A.10.1 Editing in the Attribute Table

Each map layer (shapefile) has an attribute table, which displays the dataset for the selected map layer. From the Map Layer Attribute dialog box (Figure A-57), there are editing tools that allow the user to edit the attributes.

- From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-2), click Open Attribute Table. The Map Layer Attributes dialog box (Figure A-57) will open for the selected map layer. For non-editing attribute table functionality refer to Section A.4.

- Note, when a single cell in the attribute table (Figure A-57) is selected (e.g., row 1, column 1), the keyboard arrow keys (and the tab and enter keys) can be utilized to step through the table one cell at a time (Figure A-57).

Attribute Editing Tools

- **Open Field Calculator Tool**
  This tool allows the user to create a new field or update an existing field with a calculated result based on a specified expression. The Open Field Calculator tool is only enabled if feature editing has been enabled.

- **Undo Tool**
  Undo will undo the last edits made in the attribute table. The Undo tool is only available when editing has been enabled.

- **Redo Tool**
  Redo will redo an edit which was undone (by clicking Undo) in the attribute table. The Redo tool will only be available when editing has been enabled.
**Start Feature Edit Session Tool**

*Start Feature Edit Session* will start a feature editing session which allows the user to edit cells and add/delete columns in the attribute table, as well as edit the feature data. Once an editing session has been started the *Start Feature Edit Session* will be replaced with *Stop Feature Edit Session*.

**Stop Feature Edit Session Tool**

*Stop Feature Edit Session* will end an active editing session of the attribute table. Once an editing session has been stopped the *Stop Feature Edit Session* will be replaced with *Start Feature Edit Session*.

### Editing Attribute Table Shortcut Menu

While editing mode is active, selected column(s) in the attribute table have several editing options. Right-click on a column, a shortcut menu will appear (Figure A-50), from the shortcut menu the user can sort the column, calculate statistics, do a find for defined items, a field calculator is provided, and the selected column can be deleted.

![Figure A-58. Attribute Table – Column Shortcut Menu – Active Editing Session](image)

Other options which become available in edit mode are the standard cut/copy/paste functionality. Information in a selected cell can be edited or replaced by typing directly into the selected cell. However, depending on the column type: **String** (e.g., “Masonry”), **Integer** (e.g., 10), or **Double** (e.g., 0.5); only like types can be entered. In other words, only integers can be entered into integer cell(s) or column(s), with the exception of string columns which can contain integers or doubles. To identify the type of data a column can contain, hover over the column header (Figure A-59) for the tooltip that contains the type.

![Figure A-59. Attribute Table – Column Tooltips – Active Editing Session](image)
Furthermore, depending on the character limit an entered value could be truncated by limits. For example, if *ManufacturedLogCabin* is entered into cell that has a character limit of 12 characters, then after **Stop Feature Edit Session** is clicked, then the extra characters beyond the character limit will automatically be removed and only *Manufactured* will remain.

**Field Calculator**

This menu command functions similarly to **Open Field Calculator**, the difference is any action will be done on the selected column and new fields cannot be created.

**Delete Column**

Deletes the selected column, a **Confirm Delete** message window will (Figure A-60) asking the user to confirm that the selected field should be deleted. Click **Yes**, the column will be deleted, and the **Confirm Delete** message window will close.

![Confirm Delete Message Window](image)

Figure A-60. Confirm Delete Message Window

**Attribute Field Calculator**

The **Field Calculator** (Figure A-61) can be utilized to add new calculated fields or update existing fields in the selected column during an active editing session.

To create a new field:

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-2), click **Open Attribute Table**. The **Map Layer Attributes** dialog box will open (Figure A-57).

2. Start an editing session by clicking **Start Feature Edit Session**. Alternatively, users can activate an editing session by right-clicking on the map layer of interest, from the shortcut menu (Figure A-2), click **Edit**. The user can now edit the map layer of interest, and only one map layer/map attribute table can be edited at one time.

3. From the **Map Layer Attributes** dialog box (Figure A-57) click **Open Field Calculator**, the **Field Calculator** dialog box will open (Figure A-61).

4. To add a new calculated field for the selected map layer, from the **Field Selection** box, select **Create New Field** (Figure A-62). Enter a name in the **Output Field Name** box, which has a limit of ten characters.
5. For the new field create an expression in the box below the Available Fields box (Figure A-62). For example, in Figure A-62, a new field FoundHtNew has been created. To create the expression for the new field based on an existing field, double-click on the existing field of interest from the Available Fields box (e.g., FoundHt in Figure A-62) to add the field name to box below the Available Fields box. The Functions box (Figure A-62) provides commands and functions to use in creating the executable expression.

An example expression using FoundHtNew, is displayed in Figure A-62, $[\text{FoundHt}] - 0.2$. The result of the expression is displayed at the bottom of the Field Calculator dialog box (Figure A-62) - Example: First data record (row id = 0) would be equal to ‘0.8’.
Figure A-62. Field Calculator Dialog Box – Create New Field

Note: when creating a new attribute field that is a string field (e.g., text, symbols, numbers, or any sequence of characters) then HEC-LifeSim requires that the text in the executable expression box be contained in double quotation marks.

6. Case Sensitive (Figure A-62) when selected, means that the entered expression will be case sensitive.

7. If the user selects Apply To Selected Range (Figure A-62), then the expression will only be applied to features selected in the Map Layer Attributes dialog box (Figure A-57), and will not alter features that were not selected. Apply To Selected Range will only work for existing fields and will not be enabled at the time a new field is created.

8. Click Execute, the Field Calculator dialog box (Figure A-61) close. The user will be returned to the Map Layer Attributes dialog box (Figure A-57) where a newly calculated field will be present (e.g., FoundHtNew). New fields will be added to the end of the attribute table (Figure A-57).

9. When a new field has been created, a message will appear notifying the user that the new field has been created and the change cannot be undone.

10. Once adding a new field has been complete, from the Map Layer Attributes dialog box (Figure A-57), click Stop Feature Edit Session. Alternatively, from the Map Layers tab on the HEC-LifeSim main window (Figure A-1), click Save from the Editor Toolbar.
Updating an existing field will overwrite the original data in the field, so caution must be taken when using this option. However, changes made to existing fields can be undone by clicking ![undo](logo.png).

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer of interest, from the shortcut menu (Figure A-2), click **Open Attribute Table**. The **Map Layer Attributes** dialog box will open (Figure A-57).

2. Start an editing session by clicking **Start Feature Edit Session**. Alternatively, users can activate an editing session by right-clicking on the map layer of interest from the **Map Layers** tab on the HEC-LifeSim main window, from the shortcut menu (Figure A-2), click **Edit**. The user can now edit the map layer of interest, and only one map layer/map attribute table can be edited at one time.

3. From the **Map Layer Attributes** dialog box (Figure A-57) click **Open Field Calculator**, the **Field Calculator** dialog box will open (Figure A-61).

4. To update an existing field for the open map layer, select **Update Existing Field** (Figure A-63). From the **Update Existing Field** list (Figure A-63), select the field that needs to be updated.

![Field Calculator Dialog Box – Update Existing Field](image.png)

5. Create an expression in the box below the **Available Fields** box (Figure A-63). To create the expression to update the existing field based on another existing field, double-click on the field of interest from the **Available Fields** box (e.g., *FoundHt* in Figure A-62) to add the field name to box below the **Available Fields** box. The **Functions** box (Figure A-62) provides commands and functions to use in creating the executable expression.

An example expression for the field *FoundHtNew*, is displayed in Figure A-62, 

\[ \text{[FoundHt]}-0.2 \]  

The result of the entered expression is shown at the bottom of the **Field**
**Calculator** dialog box (Figure A-62) - Example: First data record (row id = 0) would be equal to '0.8'.

**Note**: when creating a new attribute field that is a string field (e.g., text, symbols, numbers, or any sequence of characters) then HEC-LifeSim requires that the text in the executable expression box be contained in double quotation marks.

6. **Case Sensitive** (Figure A-62) when selected, means that the expression will be case sensitive.

7. If the user selects **Apply To Selected Range** (Figure A-61), then the expression will only be applied to features selected in the **Map Layer Attributes** dialog box (Figure A-57), and will not alter features that were not selected. **Note**, **Apply To Selected Range** will only work for existing fields and will not be enabled at the time a new field is created.

8. Click **Execute**, the **Field Calculator** dialog box (Figure A-61) close. The user will be returned to the **Map Layer Attributes** dialog box (Figure A-57) where the updated field will be present (e.g., *FoundHtNew*).

9. For the updated field, the user can click **Redo** (Figure A-57) from the **Map Layer Attributes** dialog box (Figure A-57) to revert back to the original stated of the selected field. The **Redo** button will then become active and the user can redo the change made to the field.

10. Once adding a new field has been complete, from the **Map Layer Attributes** dialog box (Figure A-57), click **Stop Feature Edit Session**. Alternatively, from the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), click **Save** from the **Editor Toolbar**.

**A.10.2 Adding Features to a New Shapefile**

After creating a new shapefile (described in Section A.5) the user can add features by:

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the newly created map layer. From the shortcut menu (Figure A-2), click **Edit**. The selected map layer is now in an active editing session and the **Editor Toolbar** is active.

2. To add new features to the selected map layer, from the **Editor Toolbar**, click **Add new features**. Notice, in the **Map Window** the cursor will change to **Add** (note the dot in the center of the cursor). Click inside the **Map Window** and new points will be placed at the center of the cross-hairs (where the dot is located).

Polylines and polygons start at the first click and each subsequent mouse click will create a new vertex point in the polyline or polygon. To end the polyline or polygon double-click the mouse at the desired location. Click **Redo** to undo newly added features.

**Note**: When a new feature is added a new row is added to the bottom of the map layer's **Attribute** table with empty cells for text columns and zero's for numeric columns.
3. Once the user is done adding new features, from the Editor Toolbar click Save Edits, and then click Stop Editing. If the editing session is ended before Save Edits has been clicked, a Save Edits message window will open (Figure A-64) asking the user if the edits need to be saved. Click Yes to save the edits made to the map layer, and the Save Edits message window will close (Figure A-64). If the user did not intend to exit the editing session, click Cancel to return to the editing session.

Figure A-64. Save Edits Message Window

A.11 Editing Point Map Layers

The user can remove, move, or add points in newly created map layers (described in Section A.5) or existing point map layers.

A.11.1 Add New Point Features

To add new point features:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on the point map layer (newly created or existing). From the shortcut menu (Figure A-2), click Edit. The selected map layer is now in an active editing session and the Editor Toolbar is active.

2. To add new point features to the selected map layer, from the Editor Toolbar, click Add new features Map Window. Notice, in the Map Window the cursor will change to (note the dot in the center of the cursor). Click inside the Map Window and new points will be placed at the center of the cross-hairs (or wherever the dot is located; Figure A-65a).

With snapping enabled (refer to Section A.13.1 for more information), when the cursor gets close to the snap to feature map layer the dot in the middle of the cursor will "snap" to the snap to feature and new points will be placed at the snap point. Click at the desired location and a point will be added with default properties (Figure A-65b).

3. Continue clicking in the Map Window to add new points at desired locations.
4. Once the user is done adding new point features, from the Editor Toolbar click Save Edits, and then click Stop Editing. If the editing session is ended before Save Edits has been clicked, a Save Edits message window will open (Figure A-64) asking the user if the edits need to be saved. Click Yes to save the edits made to the map layer, and the Save Edits message window will close. If the user did not intend to exit the editing session, click Cancel to return to the editing session.

A.11.2 Move Point Features

To move an already existing point (or points) in the Map Window:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer. From the shortcut menu (Figure A-2), click Edit. The selected map layer is now in an active editing session and the Editor Toolbar is active.

2. From the General Toolbar, click the Select tool; to select features click on the feature or click, hold, and drag a rectangle around the features to select them in the Map Window (Figure A-66A and B).

Note, if more than one map layer is displayed in the Map Window and the user only wants one map layer to be selected (e.g., map layer being edited) use the Selectable Layers list to set the selectable layers as explained in Section A.1.1.

3. With the point selected, click and drag the point to the desired location (Figure A-66, C and D). The user can move also multiple points.

4. Once the user is done moving point features, from the Editor Toolbar click Save Edits, and then click Stop Editing. If the editing session is ended before Save Edits has been clicked, a Save Edits message window will open (Figure A-64) asking the user if the edits need to be saved. Click Yes to save the edits made to the map layer, and the Save Edits message window will close. If the user did not intend to exit the editing session, click Cancel to return to the editing session.
A.11.3 Delete Point Features

To remove an already existing point (or points) in the Map Window:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on the map layer that represents the new shapefile that has been created. From the shortcut menu (Figure A-2), click Edit. The selected map layer is now in an active editing session and the Editor Toolbar is active.

2. From the General Toolbar, click the Select tool; select the point(s) to remove (Figure A-66A). The point(s) are highlighted (Figure A-66B) in the Map Window, use the Delete key to delete the selected point feature(s). Another option for deleting the selected points, is right-click in the Map Window, from the shortcut menu (Figure A-67) click Delete Selected Features. Either way the selected features are deleted from the selected map layer.
3. Once the user is done deleting point features, from the Editor Toolbar click Save Edits, and then click Stop Editing. If the editing session is ended before Save Edits has been clicked, a Save Edits message window will open (Figure A-64) asking the user if the edits need to be saved. Click Yes to save the edits made to the map layer, and the Save Edits message window will close. If the user did not intend to exit the editing session, click Cancel to return to the editing session.

### A.12 Editing Polyline or Polygon Map Layers

The user can remove, move, or add vertices in polyline or polygon map layers (shapefiles).

#### A.12.1 Add Vertex Points

To add new vertex points:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer. From the shortcut menu (Figure A-2), click Edit. The selected map layer is now in an active editing session and the Editor Toolbar is active.

2. From the General Toolbar, click the Select tool; double-click on a specific polyline or polygon feature in the selected map layer. Note, if more than one map layer is displayed in the Map Window and the user only wants one map layer to be selected use the Selectable Layers list (Section A.1.1) to set the map layer to be edited.

3. When the user double-clicks on a polyline or polygon feature, the vertex points (black squares) will display and the user will be in the vertex edit mode. At this point depending on the feature (polyline or polygon) several Map Window editing tools will become available in the Editor Toolbar (Figure A-68).

4. From the Editor Toolbar, click Insert Vertex ( ), locate on the Map Window where the user want to add a new vertex point, click the location, and a new vertex point will be added. Alternatively, the user can add a new vertex in the vertex edit mode, by right-
clicking on the location where a vertex point is to be added, from the shortcut menu (Figure A-69), click **Insert Vertex**, and a new vertex point will be added.

![Figure A-69. Vertex Edit Mode Shortcut Menu](image)

5. Once the user is done adding vertex points, from the **Editor Toolbar** click **Save Edits**, and then click **Stop Editing**. If the editing session is ended before **Save Edits** has been clicked, a **Save Edits** message window will open (Figure A-64) asking the user if the edits need to be saved. Click **Yes** to save the edits made to the map layer, and the **Save Edits** message window will close. If the user did not intend to exit the editing session, click **Cancel** to return to the editing session.

### A.12.2 Delete Vertex Points

To delete vertex points:

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer. From the shortcut menu (Figure A-2), click **Edit**. The selected map layer is now in an active editing session and the **Editor Toolbar** is active.

2. From the **General Toolbar**, click the **Select** tool; double-click on a specific polyline or polygon feature in the selected map layer. **Note**, if more than one map layer is displayed in the **Map Window** and the user only wants one map layer to be selected use the **Selectable Layers** list (Section A.1.1) to set the map layer to be edited.

3. To remove a vertex or vertices points, select the vertex or vertices points to be deleted, click the **Delete** key. Another way, is right-click on the vertex point that is to be deleted, from the shortcut menu (Figure A-69), click **Delete Selected Features**. Either way, the vertex point is deleted.

4. Once the user is done deleting vertex points, from the **Editor Toolbar** click **Save Edits**, and then click **Stop Editing**. If the editing session is ended before **Save Edits** has been clicked, a **Save Edits** message window will open (Figure A-64) asking the user if the edits need to be saved. Click **Yes** to save the edits made to the map layer, and the **Save**
Edits message window will close. If the user did not intend to exit the editing session, click Cancel to return to the editing session.

A.12.3 Edit a Line Feature – Shorten

The user can shorten the length of line features in newly created (described in Section A.5) or existing polyline map layer by:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer. From the shortcut menu (Figure A-2), click Edit. The selected map layer is now in an active editing session and the Editor Toolbar is active.

2. From the General Toolbar, click the Select tool; click on a specific line feature in the selected map layer. Note, if more than one map layer is displayed in the Map Window and the user only wants one map layer to be selected use the Selectable Layers list (Section A.1.1) to set the map layer to be edited.

3. Once the line feature to be broken is selected, from the Editor Toolbar, select Break line feature, the cursor will change to (note, the dot which follows the cursor along the selected line feature). Note, if more than one map layer is displayed in the Map Window and the user only wants one map layer to be selected use the Selectable Layers list (Section A.1.1) to set the map layer to be edited.

4. Hover the cursor over the exact location to break the selected line feature, and a dot will appear on the line feature. Move the dot to the location where the line will be broken (i.e., at the edge of an Emergency Planning Zone polygon map layer). Figure A-70A, provides an example of what the user might visualize.

5. Wherever the dot is located on the line feature, when the mouse is clicked, that is where the break in the line will occur (Figure A-70B). As an example, the line section outside of a Emergency Planning Zone (EPZ) can be deleted if the user breaks the line at the edge of the EPZ, and then selects the line outside of the EPZ. Click the Delete key or right-click, from the shortcut menu (Figure A-70C), click Delete Selected Features, which will delete the select line section (Figure A-70D).

6. Once the user is done modifying map layer features, from the Editor Toolbar click Save Edits, and then click Stop Editing. If the editing session is ended before Save Edits has been clicked, a Save Edits message window will open (Figure A-64) asking the user if the edits need to be saved. Click Yes to save the edits.
made to the map layer, and the **Save Edits** message window will close. If the user did not intend to exit the editing session, click **Cancel** to return to the editing session.

### A.12.4 Edit a Line Feature – Lengthen

The user can lengthen a line feature in newly created (described in Section A.5) or existing polyline map layer by:

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer. From the shortcut menu (Figure A-2), click **Edit**. The selected map layer is now in an active editing session and the **Editor Toolbar** is active.

2. From the **General Toolbar**, click the **Select** tool; click on a specific line feature in the selected map layer. Note, if more than one map layer is displayed in the **Map Window** and the user only wants one map layer to be selected use the **Selectable Layers** list (Section A.1.1) to set the map layer to be edited.

3. From the **Editor Toolbar**, click **Continue from end (lines only)**, the cursor will change to , with a line connected to the end of the selected polyline feature (Figure A-71). Click the cursor at the desired location to continue the line, and double-click to end the lengthened line. Note, the user can reverse the line from a shortcut menu, click **Reverse Selected Features** (Figure A-71).

4. Once the user is done modifying map layer features, from the **Editor Toolbar** click **Save Edits**, and then click **Stop Editing**. If the editing session is ended before **Save Edits** has been clicked, a **Save Edits** message window will open (Figure A-64) asking the user if the edits need to be saved. Click **Yes** to save the edits made to the map layer, and the **Save Edits** message window will close. If the user did not intend to exit the editing session, click **Cancel** to return to the editing session.

### A.12.5 Adding New Features

Adding new features:
1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer. From the shortcut menu (Figure A-2), click **Edit**. The selected map layer is now in an active editing session and the **Editor Toolbar** is active.

2. From the **General Toolbar**, click the **Select** tool; click on a specific line feature in the selected map layer. Note, use the **Selectable Layers** list (Section A.1.1) to set the map layer to be edited as the only selectable map layer.

3. From the **Editor Toolbar**, click **Add new line or polygon to existing feature** ( ), the cursor will change to (note the dot in the center of the cursor). Click the desired location, where the user will begin drawing the new line or polygon to the existing selected feature. Each subsequent click of the cursor will create a new vertex point to the polyline or polygon (Figure A-72). Double-click to complete the new addition to the existing feature.

![Figure A-72. Add New Line or Polygon - Existing Feature Tool](image)

---

**Polyline** | **Polygon**
---|---
![Polyline](image) | ![Polygon](image)
4. Once the user is done modifying map layer features, from the **Editor Toolbar** click **Save Edits**, and then click **Stop Editing**. If the editing session is ended before **Save Edits** has been clicked, a **Save Edits** message window will open (Figure A-64) asking the user if the edits need to be saved. Click **Yes** to save the edits made to the map layer, and the **Save Edits** message window will close. If the user did not intend to exit the editing session, click **Cancel** to return to the editing session.

### A.13 Create Destination Locations Example

The following section gives an example of creating a destination location shapefile for use in HEC-LifeSim. Destinations data is required in a HEC-LifeSim study to represent possible evacuation locations during flooding events. The destination data is represented as points in space, HEC-LifeSim will find the nearest road from a destination point and consider that the evacuation location. In other words, destination points do not need to connect with a road for HEC-LifeSim simulations to be successful.

#### A.13.1 Add Features to the Destination Locations Map Layer

After creating the destination shapefile (described in Section A.5) the user can add features with the **Feature Snapping Settings** tool from the **Editor Toolbar** by:

1. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer (e.g., *Example_Destinations*). From the shortcut menu (Figure A-2), click **Edit**. The selected map layer is now in an active editing session and the **Editor Toolbar** is active.

2. This step is optional as HEC-LifeSim will find the nearest road from a destination point and consider that the evacuation route for the destination point. From the **Editor Toolbar**, click **Feature Snapping Settings**, a **Snapping Settings** window will display (Figure A-73). From the **Snap To Layer** list, the user will select a map layer to base the newly added feature points to snap to (e.g., *Example_Roads*).
• If the **Snap To Feature** is a polyline map layer then all snapping options will be available. Also, the map layer selected (e.g., `Example_Roads`) needs to be active in the HEC-LifeSim study.

3. To add new features, from the **Editor Toolbar**, click ![Add new features Map Window](image). Notice, in the **Map Window** the cursor will change to ![cursor](image) (there will be a dot in the center of the cursor). Click inside the **Map Window** and new points will be placed at the center of the cross-hairs (Figure A-74 a).

![Figure A-74. Add New Features Tool](image)

- If snapping is enabled in Step 2 (if desired), then when the cursor gets close to the snap to feature map layer the dot in the middle of the cursor will "snap" to the snap to feature and new points will be placed at the snap point. Click at the desired location and a point will be added with default properties (Figure A-74b).

4. Destinations typically are viewed in the map window with a ✪ star symbol. Next the properties for the newly created destinations map layer (e.g., `Example_Destinations`) should be modified from the default general point layer symbol. Alternatively, users can modify the map layer properties before adding any new points to the newly created map layer.

5. From the **Map Layers** tab on the HEC-LifeSim main window (Figure A-1), right-click on the point map layer of interest (e.g., `Example_Destinations`), from the shortcut menu (Figure A-2) click **Properties**, the **Map Layer Properties** dialog box will open (Figure A-42).

6. To change the symbol type, from the **Map Layer Properties** dialog box (Figure A-42), from the **Symbols** box (Figure A-44), select a new symbol.

7. Change the **Size** of the symbol (e.g., size 11) by entering the number in the **Size** box (Figure A-42).
8. Change the fill color, click the box next to Fill Color (Figure A-42), the Select a Color dialog box will open (Figure A-43). From the Select a Color dialog box choose a color from the Common Colors box (Figure A-45). Click OK, the Select a Color dialog box will close, and the user will be returned to the Map Layer Properties dialog box (Figure A-42).

9. From the Map Layer Properties dialog box (Figure A-42), click Apply button and check to see if the desired changes were made to the map layer in the Map Window (Figure A-1). Once the user has entered all of the desired features, click Close, changes will be saved to the map layer (e.g., Example_Destinations) and the Map Layer Properties dialog box will close (Figure A-42).

A.13.2 Add Attributes to the Destination Locations Map Layer

After all of the necessary destination points have been added to the map layer (e.g., Example_Destinations), as described in Section A.13.1, the attributes for the new map layer must be entered by:

1. From the Map Layers tab on the HEC-LifeSim main window (Figure A-1), right-click on a map layer (e.g., Example_Destinations). From the shortcut menu (Figure A-2), click Open Attribute Table. The Map Layer Attribute Table dialog box will open (Figure A-57) in an active editing session.

2. Click (Open Field Calculator), the Field Calculator dialog box will open (Figure A-61), which has two options: Create New Field or Update Existing Field. Create New Field is the default.

3. Enter a name (e.g., Name) in the Output Field Name box (Figure A-61), the attribute name is limited to ten characters.

4. The attribute entered is given a name, and at the same time the Field Type is set. The Field Type will be either: String (e.g., “Masonry”), Integer (e.g., 10), or Double (e.g., 0.5). Furthermore, the total number of characters entered in the Field box (Figure A-61) will set the character length.

Note: when creating a new attribute field that is a string field (e.g., text, symbols, numbers, or any sequence of characters) then HEC-LifeSim requires that the text in the executable expression box be contained in double quotation marks.

5. Click Execute (Figure A-61) to create the new field (e.g., Name). A Warning message window will open (Figure A-75) asking for confirmation to create the new field during an active editing session. Click Yes, in the Warning message window and the Field Calculator dialog box (Figure A-61) will close and the new field will be added to the Attributes table (Figure A-57).
6. Now the names of the destinations need to be entered. One way to add names to destinations is by using the cardinal directions (Figure A-76). Utilizing the cardinal directions for the study area to name destinations can be very useful for projects that contain multiple emergency planning zones. Also, using cardinal directions can be useful when completing the Destination Zone Assignments tab of the Alternative Editor (Chapter 4) when creating alternatives.

7. Alternatively, the names of the destinations could be entered based on map layers in the Map Window (Figure A-1). To use this option, select the first row of the table (Figure
A-76), right-click on the row identification number, from the shortcut menu, click **Zoom to Selected**. The **Map Window** (Figure A-1) will zoom to the designated destination location. If an **OpenStreetMap** web layer has been added to the **Map Window** (Section A.3.2) then the **OpenStreetMap** web layer can be utilized to name the selected destination. For example, in Figure A-76, the **Name_2** column, and from Figure A-77, the **Name** column provide two examples for a completed table utilizing the **OpenStreetMap** web layer to name the created destinations.

8. Manually type (or copy and paste) an appropriate name (e.g., *I-515 N; Lake M Pkwy*) in the newly created column for each destination that has been added (Figure A-77).

9. Once the user is done adding new features, from the **Editor Toolbar** click **Save Edits**, and then click **Stop Editing**. If the editing session is ended before **Save Edits** has been clicked, a **Save Edits** message window will open (Figure A-64) asking the user if the edits need to be saved. Click **Yes** to save the edits made to the map layer, and the **Save Edits** message window will close. If the user did not intend to exit the editing session, click **Cancel** to return to the editing session.

![Figure A-77. Completed Attribute Table – Map Window View](image-url)
Appendix B

Editing Road Network Data for use in HEC-LifeSim

The road network is an important part of the HEC-LifeSim computations when simulating the evacuation process. A road network with missing connectivity or incorrect directions on one-way roads can lead to erroneous results. This appendix provides some methods for editing the road network dataset to provide a reliable foundation for traffic simulation. This appendix makes use of the editing functionality in the Map Window of the HEC-LifeSim main window (Figure B-1). The Map Window functionality and a full list of the tools available can be found in Appendix A. The road network used in the following examples was obtained from OpenStreetMap (https://www.openstreetmap.org/). This appendix focuses on two aspects of road network improvement:

- Verifying network connectivity.
- Verifying one-way street direction.

Figure B-1.  HEC-LifeSim Main Window – Map Window – Road Network Layer

B.1  Overview

The road network connectivity defines how vehicles can traverse from one road segment to the next road segment in HEC-LifeSim. Roads are considered connected if the individual road segments share an end point.
If two roads do not share an end point then a vehicle cannot move between the two roads. Conversely, if two roads share an end point a vehicle can move between the roads even if one is a bridge and the other is the road going underneath. The first step is to check for disconnect between road segments (see Section B.1.1 and Section B.1.2). Another step to verify the direction on one-way streets (refer to Section B.2).

### B.1.1 Disconnect Invalid Road Segment Connections

Invalid road segment connections can occur several ways. For example, it is common for overpasses or underpasses to have roads connected at the overpass intersection. In HEC-LifeSim, this connection would imply that vehicles can jump from an overpass down onto a highway as if it were a standard intersection.

For example, in Figure B-2, in an off-ramp that goes underneath a highway is displayed. The road segment that goes underneath the highway shares an endpoint with the highway. The invalid road segment connection would allow vehicles to immediately jump from the highway to the underpass rather than take the off ramp, which would affect simulation results (i.e., destination arrival times, evacuation times, evacuation outflow).

![Invalid connectivity, shares end point with the highway segments.](image)

Figure B-2. Road Network with Bad Connectivity

The following steps can be used to fix road network connectivity issues:
1. To add a road network layer to the **Map Window**, from the **Study** tab, from the **Road Networks** folder, right-click on a road network dataset. From the shortcut menu, click **Show in Map Window**, the select road network dataset will now display in the **Map Window** of the HEC-LifeSim main window (Figure B-1).

2. To start an edit session, from the **Map Layers** tab (Figure B-2), right-click a road network layer, from the shortcut menu click **Edit**. Another way to start an edit session is from the **Map Layers** tab (Figure B-2), right-click on a road network layer, from the shortcut menu click **Open Attribute Table**. The **Map Layer Attributes** dialog box will open (Figure B-3), click **(Start Feature Edit Session)**, close the **Map Layer Attributes** dialog box. Either way, the **Edit Toolbar** (Figure B-4) on the HEC-LifeSim main window (Figure B-4) now becomes active.

3. Use the **Break Line Feature** tool **K** (hot key **K**) to break the connected line segment away from the highway segment (Figure B-5).
4. Now select the segment that shares an end point with the highway segment using the Select tool and delete the selected segment. Either right-click on the segment and from the shortcut menu click Delete Selected Features (Figure B-6), or press Delete key.

![Figure B-6. Road Network – Delete Undesired Road Segment](image)

5. Now select the Snapping tool (Figure B-4) to make sure that when re-connecting the line segment it will be properly connected by having the network points directly on top of each other. Click , a Snapping window (Figure B-7) will open.

![Figure B-7. Snapping Options – Road Network – Reconnect Road Segments](image)

6. Select Enable Snapping (Figure B-7), from the Snap To Layer list, select the road network layer that will be edited (e.g., Roads OSM), and then select End Points (Lines) (Figure B-7).

7. After snapping has been enabled, click , and double-click the other road segment that is connected to the highway end point to enter vertex editing mode (Figure B-8a). Next, move the mouse over the vertex that will be connected, left-click, hold and drag to move the vertex towards the disconnected road segment. Once close enough, the indicator line will snap to the endpoint of the open road segment (Figure B-8b). Release the left-click to finish moving the vertex. Either left-click away from the line segment or right-click and click Finish Editing Vertices from the shortcut menu to exit the editing session (Figure B-8c).
8. Now, the road segment does not share an end point with the highway road segments and in HEC-LifeSim vehicles will have to, appropriately, take the highway off-ramp to get to the underpass (Figure B-9).

9. This process should be repeated for any other roads in the road network that should not be connected.

10. Remember to save often (from the Edit Toolbar (Figure B-4) click ). To avoid spending an hour editing the road network and then get surprised with a computer restart or worse an unexpected error in the software.
B.1.2 Roads that should be Connected

Road segments that represent a continuous road can sometimes lack a common endpoint (Figure B-10). When this happens, vehicles in HEC-LifeSim cannot move from one segment to the next when in reality the vehicles clearly should be able move freely.

The following steps can be used to fix the connectivity issue:

1. A tool that can aid in finding connectivity issues is to display a shapefile that shows locations where a line segment's endpoint is not shared with another line segment. From the HEC-LifeSim main window (Figure B-1), from the Study tab, from the Road Networks folder, right-click on a road network dataset. From the shortcut menu, click Show Dangles in Map Window, a shapefile that contains dangle locations will display in the Map Window of the HEC-LifeSim main window (Figure B-1).

2. To connect the road segment at the West Spruce Street intersection, from the Map Layers tab (Figure B-2), right-click a road network layer, from the shortcut menu click Edit. Another way to start an edit session is from the Map Layers tab (Figure B-2), right-click on a road network layer, from the shortcut menu click Open Attribute Table. The Map Layer Attributes dialog box will open (Figure B-3), click (Start Feature Edit Session), close the Map Layer Attributes dialog box. Either way, the Edit Toolbar (Figure B-4) on the HEC-LifeSim main window (Figure B-1) now becomes active.

3. Now turn on snapping, click , from the Edit Toolbar (Figure B-4), a Snapping window will open (Figure B-7). Make sure that the re-connected line segment is properly connected by having the network points directly on top of each other. From the Snapping
window (Figure B-7), click **Enable Snapping**, from the **Snap To Layer** list select the road network that is currently being edited (e.g., *Roads OSM*), and then select **End Points (Lines)**.

4. Click ![enter_vertex_editing](image1.png), double-click the road segment that is not connected to the intersection to enter vertex editing mode (Figure B-11a). Next, move the mouse over the vertex to connect, left-click hold and drag to move the vertex towards the intersection. Once close enough, the indicator line will snap to the end point of the intersection (Figure B-11b). Release the left-click to finish moving the vertex. Either left-click away from the line segment or right-click and click **Finish Editing Vertices** from the shortcut menu to exit the editing session (Figure B-11c).

5. Now, the road segment that was previously disconnected will now allow traffic to continue on *West Spruce Street* (Figure B-12).
6. This process should be repeated for any other roads in the road network that should be connected.

7. Remember to save often (from the Edit Toolbar (Figure B-4) click ). To avoid spending an hour editing the road network and then get surprised with a computer restart or worse an unexpected error in the software.

B.2 Verify One-Way Street Direction

HEC-LifeSim’s traffic simulation engine allows road segments to either be one-way or two-way road segments. If a road is considered one-way, then vehicles can only travel in one direction along the road segment. The direction is defined from the first point in the road segment to the last point in the road segment and can be defined by enabling arrows to be drawn at the end of one-way roads through the road network map layer properties. For details on how to use the map layer properties refer to Section A.8 of Appendix A. Sometimes a road segment that is defined as one-way will be pointing in the wrong direction. This would mean that vehicles would have to find a way around the incorrectly oriented one-way segment. The following example (Figure B-13) shows a case where a one-way highway segment is pointing in the wrong direction and needs to be fixed.

To fix the orientation of a one-way road segment which is pointing in the wrong direction follow the steps below:
1. A tool that can aid in finding connectivity issues is to display a shapefile that shows locations where a line segment’s endpoint is not shared with another line segment. From the HEC-LifeSim main window (Figure B-1), from the Study tab, from the Road Networks folder, right-click on a road network dataset. From the shortcut menu, click Show Dangles in Map Window, a shapefile that contains dangle locations will display in the Map Window of the HEC-LifeSim main window (Figure B-1).

2. From the Map Layers tab (Figure B-2), right-click a road network layer, from the shortcut menu click Edit. Another way to start an edit session is from the Map Layers tab (Figure B-2), right-click on a road network layer, from the shortcut menu click Open Attribute Table. The Map Layer Attributes dialog box will open (Figure B-3), click (Start Feature Edit Session), close the Map Layer Attributes dialog box. Either way, the Edit Toolbar (Figure B-4) on the HEC-LifeSim main window (Figure B-1) now becomes active.

3. Once edit mode has been initiated, click , and select the road segment that is oriented in the wrong direction. With the correct segment selected, either press the R key, or right-click, and from the shortcut menu click Reverse Selected Features (Figure B-14) to reverse the direction of the line segment.

![Figure B-14. Example – Reverse Selected Features – Shortcut Menu](image)

Note, reversing the direction of selected features applies to all features that are currently selected. Make sure that selected line features only contain lines whose direction is desired to be reversed.

4. Now, the one-way road segment that was previously oriented in the wrong direction (against the flow of traffic) will allow traffic to continue in the appropriate direction (Figure B-15).

5. This process should be repeated for any other roads in the road network that are defined as one-way roads and are oriented in the wrong direction.

6. Remember to save often (from the Edit Toolbar (Figure B-4) click ). To avoid spending an hour editing the road network and then get surprised with a computer restart or worse an unexpected error in the software.
Figure B-15. Example - Better Network Connectivity – Following Road Network Edits
Appendix C

References


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Appendix D

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