Multi-hazard Loss Estimation Methodology

Flood Model

Hazus®-MH

User Manual

Developed by:
Department of Homeland Security
Federal Emergency Management Agency
Mitigation Division
Washington, D.C.

This manual is available on the FEMA Hazus website at www.fema.gov/plan/prevent/hazus.

To order the Hazus software visit www.msc.fema.gov and go to the Product Catalog to place your order.

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Message to Users

The Hazus Flood Model produces loss estimates for vulnerability assessments and plans for flood risk mitigation, emergency preparedness, and response and recovery. The methodology deals with nearly all aspects of the built environment, and a wide range of losses. The user can evaluate losses from a single flood event, or for a range of flood events allowing for annualized estimates of damages. Using the extensive national databases that are embedded in Hazus, users can make general loss estimates for a region. These databases contain information such as demographic aspects of the population in a study region, square footage for different occupancies of buildings, and numbers and locations of bridges. The Hazus methodology and software are flexible enough so that locally developed inventories and other data that more accurately reflect the local environment can be substituted, resulting in improved loss estimates.

The methods within the Hazus Flood Model are commonly used by federal, state, and local agencies for planning studies and are considered "reasonable." Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning floods and their effects upon buildings and facilities. They also result from the approximations that are necessary for comprehensive analyses. Factors such as incomplete or inaccurate inventories of the built environment, demographics and economic parameters can result in a range of uncertainty of two or more in loss estimates produced by the Hazus Flood Model.

Users should be aware of the following specific limitations:

- While the Hazus Flood Model can be used to estimate losses for an individual building, the results must be considered as average for a group of similar buildings.

- When using embedded inventories, accuracy of losses associated with lifelines may be less than for losses from the general building stock. The embedded databases and assumptions used to characterize the lifeline systems in a study region are necessarily incomplete and oversimplified.

- The Flood Model performs its analysis at the census block level with small numbers of buildings. Damage analysis of these small numbers makes the Flood Model more sensitive to rounding errors. These results should be used with suitable caution.

Hazus should still be regarded as a work in progress. Additional damage and loss data from actual floods and further experience in using the software will contribute to improvements in future releases. To assist us in further improving Hazus, users are invited to submit comments on methodological and software issues by letter, fax or e-mail to:

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Chapter 1 Introduction to the Flood Loss Estimation Methodology

1.1 Overview of the Methodology

Hazus provides nationally applicable, standardized methodologies for estimating potential wind, flood, and earthquake losses on a regional basis. **Hazus** can be used to conduct loss estimation for floods and earthquakes, and contains a preview model for hurricane loss estimation. The multi-hazard **Hazus** is intended for use by local, state, regional officials, and consultants to assist mitigation planning and emergency response and recovery preparedness. For some hazards, **Hazus** can also be used to prepare real-time estimates of damages during or following a disaster.

The **Hazus** Flood Model is for floodplain managers, their contractors, and others who are responsible for protecting citizens and property from the damaging effects of flooding. It is an integrated system for identifying and quantifying flood risks based on state-of-the-art analysis. It provides an analytic, decision support tool to help communities make informed decisions regarding land use within their flood prone areas.

An overall schematic of the **Hazus** Flood Model methodology is presented in Figure 1.1.

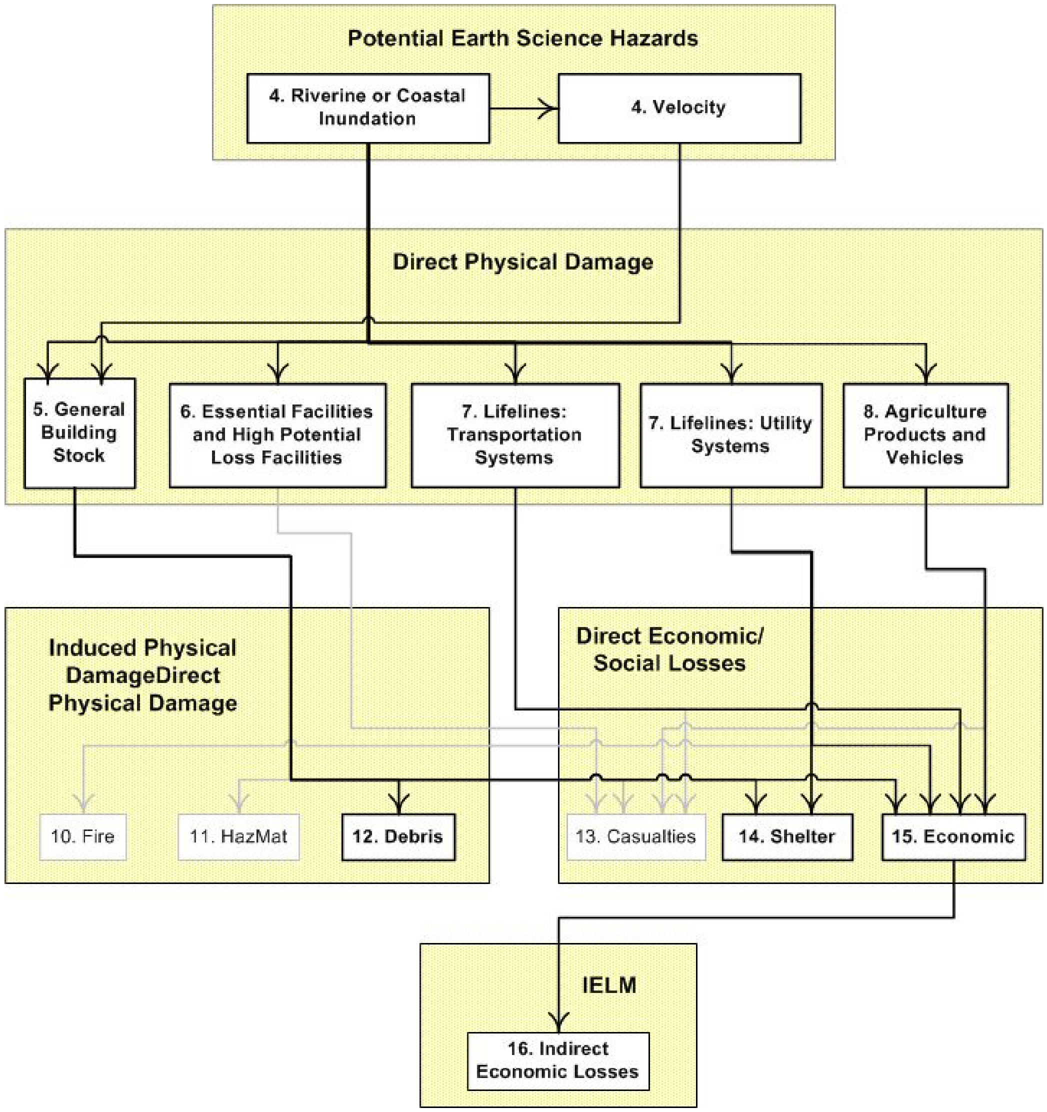


Figure 1.1 Flood Model Schematic

As shown in this figure, the Flood Model methodology consists of two basic analytical processes: Potential Earth Science Hazards, in this case the flood hazard analysis, and damage analysis, in this case the flood loss estimation analysis. In the hazard analysis phase, characteristics such as frequency, discharge, and ground elevation are used to model the spatial variation in flood depth and velocity. During the loss estimation phase, structural and economic damage is calculated based on the results of the hazard analysis through the use of vulnerability curves. Model results can then be conveyed to the user via a series of reports and maps.

The **Hazus** software requires ArcGIS 10 with SP 1 to run and the Flood Model requires the associated spatial analyst extension. After study region aggregation, the program runs efficiently on a desktop computer. This manual gives detailed instructions for using the **Hazus** program, but assumes that users have some proficiency with Geographic Information Systems (GIS) software.

1.2 Flood Hazards Considered in the Methodology

The **Hazus** Flood Model analyzes both riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth.

Depth, duration and velocity of water in the floodplain are the primary factors contributing to flood losses. Other hazards associated with flooding that contribute to flood losses include channel erosion and migration, sediment deposition, bridge scour and the impact of flood-born debris. The **Hazus** Flood Model allows users to estimate flood losses due to depth of flooding although Level 1 users can develop order of magnitude losses due to flood velocity to the general building stock (GBS). The agriculture component will allow the user to estimate a range of losses to account for flood duration. The Flood Model does not estimate the losses due to high velocity flash floods at this time.

Flood warning is one offsetting component to the primary flood damage factors identified above. The Flood Model allows the user to perform "what-if?" analyses to identify what percentage of losses avoided may make a warning system beneficial. This methodology follows the U.S. Army Corps of Engineers approach using the "Day" curves.

In different contexts, flood hazard may have different meanings. Hazard can mean risk in some contexts and it can mean a source of danger in others. The hazard may be that an area is inundated about once every 10 years (risk) or it may be that an area is subject to flood depths ranging from 5 to 10 feet (source of danger). Flood frequency studies combine these ideas and define flood hazard in terms of the chance that a certain magnitude of flooding is exceeded in any given year.

Flood magnitude is usually measured as a discharge value, flood elevation, or depth. For example one may refer to the 100-year flood elevation. It is the elevation, at the point of interest, that has a one percent (1%) annual chance of being exceeded by floodwater. Using the flood frequency convention, flood hazard is defined by a relation between depth of flooding and the annual chance of inundation greater than that depth. The relation is called a depth-frequency curve.

1.3 Types of Buildings and Facilities Considered

An important requirement for estimating losses from floods is the identification and valuation of the building stock, infrastructure, and population exposed to flood hazard (i.e., an inventory.) Consequently, the **Hazus** Flood Model uses a comprehensive inventory in estimating losses. This inventory serves as the default when a user does not have better data available. The inventory consists of a proxy for the general building stock in the continental United States. Additionally, the model contains national data for essential facilities (e.g., police stations), high potential loss facilities (e.g., dams), selected transportation (e.g., highway bridges) and lifeline systems (e.g., potable water treatment plants), demographics, agriculture products (e.g., corn), and vehicles. This inventory is used to estimate damage (%), and the direct economic losses for some elements (i.e., the general building stock) or the associated impact to functionality for essential facilities.

The Earthquake Model's general building stock is currently available at the census tract level, but increased resolution is needed to support the Flood Model. The census block was chosen as the level of aggregation due to its relatively small geographic size and the capability of the census to identify data at that level of detail. As the census data only provides sufficient information for the development of the residential structures data, Dun & Bradstreet (D&B) provided data for non-residential structures at the census block level.

1.4 Levels of Analysis

The Flood Model is designed for three levels of analysis:

Level 1 This is the simplest type of analysis requiring minimum effort by the user. It is based primarily on data provided with the software (e.g., census information, broad regional patterns of foundation distributions and no floodplain code adoption, etc.). The user is not expected to have extensive technical knowledge. While the methods require some user supplied input to run, the type of input required could be gathered by contacting government agencies or by referring to published information. At this level, estimates will be crude and will be appropriate as initial loss estimates to determine where detailed analyses are warranted.

Some components of the methodology cannot be performed in a Default Data Analysis since they require more detailed inventory than that provided with the methodology. The following are not included in the Default Data Analysis: damage/loss due to ground failure or erosion (riverine only), damage/loss due to earthquake driven flooding such as tsunamis or seiche, damage/loss due to dam failure. At this level, the user has the option (not required) to enter information about their own local facilities in lieu of using the default point facilities (e.g., essential facilities). The user also has the option to replace the general building stock utilizing tools provided with **Hazus**. One week to one month would be required to collect relevant information depending on the size of the region and the level of detail the user desires.

Level 2 analysis improves level 1 results by considering additional data that are readily available or can be easily converted or computed to meet methodology requirements. In Level 2, the user may need to determine parameters from published reports or maps as input to the model. It requires more extensive inventory data and effort by the user than the Default Data Analysis. The purpose of this type of analysis is to provide the user with the best estimates of flood damage/loss that can be obtained using the standardized methods of analysis included in the methodology. Flood Model users will be required to use the Flood Information Tool (FIT) to pre-process their flood hazard data for use in the Flood Model. This is to ensure consistency in their local data and format the data to be read by the Flood Model. It is likely that the user will need to employ consultants to assist in the implementation of certain methods. For example, knowledgeable users of hydrology and hydraulics models are required to define flood elevations.

All components of the methodology can be performed at this level, with the exception of the velocity analysis, and the best results would be based on locally (user) developed inventories. As the user provides more complete data, the quality of the analysis and results improve. Depending on the size of the region and the level of detail desired by the user, one to six months would be required to obtain the required input for this type of analysis.

Level 3 analyses require extensive efforts by the user in developing information on the flood hazard and the measure of exposure. This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology. At this level, one or more technical experts are required to acquire data, perform detailed analyses, assess damage/loss, and assist the user in gathering extensive inventory data. It is anticipated that at this level there will be extensive participation by local utilities and owners of special facilities. There is no standardized Advanced Data and Models Analysis study. The quality and detail of the results depend upon the level of effort. Six months to two years would be required to complete an Advanced Data and Models Analysis. Each subsequent level builds on and adds to the data and analysis procedures available in previous levels.

Figure 1.2 provides a graphic representation of the various levels of analysis and the subsequent user sophistication to achieve that level of analysis.

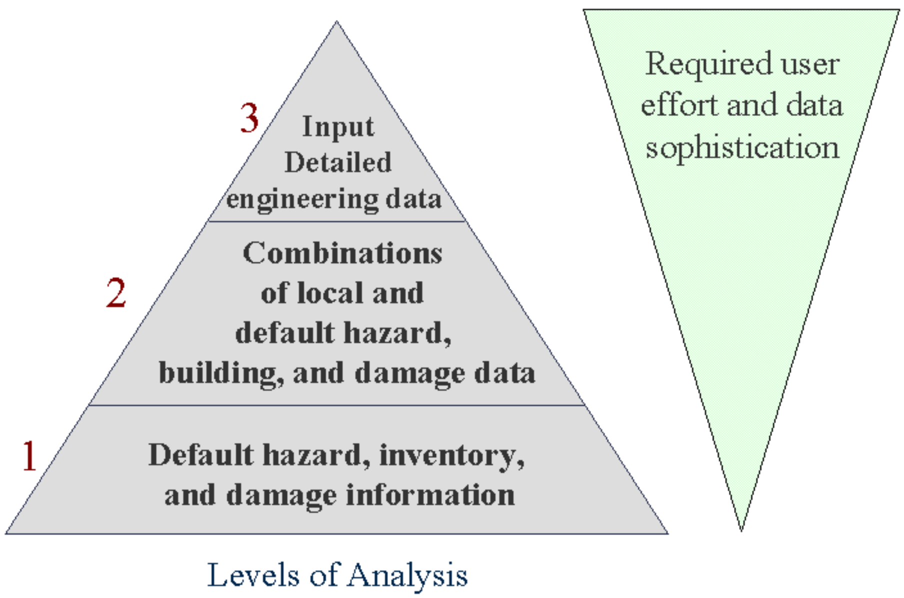


Figure 1.2 Levels of Analysis and User Sophistication

The attributes of the model for each level of analysis and examples of typical applications are presented in Table 1.1.

Table 1.1 Attributes of the *Hazus* Flood Model

	Level 1	Level 2	Level 3
Hazard	User supplied Digital Terrain or Elevation Model (DEM), typically the USGS 30-meter DEM. The Flood Model will use default hazard data including Hydrologic Unit Codes, and accumulation methodology to develop approximate stream centerlines. USGS regression equations and gage records will be used to determine discharge frequency curves.	User supplied flood stream cross-sections attributed with elevations, or lines of Base Flood Elevation (BFE). Coastal users will supply polygons attributed with the BFE. A flood boundary of some form is required. User supplied hazard data pre-processed via the FIT. DEM consistent with their FIT data.	Similar to Level 2 although the user will likely work with Hydraulic models outside of the Flood Model and the FIT. User will be required to pre-process the data through the FIT.
Inventory	Hazus default data. Allocation of census block data via statistical analysis, and broad assumptions for first floor height based on foundation distributions. Agriculture products, vehicles, essential facilities, some transportation and utility facilities.	User supplied inventory data, such as Tax Assessor data, and inventory data developed via site surveys processed through the Comprehensive Data Management System (CDMS) tool. Users enhance the first floor height and other parameters.	High quality data re: building values, flood vulnerabilities, contents, occupancies, etc, extended to industrial and other high-value facilities.
Damage Curves	Broad regional default curves based on available FIA or USACE depth damage curves. Library of curves available for user selection. User may create their own function using library curves as guides.	User specifically modifies the existing curve library for local practices.	User-input curves based on detailed building surveys, specific crop conditions etc.
Damage Estimation	Area weighted damage estimates based on the depth of flooding within a given census block. Losses developed for general building stock, essential facilities, vehicles, agricultural products, select transportation and utility features.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.
Direct Loss/ Impacts	Cost of repair / replacement, shelter needs, temporary housing, vehicles, crop & livestock losses.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.
Induced Losses	Debris developed from direct damage to buildings based on floor areas from the general building stock.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves. Site specific debris generation currently not available in the Flood Model, must be based on census block attribution of floor area.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves. Site specific debris generation currently not available in the Flood Model, must be based on census block attribution of floor area.

Table 1.1 Attributes of the *Hazus* Flood Model

	Level 1	**Level 2**	**Level 3**
Indirect Loss/ Impacts	Sectoral economic impacts.	Sectoral economic impacts.	Sectoral economic impacts.
Typical Applications	• Flood mitigation / regulatory policy-making, regional, state, federal levels • Pre-feasibility studies • Real-time emergency response with no warning • Preliminary planning, zoning development	• Planning, zoning, development • Selecting mitigation alternatives • Pre-feasibility engineering studies • Emergency planning and real-time response • Environmental impact analysis • Education	• Analysis for essential, cultural, high-loss potential facilities • Emergency planning and real-time response • Mitigation and engineering research • Scientific research

1.5 Assumed Levels of Expertise of Users

Flood model users can be broken into two groups: those who perform the analysis, and those who use the results. For some efforts these two groups will consist of the same people, but generally this will not be the case. However, the more interaction that occurs between these two groups, the better the analysis will be. End users of the loss estimation analysis need to be involved from the beginning to make results more usable.

Those who performed the Flood Model analysis must, at a minimum, have a basic understanding of flood risk issues. Even Level 1 users will be prompted to enter appropriate community specific information, such as the drainage area the model should use when generating the stream network, or the 100-year Still Water Elevation (SWEL) when performing a coastal analysis. In many cases, the results will be presented to audiences (i.e., city councils and other governing bodies) that have little technical knowledge of the flood loss problem.

To obtain the best results, it is assumed that the loss analysis will be performed by a team consisting of floodplain manager(s), structural engineer(s), economist(s), sociologist(s), hydrologist(s), emergency planner(s), public works personnel, and the loss estimate users. These individuals are needed to develop flood return periods or discharges of interest or concern, develop and classify building inventories, provide and interpret economic data, provide information about the local population, and to provide guidance on what loss estimates are needed to fulfill the user's goals. The participation of at least one GIS specialist with some level of familiarity or expertise in data management and GIS would be very beneficial.

If a local or state agency is performing the analysis, some of the expertise can be found in-house. Experts are generally found in several departments: building permits, public works, planning, public health, engineering, information technologies, finance, historical preservation, natural resources, and land records. Although internal expertise may be most readily available, participation of individuals from academic institutions, citizen organizations, and private industry cannot be underestimated.

1.6 When to Seek Help

The results of a loss estimation analysis should be interpreted with caution. If using the Level 1 methodology with default data, there will be a great deal of uncertainty associated with the loss estimate. If the loss estimation team does not include individuals with expertise in the areas described above, then it is likely that one or more outside consultants may be required to assist with interpreting the results. It is also advisable to retain objective reviewers with subject expertise to evaluate and comment on map and tabular data outputs.

A consultant familiar with hydrology and hydraulics (H&H) will understand the basis of the methodology and can provide a great deal of input on the utilization of output results. Attention should be given to any differences in the methodology used to define documented scenarios. A scenario event that is defined without an in-depth understanding of the flood sources and built environment may not be appropriate for the loss estimation analysis.

If the user intends to modify the default inventory data or parameters, assistance will be required from an individual with expertise in the subject. For example, if the user wishes to change default percentages of model foundation types for the region, a structural engineer with knowledge of regional design and construction practices will be helpful. Similarly, if depth-damage relationships or other curves selected from the damage function library need editing, input from a structural engineer is recommended. Modifications to defaults in the direct and indirect economic modules require input from an economist.

Zimmerman Associates, Inc. has established technical help for **Hazus** users. Users should contact the Hazus Help Desk at https://support.hazus.us. For information on technical support users, agency and organizational websites are also listed in this report to access Frequently Asked Questions (FAQs), software updates, training opportunities, and User Group activities.

1.7 Methodology Results

There is a great deal of flexibility in displaying output. Tables of social and economic losses can be displayed on the screen, printed, or pasted into electronic documents. Most outputs can also be mapped. Colors, legends and titles can be easily altered. Results can be compiled to create electronic presentations, or as inserts to a community project report.

Examples of graphical and numerical outputs that can be produced by the program are found in Figure 1.3 and Figure 1.4.

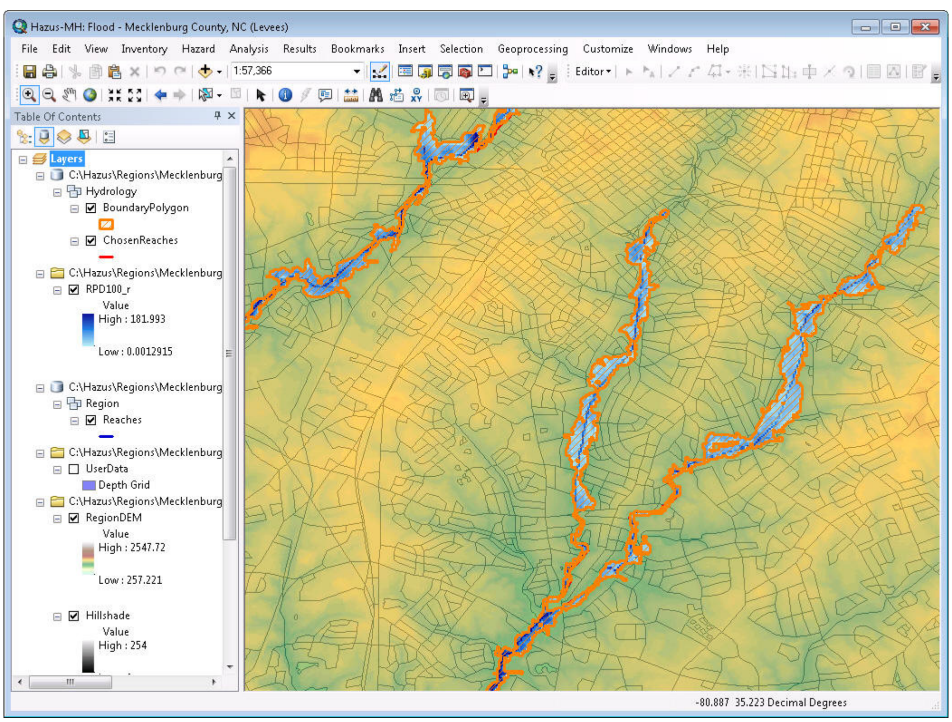
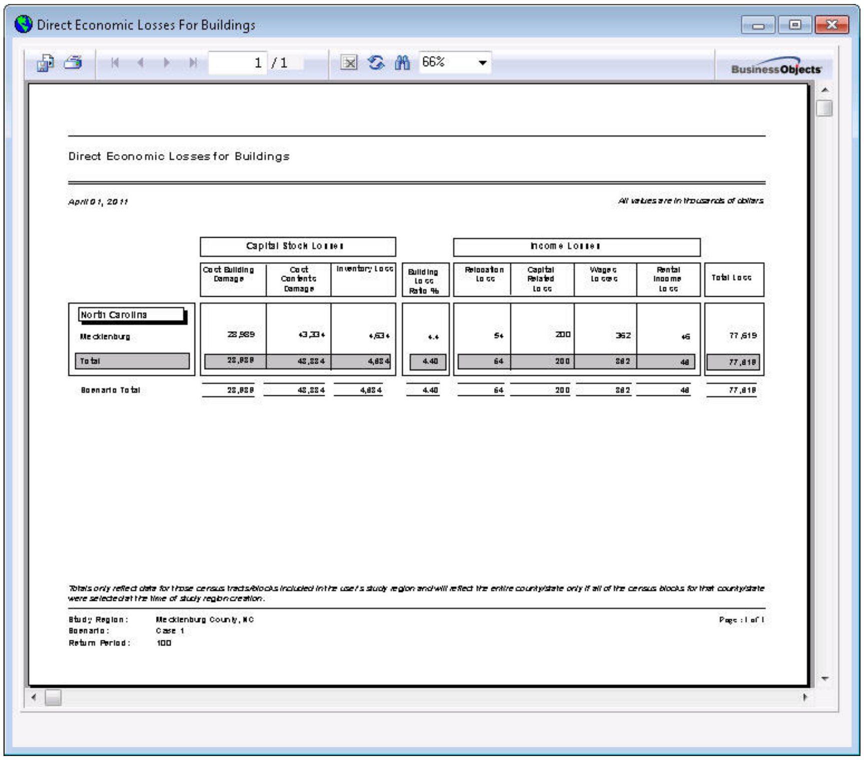


Figure 1.3 Sample Graphic Output Flood Depth Grid for A 100-Year Flood



Direct Economic Losses For Buildings

Direct Economic Losses for Buildings

April 01, 2011 *All values are in thousands of dollars*

	Capital Stock Losses				Income Losses				
	Cost Building Damage	Cost Contents Damage	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
North Carolina									
Mecklenburg	28,989	43,334	4,634	4.4	54	200	362	46	77,619
Total	28,989	43,334	4,634	4.40	54	200	362	46	77,619
Scenario Total	28,989	43,334	4,634	4.40	54	200	362	46	77,619

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: Mecklenburg County, NC
Scenario: Case 1
Return Period: 100

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Figure 1.4 Sample Numerical (Crystal Report) Output

1.8 Uncertainties in Loss Estimation

The user should always be aware that numbers produced by software models such as **Hazus** are to be used with a certain degree of caution. Uncertainty within the results can be introduced from a number of sources including the use of national datasets to represent local conditions, simplifications within the model introduced to allow the model to have flexibility with Level 1 users, and errors introduced as part of the mathematical processing within the software code. Finally, user input can also have a great affect on the uncertainty associated with the results. At this time, the Flood Model does not provide the user with an assessment or "treatment" of uncertainty. As a planning tool, the consistency and value of the results developed by **Hazus** cannot be understated. When properly used, the results developed by **Hazus** can allow a user to identify and manage the flood hazard especially as it relates to development trends and the management of fiscal resources.

1.9 Applications of the Results

Figure 1.5 summarizes the output that can be obtained from an analysis. There is a great deal of flexibility in displaying output. Tables of social and economic losses can be displayed on the screen, printed out or pasted into electronic documents. Most outputs can also be mapped. Colors, legends and titles can be altered easily. Details are provided in Chapter 10.

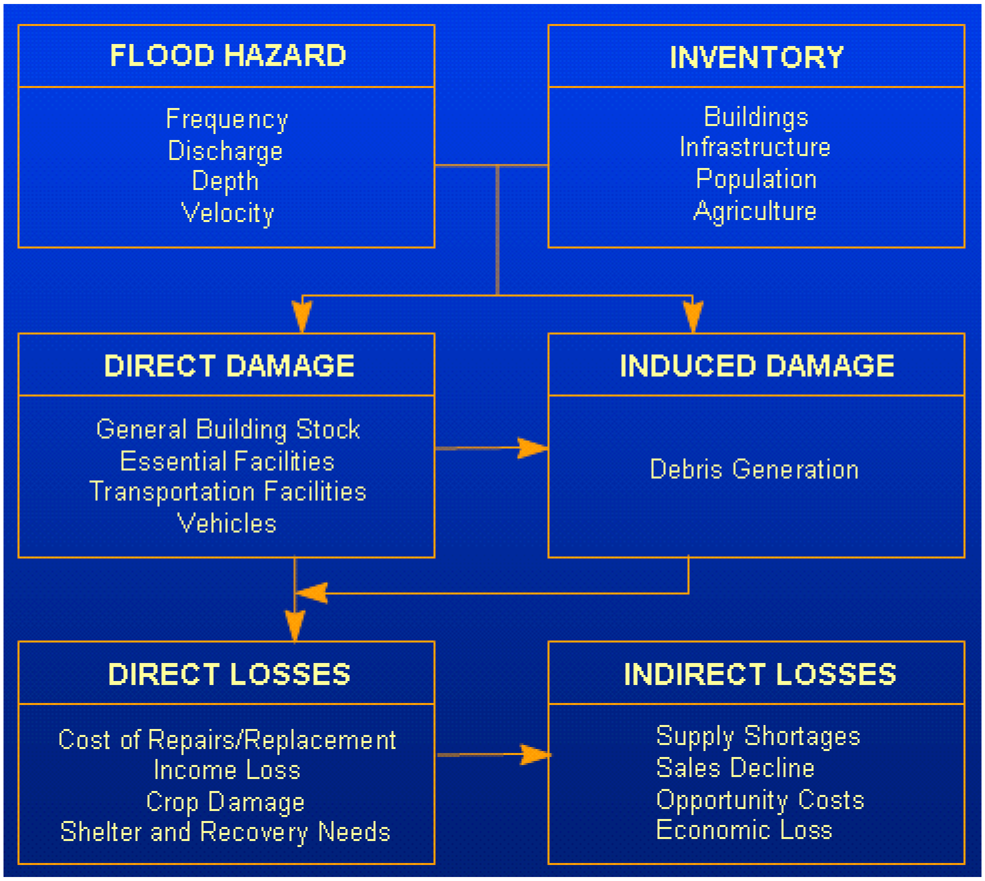


Figure 1.5 Sample Numerical (Crystal Report) Output

1.10 Organization of the Manual

The *User Manual* provides the background and instructions for developing an inventory to complete a flood loss estimation study using **Hazus**. It also provides information on how to install and run the software, and how to interpret and report model output. The contents and organization of the User Manual are outlined below.

The Technical Manual accompanies this publication. It documents the default data and explains the methodology used to calculate flood related losses. Together, the two manuals provide a comprehensive overview of the nationally applicable loss estimation methodology.

Chapter 1: Provides the user with a general understanding of the purpose, uses and components of a regional flood loss estimation analysis.

Chapter 2: Gives instructions for installing, starting, and installation verification of **Hazus**.

Chapter 3: Provides an analysis using only default data.

Chapter 4: Provides an overview of the types of data required to run the loss analysis, as well as a description of the default databases.

Chapter 5: Contains detailed information about what data are needed to complete a loss study, sources of inventory, how to collect inventory, and related expenses to anticipate. This chapter also describes how to convert data to the correct format for the methodology, and how to enter data into **Hazus**.

Chapter 6: Includes instructions for entering data, editing records and geocoding addresses.

Chapter 7: Provides the user with a discussion on how to display, modify and print databases.

Chapter 8: Discusses the Flood Information Tool (FIT) briefly. This ArcGIS extension is designed to process user-supplied flood hazard data into the format required by the Hazus Flood Model.

Chapter 9: Provides a detailed step-by-step description of how to run an analysis using **Hazus**, including analysis with user-supplied data.

Chapter 10: Discusses how to view results and provides suggestions on how to develop a report.

Chapter 11: References.

The *User Manual* is written in language that should be easily understood by a user of the methodology. Highly technical terms are avoided where possible, but a glossary of terms is provided in Appendix D to supplement any definitions that are needed. A compilation of relevant references is found in the References Section.

The appendices contain detailed information about the structure of the methodology.

Appendix A Installation verification provides a quick start tutorial for the **Hazus** Flood Model.

Appendix B Provide descriptions of the model building types that are used in the methodology.

Appendix C Provides the user with examples of using the **Hazus** Flood Model to support policy decisions and other flood-related applications. The chapter also provides a complete explanation of the "what if?" capabilities of the Flood Model.

Appendix D Database dictionary containing details about the format of the **Hazus** databases.

Appendix E	GIS Data Dictionary containing metadata regarding GIS datasets used as input in the flood hazard computations.
Appendix F	Running Hazus-MH with SQL Server 2008 R2.

Chapter 2 Installing and Starting Hazus-MH

Please refer to the *Installation Instructions.pdf* document that comes with the Hazus-MH software for installation assistance. It is very important to read these instructions before attempting to install Hazus-MH. Contact Hazus Technical Support if you cannot locate the instructions document (https://support.hazus.us or 1-877-283-8789).

Chapter 3 Running Hazus Flood with Default Data

Running **Hazus** with default data requires a minimum of effort and technical expertise. **Hazus** contains a variety of default parameters and databases. The analysis uses data provided with the methodology, such as the general building stock data and broad regional patterns of floodplain code adoption. A small amount of user-supplied input is required to run the analysis, but this input can be gathered by contacting government agencies or referring to readily available published sources.

The results of a **Hazus** run using default data will have large margins of error. This type of output would be appropriate for regional, state or national level analyses. At the local level, this type of analysis is most appropriate as an initial loss estimation study to determine where more detailed data collection and analysis are warranted. Conducting a run using default data is an excellent way to become familiar with using **Hazus**.

Some components of the methodology cannot be performed in an analysis using default data because they require more detailed inventory than that provided with the methodology. For example, you can only analyze damage and loss for wastewater systems if you provide a detailed inventory of the facilities.

This Section takes you step-by-step through the process of producing and presenting flood loss estimates from default data with **Hazus**.

3.1 Defining the Study Region

The first step of any **Hazus** run is defining the *study region*, the geographic area that will be analyzed. The first time you use **Hazus**, you must define a study region before you can access the program. In subsequent uses, you may open an existing study region or define a new one.

The study region can be any combination of states, counties, census tracts or census blocks. Currently if you want to create a study region that matches a city boundary, you will need to know what census tracts are contained within the city. In many cases, the region boundary will follow political boundaries such as counties, or those municipalities that are city-counties. It is important to note that **Hazus** will not include any inventory data outside the area you have defined as the study region. Some hazard specific data required for the analysis may extend beyond the study region you have selected. In fact, **Hazus** will not allow you to add any facilities that are not contained within the study region boundary.

The methodology is based upon using census blocks as the smallest geographic unit (this is different from the earthquake model which uses census tract as the smallest unit). A census block is the smallest Census Bureau geographic entity; it generally is an area bounded by streets, streams, and the boundaries of legal and statistical entities, such as metropolitan area, census tracts, etc. every effort is made to make the census block as homogeneous as possible in terms of income, population and other characteristics.

Immediately upon opening the **Hazus** program, you are prompted to create or open a study region, as shown in Figure 3.1. If you have already created a study region, you can open it now. If there are no study regions created on your machine, you will need to create one now. Select the button labeled *Create a new region* and click *OK*. This Section will create and use a study region for Alamance County, North Carolina as an example.

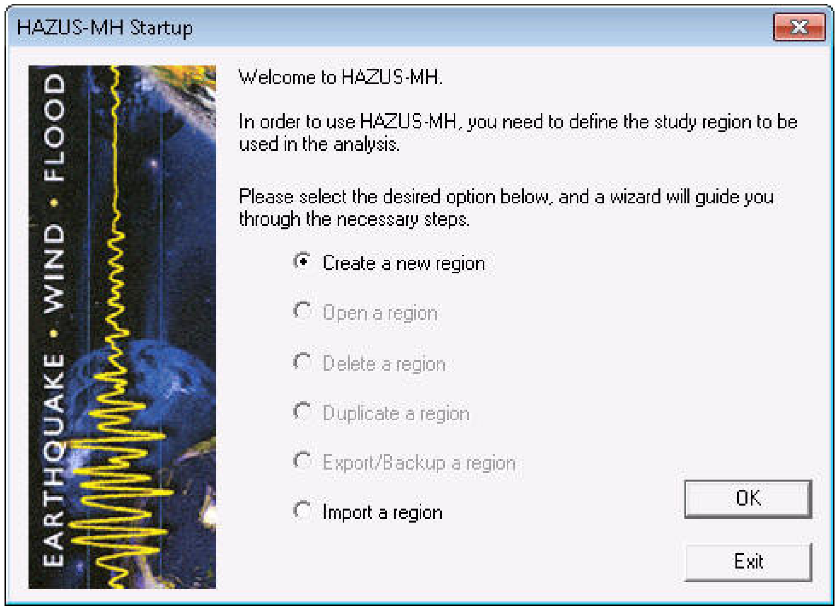


Figure 3.1 Hazus Start-up Window

Next, **Hazus** will lead you through the process of creating a study region. First you will be prompted to name your study region. You may also choose to write a description of the study region that you will be able to view when opening study regions later. This is shown in Figure 3.2. Be sure not to include leading or trailing spaces in the study region name. Press **Next** when you are ready to proceed.

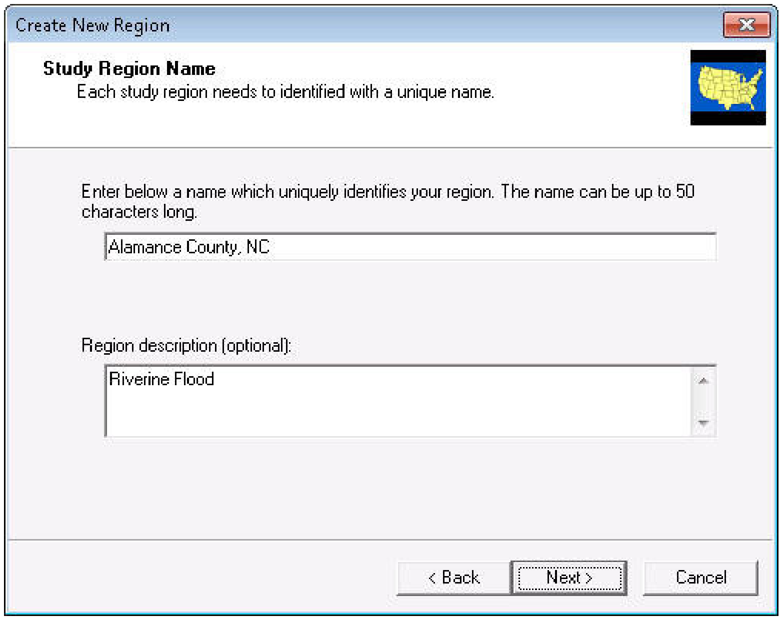


Figure 3.2 Naming the Study Region

The next window will prompt you to select which hazards you are interested in examining for your community. The analysis for each hazard requires different default information, and the study region you create will include only the information needed for the hazards you intend to run. For this example, we select only *Flood*, as shown in Figure 3.3. Note it is recommended that the flood user limit the size of their study regions to approximately four counties in size due to the large amount of data required for the flood analysis.

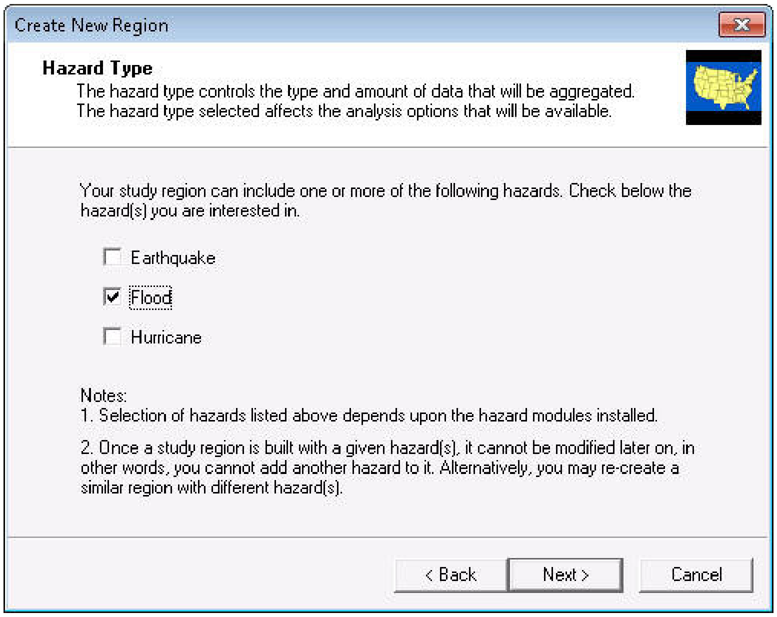


Figure 3.3 Select Hazards for a Study Region

The next step in creating a study region is shown below in Figure 3.4 is to select the level of detail you would like for your study region.

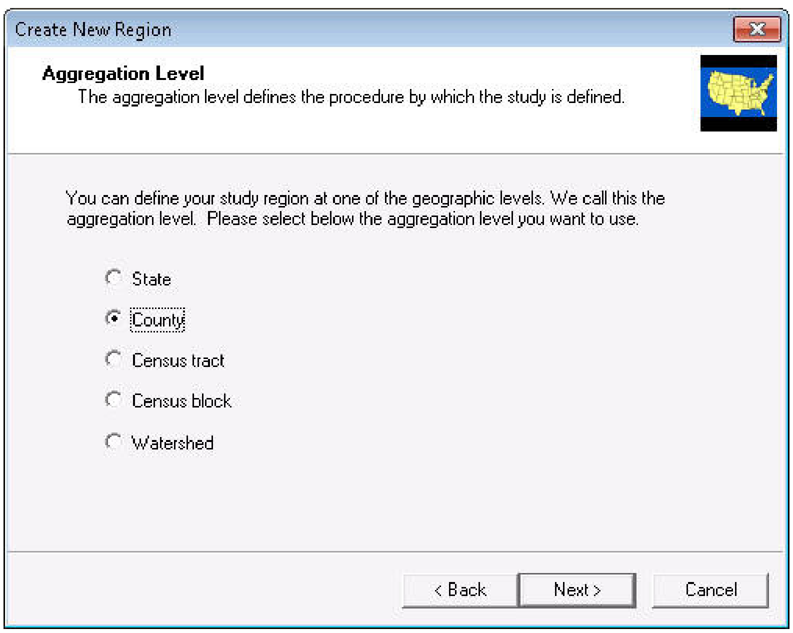


Figure 3.4 Study Region Aggregation Level

The aggregation level defines the resolution at which your study region will be defined. If you wish to be able to perform analyses anywhere within a county, select the “County” aggregation level. If you wish to select a sub-county study region by census tracts or blocks, select the appropriate radio button. The aggregation level does not affect the resolution of results. All Flood Model results are computed at the census block level, regardless of the level of aggregation.

The next steps involve selecting the state your study region is located in, and then the county or counties to be included in the region. You can do this by selecting from a list of states and then a list of counties, or by selecting both from a map. For example, you can select a county individually by single clicking on its name (or select multiple counties by single-clicking on the name of the first county and holding down the “Ctrl” key while single-clicking on the remaining counties). These steps are illustrated in Figure 3.5 and Figure 3.6.

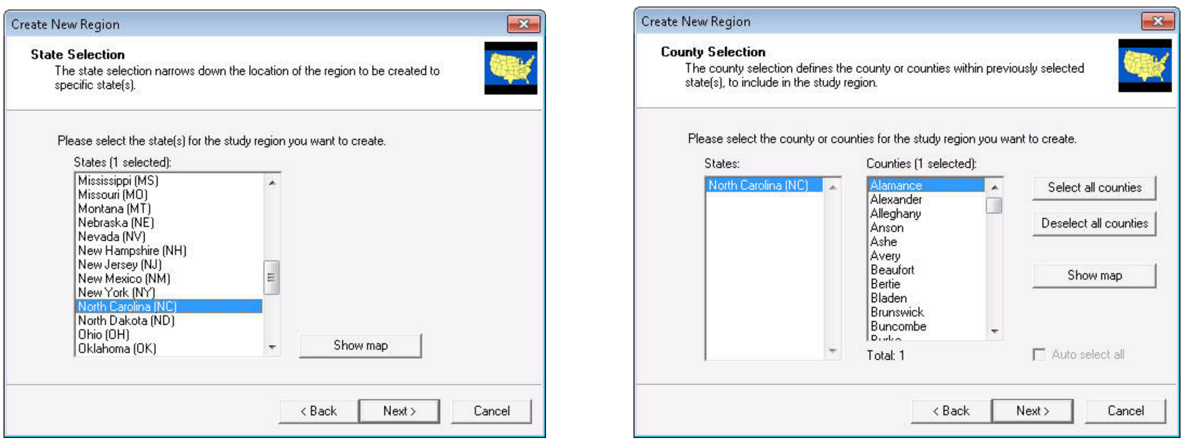


Figure 3.5 Select State and Counties by List

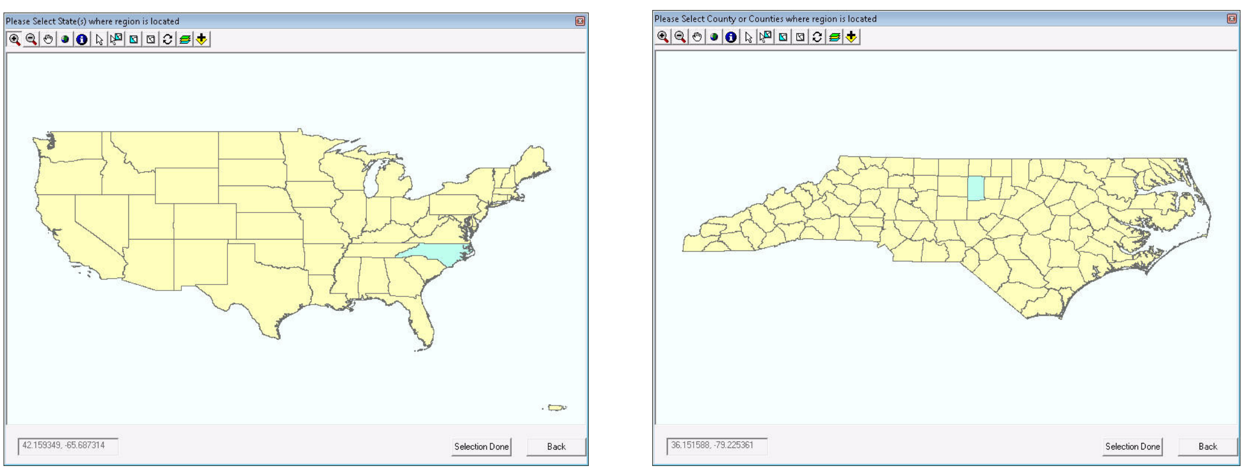


Figure 3.6 Select State and County by Map

If you choose to select your state and counties by map, you can use the “Identify” tool (the button with the lower-case *i*) to click on an area to identify it.

After identifying the state and counties and clicking *Next*, **Hazus** will start to build the study region. The process of building a study region will take some time, depending on the processor speed of your computer and the size and level of detail of the study region you have defined. For a study region of one county, it could take **Hazus** between five minutes and 20 minutes to process the information. This process requires time because of the large amounts of data that are being loaded into the study region.

When the study region is complete, the same window that appeared when you first opened **Hazus** will appear again. This time, you should select *Open a region*.

Hazus will present you with a list of all of the study regions that have been created on your computer. If the study region you just created is your first, you will only see one region listed. In Figure 3.7, there are two study regions to choose from, meaning that the Alamance County, North Carolina region created in the example was the second region to be created on that computer. Select the name of the region you just created and click *Next* to open it.

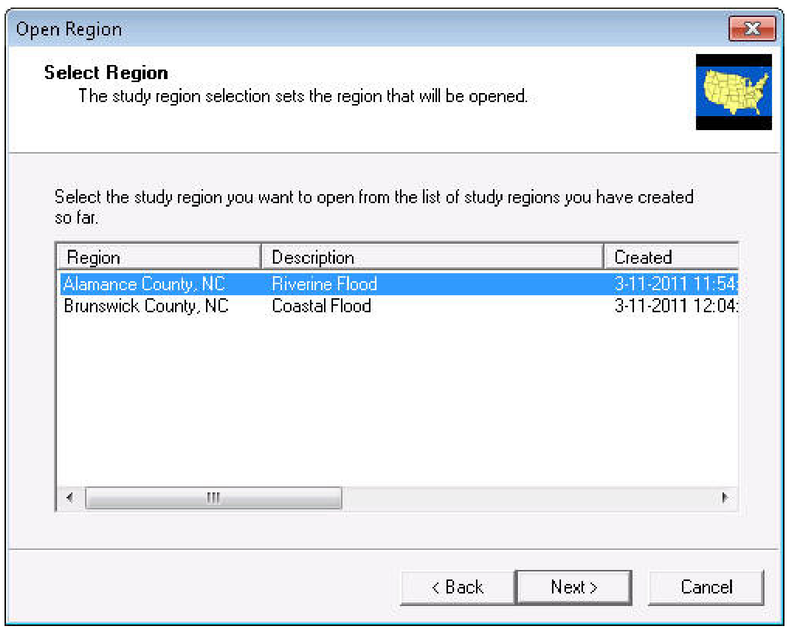


Figure 3.7 Selecting which Study Region to Open

The study region will open in the **Hazus** window, showing the outline of the region you have created along with a delineation of the census tracts, as shown in Figure 3.8 for Alamance County, North Carolina.

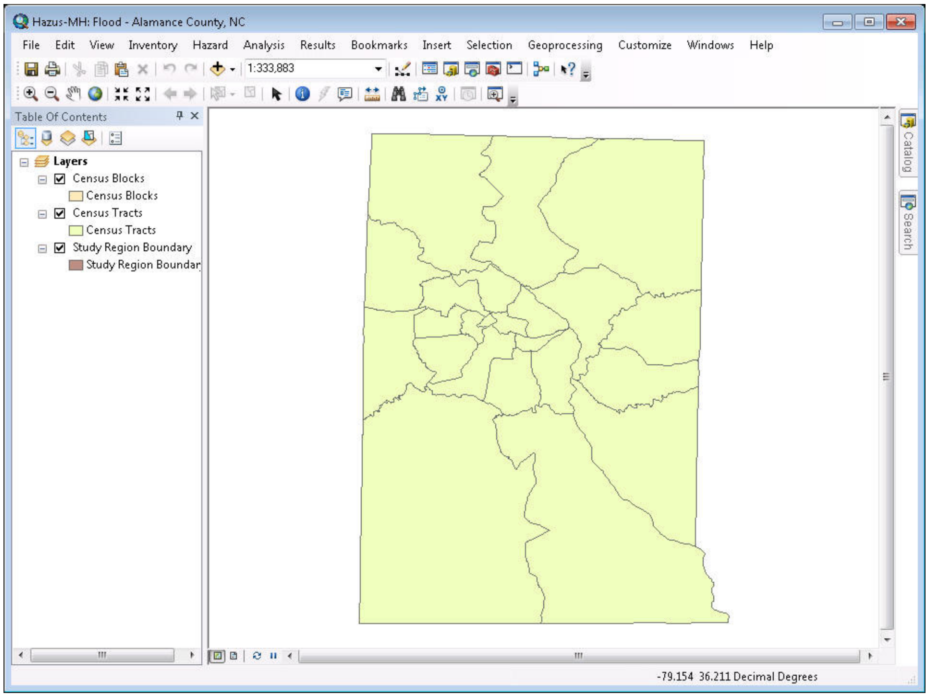


Figure 3.8 The Opened Study Region

3.2 Examining Inventory Data

As noted, this Section describes how to conduct a **Hazus** analysis using the default data and methods provided with the program. This means that we will not change any of the inventory data that the program has compiled. Later Sections examine how to alter the data and methods. We will, however, examine these data to better understand the information that **Hazus** includes.

3.2.1 Inventory Menu Items

If you click on the *Inventory* menu, you will see listed all of the types of inventory data that are included in your study region. Figure 3.9 shows these menu items and the submenu items for *General Building Stock*.

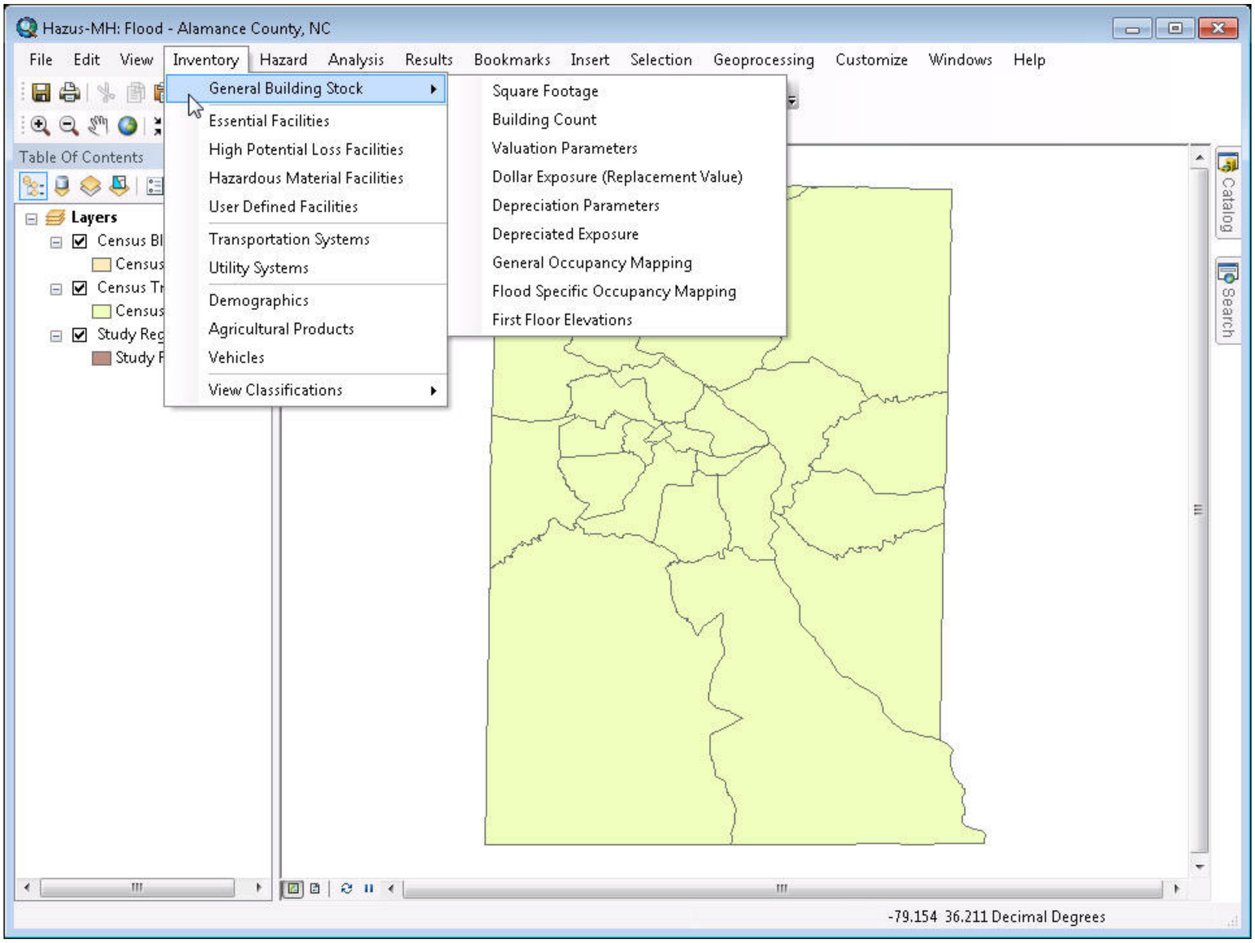


Figure 3.9 Inventory and General Building Stock Menu Items

These menu items include both listings of inventory, such as the number of buildings in the study region, and presentation of some built-in calculation parameters, such as parameters used to determine the value of the general building stock in the study region.

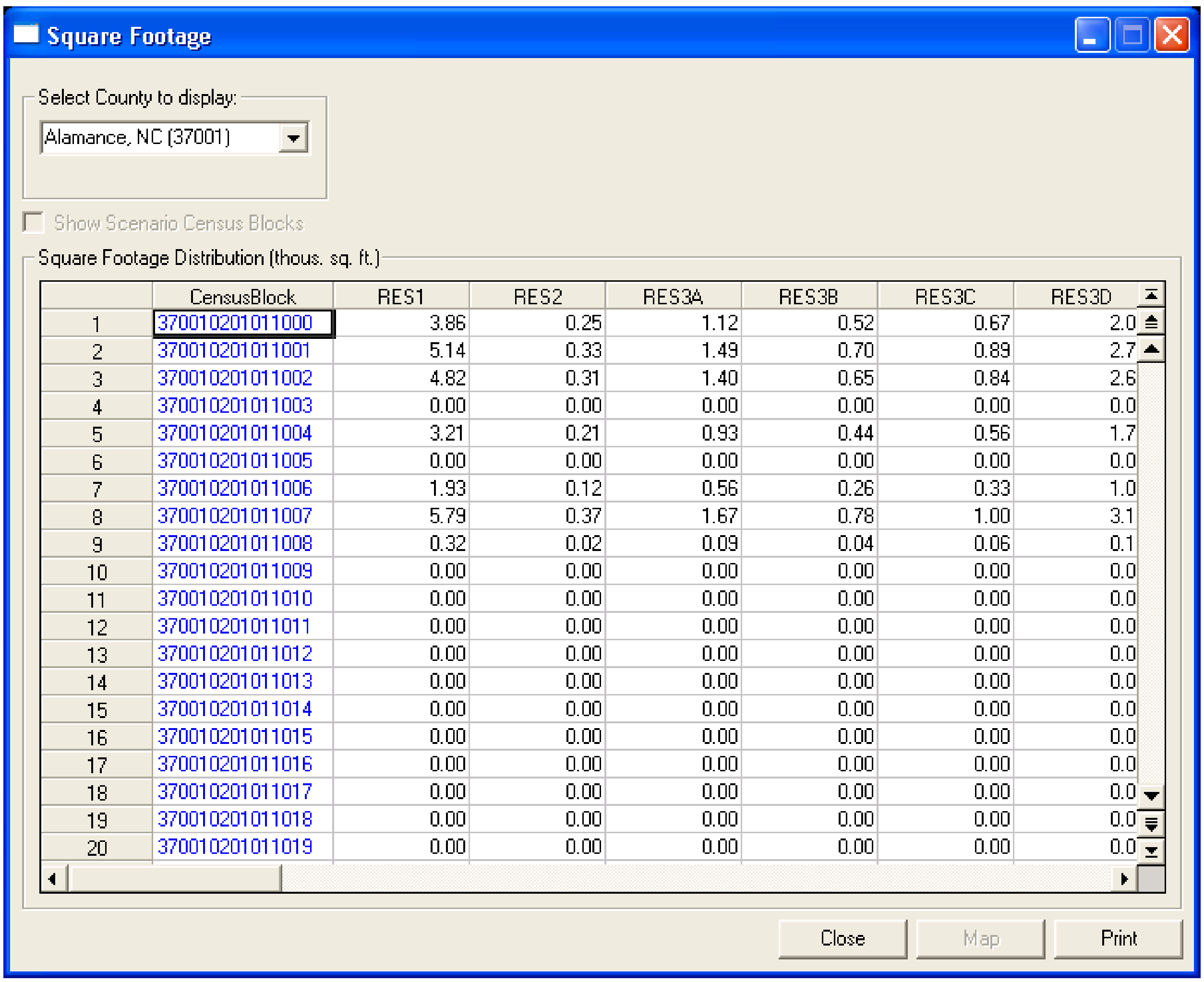
In this section, we will examine several of the inventory and parameter items in both table and map forms. You should familiarize yourself with all of the items by selecting each menu item and exploring all of the windows.

3.2.2 General Building Stock

The General Building Stock (GBS) includes residential, commercial, industrial, agricultural, religious, government, and educational buildings. Damage is estimated in percent and is weighted by the area of inundation at a given depth for a given census block. It is assumed that the entire composition of the GBS within a given census block is evenly distributed throughout the block.

3.2.2.1 Square Footage

The Square Footage browser allows you to view or modify the general building stock square footage by specific occupancy and census tract. The data in this browser are common to all three hazards.



	CensusBlock	RES1	RES2	RES3A	RES3B	RES3C	RES3D
1	370010201011000	3.86	0.25	1.12	0.52	0.67	2.0
2	370010201011001	5.14	0.33	1.49	0.70	0.89	2.7
3	370010201011002	4.82	0.31	1.40	0.65	0.84	2.6
4	370010201011003	0.00	0.00	0.00	0.00	0.00	0.0
5	370010201011004	3.21	0.21	0.93	0.44	0.56	1.7
6	370010201011005	0.00	0.00	0.00	0.00	0.00	0.0
7	370010201011006	1.93	0.12	0.56	0.26	0.33	1.0
8	370010201011007	5.79	0.37	1.67	0.78	1.00	3.1
9	370010201011008	0.32	0.02	0.09	0.04	0.06	0.1
10	370010201011009	0.00	0.00	0.00	0.00	0.00	0.0
11	370010201011010	0.00	0.00	0.00	0.00	0.00	0.0
12	370010201011011	0.00	0.00	0.00	0.00	0.00	0.0
13	370010201011012	0.00	0.00	0.00	0.00	0.00	0.0
14	370010201011013	0.00	0.00	0.00	0.00	0.00	0.0
15	370010201011014	0.00	0.00	0.00	0.00	0.00	0.0
16	370010201011015	0.00	0.00	0.00	0.00	0.00	0.0
17	370010201011016	0.00	0.00	0.00	0.00	0.00	0.0
18	370010201011017	0.00	0.00	0.00	0.00	0.00	0.0
19	370010201011018	0.00	0.00	0.00	0.00	0.00	0.0
20	370010201011019	0.00	0.00	0.00	0.00	0.00	0.0

Figure 3.10 Square Footage Browser

3.2.2.2 Building Count

The Building Count browser allows you to view the general building stock count by census block. Each census block located within the study region appears in the left-hand column of the table, identified by the number assigned by the US Census Bureau. For each census block, the total number of buildings is listed, along with the number of buildings assigned to each category of use or general occupancy. **Hazus** identifies seven general occupancy categories (residential, commercial, industrial, agriculture, religion/non-profit, government and education), which are explained more fully in the Technical Manual. When viewing the building counts by specific occupancy, you can modify the data. When viewed by general occupancy, general building type, or specific building type, the data are read-only. The data displayed in this browser are common to all three hazards (except when viewed by specific building type).

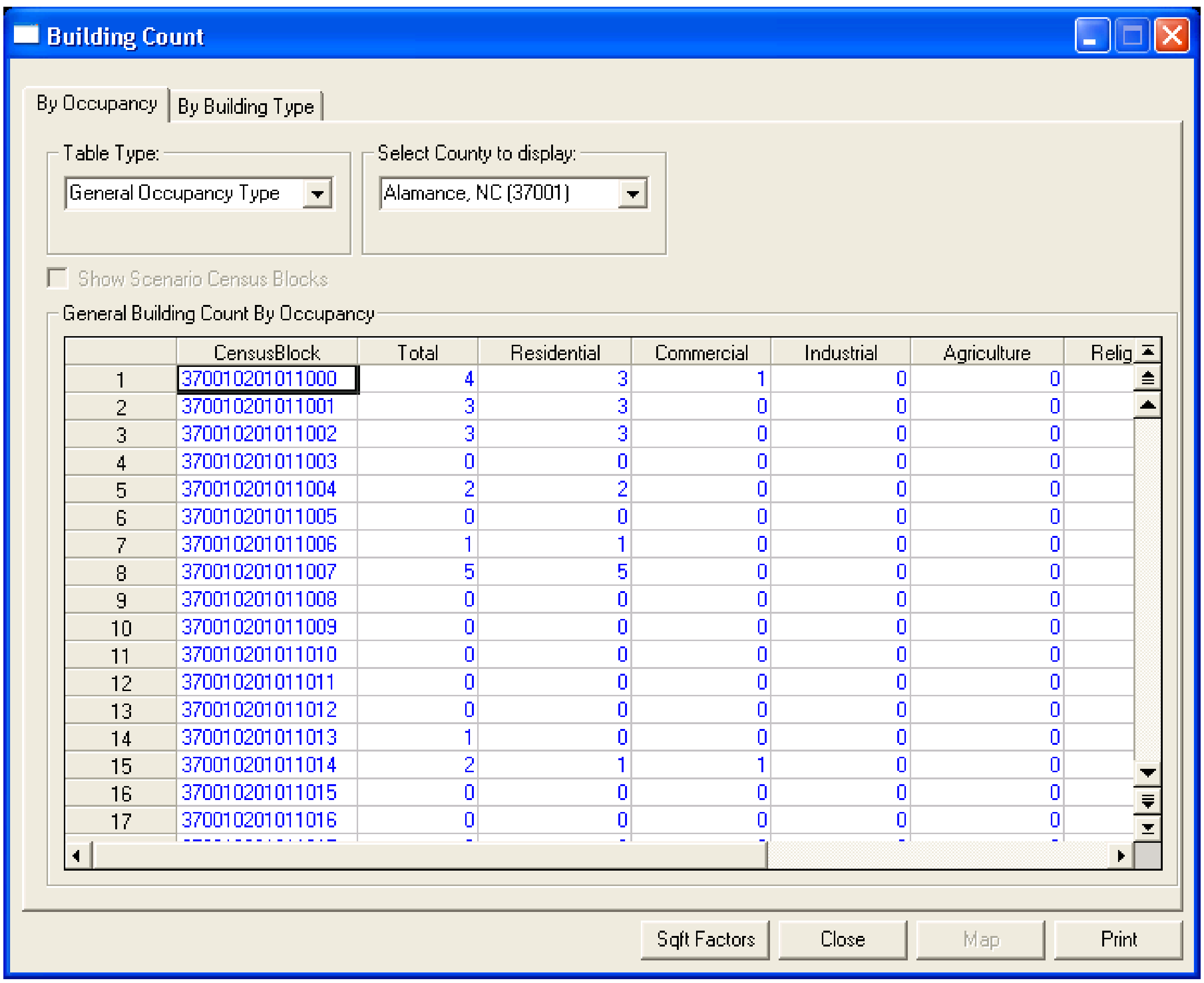
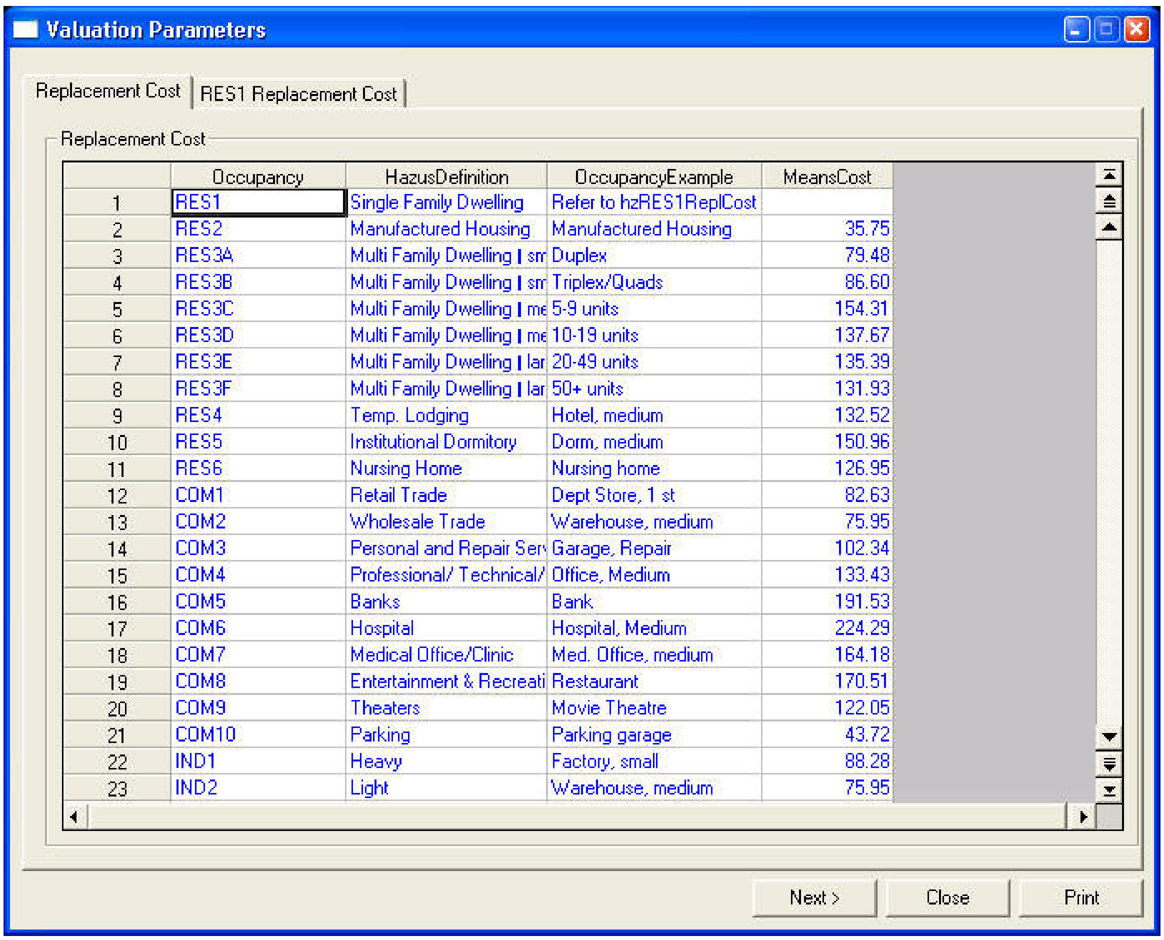


Figure 3.11 Building Count Browser

3.2.2.3 Valuation Parameters

The Valuation Parameters includes many views, all of which cannot be edited. The first view (Figure 3.12) shows replacement costs for each specific occupancy. Below is a list of the views available when the user selects the *Next* > button.

1. Replacement Cost (Figure 3.12, refer to Table 14.1 and 14.2 in Technical Manual)
2. Location Factors
3. Single Family (RES1) Garage Distributions by Census Block
4. Single Family (RES1) Garage Replacement Cost (refer to Table 14.3 in Technical Manual)
5. Single Family (RES1) Basement Distribution by Census Block
6. Height Distribution (Number of Stories) by Census Block

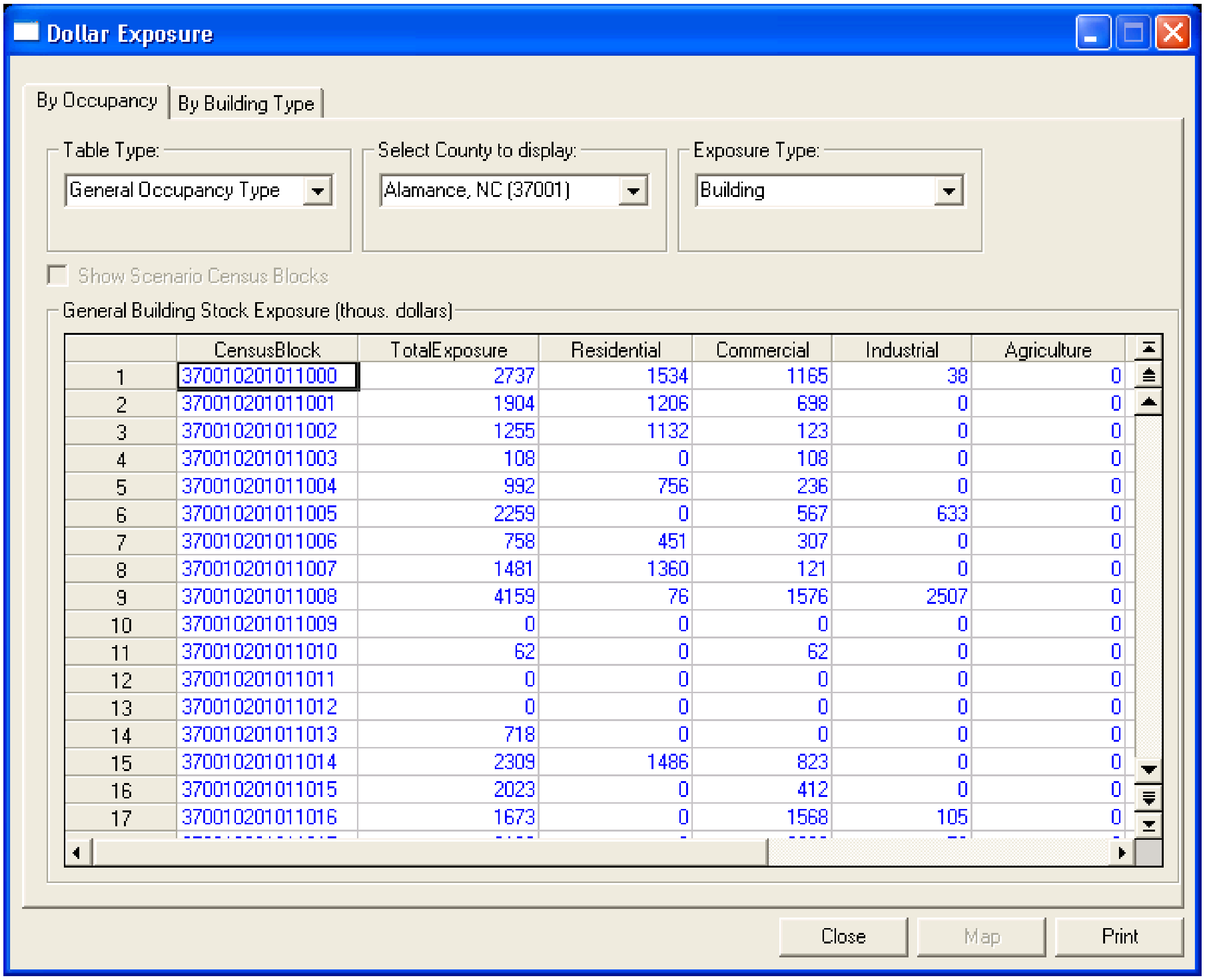


	Occupancy	HazusDefinition	OccupancyExample	MeansCost
1	RES1	Single Family Dwelling	Refer to hzRES1ReplCost	
2	RES2	Manufactured Housing	Manufactured Housing	35.75
3	RES3A	Multi Family Dwelling | sm	Duplex	79.48
4	RES3B	Multi Family Dwelling | sm	Triplex/Quads	86.60
5	RES3C	Multi Family Dwelling | me	5-9 units	154.31
6	RES3D	Multi Family Dwelling | me	10-19 units	137.67
7	RES3E	Multi Family Dwelling | lar	20-49 units	135.39
8	RES3F	Multi Family Dwelling | lar	50+ units	131.93
9	RES4	Temp. Lodging	Hotel, medium	132.52
10	RES5	Institutional Dormitory	Dorm, medium	150.96
11	RES6	Nursing Home	Nursing home	126.95
12	COM1	Retail Trade	Dept Store, 1 st	82.63
13	COM2	Wholesale Trade	Warehouse, medium	75.95
14	COM3	Personal and Repair Serv	Garage, Repair	102.34
15	COM4	Professional/ Technical/	Office, Medium	133.43
16	COM5	Banks	Bank	191.53
17	COM6	Hospital	Hospital, Medium	224.29
18	COM7	Medical Office/Clinic	Med. Office, medium	164.18
19	COM8	Entertainment & Recreati	Restaurant	170.51
20	COM9	Theaters	Movie Theatre	122.05
21	COM10	Parking	Parking garage	43.72
22	IND1	Heavy	Factory, small	88.28
23	IND2	Light	Warehouse, medium	75.95

Figure 3.12 Valuation Parameters, Replacement Cost Browser

3.2.2.4 Dollar Exposure

The Dollar Exposure browser allows you to view the general building stock dollar exposure by census tract. When viewing the dollar exposures by specific occupancy, you can modify the data. When viewed by general occupancy, general building type, or specific building type, the data are read-only. The data displayed in this browser are common to all three hazards (except when viewed by specific building type).



	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370010201011000	2737	1534	1165	38	0
2	370010201011001	1904	1206	698	0	0
3	370010201011002	1255	1132	123	0	0
4	370010201011003	108	0	108	0	0
5	370010201011004	992	756	236	0	0
6	370010201011005	2259	0	567	633	0
7	370010201011006	758	451	307	0	0
8	370010201011007	1481	1360	121	0	0
9	370010201011008	4159	76	1576	2507	0
10	370010201011009	0	0	0	0	0
11	370010201011010	62	0	62	0	0
12	370010201011011	0	0	0	0	0
13	370010201011012	0	0	0	0	0
14	370010201011013	718	0	0	0	0
15	370010201011014	2309	1486	823	0	0
16	370010201011015	2023	0	412	0	0
17	370010201011016	1673	0	1568	105	0

Figure 3.13 Dollar Exposure Browser

3.2.2.5 Depreciation Parameters

The Depreciation Parameters browser allows you to view the median year built and median age of a census block. The parameter for the depreciation of buildings is based on the age of the building. These parameters are used to determine the depreciated exposure of a census block as seen below in Figure 3.14.

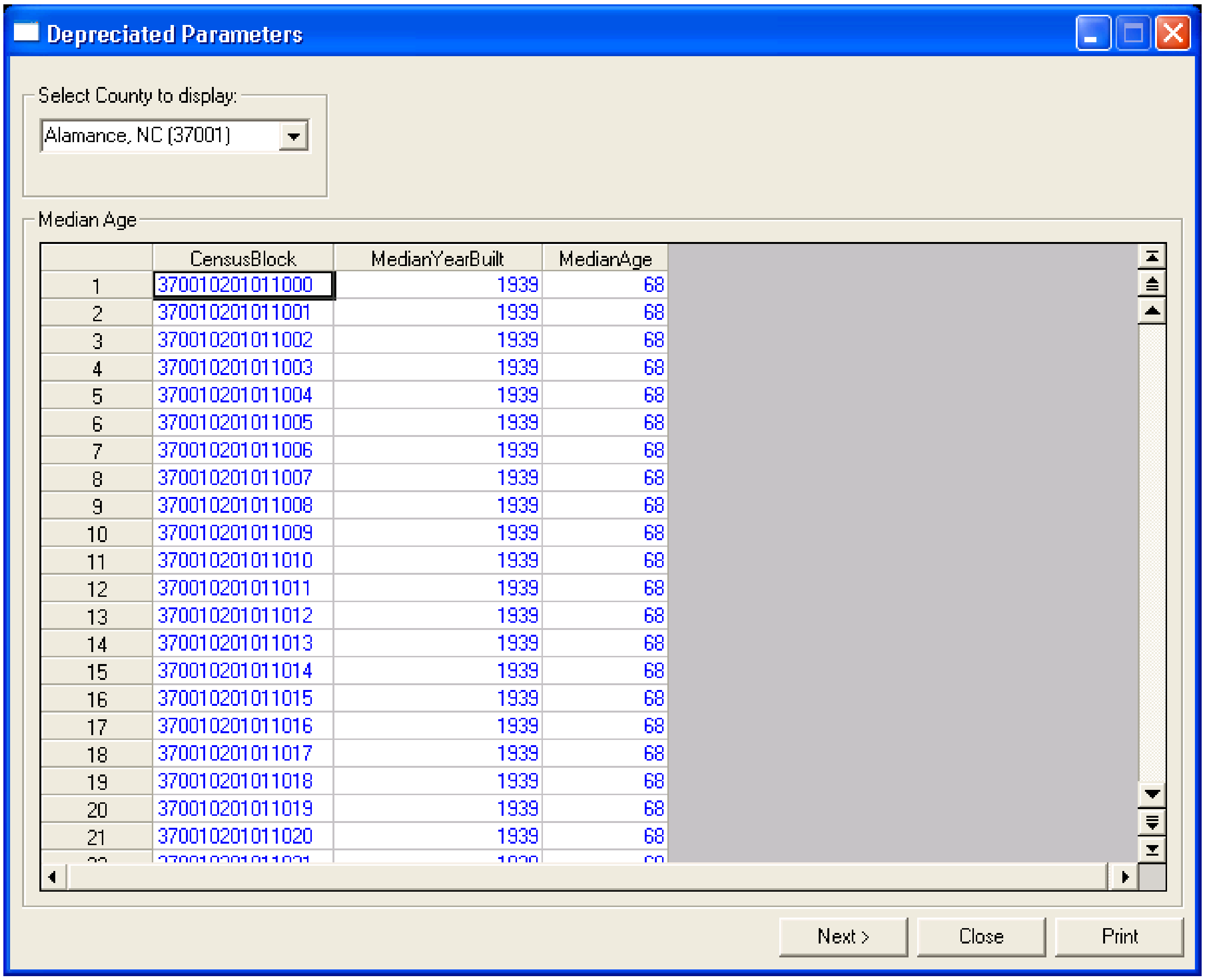
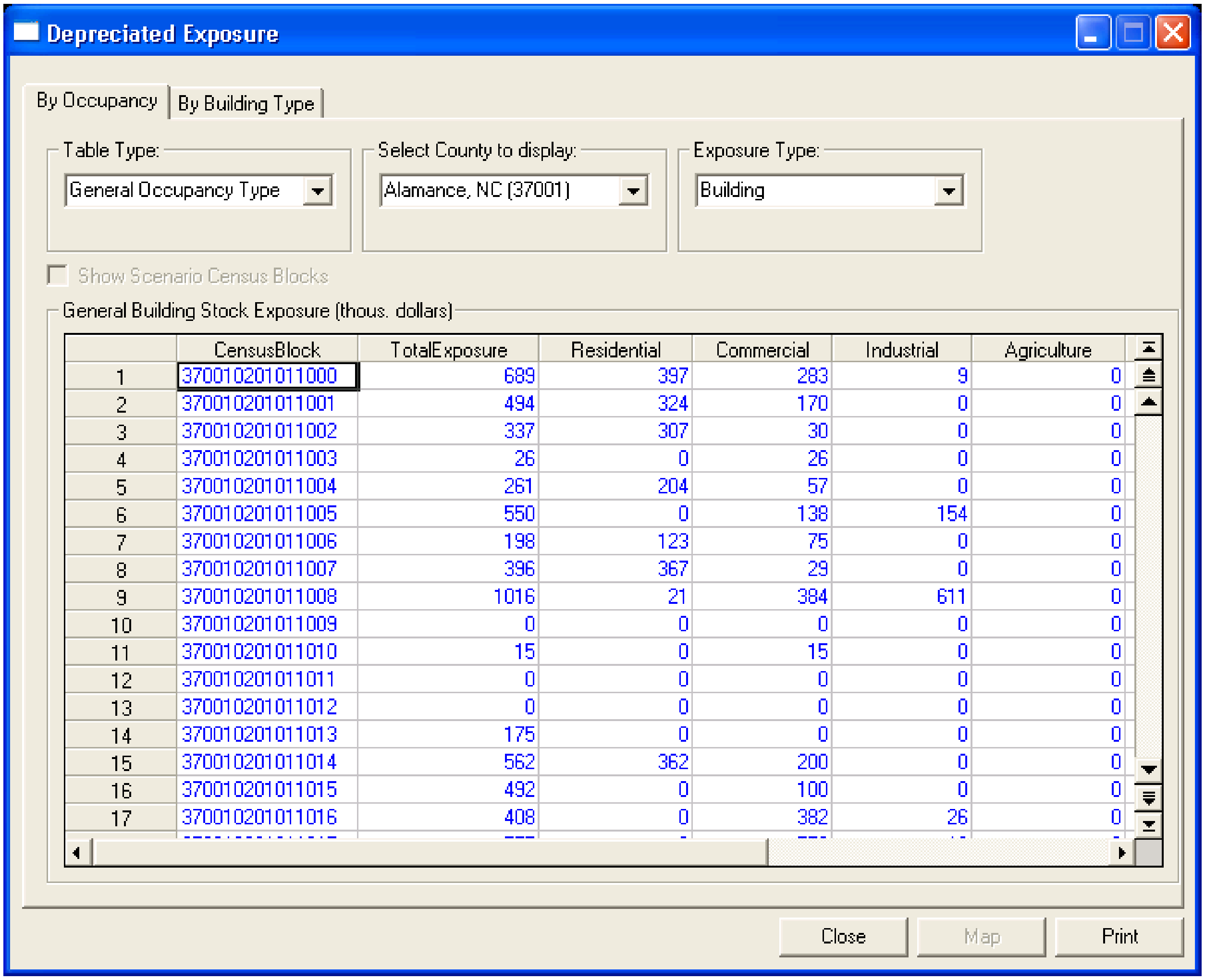


Figure 3.14 Depreciation Parameters Browser

3.2.2.6 Depreciated Exposure

The Depreciated Exposure browser allows you to view the total exposure (in thousands of dollars) by occupancy or by building type. The depreciated exposure is determined by subtracting the median age of a census block (as seen in Figure 3.15) from the current calendar date to get the age of the building. That age is then multiplied to a depreciation curve that will determine the depreciated value to the census block.



	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370010201011000	689	397	283	9	0
2	370010201011001	494	324	170	0	0
3	370010201011002	337	307	30	0	0
4	370010201011003	26	0	26	0	0
5	370010201011004	261	204	57	0	0
6	370010201011005	550	0	138	154	0
7	370010201011006	198	123	75	0	0
8	370010201011007	396	367	29	0	0
9	370010201011008	1016	21	384	611	0
10	370010201011009	0	0	0	0	0
11	370010201011010	15	0	15	0	0
12	370010201011011	0	0	0	0	0
13	370010201011012	0	0	0	0	0
14	370010201011013	175	0	0	0	0
15	370010201011014	562	362	200	0	0
16	370010201011015	492	0	100	0	0
17	370010201011016	408	0	382	26	0

Figure 3.15 Depreciated Exposure Browser

3.2.2.7 General Occupancy Mapping

Shared among the three models, the General Occupancy Mapping dialog allows the user to define the distribution of general building types (e.g., Wood) for their study region. The default distribution is not editable by the user and is assigned to all of the census blocks within the study region. There is one General Occupancy Mapping scheme per state and a study region consisting of more than one state will display the default schemes for both states. Figure 3.16 below shows the General Occupancy Mapping Scheme as seen when opened by the user.

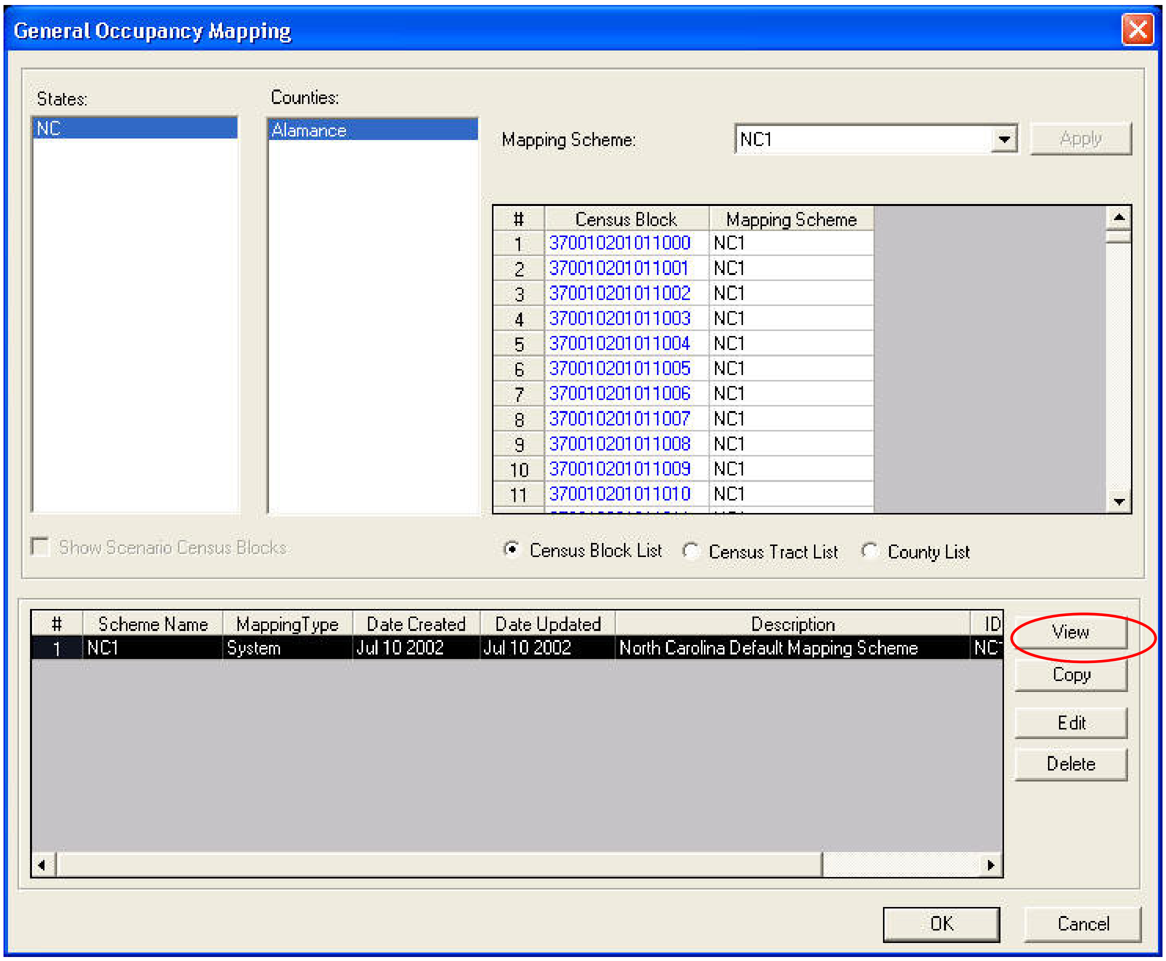
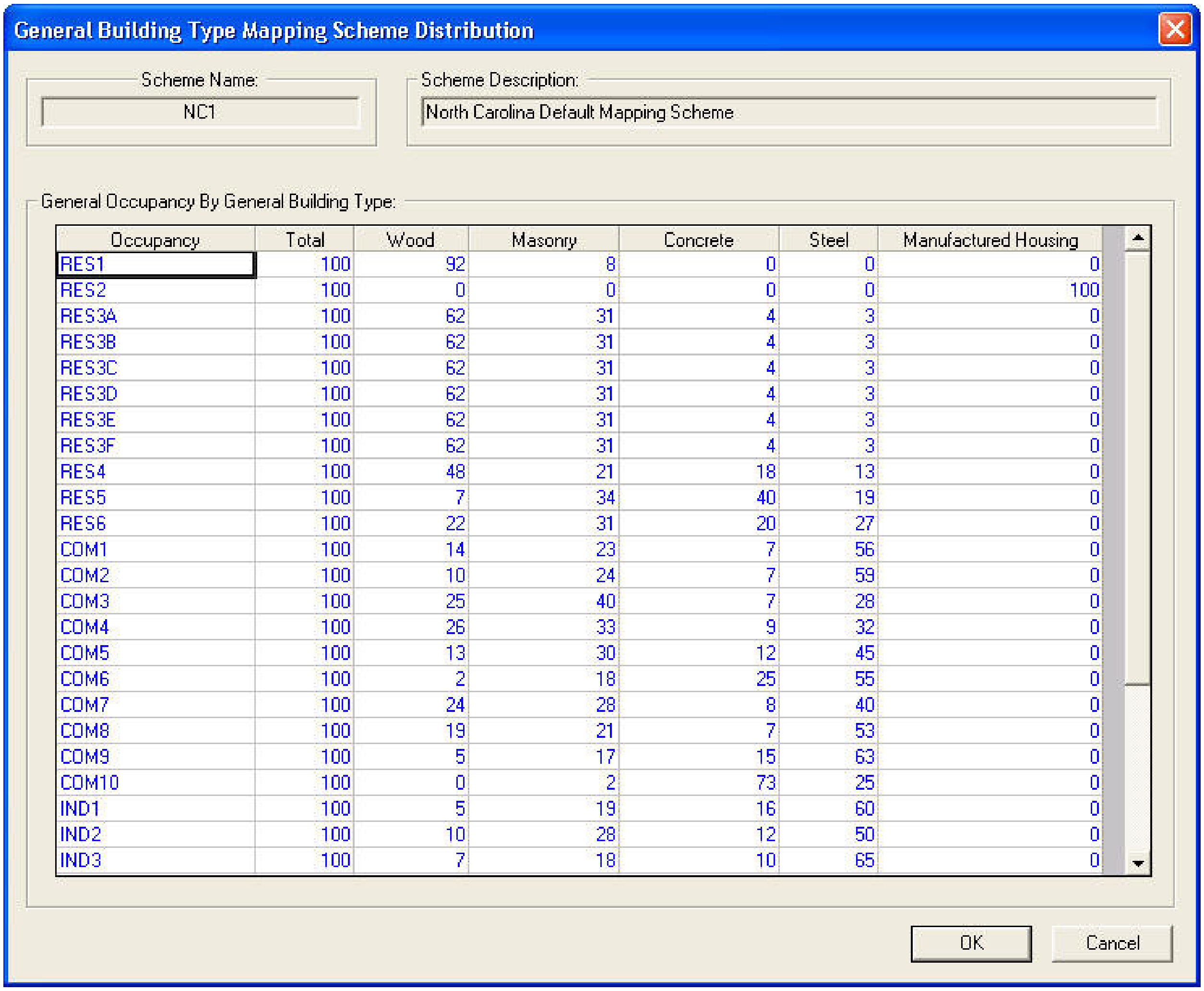


Figure 3.16 General Occupancy Mapping Overview

Highlighting the default scheme in the lower grid allows the user to view the default scheme. By selecting the **View** button (circled) the dialog seen in Figure 3.17 will open for the user to view the default distribution.



Occupancy	Total	Wood	Masonry	Concrete	Steel	Manufactured Housing
RES1	100	92	8	0	0	0
RES2	100	0	0	0	0	100
RES3A	100	62	31	4	3	0
RES3B	100	62	31	4	3	0
RES3C	100	62	31	4	3	0
RES3D	100	62	31	4	3	0
RES3E	100	62	31	4	3	0
RES3F	100	62	31	4	3	0
RES4	100	48	21	18	13	0
RES5	100	7	34	40	19	0
RES6	100	22	31	20	27	0
COM1	100	14	23	7	56	0
COM2	100	10	24	7	59	0
COM3	100	25	40	7	28	0
COM4	100	26	33	9	32	0
COM5	100	13	30	12	45	0
COM6	100	2	18	25	55	0
COM7	100	24	28	8	40	0
COM8	100	19	21	7	53	0
COM9	100	5	17	15	63	0
COM10	100	0	2	73	25	0
IND1	100	5	19	16	60	0
IND2	100	10	28	12	50	0
IND3	100	7	18	10	65	0

Figure 3.17 General Occupancy Mapping Scheme Distribution by Building Type

As seen in the figure, the building type distribution is defined by the specific occupancies used in the three hazard models. The blue text indicates that the user cannot edit the text. If the user selects the **Copy** button immediately below the **View** button, the user will see the dialog shown in Figure 3.18 below where the user can name the new mapping scheme.

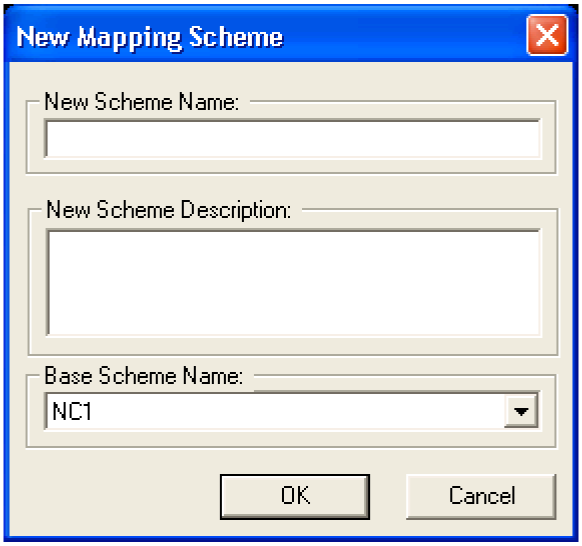


Figure 3.18 New Mapping Scheme Dialog

The user is required to enter a New Scheme Name, which will be displayed in the Mapping Scheme dialog. The user may want to enter a New Scheme Description to distinguish this scheme from others should the user create multiple schemes. The Base Scheme Name is not editable, and provides the user with an indication of the mapping scheme that served as the basis for the new scheme. When the user clicks on **OK**, the dialog seen in Figure 3.19 is opened.

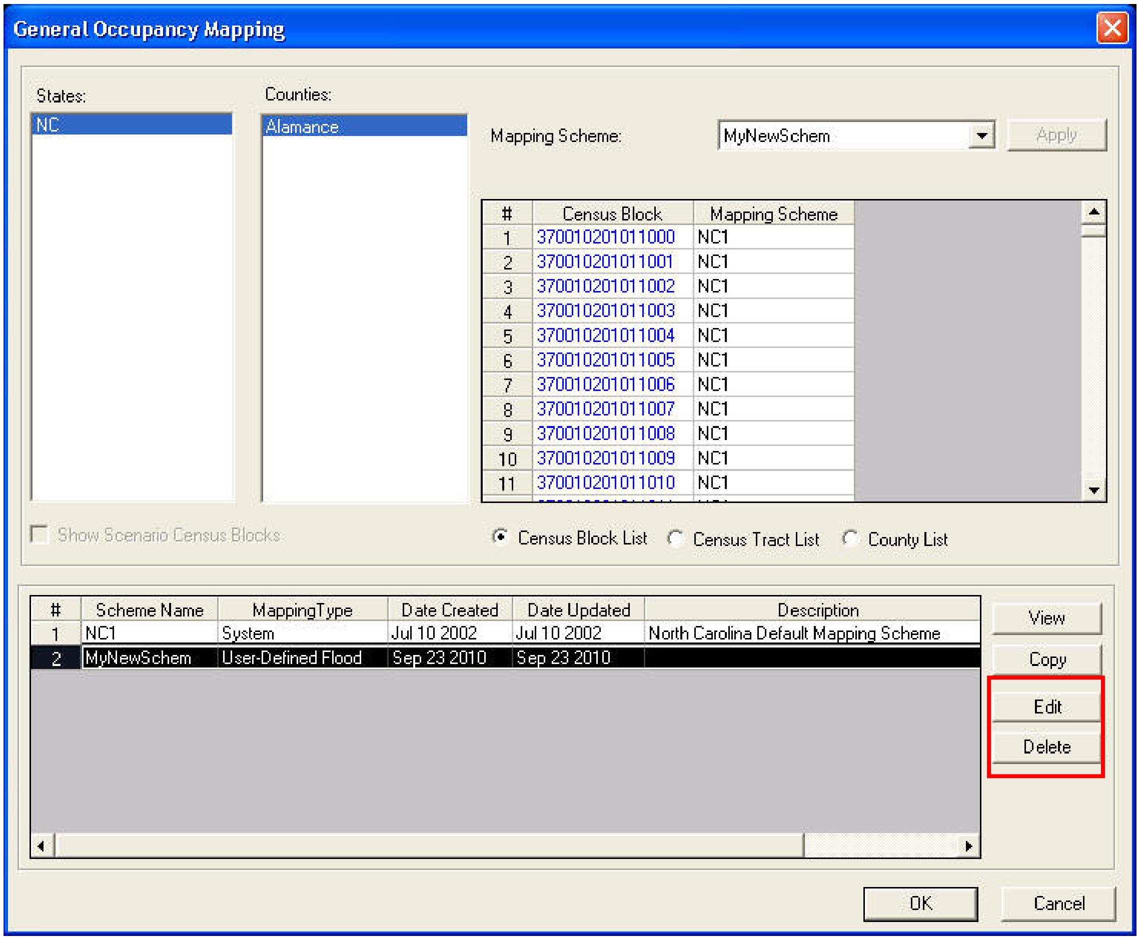


Figure 3.19 General Occupancy Mapping with User Defined Mapping Scheme

When the user created mapping scheme is selected (as seen in Figure 3.19) the command buttons **Edit** and **Delete** (red box) are enabled. The user can use the **Edit** button to open a dialog similar to that seen in Figure 3.17 except the field text will be black and the user is allowed to edit the information and change the mapping scheme. Please note that the user is not allowed to edit the specific occupancy identification (e.g., RES1) and this text remains blue.

3.2.2.8 Flood Specific Occupancy Mapping

Flood specific occupancy mapping is an example of a hazard specific default data parameter included with the **Hazus** model. The flood specific occupancy mapping "maps" the specific occupancy categories for buildings, such as *RES1* and *RES2*, to physical building characteristics that affect flood damage. Specifically, these physical building characteristics include the type of building foundation and the height of the building's first floor above grade. There are three default mapping schemes that come with the **Hazus** program. Figure 3.20, below, indicates which of the three default schemes has been assigned to each census block in your study region. For the example region, the default scheme *RiverineDflt* has been assigned to all census blocks.

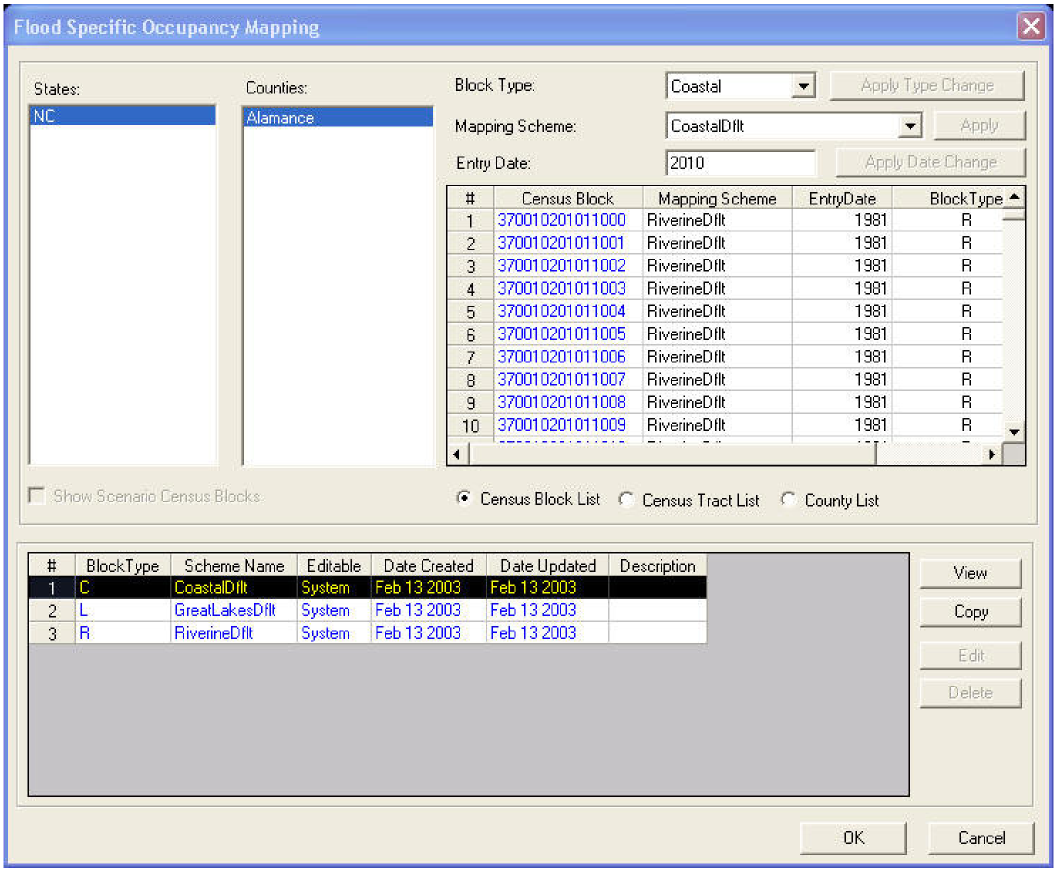


Figure 3.20 Flood Specific Occupancy Mapping Overview

If you select the *RiverineDflt* row in the *Flood Building Mapping* window, and press **View**, the window shown in Figure 3.21 will appear. Select any specific occupancy classification, such as COM1, to view the default assumptions for structures built before and after a Flood Insurance Rate Map (FIRM) was made for the community (i.e., Pre-FIRM and Post-FIRM).

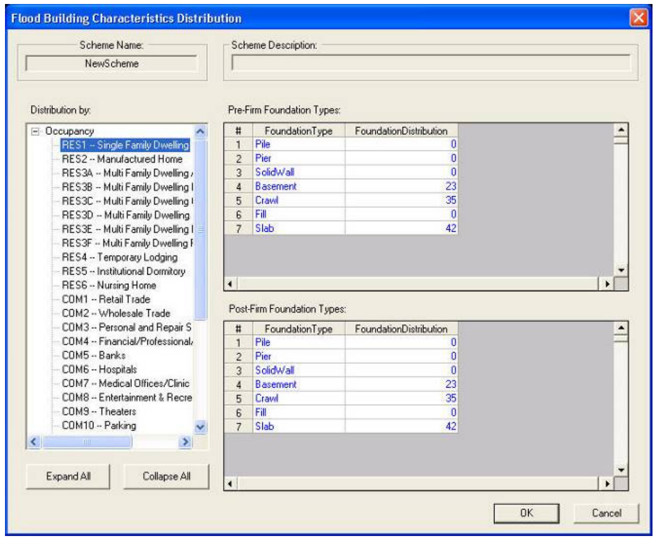


Figure 3.21 Sample Riverine Flood Specific Occupancy Mapping

If the user selects either the *CoastalDflt* or the *GreatLakesDflt* row in the Flood Building Mapping window, and press **View**, the window shown in Figure 3.22 will appear. Selecting any specific occupancy classification, such as COM1, and the dialog seen in Figure 3.22 will appear. While similar in many ways to the Riverine Occupancy Mapping scheme, the Coastal and Great Lakes Occupancy Mapping Scheme are different in the Post-FIRM classification due to the identification of A-Zone and V-Zone designations in coastal areas. The Flood Model has chosen to address the Great Lakes with a V-Zone area to account for the possibility that wave affects on structures near the shorelines is a hazard some communities may want to analyze. While this is different than the current FEMA mapping methodology, the Flood Oversight Committee approved the approach.

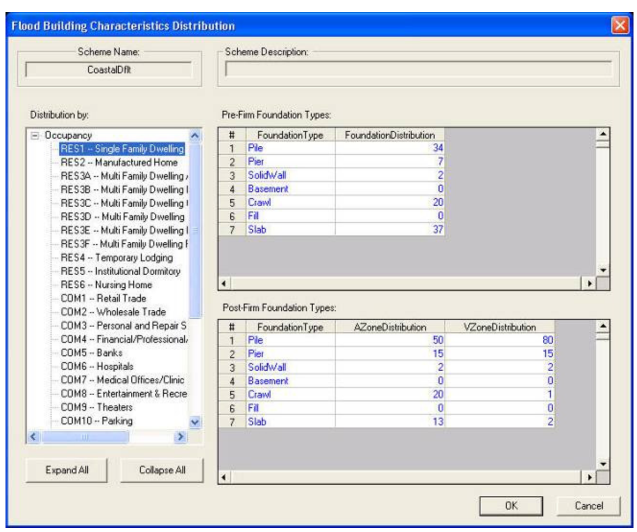
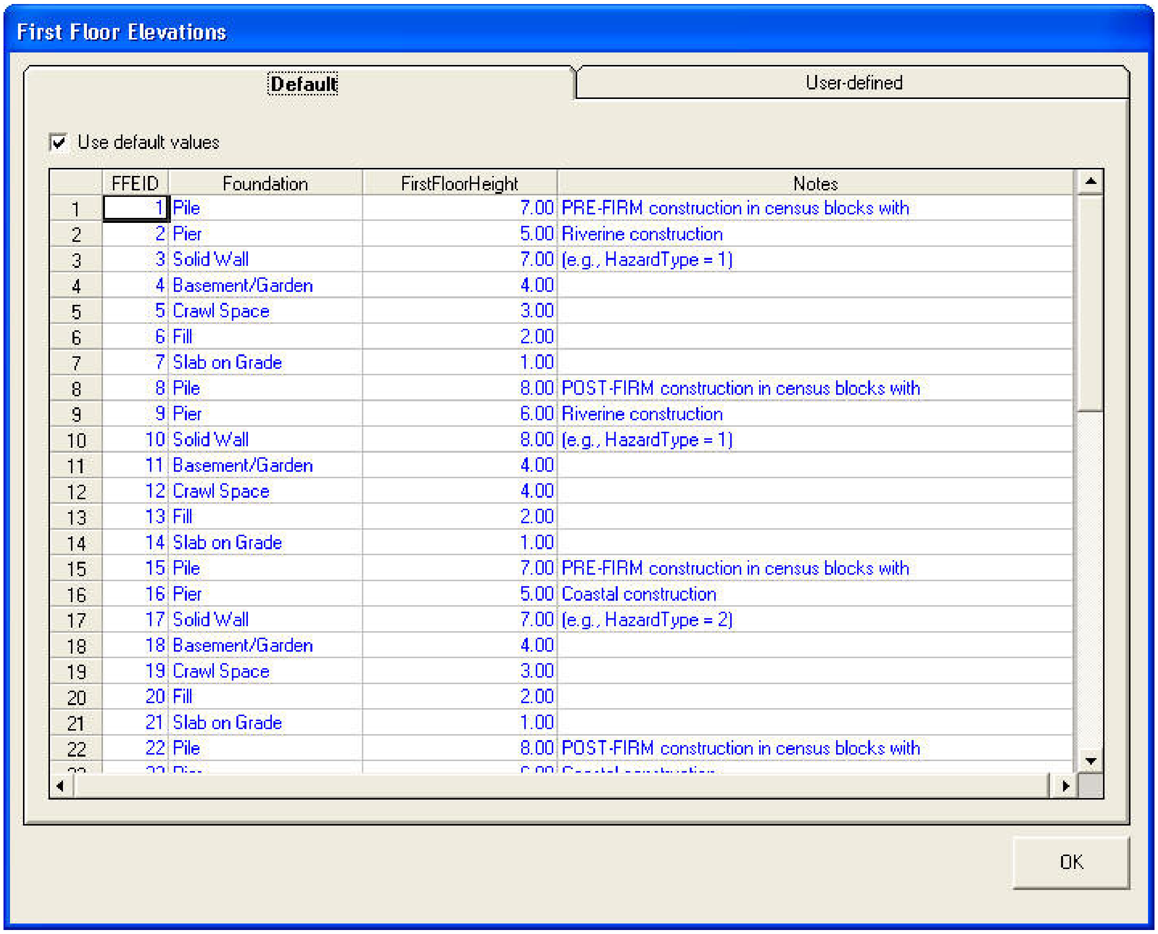


Figure 3.22 Sample Coastal Flood Specific Occupancy Mapping

3.2.2.9 First Floor Elevations

First floor elevation default values (in feet) for each foundation type are shown in the Figure 3.23 below. Users are able to define their own first floor elevations for each foundation type to use in Hazus in the User-defined tab (only First Floor Height is editable by the user).

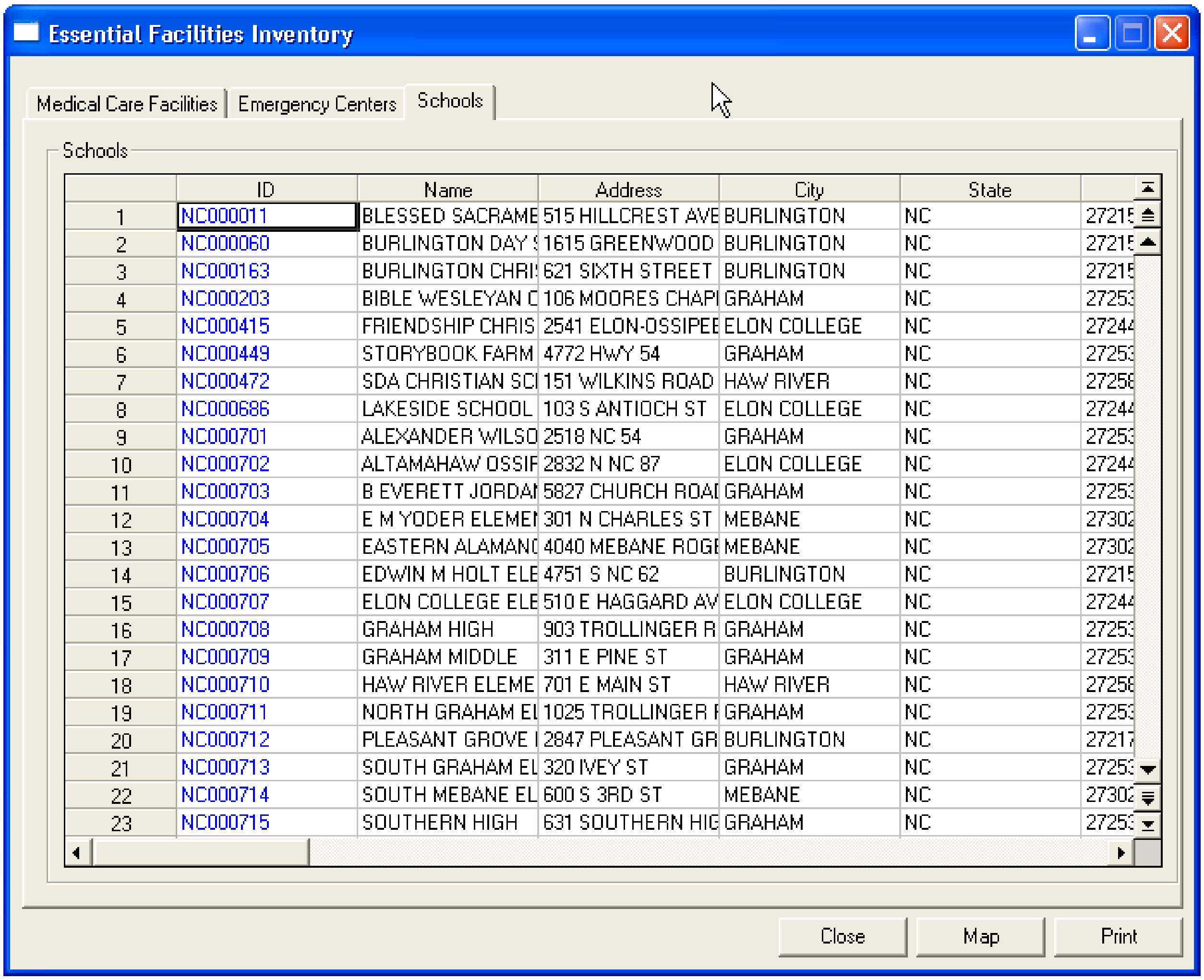


	FFEID	Foundation	FirstFloorHeight	Notes
1	1	Pile	7.00	PRE-FIRM construction in census blocks with
2	2	Pier	5.00	Riverine construction
3	3	Solid Wall	7.00	(e.g., HazardType = 1)
4	4	Basement/Garden	4.00	
5	5	Crawl Space	3.00	
6	6	Fill	2.00	
7	7	Slab on Grade	1.00	
8	8	Pile	8.00	POST-FIRM construction in census blocks with
9	9	Pier	6.00	Riverine construction
10	10	Solid Wall	8.00	(e.g., HazardType = 1)
11	11	Basement/Garden	4.00	
12	12	Crawl Space	4.00	
13	13	Fill	2.00	
14	14	Slab on Grade	1.00	
15	15	Pile	7.00	PRE-FIRM construction in census blocks with
16	16	Pier	5.00	Coastal construction
17	17	Solid Wall	7.00	(e.g., HazardType = 2)
18	18	Basement/Garden	4.00	
19	19	Crawl Space	3.00	
20	20	Fill	2.00	
21	21	Slab on Grade	1.00	
22	22	Pile	8.00	POST-FIRM construction in census blocks with

Figure 3.23 Sample First Floor Elevations, Default Tab

3.2.3 Essential Facilities

Most of the essential facility inventory data is common to all three hazards. The only hazard-specific data is the specific building type, if that information is available.



	ID	Name	Address	City	State	
1	NC000011	BLESSED SACRAME	515 HILLCREST AVE	BURLINGTON	NC	27215
2	NC000060	BURLINGTON DAY S	1615 GREENWOOD	BURLINGTON	NC	27215
3	NC000163	BURLINGTON CHRIS	621 SIXTH STREET	BURLINGTON	NC	27215
4	NC000203	BIBLE WESLEYAN C	106 MOORES CHAPI	GRAHAM	NC	27253
5	NC000415	FRIENDSHIP CHRIS	2541 ELON-OSSIPEE	ELON COLLEGE	NC	27244
6	NC000449	STORYBOOK FARM	4772 HWY 54	GRAHAM	NC	27253
7	NC000472	SDA CHRISTIAN SCI	151 WILKINS ROAD	HAW RIVER	NC	27258
8	NC000686	LAKESIDE SCHOOL	103 S ANTIOCH ST	ELON COLLEGE	NC	27244
9	NC000701	ALEXANDER WILSO	2518 NC 54	GRAHAM	NC	27253
10	NC000702	ALTAMAHAW OSSIF	2832 N NC 87	ELON COLLEGE	NC	27244
11	NC000703	B EVERETT JORDAI	5827 CHURCH ROAI	GRAHAM	NC	27253
12	NC000704	E M YODER ELEMEI	301 N CHARLES ST	MEBANE	NC	27302
13	NC000705	EASTERN ALAMANC	4040 MEBANE ROGE	MEBANE	NC	27302
14	NC000706	EDWIN M HOLT ELE	4751 S NC 62	BURLINGTON	NC	27215
15	NC000707	ELON COLLEGE ELE	510 E HAGGARD AV	ELON COLLEGE	NC	27244
16	NC000708	GRAHAM HIGH	903 TROLLINGER R	GRAHAM	NC	27253
17	NC000709	GRAHAM MIDDLE	311 E PINE ST	GRAHAM	NC	27253
18	NC000710	HAW RIVER ELEME	701 E MAIN ST	HAW RIVER	NC	27258
19	NC000711	NORTH GRAHAM EL	1025 TROLLINGER I	GRAHAM	NC	27253
20	NC000712	PLEASANT GROVE I	2847 PLEASANT GR	BURLINGTON	NC	27217
21	NC000713	SOUTH GRAHAM EL	320 IVEY ST	GRAHAM	NC	27253
22	NC000714	SOUTH MEBANE EL	600 S 3RD ST	MEBANE	NC	27302
23	NC000715	SOUTHERN HIGH	631 SOUTHERN HIG	GRAHAM	NC	27253

Figure 3.24 Essential Facilities Inventory Data Browser

3.2.4 High Potential Loss Facilities

The High Potential Loss Facilities (HPLF) browser allows you to view and map the default database for your study region. Damage and loss are not computed for HPLF's in the present version of the Flood Model.

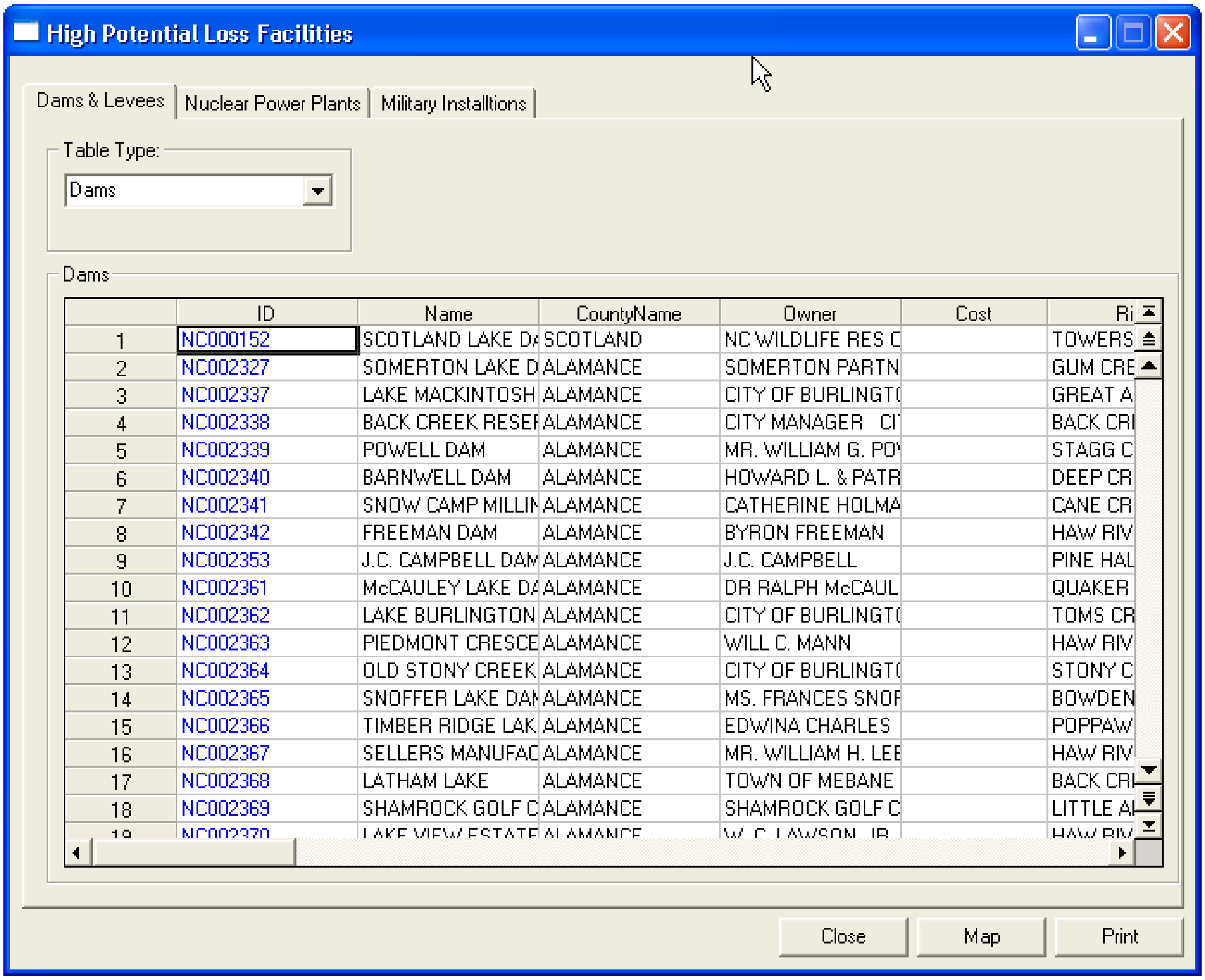


Figure 3.25 High Potential Loss Facilities Inventory Data Browser

3.2.5 User-Defined Facilities

User-Defined Facilities (UDFs) are any individual buildings that you may wish to add to the study region. The Flood Model outputs damage state probabilities for each UDF. UDFs default to the General Building Stock mapping schemes defined for the census tracts in which they are located. However, you can define a specific building type and a set of wind building characteristics if such information is available for an individual UDF.

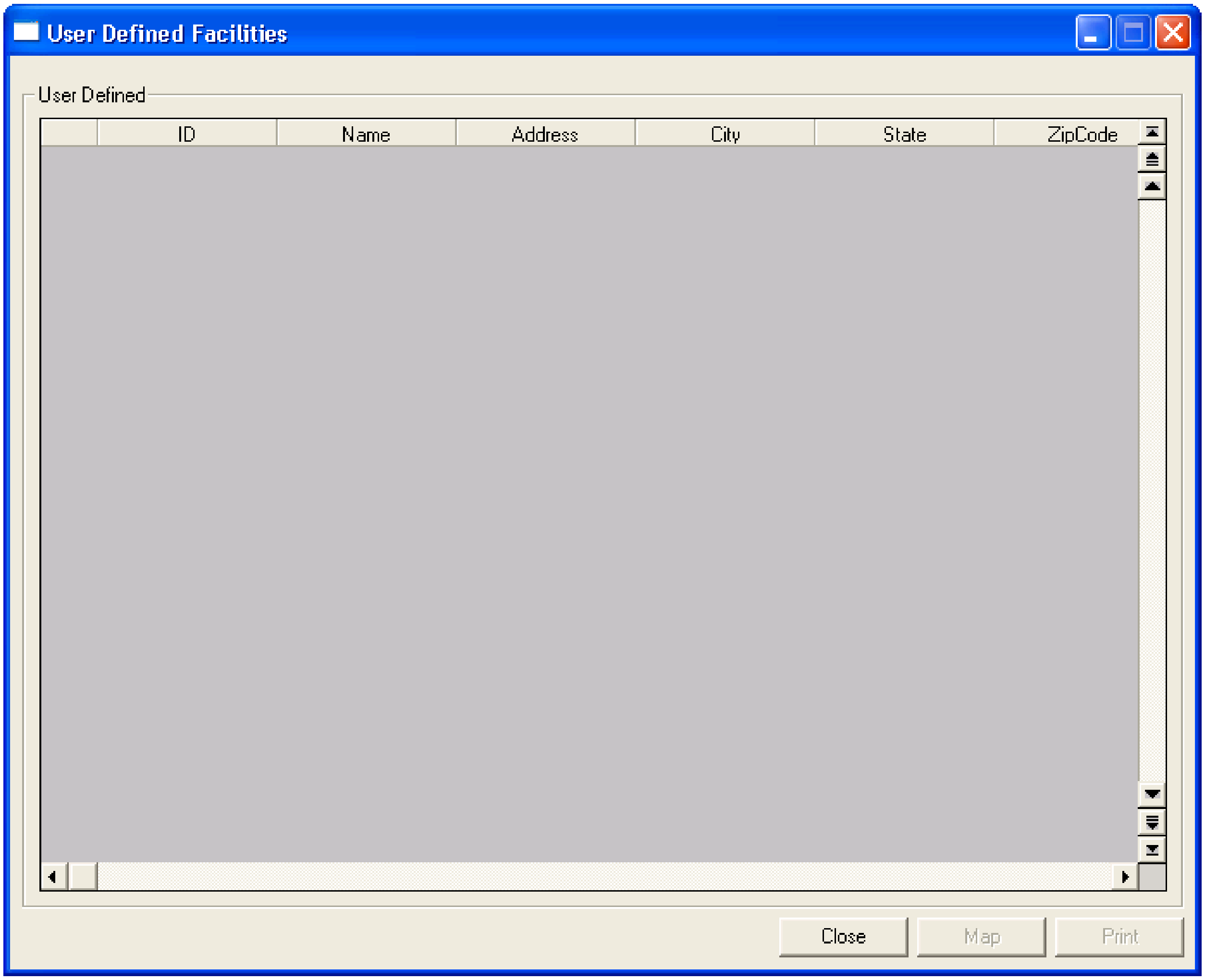


Figure 3.26 User Defined Facilities Browser

3.2.6 Transportation Systems

The Transportation Systems browser allows you to view and map the default database for your study region.

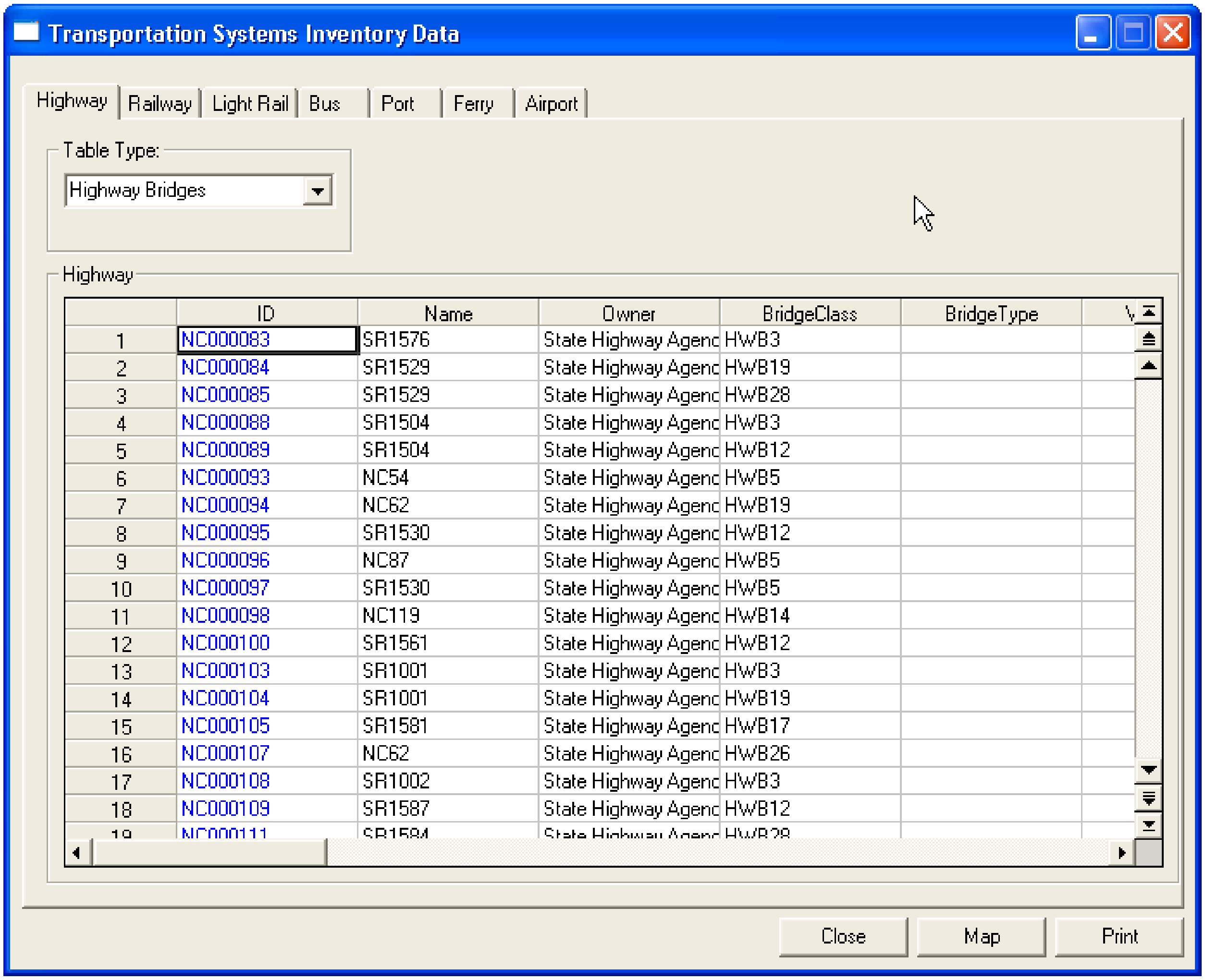


Figure 3.27 Transportation Systems Data Browser

3.2.7 Utility Systems

The Utilities Systems browser allows you to view and map the default database for your study region.

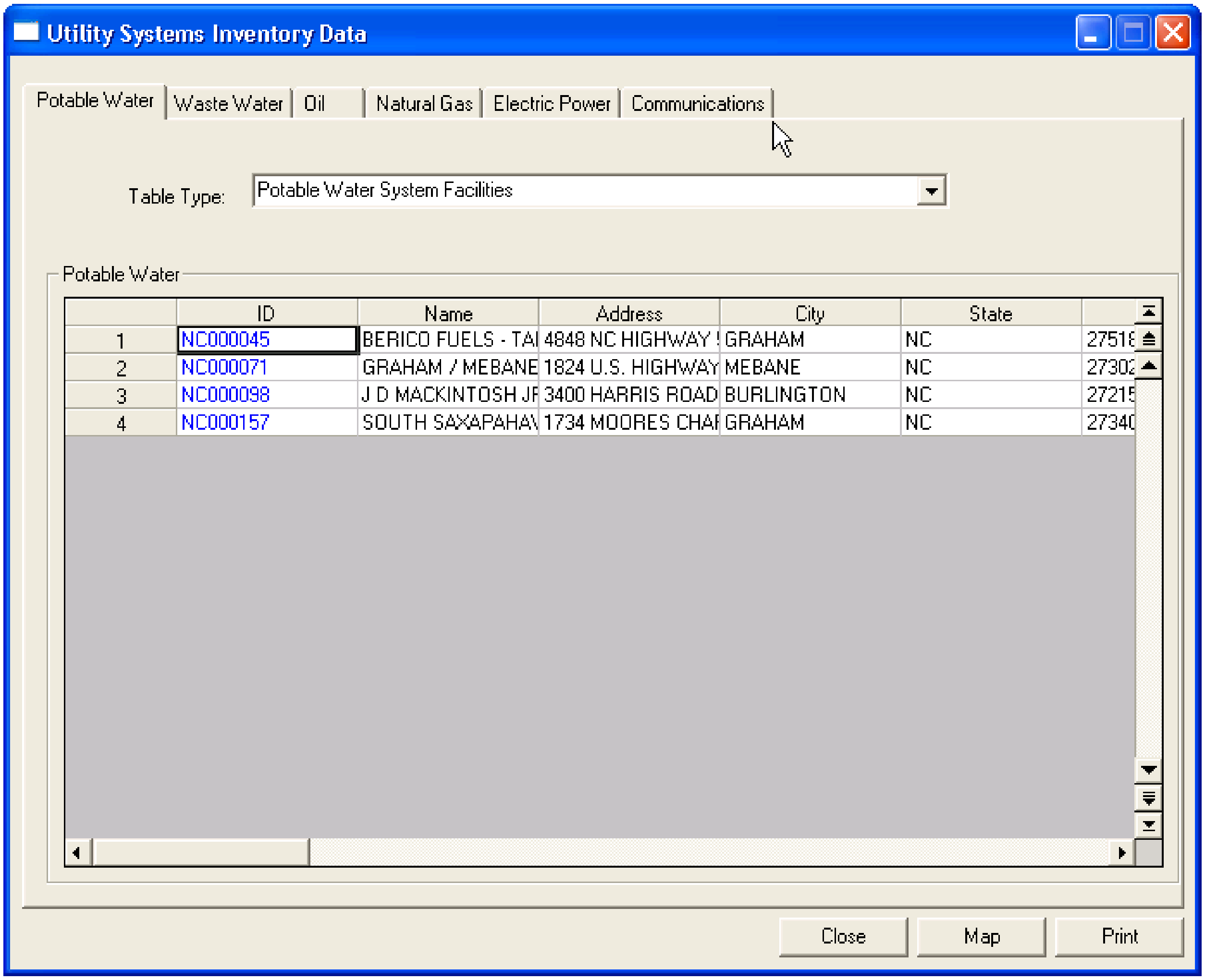
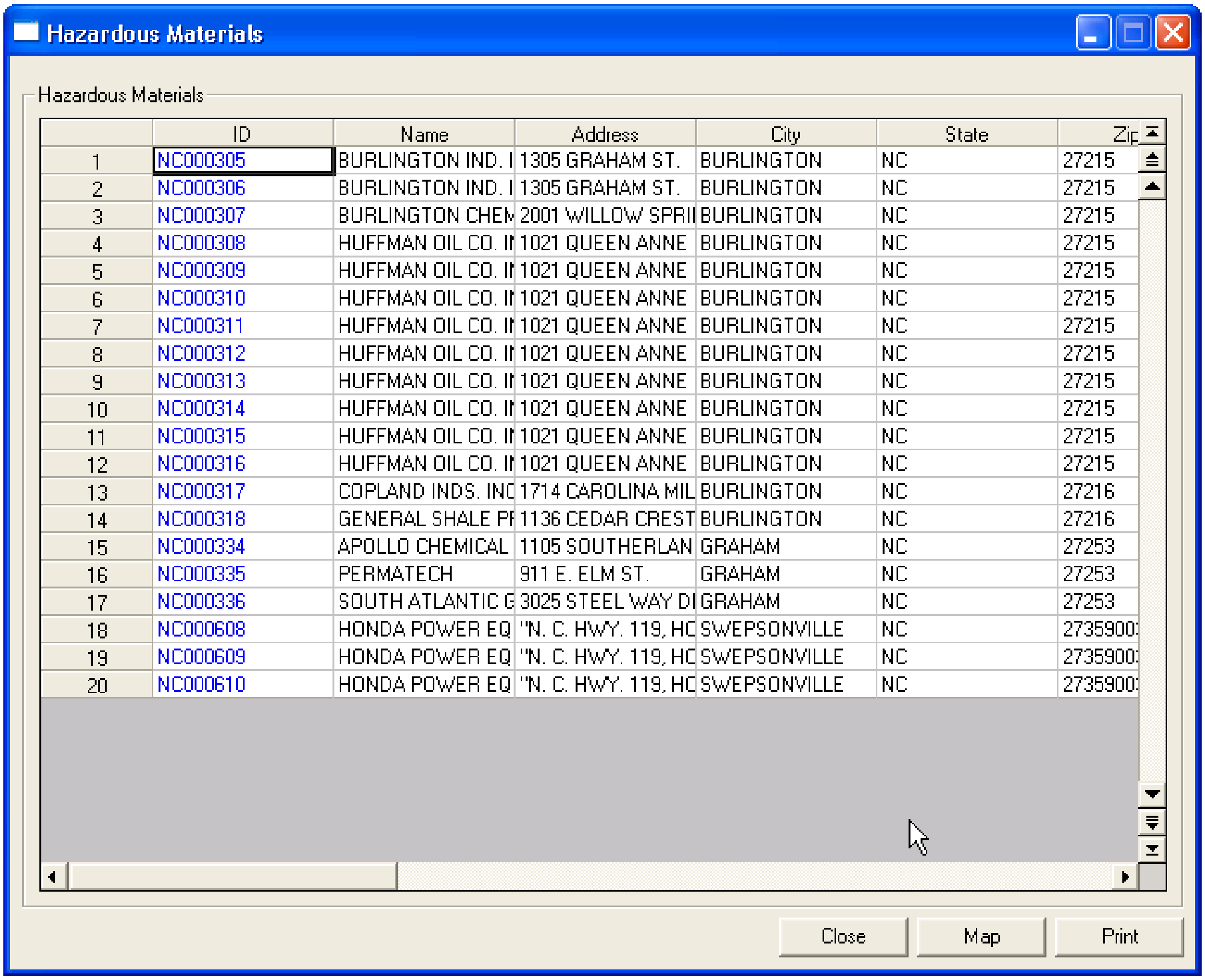


Figure 3.28 Utility Systems Data Browser

3.2.8 Hazardous Materials

The Hazardous Materials browser allows you to view and map the default database for your study region. Damage and loss are not computed for Hazardous Materials sites in the present version of the Flood Model.

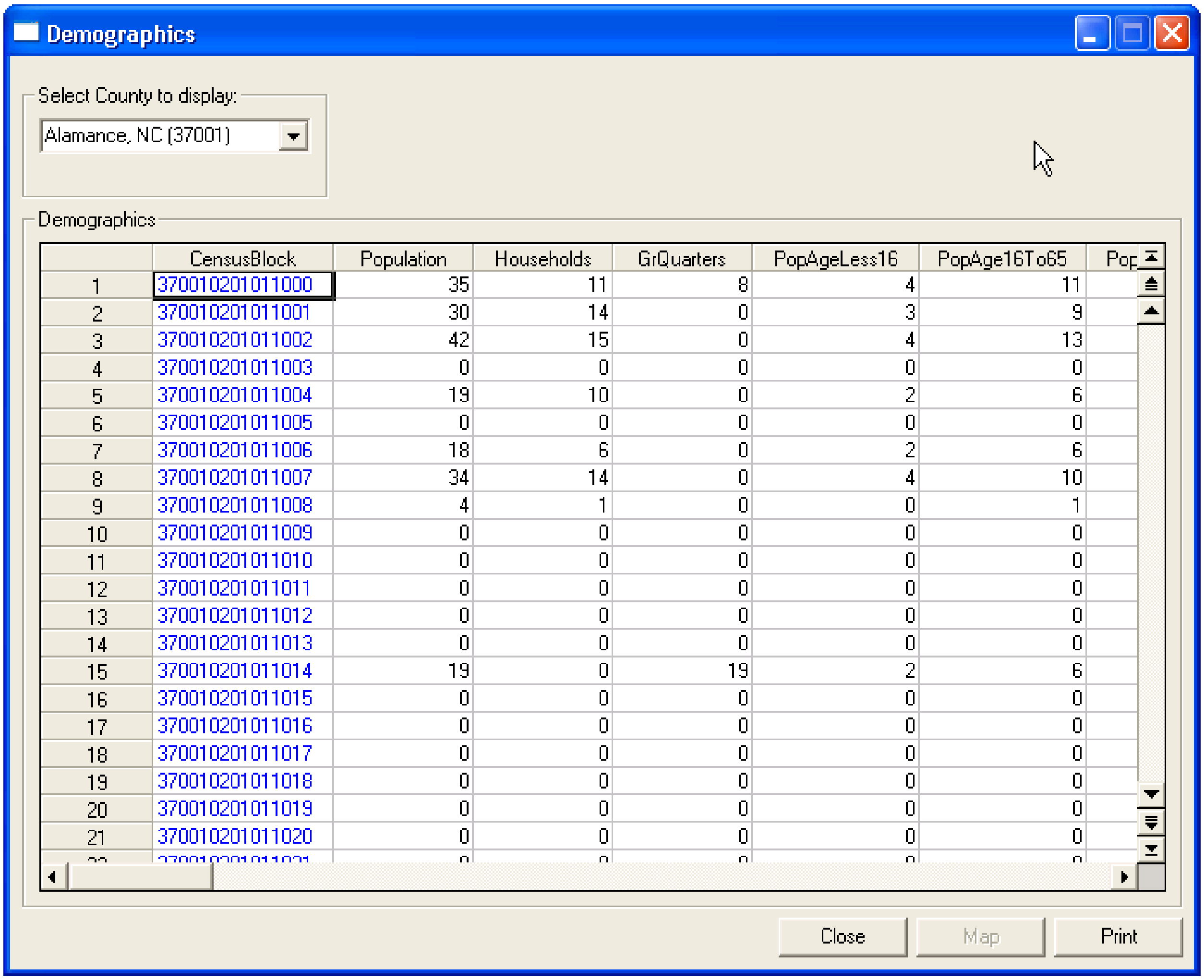


	ID	Name	Address	City	State	Zip
1	NC000305	BURLINGTON IND. I	1305 GRAHAM ST.	BURLINGTON	NC	27215
2	NC000306	BURLINGTON IND. I	1305 GRAHAM ST.	BURLINGTON	NC	27215
3	NC000307	BURLINGTON CHEM	2001 WILLOW SPRI	BURLINGTON	NC	27215
4	NC000308	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
5	NC000309	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
6	NC000310	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
7	NC000311	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
8	NC000312	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
9	NC000313	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
10	NC000314	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
11	NC000315	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
12	NC000316	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
13	NC000317	COPLAND INDS. INC	1714 CAROLINA MIL	BURLINGTON	NC	27216
14	NC000318	GENERAL SHALE P	1136 CEDAR CREST	BURLINGTON	NC	27216
15	NC000334	APOLLO CHEMICAL	1105 SOUTHERLAN	GRAHAM	NC	27253
16	NC000335	PERMATECH	911 E. ELM ST.	GRAHAM	NC	27253
17	NC000336	SOUTH ATLANTIC G	3025 STEEL WAY DI	GRAHAM	NC	27253
18	NC000608	HONDA POWER EQ	"N. C. HWY. 119, HC	SWEPSONVILLE	NC	2735900
19	NC000609	HONDA POWER EQ	"N. C. HWY. 119, HC	SWEPSONVILLE	NC	2735900
20	NC000610	HONDA POWER EQ	"N. C. HWY. 119, HC	SWEPSONVILLE	NC	2735900

Figure 3.29 Hazardous Materials Data Browser

3.2.9 Demographics

The Demographics browser allows you to view and map the default database for your study region. Demographics data are used in the shelter requirements methodology.



	CensusBlock	Population	Households	GrQuarters	PopAgeLess16	PopAge16To65
1	370010201011000	35	11	8	4	11
2	370010201011001	30	14	0	3	9
3	370010201011002	42	15	0	4	13
4	370010201011003	0	0	0	0	0
5	370010201011004	19	10	0	2	6
6	370010201011005	0	0	0	0	0
7	370010201011006	18	6	0	2	6
8	370010201011007	34	14	0	4	10
9	370010201011008	4	1	0	0	1
10	370010201011009	0	0	0	0	0
11	370010201011010	0	0	0	0	0
12	370010201011011	0	0	0	0	0
13	370010201011012	0	0	0	0	0
14	370010201011013	0	0	0	0	0
15	370010201011014	19	0	19	2	6
16	370010201011015	0	0	0	0	0
17	370010201011016	0	0	0	0	0
18	370010201011017	0	0	0	0	0
19	370010201011018	0	0	0	0	0
20	370010201011019	0	0	0	0	0
21	370010201011020	0	0	0	0	0

Figure 3.30 Demographics Data Browser

3.2.10 Agriculture Products

This dataset is unique to the Flood Model and allows the user to gain some insight into the potential losses that could occur due to flooding of planted cropland. Selecting Agriculture Products on the Inventory menu opens the dialog seen in Figure 3.31. The agriculture product data was developed using national datasets that include merged GIS data for the County, Hydraulic Unit Codes (drainage basins), and Land Use and Land Cover. This allows the Flood Model to define the agriculture products data at the county level as well as smaller sub-county regions. These smaller sub-county regions do not correlate with the census block or tract boundaries, but they do correlate with the county boundary. As shown in the figure, the user is shown the county summary and can select a radio button to view the sub-county polygons.

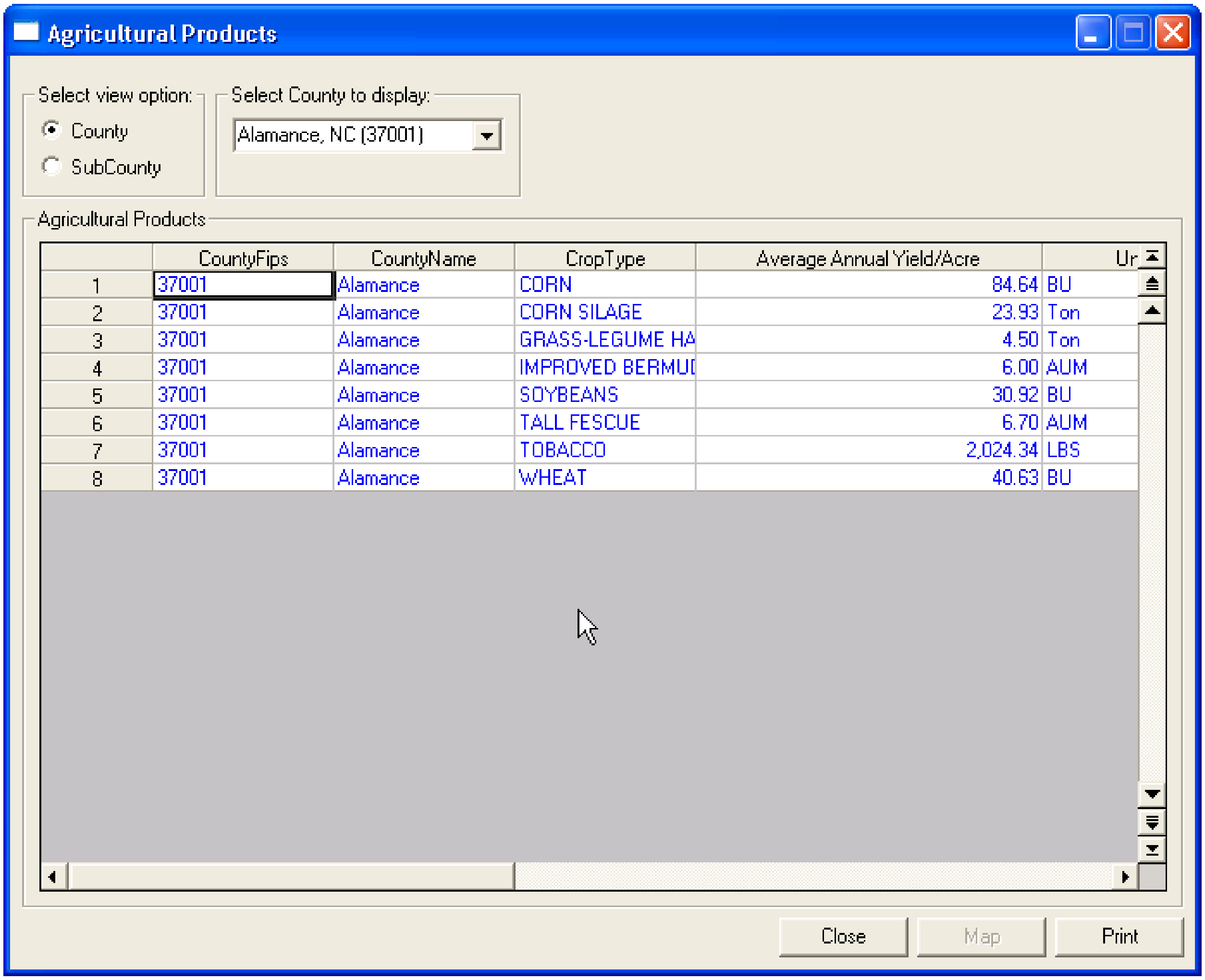


Figure 3.31 Agriculture Products County Level View

Selecting the radio button displays the dialog Figure 3.32 and the user is free to view the agriculture products within the sub-county areas. The user is also allowed to add, remove and edit the crops within the sub-county regions. The user cannot change the sub-county polygons, but can remove crops, add crops, modify the output, and the crop value as necessary to meet local conditions. As will be discussed further in the discussion on the damage functions, only the crop types previously identified have damage functions.

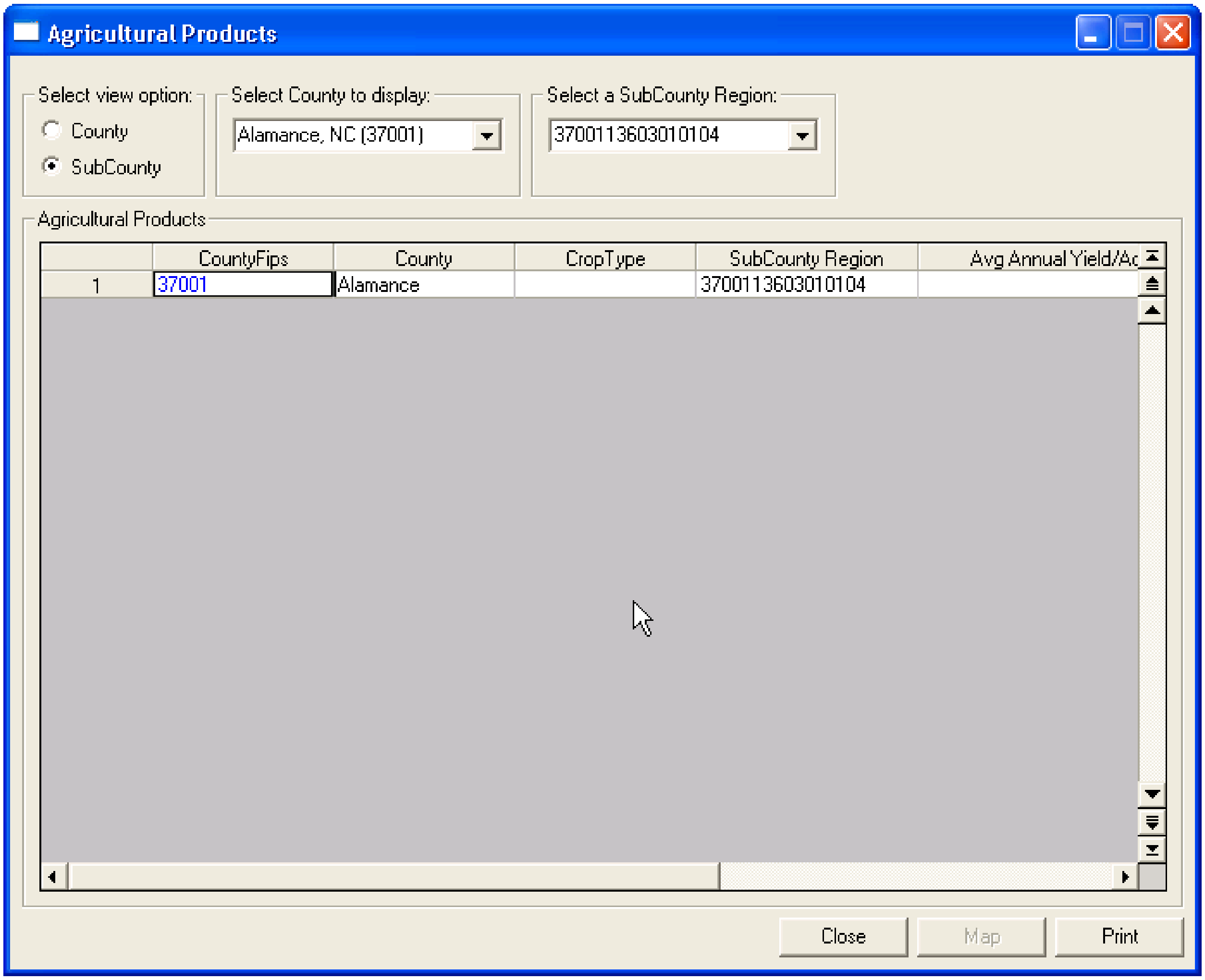


Figure 3.32 Agriculture Products Sub-County View

3.2.11 Vehicle Data

Another dataset unique to the Flood Model, the vehicle inventory was developed to allow the user to assess the additional losses possible due to vehicles remaining within the flood areas. The data was developed using the square footage occupancy data for the various occupancy classes. The methodology is similar to that used by Metropolitan Planning Organizations to identify parking and traffic patterns for planned development and provides an appropriate approximation of the number of vehicles each occupancy classification will typically have nearby. Because vehicles are used by their owners throughout the day, the Flood Model has identified two "snapshots" of time, the nighttime, when passenger vehicles are more likely to be concentrated near residential structures and commercial industrial vehicles are more likely to remain in commercial areas, and the daytime where the commercial and industrial areas will see an influx of all varieties of vehicles.

Selection of Vehicles on the Inventory menu will open a dialog as seen in Figure 3.33.

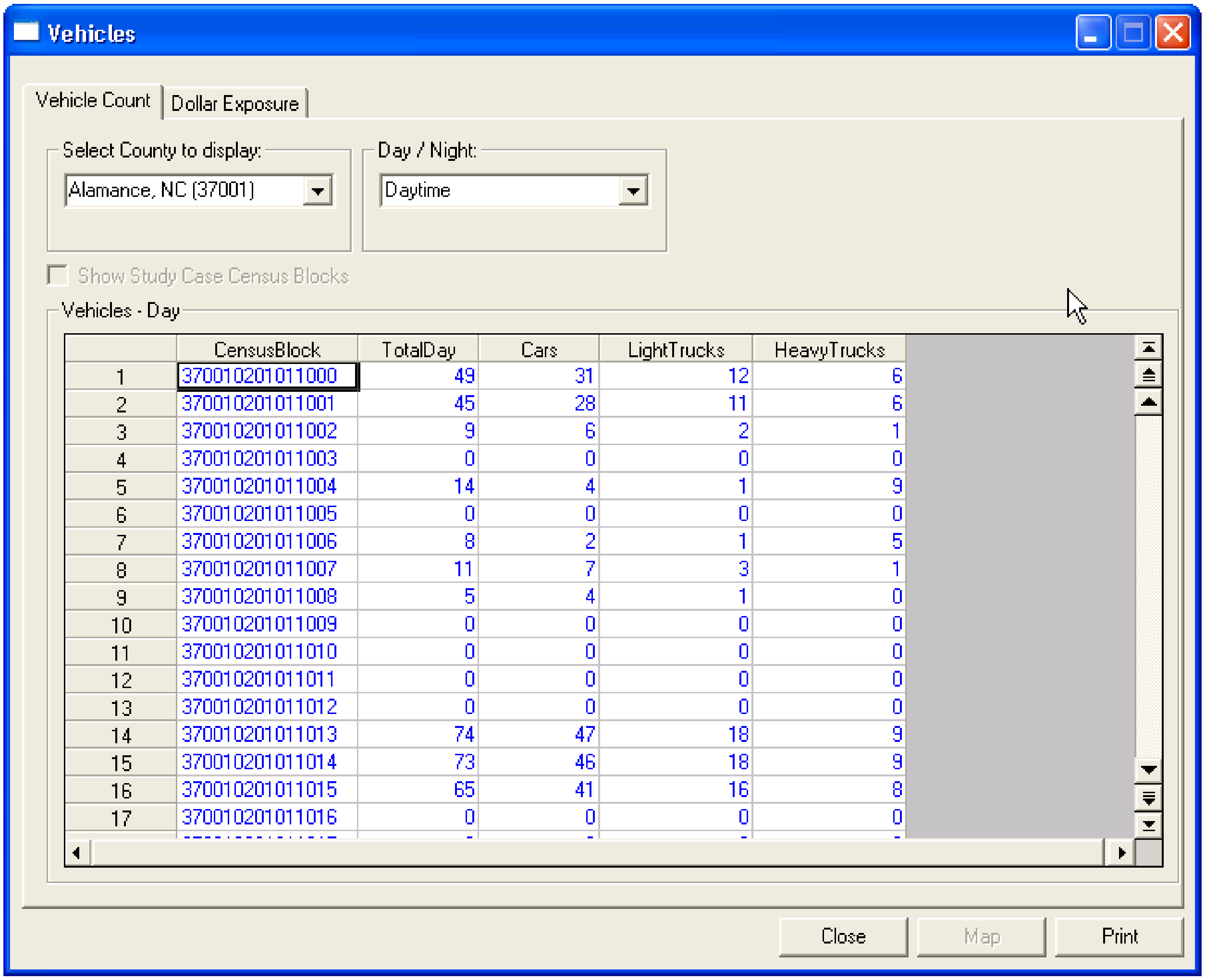


Figure 3.33 Daytime Vehicle Count

Selection of the dollar exposure tab allows the user to view the estimated value of the vehicles within any given census block. The vehicle valuation is based on the distribution of new and used vehicles provided by each states Department of Motor Vehicles and the average sale price of these vehicles. The Flood Model looks at passenger cars, light trucks (including SUVs), and heavy trucks (commercial/industrial vehicles including 18-wheelers). In this version of the Flood Model, the vehicle data is not editable, but in future versions, this data will be editable.

3.2.12 View Classification

The View Classification browser allows you to view definitions of the classification categories.

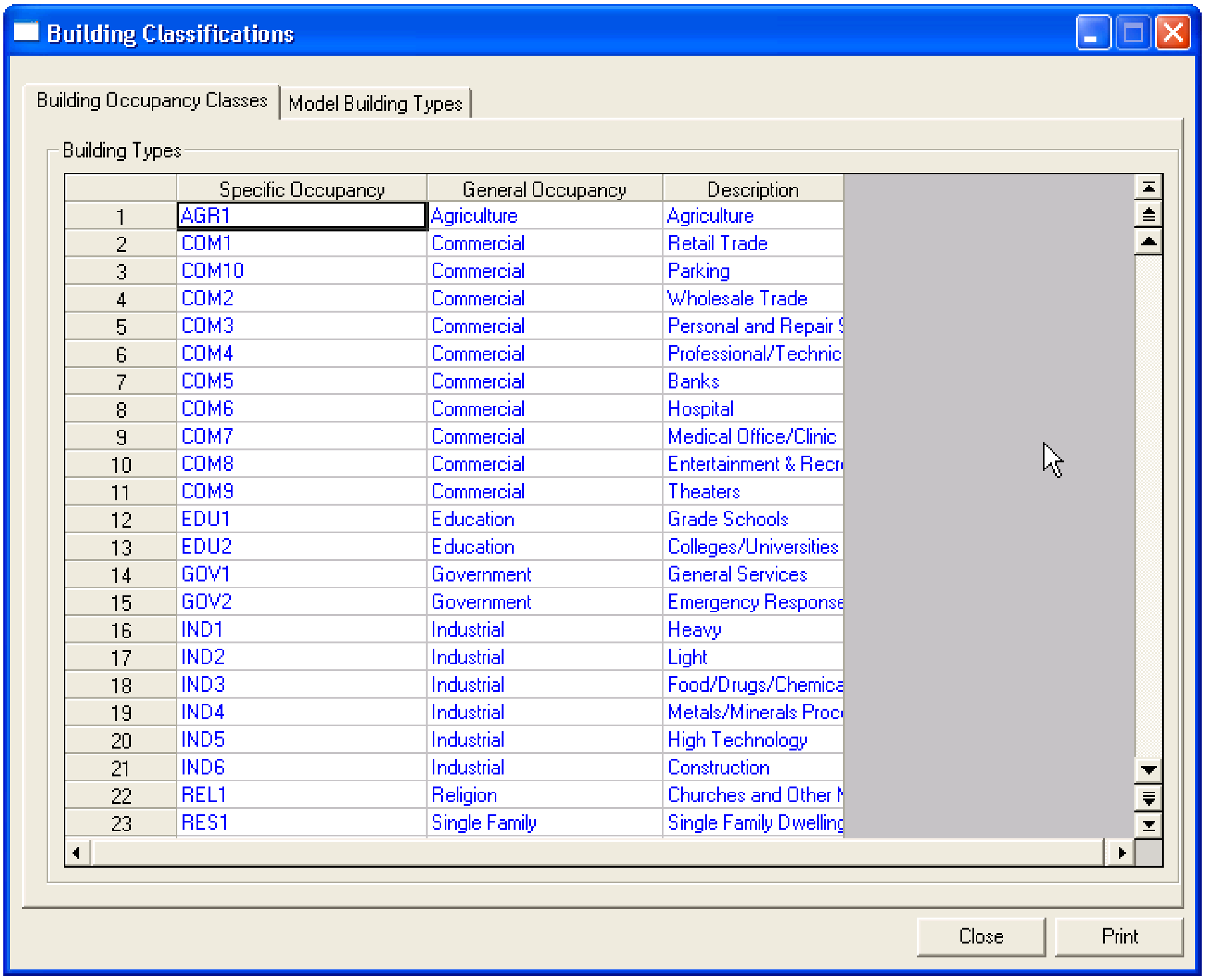


Figure 3.34 View Classification Browser

3.2.13 Showing Tabular Data on Map

Tabular data can be shown on the study region map in addition to graphic form. To map data, simply open the window that contains the data you are interested in. Highlight the column you would like to map by single clicking on the column header as shown in Figure 3.35. You will notice that the **Map** button at the bottom of the window now becomes active. Press the **Map** button and a thematic map of the data is automatically developed as seen in Figure 3.36.

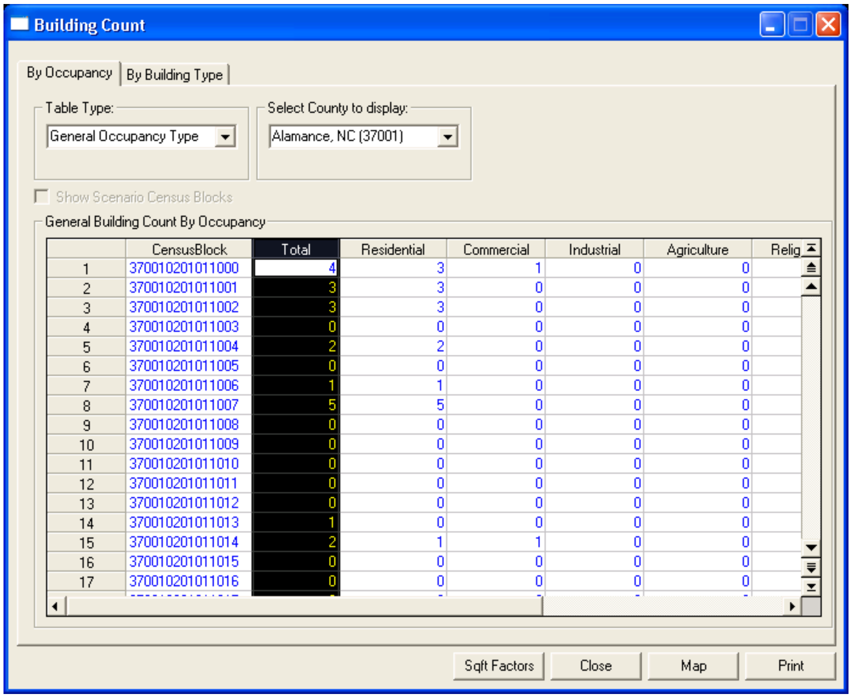


Figure 3.35 Selecting Data to Map

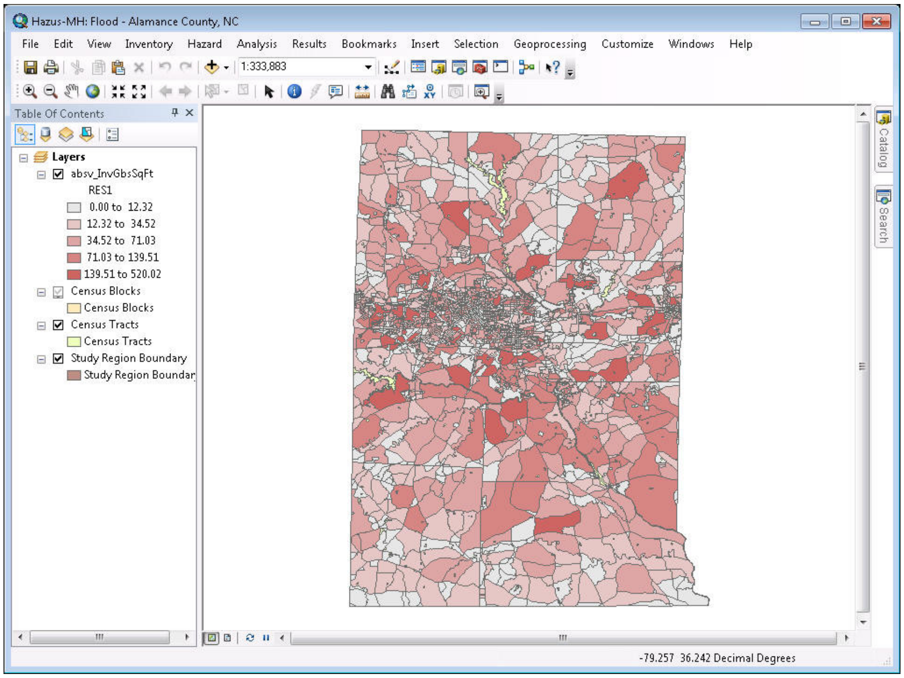


Figure 3.36 Mapping Tabular Data

Mapping any inventory data, even with the scenario census blocks box checked, will result in mapping all study region census blocks. Hazus is performing as designed, the scenario census blocks is available primarily for browser editing, not mapping.

3.2.14 Printing Tabular Data

Tabular data can be printed by clicking the **Print** button at the bottom of the display window, as seen in Figure 3.37 (circled).

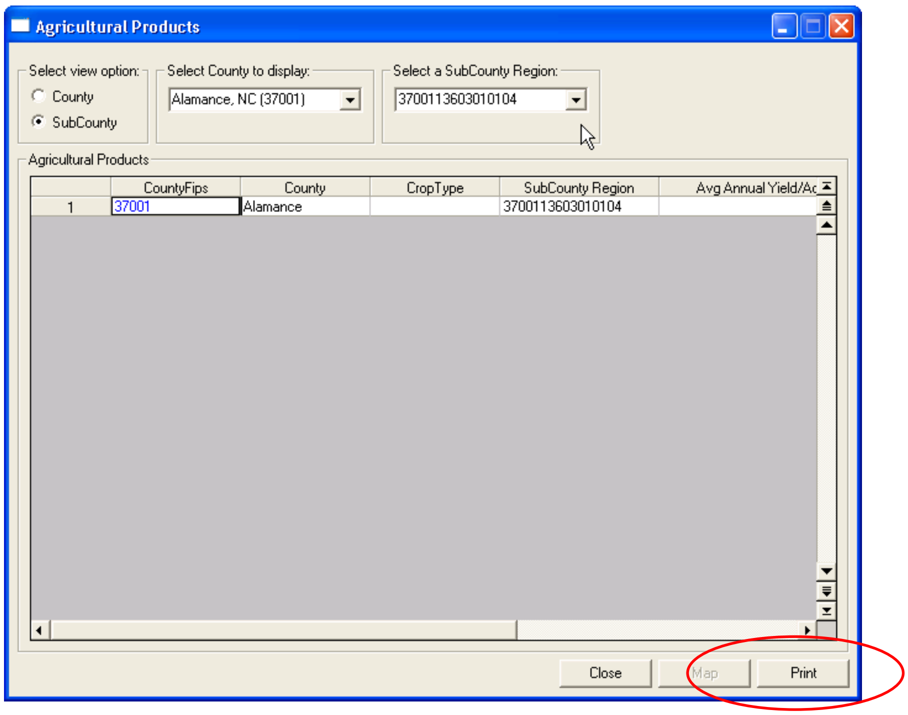


Figure 3.37 Printing Tabular Data

3.3 Defining the Flood Hazard

A key step in running a **Hazus** analysis is defining the flood hazard for your study region. This involves importing topography data, calculating stream networks for riverine hazard, and defining the flooding hazard you wish to analyze. The analysis can be conducted for riverine flood hazard, coastal flood hazard, or both.

Table 3.1 shows the analysis process for the flood hazard. When performing a combined analysis (riverine and coastal) the user is required to perform all of the steps noted:

Table 3.1 Hazus Menu Items

Hazus Flood Hazard Analysis Process	
Riverine Hazard	**Coastal Hazard**
User Data	
Define Terrain (Input DEM)	Define Terrain (Input DEM)
Import FIT Projects, User-defined Depth Grids, HEC-RAS .FLT Grids	Import FIT Projects, User-defined Depth Grids
Develop Stream Network	No Equivalent
Create New Scenario	
Select Reaches, FIT Projects, User-defined Depth Grids, HEC-RAS Grids	Select Shorelines, FIT Projects, User-defined Depth Grids
Hydrology	No Equivalent
No Equivalent	Characterize Shoreline
Delineate Floodplain (Hydraulics analysis) for suite, single return period, specific discharge, annualized return periods	Delineate Floodplain (frontal dune erosion, WHAFIS, wave runup, zone determination) for suite, single return period, annualized return periods
Develop Flood depth grid (completed base hazard analysis)	
Optional Hazard Analysis Perform What If – Levee Assessment Perform What If – Flow Regulation Perform What If – Velocity grid	Optional Hazard Analysis (currently disabled) Perform What If – Long-term Erosion Perform What If - Shore Protection

3.3.1 Selecting the Flood Hazard Type

The riverine and coastal hazards have different requirements in terms of the development of the hazard and the digital elevation data required to support the analysis. To prevent the user from having to carry the penalty of digital terrain data that is not required and to enable only those menu items needed to support their hazard of choice, the first menu item on the Hazard Menu requires the user to select the hazard for which they want to analyze within their study region. The selection dialog can be seen in Figure 3.38.

Figure 3.38 Flood Hazard Type Selection

The user should think carefully about which hazard type (or both) they are interested in analyzing as the selection will drive the entire hazard assessment and changing the selection will change the DEM requirement and prevent the user from accessing some of the menu items.

For example, selection of the *Riverine only* button will require a DEM that covers both the study region and all the watersheds that intersect that study region and will require the user to develop a stream network before other hazard menu items are enabled.

3.3.2 Defining Topography

As might be anticipated, topography is the most critical element to the Flood Model. The Flood Model has developed an approach to simplify the effort to obtain digital elevation data and bring these data into the model. Primarily, the data extent is identified and the user is asked to download and point the Flood Model to the resulting ArcGIS grid dataset.

For this section on running a default analysis, we will examine the process of importing DEM data from the U.S. Geological Survey (USGS) web page.

The Level 2 user should note that in some cases they will need to bring in a DEM layer sufficient to meet the extent requirements defined for Level 1 users since there is always the possibility that the user may ask the Flood Model to extrapolate their FIT input data and exceed the flood boundaries they brought in.

3.3.3 Download DEM Data from USGS

The USGS website contains downloadable data from the National Elevation Dataset (NED). The NED is a digital data set available from USGS that provides national elevation data in a downloadable form with consistent datum, elevation unit, and projection. This dataset has been chosen to be the default data for the Flood Model. This does not preclude a user from bringing in his or her own DEM.

To import DEM data, first select the *Hazard* menu and the *User Data* submenu, as shown in Figure 3.39. A window will pop up with four tabs: DEM, FIT, Depth Grid, and HEC-RAS. In the DEM tab, select “Determine required DEM extent” button, as shown in Figure 3.40.

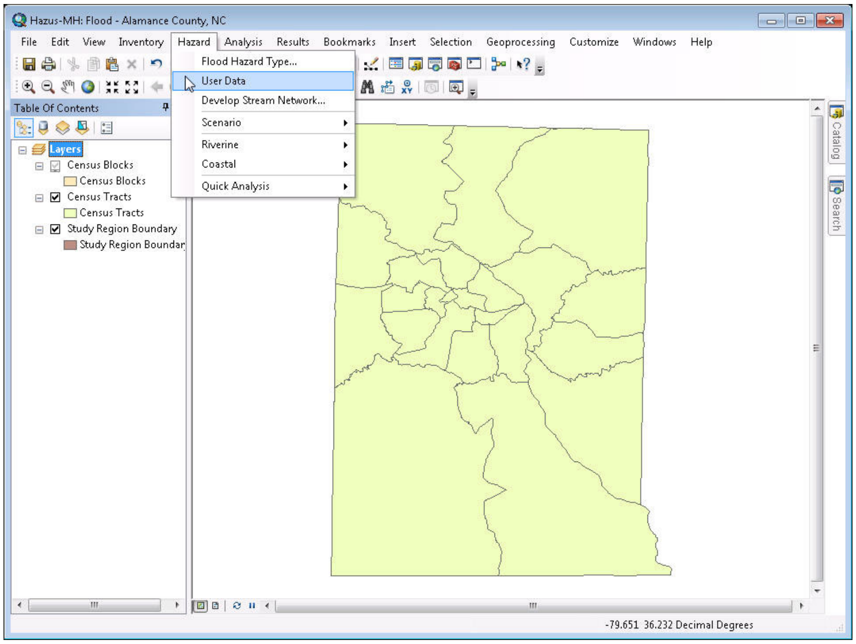


Figure 3.39 Hazard and User Data Paths Menus

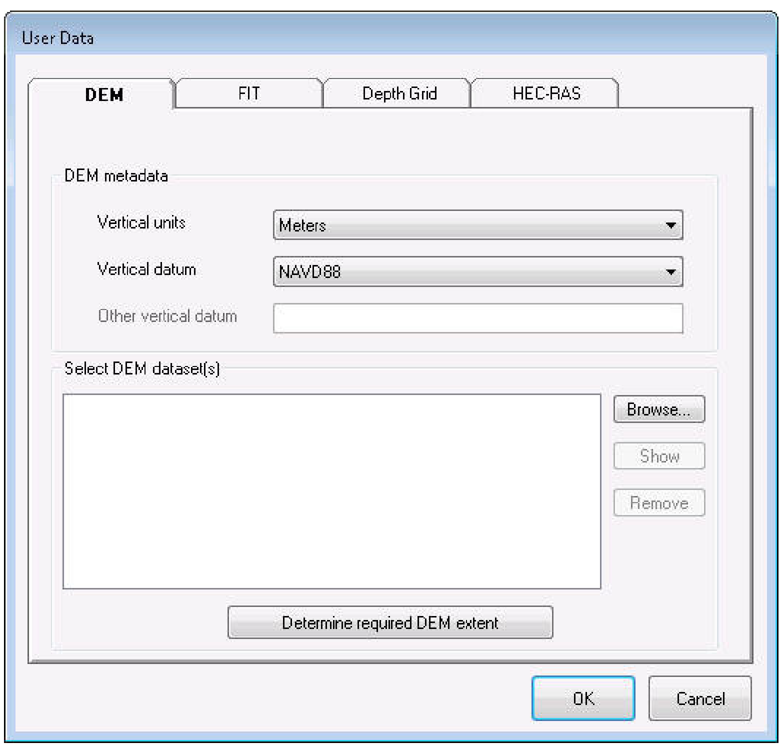


Figure 3.40 User Data Window

The window that pops up, shown in Figure 3.41, lists the latitude and longitude coordinates that you will need when downloading the USGS DEM data for your study region. The latitude and longitude shown may extend beyond the defined boundaries of your study region because the watersheds that affect the region's flood risk probably extend outside the political boundaries. This window includes simple instructions for downloading data from the USGS web site. More detailed instructions appear below.

Users of all Levels should note that any DEM provided to the Flood Model will need to meet the coordinate constraints established by this dialog. The Model will discontinue processing if the model identifies gaps in the data coverage. This does not preclude a user from using his or her own DEM.

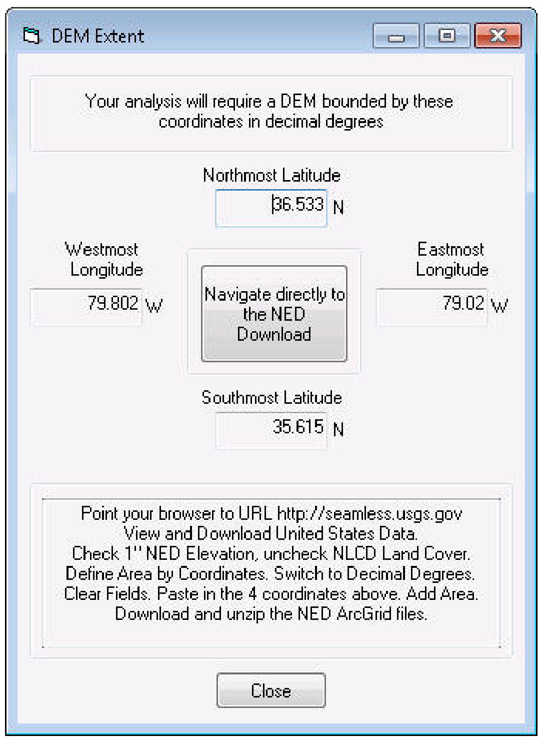


Figure 3.41 Coordinates for Required DEM

If pop-up blockers are enabled on your machine, it is important that they are disabled when you try to download the DEM.

The USGS makes minor modifications to their seamless website on a regular basis. Therefore the following dialogs may not be exact representations of what the user may find on the website. In general, however the basic functionality of the website has not changed and the following discussion should serve as an effective guide.

There are two ways to acquire the DEM from the NED website. The easiest is to click on the button "Navigate directly to the NED Download." This will access the NED site, enter the required coordinates, and direct the user to the download page.

However, it is possible that in the future the USGS will change the URL to their download site, which will necessitate users to go through the unabbreviated download process. To do so, proceed to the USGS web site http://seamless.usgs.gov/. Click on the button that reads *View and Order Data Sets – United States Viewer* on the welcome screen identified with the arrow in Figure 3.42 below. On the web page, shown in Figure 3.43, note that multiple boxes are checked under the heading *Download Layers* on the right-hand side of the page. Deselect all boxes except the *NED*. Then, click on the link on the left-hand side of the screen, towards the bottom of the page that reads *Define Area by Coordinates*. Note that you may have trouble viewing this link if your browser window is not large enough. The viewer is most easily seen if your screen resolution is 1024 x 768 pixels.

Figure 3.42 USGS Seamless Welcome Screen

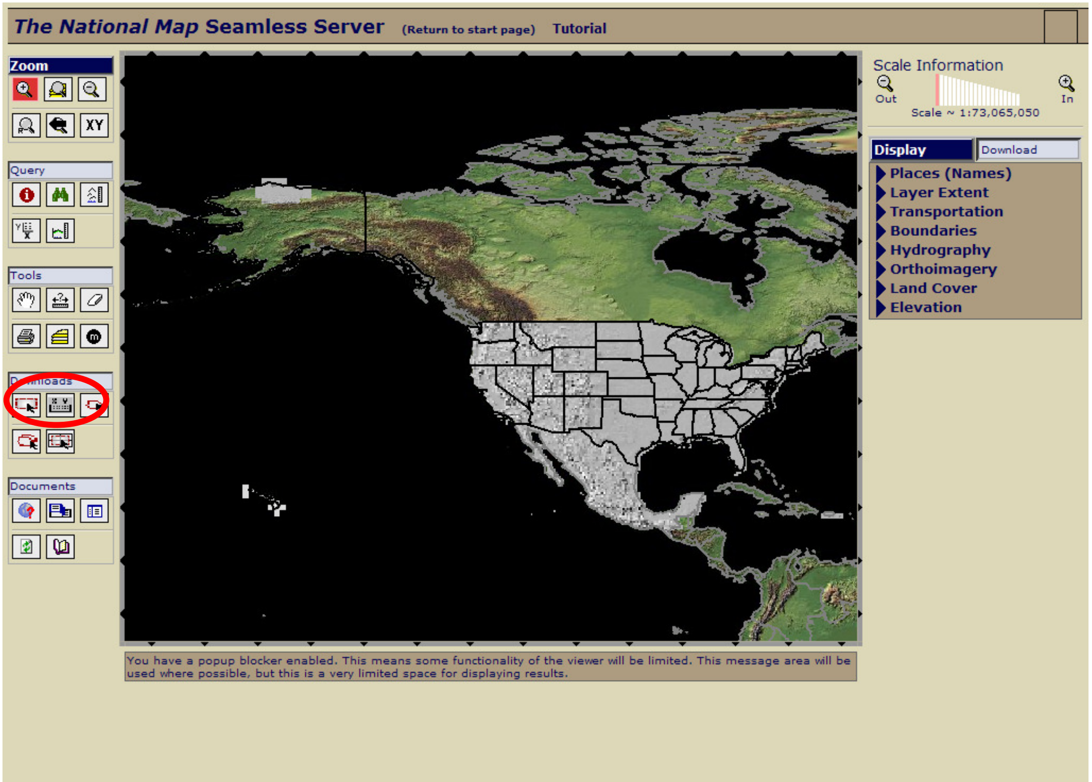
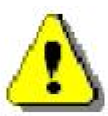


Figure 3.43 USGS Web Page for Seamless Data Distribution System



Be sure to check all other data layers off other than the NED. Failure to do so will typically lead to a message asking you to place an order for a CD-ROM of the data with an associated cost recovery fee. Rather large areas of NED data can be downloaded for free if the NED is the only layer requested.

The next web page you come to will prompt you to enter the latitude and longitude coordinates that define the limits of the DEM data you wish to download. Switch to entering coordinates in decimal degrees by clicking on the link. Then, copy the coordinates from your **Hazus** study region *DEM Extent* window onto the USGS page, as shown in Figure 3.44. When you are done, press the **Add Area** button (circled). If incorrect numbers are entered or you would like to start over, click on **Clear Fields** to remove all data from the fields.

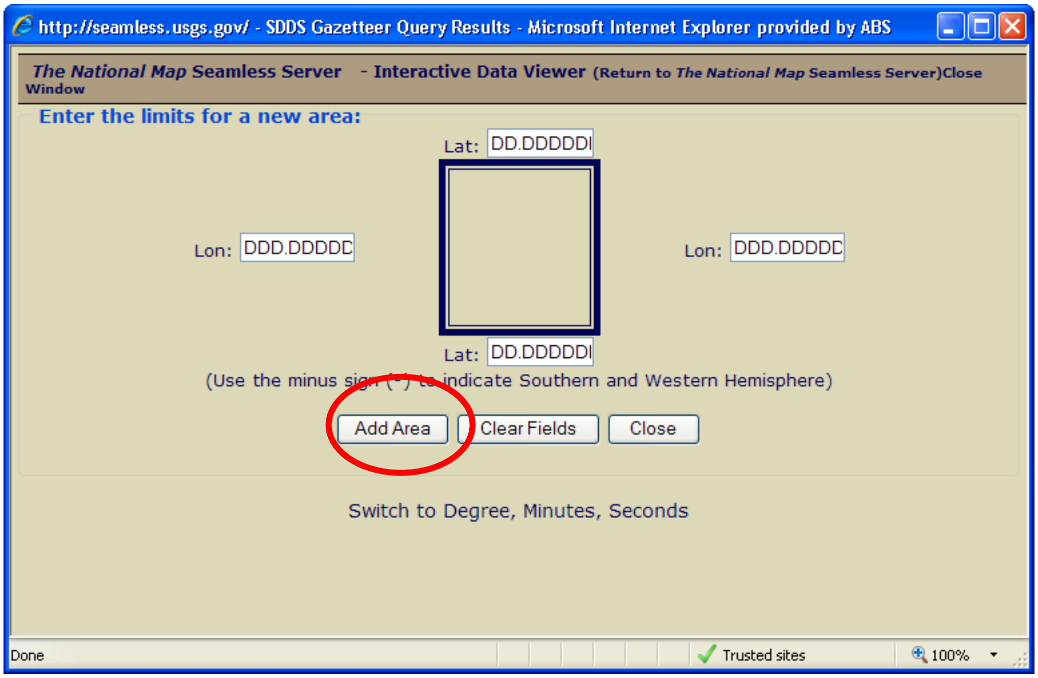


Figure 3.44 USGS Web Page Defining Geographic Area for DEM Data

The next page that will pop up will look similar to Figure 3.45. Click on the *Download* link and proceed to download the DEM data. The data will be stored in the form of a zip file, which you will need to unzip in any location you wish on your computer. Any WinZip compatible program should be able to unzip the data. For large areas, the user will be given the DEM in multiple zip files that they need to unzip and then select all one by one in the set DEM Data Paths dialog.

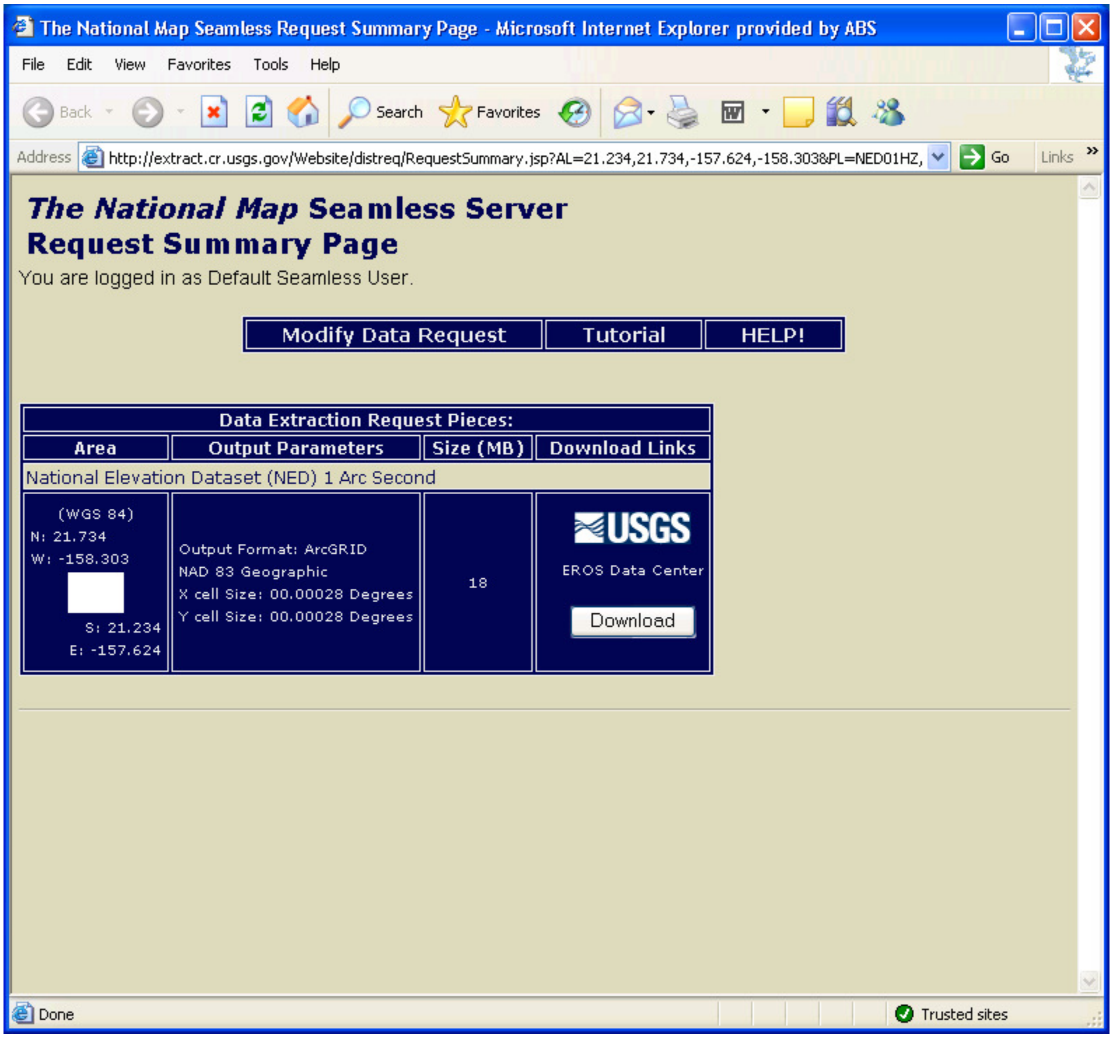


Figure 3.45 Download Page for USGS DEM Data

Users that have Windows XP installed on their computer may run into problems with downloading the DEM from the USGS website. Windows XP comes with an automatic pop-up blocker that will deter the downloading process. The following screenshots are an example of what users might see. When the user clicks on the Information Bar, the user has the three options, shown below. Selection of the “Download File” option will not produce desired results, as seen in Figure 3.46.

Figure 3.46 Security Settings Blocking Download

To avoid this problem, go to the "Tools" menu and click on "Internet Options", as shown in Figure 3.47.

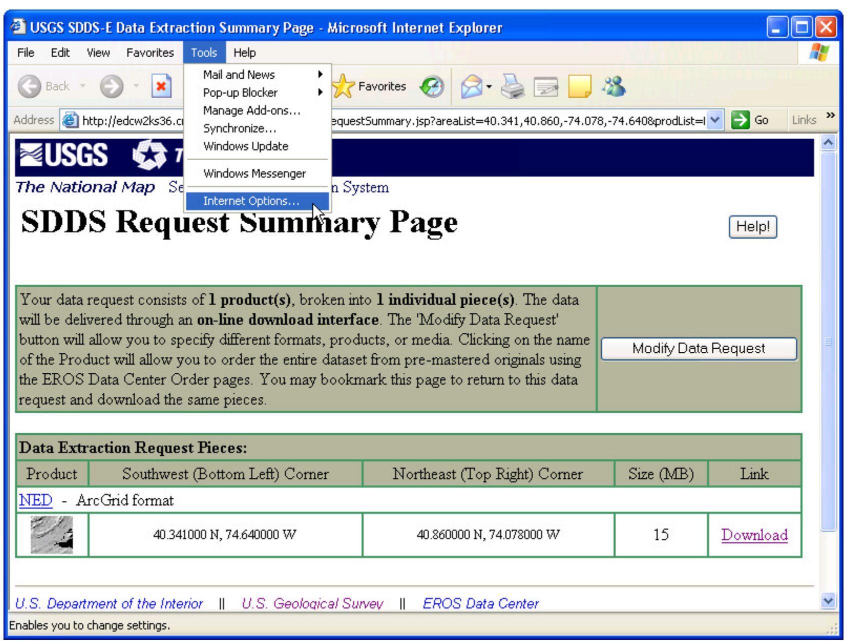


Figure 3.47 Set Internet Options for Download

Go to the "Security" tab, and click on "Custom Level" (circled in Figure 3.48).

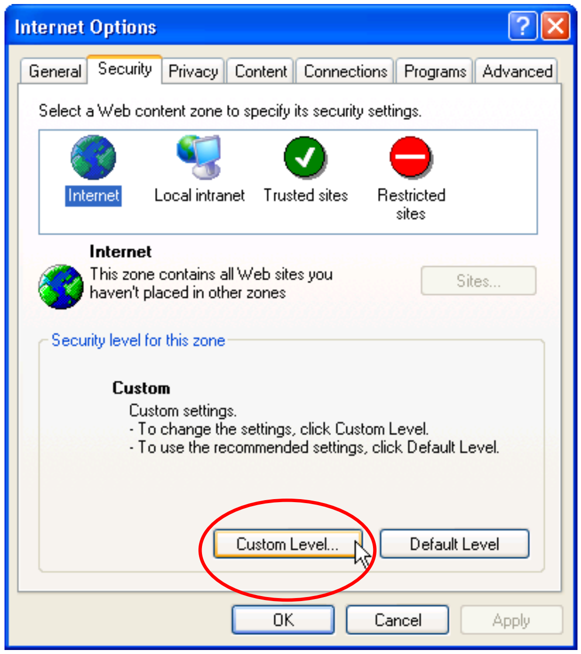


Figure 3.48 Internet Options

Scroll down to the Downloads section, and click "Enable" for all <u>two</u> options identified as "*Automatic prompting for file downloads"* and "*File download*" as shown in Figure 3.49 and click "OK"

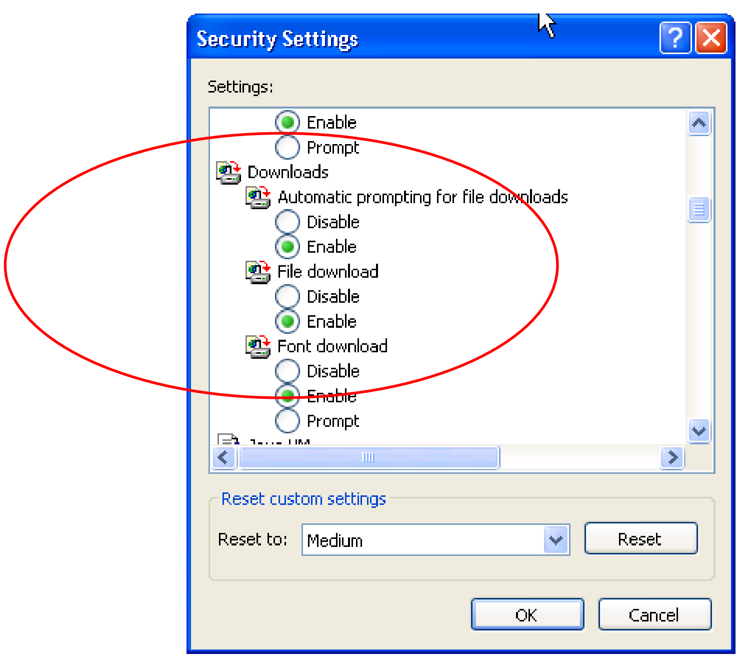


Figure 3.49 Security Settings for Download

Click "OK" to close the Internet Options window and restart the DEM download process.

3.3.4 Incorporate DEM Data

To incorporate the DEM data downloaded from USGS into the study region, you are prompted to enter three pieces of information in the DEM tab. First, enter the vertical datum used in the DEM file. Data downloaded from the USGS web site uses the NAVD88 vertical datum. Second, enter the vertical units of the DEM file, which should be Meters for USGS NED data. Third, click on the **Browse** button to locate the location of the unzipped DEM file on your computer. Click **OK**.

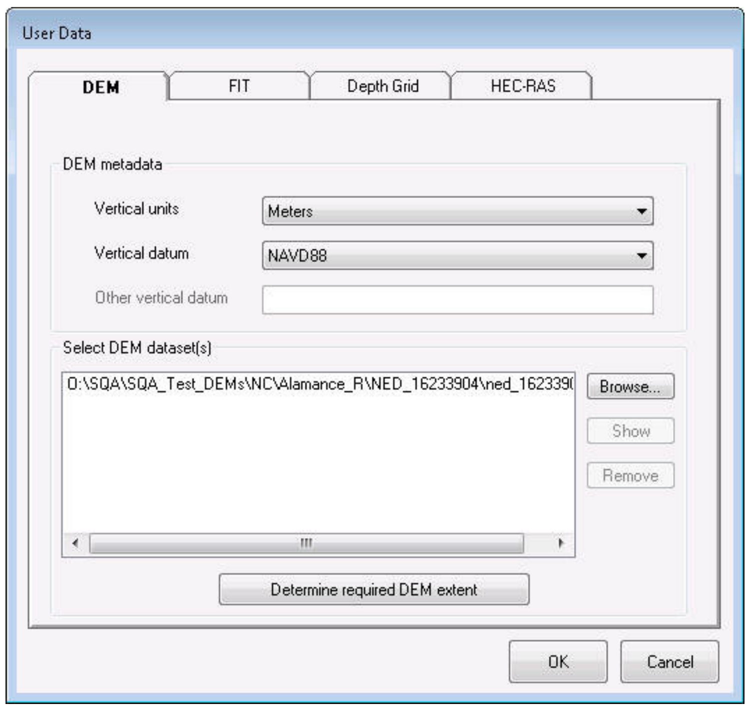


Figure 3.50 Setting DEM Data Paths

At this point, your computer will process the data in the DEM files, and select only those areas that are relevant to your study region. When this process is complete, a message box will notify the user that they can continue with the other hazard components. In some cases, the study region will require more than one DEM file from the USGS. If that is the case, the user should browse to each DEM individually to add them to the dialog seen in Figure 3.50 and the model will automatically merge the datasets for use in the Flood Model.

Note that Spatial Analyst extension must be active in ArcGIS for the DEM file to be properly integrated into the study region.

It has been observed that if the required DEM extent is large and USGS NED data is downloaded as multiple zip files, very rarely the USGS provided pieces will have a gap between them. This would have caused the stream network to be constructed incorrectly so Hazus will validate the input DEM pieces and stop the process without going any further. The user will see the message below.

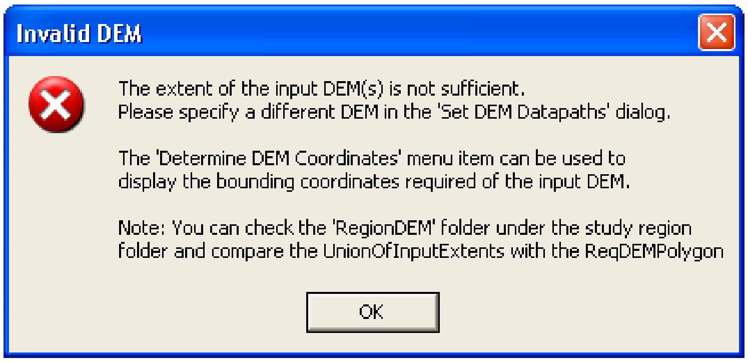


Figure 3.51 Input DEM Validation Failed

The users who experience this issue can look at the UnionOfInputExtents and ReqDEMPolygon feature classes under the RegionDEM folder. The user should determine where the gap is occurring and causing the required DEM polygon not being completely contained within the union of input extents. The user then can note the coordinates, go to USGS NED website (http://seamless.usgs.gov/) and download the missing piece separately by following steps laid out in Download DEM Data from USGS section. Adding this additional piece through the DEM Data Paths dialog solves the problem. As seen in the example below (Clark County, NV), the UnionOfInputExtents have a gap that overlaps with the ReqDEMPolygon and additional piece of DEM is needed to cover that area. To better visualize the gap, the user can zoom in to area where it looks like the union polygon has a line cutting through it.

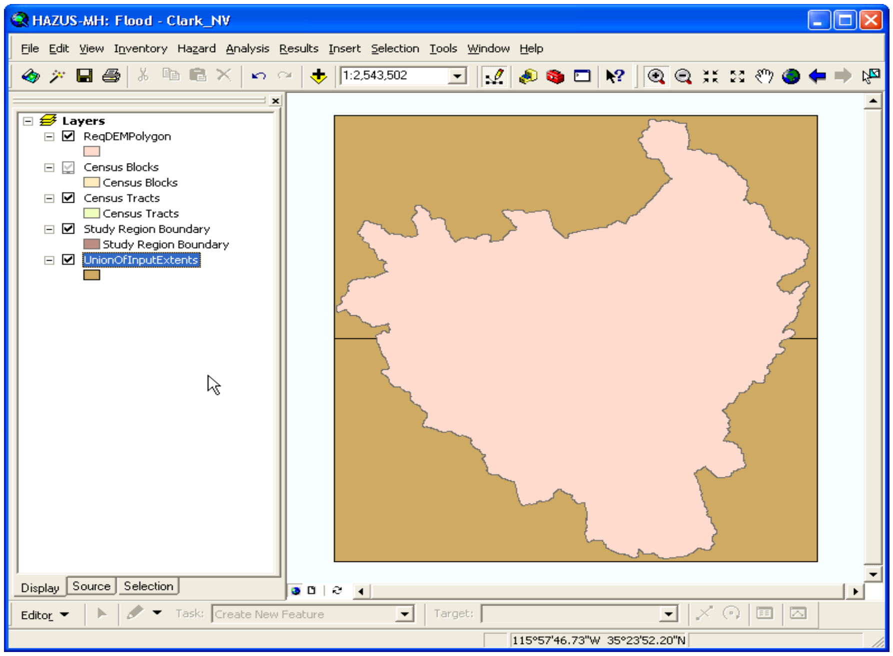


Figure 3.52 Example of Gap in USGS DEM

It has been observed that a portion of the DEM from the USGS NED site is missing, most commonly seen in study regions that are along the U.S. border. This would have caused the stream network to be constructed incorrectly so Hazus will validate the input DEM pieces and stop the process without going any further. The users will see the message below.

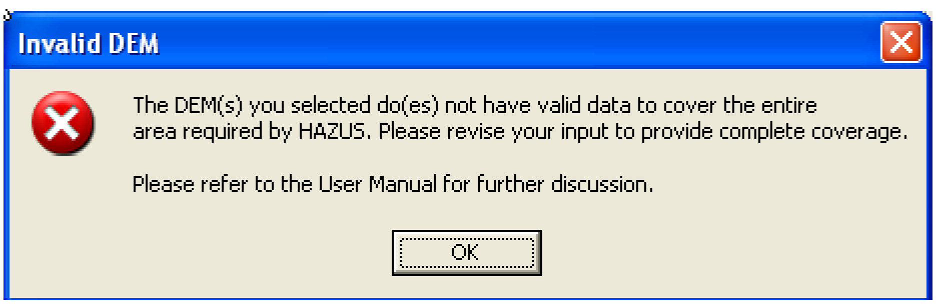


Figure 3.53 Input DEM Validation Failed

This issue is known to be triggered along the U.S. border, when the DEM source is from the USGS NED. Add the required DEM polygon and all input DEMs to the map to visualize the part that is missing. The current workaround is to obtain the 'missing' DEM(s) for the other side of the border.

3.3.5 Import Other User Data

A new feature in Hazus is the ability for users to import flood depth grids and HEC-RAS floating-point binary (.FLT) grids, as well as FIT projects. Users now have the option to bypass processing the DEM if they plan on running a scenario that only includes the FIT projects, flood depth grids, and/or HEC-RAS .FLT grids.

3.3.5.1 Import FIT Results

The flood information tool (FIT) is an ArcGIS extension separate from Hazus that can be used to create flood hazard data for import to HAZUS. The data are prepared outside of Hazus and model allows users to indicate the file location of FIT output. For more information regarding FIT, see section 4.2. Select *User Data* from the *Hazard* menu. In the User Data window, select the FIT tab and depending on the flood hazard type selected earlier, there will be a Riverine and/or Coastal tab available.

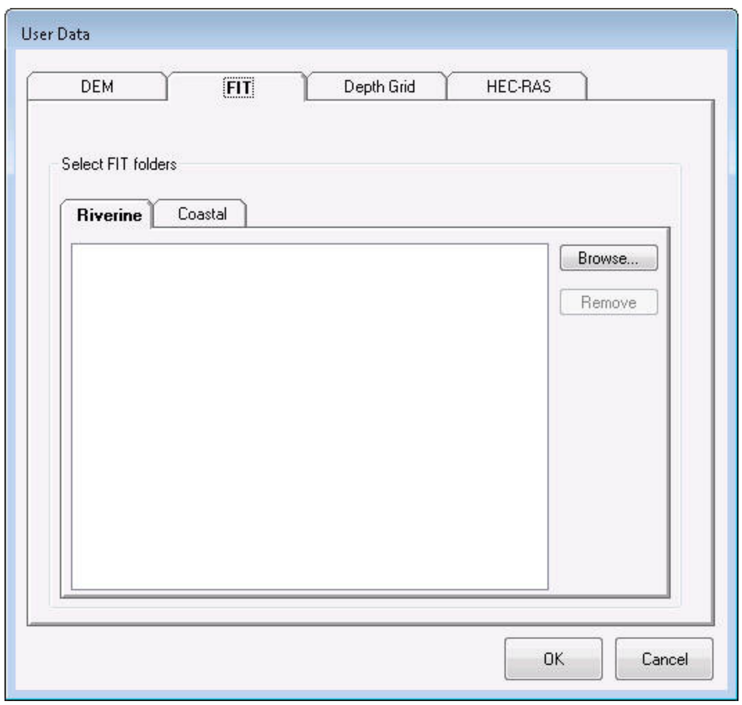


Figure 3.54 Importing FIT Data

Use the **Browse** button to browse to the location of the FIT working directory on disk. The browse dialog is intended to select a folder, not the contents of it, so be sure to click on the working directory (not double-click). It is important that users import the FIT working directory into the correct hazard tab. Repeat the process to import additional FIT working directories.

3.3.5.2 Import Flood Depth Grid Results

In order to import flood depth grid results into HAZUS, select *User Data* from the *Hazard* menu. In the User Data window, select the Depth Grid tab, as seen in Figure 3.55.

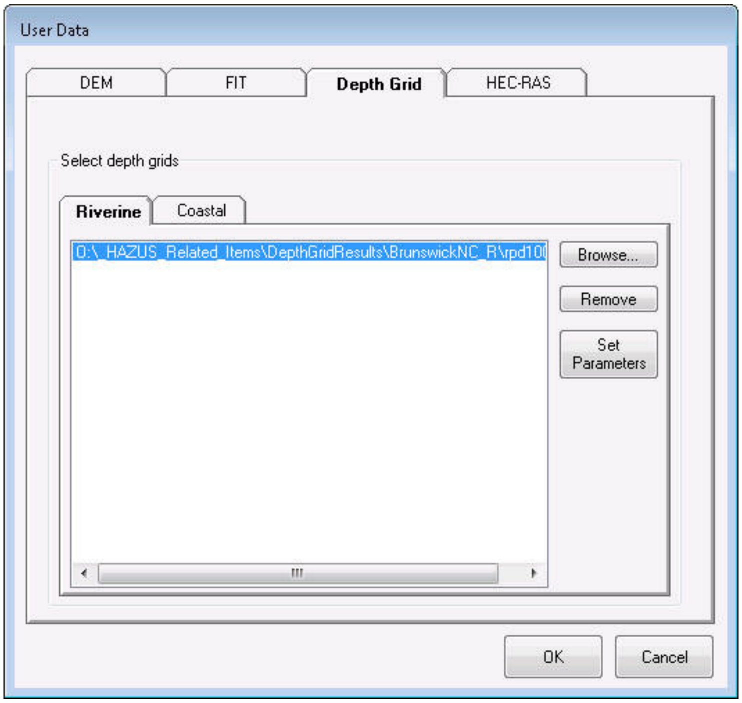


Figure 3.55 Importing Depth Grid Data

Use the **Browse** button to browse to the location of the flood depth grid on disk. The browse dialog is intended to select a raster. After the flood depth grid is selected, click on the newly imported flood depth grid and select the **Set Parameters** button. A window will pop up and ask the user to set the parameters to the flood depth grid. Select the **Units** (feet or meters) and input the **Return Period** of the flood depth grid, as seen in Figure 3.56. It is important that users import the flood depth grid into the correct hazard tab. Repeat the process to import additional flood depth grids.

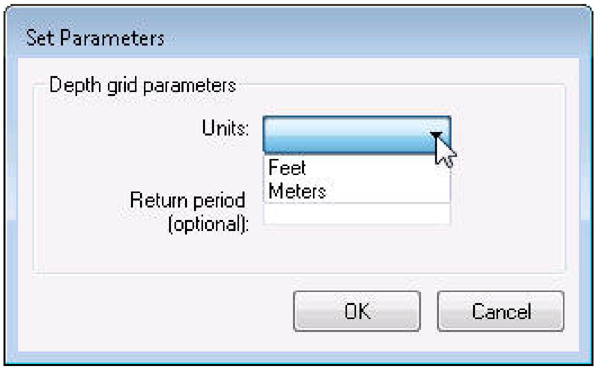


Figure 3.56 Set Parameters for Depth Grid

3.3.5.3 Import HEC-RAS .FLT Grid Results

Users of HEC-RAS (Hydrologic Engineering Center's River Analysis System) can import results into Hazus. The dialog allows the user to import HEC-RAS (via RAS Mapper) hydraulic output floating-point binary (.FLT) grids to be used in the Flood Model. The HEC-RAS .FLT grids are implicitly treated as Riverine.

In order to import HEC-RAS .FLT grid results into Hazus, select *User Data* from the *Hazard* menu. In the User Data window, select the HEC-RAS tab, as seen in Figure 3.57.

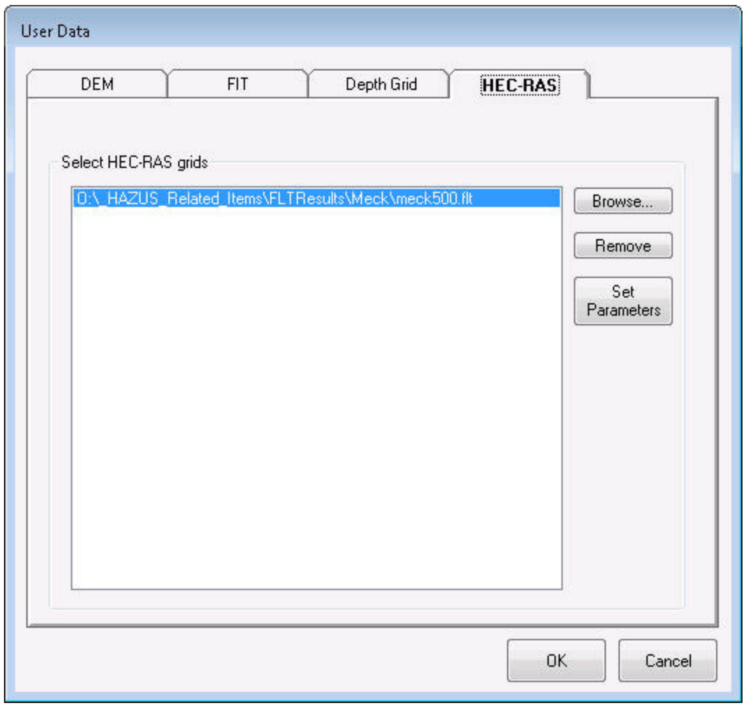


Figure 3.57 Importing HEC-RAS .FLT Grid Data

Use the **Browse** button to browse to open a standard Windows browser dialog (Figure 3.58) that allows the user to select HEC-RAS (produced via RAS Mapper) hydraulic output floating-point binary (.FLT) grid. The browse dialog is intended to select a floating-point binary file. After the .FLT grid is selected, the Flood Model to validate the input by making sure the .FLT grid's associated floodplain boundary (by default HEC-RAS saves it as FloodMap) is located partially within the study region (geographically), and it contains projection information (prj.adf). The Flood Model does not validate the integrity between the FLT grid and the floodplain boundary polygon (by default HEC-RAS saves it as FloodMap).

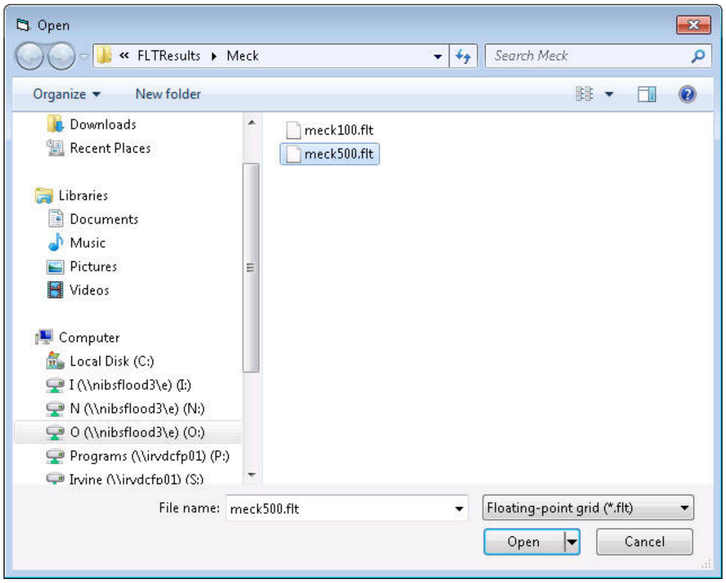


Figure 3.58 Open Dialog when Browsing for HEC-RAS Dataset

Click on the newly imported .FLT grid and select the **Set Parameters** button. A window will pop up and ask the user to set the parameters to the .FLT grid. Select the **Units** (feet or meters) and input the **Return Period** of the flood depth grid, as seen in Figure 3.59. Repeat the process to import additional HEC-RAS .FLT grids.

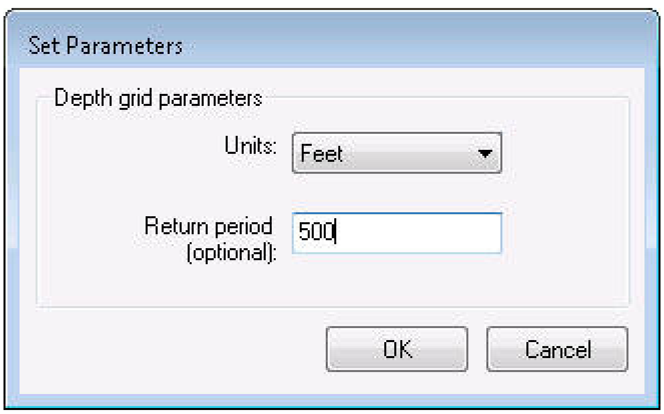


Figure 3.59 Set Parameters for .FLT Grid

3.3.6 Riverine

At this point, the procedure for analyzing the hazard of the study region differs depending on whether your study region has riverine flood hazard, coastal flood hazard, or both.

3.3.6.1 Generate a Stream Network

If your study region is subject to riverine flood hazard, your next step is to generate a stream network. This is not required if you are only running Scenarios with user-supplied flood hazard data (FIT, depth grids, .FLT grids). This is a one-time analysis and establishes the river network identity for all subsequent Scenarios. Select *Develop Stream Network* from the *Hazard* menu. The window shown in Figure 3.60 will appear. Enter an appropriate stream drainage area (in units of square miles), and click **OK**.

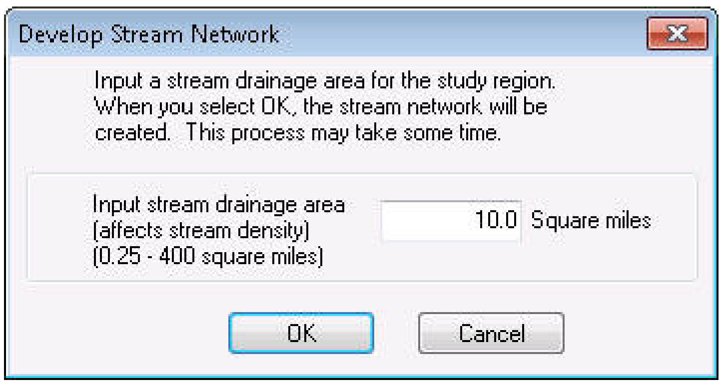


Figure 3.60 Selecting Input Stream Drainage Area

Your computer will process the DEM for your study region to determine the locations of streams. This analysis will take some time, ranging from five minutes to several hours, depending on your computer's processing speed, the size of the study region, and the complexity of the DEM. When the process is complete, the streams identified will appear on your study region, similar to Figure 3.61.

Selection a small number for the drainage area such as 1 square mile will result in a highly defined stream network. This value represents the total land area, in square miles, that drains into any given reach excluding that drainage at the starting node of the reach (the downstream node from the prior reach). The smaller the drainage area input by the user, the more processing time required by the Flood Model for subsequent analyses.

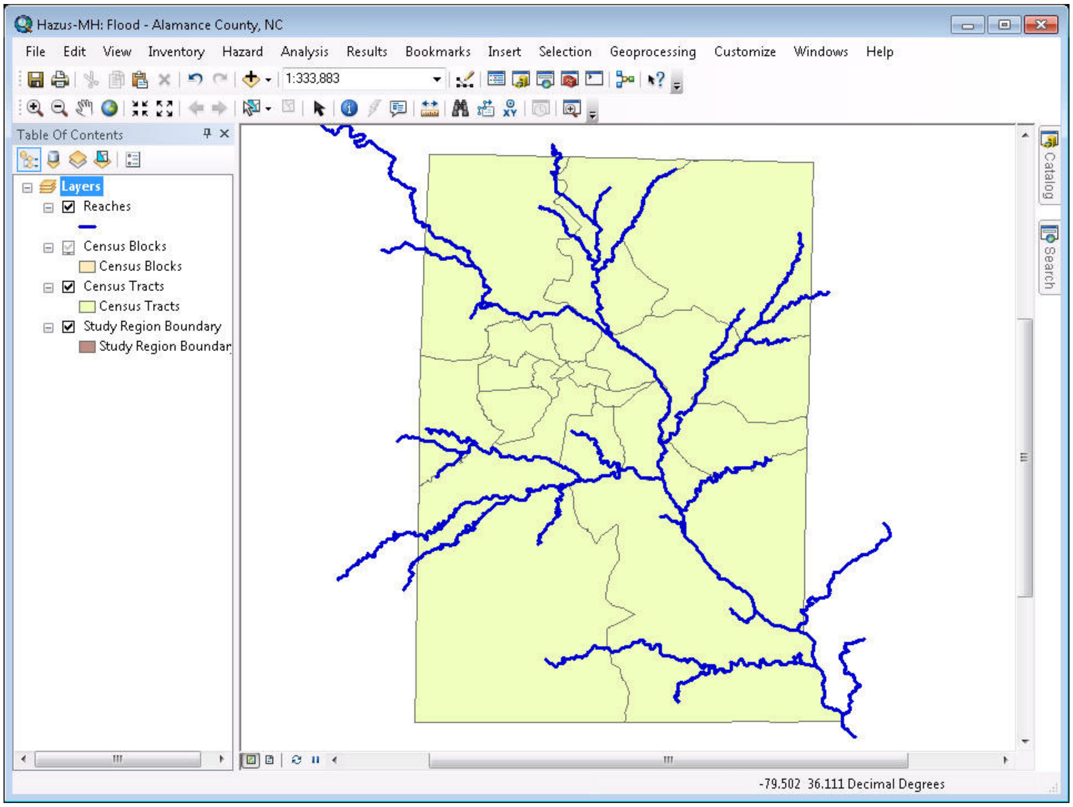


Figure 3.61 Stream Network

Running the stream network the first time is fairly time consuming because the model performs an analysis that fills in spurious sinks in the DEM. However, in order to save the user time, the model saves the results of the sink filling process so that if the user decides to change the drainage area number, the model will not need nearly as much time to perform the analysis. For example, if the user runs stream network at 5 square miles and then decides that the network is not fine enough, the change to 1.0 square miles will run significantly quicker than the original analysis.

If a river to be analyzed forms a border between counties, it is suggested to include the counties on both sides of the river when creating the study region. The stream network in Hazus is known as a synthetic network because it is derived entirely from the DEM. No imagery or pre-existing map layers are used in its generation. More specifically, streams in a synthetic network exist wherever at DEM grid cell locations that receive drainage from a threshold number of upstream grid cells. If the DEM is not large enough, the threshold number of grid cells may not be reached. An example of this is shown in Figure 3.62. It shows a study region consisting of one county, for which the one river (in red) forms a border. But because the DEM does not include areas draining to both sides of the river, the resulting synthetic stream is discontinuous. There are simply not enough DEM grid cells draining to the discontinuous portions for them to properly delineate.

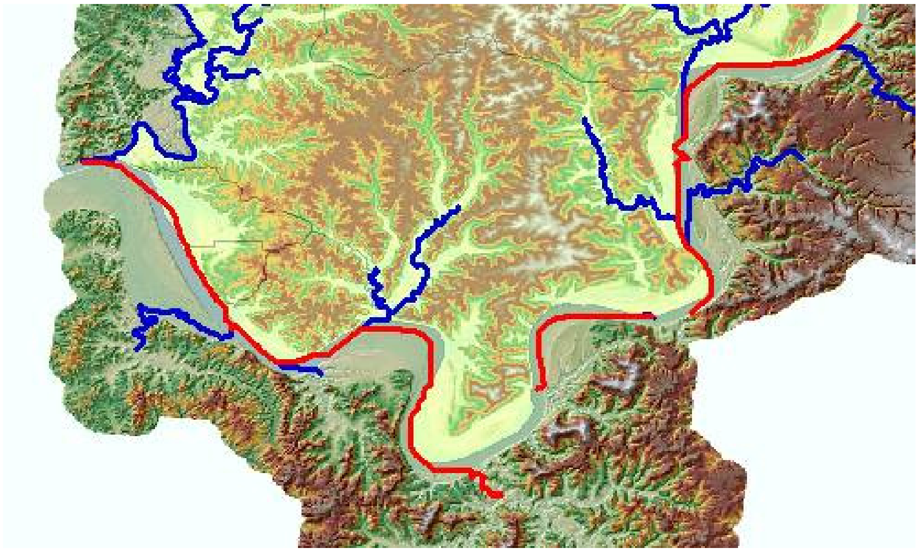


Figure 3.62 Discontinuous Synthetic Stream

The solution to this discontinuity is to include counties on both sides of the river during study region creation. This in turn will result in a larger DEM that drains to both sides of the river. Figure 3.63 illustrates this concept, using the same stream as shown in Figure 3.62. The second study region consisting of counties on either side of the river (shown in red). The resulting synthetic stream network is now continuous.

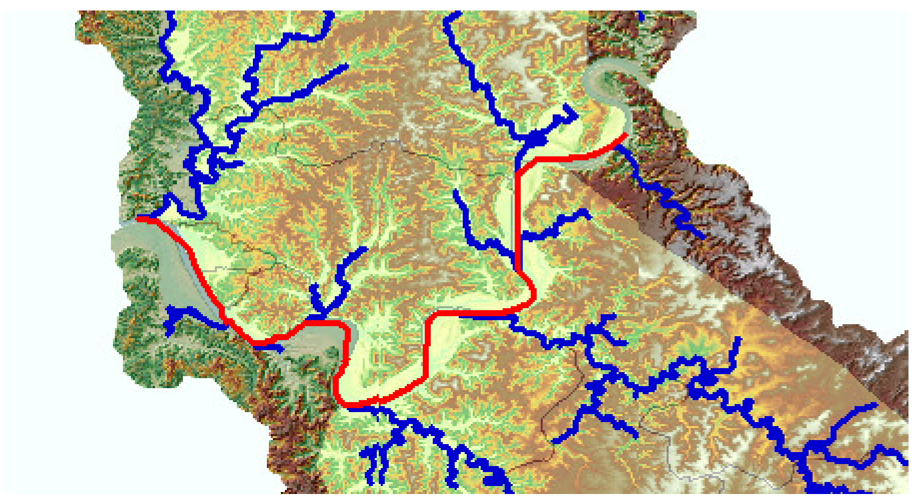


Figure 3.63 Continuous Synthetic Stream

3.3.6.2 Defining a Scenario

Next, select *Scenario* under the *Hazard* menu, and select *New*. A scenario defines the specific stream reaches, or lengths of coastline for coastal users, and the hydrologic and hydraulic characteristics that you wish to include in one analysis run. A scenario could include all stream reaches in your study region, but because the analysis requires significant computer processing, you may wish to divide the region into several smaller scenarios.

You will be prompted with a window to name your scenario and, optionally, write a description. Be careful not to include any leading or trailing spaces in the scenario name. When opening scenarios in the future, your description will be visible to help you differentiate between similar scenarios. Figure 3.64 shows an example of the scenario-naming dialog.

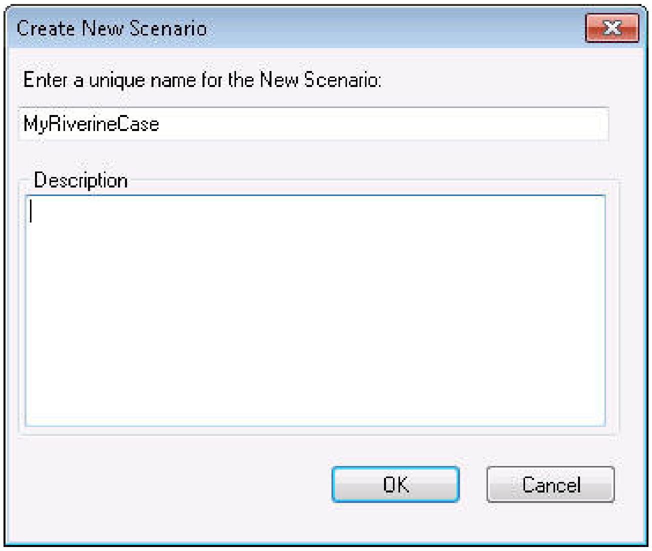


Figure 3.64 New Scenario Naming

After naming the scenario, a window will open enabling you to select which stream reaches you would like to include in the scenario, shown in Figure 3.65. Select the map layer type (radio button) and use the *Add to selection* tool (the button with the plus icon) to select particular features by clicking on them, or to drag a box and select features (in this case, stream reaches). If you hold down the shift key, you can add or remove additional features to your selection by clicking on them. Once you have selected the features you want to include, which will be highlighted, click on *Save selection*.

After selecting the features in the map layer, users must select *Save selection* for each specific map layer type. For example, a user wants to create a scenario with river reaches, coastal shorelines, and FIT analysis areas. The user must do the following: 1. Select *River reaches* radio, select *Add to selection* button, select reach(es), click *Save selection*. 2. Select *Coastal shorelines* radio, select *Add to selection* button, select shoreline(s), click *Save selection*. 3. Select *FIT analysis areas* radio, select *Add to selection* button, select FIT area(s), click *Save selection*. Click *OK*.

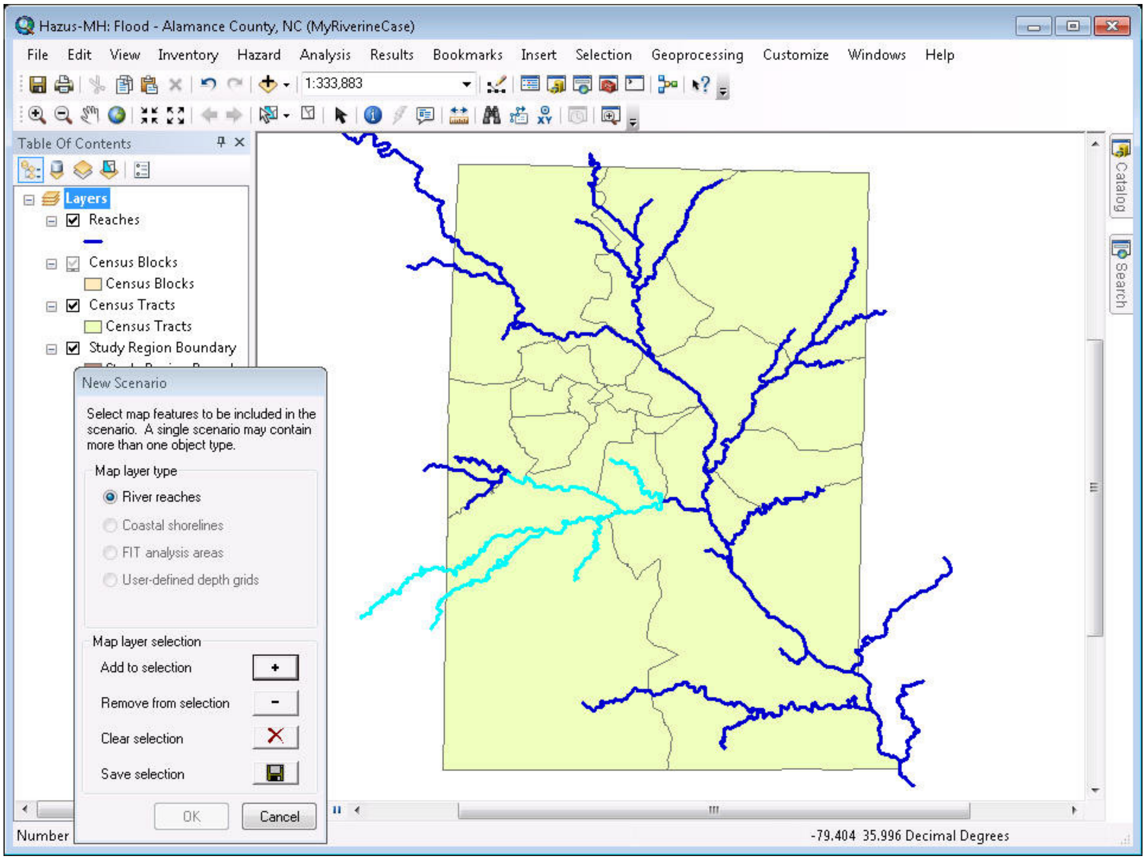


Figure 3.65 Selecting River Reaches for a Scenario

After you save the stream reaches you have selected, you can press *OK* to complete the definition of the scenario. The color of the highlighting of the selected reaches will change when this process is complete.

If you have imported any FIT data and/or flood depth grid(s), you can select those areas by clicking on the FIT analysis areas and/or the User-defined depth grids radio buttons. Select and save FIT areas and/or flood depth grids in the same manner as reach selection.

If more than one FIT area and/or flood depth grid was selected for the scenario, the dialog will expand to show the list of selected FIT areas and/or flood depth grids (in their respective radio button) selections, as seen in Figure 3.66. Users can select one or more FIT areas and/or depth grids for their scenario.

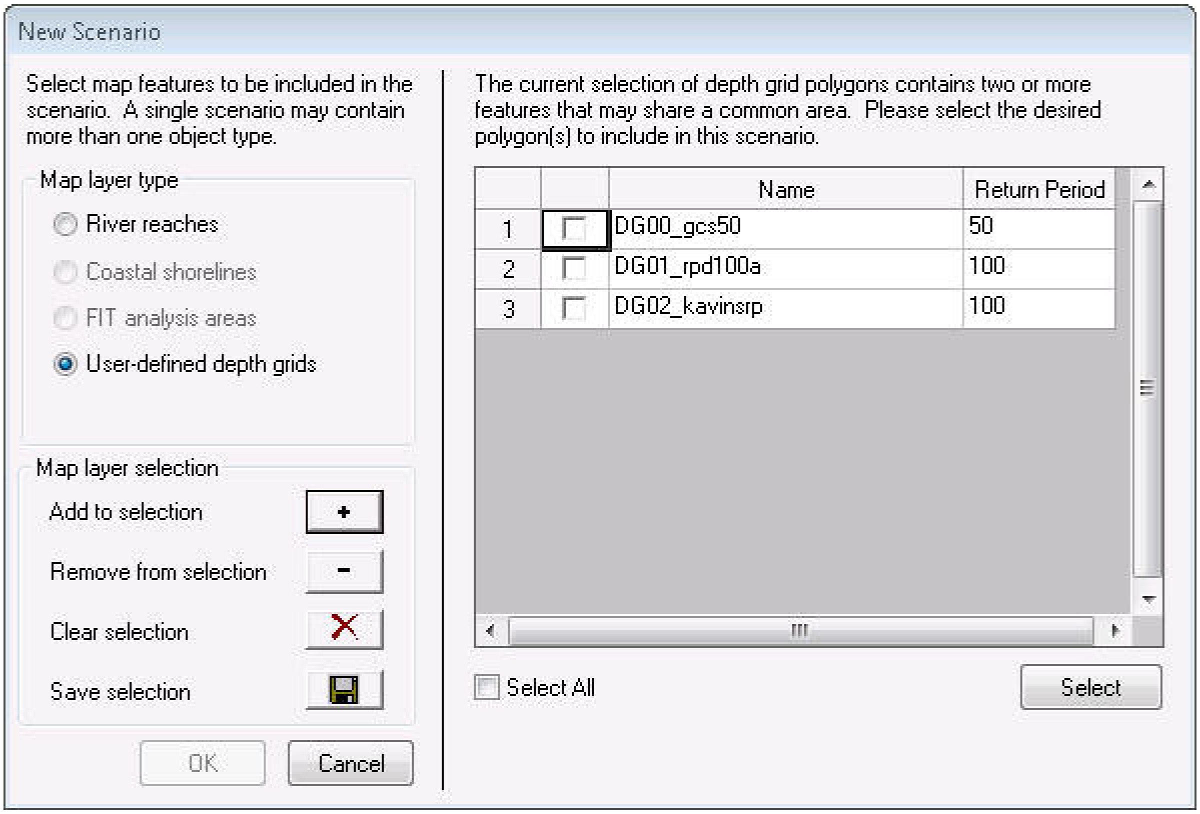


Figure 3.66 Selecting Single/Multiple FIT/UDG for a Scenario

The Scenario "Save As" capability was created to allow users to skip the hazard analysis every time they wanted to run different parameters in the Inventory or Analysis menu. It is designed to save time for the user so that they can skip the hazard portion and rerun Analysis. It also gives the user a way to preserve previous results without using the Duplicate Study Region function, which requires much more disk space. The results tables are Scenario specific and the creation of a new scenario through the "Save As" function assumes the user wants new results. Therefore, the old results are not carried over.

In order to use the "Save As" capability, the scenario to be saved needs to be open. The user then selects "Save As" from the Scenario selections under the Hazard menu, as seen in Figure 3.67.

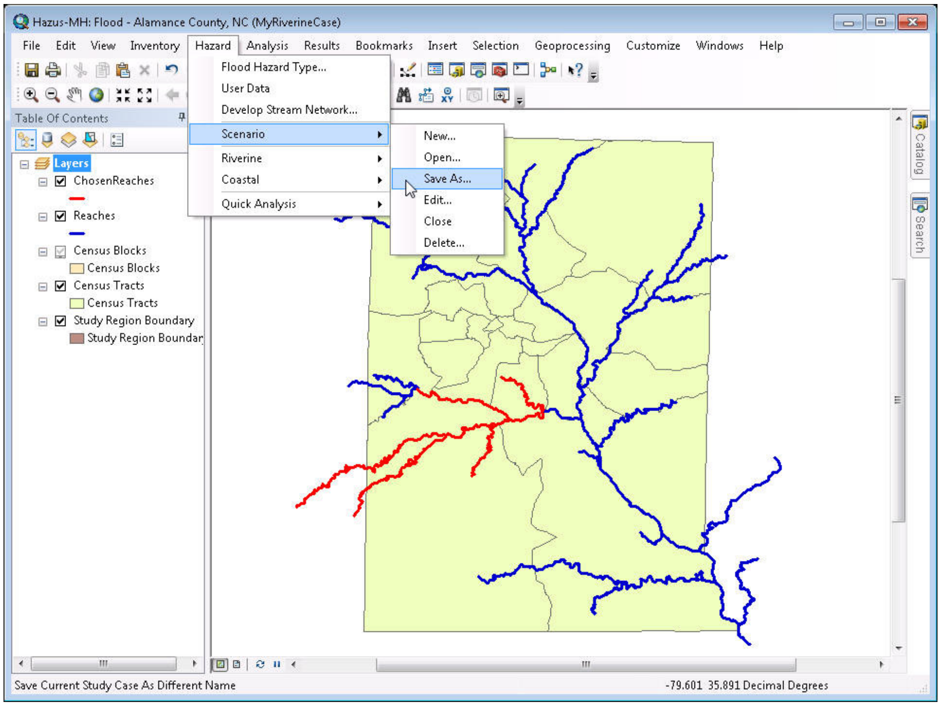


Figure 3.67 Scenario "Save As" Menu

You will be prompted with a window to name your new scenario and, optionally, write a description. Figure 3.68 shows an example of the Scenario Save As naming dialog.

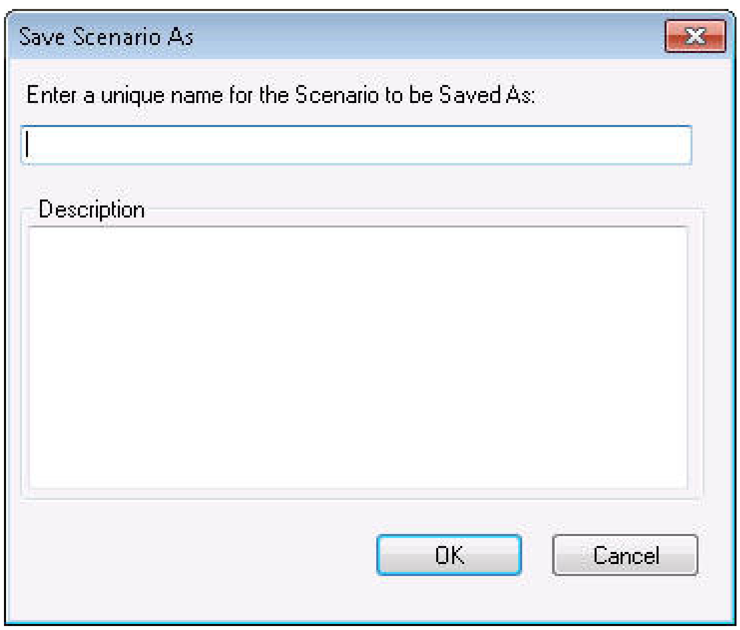


Figure 3.68 Scenario "Save As" Naming

After clicking OK, Hazus will save the old scenario and automatically open the new scenario.

When a user modifies the Inventory, he/she is affecting all future results, meaning that any analysis from that point on will use the updated inventory. It is recommended that if the Inventory is modified, the Analysis should be rerun. Users that plan on modifying the inventory should "duplicate" the Study Region to compare results, otherwise the results are overwritten. The results will be overwritten if and only if the user reruns Analysis on the same scenario.

Users that plan on modifying the functions/parameters in the Damage & Loss Estimate Analysis should use the Save As capability to compare results between scenarios, otherwise they are overwritten. The changes to damage functions are per Study Region, so the user is responsible for knowing what damage functions were used to create the results of which scenario. The user will not have a way of displaying which damage functions were used for each scenario.

Users that plan on modifying the Hazard analysis do not need to use the Save As capability. However, there are a few cases that need to be taken into consideration.

- <u>Mix grid</u>: Mix grids are created when Hazus does not know what return period to assign to the grid, such as the case of running specific discharge analysis or assigning different return periods to different reaches in a single scenario. If a user is dealing with a mix case and reruns the Hazard by changing some parameters (return period of one or more reaches, or the discharges), the changes to the depth grid and floodplain polygon due to this rerun will not be reflected in the Analysis results until the Analysis is reran.
- <u>Edits to scenario</u>: If a user reruns the Hazard by adding or subtracting at least one reach from the scenario but uses the same return period, the user should rerun the Analysis so that the results would reflect the changes in the Hazard.
- <u>FIT/User Depth Grids/.FLT Depth Grids</u>: FIT results can only be modified in FIT. Inside the Flood model, the only option available to the user in terms of modifying FIT/User Depth Grid/.FLT Depth Grid results is the ability to choose which FIT Areas/User Depth Grid/.FLT Depth Grid polygons to include in the scenario. If that kind of modification is done to the Hazard, the user should rerun the Analysis so that the results reflect the changes in the Hazard.

In all three cases, if the user reruns the Analysis without using the Save As capability, the previous results will be lost.

The Scenario "Delete" capability was designed to allow users to delete scenarios that are no longer needed. The "Delete" function allows users to delete multiple scenarios all at once by simply clicking on the scenarios.

In order to use the "Delete" capability, the scenario to be saved needs to be open. The user then selects "Delete" from the Scenario selections under the Hazard menu, as seen in Figure 3.69.

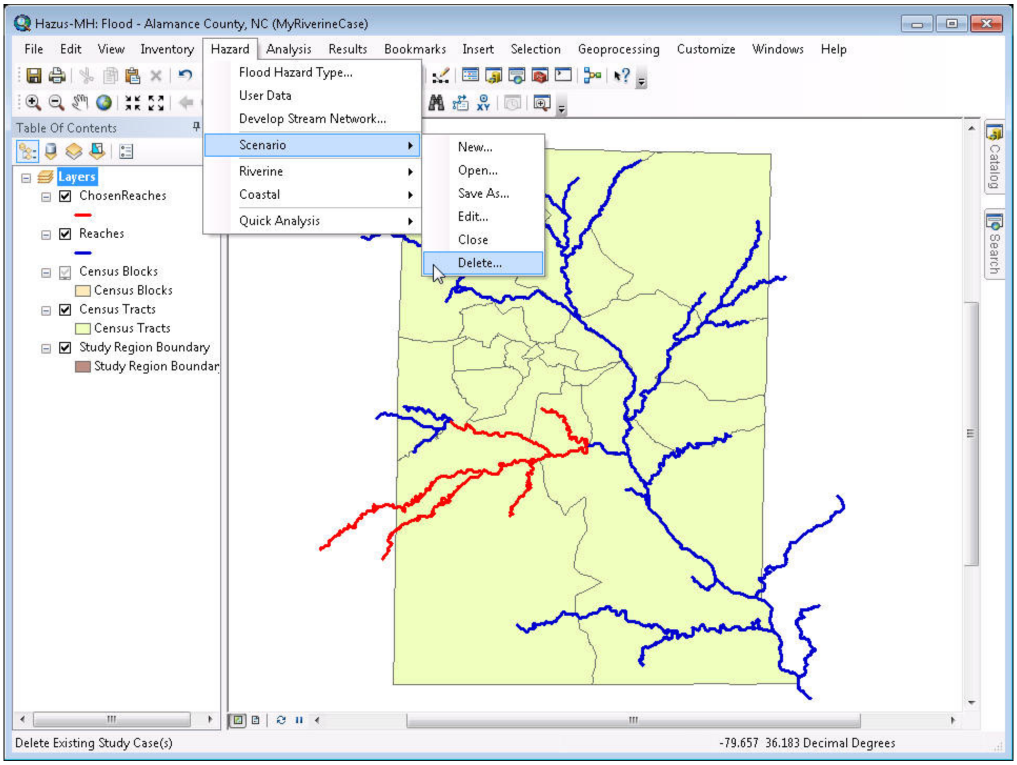


Figure 3.69 Scenario "Delete" Menu

You will be prompted with a window that shows all scenarios that have been created for the study region. Figure 3.70 shows an example of the Delete Scenario dialog.

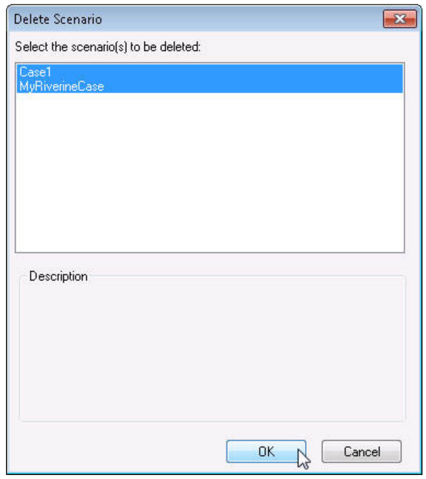


Figure 3.70 Delete Scenario

Select scenario(s) to be deleted by clicking on the scenario name and click OK.

3.3.6.3 Hydrologic Analysis

Once you've defined your scenario, the *Hydrology* option from the *Riverine* submenu becomes enabled. Selecting this submenu option will launch the hydrologic calculations for the scenario stream reaches that you have selected. These calculations will take some time, which will vary by the number and characteristics of the stream reaches selected and computer processing speed. The Flood Model has a status bar that allows the user to track the percentage of completion of the analysis. **Hazus** will notify you when the calculation is complete.

There is a tendency for ArcMap and Hazus to experience memory leaks that can lead to failure of the model to complete its analysis. Since the hydrology analysis is study region specific and is dependent only on the river network developed by the user, there are options available to reduce the possibility of the code reaching a memory limit.

In the case of hydrology, it is recommended that the user perform the hydrology analysis on a watershed-by-watershed basis, thereby limiting the level of effort within the model. There are two recommended approaches:

- Create a scenario for each watershed and perform the hydrology analysis on each scenario. The hydrology results are stored in a single table independent of scenario, or

- Create a single scenario, start with one watershed and perform the hydrology analysis. When completed, edit the scenario, add the next watershed and rerun the hydrology analysis. The model will skip those reaches that already have had the hydrology analysis performed and will perform the analysis on the added reaches. Repeat as needed to complete all watersheds in the study region.

Hydrologic analysis is only important if you wish to perform frequency-related flood analyses (i.e., 100-year return period, annualized loss, etc.). If you have a specific discharge to apply to your reach(es), proceed directly to the Delineate Floodplain (Riverine) menu item and select Single Discharge.

When running hydrologic analysis, the Hazus screen might go blank or the Task Manager "Applications" tab will indicate that Hazus is not responding. This is a common symptom for any software that is process heavy. In order to check if Hazus is still running, users should check the Task Manager "Processes" tab and sort the "CPU" column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99-100%, this is a clear indication that Hazus is not responding. Users could also check the "Performances" tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the study region folder (in "Details" view) and make sure the FlHydrologyLog is updating by looking at the "Date modified."

3.3.6.3.1 Excluding Problem Reaches from Scenario

Problem reaches are reaches for which regression equations and/or data are not available. When computing the flood hazard, analysis for a specific return period or suite of return periods will not be available for reaches designated as ProblemReaches. Input of discharges will be required to develop the flood hazard grids for ProblemReaches.

Users have the option to set Hazus to automatically remove problem reaches (if they exist) from the scenario after the hydrologic process by checking the checkbox under Customize > Flood Options, as seen in Figure 3.71.

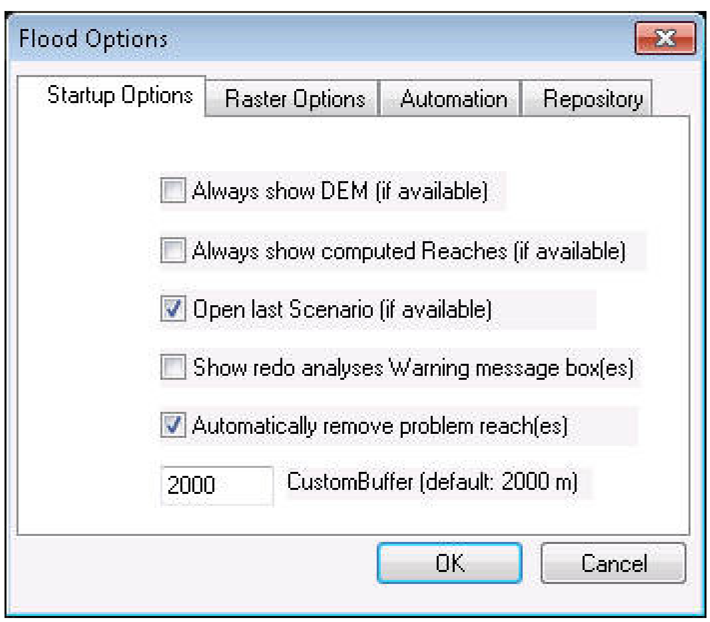


Figure 3.71 Flood Options, "Automatically remove problem reach(es)" Checked

If the user does not select to automatically remove problem reaches from the scenario, at the end of the hydrologic process, a message will notify the user that problem reaches exist in the scenario and gives the option to remove the problem reaches from the scenario (with the click of one button), as seen in Figure 3.72.

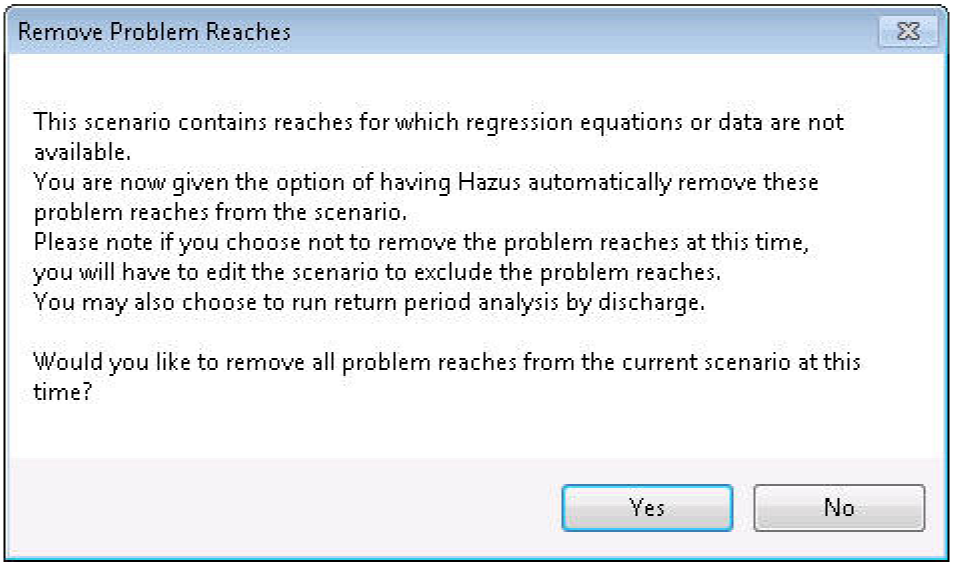


Figure 3.72 Notification and Option to Remove Problem Reaches

If the user selected 'No" in Figure 3.72 and later decide they want to remove problem reaches, users can manually edit the scenario to exclude problem reaches by editing the scenario. This only applies to cases where the problem reaches exist in the scenario.
Click on the Hazard menu, Scenario > Edit. The Scenario Edit dialog will open and all of the reaches in the scenario will be highlighted in light blue. Click on the "Remove Problem Reaches" button (as seen in Figure 3.73), all of the problem reaches will be de-selected, and then click on the "Save selection" button. After the user clicks "OK", the new scenario will be mapped, shown in Figure 3.74.

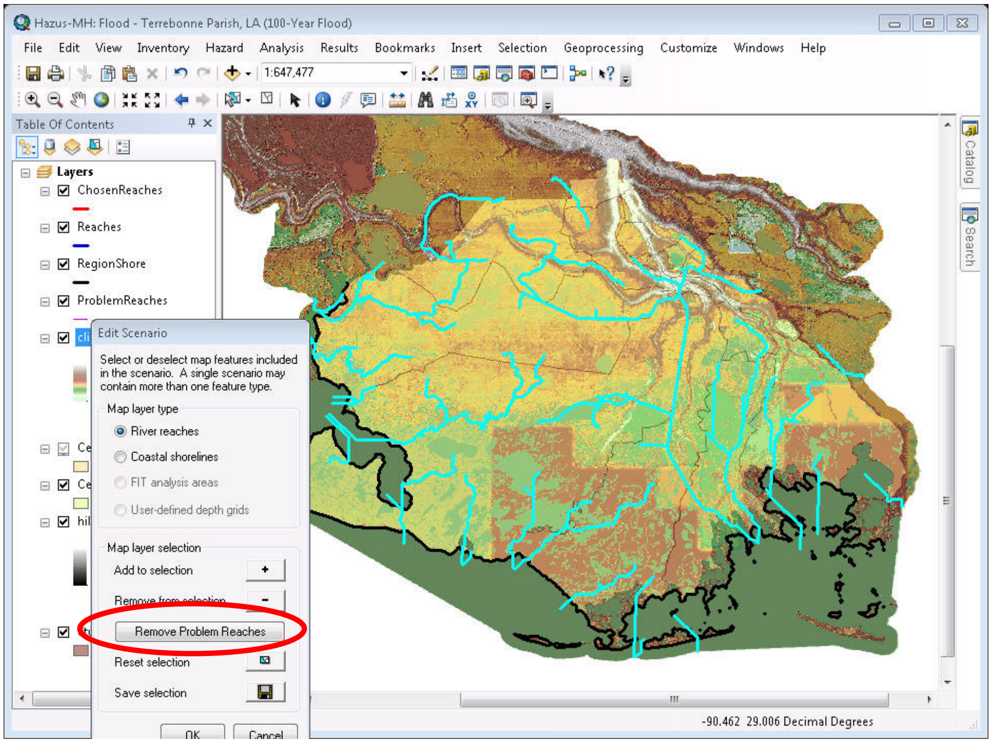


Figure 3.73 Edit Scenario Dialog to Remove Problem Reaches

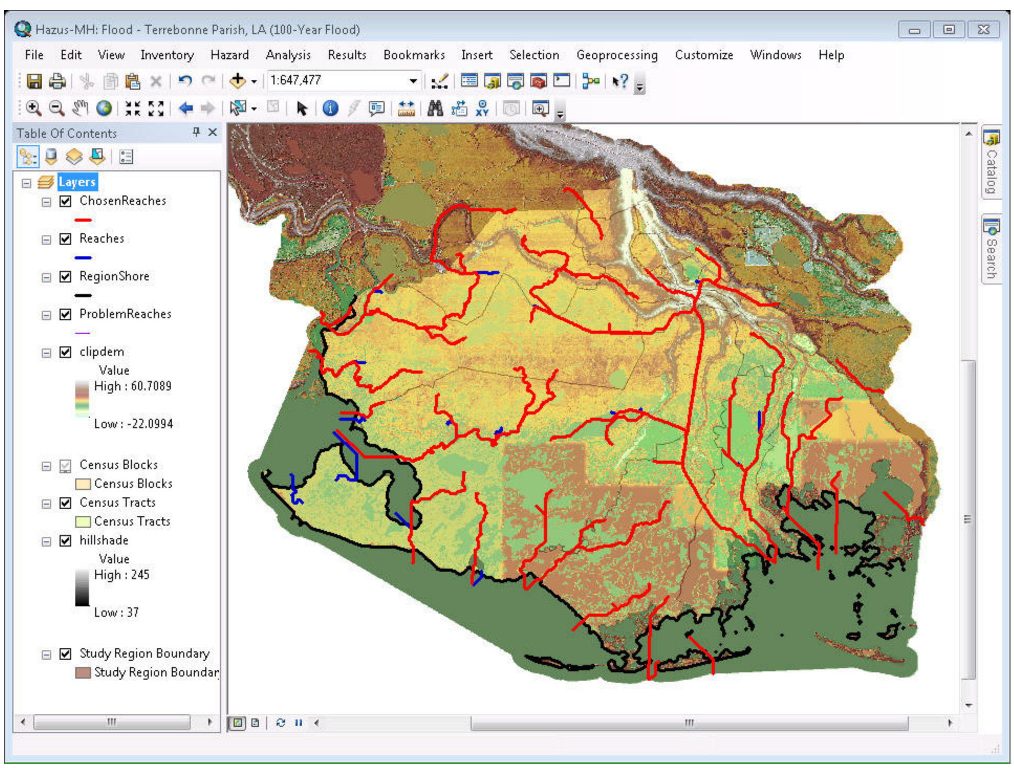


Figure 3.74 Edited Scenario with Problem Reaches removed

If the Scenario is a riverine/coastal scenario, the Shoreline Characterization dialog will appear after edits are made to the scenario. The original parameters that were set for the shoreline(s) are saved if shoreline(s) weren't added/removed to the scenario. Users can select the 'Next' and 'Finish' buttons if they do not wish to modify the existing parameters.

The Scenario is now ready to start Hydraulics (Riverine\Delineate Floodplain) for the ChosenReaches. **(The Hydrology does not need to be rerun since Hazus has already computed discharges for non-ProblemReaches. If Hydrology is rerun, the results will remain the same since the ProblemReaches have been removed from the Scenario).**

3.3.6.4 Delineate Floodplain - Riverine Hazard

Once the hydrologic calculations are completed, the *Delineate Floodplain* submenu option on the *Riverine* submenu on the *Hazard* menu becomes enabled. Select this submenu option, and the window shown in Figure 3.75 will appear. From the pull-down menu, you can select the type of hazard analysis you would like to run. At the bottom of the window, Hazus will indicate how much virtual memory is available on the machine and the estimated virtual memory that will be used for the hydraulic analysis. If the text is in red, as seen in Figure 3.75 the hydraulics process will need more memory than what is available. If this occurs, it is recommended that users remove reaches from the scenario.

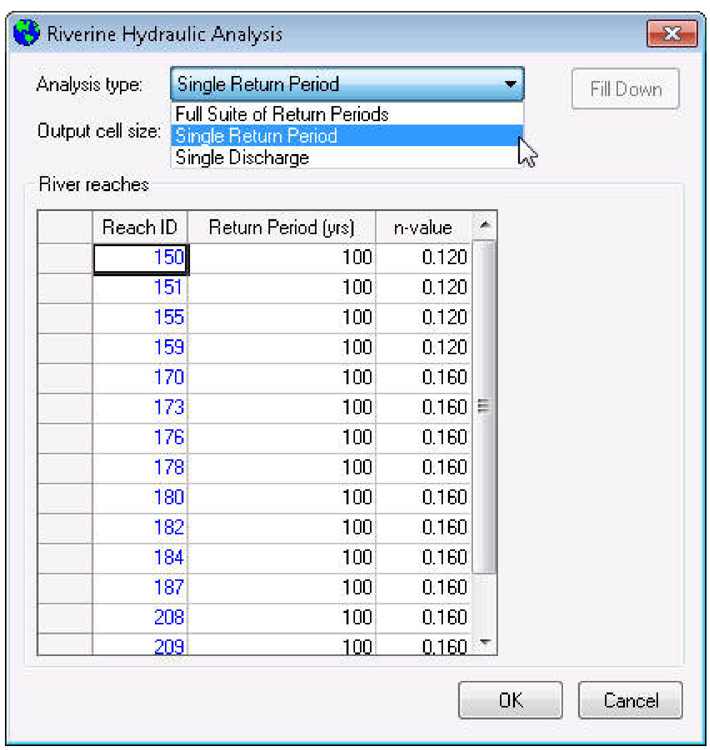


Figure 3.75 Calculate Hazard Window

1. Selecting *Full Suite of Return Periods* will calculate flood depths and floodplains for the 10-year, 25-year, 50-year, 100-year, and 500-year return period floods on each of the stream reaches in your scenario. The Flood Model will produce a single 10-year flood depth grid for the entire group of selected reaches. This process is duplicated for the other four return intervals.

2. Selecting *Single Return Period* lets you specify a return period between 10 years and 500 years for which the flood characteristics will be calculated. You can choose different return periods for different stream reaches, if you wish. Depending on the user selection, the resultant grid will be a single return interval for all reaches selected by the user, similar to option 1 above, or a single grid of mixed return intervals for the selected reaches.

3. Selecting *Single Discharge* allows you to input anticipated stream discharge levels for each stream reach. Similar to *Single Return Period*, the user can enter different discharges for each reach.

If the user opts to run different return intervals or specific discharges for each reach in their scenario, the Transportation Bridge analysis cannot be run as the return interval for the reaches in question needs to be known.

This completes the hazard definition for the riverine analysis. When performing a mixed case analysis (riverine and coastal), the user will need to perform the steps outlined in this section for the riverine portion of their analysis. The next section will define how to operate the Flood Model for the coastal analysis. Please feel free to skip this section and read about the *Analysis* and *Results* functionality.

When running hydraulic analysis, the Hazus screen might go blank or the Task Manager "Applications" tab will indicate that Hazus is not responding. This is a common symptom for any software that is process heavy. In order to check if Hazus is still running, users should check the Task Manager "Processes" tab and sort the "CPU" column in descending order. The "CoreOfHydraulics.exe" process should be on top. If the "System Idle Process" is constantly on top at 99-100%, this is a clear indication that Hazus is not responding. Users could also check the "Performances" tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the scenario folder (in "Details" view) and make sure the FlHydraulicsLog is updating by looking at the "Date modified."

Cell sizes are obtained from the DEM, FIT, user-defined depth grids, and/or HEC-RAS .FLT depth grids, depending on what is being used in the scenario. From the pull-down menu, you can select which cell size will be used for the final depth grid (if more than one is available).

Using a smaller cell size could dramatically increase the processing time and the size of the output raster. Also, using a smaller cell size in areas that had a larger cell size ***does not*** increase the accuracy of the depth grid, it will just preserve the high accuracy in the areas that had small cell sizes. On the flip side, using a larger cell size will result in a faster processing time, but will cause the user to lose the higher accuracy in the areas that had small cell sizes.

3.3.6.4.1 Reaches with Hydraulic Problems

As the user is running the hydraulics (i.e. Delineate Floodplain), the user might notice that it is taking a long time. It is possible that the hydraulic process is hanging (stuck on a couple of reaches and cannot finish hydraulics). The following are instructions to go around the problem.

1. Look in the log (flHydraulicsLog.txt located in Scenario folder) and note any reaches (ReachID) that have many errors and did not successfully complete processing. Example below:

```
: -----------------------------------------------------------------------
 : ReachID: 202            Core of Hydraulics
: -----------------------------------------------------------------------
modLevelOne - CoreOfHydraulics: Reach 100 of 267
modLevelOne - CoreOfHydraulics: Return period: 100
modLevelOne - CoreOfHydraulics: What-if:
modLevelOne - CoreOfHydraulics: Available memory: 1631.05 mb
modInitialBuffer - InitBuffer: Reach length = 0.2 km
modInitialBuffer - InitBuffer: Reference (downstream node) discharge: 3,981 cfs
modXSections - PlaceInitXsects: Short centerline length: 964.462826043346 feet
modXSections - PlaceInitXsects: Buffer 3 of 9
modXSections - PlaceInitXsects: Buffer 4 of 9
modXSections - PlaceInitXsects: Buffer 5 of 9
modXSections - PlaceInitXsects: Buffer 6 of 9
modXSections - PlaceInitXsects: Buffer 7 of 9
modXSections - PlaceInitXsects: Buffer 8 of 9
modXSections - PlaceInitXsects: Buffer 9 of 9
modXSections - PlaceInitXsects: Cross section count: 3
modXSections - InitialXSectElevs: Drainage area reset from 219.9631 to 140.0594
modXSections - InitialXSectElevs: Drainage area reset from 220.2029 to 140.0594
GeometryToFeatureClass: Feature class: LeftBuffer
GeometryToFeatureClass: Feature class: RightBuffer
modGeometry - CleanPolygonIslands: Input geometry is nothing, leaving early.
ModBoundsandEnds - ValidateFloodPolygon: Error Number: 91
ModBoundsandEnds - ValidateFloodPolygon: Error: Object variable or With block variable not set
modGeometry - CleanPolygonIslands: Input geometry is nothing, leaving early.
modGeometry - IntersectABS: Input geometry #1 is invalid. No intersection.
modLimits - NewLimitsandCenterlines: Error Number: 91
modLimits - NewLimitsandCenterlines: ERROR: Object variable or With block variable not set at 8
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modWsePts - FinalWsePts: Error Number: 5
modWsePts - FinalWsePts: ERROR: Invalid procedure call or argument at 2
modLevelOne - CoreOfHydraulics: WARNING: FinalWsePts failed, continuing process using points from InitialWsePts and/or IncreaseWsePts
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 45
modAddBack - AddBack: Entering
modAddBack - FillDEMMask: Error Number: 91
modAddBack - FillDEMMask: ERROR: Object variable or With block variable not set at 4
modAddBack - AddBack: Error Number: 91
modAddBack - AddBack: ERROR: Object variable or With block variable not set at 5
MakePermanent: Entering for grid: 202
MakePermanent: Path: C:\Program Files\HAZUS-MH\StudyRegion\PSchneider_NV5County\Hydraulics\Reaches\100
MakePermanent: Leaving
modAddBack - AddBack: Leaving
GeometryToFeatureClass: Feature class: 202_cl
ExportGDBFClass: Error: Featureclass Reach202ConvPGRP100 not found.
modLevelOne - CoreOfHydraulics: Leaving
```

2. Open the Attribute Table for the ChosenReaches layer
3. Search for the reach using the ArcID and highlight/select the problem reach
4. Right click on the line of the selected reach and select "Zoom to Selected" as seen in Figure 3.76 below.

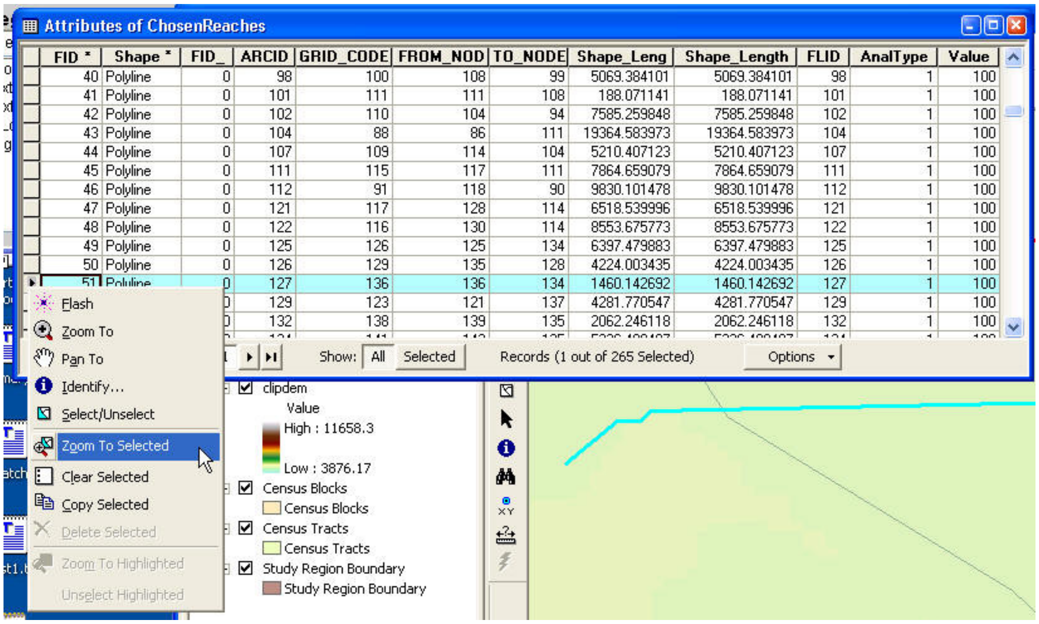


Figure 3.76 ChosenReaches Attribute Table, "Zoom to Selected" reach

5. The map will now zoom into the reach selected. Keep zooming out of the map to properly locate where the selected reach is on the map as a whole. Keep in mind what the reach looks like.

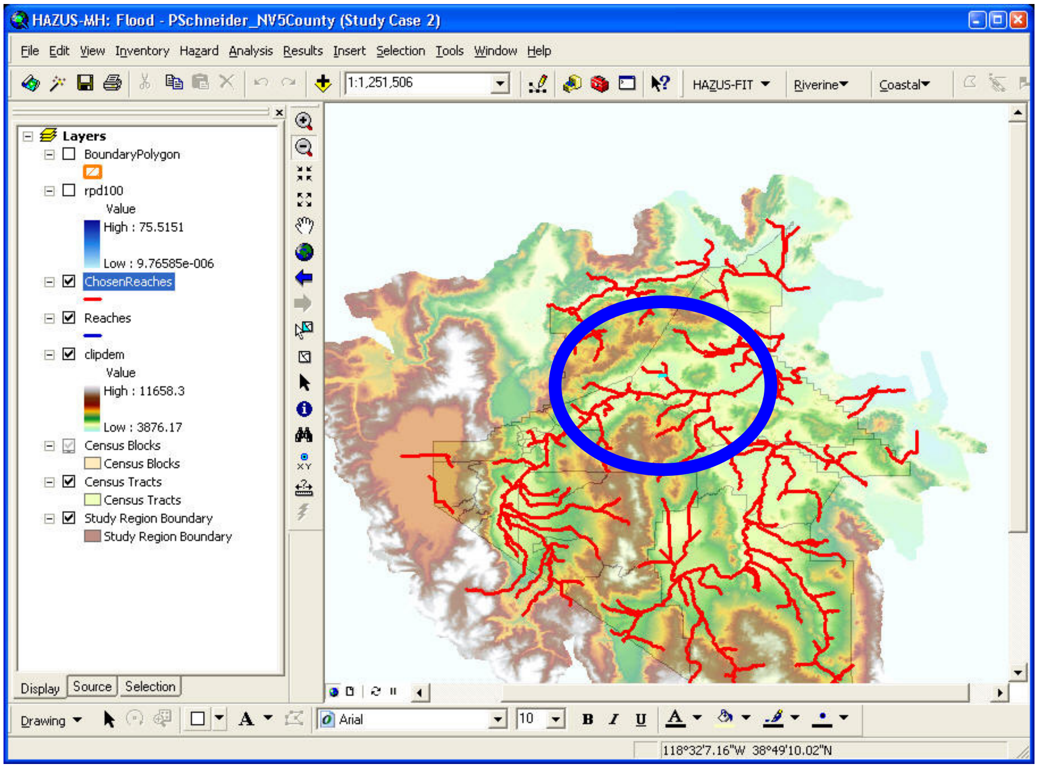


Figure 3.77 Selected ChosenReach (highlighted), Zoomed Out

6. Click on the Hazard menu, Scenario, Edit.
7. Once the Edit tool is available, zoom in to the area where the problem reach is located.
8. Click on "Remove from selection" in the Edit tool and select the problem reach. The reach selected will no longer be highlighted in light blue and will be highlighted in red.
9. Click on "Save selection" in the Edit tool.
10. After the selection has been saved, the problem reach will appear to be dark blue and is excluded from the scenario.
11. Click "OK" in the Edit tool.
12. If the Scenario is a riverine/coastal scenario, the Shoreline Characterization dialog will appear after edits are made to the scenario. The original parameters that were set for the shoreline(s) are saved if shoreline(s) weren't added/removed to the scenario. Users can select the 'Next' and 'Finish' buttons if they do not wish to modify the existing parameters.
13. The Scenario is now ready to re-start Hydraulics (Riverine\Delineate Floodplain) for the ChosenReaches. **(The Hydraulics will automatically rerun any reaches that did not successfully process in the previous run, skip any reaches that have been successfully processed, and then will continue on the last reach processed).**

3.3.6.4.2 Failed Reaches

Failed reaches are reaches that have been processed in the hydraulics process, but for some reason, do not produce a flood depth grid. A message will notify the user when a reach fails during the hydraulics process, as seen in Figure 3.78. Click on the "Close" button and the hydraulics process will continue processing the next reach in the queue. The "FailedReaches" layer will appear on the map after the hydraulics process completes, as seen below in Figure 3.79.

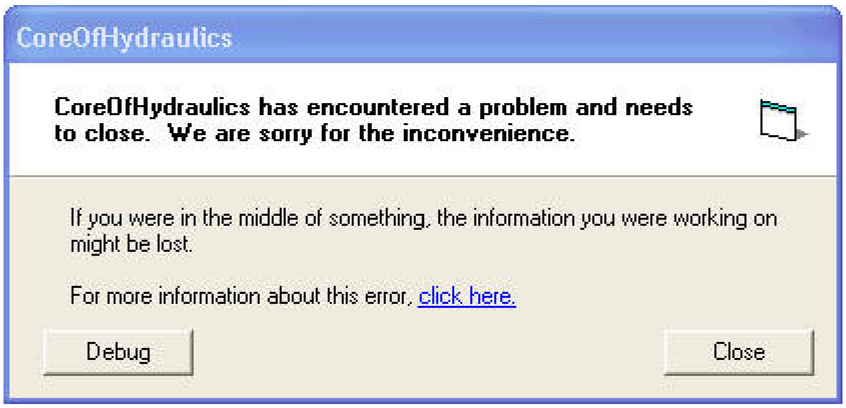


Figure 3.78 CoreOfHydraulics Error Message

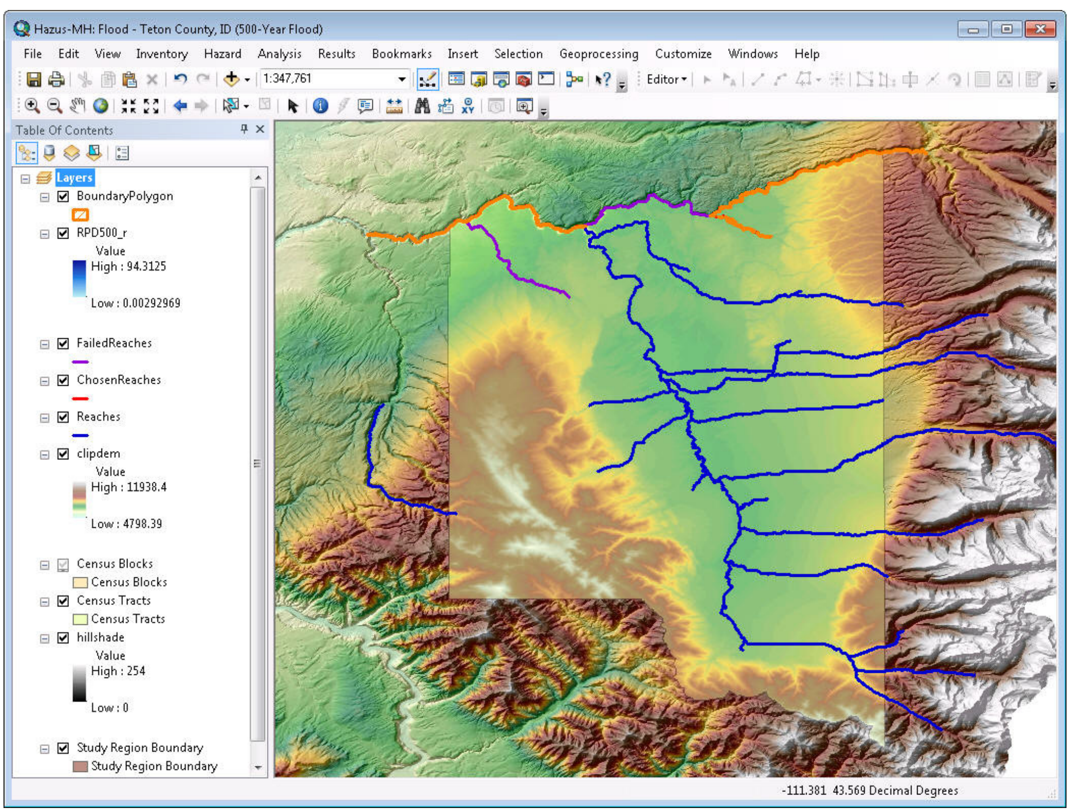


Figure 3.79 FailedReaches (purple) on Map after Hydraulics Completed

The hydraulics process should complete even if there are failed reaches. The only reason the hydraulics process will not complete is if a failed reach causes the hydraulics process to hang. If the hydraulics process hangs, users are recommended to refer to the section above, 3.3.6.4.1 Reaches with Hydraulics Problems.

When running the analysis on a scenario with failed reaches, the analysis will process in areas where the depth grid exists.

3.3.6.5 Riverine Automation

The riverine automation feature allows users to set the parameters for a riverine scenario to run from stream network through GBS analysis. There are two requirements that need to be fulfilled before users can set the riverine automation parameters. Selection of *Riverine Only* or *Riverine and Coastal* on the Hazard Type dialog will enable the riverine automation to run, however the automation feature is for riverine-only scenarios. The user is then required to input the DEM and process it in Hazus.

To perform the riverine automation analysis, the user should perform the following steps:

1. Select *Flood Options* from the *Customize* menu (as shown in Figure 3.80).

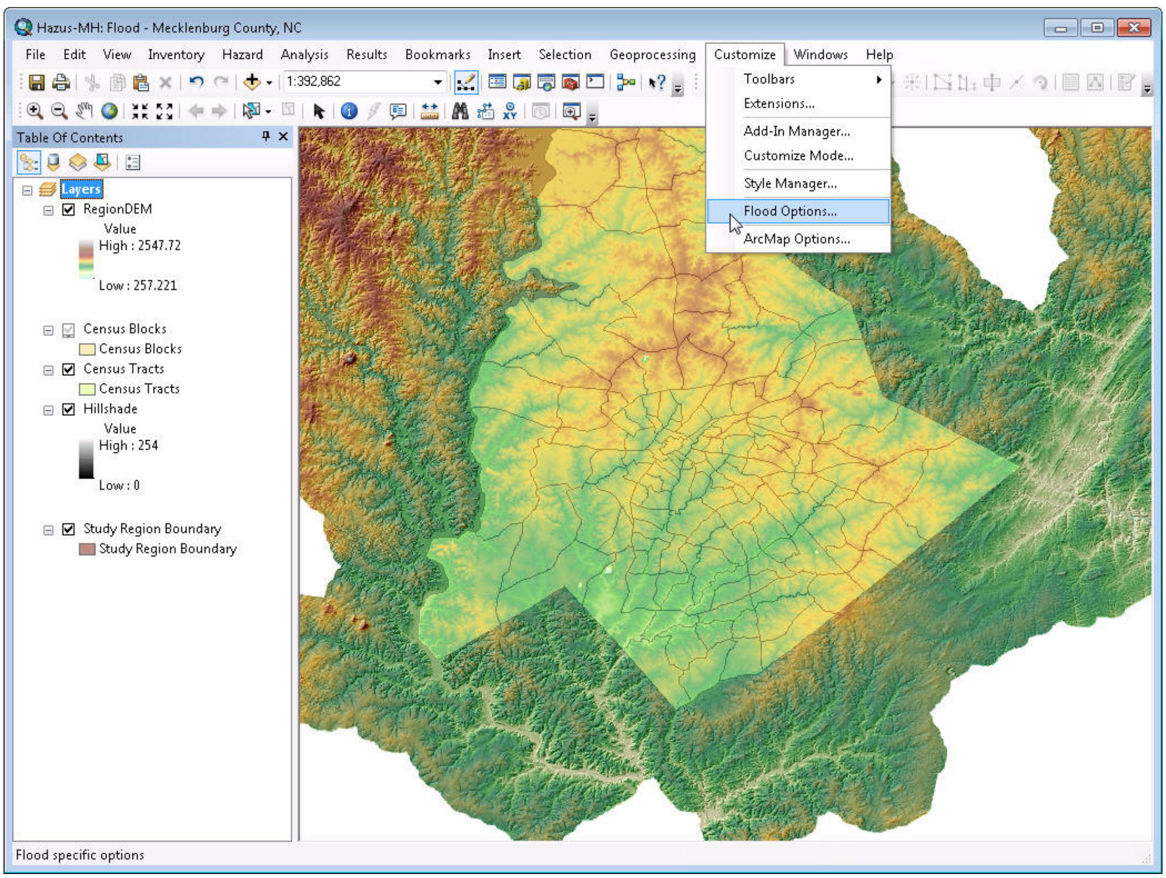


Figure 3.80 Select Flood Options

2. Navigate to the Automation tab. The user needs to set the parameters required to run the automation, as seen in Figure 3.81.

    a. Select "Run Automation" checkbox.

    b. Set drainage area for study region

    c. DEM Path is automatically included based on the previous DEM analysis. Editing the path will have no effect on the DEM or DEM path.

    d. Input scenario name (the name must be unique). All reaches that are developed by the stream network will be selected and included in the scenario.

    e. Select return period. If the user selects the Single return period, Hazus will run through the GBS analysis. If the user selects the Suite option, Hazus will run through the GBS analysis *and* the AAL analysis.

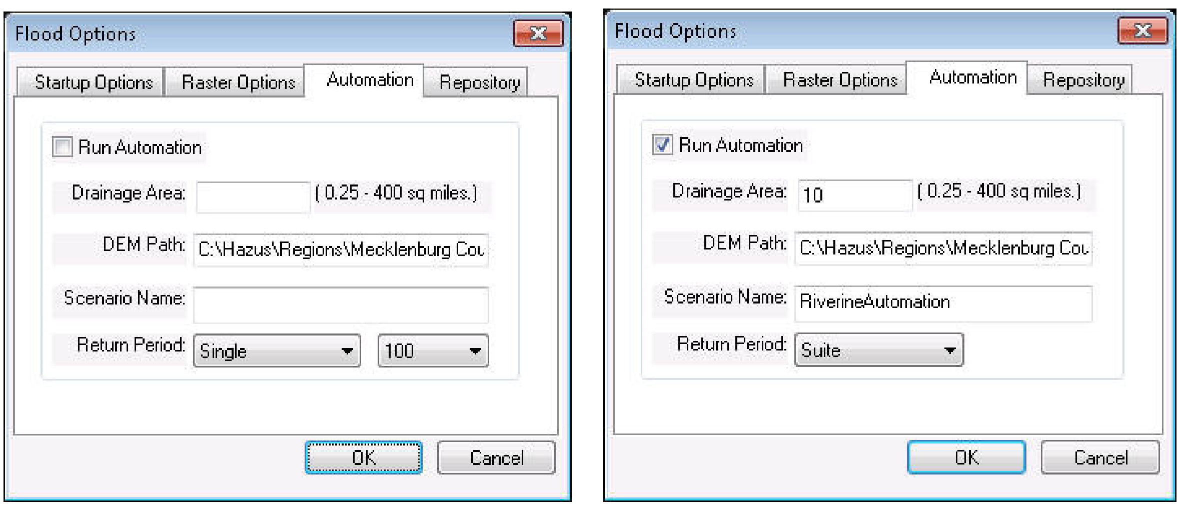


Figure 3.81 Automation tab, before and after parameter input

3. Select *OK* and Hazus will run the automation. Once complete, Hazus will notify that the analysis is complete. GBS results are available to view.

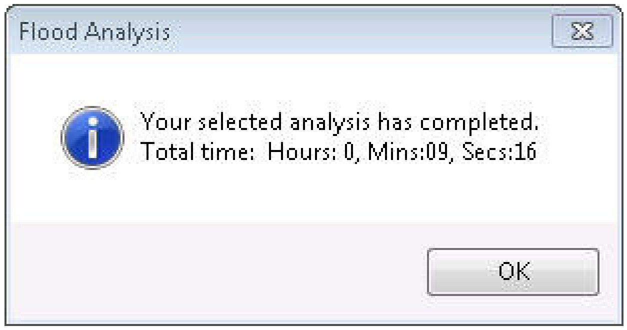


Figure 3.82 Automation Complete

3.3.7 Coastal

If the flood hazard of concern is coastal, you will not be required to generate a stream network or run the hydrologic analysis. You will still be required to obtain and identify the Digital Elevation Model to be used in the analysis. The extent of the DEM necessary for coastal is different from that required for riverine. The necessary DEM is determined by the union of the region shoreline with the study region boundary.

Once the DEM has been added (see Section 3.3.3 and Section 3.3.4) the user can move directly to defining a scenario by selecting *New* from the *Scenario* submenu and the *Hazard* menu. As with the riverine analysis, the user is required to enter a name and, if desired, a description for the scenario, and click **OK** as seen in Figure 3.83 below.

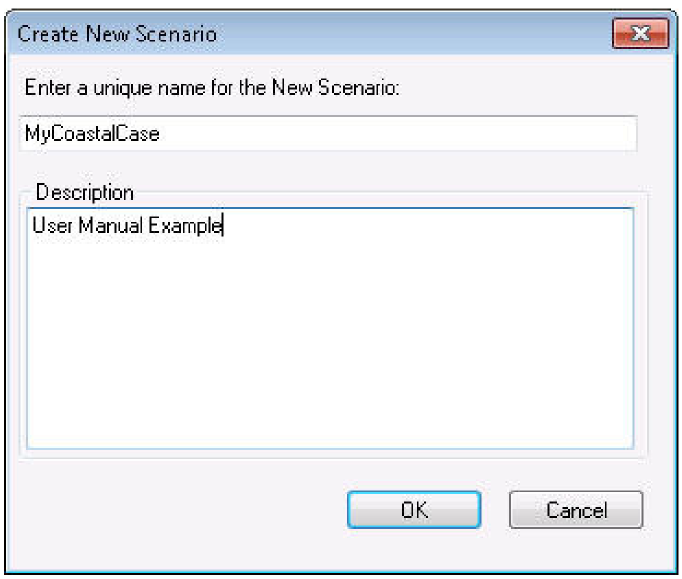


Figure 3.83 New Scenario (Coastal)

After the user has specified the scenario name and clicked on **OK**, the window shown in Figure 3.84 will emerge. Like the riverine model, the user will be asked to select a shoreline or shorelines for analysis. The Flood Model uses a standard GIS selection tool to allow the user to select the shorelines and the user should click on the select icon and proceed to either click on the shoreline or draw a box to select more than one shoreline.

To select discontinuous shorelines such as islands, the user can press the Shift key while selecting additional shorelines. To deselect shorelines, the user can press the Shift key and click on the shorelines that are not to be included in the selected shorelines.

Hazus has a built-in default national shoreline that is delineated by county. In study regions that are sub-county or a combination of multiple sub-counties, all of the associated shorelines of the counties will be brought in. This is by design and it is to account for the fact that coastal flooding at a specific location does not necessarily originate from the closest shoreline to that location.

The Flood Model has shorelines for mainland areas, barrier islands, large islands, small islands and the Great Lakes. These shorelines have been smoothed to allow the Flood Model to build shore normal transects in a less time consuming fashion.

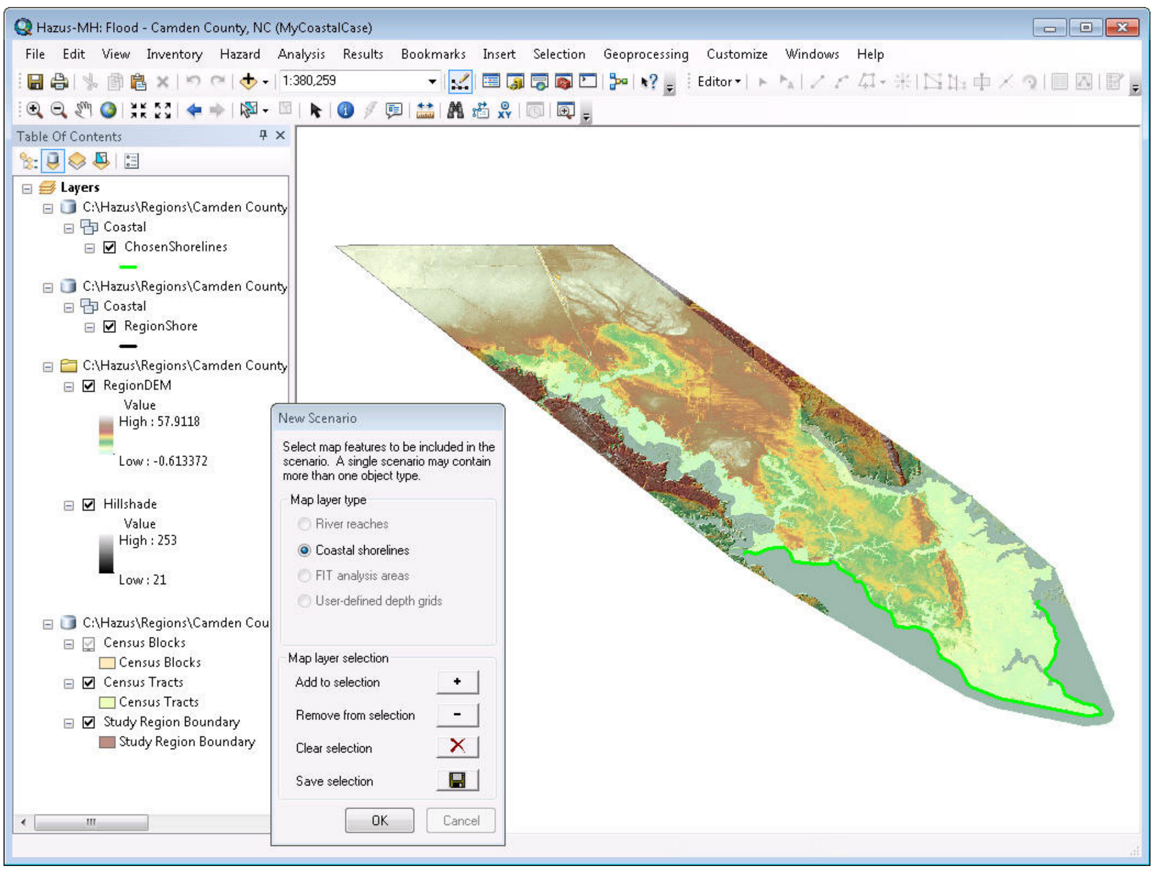


Figure 3.84 Selecting a Shoreline for a New Coastal Scenario

Once the shorelines have been selected, click on the **Save Selected Objects** button (the floppy disk icon) and the **OK** button will become enabled. This completes the process of creating the new scenario and selecting shorelines. The next step in the process is to characterize the chosen shorelines.

3.3.7.1 Shoreline Characterization

To characterize the shoreline, the Shoreline Characterization window will automatically pop up after shoreline(s) are selected for the scenario. Selection of this menu item starts a process where the user identifies where they would like to start characterizing the shoreline (Shoreline Start) and where they would like to finish the characterization (Shoreline Finish). In between these two points, the user will want to add any breaks in the shoreline (Breaklines) where the geographic characteristics of the shoreline change. The Flood Model will develop transects and perform the aforementioned analysis (e.g., WHAFIS) only between the Start and End lines. If the default locations are moved, the model will limit the development of transects between these locations.

The Flood Model will develop transects and perform analyses such as WHAFIS between the Start and End lines – either the default or those generated by the user. The Flood Model will still develop a Stillwater elevation surface over the entire study region to insure that flooding through other low-lying areas is properly accounted for.

The first dialog allows the user to perform the segmentation of their shoreline if necessary. Figure 3.85 shows the dialog, which is interactive with the map layer as shown.

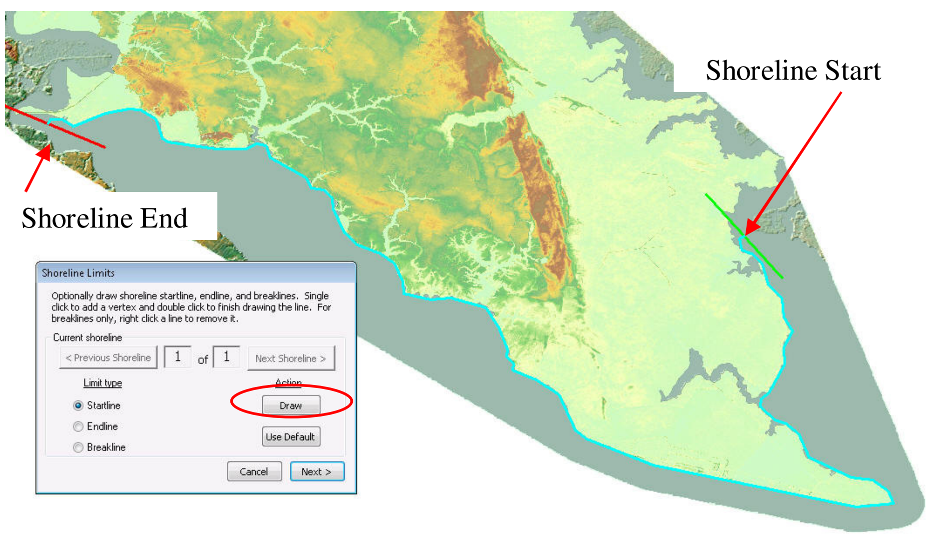


Figure 3.85 Setting Shoreline Limits

The user can leave the shoreline start and end as seen in the dialog above or select the limit to be changed (Startline or Endline) and click the Draw button (circled) to draw a new line on the map. The model will remove the default line and replace it with a line in the location of the users choosing. For example, Figure 3.86 shows what the user might see upon changing the shoreline start point (Startline).

The user must be sure to draw the line so that it crosses the shoreline only once. This could be from inland into the flood source, or from the flood source inland. The Flood Model will automatically make the line shore normal or perpendicular to the shoreline.

Hazus allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking the **Draw** button, the tool gets set to the 'Line' tool, and the customization gets locked, therefore users will not be able to select any other tool until the Startline, Endline, and Breakline(s) are drawn.

The user can move the startline if the initial effort is not in the right location by merely reselecting the **Draw** button and drawing the startline in another location. Similarly, if the user decides not to change the startline after having drawn one, the user can click on the **Use Default** button and restore the Shore Startline to its default location.

Clicking on the **Use Default** button will only restore the active Limit Type such as the Startline or the Endline. To restore both the Startline and the Endline the user needs to select the radio button and click on the **Use Default** Button for each line.

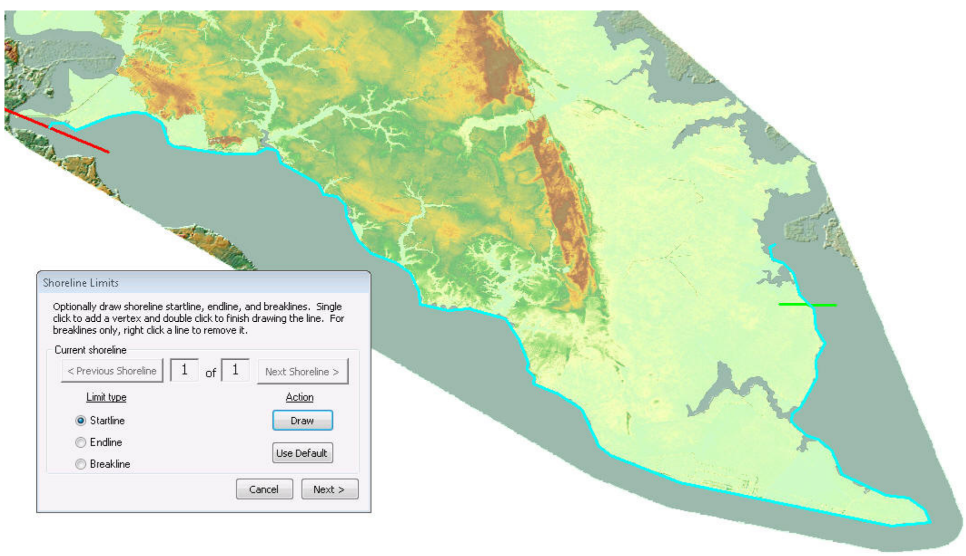


Figure 3.86 Resetting the Shoreline Start Line

An example of changing the shoreline end (endline) can be seen in Figure 3.87 below. In a similar fashion, the user can change the location of their endline by clicking on the **Draw** button and drawing a new line. To restore the default, the user needs to click on the **Use Default** button with the Endline radio button enabled.

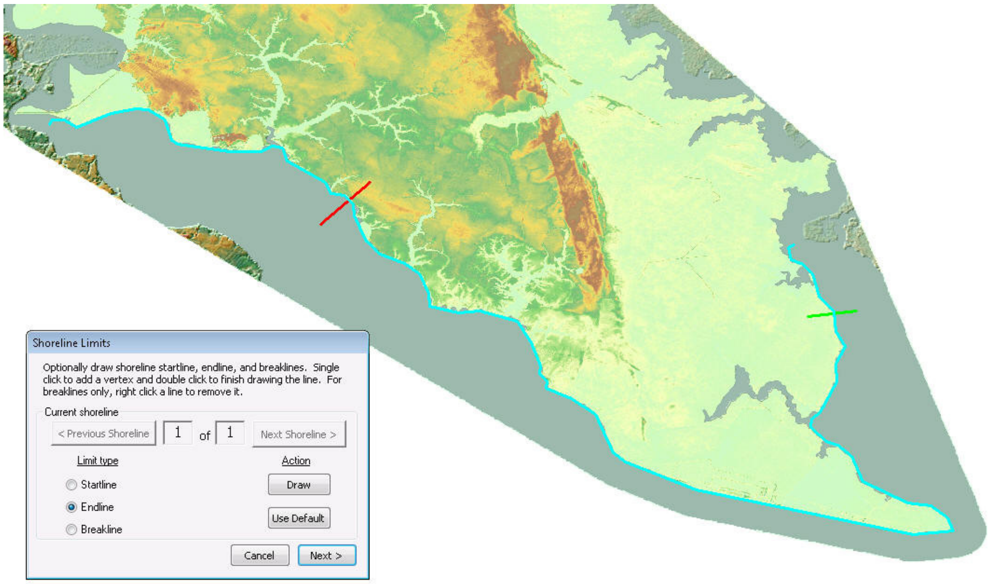


Figure 3.87 Resetting the Shoreline End Line

As stated previously, if the study region shoreline has differing geography, the user will want to segment the shoreline and classify the shoreline into the proper geophysical properties. Segmenting the shoreline means that the user will need to select the Breakline radio button and select **Draw**. As with the Startline and the Endline drawing, the user will draw a line crossing the shoreline only once. An example of the result is shown in Figure 3.88 below.

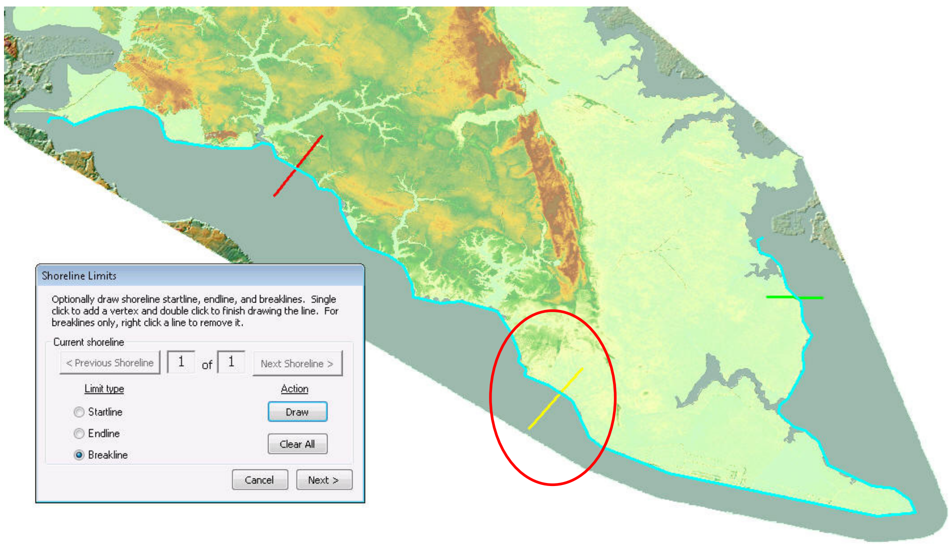


Figure 3.88 Adding a Breakline to the Selected Shoreline

The user cannot change or move a breakline once it has been drawn, to move the line, the user will need to clear the breakline using the Clear All button and redraw the breakline in the new location.

In the case of Figure 3.88 above, the user added a single breakline (circled above) and has decided to progress to the next step. By selecting **Next>**, the user will move to a dialog that obtains needed information regarding the wave exposure and 100-year still water elevation.

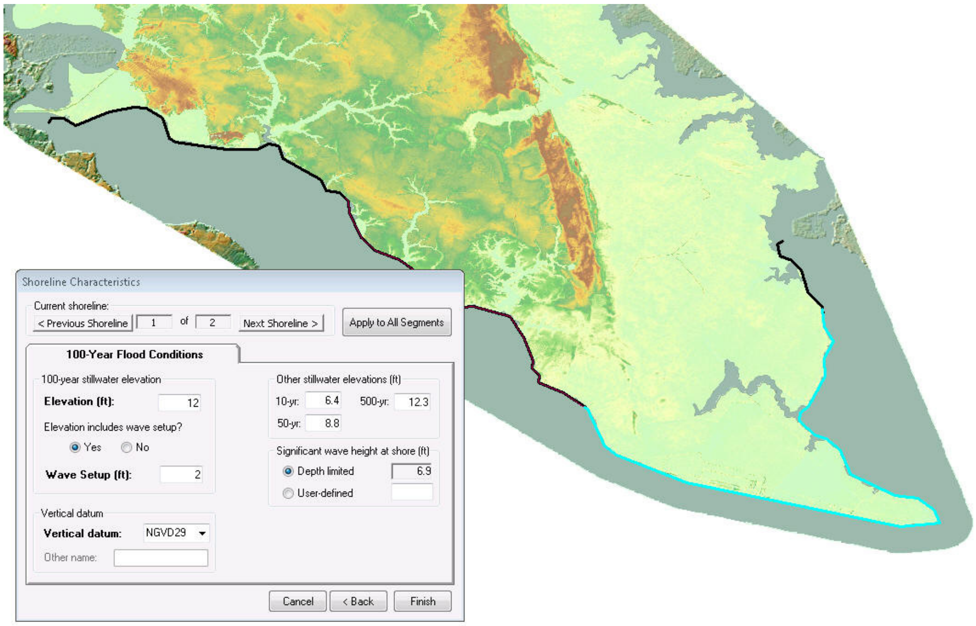


Figure 3.89 Shoreline Characterization – Stillwater Flood Conditions Tab

In order for the coastal analysis to have a starting point, the user must provide the 100-year still water elevation from a Flood Insurance Study. This information is readily available online at the FEMA Map store at http://store.msc.fema.gov/. The following figures give the user an idea of how the data can be captured from the FEMA web site. Remember that internet websites are constantly being changed and the look and feel may no longer be exactly the same as seen in Figure 3.90 through Figure 3.94.

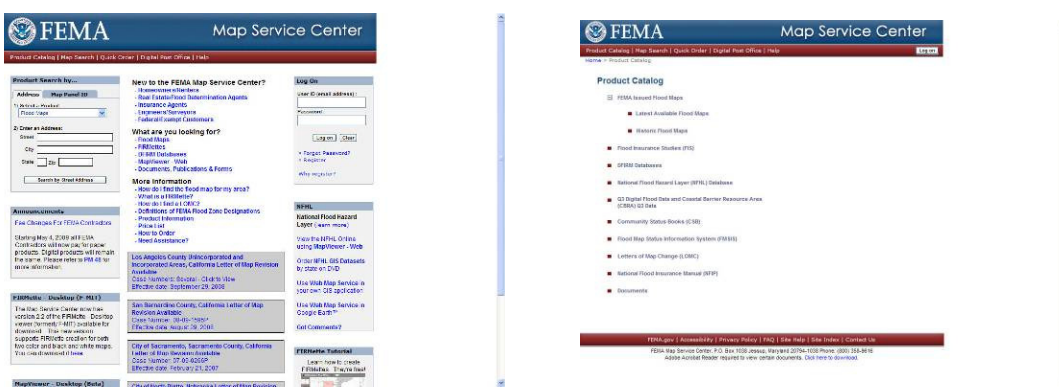


Figure 3.90 FEMA Map Store Welcome Page and Map Catalogue Screen

Figure 3.91 Selecting the State or Territory and County or Parish

Figure 3.92 Selecting the Community and Preparing to "Get" the FIS

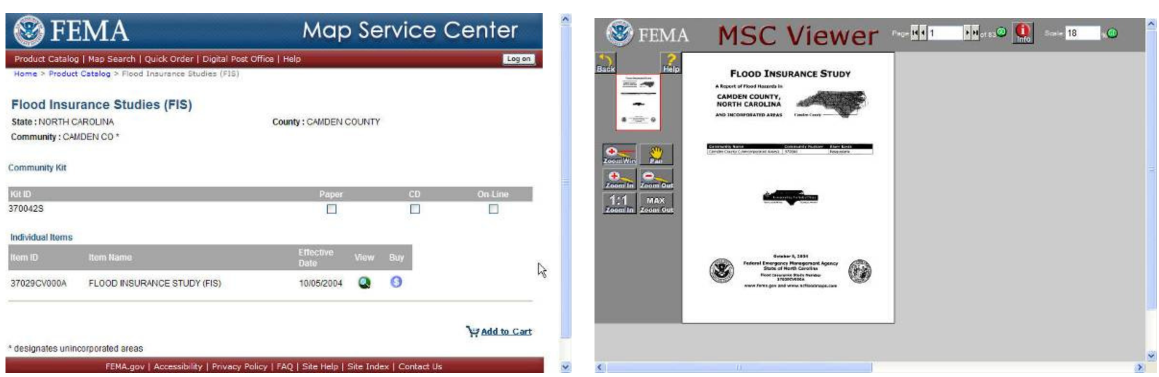
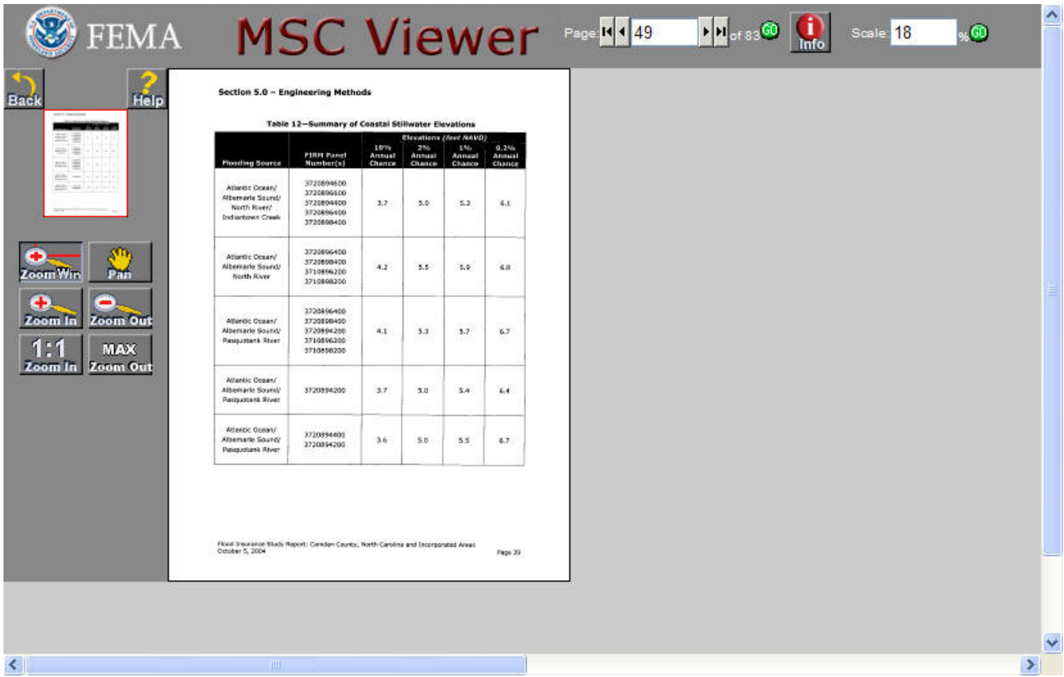


Figure 3.93 Flood Insurance Study Listing (if more than one) and the Selected FIS



Section 5.0 – Engineering Methods

Table 12—Summary of Coastal Stillwater Elevations

Flooding Source	FIRM Panel Number(s)	Elevations (feet NAVD) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean/ Albemarle Sound/ North River/ Indiantown Creek	3720894600 3720896600 3720894400 3720896400 3720898400	3.7	5.0	5.3	6.1
Atlantic Ocean/ Albemarle Sound/ North River	3720896400 3720898400 3710896200 3710898200	4.2	5.5	5.9	6.8
Atlantic Ocean/ Albemarle Sound/ Pasquotank River	3720896400 3720898400 3720894200 3710896200 3710898200	4.1	5.3	5.7	6.7
Atlantic Ocean/ Albemarle Sound/ Pasquotank River	3720894200	3.7	5.0	5.4	6.4
Atlantic Ocean/ Albemarle Sound/ Pasquotank River	3720894400 3720894200	3.6	5.0	5.5	6.7

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Figure 3.94 FIS Page with Still Water Elevations (image rotated 90 degrees)

Once the FIS has been obtained, the user can input the value in the Elevation field. This field and the vertical datum field are required. The other still water elevation boxes are calculated using the standard FEMA ratios, but can be edited and overwritten by the user if the data is available within the FIS.

The user should review the FIS carefully to determine if the 100-year SWEL includes wave setup. If it does, the user should put in the 100-year still water elevation as noted in the FIS, but must also check the **Yes** radio button under the "*Elevation includes wave setup?*" question. Doing this will enable the **Wave Setup (ft)** text box and the user should enter the wave setup value here. If the user cannot identify if wave setup is included, quickly graph the stillwater elevations listed in the FIS and see if the 100-year SWL is higher than expected by the graph. If so, it most likely includes wave setup.

Fields that require data input in order for a coastal analysis to be performed are in red text. Other fields are automatically loaded with default parameters or do not need to be completed.

Once the user has completed inputting the required information on both tabs of the shoreline characterization dialog the process is completed and the Flood Model has the necessary data to perform a coastal analysis for any given return interval.

3.3.7.2 Delineate Floodplain – Coastal Hazard

Under the *Hazard* menu, *Coastal* submenu, the user will see the *Delineate Floodplain* option enabled. Selection of this option will open a dialog that allows the user to select their hazard analysis options. At the bottom of the window, **Hazus** will indicate how much virtual memory is available on the machine and the estimated virtual memory that will be used for the coastal analysis. Figure 3.95 below shows the Coastal hazard analysis dialog.

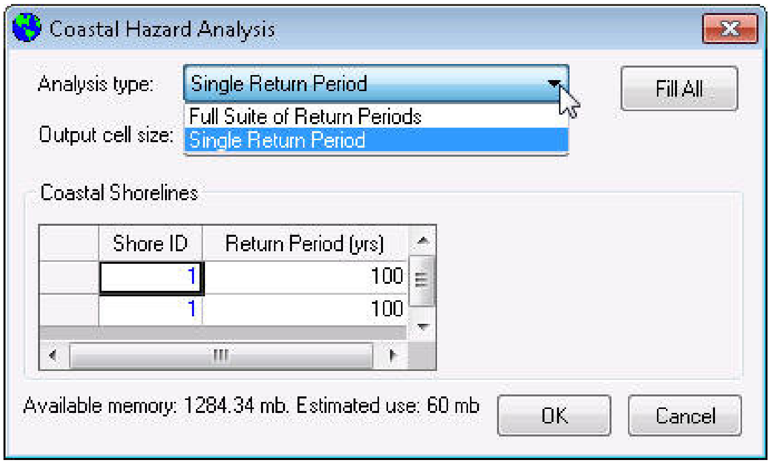


Figure 3.95 Calculate Hazard – Coastal Hazard Options

The coastal analysis has two options available to the user:

1. Selecting *Full Suite of Return Periods* will calculate flood depths and floodplains for the 10-year, 25-year, 50-year, 100-year, and 500-year return period floods the entire shoreline in your scenario. The Flood Model will produce a single 10-year flood depth grid for shoreline. This process is duplicated for the other four return intervals.

2. Selecting *Single Return Period* lets you specify any flood return period for which the flood characteristics will be calculated. Unlike riverine, you cannot choose different return periods for different shoreline segments. The results will be a grid of flood depth for the selected return period.

When running hydraulic analysis, the **Hazus** screen might go blank or the Task Manager “Applications” tab will indicate that **Hazus** is not responding. This is a common symptom for any software that is process heavy. In order to check if Hazus is still running, users should check the Task Manager “Processes” tab and sort the “CPU” column in descending order. The “CoreOfHydraulics.exe” process should be on top. If the “System Idle Process” is constantly on top at 99-100%, this is a clear indication that **Hazus** is not responding. Users could also check the “Performances” tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the scenario folder (in “Details” view) and make sure the FlCoastalLog.txt is updating by looking at the “Date modified.”

3.3.8 Riverine and Coastal

The primary reason the user is asked to select between *Riverine Only*, *Coastal Only*, or *Riverine and Coastal* is to limit the DEM requirements for the user. Selection of *Riverine and Coastal* on the Hazard Type dialog will require the user to get a DEM that supports the analysis for both hazard types. Once the user has provided the DEM, they are free to perform any of the hazard analysis. For example, if the user selects *Riverine and Coastal*, they will be required to build the *Stream Network* and the shorelines will already be available to the user. During the creation of scenarios, the user will have the option to build a scenario with only river reaches, only shorelines, or a combination of reaches and shorelines. The Flood Model maintains the riverine and the coastal hazard depth grids separately because the depth of flooding alone does not determine which hazard is producing the most damage by occupancy.

If the user has chosen to run a scenario with river reaches and coastal shorelines, the Flood Model will analyze the impact of both hazards on the inventory independently and then compare the resulting losses to see which hazard is the controlling hazard, or the hazard with the greatest impact on that occupancy or structure.

To perform a combined analysis, the user should perform the following steps:

1. Create Stream Network (required),
2. Create Scenario and select river reaches and shorelines – Note: The user needs to select the *River reaches* radio button, select reach(es) using *Add to selection* button, and *Save selection*, then select the *Coastal shorelines* radio button, select shoreline(s) using *Add to selection* button, and *Save selection* to ensure that both selected layers are saved. Click *OK* when selection is complete.
3. Characterize the shoreline
4. Run hydrology
5. Delineate floodplain (riverine)
6. Delineate floodplain (coastal)

Once the user has completed this effort, they are ready to perform the hazard "*What-ifs*" or go onto the *Analysis* menu.

3.3.9 Using Hazard What-Ifs

The Flood Model Oversight Committee identified specific items that they believed would enhance the user community acceptance of the Flood Model. These capabilities provided a level of "What-if" functionality to the user allowing them to utilize the Flood Model as a planning tool. The Flood Model "what if" scenarios include riverine levee, riverine flow regulation, riverine velocity, coastal long-term erosion, and coastal shore protection. The following sections provide a description of the process to generate the hazard (depth grid) for the what-if analysis.

Use of What-If scenario functionality requires that the flood hazard has already been computed. Levee, flow regulation, and velocity analysis require the Riverine hazard to be completed. Long-term erosion and shore protection routines require the coastal hazard to have been completed.

3.3.9.1 Riverine Levee

In general, DEMs are not reliable for identifying a continuous embankment with relatively little width. Because grid cells are connected at the corners as well as the sides, an embankment that is not a straight line, in the strictest sense, must be at least two cells wide to be treated as a barrier to flow. A tool is available in **Hazus** to add a levee alignment, attribute the levee with a level of protection and, for level 1 analyses determines the effects of a levee on flood depths within the unprotected portion of the floodplain.

Select *Riverine* from the *Hazard* menu. On the sub-menu, select *Levee*. The levee option is drawn with the mouse after clicking the **Draw** button. Flood depth grids have been created for the reach and the user chooses a grid on which to draw the levee alignment. The alignment should cross the floodplain twice. Then enter the recurrence interval, in years, corresponding to the level of protection provided by the levee and click **OK**.

Hazus allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, the tool gets set to the 'Line' tool, and the customization gets locked, therefore, users will not be able to select any other tool until the levee is drawn.

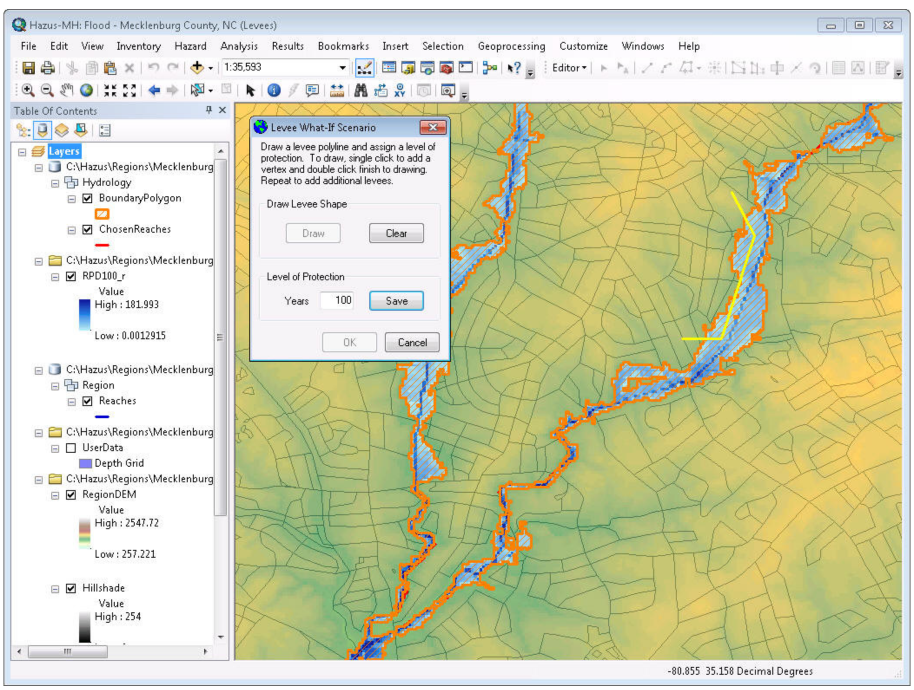


Figure 3.96 Riverine Levee

The model then enforces the levee into the DEM and the flood hazard for the scenario is recomputed.

3.3.9.2 Riverine Flow Regulation

The default hydrologic analyses apply to unregulated drainage areas. Regulation, through diversions and/or storage, changes the flood frequency curves downstream. **Hazus** provides a tool for incorporating the downstream effects of flow regulation. The tool allows users to modify the unregulated flood frequency curve at a specific location by entering one or more pairs of recurrence intervals and discharge values. **Hazus** identifies downstream reaches affected, and modifies the corresponding flood frequency curves as appropriate, prior to re-computing the flood hazard.

Select *Riverine* from the *Hazard* menu. On the sub-menu, select *Flow Regulation*. Click the **Draw** button to identify the location of a regulating structure, such as a flood control reservoir. Upon clicking the **Apply** button, the algorithm finds the drainage area upstream of that location and defines the unregulated flood frequency curve. The curve is plotted and a table of recurrence intervals and associated discharge values is presented for the user. Enter the return period and discharge of the regulating structure and click **OK**.

Hazus allows users to zoom in and out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, users will not be able to select any other tool until the regulation structure is drawn.

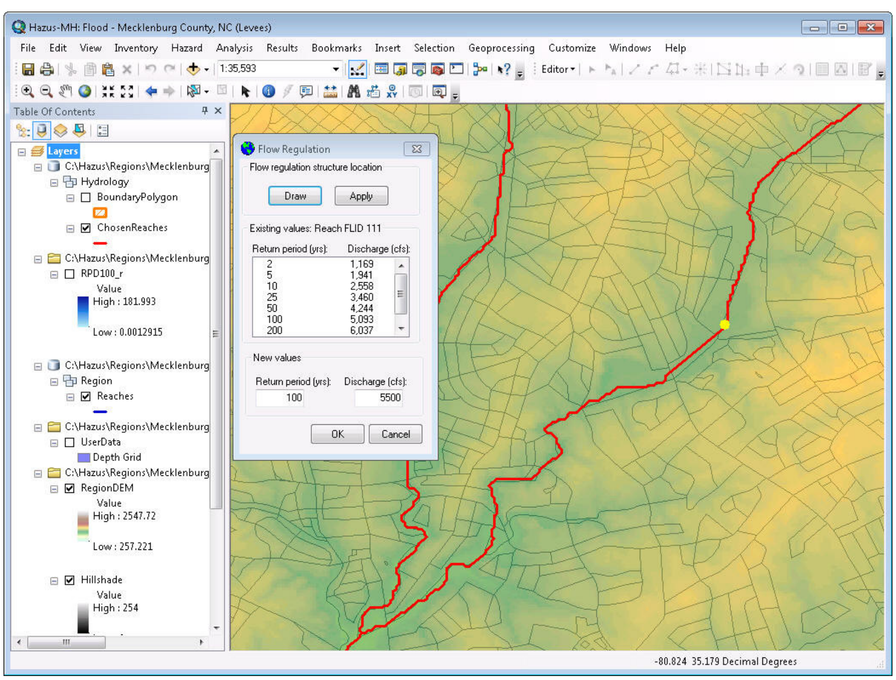


Figure 3.97 Riverine Flow Regulation

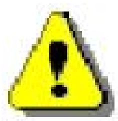
3.3.9.3 Riverine Flow Velocity

The velocity of floodwater can contribute to the flood hazard by carrying large amounts of sediment and debris, impacting structures, and eroding soil from stream banks and under foundations. In the velocity analysis, the spatial distribution of the floodwater velocities is estimated.

Select *Riverine* from the *Hazard* menu. On the sub-menu, select *Velocity*.

3.3.10 Using Quick Look

The Quick Look feature allows the user to quickly produce a rough estimate of flood damages, without working through the process of generating a stream network or Delineate Floodplain. Instead of generating a floodplain associated with a specific return period or rainfall amount, Quick Look lets the user enter an anticipated flood depth for an area of their selection. Then, based on the infrastructure present in the area you select, approximate damages are estimated.



The Quick Look analysis is only performed on the General Building Stock (GBS). The GBS results tables are populated and a summary report uniquely developed for the Quick Look is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

Quick Look is only appropriate for small areas with similar elevations. The Quick Look function assumes a standard depth of water over the entire area you select, and does not use any topology (DEM) or check for the veracity of the flood depths input by the user. If you select an area with significant elevation gradations, Quick Look will assume that high elevation locations have the same level of flood depth as low elevation locations, which would produce meaningless results. The Quick Look does allow the user to create multiple polygons with differing flood depths.

Select *Quick Analysis* from the *Hazard* menu and select *Quick Look* from the submenu. Click on **Draw** in the window that pops up. Using the cursor, draw a polygon with as many sides as you wish, illustrated in Figure 3.98. Double-click when you have selected the area you wish. Next, enter a flood depth for the polygon you have selected. Click **Save**, then click **OK**.

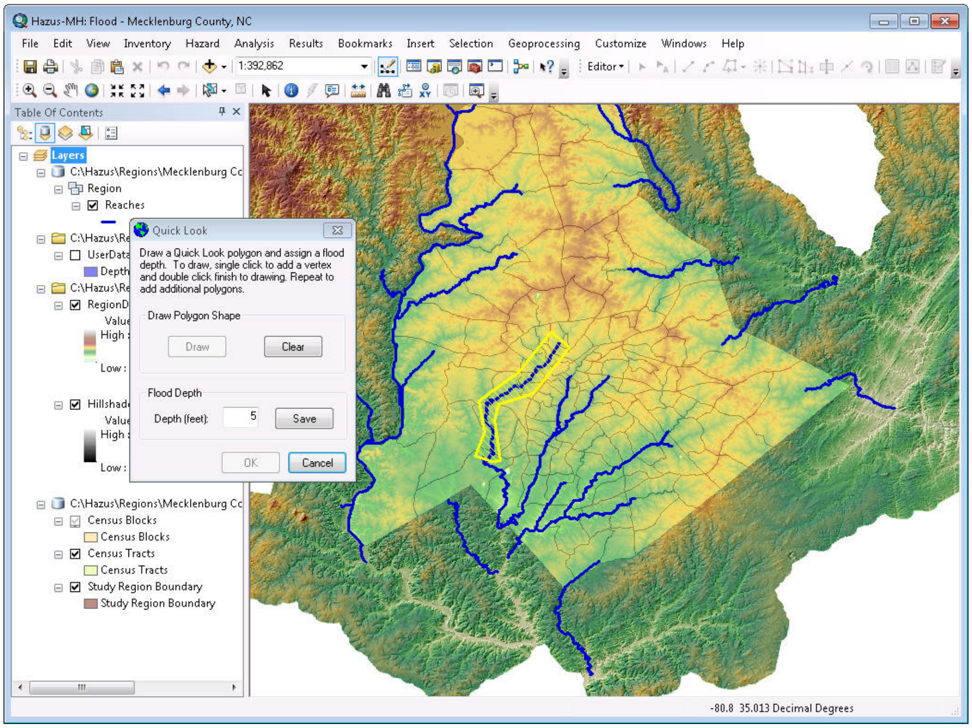


Figure 3.98 Drawing a Polygon for Quick Look

Only one quick look analysis can be performed in a given study region. Additional quick look analysis efforts will over write the results from the previous analysis. Quick Look will not run if a scenario is open. It is independent from the scenario(s).

Hazus allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, users will not be able to select any other tool until the polygon is drawn.

3.3.11 Using Enhanced Quick Look

Similar to the Quick Look function, Enhanced Quick Look is an analysis option where the user is providing a polygon that represents the floodplain boundary and the DEM for the region. **Hazus** will estimate the flood depth within that boundary. Enhanced Quick Look does not establish a flow regime. The analysis performed is therefore based on this user supplied anecdotal information and should be used with great care.

Select *Quick Analysis* from the *Hazard* menu and select *Enhanced Quick Look* from the submenu. A window will pop up and ask the user to select the Vertical Units and Vertical Datum of the polygon. Users will also have to browse to the appropriate location for the DEM and floodplain boundary polygon, as illustrated in Figure 3.99. The analysis will start as soon as the user clicks **OK**.

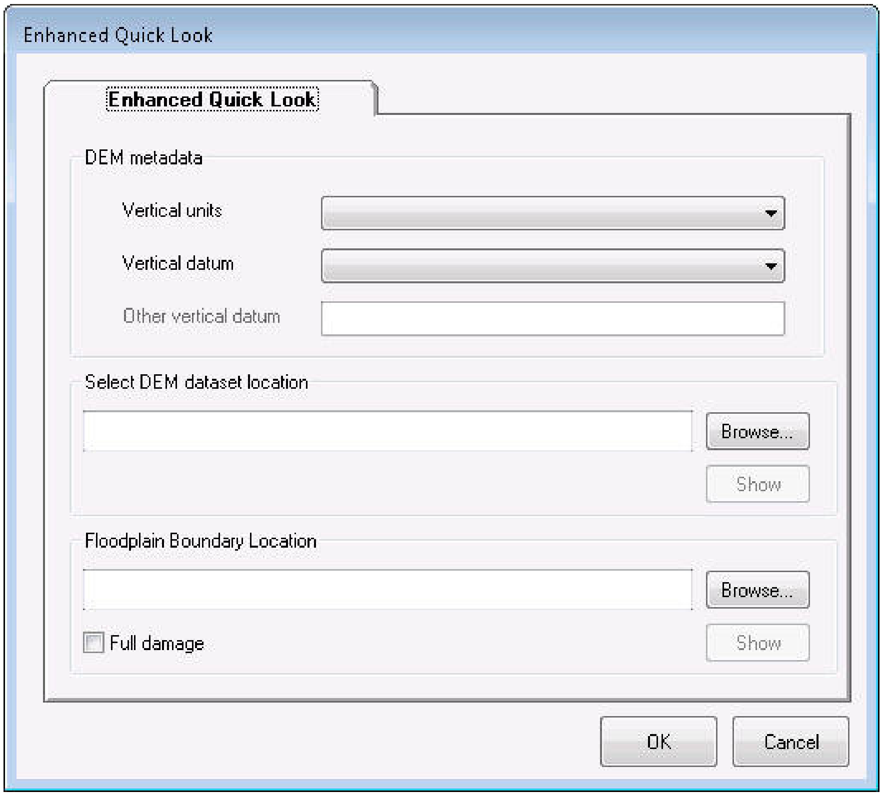


Figure 3.99 Enhanced Quick Look

Only one enhanced quick look analysis can be performed in a given study region. Additional quick look analysis efforts will over write the results from the previous analysis. Enhanced Quick Look will not run if a scenario is open. It is independent from the scenario(s).

The Enhanced Quick Look analysis is only performed on the General Building Stock (GBS). The GBS results tables are populated and a summary report uniquely developed for the Enhanced Quick Look is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

3.3.12 Combined Hurricane and Flood Hazard

The **Hazus** Hurricane Model can now be used to derive storm surge and wave models, which in turn can be used as inputs to the Coastal Flood Model. These inputs will be used to determine the extent of flooding due to a wind-driven storm, and the flood losses associated with the hurricane can be estimated.

In order to run a combined hurricane and flood hazard, the user needs to build a multi-hazard (flood and hurricane) study region that includes a shoreline (i.e., must be a coastal region). The user must run the Hurricane Model first, ensuring that the storm surge analysis option is selected. After the Hurricane Model has been run, reopen the study region in the Flood Model.

In the Flood Model, the hazard type "Coastal surge" would be enabled, as seen in Figure 3.100.

Figure 3.100 Hazard Type, Coastal Surge Enabled

After the hazard type is set, the user must import a DEM for the study region through the User Data dialog (Figure 3.101). The User Data dialog will only contain two tabs, DEM and Coastal Surge. Figure 3.102 shows the Coastal Surge tab, where the Surge Elevation Grid (SLOSH) and Significant Wave Height Grid (SWAN) that were produced by the Hurricane Model are located in the Study Region folder as surge.flt, surge.hdr (SLOSH), and waveht.flt, waveht.hdr (SWAN).

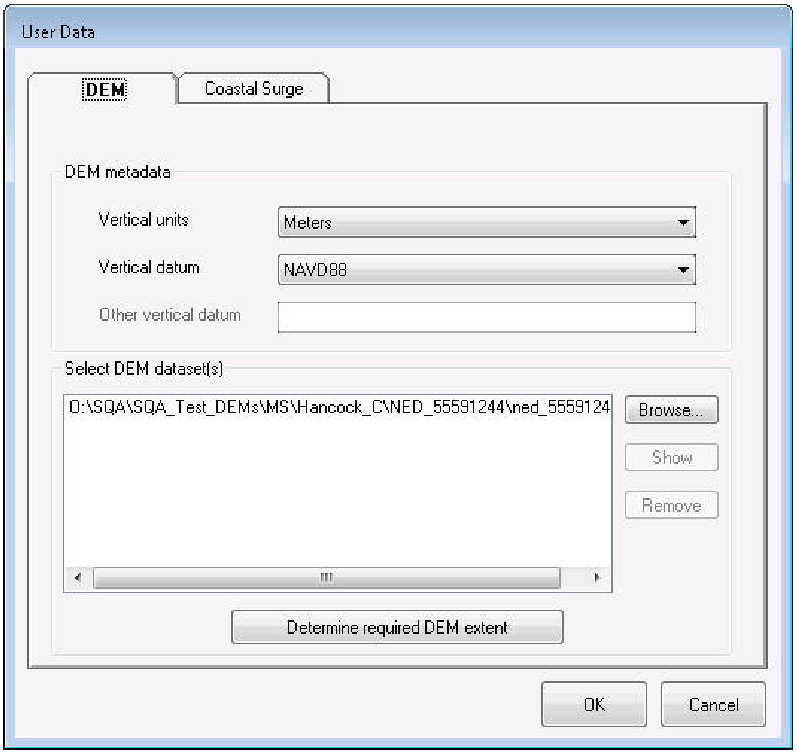


Figure 3.101 User Data Dialog, DEM Tab

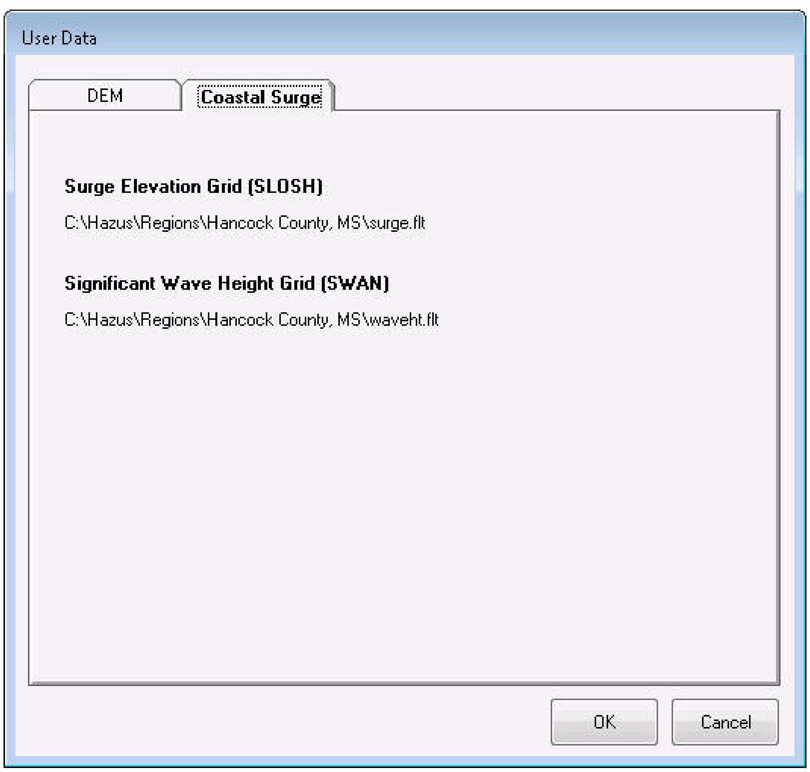


Figure 3.102 User Data Dialog, Coastal Surge Tab

Users then need to create a new scenario, which only requires naming the scenario. In the coastal surge scenarios, the surge and waveht files are automatically selected and users do not need to select or save any features as the Hurricane Model supports only one scenario per study region.

After the scenario is created, a message box will pop-up and notify users to continue on to Coastal > Delineate Floodplain, shown in Figure 3.103.

Figure 3.103 Coastal Surge Scenario Message Box

If the user selected “No Waves” in the Storm Surge analysis for the Hurricane Model, only the surge elevation grid was created for the study region. The wave height grid (waveht.flt) was not produced and the shoreline needs to be characterized. In this case, after creating a new scenario, the shoreline limits and characterization dialog will pop-up, as seen in Figure 3.104 and Figure 3.105.

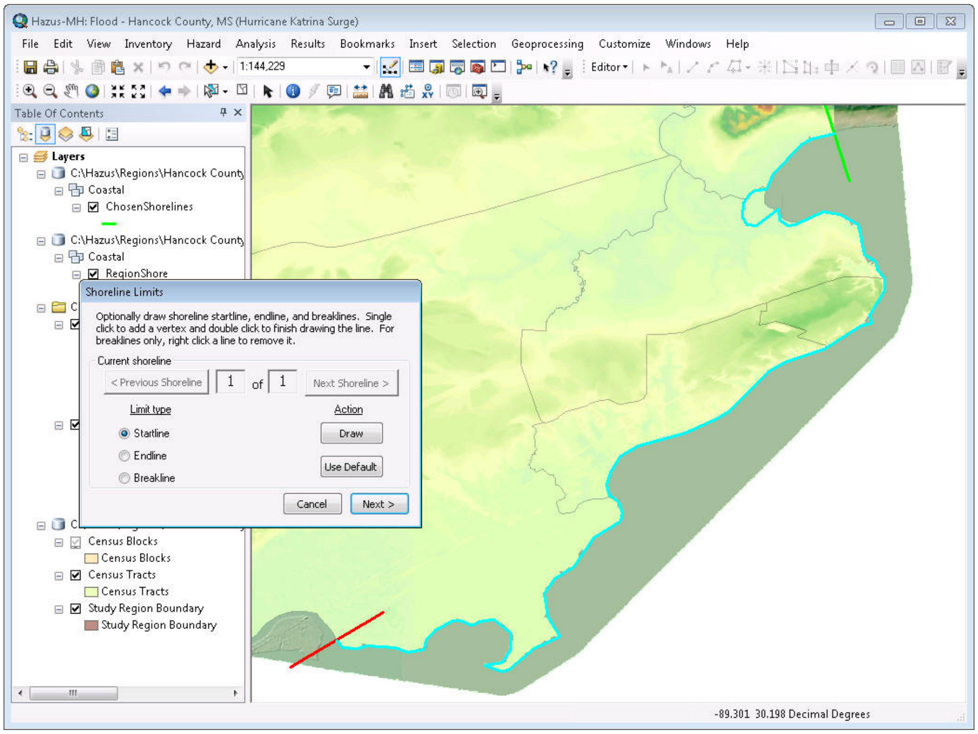


Figure 3.104 Coastal Surge Shoreline Limits

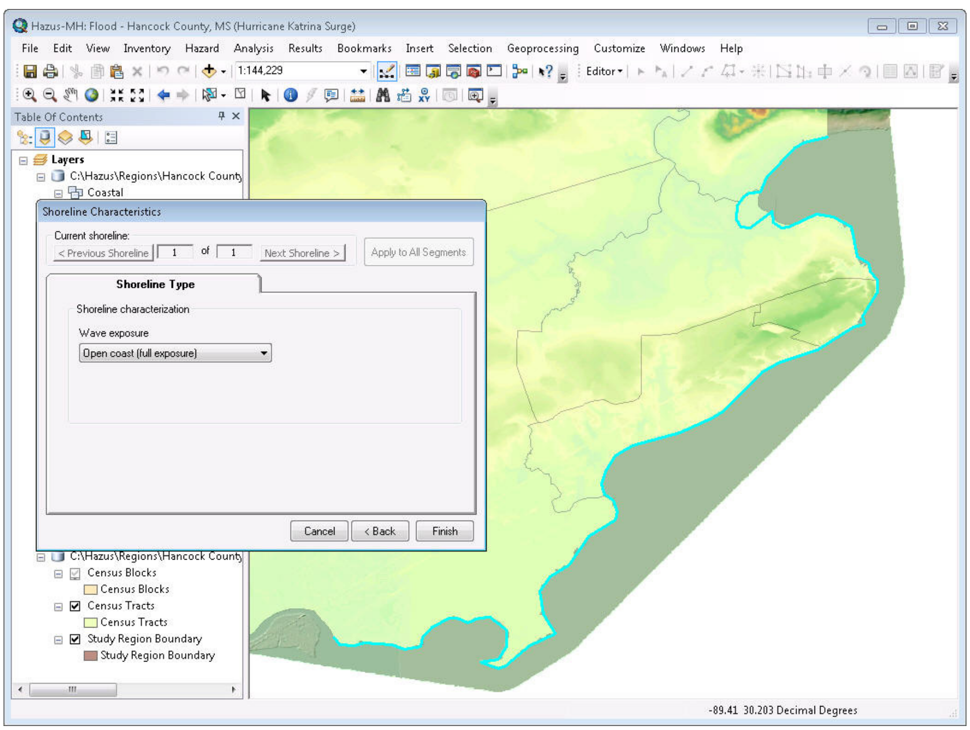


Figure 3.105 Coastal Surge Shoreline Characterization

The Shoreline Type tab has one required input, wave exposure. The default parameter is Moderate wave exposure. The options for the wave exposure include:

- Open Coast (full exposure): This would be any shoreline where the storm surge and waves come directly off open waters without the benefit of any barrier islands or other land mass protection. Think in terms of lines of waves marching directly onto the shoreline uninterrupted.

- Moderate exposure: This is best represented by a shoreline that is slightly protected from the storm surge and associated waves. This might be a shoreline that has some small islands or a low-lying sandbar that helps break the direct force of the waves on the shoreline. This shoreline might be angled somewhat to the direct line of the waves and therefore receiving a portion of the wave front. This is the **Hazus** default.

- Minimal exposure: This is best represented by a shoreline that is not in direct line with the storm surge or the waves. This might include an exposed shoreline that is running somewhat parallel to the storm surge and therefore is not bearing the brunt of the wave fronts.

- Sheltered: This is best represented by the shoreline within a bay or protected by a larger barrier island. This could also be a shoreline along a large river inlet. The shoreline is sheltered from the wave front and is most likely subjected to still water flooding.

At the top of the dialog, the user can switch from one shoreline segment (if more than one) to another and back. If there are multiple segments and most have a single characteristic and a few with unique characteristics, the user can save time and effort by applying the common characteristic to all segments by pressing "Apply to All Segments" button, and then edit those unique segments.

Figure 3.106 displays the completed hazard portion of the coastal surge model. The coastal surge model outputs a Mix0_c flood depth grid, comprised of SLOSH and wave height grids, to the map, as seen in Figure 3.107.

Hazus has a limit of 1 scenario for the Coastal Surge flood hazard type. If the user already completed the coastal surge model in a study region and decides that they want to re-run the Hurricane module, the user ***must*** delete the previous flood scenario and re-input the DEM in the User Data dialog in the Flood module.

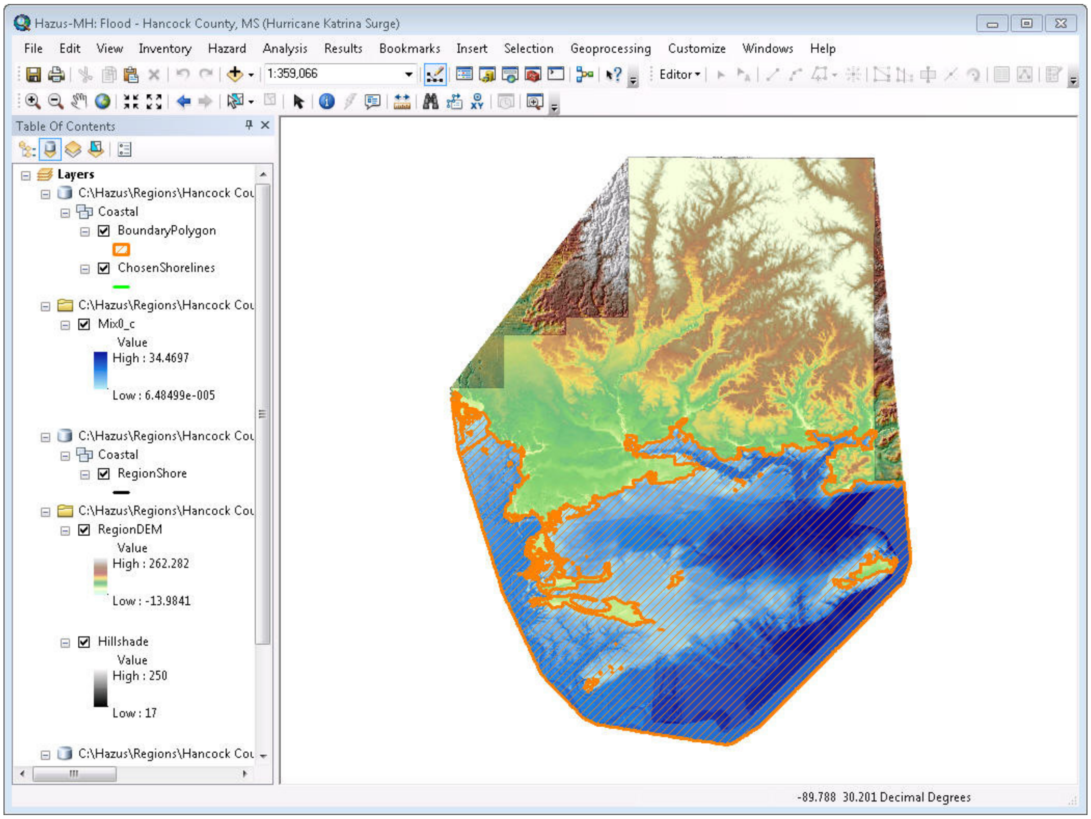


Figure 3.106 Coastal Surge Hazard Complete

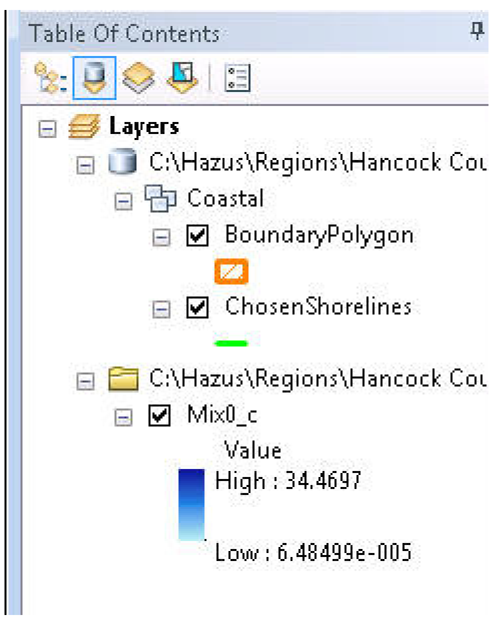


Figure 3.107 Mix0_c Coastal Surge Flood Depth Grid

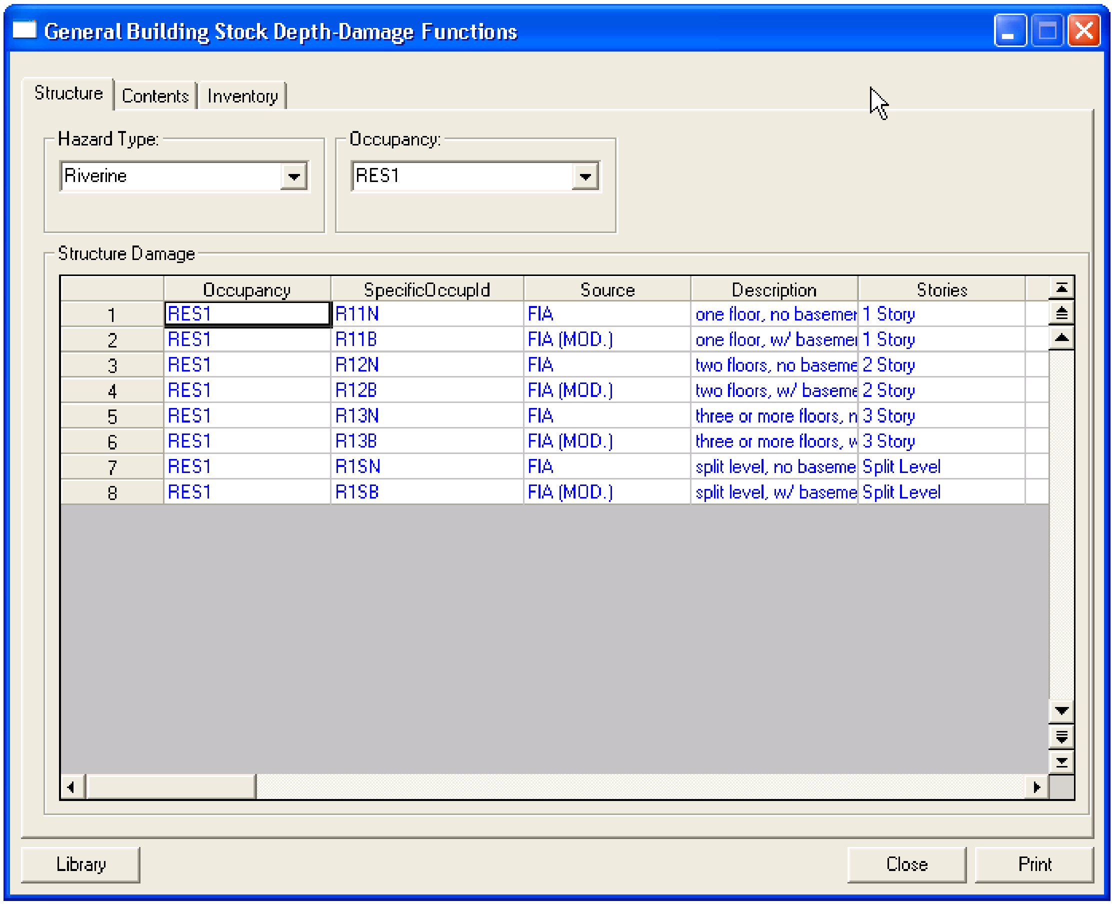
3.4 Running an Analysis Using Default Data

In a **Hazus** loss analysis, the characteristics of the structures and people of the study region are analyzed for vulnerability to the flood or floods, which have been calculated in your scenario. Default damage functions, which estimate percent damage relative to the depth of floodwater as measured from the top of the first finished floor (riverine) or bottom of the first flood (coastal), are provided with the **Hazus** program. Other damage functions were collected or developed for vehicles, riverine velocity, utility components, and transportation bridges.

3.4.1 Viewing Damage Functions

Under the *Analysis* menu, you can view the functions that will be used to estimate damage of various types. This section looks at one set of those functions, and you are encouraged to familiarize yourself with all of them.

Selecting *Buildings* from the *Analysis* menu *Damage Functions* submenu, the window shown in Figure 3.108 appears. This table provides information on the default damage function associated with each specific occupancy class (e.g., RES1) and subclass (e.g., RES1, 1 story, no basement). By scrolling to the right in this window you will see the percent of damage, expressed in terms of building replacement cost, estimated at different water depths. The pull-down menus at the top of the window allow you to view the default damage functions for the coastal hazard and other occupancy classes such as COM1. Clicking on the different tabs at the top (Structure, Contents, Inventory) allows you to view default damage functions associated with building structures, and their contents for all specific occupancy types, and inventory for selected occupancies (e.g., COM1, IND1-6 and AGR1).



	Occupancy	SpecificOccupId	Source	Description	Stories
1	RES1	R11N	FIA	one floor, no basemer	1 Story
2	RES1	R11B	FIA (MOD.)	one floor, w/ basemer	1 Story
3	RES1	R12N	FIA	two floors, no baseme	2 Story
4	RES1	R12B	FIA (MOD.)	two floors, w/ baseme	2 Story
5	RES1	R13N	FIA	three or more floors, n	3 Story
6	RES1	R13B	FIA (MOD.)	three or more floors, w	3 Story
7	RES1	R1SN	FIA	split level, no baseme	Split Level
8	RES1	R1SB	FIA (MOD.)	split level, w/ baseme	Split Level

Figure 3.108 Building Depth-Damage Functions by Occupancy (Riverine)

If you click on the *Library* button at the lower left of the window, Figure 3.109 will appear on your screen. Viewing the library of damage functions allows the user to review other damage functions applicable to the occupancy under consideration relative to the current default, as well as replace the current default with another function from the library.

The library dialog makes heavy use of color codes to help the user identify any changes and selections they may make in the dialog. The Library dialog is composed of three windows.

The left window is the navigation window where the user can change between occupancies, foundation heights and number of stories. This window allows the user to select a specific occupancy (e.g., RES1) and shift through the potential foundation types (slab on grade, fill, basement, crawlspace, pier, post, and pile) and number of stories typical for the selected specific occupancy (1-story, 2-story, 3-story, split level for residential and low, mid, and high rise for non-residential) within that occupancy. The sub-occupancies displayed in the window are a form of shorthand that identifies the occupancy class. The short hand was developed by taking the first letter and numeric values of the specific occupancy name (e.g., RES1 becomes R1 and COM10 become C10), this is concatenated with the value for the number of stories (e.g., 2-story becomes 2 and Low rise becomes L), and finally the existence of a basement derives the last value (e.g., structures with a basement get a B and structures without get an N). Therefore the residential occupancy classified as RES1 with 1-story and no basement becomes R11N while the commercial occupancy classified as COM10, mid-rise, with a basement become C10MB.

The bottom right grid is where the library of damage functions is displayed for the user to view and/or select. The user can browse between damage functions for the foundation and number of stories by selecting the sub-occupancies in the left column grid. In this case, Figure 3.109 is displaying all of the functions available for the sub-occupancy R11N (RES1, 1 Story, with no basement). Selection of C10MB (COM10, mid-rise, with basement) would display an entirely different set of damage functions in the grid on the lower right.

Finally, the window in the upper right is used to allow the user to make comparisons and selections among the damage functions. The first row in the grid will always display the **Hazus** default function in red. The second line in the upper right grid displays the "current" function or any damage function that the user has highlighted in the lower window. To help the user view the current function, it is also displayed in green text. The user may want to use the "current function" line as a way of displaying a function and directly comparing it to the default damage function. Figure 3.109 is currently displaying a USACE New Orleans District damage function (highlighted row 10) for RES1, 1-story slab on grade. The third row in the upper right grid displays any function the user may have "selected" as their damage function. That is, a damage function the Flood Model will use rather than the default damage function. This is how the user can essentially override the default damage functions with either a library function that they believe better represents their local area, or a custom function they may have built themselves. Figure 3.109 is displaying a USACE New Orleans District damage function (lower right grid, blue text RES1 1-story, pier foundation) that was selected in place of the default function.

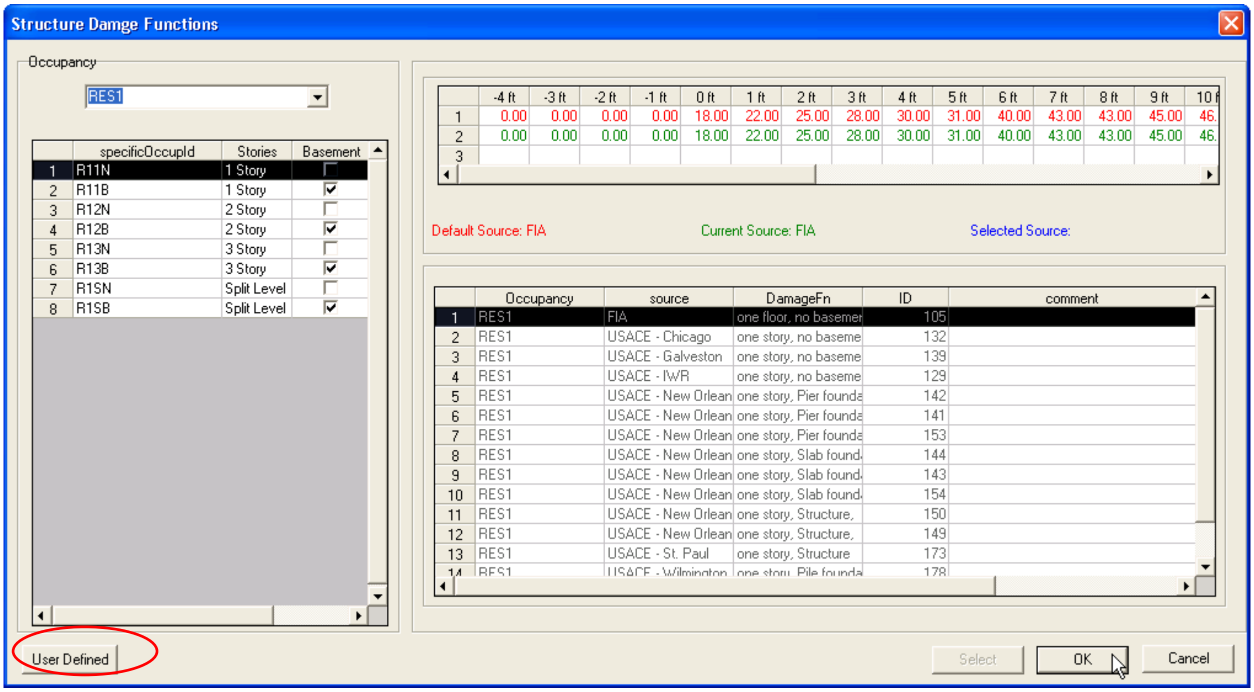


Figure 3.109 Building Depth-Damage Function Library

If the user chooses, they may use one of the library functions to build their own custom damage function. To do this, the user would click on the User Defined button in the lower left corner of the dialog (circled). When the user selects this button, the Flood Model takes the highlighted damage function, if any, and opens an editable dialog for the user to make modifications. Figure 3.110 shows the dialog. The Flood Model inserts the damage function description from the starting damage function the user selected (or the default damage function if none is selected) and adds a comment that identifies for the user what the original source damage function was. This will allow the user to maintain some idea of where they started the process. The user is required to enter a source (or name) for the damage function. It is recommended that the user do not edit the Comment or description.

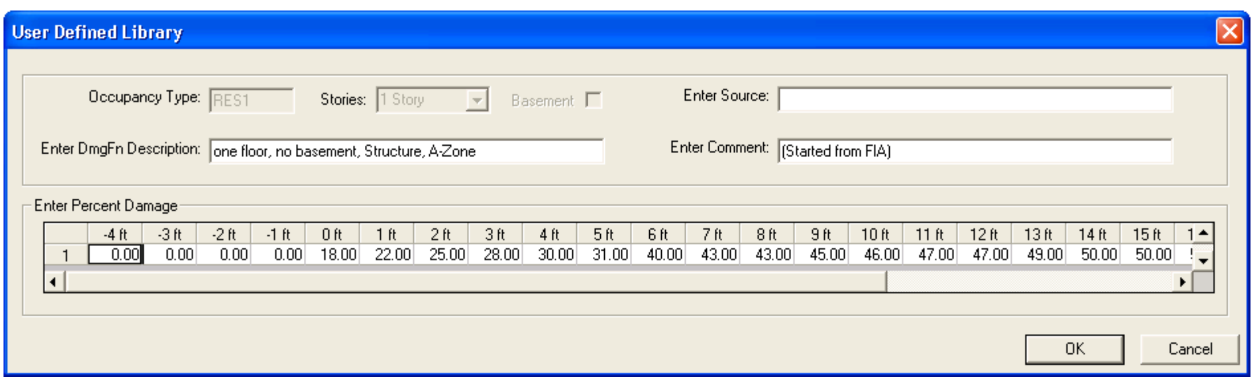


Figure 3.110 Editing Dialog for User Defined Function Development

If the user has decided to select a new damage function for use in the Flood Model, the entry dialog will highlight the damage function to remind the user that a default function is not being used. Figure 3.111 shows how the change would appear in the entry dialog as compared to that seen in Figure 3.108 earlier in this section.

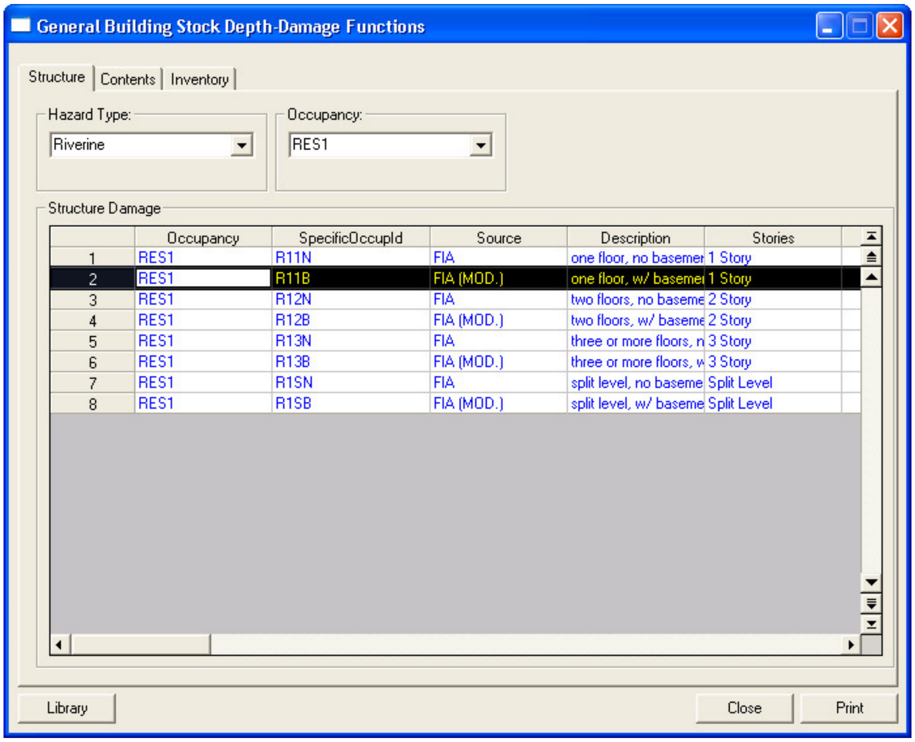


Figure 3.111 Building Damage Function Dialog with a User Selected Damage Function

Similar default damage functions for other facilities, as seen in Figure 3.112 below. The damage function dialogs for Essential Facilities functions in the same fashion as discussed above for the General Building Stock. In most cases, the damage functions available in the essential facilities dialog area also available for the Government structures in general building stock. The essential facilities dialog does not have an inventory tab since the essential facilities occupancies do not produce inventory for sale.

Figure 3.112 Damage Functions Submenu

The Transportation Systems damage function dialog looks slightly different as there is only structure damage function (no contents or inventory) and the dialogs tabs allow the user to shift between Highway, Railway, and Light Rail facilities. Currently the Flood Model has damage functions for bridges only.

Upon viewing the transportation bridge damage functions, the user will see that they are based on return period. It is important to remember that running an analysis on bridges cannot be done if the user runs mixed return periods on their selected reaches. In other words, if the user assigns a different return period to each reach, or a single discharge on the reaches, the Flood Model will not be able to analyze the transportation bridges.

The entry dialog for transportation facilities can be seen in Figure 3.113 below.

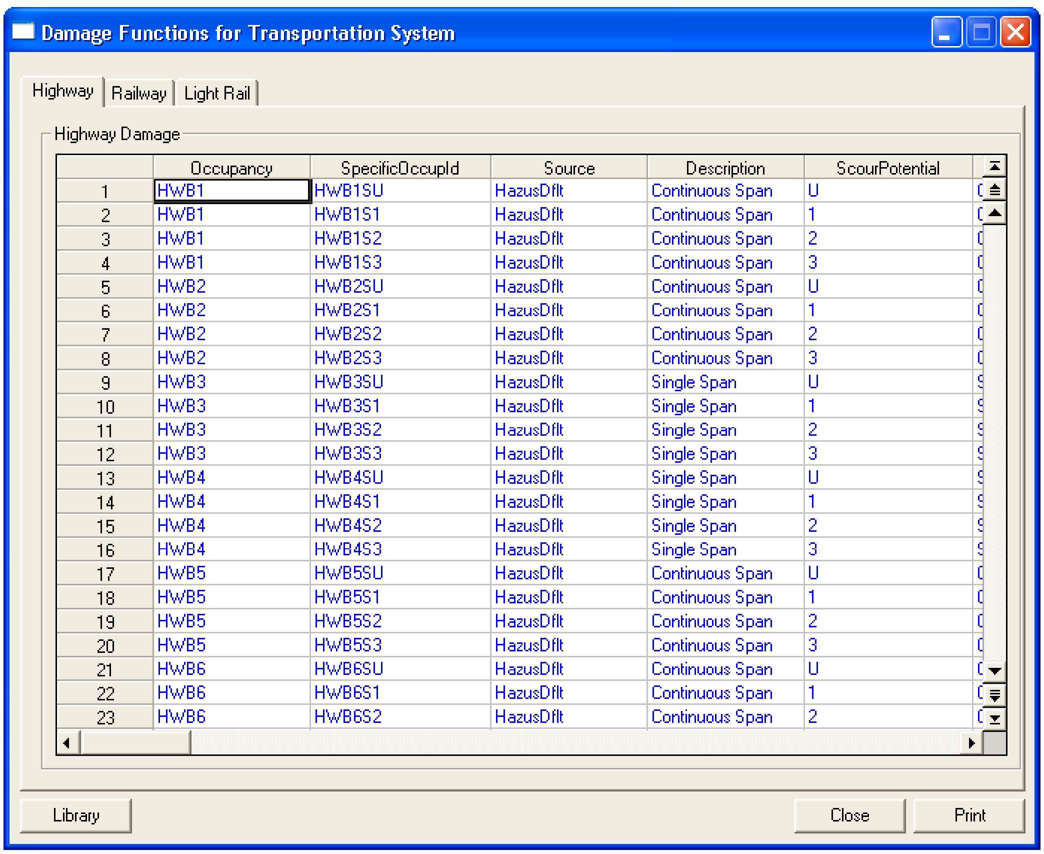


Figure 3.113 Transportation Damage Function Dialog

The entry dialog for utility facilities can be seen in Figure 3.114. As with the transportation facilities, the tabs allow the user to choose the utility facility for review since there are no contents or inventory functions available.

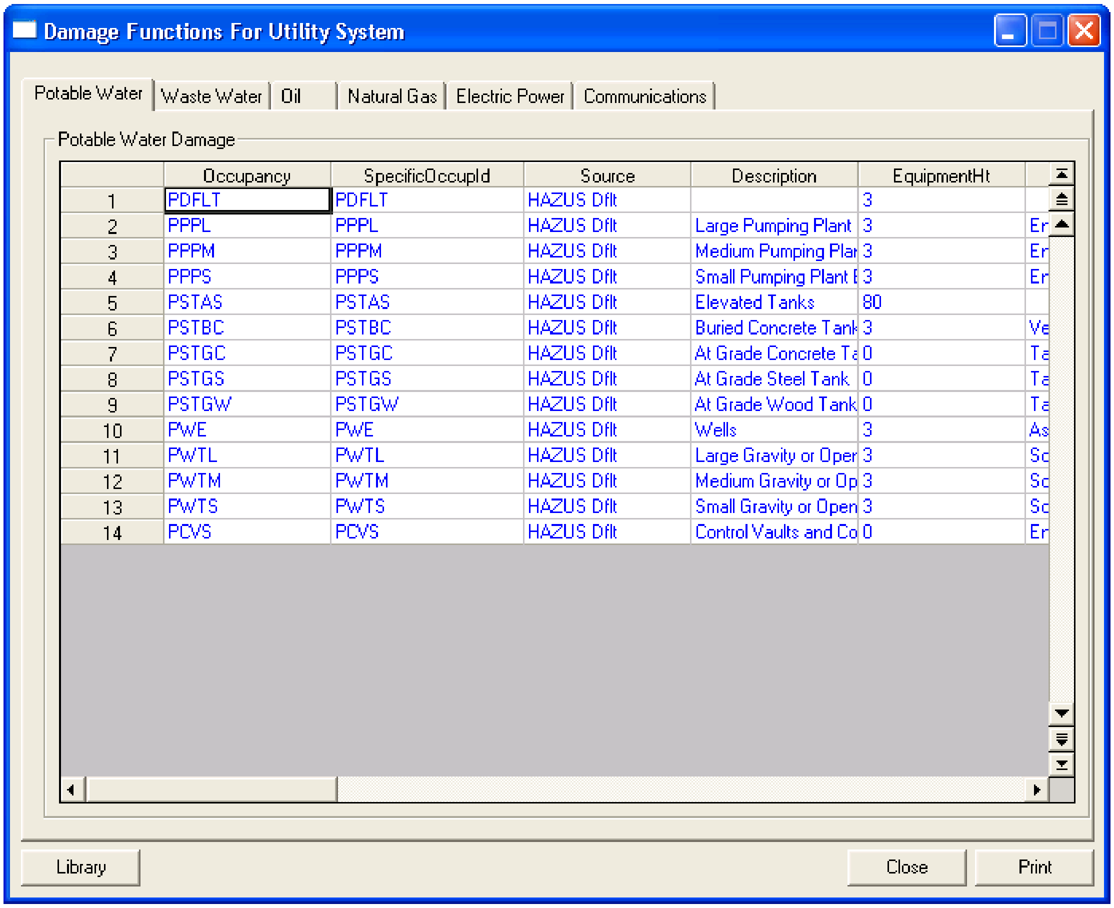
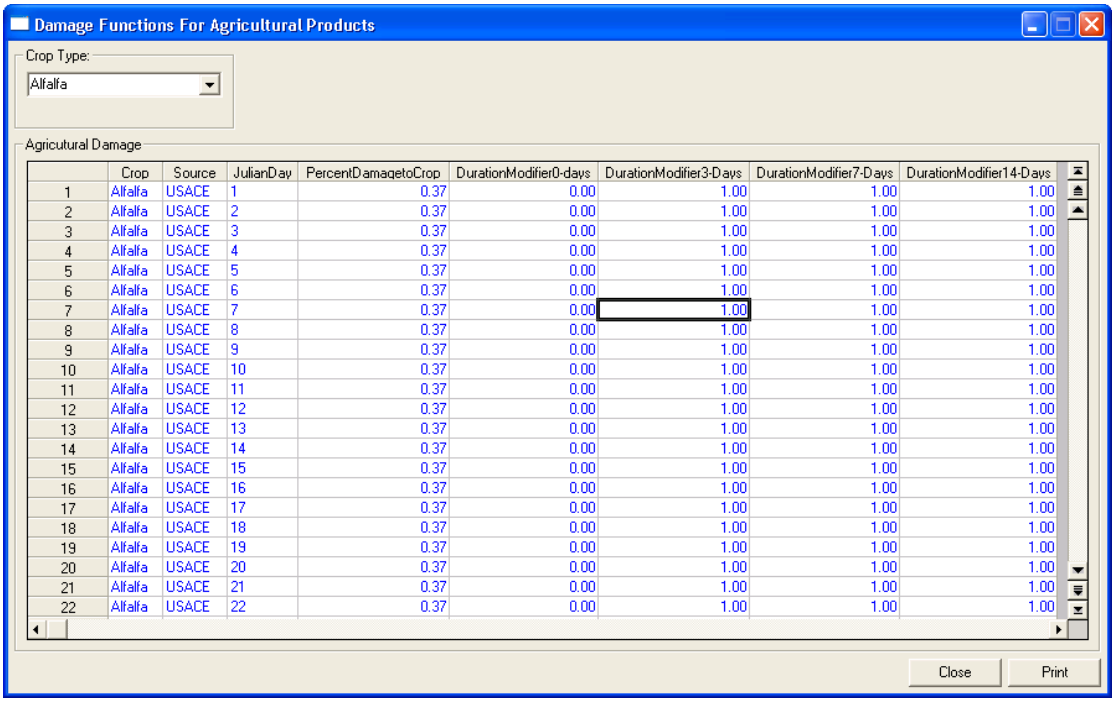


Figure 3.114 Utility Facility Damage Function Dialog

The Agriculture products damage function dialog behaves similar to the GBS damage function browsers, but has been modified to support the different crops available to the user. The entry dialog can be seen in Figure 3.115.

The Flood Model team gathered a number of damage functions from the US Army Corps of Engineers (UASCE) for various crops. The total number of damage functions available were limited and in some cases functions had to be created to allow the users to work with the top agricultural crops within each state. The damage functions are based on a Julian calendar system. For the user's convenience, the Flood Model makes the conversion between the standard calendar day and month to the Julian date.

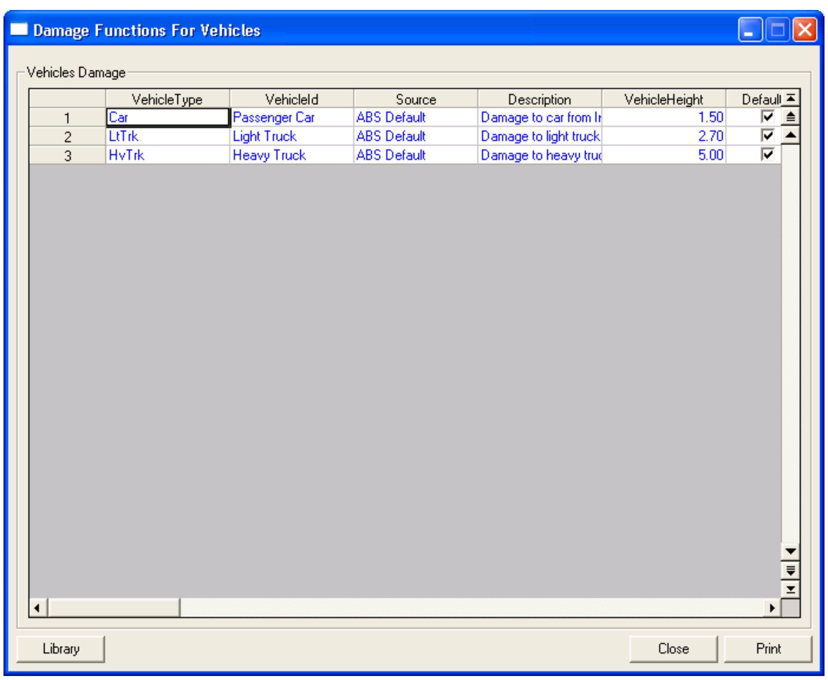
At this time, the Flood Model assumes a short duration, slow rise flood when analyzing losses. Agriculture crops are particularly sensitive to duration and the functions obtained from the USACE had damage modifiers that allows for the estimation of flood damages should the flood last 0-days, 3-days, 7-days and 14-days. The damage functions all indicate that the maximum damage is obtained at the 14-day interval.



	Crop	Source	JulianDay	PercentDamagetoCrop	DurationModifier0-days	DurationModifier3-Days	DurationModifier7-Days	DurationModifier14-Days
1	Alfalfa	USACE	1	0.37	0.00	1.00	1.00	1.00
2	Alfalfa	USACE	2	0.37	0.00	1.00	1.00	1.00
3	Alfalfa	USACE	3	0.37	0.00	1.00	1.00	1.00
4	Alfalfa	USACE	4	0.37	0.00	1.00	1.00	1.00
5	Alfalfa	USACE	5	0.37	0.00	1.00	1.00	1.00
6	Alfalfa	USACE	6	0.37	0.00	1.00	1.00	1.00
7	Alfalfa	USACE	7	0.37	0.00	1.00	1.00	1.00
8	Alfalfa	USACE	8	0.37	0.00	1.00	1.00	1.00
9	Alfalfa	USACE	9	0.37	0.00	1.00	1.00	1.00
10	Alfalfa	USACE	10	0.37	0.00	1.00	1.00	1.00
11	Alfalfa	USACE	11	0.37	0.00	1.00	1.00	1.00
12	Alfalfa	USACE	12	0.37	0.00	1.00	1.00	1.00
13	Alfalfa	USACE	13	0.37	0.00	1.00	1.00	1.00
14	Alfalfa	USACE	14	0.37	0.00	1.00	1.00	1.00
15	Alfalfa	USACE	15	0.37	0.00	1.00	1.00	1.00
16	Alfalfa	USACE	16	0.37	0.00	1.00	1.00	1.00
17	Alfalfa	USACE	17	0.37	0.00	1.00	1.00	1.00
18	Alfalfa	USACE	18	0.37	0.00	1.00	1.00	1.00
19	Alfalfa	USACE	19	0.37	0.00	1.00	1.00	1.00
20	Alfalfa	USACE	20	0.37	0.00	1.00	1.00	1.00
21	Alfalfa	USACE	21	0.37	0.00	1.00	1.00	1.00
22	Alfalfa	USACE	22	0.37	0.00	1.00	1.00	1.00

Figure 3.115 Agriculture Products Damage Function

The final damage function viewer is for Vehicles. Figure 3.116 below shows the entry dialog for vehicles.



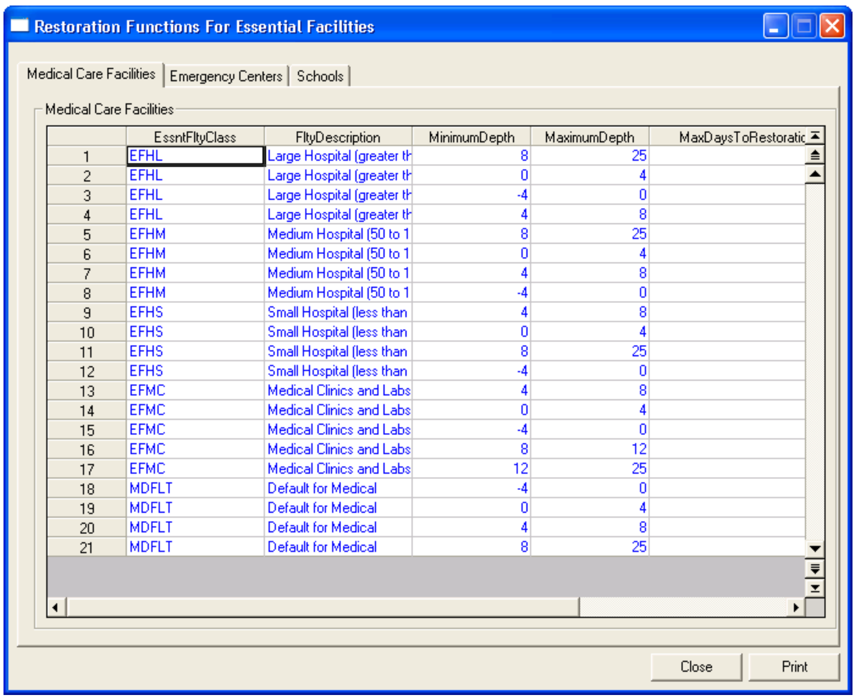
	VehicleType	VehicleId	Source	Description	VehicleHeight	Default
1	Car	Passenger Car	ABS Default	Damage to car from Ir	1.50	☑
2	LtTrk	Light Truck	ABS Default	Damage to light truck	2.70	☑
3	HvTrk	Heavy Truck	ABS Default	Damage to heavy truc	5.00	☑

Figure 3.116 Vehicle Damage Function

3.4.2 Viewing Restoration Functions

The Flood Model provides restoration functions for GBS and Essential Facilities. The GBS restoration functions are discussed in the *Analysis* menu, *Parameters* submenu discussion as the GBS values are included in the *Direct Economic* parameter tables. Built off the restoration timelines for the related GBS occupancies, the essential facilities restoration models provide the user with a general indication of the maximum restoration time for 100% operations. Obviously, there will be a great deal of effort to quickly restore essential facilities to full functionality and therefore this will be an indication of the maximum downtime.

The *Analysis* menu, *Restoration Functions* submenu opens the dialog seen in Figure 3.117 below. In this case, the figure shows the dialog on the Emergency Center Tab where the user can select Emergency Centers, Police Stations and Fire Stations. The restoration functions are editable and the user can adjust the "Max Days To Restoration" column and the "Functional Depth" column. These values are based on the depth of flooding at the specific facility (the latitude and longitude).



	EssntFltyClass	FltyDescription	MinimumDepth	MaximumDepth	MaxDaysToRestoratic
1	EFHL	Large Hospital (greater th	8	25	
2	EFHL	Large Hospital (greater th	0	4	
3	EFHL	Large Hospital (greater th	-4	0	
4	EFHL	Large Hospital (greater th	4	8	
5	EFHM	Medium Hospital (50 to 1	8	25	
6	EFHM	Medium Hospital (50 to 1	0	4	
7	EFHM	Medium Hospital (50 to 1	4	8	
8	EFHM	Medium Hospital (50 to 1	-4	0	
9	EFHS	Small Hospital (less than	4	8	
10	EFHS	Small Hospital (less than	0	4	
11	EFHS	Small Hospital (less than	8	25	
12	EFHS	Small Hospital (less than	-4	0	
13	EFMC	Medical Clinics and Labs	4	8	
14	EFMC	Medical Clinics and Labs	0	4	
15	EFMC	Medical Clinics and Labs	-4	0	
16	EFMC	Medical Clinics and Labs	8	12	
17	EFMC	Medical Clinics and Labs	12	25	
18	MDFLT	Default for Medical	-4	0	
19	MDFLT	Default for Medical	0	4	
20	MDFLT	Default for Medical	4	8	
21	MDFLT	Default for Medical	8	25	

Figure 3.117 Essential Facilities Restoration Functions

3.4.3 Setting Analysis Parameters

There are several parameters that the user may want to view and/or modify prior to starting their analysis. In one case, Agriculture, the user is required to input a value before the Flood Model can perform the analysis. This section will walk the user through the parameters available to the user. Every attempt has been made to provide default values wherever possible and this allows the model to perform most requested analysis without user intervention.

The Analysis menu Parameters submenu appears in Figure 3.118 below. The menu provides access to the default parameters used in the analysis of *Debris*, *Shelter*, *Agriculture*, *Direct Economic*, and *Indirect Economic*. The Casualties menu item opens a word document that provides the user with some guidance on the natural average for casualties. The Flood Model does not provide estimates for flood related casualties at this time.

Figure 3.118 Analysis Parameters Menu

Selection of the Debris menu item opens an editable dialog that allows the user to view the default debris values. Debris is estimated based on the depth of flooding within the structure, similar to the estimation of GBS damage, specific occupancy, and whether the foundation has a footing or a slab. The user can use the combo boxes to shift between specific occupancies and the foundation types.

Debris is estimated in three main classifications that align loosely with the earthquake models method of classification including: finishes (dry wall, flooring, insulation, etc,), structure (framing, walls, exterior cladding), and foundation weight (concrete slab, concrete block or other foundation). Unlike the earthquake model, where moderate damage may still result in the foundation being removed, flooding requires the structure to be considered substantially damaged before the foundation is removed.

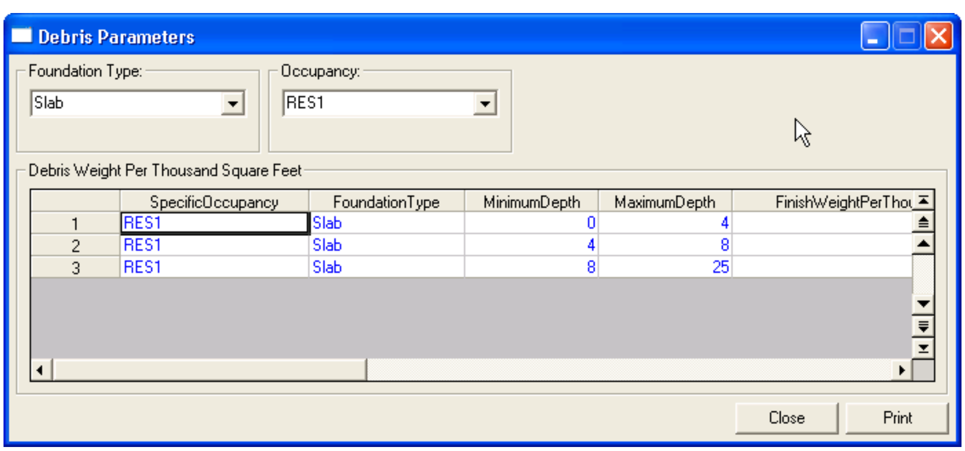


Figure 3.119 Debris Analysis Parameters

The *Shelter* menu item opens a dialog with multiple tabs and allows the user to gain access to the various parameters that affect the number of people who are evacuated (displaced) and the number of people who require short term sheltering. Since the Flood Model does not address flooding such as flash flooding or long-duration flooding at this time, there is an assumption that the local authorities will have time to alert the residents and evacuate directly from the areas that will flood. This means any portion of a census block that is flooded initially is assumed to have all of the residents removed from the area. Ultimately, the level of damage within the GBS will determine how many people require short-term sheltering.

The first tab (Figure 3.120) of the shelter parameter dialog allows the user to identify at what flood depth people are no longer allowed into or out of the flooded area. This input will not impact the results, but is provided to allow the user to think about their local plans and what access controls might be in place. The next input, the evacuation buffer, will have a direct impact on the results. This value is a buffer the Flood Model will add to the current floodplain polygon. In essence, this value will increase the floodplain polygon by the distance input by the user, such as 500-feet. The model will then estimate the total population within the floodplain boundary and the buffer to identify the displaced population.

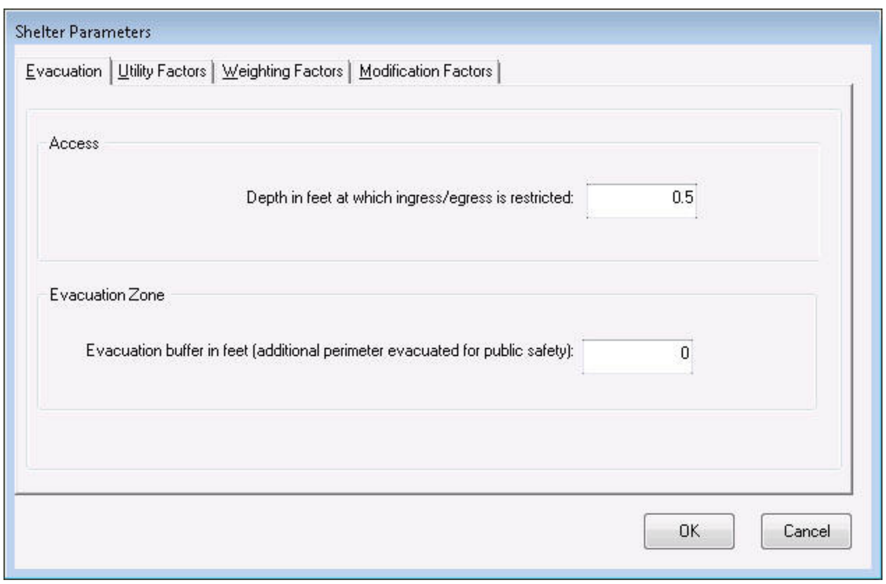


Figure 3.120 Shelter Evacuation Parameter

The Utility Outage tab is used in the determination of the short-term shelter needs. The lack of utilities to areas impacted by floodwaters will prevent some of the displaced population from immediately returning to their homes. This percentage factored in as the short-term needs is developed.

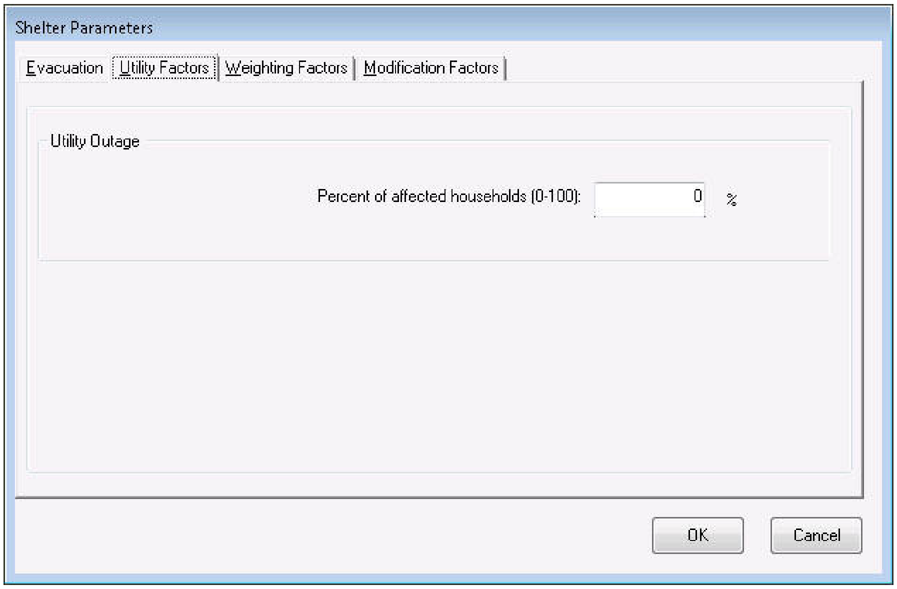


Figure 3.121 Shelter Utility Outage Parameter

The Weighting Factors tab is a table where the user can modify the weighting applied to certain demographic characteristics for the population. As seen in Figure 3.122 below, this includes income, age, ethnicity, and home ownership. Initially developed for the earthquake model, the weighting parameters do not have the same values and have much less emphasis on factors such as ethnicity (where the decision to seek shelter in earthquakes does vary with ethnicity) and ownership. As parameters, the fact that authorities evacuate most every resident and the population is not concerned about the structural integrity of the shelter site greatly reduces their importance. Age and Income carries about the same weighting as the earthquake model because these do tend to drive the decision to seek housing in a shelter site or an alternative location such as a hotel.

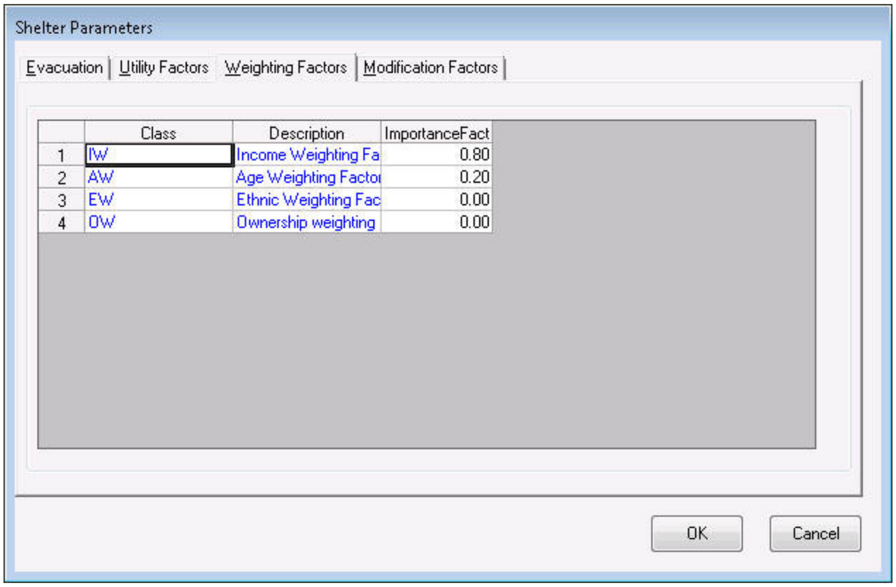


Figure 3.122 Shelter Weighting Factors

The Modification Factors tab could be considered more correctly the weighting factors sub classification weighting. For example, Figure 3.123 shows the Age modification factors. These factors allow the user to place more emphasis or increase the importance of the population under 16 thereby increasing the number of people under the age of 16-years who would seek shelters. The combo box provides the user access to the Income weighting also. Like the age factor, this allows the user to place more importance on those residents that fall within a certain income range.

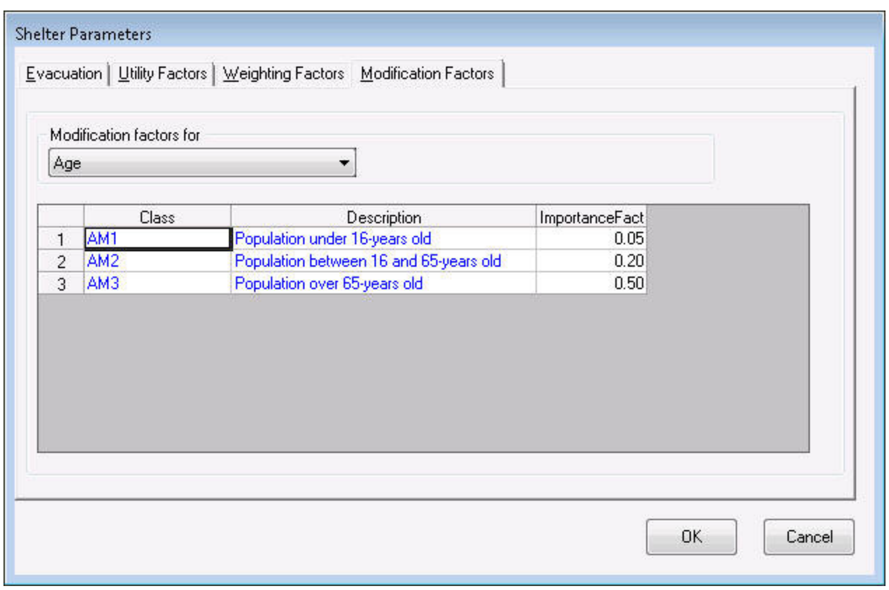


Figure 3.123 Shelter Modification Factors

Probably most important among the analysis parameters because no default value can be provided, the *Agriculture* menu item requires some user input in order for the agriculture analysis to run properly. Agriculture products are very dependent on the date when the flooding occurs. For example, if the flood occurs during the winter, and the type of crops grown in the region are typically planted in the spring, the net loss to the region will be pretty small. If, however, the flooding occurs just prior to harvest, when the farmers are the most heavily invested and their opportunity to replant the smallest, then the impacts and losses will be greater.

As stated previously, the Flood Model can determine the Julian date depending on the date the user inputs to the Flood Model. Figure 3.124 shows the dialog where the user provides a calendar date. The combo boxes allow the user to quickly select the day (01-31) and month (Jan.-Dec.) for conversion into Julian date (1-365).

Figure 3.124 Agriculture Calendar Date Parameter

The *Direct Economic* parameter menu item opens the dialogs seen in Figure 3.125 through Figure 3.127. These dialogs provide the user with access to the default parameters that control the estimation of the direct damages to the general building stock. This includes the impact of the flood scenario on the wages, income, inventory and the maximum restoration time for the general building stock.

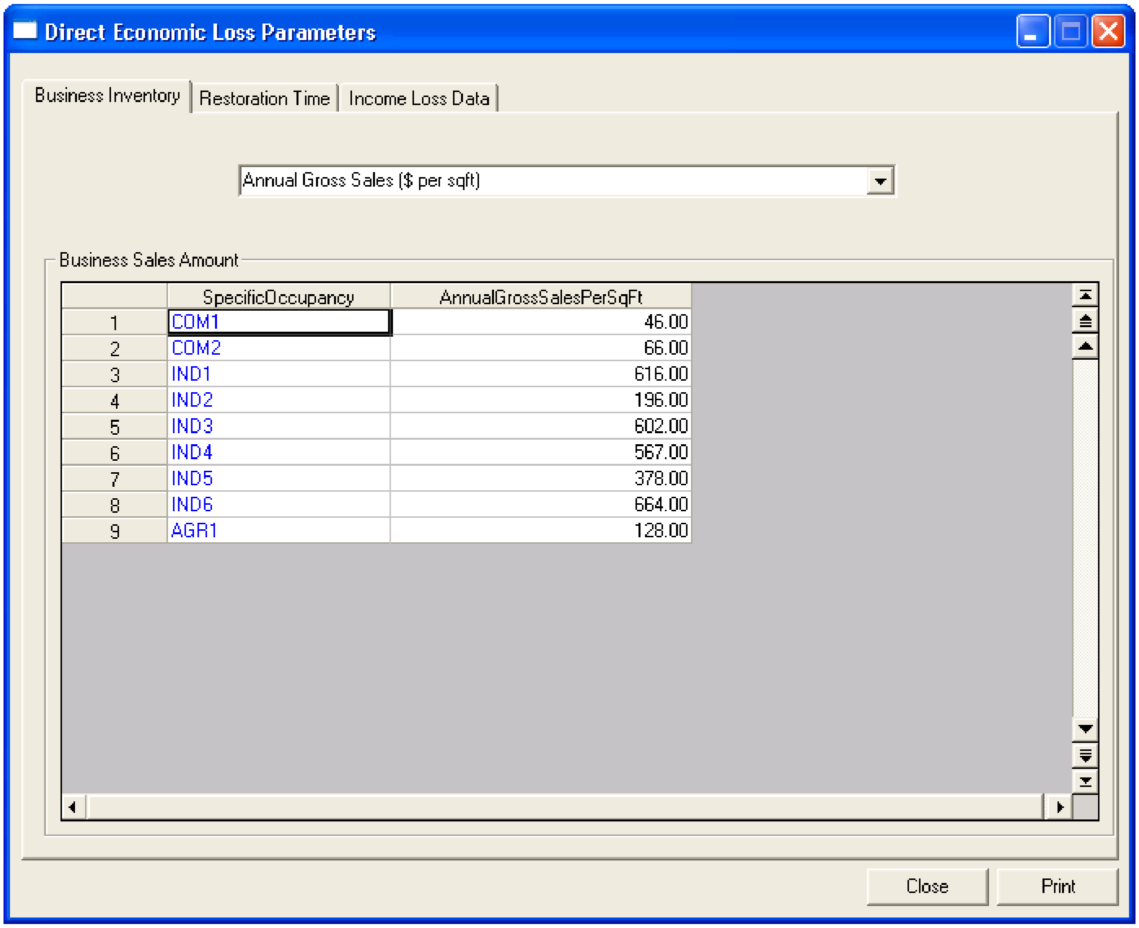


Figure 3.125 Direct Economic Parameter – Business Inventory

The GBS restoration functions define the maximum amount of time it should take for any given specific occupancy to be restored. For example, in Figure 3.126 the RES1 restoration time is based on the depth of flooding within the structure. In the case of the RES1, it is can be seen that even though the water has not fully entered the structure, it may take up to a year to clean up the structure, replace any sub-flooring that may be damaged, obtain permits, and inspections. Again, this is a maximum timeline meant to provide a conservative estimate for the losses associated with the restoration process.

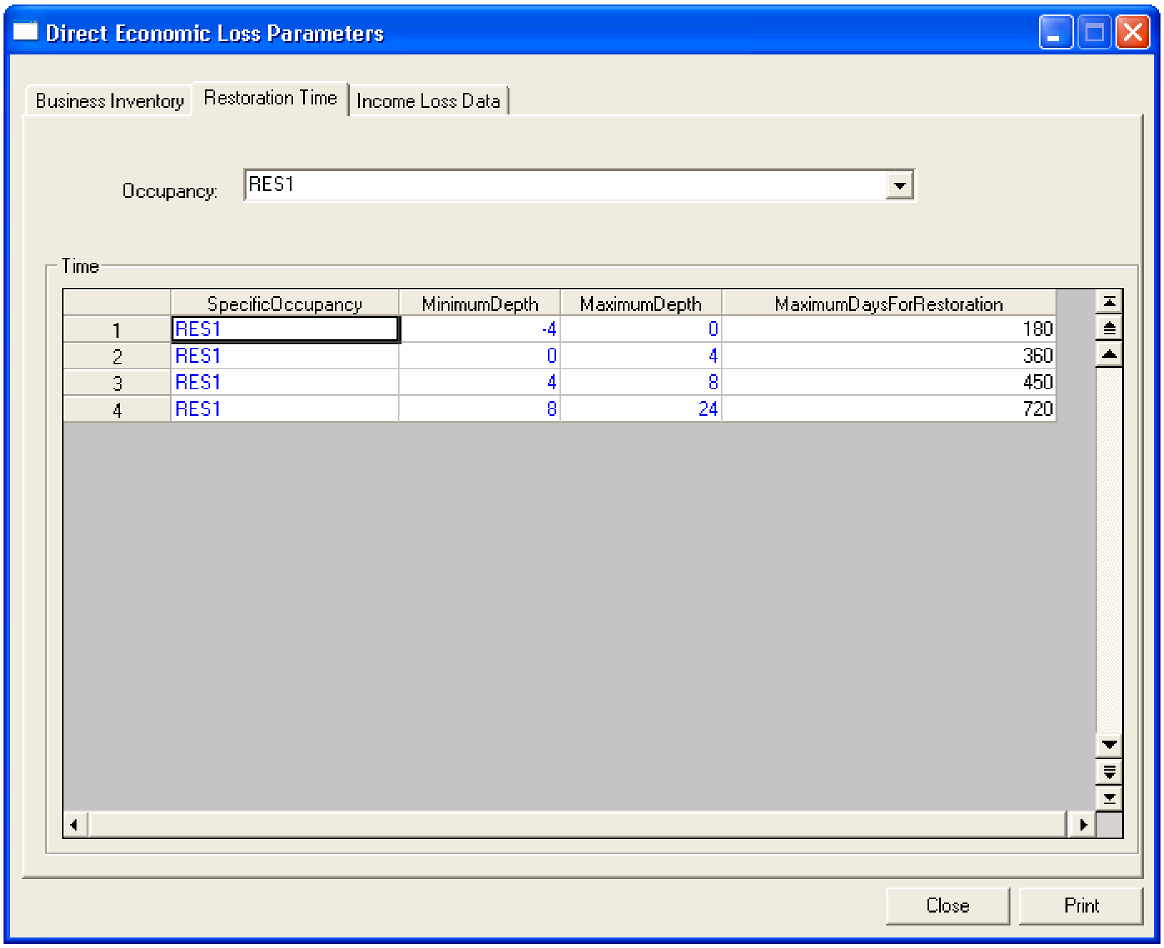


Figure 3.126 General Building Stock Maximum Restoration Time

It is important to note that some of the factors shown on the Direct Economic dialogs also feed into the Indirect Economic Loss Module. One example of can be viewed by the user through the selection of the Wages and Capital Related Income parameters found in the combo box at the top of the dialog in Figure 3.127 below. Parameters from these tables are used to identify IELM needs such as the total employees within the study region.

These parameters are also used to develop the direct losses for wages and capital income presented in the GBS Economic Losses.

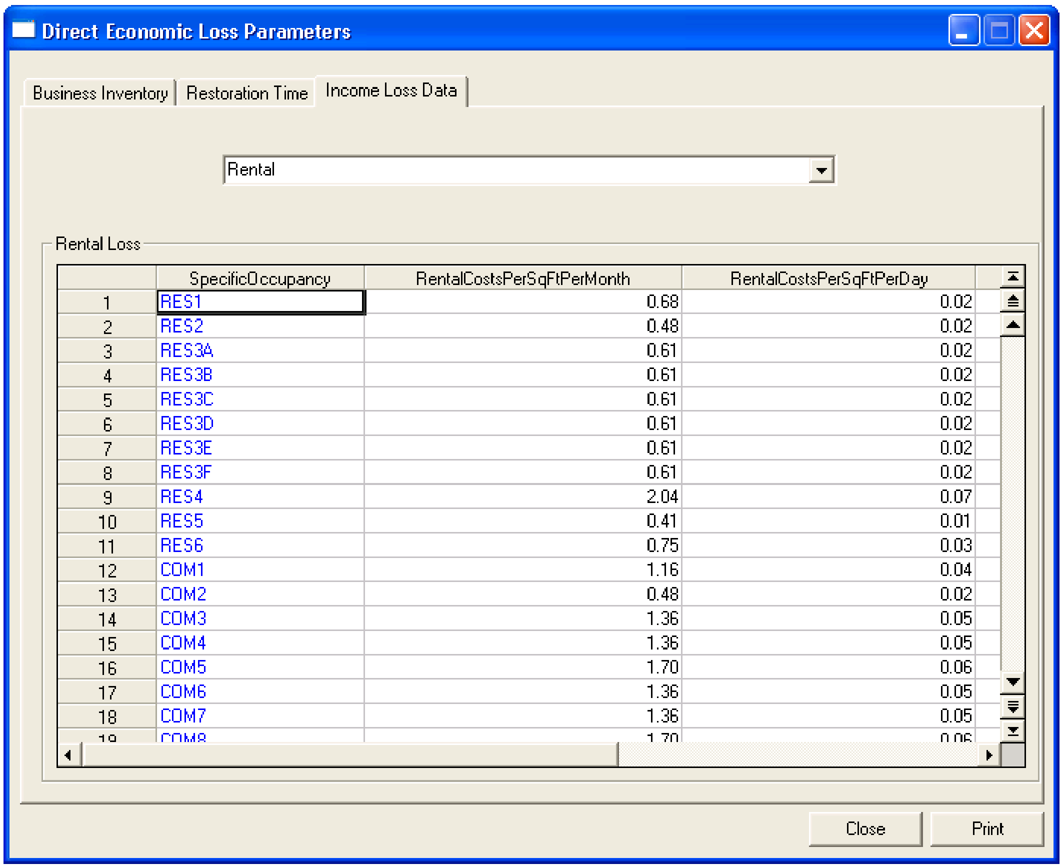


Figure 3.127 Income Loss Data – Rental, Owner Occupied, Wages and Capital, and Recapture Factors

3.4.4 Flood Warning

Another key parameter the user can use to perform "what-if" type analysis efforts is the Flood Warning. Flood warning is an interesting issue in that everyone assumes that damage and losses can be reduced with effective flood warning, but there is considerable disagreement over the amount of reduction, or even if it is possible to reduce damages based on effective warning. The Flood Model takes advantage of the famous Day curve developed by the USACE. This curve attempts to quantify the maximum level of damage reduction achievable based on the amount of time a flood warning has been available. The curve itself approaches a maximum value of approximately 35% for structural, content, and business inventory losses regardless of how much warning is available.

Instead of having the user input a warning time and interpreting the Day curve to provide an expected reduction in damage, the Flood Model provides the Day curve in the Technical Manual and asks the user to estimate their warning time and find the expected reduction in damage, putting this factor into the dialog seen in Figure 3.128 below. The Flood Model will then uniformly reduce the damage by the anticipated reduction. In the case of vehicles, there was no evidence of documentation that provides any guidance on how much vehicular damage can be avoided with warning. Conventional wisdom would indicate that the percentage should be relatively high. With little information to work from, the Flood Model has provided the user to opportunity to select their vehicular reductions.

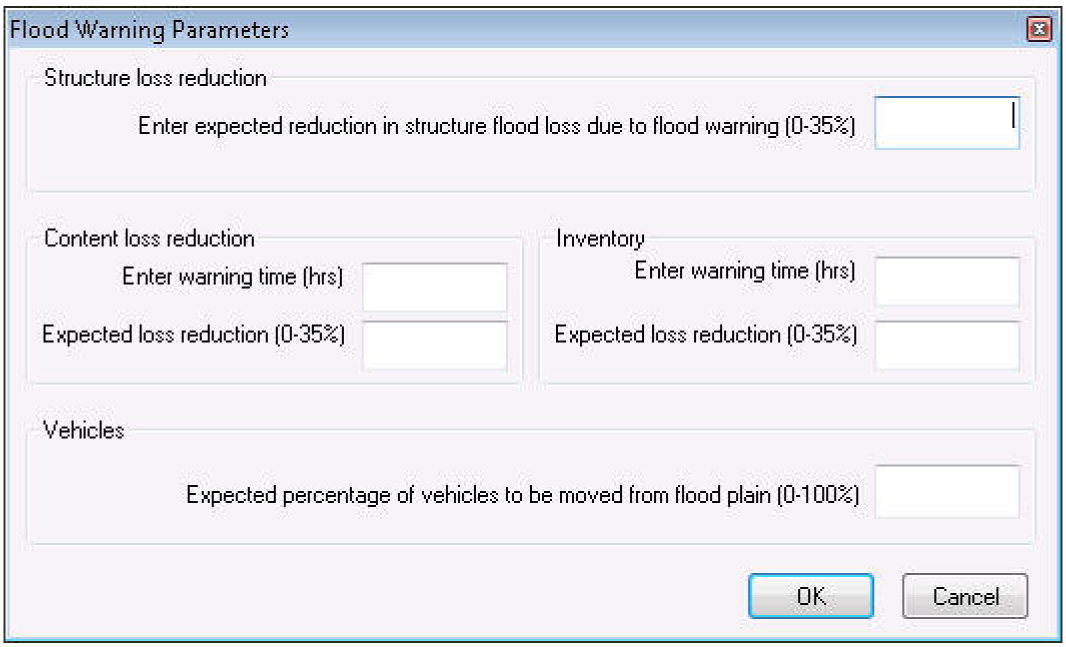


Figure 3.128 Warning Parameters

Note that the parameters for structures, contents, and business inventory are limited to a maximum of 35% based on the maximum provide by the Day curves. The user could input 100% reduction for vehicular damage and this may not be unreasonable if an area is evacuated with plenty of warning time. Note that the Flood Model has provided the user the option to input the warning time to help them remember the parameters that led to a particular value input into the dialog.

3.4.5 Annualized Loss

Annualized loss is a process by which the user can determine their maximum potential annual loss. This analysis requires that the user has performed an Annualized Loss on the Calculate hazard menus for Riverine, Coastal or both as shown in the Figure 3.129 below.

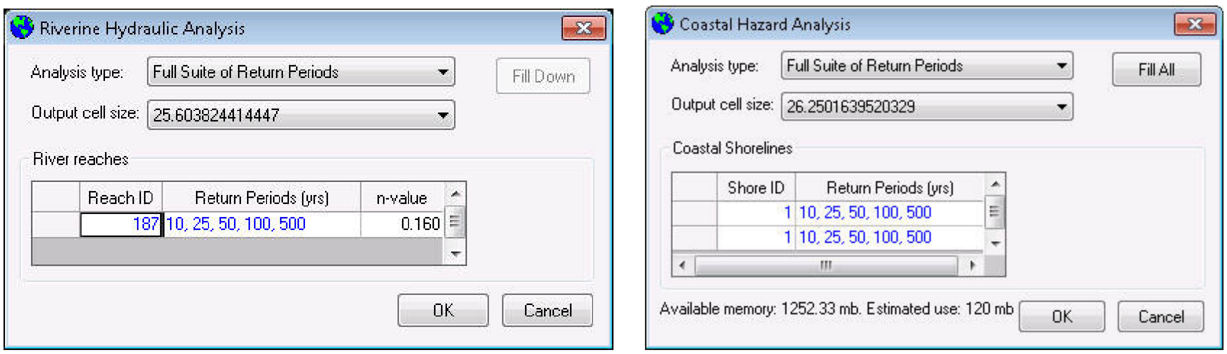


Figure 3.129 Hazard Analysis – Annualized Loss Selection

In order to perform an annualized loss assessment, the user must perform the following steps. 1) Select *Delineate Floodplain* on the *Riverine* or *Coastal* submenu. 2) Complete general building stock analysis from the *Run* selection on the *Analysis* menu. 3) Select *Annualized Loss* on the *Analysis* Menu. The first step ensures that all of the flood depth grids necessary to perform an annualized loss (10-, -25, 50-, 100-, and 500-year) are available. The second step creates the analysis results from the return periods analyzed. The third step sets the analysis bits that tell the Flood Model to interpolate and extrapolate for other return periods and develop a maximum probably annual loss.

With the hazard developed for all of the necessary return periods, selection of the *Annualized Loss* menu item will set a flag that starts the analysis. Annualized losses are essentially the summation of losses over all return periods multiplied by the probability of those floods occurring. In mathematical terms, the analysis essentially looks like this:

AL = Σ (Prob of Occurrence) * ($ loss)

Naturally, the more losses you assess, the more accurate your answer will become. Because all three models within **Hazus** need to produce common intervals to allow for the multi-hazard analysis, the Flood Model interpolates for some return intervals and extrapolates to others in alignment with the earthquake and wind models. The user can view the results of the analysis in the Results browsers and Crystal Summary Reports (available under Results/Summary Reports/Loss tab).

3.4.6 Quick Look and Enhanced Quick Look

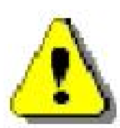
The Quick Look and Enhanced Quick Look was created to provide a user a way of performing a very quick "snapshot" type analysis to gain some insight into a particular problem. The Quick Analysis is intended to be used on vary localized flooding issues, and is intended to allow the user to establish some known condition and attempt to provide a quick quantification of potential loss. Quick Look and Enhanced Quick Look do not establish a flow regime.

An example of how the Quick Analysis might be used is if there are heavy rains in a community and there is one basin within the community where water typically collects. It has been several years and development has been allowed to occur in the area, which is outside of any regulatory floodplain. In Quick Look, the user can quickly draw a few polygons, assigning a depth of flooding to each in accordance with the recollections of the local population. In Enhanced Quick Look, the user can import a floodplain boundary polygon along with the DEM. The user would then perform a loss analysis to identify potential loss for either Quick Look or Enhanced Quick Look.

The quick analysis results can be viewed in the Quick Analysis Crystal Reports.

3.4.7 Combined Hurricane and Flood Analysis

The objective of the combined loss analysis is to estimate the total losses sustained by the general building stock within a region due to the winds, storm surge and waves generated by a single, user-specific hurricane scenario. The primary motivation for the combined hurricane and flood loss analysis is to avoid "double counting" of damage in cases where the same building is exposed to both hurricane and flood hazards during a hurricane. At a minimum, the combined hurricane and flood loss must be at least the larger of the hurricane-only or the flood-only loss. At a maximum, the combined loss must be no larger than the lesser of the sum of the hurricane-only and flood-only losses or 100% of the building (or contents) replacement value.



The coastal surge analysis is only performed on the General Building Stock (GBS). The GBS results tables are populated and a summary report uniquely developed for the Combined Hurricane and Flood is populated.

Once the hazard portion of the Coastal Surge Model is complete, users need to run the analysis on the general building stock to determine the flood-only loss. Under the Analysis menu, select "Run." Select "General Building Stock Damage and Loss" in the Analysis Options dialog, and then click OK, as seen in Figure 3.130.

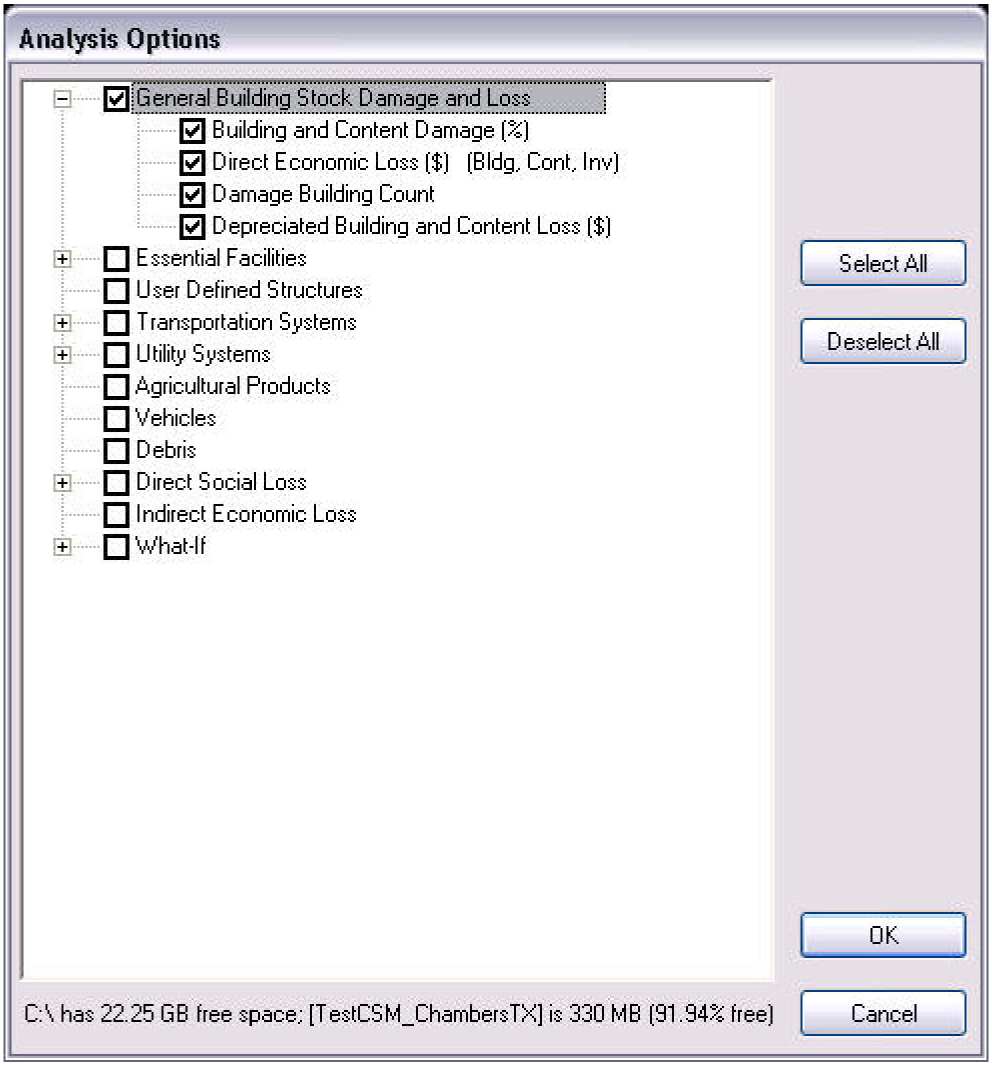


Figure 3.130 Selecting Analysis Options for Coastal Surge Model

When the GBS analysis is complete, the "Combined Wind and Flood…" menu item is enabled under the Analysis menu. Select the "Combined Wind and Flood…" menu item, seen in Figure 3.131, to run the analysis that combines the losses from the hurricane and flood hazards.

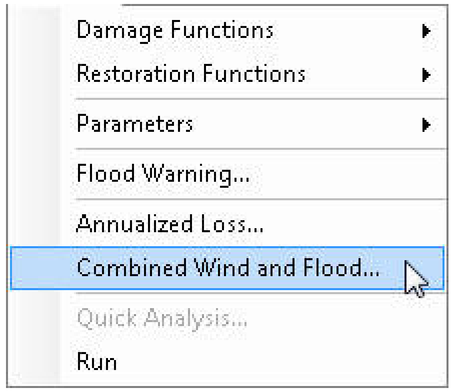


Figure 3.131 Combined Wind and Flood

A message box and status dialog will appear notifying the user that the Combined Wind and Flood Coastal Surge analysis is running (seen in Figure 3.132), and another message box will notify the user once the analysis is complete, as seen in Figure 3.133.

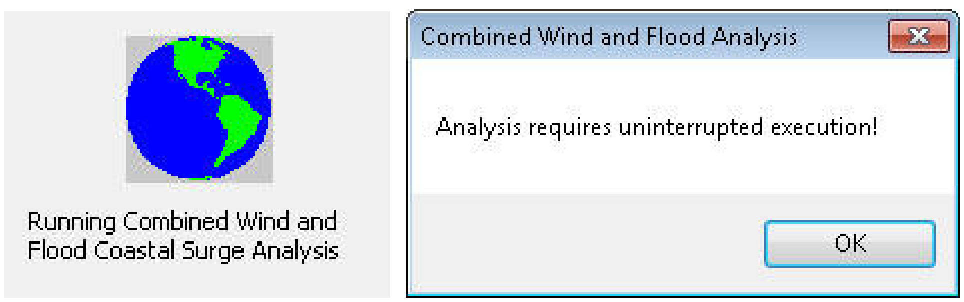


Figure 3.132 Combined Wind and Flood Coastal Surge Analysis

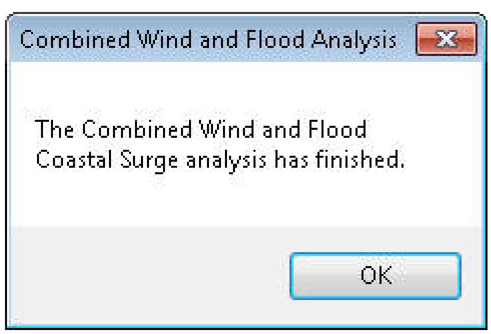


Figure 3.133 Combined Wind and Flood Coastal Surge Completed

The combined coastal surge analysis results can be viewed in the Combined Wind and Flood Loss browser under the Results menu and the Combined Wind and Surge Loss Crystal Report (available under Results/Summary Reports/Loss tab).

3.4.8 Running an Analysis

Once the user parameters have been selected or modified, select *Run* from the *Analysis* menu. The window shown in Figure 3.134 will pop up.

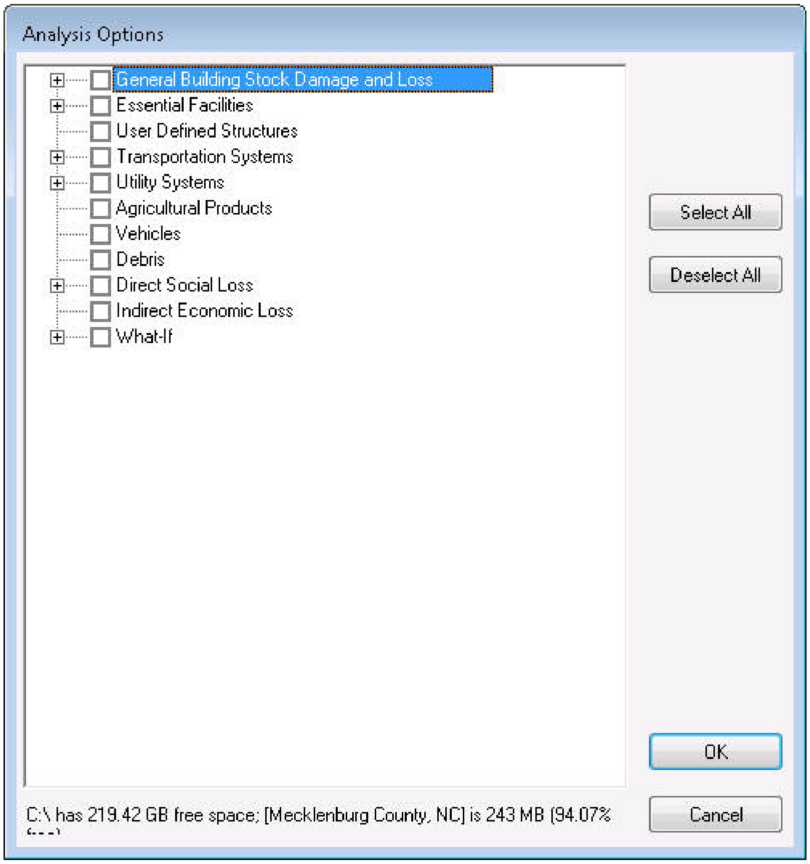


Figure 3.134 Selecting Analysis Options

Clicking on the plus and minus signs will expand and collapse the lists of available options. Click on the boxes of the analysis options you are interested in running, which will be marked with a check mark to indicate they are selected. Note that some analysis options have pre-requisite analysis requirements and selection of that option will automatically check the box of the prerequisite. At the bottom of the window, Hazus will indicate the amount of hard drive disk space available on the machine and the percentage of the study region's database that has been used so far. The study region's database has a limit of 4 GB, therefore, if the percentage used is more than 50 percent, there is less than 2 GB of space that can be used for the analysis.

Hazus can conduct default analysis runs for the following items:

- General building stock
- Essential facilities
- Selected infrastructure, including highway bridges and water systems
- Agriculture products,
- Vehicles,
- Debris,
- Shelter requirements

The types of default data provided for your study region limit the analysis modules that you can run. In order to run a What-If analysis, the same analysis must have been run from the hazard menu. When you have selected the desired analysis options, click *OK*.

When running the Analysis, the **Hazus** screen might go blank or the Task Manager “Applications” tab will indicate that **Hazus** is not responding. This is a common symptom for any software that is process heavy. In order to check if **Hazus** is still running, users should check the Task Manager “Processes” tab and sort the “CPU” column in descending order. The “sqlservr.exe” process should be on top. If the “System Idle Process” is constantly on top at 99-100%, this could be an indication that **Hazus** is not responding. Users could also check the “Performances” tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the scenario folder (in “Details” view) and make sure the FlAnalysisLog is updating by looking at the “Date modified.”

Running the Analysis, specifically the General Building Stock Damage and Loss, can take up many hours to process and successfully complete.

For users who would like to view the intermediate analysis completion status, go to *Customize* menu and select *Flood Options*, and check the “Show redo analyses warning message box(es)” checkbox (example shown in Figure 3.135). This option only applies if the user is redoing the analyses.

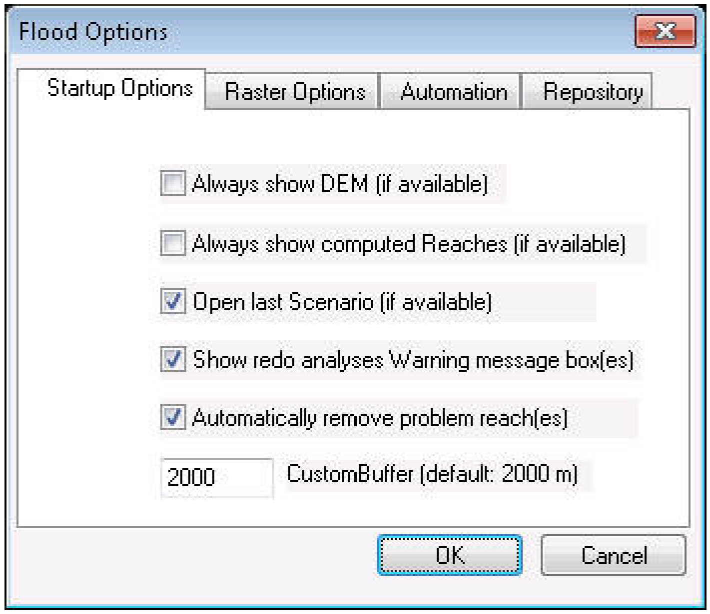


Figure 3.135 Flood Options

3.5 Viewing Analysis Results

Analysis results can be viewed in tabular, map or printed report formats. Before viewing results, you need to specify which scenario results you would like to open. Through this selection process, the user identifies which Scenario, Return Period, and Analysis Options.

3.5.1 Selecting a Scenario to View Results

Select *View Current Scenario Results By* from the *Results* menu. The window shown in Figure 3.136 will appear. You must select one of the available hazard analyses before you can review results in any form.

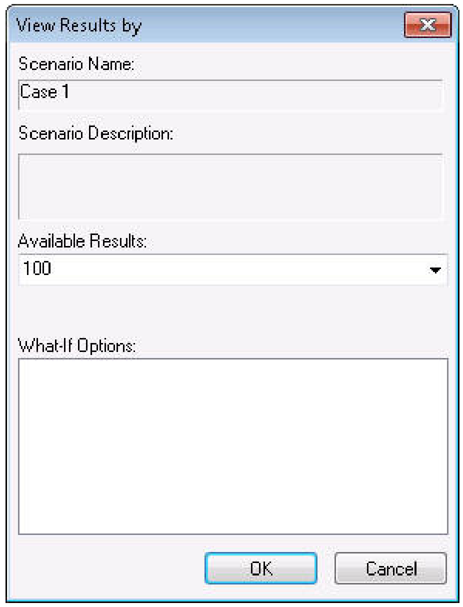


Figure 3.136 Selecting Available Results to View

3.5.2 View Tabular Results

We will view general building stock results as an example of viewing results in tabular form. From the *Results* menu and the *General Building Stock Damage* submenu, select *By Occupancy*. Results similar to those shown in Figure 3.137 will be shown.

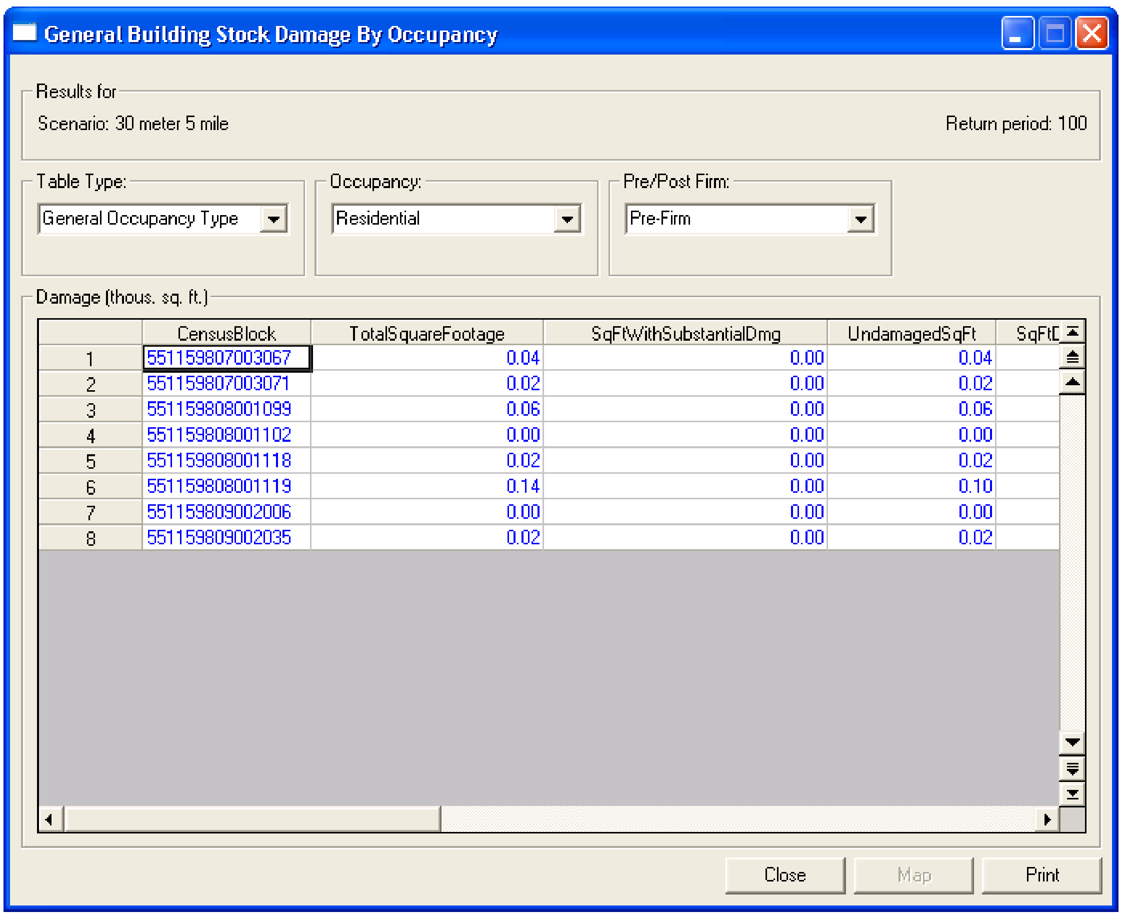


Figure 3.137 General Building Stock Damage by General Occupancy Table

General building stock damage results can also be displayed by building type and building count.

3.5.3 View Mapped Results

You can view mapped results of both the flood hazard and the resultant damage. To see the flood hazard mapped, select *Results/Flood Hazard Maps/Thematic Map of Depth*. The depth grid is shown in blue, with the floodplain boundary on top in orange.

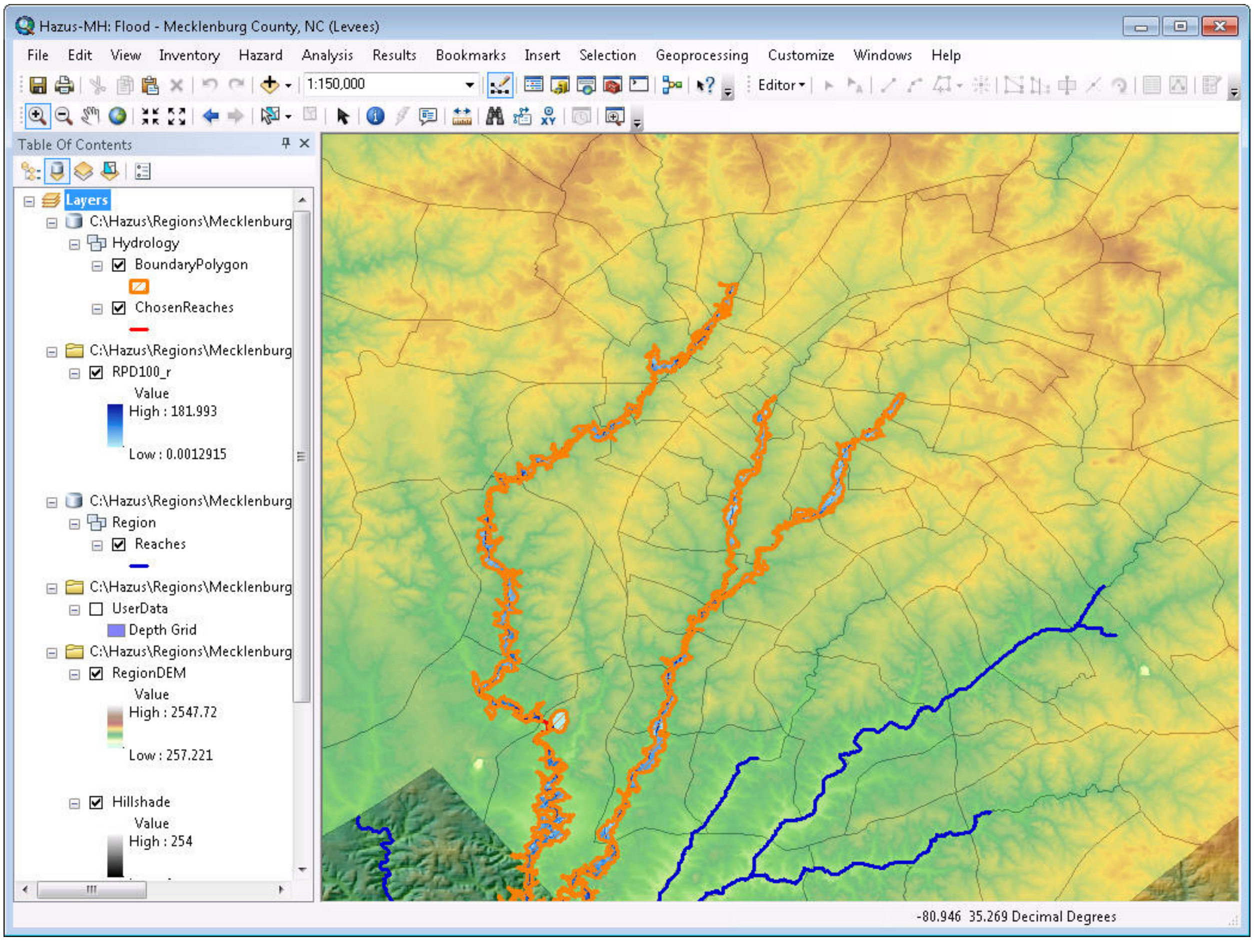


Figure 3.138 Thematic Depth Grid Map

To map the damage, first, view the results of interest in table form. The procedure to map results is the same as that to map inventory data, illustrated in section 3.2.1. Select the column of results that you like to map. Click on the *Map* button at the bottom of the window showing tabular results. Mapped results should appear on the screen.

3.5.4 Other Results

The results menu contains items to view many other results through tables and thematic maps. To avoid repetition, each menu item will not be discussed herein. Results will be available for those analysis modules checked in the Analysis/Run dialog.

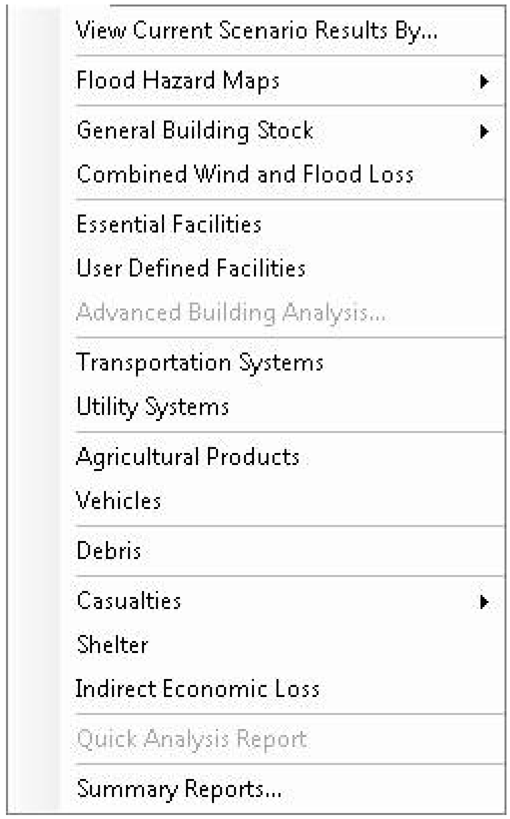


Figure 3.139 Results Menu

3.5.5 Print Reports

You can print results directly in table or map forms, or you can select one of the numerous pre-formatted reports built-in to **Hazus**. To access these pre-formatted reports, select *Summary Reports* from the *Results* menu (Figure 3.140). The Flood Model provides 40 such reports in categories of inventory exposure, building damage, lifeline damage, induced, losses, and other.

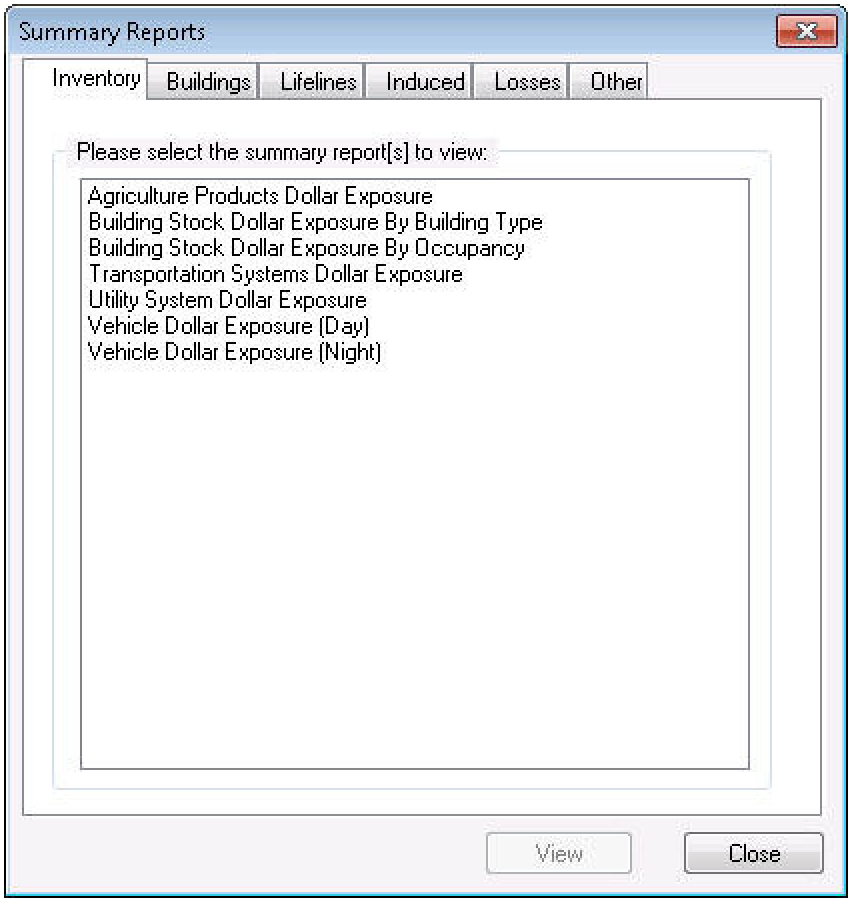


Figure 3.140 Summary Reports Dialog

To display a report, select the report of interest and click on the **View** button (Figure 3.140).

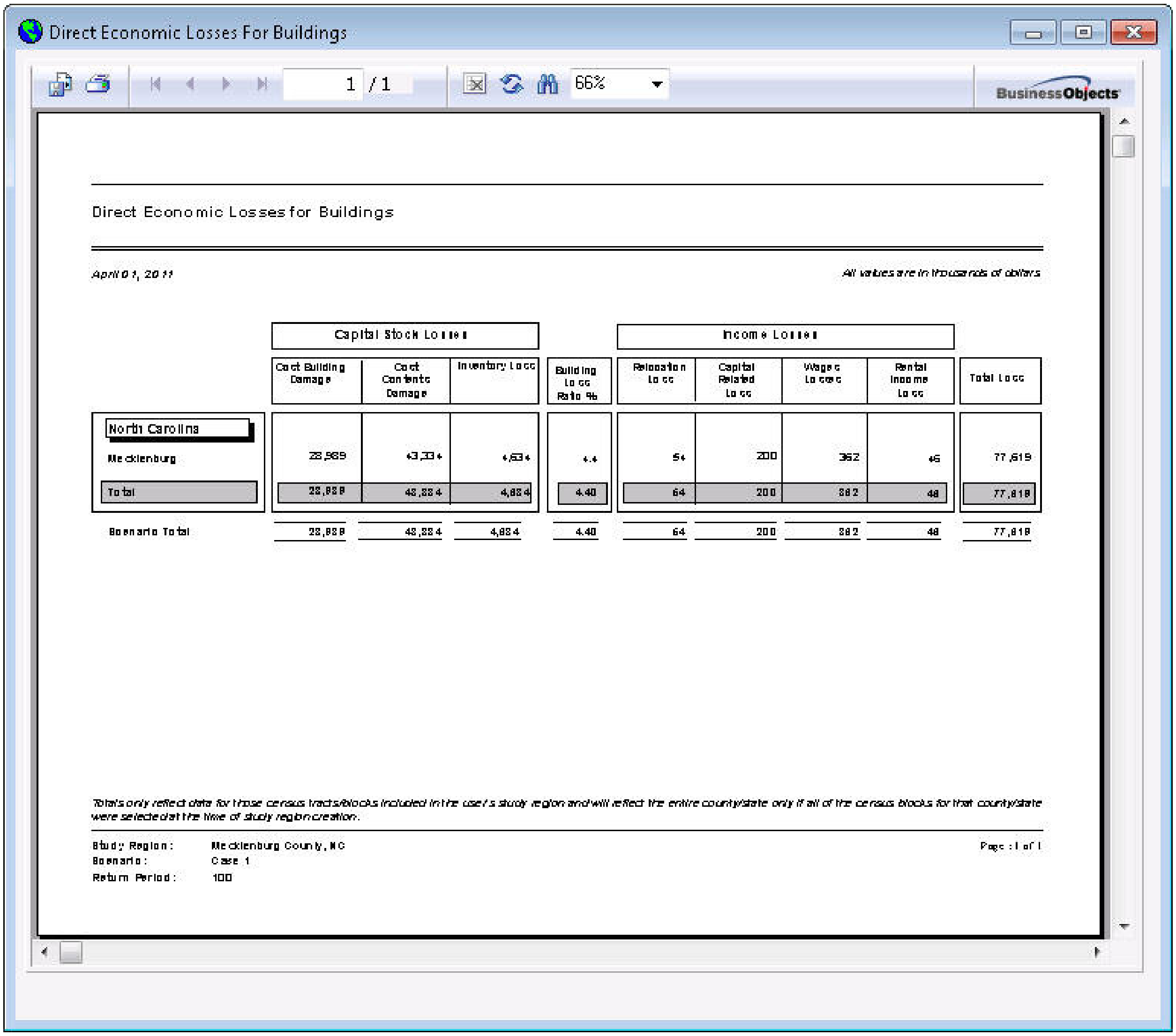


Figure 3.141 Sample Summary Report

To print the report, click on the print button in the upper left hand corner of the report window. In addition, the summary report can be exported to a number of file formats by clicking on the export button in the upper left hand corner of the report window.

3.5.6 Export Results Using Repository

Hazus includes a feature called Repository that exports the GBS results from each scenario into a SQL Server database defined by the user. ***NOTE:*** The user must run the Repository *after* running GBS analysis in order to view results in the SQL Server database.

To run the repository feature, the user should perform the following steps:

1. Select *Flood Options* from the *Customize* menu.

2. Navigate to the Repository tab. The user needs to set the parameters required to run the repository, as seen in Figure 3.142.

   a. Select "Output Results to Repository" checkbox.

   b. Set Repository Instance, which should be automatically populated to the local machine and SQL Instance. Users can edit the Repository Instance, if needed. Click on "Verify" to ensure the repository instance is valid.

   c. Set Repository Database name (the name must be unique). Click on "Verify" to ensure the repository database name is valid.

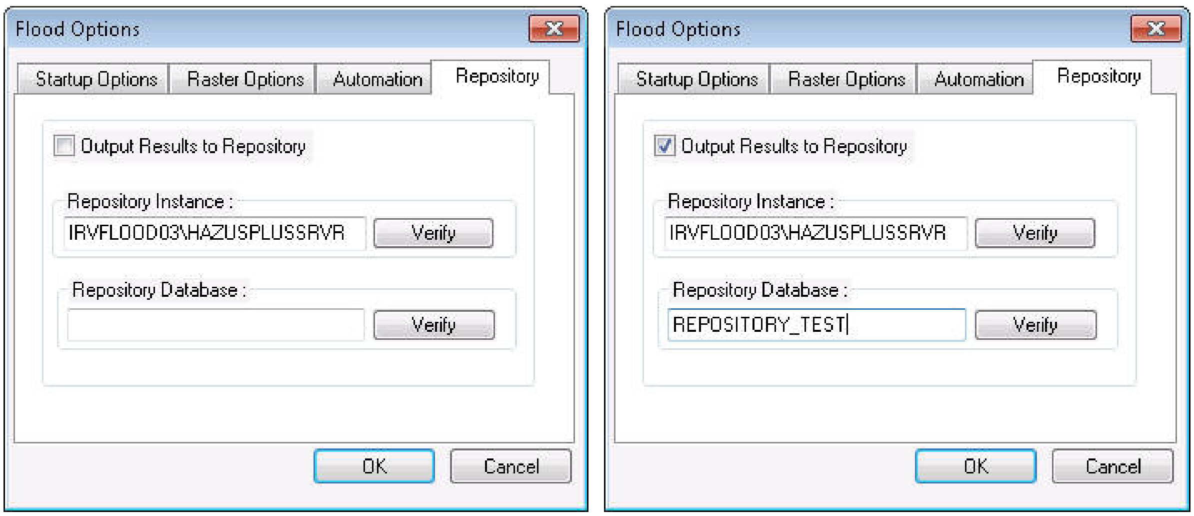


Figure 3.142 Repository tab, before and after parameter input

   d. Click *OK* button. A message indicating the parameters, as seen in Figure 3.143 below, will pop-up and validate the Repository's instance and database. Click *OK* and the results will be exported to a SQL Server Database.

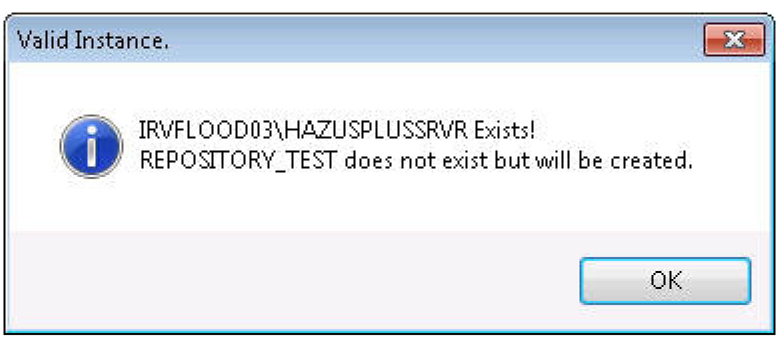


Figure 3.143 Validated Repository Instance and Database Creation

3. The results are exported to the new SQL Server database. It can be located in SQL Server Management Studio by navigating to Databases > REPOSITORY_TEST (in this sample case) > Tables > dbo.AALRepository.

   a. To view the results, create a new query in SQL Server.

   b. Select the newly created database and query the following:

      select * from AALRepository

   c. A line for each scenario in the study region should populate with the total GBS results, as seen in Figure 3.144.

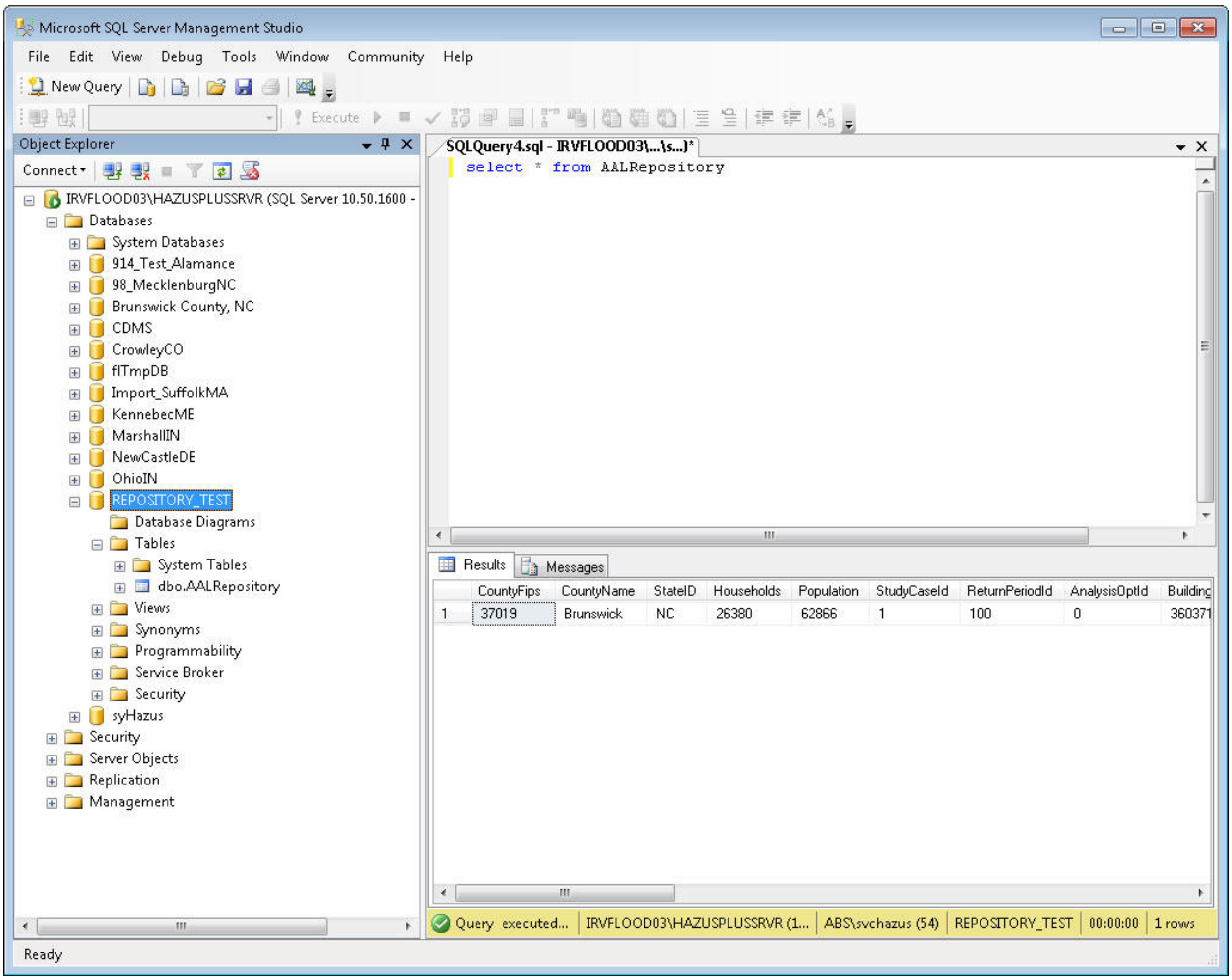


Figure 3.144 Exported Repository Results in SQL Server

3.6 Default Databases

The loss estimates produced are crude estimates of losses based on a minimum of local input. Most users will develop a local inventory that best reflects the characteristics of their region, such as building types and demographics. The quality and uncertainty of the results are affected by the detail and accuracy of the community-specific data provided. Estimates produced using default data, as done in this Section, should only be used as initial estimates to determine where more detailed data collection and analyses are warranted, or for studies covering large geographic areas.

This section describes the types of data that are supplied as defaults with **Hazus**. Default inventory databases are of two types. The first type is a national listing of individual facilities, such as dams, bridges, or locations where hazardous materials are stored. These databases are modified versions of publicly available databases. The modifications that have been made have been to eliminate data elements that are not needed for natural disaster loss estimations. The second type of default database consists of data aggregated on a county, census tract or census block level. Examples are building stock square footage for each census block. These default databases are also derived from publicly available data.

The default databases are stored on the **Hazus** DVD. When you create a study region, **Hazus** extracts only those portions of the databases that are relevant to your study region and your selected hazards, and stores them on your computer's hard drive. You can then access these region specific default databases and update them with improved information that you have obtained, as discussed in Section 7.

A list of default inventory information currently supplied with **Hazus** appears in Table 4.1 in the next Section.

In addition to default databases, the user is supplied with default analysis parameters documented throughout the Technical Manual. In many cases these parameters are defined on a national basis without adjustments for regional variations. In other cases such as with percent of buildings with basements, regional variations are included. Examples of default parameters are costs per square foot to replace a structure of a certain specific occupancy class and estimated height of the first floor above grade for various foundation types. Depth-damage curves are supplied for each specific occupancy class. The user can modify all of these parameters if better information is available, as discussed in Sections 7 and 9.

Chapter 4 Data Needed for a More Complete Loss Estimation Study

To estimate losses due to natural disasters, you need to characterize both the potential hazard and the environment that will be impacted. Clearly, a flood that occurs near a densely populated region will cause different types of losses than one that occurs in a mostly agricultural region. The **Hazus** software comes with default data about the buildings, utilities and people that occupy an area, and the hydrologic and hydraulic characteristics of flooding events. These defaults provide good starting points for flood risk analyses, but many users will want to collect better data on their community's inventory and hazard characteristics.

This section describes the approach you should take for developing more detailed data sets on the structures, people and characteristics that contribute to your community's flood risk. Compiling a community inventory is discussed, followed by a discussion of improving flood hazard data. For ideas about potential sources for this information, see Section 5.

4.1 Developing an Inventory

The inventory data analyzed by **Hazus** includes the general building stock, essential facilities, high potential loss facilities, transportation systems, utility systems, facilities storing hazardous materials, demographics, agricultural products, vehicles, and user-defined facilities. First, you need to identify the elements of the inventory that are most critical for the analyses you wish to run. For example, if you are most interested in potential economic losses in residential structures, your data collection efforts should focus on collecting data on the number of residential buildings, their characteristics, and values. Second, design an approach for collecting the data. Some data can be found in pre-existing computer databases; others will have to be compiled into databases for the first time. All data collection and compilation efforts need to be done using the classification schemes required by **Hazus**, introduced below and discussed in more detail in the Technical Manual.

4.1.1 Inventory Components

Table 4.1 lists the inventory components that can be analyzed by **Hazus**. Each user should identify those items that are most important to their communities. Some of these items have default data provided with the **Hazus** software, as indicated. While **Hazus** allows users to input data on all of these topics, the damage and losses are only calculated for specific types of facilities, as indicated. Even though **Hazus** does not calculate detailed losses for military facilities, as an example, it can be useful to input detailed data about these facilities and view their locations and characteristics in the context of the calculated flood hazard.

Table 4.1 Hazus Flood Inventory Components

TYPE OF INFRASTRUCTURE	INPUT DATA	DEFAULT DATA
General Building Stock	• Square footage by specific occupancy class	✓
	• Number of buildings by specific occupancy class	✓
	• Replacement cost per square foot by specific occupancy class	✓
	• Dollar exposure	✓
	• Depreciation parameters	✓
	• Foundation types and first floor heights by specific occupancy class	✓
Essential Facilities	• Medical care facilities	✓
	• Emergency operations centers	✓
	• Police stations	✓
	• Fire stations	✓
	• Schools	✓
High Potential Loss Facilities	• Dams and levees	✓
	• Nuclear facilities	
	• Military facilities	
Transportation Systems	• Highways infrastructure	✓
	• Railway infrastructure	
	• Airports	✓
	• Bus, port, light rail, and ferry infrastructure	
Utility Systems	• Potable water systems	✓
	• Wastewater infrastructure	
	• Oil and gas infrastructure	
	• Electric power infrastructure	
	• Communications infrastructure	
Hazardous Materials	• Specific locations and characteristics	✓
Demographics	• Population by age, race, and income levels	✓
	• Day and night populations	✓
	• Number of property owners and renters	✓
	• Rental and vacancy rates	✓
Agricultural Products	•	
Vehicles	• Vehicles by type and value	✓
	• Vehicles during day and night hours	✓
User defined facilities	• Any facilities which the user wishes to analyze on an individual basis	

For detailed information about the exact format of data to collect, please see the Technical Manual and examine the tables under the *Inventory* menu.

4.1.2 Approach

In developing a regional inventory, it is almost impossible from a cost point of view to individually identify and inventory each man-made structure. Some important structures such as hospitals, schools, emergency operation centers, fire stations, important bridges, and electrical power substations may be identified individually, but the majority of buildings in a region are grouped together collectively and identified by their total value or square footage. To permit modeling of spatial variation in types and occupancies of buildings, a region is built up from sub-regions, and the inventory is collected for each sub-region. In the flood loss estimation methodology, census blocks are used as the basic sub-region unit, and all regions are built up by aggregating data for individual census blocks. Thus for each census block, your inventory might consist of the number of square feet of buildings by specific occupancy type, the probability of a building having a specific foundation by specific occupancy type, and the average height of the first floor above grade by foundation type.

In the **Hazus** loss estimation methodology, the residential, commercial, industrial and other buildings that are not identified individually are aggregated and in aggregate, are referred to as the General Building Stock (GBS). The General Building Stock is inventoried by calculating, for each census block, the total square footage of groups of buildings with specific characteristics (i.e., calculating the total square footage of all one story single family homes that have basements). While the default GBS data has been built from data in the U.S. Census, and from data on commercial enterprises provided by Dun & Bradstreet, replacing the default data with more precise data collected at the local level can be problematic. There are rarely reliable and complete databases that provide the necessary information such as building size, foundation type, height of the first floor, and value of contents that could be used to obtain total values for each census block or tract. Therefore, in general, inferences are made about large groups of buildings based on land use patterns, census information, business patterns, assessors' data, insurance information, etc. Similar types of inferences are made with respect to lifeline systems (e.g., the number of miles of water supply pipe in a census block may be inferred from the number of miles of streets).

In contrast to the inventory of General Building Stock, which is maintained in terms of total square footage or building counts per census block or tract, facilities that have some special significance such as essential facilities or components of lifeline systems can be maintained in the database by individual location. Within **Hazus,** losses for essential facilities and some lifeline components are computed for individual facilities, whereas losses for the General Building Stock are calculated by census block or tract. While some inferences may be required to supplement available data for site-specific facilities when data are unavailable, these data are often more readily available than those required for the General Building Stock. Sometimes there will be few enough of these facilities that you can actually go to the site and collect the required inventory information. Sources of inventory information and how to go about collecting it are discussed in Section 5.

4.1.3 Classification Systems

There are two issues that must be considered in the development of an inventory: classification of data, and collection and handling of data. Classification systems are essential to ensuring a uniform interpretation of data and results. As discussed earlier, it is almost impossible, from a cost point of view, to identify and individually inventory each building or component of each lifeline. Thus losses in a regional study are estimated based on general characteristics of buildings or lifeline components, and classification systems are a tool to group together structures or lifeline components that would be expected to behave similarly in a flood event. For each of the types of data that must be collected to perform a loss study, a classification system has been defined in this methodology.

For example, the building classification system used in this methodology has been developed to provide the ability to differentiate between buildings with substantially different damage and loss characteristics. In general, the amount of damage sustained by buildings is different due to their precise location, the elevation of the first floor, the value of the structure and contents, and the building's configuration and exposure to flood waters. As a consequence of these variations, no two buildings will experience the same levels of damage when subjected to a flood. Therefore, occupancy classes and model building types are defined to represent the typical characteristics of buildings in a class. Within any given class there will be a great deal of variation.

To model flood losses within **Hazus**, the most relevant classification for the General Building Stock is the occupancy classification scheme. The occupancy classification scheme is broken into general occupancy and specific occupancy classes. The general occupancy classification system consists of seven groups: residential, commercial, industrial, agriculture, religion/non-profit, government, and education. The specific occupancy classification scheme consists of 33 classes, shown in Table 4.2. Occupancy classes are used to account for the fact that contributions to losses are driven by both the structural characteristics and non-structural elements, and the types and costs of both structural and non-structural elements are often governed by the occupancy of the building, e.g., in a warehouse there may be few expensive wall coverings, whereas a bank may have expensive lighting and wall finishes. If these two buildings experience the same depths of flooding, the costs to repair the bank will be greater than the warehouse due to the more expensive finishes. Other issues related to occupancy may also be important, such as rental costs, number of employees, type of building contents and importance of function.

Table 4.2 Hazus Specific Occupancy Classes

Hazus-MH Label	Occupancy Class	Hazus-MH Label	Occupancy Class
RES1	Single Family Dwelling	COM7	Medical Office/Clinic
RES2	Mobile Home	COM8	Entertainment & Recreation
RES3A	Multi Family Dwelling - Duplex	COM9	Theaters
RES3B	Multi Family Dwelling – 3-4 Units	COM10	Parking
RES3C	Multi Family Dwelling – 5-9 Units	IND1	Heavy
RES3D	Multi Family Dwelling – 10-19 Units	IND2	Light
RES3E	Multi Family Dwelling – 20-49 Units	IND3	Food/Drugs/Chemicals
RES3F	Multi Family Dwelling – 50+ Units	IND4	Metals/Minerals Processing
RES4	Temporary Lodging	IND5	High Technology
RES5	Institutional Dormitory	IND6	Construction
RES6	Nursing Home	AGR1	Agriculture
COM1	Retail Trade	REL1	Church/Membership Organizations
COM2	Wholesale Trade	GOV1	General Services
COM3	Personal and Repair Services	GOV2	Emergency Response
COM4	Business/Professional/Technical Services	EDU1	Schools/Libraries
COM5	Depository Institutions	EDU2	Colleges/Universities
COM6	Hospital		

For more detail about the **Hazus** classification systems, please refer to the Technical Manual.

4.2 Improving Flood Hazard Data

Improving the quality of flood hazard information will make the analyses more accurate. Improved information could include superior ground elevation data, FIRM floodplain boundaries, or the output of detailed, local hydrologic analyses. The Flood Information Tool (FIT) has been developed to process user-supplied hazard data, in a wide variety of forms, into the formats required by the **Hazus** model. A schematic of the FIT appears in Figure 4.1. The FIT has a separate manual, which users who plan to enhance their flood hazard data should consult. A brief overview of the capabilities of the FIT is presented below.

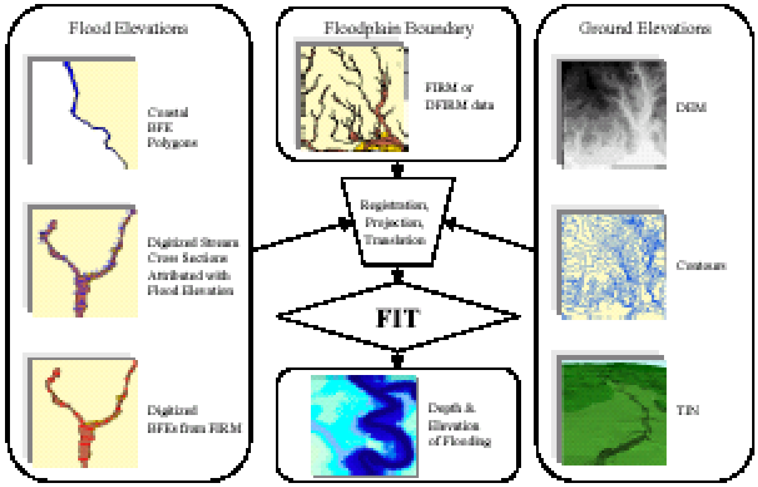


Figure 4.1 FIT Schematic

4.2.1 Riverine Capabilities

The riverine portion of the FIT was developed to allow users of **Hazus** to incorporate results of their own, stream-specific, hydraulic models. The primary FIT output is a flood depth grid or a set of such grids formatted for use in **Hazus**. The spatial data required to run the riverine portion of the FIT are a digital elevation model (DEM), a set of polylines (cross sections) attributed with flood elevations, and a polygon that defines a representative floodplain boundary. The DEM should be an ArcInfo grid; the polyline and polygon files should be ESRI feature classes.

4.2.2 Coastal Capabilities

The coastal portion of the FIT was developed to allow users of **Hazus** to incorporate data from coastal flood hazard maps produced by FEMA or produced by other sources. The result of the FIT is a flood depth grid or a set of such grids formatted for use in **Hazus.** The data required to run the coastal portion of the FIT are a digital elevation model (DEM), a set of polygons (areas subject to flooding) attributed with base flood elevations (BFE) and FEMA flood hazard zones (e.g., zone VE, zone AE, etc.) and a polygon representing the analysis boundary. The DEM is an ARCINFO grid; the polygon files are ESRI feature classes. The flood elevation polygons used by the coastal FIT must be associated with the base flood (100-year flood). They are used by the FIT to generate a 100-year flood elevation grid, and form the basis for all other return period flood surfaces calculated by the FIT.

Chapter 5 Updating Hazus Inventory Data (Collecting Data)

A limiting factor in performing a loss estimation study is the cost and quality of the inventory. Collection of inventory is without question the most costly part of performing the study. Crude estimates of damage do not require extensive inventory data and can be performed on a modest budget. As the damage estimates become more precise, the need for better inventory information increases, as does the cost to obtain this information. Since many municipalities have limited budgets for performing a flood loss estimation study, **Hazus** accommodates different users with different levels of resources. It should be understood, however, that the uncertainty of the loss estimates increases with less detailed inventory, and that there are uncertainties associated with modules other than inventory. For example, even with a perfectly accurate inventory of buildings in the study region, **Hazus** or any other loss estimation methodology cannot infallibly predict damage and associated losses.

Inventory information will come from and/or be collected in databases compatible with the GIS technology. Once collected and entered into the database, the data will also be available to users for other applications. For example, data collected for a flood loss estimation study could also be used for city planning purposes.

5.1 Sources of Information

As discussed in Chapter 3, the use of default parameters and default inventory in performing a loss study introduces a great deal of uncertainty. Loss studies performed with only default data may be best for preliminary assessments to determine where more information is needed. For example, if the analysis using only default information suggests that hurricanes will cause a great deal of damage in a particular part of your community, you may want to collect more detailed inventory for that area to have a better understanding of the types of structures, the essential facilities and businesses that will be affected.

Regional building inventories can be built up from a variety of sources, including: federal government, state government, and local government and private sector databases. These databases may be useful for obtaining facility-specific information. Following are examples of sources of inventory data that can be accessed to enhance the **Hazus** building data:

- Locations of government facilities such as military installations and government offices
- Tax assessor's files
- School district or university system facilities
- Databases of fire stations or police stations
- Databases of historical buildings
- Databases of churches and other religious facilities

- Postal facilities (ATC-26, 1992)
- Hospitals (The AHA Guide of the American Hospital Association; ATC-23A, 1991)
- Public and private utility facility databases
- Department of transportation bridge inventory
- Dun and Bradstreet database of business establishments
- Insurance Services Office’s files of large buildings that is used for fire assessment
- real estate databases

It should be kept in mind that each of these databases includes only a portion of the building stock, and none is complete. For example, the tax assessor’s files do not include untaxed properties such as government buildings, public works and tax-exempt private properties. School district databases probably will not include private schools. A good discussion of available databases is found in ATC-13 (1985) and Vasudevan et al. (1992), although some of the databases discussed in these two references are specific to California.

Another possible source of inventory information is previous loss or hazard studies. Unfortunately many regional loss studies do not contain a listing (either hard copy or electronic) of the inventory that was used. The following sections contain more detailed information about sources of information for specific modules of the Flood Model.

5.1.1 General Building Stock

Developing the inventory for general building stock most likely will require combining information from several sources. As mentioned earlier, there is no complete single source of general building stock information. In addition, you will find that the quality and format of the information varies dramatically from county to county. Furthermore, since general building stock inventory is not normally compiled by counting individual buildings, but instead is developed using various assumptions and inferences, you may find that you need input from local engineers and building officials to ensure that you have captured unique aspects of the region.

5.1.1.1 County Tax Assessor Files

County Tax Assessor files may or may not be a source of general building stock information. Since Tax Assessor files are kept for the purposes of collecting property taxes, they may contain little or no useful structural information. The quality of the data varies widely from county to county. The most useful data will contain occupancy, structural type, square footage, height, and age. Generally, the files contain good information on the use (occupancy) of the building, since tax rates often depend on building use; therefore, either a land use code and/or a specific occupancy of the building is included. Ideally, if good information is available, you can use the Comprehensive Data Management System (CDMS) to develop region-specific occupancy to model building type relationships. However, several problems generally occur:

- Many Tax Assessor files do not contain building square footage information. In some counties, square footage is not recorded at all. In other cases, it is only sometimes recorded. You should ask the Tax Assessor before you buy the records as to what percentage of the records contain square footage information.

- Many Tax Assessor files contain square footage information that may be difficult to interpret. For example, a property that is owned by several owners (such as an office building) may appear several times in the files. Perhaps Owner #1 owns two floors of the building and Owner #2 owns eight floors. The Tax Assessor's records may not reflect the fact that Owner #1 owns 20% of the Building and Owner #2 owns 80%. In fact, sometimes both property entries will show the total building square footage instead of Owner #1 with 20% of the square footage and Owner #2 with 80%. Without going through the files record by record, this is difficult to fix.

- Since some occupants that do not pay taxes (e.g., schools, churches, and government buildings) are not usually well represented in the Tax Assessor's files. Often these types of properties include an entry and an Assessor's Parcel Number, but omit assessed value, square footage, structural type, height or age.

- Structural type may not be recorded at all in the files. You need to ask the Tax Assessor what percentage of the records has structural information before you buy the files.

- Similar comments about missing data can be made about age and height.

- Some or all of the properties in the Tax Assessor's files may contain no address information. In some counties, the Assessor's Parcel Number is the only identifier in the database. While this can be mapped to location, it is not an easy task. The file may contain a mailing address of the owner, but this is not a reliable address to locate properties. In other cases, selected properties are missing addresses. Address information is important because you can use addresses to see how the types and occupancies of buildings vary geographically.

- Perhaps one of the most difficult problems is that, in many cases, the Tax Assessors use a system of classifying structures that is difficult to map to the model building types defined in Appendix B. For example, there may only be five building types, such as steel frame, wood frame, fire resistant, masonry and other. It is difficult from this very simple classification system to determine whether masonry structures are reinforced or un-reinforced. Fire resistant construction could include a variety of structural types consisting of concrete or masonry. In these cases you will need to use local experts to help define the mix of construction.

5.1.1.2 Commercial Sources of Property Data

There are a variety of on-line services that maintain databases of real property that are designed to assist realtors and other commercial enterprises in gathering property sales data and owner information, and to assist in generating mailing lists and labels. The databases are developed from County Tax Assessor's files and updated as properties are sold or as other information becomes available. You can subscribe to one of these services and download records over a telephone line, or you can order CDs of selected counties and use software supplied by the service to extract the records on your own computer. It seems that different services tend to focus their efforts in different parts of the United States. Therefore, one service may not maintain a database on the county you wish to study while another service may. Typical costs for a county are $300 to $1000, depending on its size. Addresses and phone numbers of several on-line services are listed below. (Note: While these are California addresses, they carry data from around the country. There may be local offices for these companies.) If one of these services does not have the counties in your study region you may find that there is a service in your own community that maintains these types of records. Local real estate agencies or the local Board of Realtors would probably know about this. Alternatively, you could try calling local Tax Assessors and see if they have sold their data to this type of service.

Some of the Commercial Sources of Property Data are:

Experian Property Data (formally known as TRW)
3610 Central Avenue
Riverside, CA 92506
(800) 345-7334

Transamerica Information Management (offer a program called MetroScan)
1860 Howe Avenue, Suite 455
Sacramento, CA 98525
(800) 866-2783

DataQuick Information Services
9171 Towne Centre Drive, #404
San Diego, CA 92122
(800) 950-9171

The commercially available databases contain the same type of problems found in the County Assessor's data since they were obtained from them. Perhaps one of the main advantages of the commercially available data is that you can get some technical support in trying to put the data into databases. The software they provide enables you to look at individual properties or to sort properties in a variety of ways such as by zip code, or by census tract, or by age, or by occupancy to name a few. On the other hand, assessor's data are often stored on 9-track tape and little instruction is provided about how to extract the data.

One note of caution: The software that commercial services provide is limited in that you cannot extract the entire county at once. You are limited to extracting a certain number of records (for example 9000) at a time. A large county such as Los Angeles contains over two million records. Thus extracting all of the records for the county can be a tedious task, sometimes taking several days.

5.1.2 Occupancy to Building Type Relationships

Developing occupancy to model building type mapping schemes (in the General Occupancy Mapping Browser) that accurately reflect your study region will require combining available data with input from local experts. Collecting supplemental information about local building practices through the use of a questionnaire and/or a workshop is recommended.

5.1.3 Essential Facilities

Essential facilities, to a great degree, are owned or licensed by government agencies. Consequently, lists of these facilities often have been compiled for a region. Therefore, the time associated with collecting inventory on essential facilities may be relatively small; perhaps a day or two, if no building type information is collected and default occupancy to building type mappings are used. However, more detailed building type information may require a site visit for each facility. Some essential facilities are subject to special design and construction considerations that may help these structures perform better than the typical building when subjected to high winds.

5.1.3.1 Medical Care Facilities

Sources of inventory information for medical care facilities include the yellow pages of the telephone book, city and county emergency response offices, the American Hospital Association and previous loss studies. The default medical facilities database included with **Hazus** was developed from a FEMA database and contains the number of beds for many of the facilities. Determining the number of beds for other facilities may require the user to contact facilities on an individual basis. In some cases, county guides, such as the McCormack Guides in California, provide a listing of all health care facilities, their addresses, phone numbers and the number of beds. The State Department of Public Health in California (and its equivalent in other states) licenses health care facilities and may publish a directory of licensed facilities.

5.1.3.2 Fire Stations, Police Stations and Emergency Operations Centers

Locations of fire stations, police stations and emergency operations centers can be obtained from city and county emergency response offices. In addition, many city maps show locations of police and fire stations.

5.1.3.3 Schools

Locations of public schools and their enrollments can be obtained from district offices. The Board of Education in some states compiles a directory of all schools (public and private) in the state with names, addresses, phone numbers and enrollments. The pages of the phone book can be used as an initial listing. Regional governments may compile directories of local educational institutions (including colleges and universities).

5.1.4 Used-Defined Facilities

User-defined facilities are those structures, other than essential facilities or high potential loss facilities, which the user may wish to analyze on a site-specific basis. For example, you may wish to identify all of the pharmacies in the community. You can collect data about these types of structures using the same sources you would use for general building stock or essential facilities, namely: specific databases that may be available to you through some agency, commercial sources of property data, the phone book, interviews with owners and site visits.

5.1.5 Demographics

Population statistics are used in estimating several different losses such as casualties, displaced households and shelter needs. Population location, as well as ethnicity, income level, age and home ownership is needed to make these estimates. The 2000 Census data are included with **Hazus**. You may be able to obtain updated information from the Census Bureau or from a regional planning agency.

5.1.6 Direct Economic Loss Parameters

Direct economic losses begin with the cost of repair and replacement of damaged or destroyed buildings. However, building damage results in a number of consequential losses that are defined as direct economic losses. Thus, building-related direct economic losses (which are all expressed in dollars) comprise two groups. The first group consists of losses that are directly derived from building damage:

- Cost of repair and replacement of damaged and destroyed buildings
- Cost of damage to building contents
- Losses of building inventory (contents related to business activities)

The second group consists of losses that are related to the length of time the facility is non-operational (or the immediate economic consequences of damage):

- Relocation expense (for businesses and institutions) Capital-related income loss (a measure of the loss of services or sales)
- Wage loss (consistent with income loss)
- Rental income loss (to building owners)

5.1.6.1 County Business Patterns

County Business Patterns is an annual series published by the United States Census Bureau that presents state and county-level employment, annual payrolls, total number of establishments, and establishments by employee size. The data are tabulated by industry as defined by the Standard Industrial Classification (SIC) Code. Most economic divisions are covered, which include agricultural services, mining, construction, manufacturing, transportation, public utilities, wholesale trade, retail trade, finance, insurance, real estate and services.

The data generally represents the types of employment covered by the Federal Insurance Contributions Act (FICA). Data for employees of establishments totally exempt from FICA are excluded, such as self-employed persons, domestic service employees, railroad employees, agricultural production employees and most government employees. County Business Patterns is the only complete source of sub-national data based on the four-digit SIC system. The series, therefore, is useful in making basic economic studies of small areas (counties), for analyzing the industrial structure of regions, and as a benchmark for statistical series, surveys and other economic databases. The data can serve a variety of business uses as well as being used by government agencies for administration and planning.

County Business Patterns data are extracted from the Standard Statistical Establishment List, a file of known single- and multi-establishment companies maintained and updated by the Bureau of the Census every year. The Annual Company Organization provides individual establishment data for multi-location firms. Data for single-location firms are obtained from various programs conducted by the Census Bureau as well as from administrative records of the Internal Revenue Service (Census Bureau, 1991).

5.1.6.2 Means Square Foot Costs

The default replacement costs supplied with the methodology were derived from Means Square Foot Costs for Residential, Commercial, Industrial, and Institutional buildings. The Means publication (Means, 2006) is a nationally accepted reference on building construction costs, which is published annually. This publication provides cost information for a number of low-rise residential model buildings, and for 70 other residential, commercial, institutional and industrial buildings. These are presented in a format that shows typical costs for each model building, showing variations by size of building, type of building structure, and building enclosure. One of these variations is chosen as "typical" for this model, and a breakdown is provided that shows the cost and percentages of each building system or component. The methodology also allows the user to adjust costs for location of the structure (e.g., New York and Miami). A description of how to estimate costs from the Means publication is found in the *Flood Model Technical Manual*. For **Hazus**, selected Means models have been chosen from the more than 70 models that represent the 33 occupancy types. The wide range of costs shown, even for a single model, emphasize the importance of understanding that the dollar values shown should only be used to represent costs of large aggregations of building types. If costs for single buildings or small groups (such as a college campus) are desired for more detailed loss analysis, then local building specific cost estimates should be used.

5.1.6.3 Dun and Bradstreet

Dun and Bradstreet is an organization that tracks all businesses that are incorporated. Dun and Bradstreet maintains data on the type of business, the number of employees, the square footage of the business, the annual sales and a variety of other information. The default square footage for the occupancy classes and for all the census tracts was created from the 2 and 4 digit (Standard Industrial Classification) SIC 2006 Dun and Bradstreet data. Dun and Bradstreet provide aggregated information for a specific region on total number of employees, total annual sales and total square footage by census tract. They can also provide information on specific businesses.

5.1.6.4 Capital-Related Income

The U.S. Department of Commerce's Bureau of Economic Analysis reports regional estimates of capital-related income by economic sector. Capital-related income per square foot of floor space can then be derived by dividing income by the floor space occupied by a specific sector. Income will vary considerably depending on regional economic conditions. Therefore, default values need to be adjusted for local conditions.

5.2 Collecting Inventory Data

It should be understood that many available databases do not contain all of the information that is needed to perform a loss study. For example, they may contain street addresses, the size of the facility, or the value of the facility, but may not contain information about structural type or age. Databases may be out of date and may not contain all of the facilities in the region. Another problem the user can encounter is that databases may be in a paper rather than electronic format, making them difficult or impossible to use. Combining multiple databases can also be problematic. Issues such as double counting facilities and eliminating unnecessary information need to be addressed. In general, the majority of the building inventory used in the regional loss estimation will not be collected or kept on a facility-by-facility basis. Resource limitations make it difficult to collect such detailed information. Management and storage of such a large amount of information, while possible, is beyond the state-of-practice for many municipalities and government agencies. Maintaining facility-specific databases will be most useful for important or hazardous facilities such as hospitals, fire stations, emergency operation centers, facilities storing hazardous materials, and high occupancy facilities, to name a few. Procedures exist for supplementing facility-specific databases with area-specific inventory information. An example of an area specific inventory is the number of square feet of commercial space in a census tract or zip code. These area-specific inventories are often based on economic or land use information that is augmented using inference techniques. For example, the user may have available the number of commercial establishments in a region. Assuming an average size (in square feet) per establishment, the user can infer the total square footage of that occupancy. Similarly, a land use map may be converted to building square footage by multiplying land use area by percent of area covered by buildings.

Techniques for developing inventories include:

- Sidewalk/windshield surveys
- Analysis of land use data
- Analysis of aerial photography
- Discussions with local engineers and building officials

Chapter 6 Updating Inventory Data: Entering and Managing Data

Hazus contains a variety of default parameters and databases. You can run a loss estimation analysis using only default data (Chapter 3), but your results will be subject to a great deal of uncertainty. If you wish to reduce the uncertainty associated with your results, you can augment or replace the default information with improved data collected for your region of study.

Hazus contains one import tool for entering data: the import menu option for entering site-specific inventory dialogs (ex. hospitals, schools) and hazard data (ex. DEM). Data, which has not been imported, can still be used as overlays and for general spatial queries, but will not be treated in the loss estimation model. Users can also utilize the Comprehensive Data Management System (CDMS) tool to update and manage statewide and **Hazus** datasets.

As has been discussed in earlier sections, it is very likely that data obtained from different sources will not be in the same format. Furthermore, the data may contain a different number of fields than the data defined in **Hazus**. This will require mapping the data fields to the correct format and inclusion in the centralized geodatabase. The following sections describe importing data, entering data through **Hazus** windows, and managing the data.

6.1 Importing Features and Files

Only some offices and potential **Hazus** users will have the most current version of GIS software; others will not currently use ESRI software. Those who have previously applied **HAZUS99** for Level II analysis will recognize the similarity of data field headers and inventory requirements. All operators of **Hazus** will be starting with the newest default datasets; first to be evaluated, and then improved by directly editing the default inventories, or by importing new data files. Data that are not already formatted in GIS will require conversion to the standardized ESRI ArcGIS geodatabase format before importing.

6.1.1 Importing Site-Specific Data Files

ArcView feature classes, ArcInfo coverage files, CAD files, image files, and tabular database files (e.g., Paradox, dBase) must be converted to a geodatabase (*.mdb) for use with **Hazus**. Several file types (e.g., shapefile, drawing, tabular) may be converted to one or more geodatabases for import. MapInfo, Atlas, or other CAD file formats will generally require exporting files to a shapefile format in order to bring them into ArcGIS. Images or files designated for reference only can still be added as a simple layer for use in displays, and need not be imported. Data intended for consideration by the loss estimation model must be imported. ArcCatalog, ArcMap, or MS-Access can be used for this purpose.

Select the inventory you wish to improve from the **Hazus** Inventory menu and begin editing. Using the mouse, right-click on a browser, the “Import” option (Figure 6.1) will appear in the pop-up menu and you can select this feature. Enter the directory and filename for the database you wish to import, as in Figure 6.2.

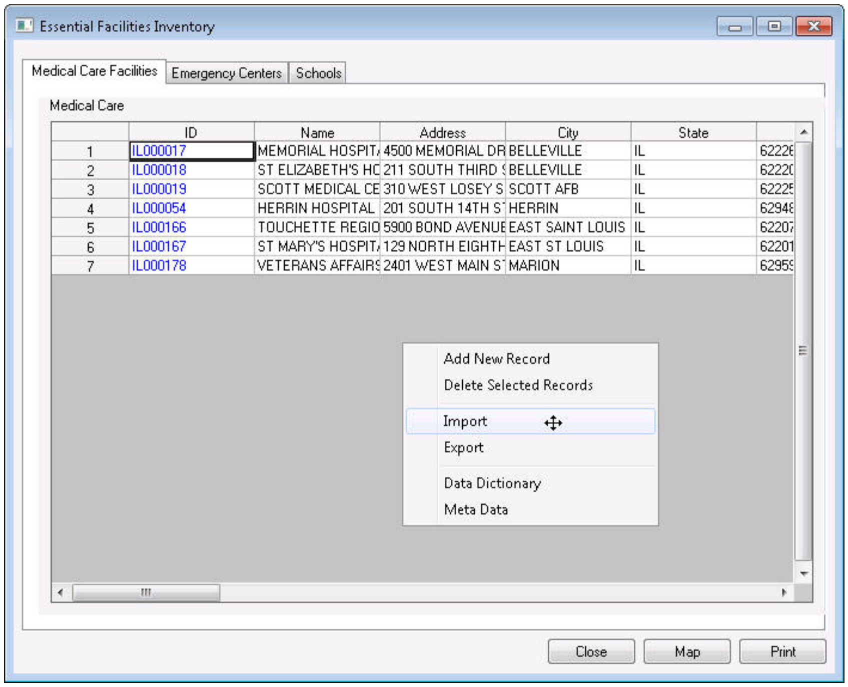


Figure 6.1 Import Features with Attributes

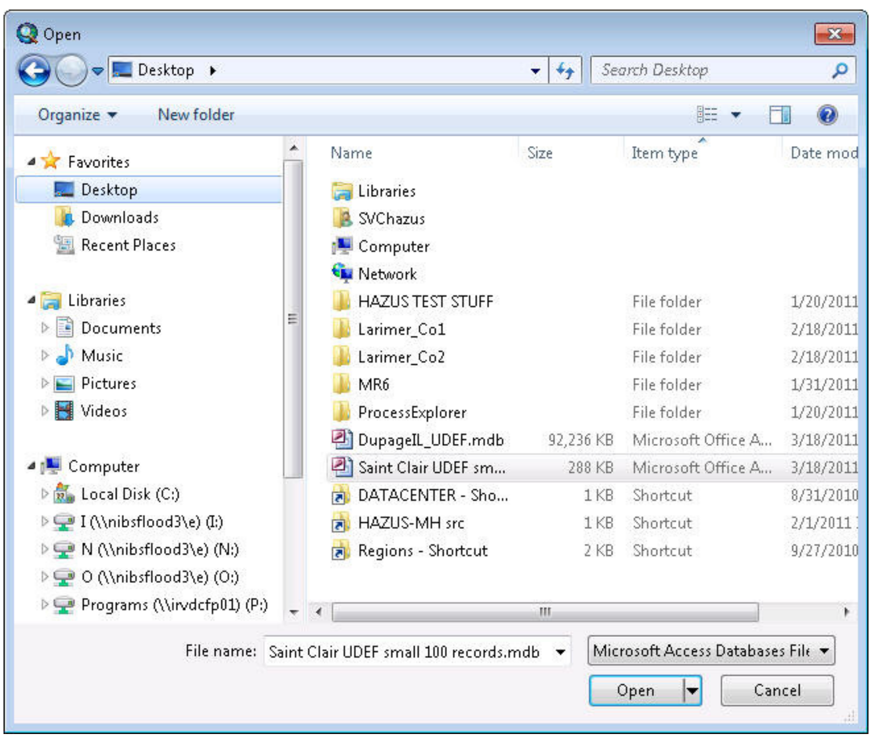


Figure 6.2 Identify the Database to be Imported

There are two important issues to keep in mind regarding the import of Microsoft Access databases to **Hazus**. First is that the Access database should be stored on a ***local*** drive. The second is that any tables to be used should have no spaces in their names. Violation of either of these two rules will result in an import failure.

6.1.2 The Import Database Utility

A database import utility has been developed to assist you in converting an electronic database to the appropriate format for **Hazus**. Clicking on the right mouse button accesses this import utility. The Database Management Tools menu (the pop-up menu), shown in Figure 6.1, will appear. Select the **Import database** and click on the name of the file you want to import; click the **OK** button.

The mapping window shown in Figure 6.3 is used to map the each field in your database (the source) to the corresponding field used in the **Hazus** database (the target database). The Database Dictionary in Appendix D contains the names and structures of all of the databases that are used by **Hazus**. From the Database Dictionary you can determine the names of the target fields. The Database Dictionary, in an abbreviated form, is available interactively in **Hazus**. To access it, click on the right mouse button; using the same menu shown in Figure 6.1, click on **Data Dictionary**. An example from the Database Dictionary is shown in Figure 6.4.

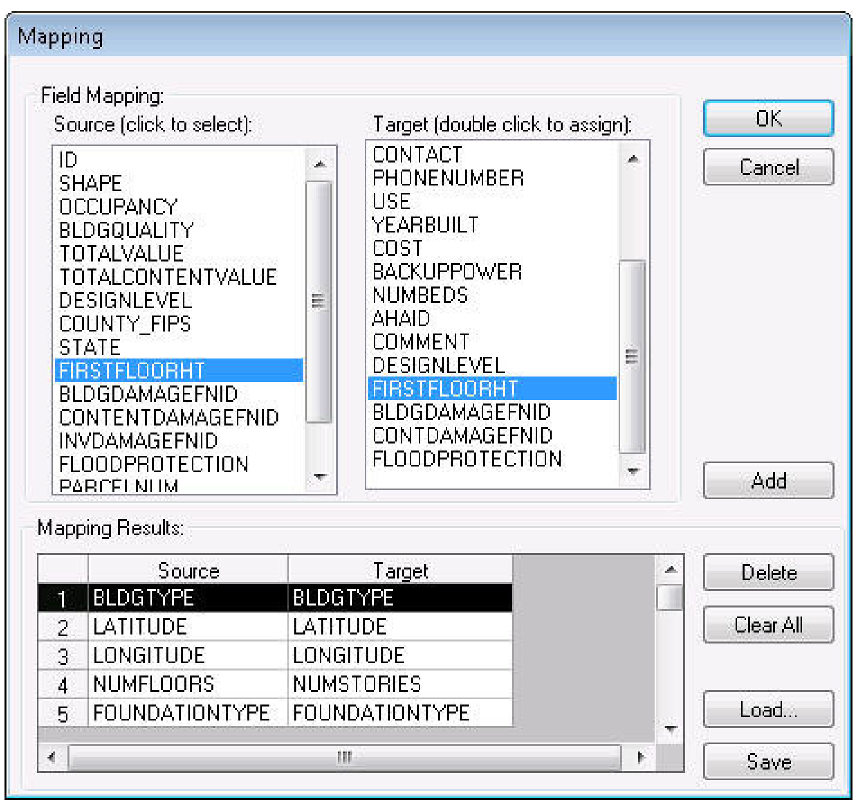


Figure 6.3 Mapping the Fields of your Data File to the Hazus Data Structure

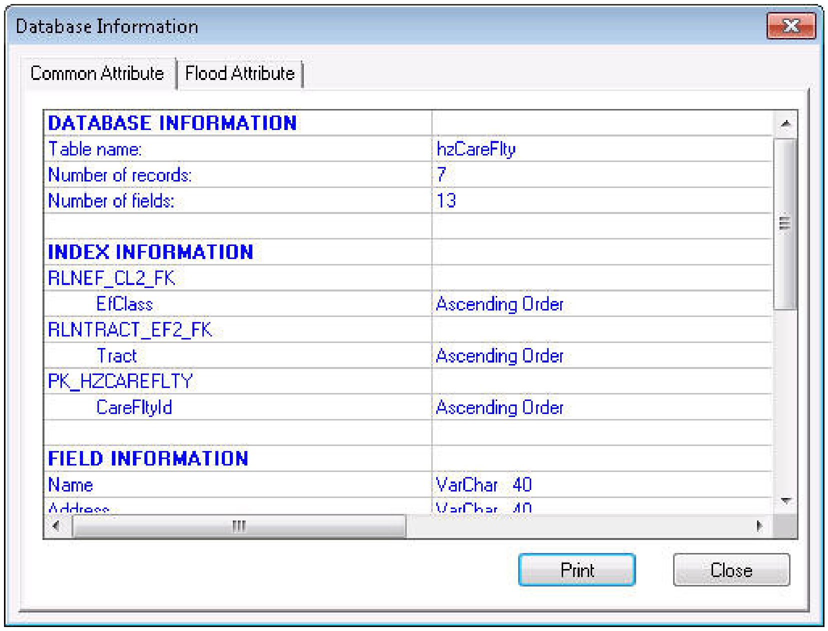


Figure 6.4 Interactive Database Dictionary

The fields from the **Source** menu do not have to be in the same order nor do they have to have the same names as the fields in the **Target** menu. For example, in Figure 6.3, the year the school was built is in a field called "YEAR_BUILT" in the **Source** file, whereas the field that contains this information is in the "YEAR_B" field in the **Target** file. To define the desired mapping scheme, simply click on a field name from the **Source** menu (e.g., LON) and the corresponding field name from the **Target** menu (e.g., LONG); then click on the **Add** button.

After performing these steps, the mapping you have defined will disappear from the **Source** and **Target** menus and will appear in the **Mapping Results** box at the bottom of the window. If you make a mistake, click the **Delete** button, and the last mapping pair you have defined will be undone. In this example, the user has already defined six relationships and is in the process of defining a seventh. When you have completed defining all of the information, click on the **OK** button, wait a few seconds, and your imported database will be displayed in **Hazus**. You do not have to map all of the fields from the **Source** menu. However, any fields you do not map will not be imported into the **Target** database.

It is possible to have several databases with the same format. To save the mapping that you have defined so that it can be reapplied to other files, click the **Save** button in Figure 6.3 and the dialog box shown in Figure 6.5 will appear. Enter a name for the mapping scheme and click the **OK** button. To retrieve the saved mapping, click on the **Load** button in Figure 6.3.

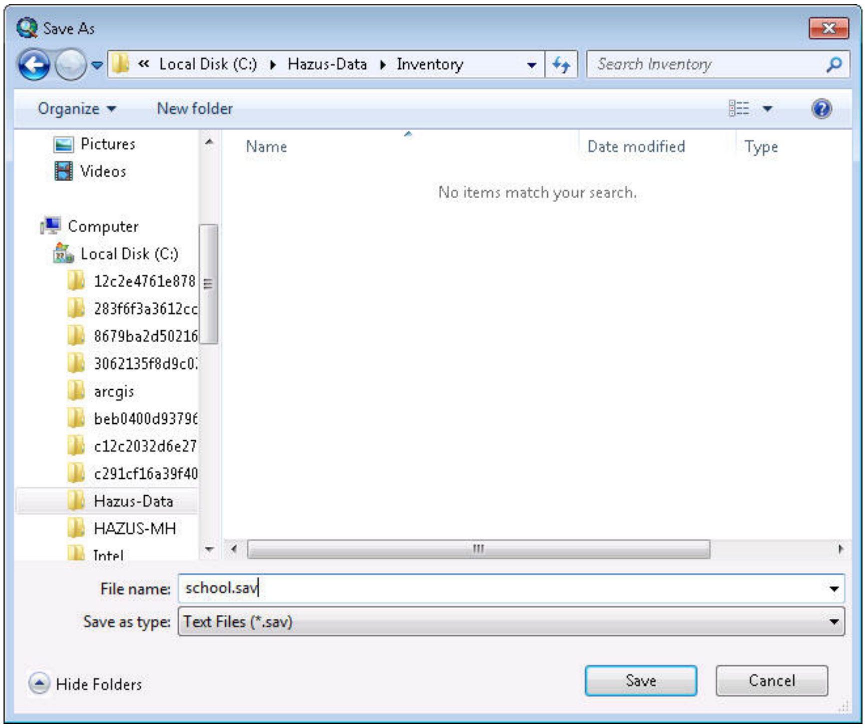


Figure 6.5 Saving a Database Mapping Scheme

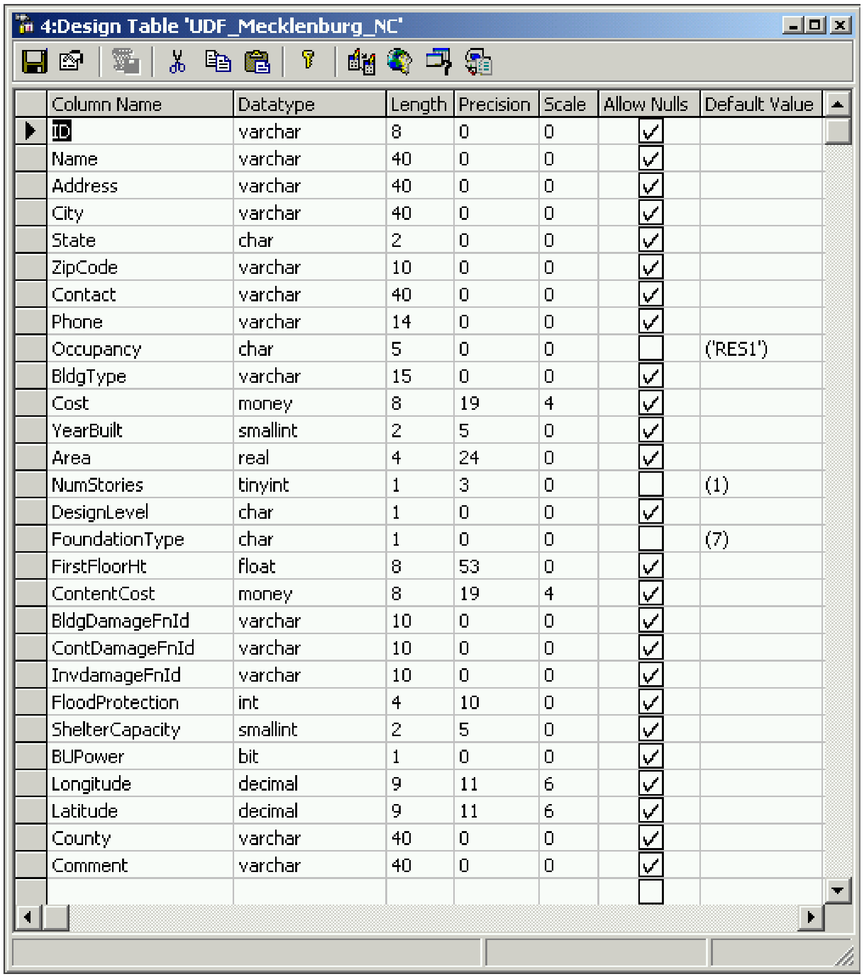
6.1.3 Pre-processing Inventory Point Data

Users can easily import the User Defined Facility (UDF) information to **Hazus** Region Database. The UDF table has to follow four requirements:

- Necessary data:
  - GIS Parcels file (Shape file)
  - HAZUS Occupancy Code (Access table)

- Pre-process the dataset:
  - Subset the Parcels in the flood plain only (easy and time-saving process)
  - Extract center coordinates (Lat/Long) for each flooded parcel (with GIS or other map systems)
  - Clean (correct errors) and group by (ID) the HAZUS occupancy code

- User Defined Facility table format and data type on SQL Server (or MS-Access) as seen in Figure 6.6 and Figure 6.7.



4:Design Table 'UDF_Mecklenburg_NC'

Column Name	Datatype	Length	Precision	Scale	Allow Nulls	Default Value
ID	varchar	8	0	0	✓	
Name	varchar	40	0	0	✓	
Address	varchar	40	0	0	✓	
City	varchar	40	0	0	✓	
State	char	2	0	0	✓	
ZipCode	varchar	10	0	0	✓	
Contact	varchar	40	0	0	✓	
Phone	varchar	14	0	0	✓	
Occupancy	char	5	0	0		('RES1')
BldgType	varchar	15	0	0	✓	
Cost	money	8	19	4	✓	
YearBuilt	smallint	2	5	0	✓	
Area	real	4	24	0	✓	
NumStories	tinyint	1	3	0		(1)
DesignLevel	char	1	0	0	✓	
FoundationType	char	1	0	0		(7)
FirstFloorHt	float	8	53	0	✓	
ContentCost	money	8	19	4	✓	
BldgDamageFnId	varchar	10	0	0	✓	
ContDamageFnId	varchar	10	0	0	✓	
InvdamageFnId	varchar	10	0	0	✓	
FloodProtection	int	4	10	0	✓	
ShelterCapacity	smallint	2	5	0	✓	
BUPower	bit	1	0	0	✓	
Longitude	decimal	9	11	6	✓	
Latitude	decimal	9	11	6	✓	
County	varchar	40	0	0	✓	
Comment	varchar	40	0	0	✓	

Figure 6.6 UDF Table Field Definitions (as seen in SQL Server)

UDF_Mecklenburg_NC : Table

Field Name	Data Type	Description
ID	Text	Field Size: 8
Name	Text	Field Size: 40
Address	Text	Field Size: 40
City	Text	Field Size: 40
State	Text	Field Size: 2
ZipCode	Text	Field Size: 10
Contact	Text	Field Size: 40
Phone	Text	Field Size: 14
Occupancy	Text	Field Size: 5
BldgType	Text	Field Size: 15
Cost	Currency	Field Size:
YearBuilt	Number	Field Size: Integer
Area	Number	Field Size: Single
NumStories	Number	Field Size: Byte
DesignLevel	Text	Field Size: 1
FoundationType	Text	Field Size: 1
FirstFloorHt	Number	Field Size: Double
ContentCost	Currency	Field Size:
BldgDamageFnId	Text	Field Size: 10
ContDamageFnId	Text	Field Size: 10
InvdamageFnId	Text	Field Size: 10
FloodProtection	Number	Field Size: Long Integer
ShelterCapacity	Number	Field Size: Integer
BUPower	Yes/No	Field Size:
Longitude	Number	Field Size: Decimal (11,6)
Latitude	Number	Field Size: Decimal (11,6)
County	Text	Field Size: 40
Comment	Text	Field Size: 40

Figure 6.7 UDF Table Field Definitions (as seen in MS-Access)

- Extraction for UDF table:
  - Extract the necessary information from the two data source tables (Flooded_Parcels & **Hazus** Occupancy code) based on structure of the above UDF table.
  - Fields distribution type:
    - **Hazus** distribution fields include: **NumStories**, **DesignLevel**, **FoundationType**, **FirstFloorHt** and **ContentCost** (see above figure)
    - Parcels information and default fields are the remaining (see above figure)
  - Most County Tax Assessor's files have square footage and the value of a building. The following are recommended data to complete a UDF. The columns on the left show what the user's data might look like and the column on the right shows how it is implemented into **Hazus**. A note on how to extract **Hazus** distribution fields as seen in Tables 6.1, 6.2, 6.3, 6.4 and 6.5:

- **NumStories**: based on occupancy and original number of stories of the parcels

Table 6.1 NumStories Field Description

Occupancy	Number of Stories From Parcels	NumStories
RES1	1	1
	2	2
	3	3
	Split level	4
RES2	1	1
	2	2
	3	3
RES3	1-2	1
	3-4	3
	5+	5
All others (including RES4 to EDU2)	1-3	1
	4-7	4
	8+	8

- **DesignLevel**: depends on the **YearBuilt**

Table 6.2 DesignLevel Field Description

YearBuilt	Design Level
Prior – 1950	1
1950 – 1970	2
Post 1970	3
0 (set to Null)	0

- **FoundationType**: based on the real foundation type in the parcels

Table 6.3 FoundationType Field Description

Real Foundation Type	FoundationType	Basement
Pile	1	0
Pier	2	0
Solid Wall	3	0
Basement /Yard	4	1
Crawl Space	5	0
Fill	6	0
Slab on Grade	7	0

- **FirstFloorHt**:

Table 6.4 FirstFloorHt Field Description

FoundationType	FirstFloorHt [ft]
Pile	7
Pier	5
Solid Wall	7
Basement /Yard	4
Crawl Space	3
Fill	2
Slab on Grade	1

- **ContentCost**: depends on cost and occupancy

Table 6.5 ContentCost Field Description

Occupancy	ContentCost
RES1 To RES6 & COM10	Cost * 0.5
COM1 To COM5, COM8, COM9, IND6, AGR1, REL1, GOV1 and EDU1	Cost * 1.0
COM6 To COM7, IND1 To IND5, GOV2 and EDU2	Cost * 1.5

- Set these default constraints:
  - **YearBuilt = Null**
  - It is recommended that the user look for the trends of surrounding buildings and set the YearBuilt to the trend or to set it to 1970.
  - **Occupancy = 'RES1'**
  - It is recommended that the user look for the trends of surrounding buildings and set the Occupancy to the trend.
  - **NumStories = 1**
  - **Foundationty = 7**
  - **FloodProtection = 0**
  - If the building is near a dam or a dike, set the FloodProtection to that level.
  - Other fields:
    - The most fields extract from the Flooded Parcels directly or query combinations with **Hazus** Occupancy Code

Required fields for UDFs to ensure analysis results:
Occupancy, BldgType, Cost, YearBuilt, NumStories, DesignLevel, FoundationType, FirstFloorHt, ContentCost, BldgDamageFnID, ContDamageFnID, Latitude, Longitude

The hzUserDefinedFacility table is linked to the flUserDefinedFacility table. Below in Table 6.6, users can see how the different fields are mapped in the two tables. The **UDEFImportSchema.SAV** file source-target field mapping:

Table 6.6 UDF Field Mapping Schema

MS Access	MSSQL	Type
CONTACT	CONTACT	hz
NAME	NAME	hz
ADDRESS	ADDRESS	hz
CITY	CITY	hz
STATE	STATE	hz
ZIPCODE	ZIPCODE	hz
PHONE	PHONENUMBER	hz
OCCUPANCY	OCCUPANCY	hz
YEARBUILT	YEARBUILT	hz
COST	COST	hz
BUPOWER	BACKUPPOWER	hz
NUMSTORIES	NUMSTORIES	hz
AREA	AREA	hz
BLDGTYPE	BLDGTYPE	fl
LATITUDE	LATITUDE	hz
LONGITUDE	LONGITUDE	hz
COMMENT	COMMENT	hz
CONTENTCOST	CONTENTCOST	hz
DESIGNLEVEL	DESIGNLEVEL	fl
FOUNDATIONTYPE	FOUNDATIONTYPE	fl
FIRSTFLOORHT	FIRSTFLOORHT	fl
SHELTERCAPACITY	SHELTERCAPACITY	hz
BLDGDAMAGEFNID	BLDGDAMAGEFNID	fl
CONTDAMAGEFNID	CONTDAMAGEFNID	fl
INVDAMAGEFNID	INVDAMAGEFNID	fl
FLOODPROTECTION	FLOODPROTECTION	fl

6.1.4 Required Fields for Importing User Defined Facilities (UDF)

Below is a list of fields that are required for each User Defined Facility.

OCCUPANCY
YEARBUILT
COST
NUMSTORIES
BLDGTYPE
LATITUDE
LONGITUDE
CONTENTCOST
DESIGNLEVEL
FOUNDATIONTYPE
FIRSTFLOORHT
BLDGDAMAGEFNID
CONTDAMAGEFNID

6.2 Adding Records to Site Specific Databases

In addition to importing entire datasets, you can add one or more site-specific (point) feature records at a time to improve inventories of essential facilities, high potential loss facilities, lifeline components and facilities storing hazardous materials. When you identify a new site, you will need to add a new feature record with attributes. To add linear lifeline features, see Section 6.5.

6.2.1 Adding Features Using the Study Region Map

You will notice that feature locations are listed in the ArcMap attribute table without the entire set of feature attributes. **Hazus** stores attributes other than the each feature identifier and coordinates using SQL Server. This design for feature and attribute storage is for efficiency, and allows for anticipated expansion to interactive web-based delivery of the program. The database design requires you to add features in the following steps:

1. Open **Hazus** Inventory menu and select the appropriate inventory (e.g., utilities) and select “Map”.
2. **Start Editing** using the ArcMap Editor toolbar.
3. Select the appropriate and available database (e.g., util.mdb for editing utility facilities).
4. Select the “point” option under the Construction Tools menu box and add features to the map, as seen in Figure 6.8.
5. Select **Save** and **Stop Editing** features.
6. Add attributes to each new feature record by placing the cursor in the desired field, shown in Figure 6.9. (Right-click on the layer and select Open Attributes Table to view attributes).
   Notes:
   a. The feature ID field cannot be edited.
   b. Several fields include a pick list for standardized data entry (see Figure 6.11)

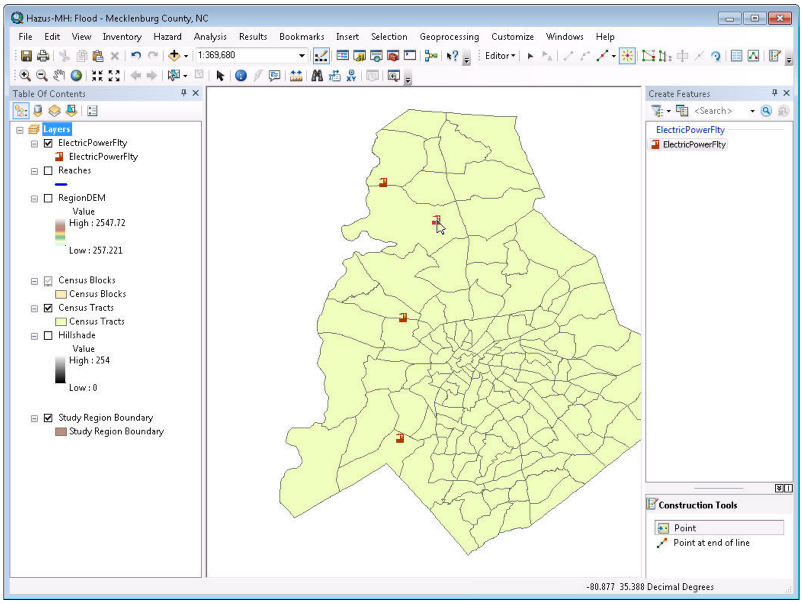


Figure 6.8 Add Site-specific Feature

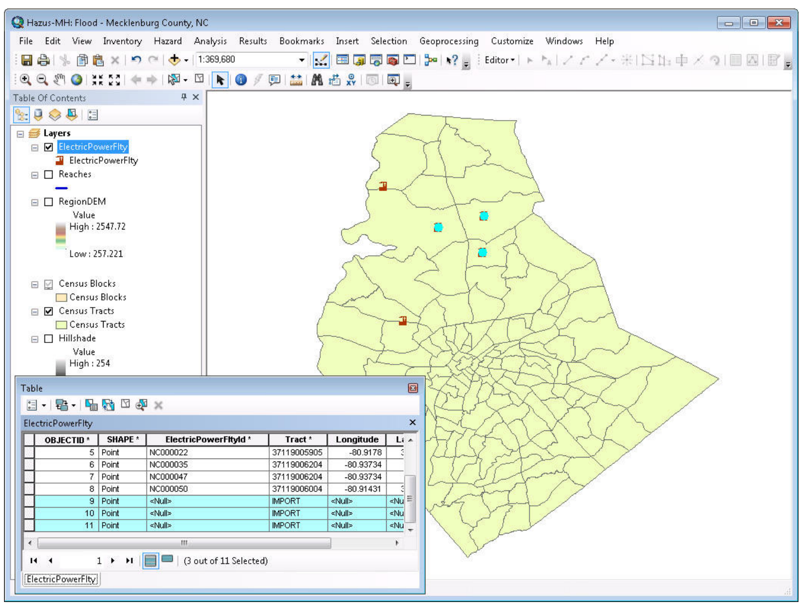


Figure 6.9 Add feature using ArcMap Edit Tool

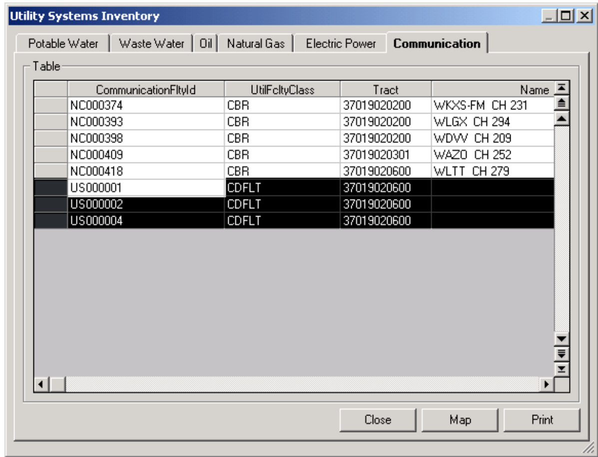


Figure 6.10 Add Attributes under Hazus Inventory Menu

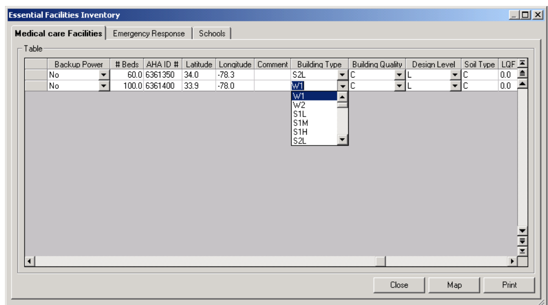


Figure 6.11 Use Attribute Pick Lists Where Available

The site-specific, or facility inventories have many more data fields than are required for estimating potential losses. The additional information is beneficial to the overall analysis, and cost-efficient to collect along with the minimum data required to run **Hazus**. At minimum, the required fields for each database are specified in Appendix D. **Hazus** will automatically assign the first four data fields (indicated with a "*") when records are added graphically. The ID numbers are associated with a particular facility, and are required for reporting the study results.

6.2.2 Adding Records to the Attribute Table

The one essential datum element ***required*** to define a facility is its location. If its location was not added graphically (see Figure 6.8), the only other way to define a facility location in **Hazus** is to type the longitude and latitude of the facility, as in Figure 6.12. If you don't know the longitude and latitude of the facility, you will need to use a geocoder[1] to get the longitude and latitude of the location and then add it to the database in **Hazus**. Once you have defined a location, click on the **OK** button and the new point feature will be saved.

[1] The geocoding process is performed outside **Hazus**. Any commercial geocoder application can be used.

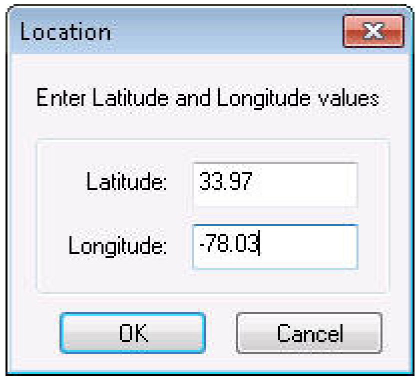


Figure 6.12 Add Record Latitude/Longitude Coordinates

When the location has been entered, a default set of attributes will be assigned to each new record, in the event no other detail is available. For example, **Hazus** assumes a generic default bridge class of HDFLT if no bridge class is supplied. To complete the new records using improved information, fill in the required fields using the pick lists provided for standardized data entry (see Figure 6.11). Complete the data fields that do not have a pick list with the best available information.

To save the new added records to the database, right-click and select **Stop Editing**. **Hazus** will prompt for confirmation and will save the data to the hard-disk.

6.2.3 Errors When Adding Records

Hazus is very strict about enforcing the rule that *all inventory data points must fall within the study region boundary*. If you define facility locations that are outside the study region, **Hazus** deletes them and displays the dialog show in Figure 6.13.

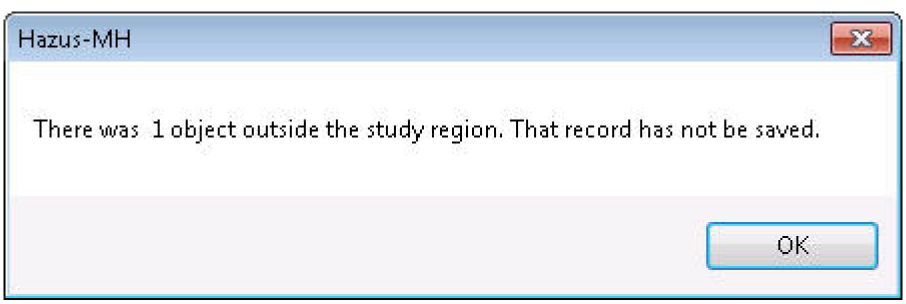


Figure 6.13 Sites Added Outside The Study Region Will Not Be Accepted

6.3 Deleting Records from Site Specific Databases

Select the record to be deleted from a database by clicking on the record marker on the left side of the record ID. When the records have been selected, use the right mouse button to display the database management options shown in Figure 6.14, and choose **Delete Selected Records**.

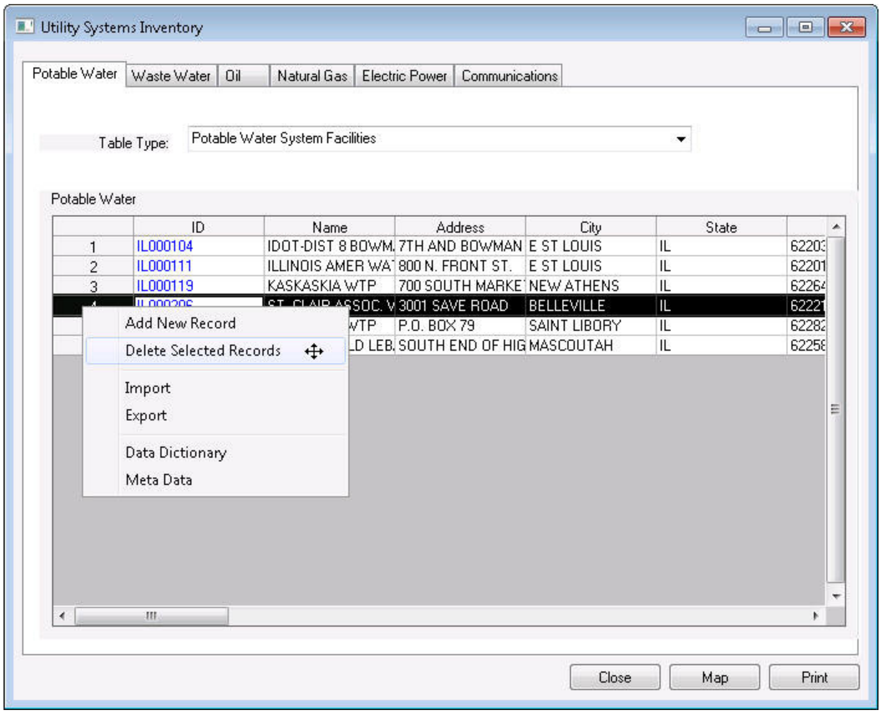


Figure 6.14 Select and Delete Records from a Facility Database

6.4 Adding Lifeline Segments

Lifeline segments must be created using ArcMap **Editor** tools. To add lifeline segments (ex. highway, railway, light rail, etc.) you must be familiar with the functionality of the "Editor" in ArcMap. Refer to the ArcMap documentation for details.

Chapter 7 Modifying Inventory Data

This section guides you through the process of modifying inventory data in the **Hazus** program. Following guidance in Sections 4 and 5, you may now have collected community-specific data that describes your local community more accurately than the default data included with the **Hazus** program. Section 6 discusses ways to process specific forms of digital data to work with the **Hazus** program. Here, you will get a detailed look at successfully modifying the inventory databases needed to run a flood loss analysis in **Hazus**.

This section does not describe how to modify flood hazard data. The Flood Information Tool (FIT) program, which is included as part of the **Hazus** software, should be used to modify flood hazard data and analysis, not inventory data. The FIT is briefly introduced in Section 4, an overview is given in Section 8, and comes with its own, detailed manual.

The default data in **Hazus** can be directly modified entry by entry in the **Hazus** program. Alternately, existing databases from other sources can be imported into **Hazus** following the guidelines given in Section 6. Both approaches to modifying data are discussed in this Section.

7.1 Modifying General Building Stock Data

There a several categories of general building stock data: basic data, financial data, and flood specific occupancy mapping. Basic data, referring to building square footage, building count, and occupancy category, should be modified by using the Comprehensive Data Management System tool (CDMS), as explained below. Financial data and flood specific occupancy mapping should be modified within the **Hazus** program. The sections below guide you through this process.

7.1.1 Building Square Footage, Count and Occupancy Category

To modify the basic building data of square footage, building count and general occupancy, you should use the Comprehensive Data Management System tool (CDMS). This tool processes databases in a variety of forms into the proper **Hazus** format.

7.1.2 Building Financial Data

Building financial data appear in four listings under the *Inventory* menu and *General Building Stock* submenu: *Valuation Parameters*, *Dollar Exposure*, *Depreciation Parameters*, and *Depreciated Exposure*.

The data in the *Valuation Parameters* tables are the key parameters used to estimate the values of structures by specific occupancy type. The detailed formula used to calculate these estimates is presented in the technical manual. You cannot change these valuation parameters. Instead, if you have improved data on the replacement costs of buildings in your study region, you should directly overwrite the *Dollar Exposure* tables.

There are two ways to replace the default data for building dollar exposure. The first is to directly edit the tables in **Hazus**. The second is to import a file with the improved data. Note that you have these two choices for many tables in **Hazus**.

7.1.3 Edit General Building Stock (GBS) Tables

Directly editing the data tables in **Hazus** is a good idea if you have improved data for only a few census blocks. For larger amounts of data, it is probably more efficient to create a database in another program and import it into **Hazus**.

When the dollar exposure window is visible, showing data by specific occupancy type, you can type directly over data in black text (all text presented in blue is non-editable). When you close this window, you will be prompted to save your changes, shown in Figure 7.1. By clicking *Yes*, you have edited the table.

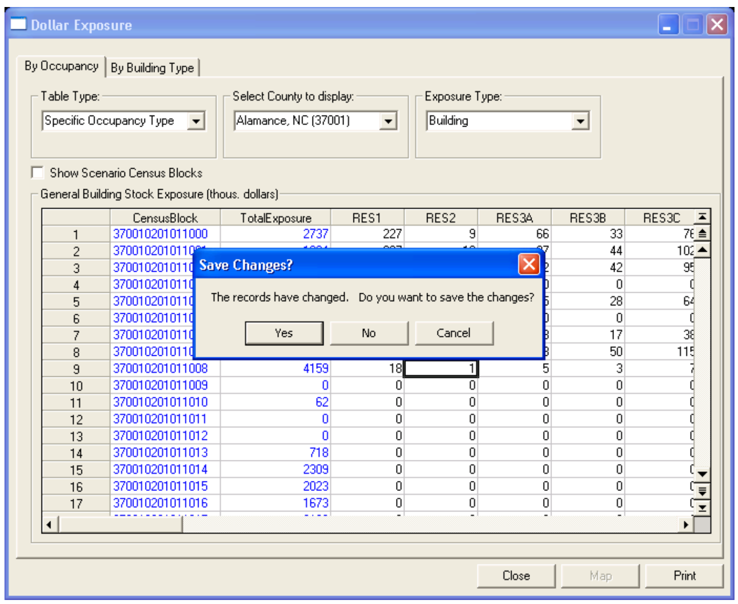


Figure 7.1 Prompt to Save Changes After Editing GBS Dollar Exposure Table

7.1.4 Import Data File

Instructions for importing a data file can be found in Section 6.1.3.

7.1.5 General Occupancy Mapping

General occupancy mapping tables contain data on the building type for each occupancy type. **Hazus** comes with one default mapping scheme and every Census Block is assigned a default mapping scheme.

When you select the *Inventory* menu, *General Building Stock* submenu, *General Occupancy Mapping*, the window shown in Figure 7.2 appears. In the top right portion of the window, you can view the default scheme assigned to each census block in your study region. By selecting the scheme listed in the lower window and pressing **View**, you can see the details of the mapping scheme.

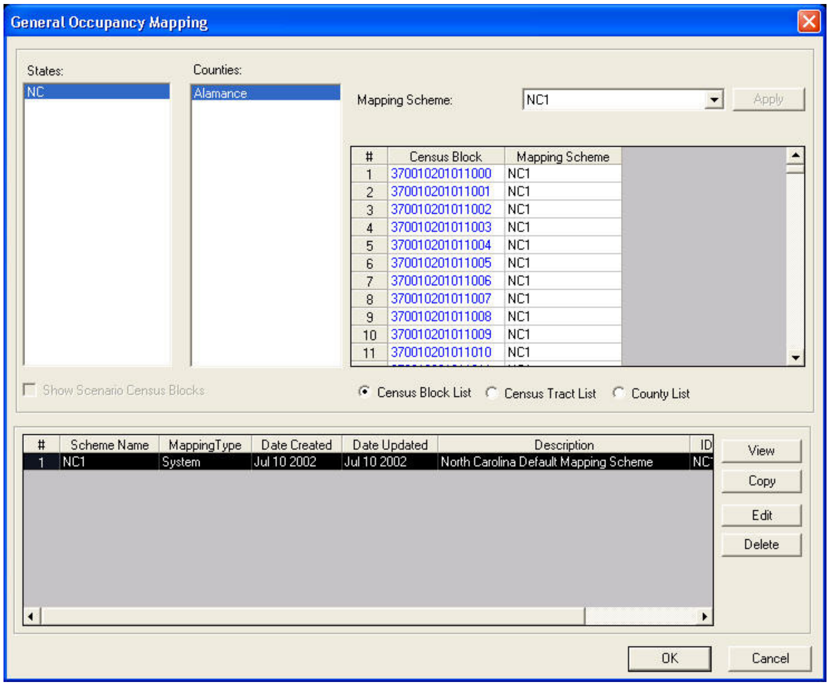


Figure 7.2 Default General Occupancy Mapping (TEMP)

To edit the mapping scheme, highlight the scheme in the lower part of the window and click **Copy**. A new window will pop-up and prompt you to name your copied scheme, as shown in Figure 7.3. Select any name and add a description if you wish. This will create a new scheme with exactly the same data as one of the **Hazus** default scheme, which can be edited. The pull-down menu at the bottom of the *New Mapping Scheme* window will allow you to select the default mapping scheme as your starting point.

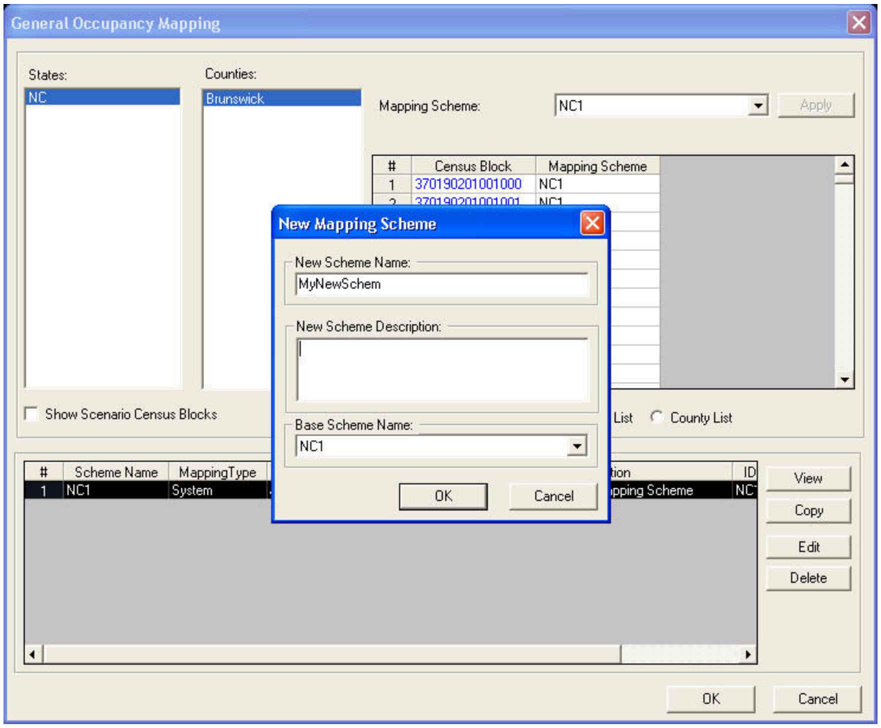


Figure 7.3 Copying a General Occupancy Mapping Scheme (TEMP)

Your new mapping scheme is now listed as one of the options in the bottom window. Highlight your new scheme and click **Edit**. The general occupancy mapping details will appear on the screen. You can select each occupancy type and edit the distribution of building types. When you have made all of your edits, click **OK**.

Next, you need to assign your new mapping scheme to the relevant areas in your study region. The scheme that was developed now appears under the *Mapping Scheme* pull-down menu as shown in Figure 7.4. Select the new scheme you have created in the *Mapping Scheme* pull-down menu. Then, highlight all of the census blocks that you would like to have your new mapping scheme assigned to, and click **Apply**. The mapping scheme should change for these census blocks. If you need to assign your new mapping scheme to the entire study region, click on the radial dial for *County List*. Select the new scheme in the *Mapping Scheme* pull-down menu, and click **Apply**.

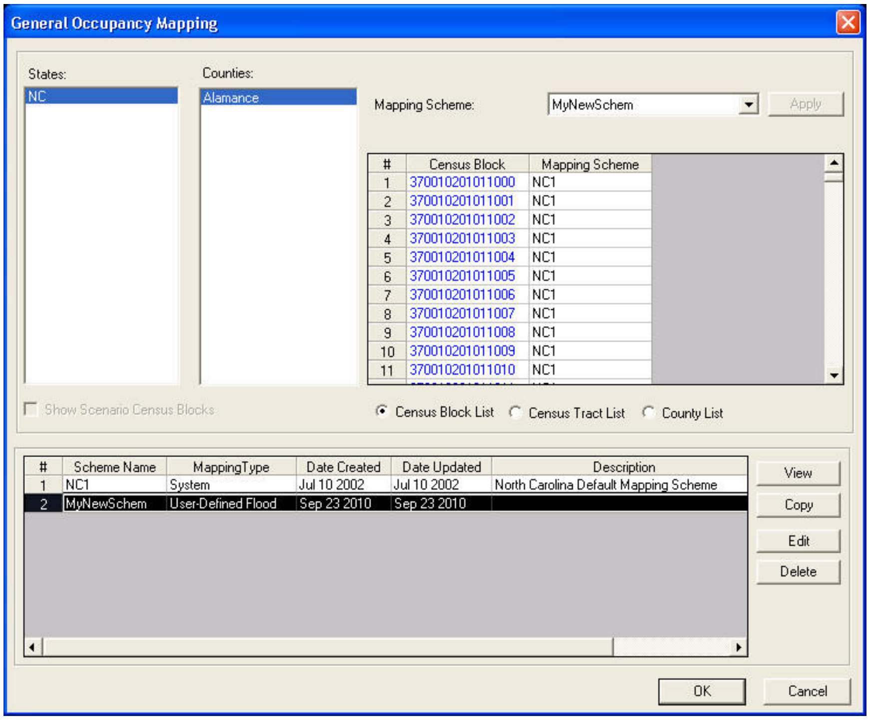


Figure 7.4 Assigning Newly Created General Occupancy Mapping

7.1.6 Flood Specific Occupancy Mapping

Flood specific occupancy mapping tables contain data on the types of foundations and average heights of first floors above grade for each specific occupancy type. **Hazus** comes with three default mapping schemes and every Census Block is assigned a default mapping scheme.

When you select the *Inventory* menu, *General Building Stock* submenu, *Flood Specific Occupancy Mapping*, the window shown in Figure 7.5 appears. In the top right portion of the window, you can view which of the default schemes is assigned to each census block in your study region. By selecting one of the schemes listed in the lower window and pressing **View**, you can see the details of the mapping scheme.

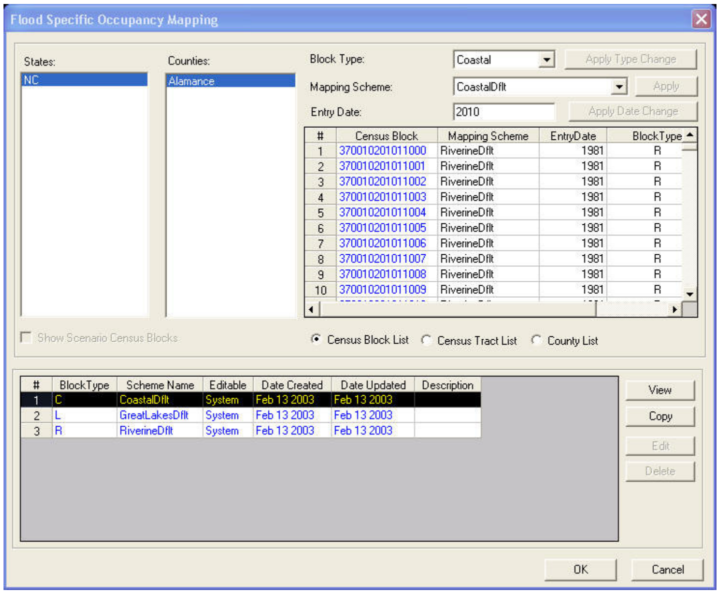


Figure 7.5 Default Flood Specific Occupancy Mapping (TEMP)

To edit a mapping scheme, highlight one scheme in the lower part of the window and click **Copy**. A new window will pop-up and prompt you to name your copied scheme, as shown in Figure 7.6. Select any name and add a description if you wish. This will create a new scheme with exactly the same data as one of the **Hazus** default schemes, which can be edited. The pull-down menu at the bottom of the *New Mapping Scheme* window will allow you to select which mapping scheme you would like as your starting point. You should select the default-mapping scheme that is relevant for the type of flood hazard present in your study region; riverine, coastal or great lakes.

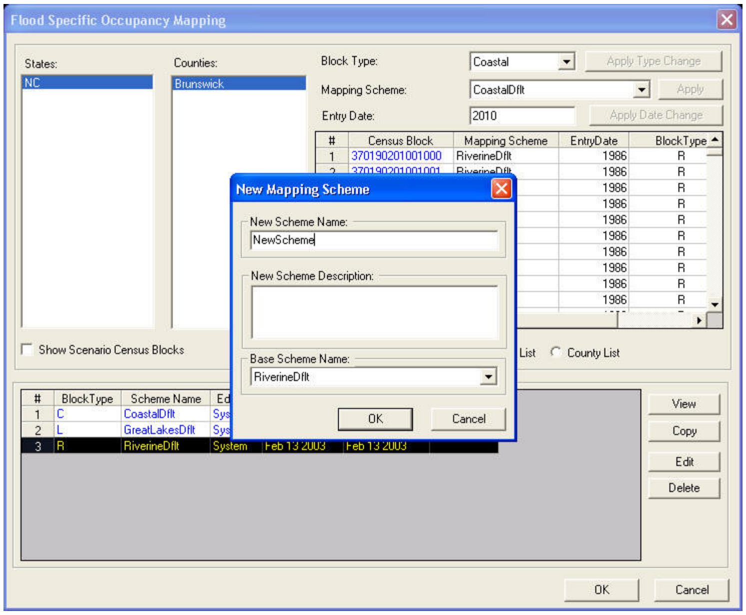


Figure 7.6 Copying a Flood Specific Mapping Scheme (TEMP)

Your new mapping scheme is now listed as one of the options in the bottom window. Highlight your new scheme and click **Edit**. The flood specific occupancy mapping details will appear on the screen. You can select each specific occupancy type and edit the distribution of foundation types and floor heights for pre- and post-FIRM structures. When you have made all of your edits, click **OK**.

Next, you need to assign your new mapping scheme to the relevant areas in your study region. The scheme that was developed in the example for this manual was riverine, and now appears under the *Mapping Scheme* pull-down menu when *Riverine* is selected in the *Hazard Type* pull-down menu, shown in Figure 7.7. Select the new scheme you have created in the *Mapping Scheme* pull-down menu. Then, highlight all of the census blocks that you would like to have your new mapping scheme assigned to, and click **Apply**. The mapping scheme should change for these census blocks. If you need to assign your new mapping scheme to the entire study region, click on the radial dial for *County List*. Select the new scheme in the *Mapping Scheme* pull-down menu, and click **Apply**.

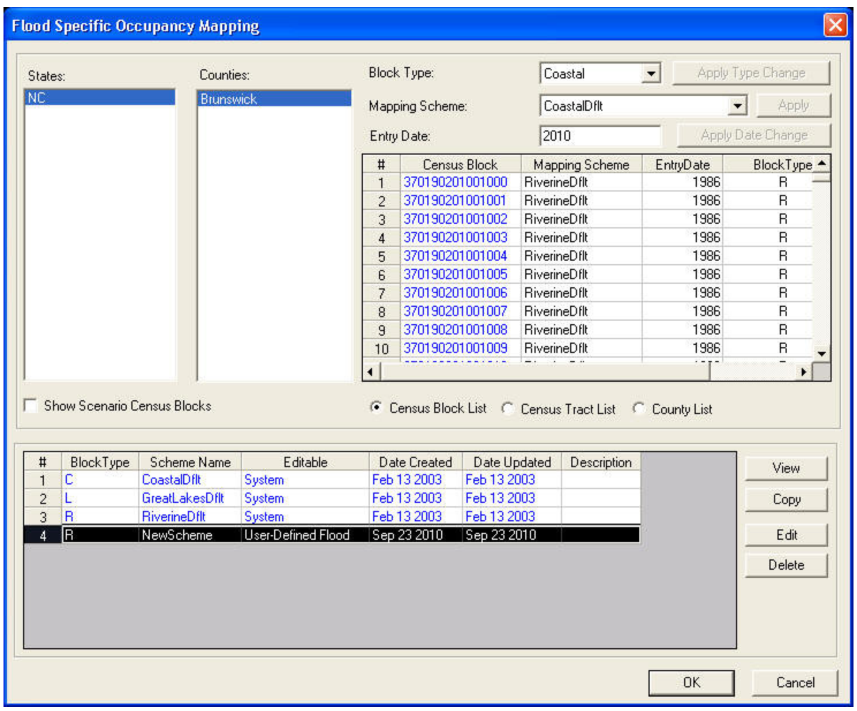


Figure 7.7 Assigning Newly Created Flood Occupancy Mapping

7.2 Modifying Facilities, Lifeline and Hazardous Materials Data

Data for essential facilities, high potential loss facilities, transportation systems, utility systems and hazardous materials can all be modified in similar ways. Again, you can modify them directly in **Hazus** or by importing data from other databases.

7.2.1 Edit Facilities, Lifeline and Hazardous Materials Tables

This manual will use emergency operations centers as an example data set to edit. Access the default data for essential facilities by selecting *Essential Facilities* from the *Inventory* menu, and click on the *Emergency Centers* tab on the top of the window. Make sure that *Emergency Centers* is selected in the *Facility-Type* pull-down menu.

You may edit the default data about emergency centers directly by typing over existing data. Be sure to save changes when you close the window.

It is also possible to add or delete records in the database. Place your cursor anywhere on the window and click on the right-hand mouse button. To add a record, select *Add New Record* from the window that pops up, shown in Figure 7.8.

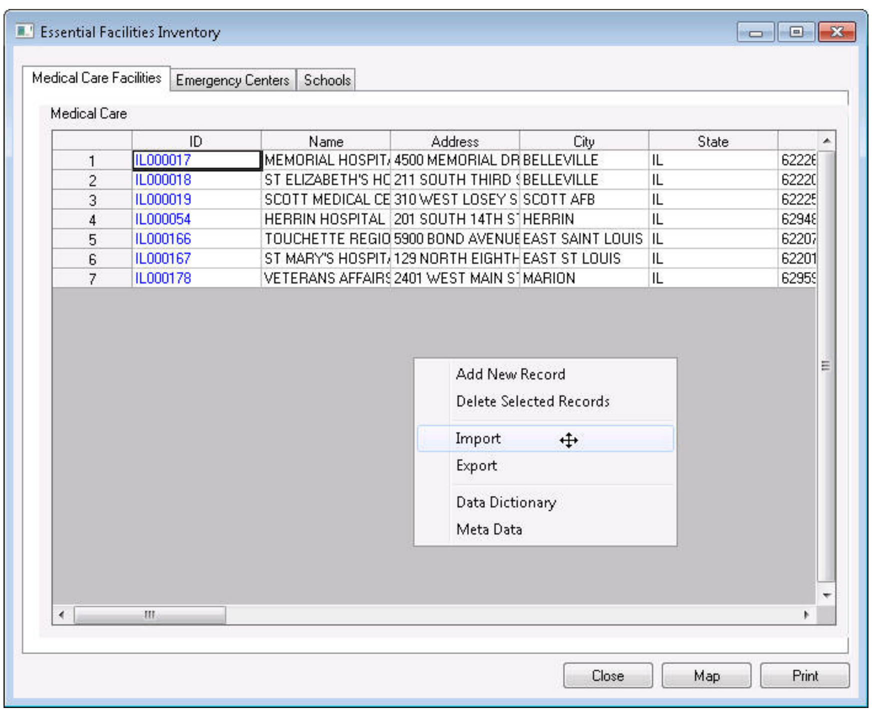


Figure 7.8 Adding a New Record

Now you will be prompted to enter the latitude and longitude of the new emergency center, shown in Figure 7.9. You must select a latitude and longitude within the case study boundary. Note that longitude should be entered as a negative number.

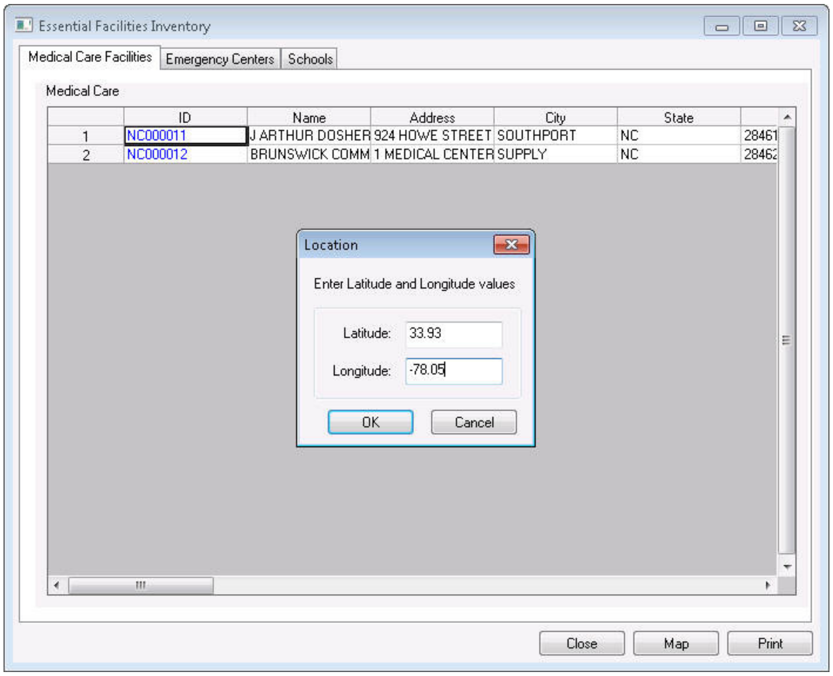


Figure 7.9 Entering Latitude and Longitude of a New Facility

A new line will appear, shown in Figure 7.10, and you may enter all of the relevant data about the newly listed facility.

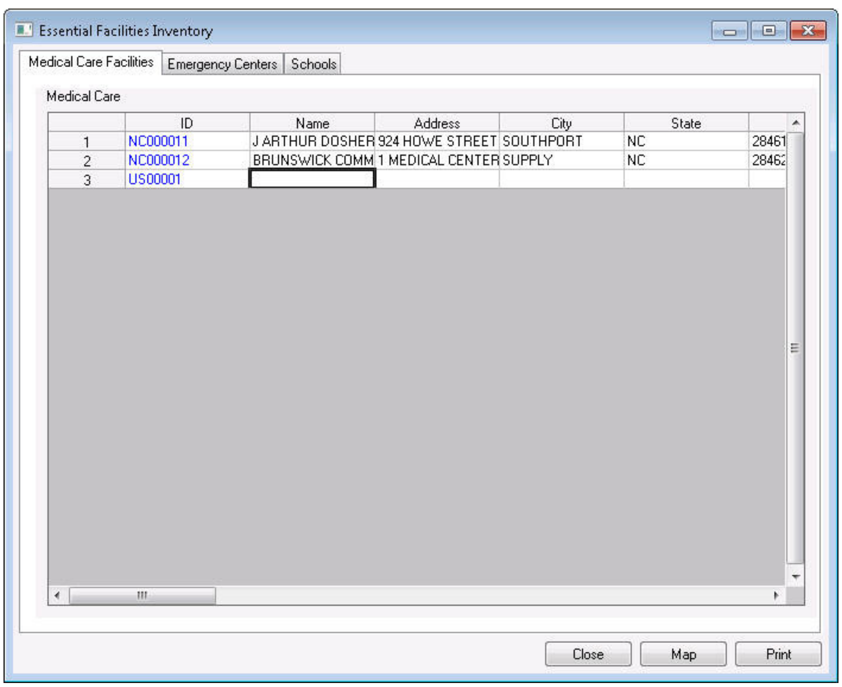


Figure 7.10 New Record Added for Data Entry

7.2.2 Importing Site Specific Data through Open Database Connectivity (ODBC)

Users can import an MS Access table into **Hazus**. However, there are rules for the table field definitions. Perhaps the easiest way is to copy the field definitions from **Hazus** and then add your custom data. This can be done using Open Database Connectivity (ODBC). Using ODBC allows users to import the data into a Study Region MS SQL Server database. Begin by opening MS Access. Select the *Blank Database* icon, and name the file at the bottom right. Rename the extension from ".accdb" to ".mdb". Then save the new database on a local drive (it's important that it is not saved to a network drive), and select **Create**.

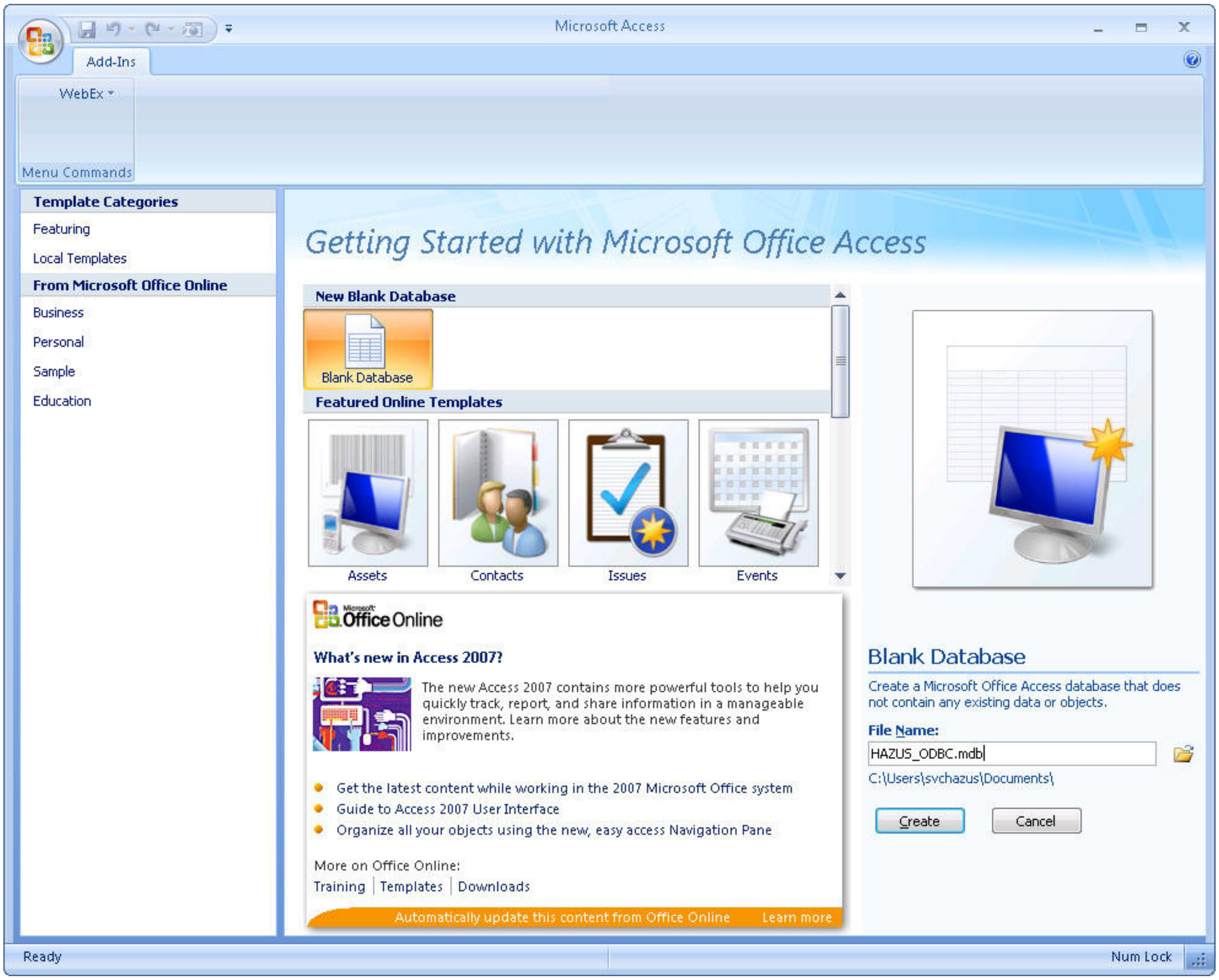


Figure 7.11 Creating a New MS Access Database

After the new Access database has been saved to disk, right-click on the header of the Access database and select *Customize Quick Access Toolbar*. In the Access Options dialog, in the *Choose commands from* dropbox, select *All Commands*. Then, scroll down to *Import or link to an ODBC database*, select **Add>>** button, and select **OK** (as seen in Figure 7.12 through Figure 7.14).

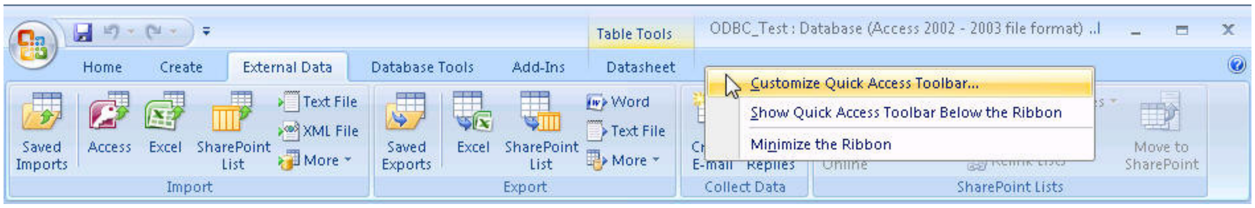


Figure 7.12 Customize Quick Access Toolbar

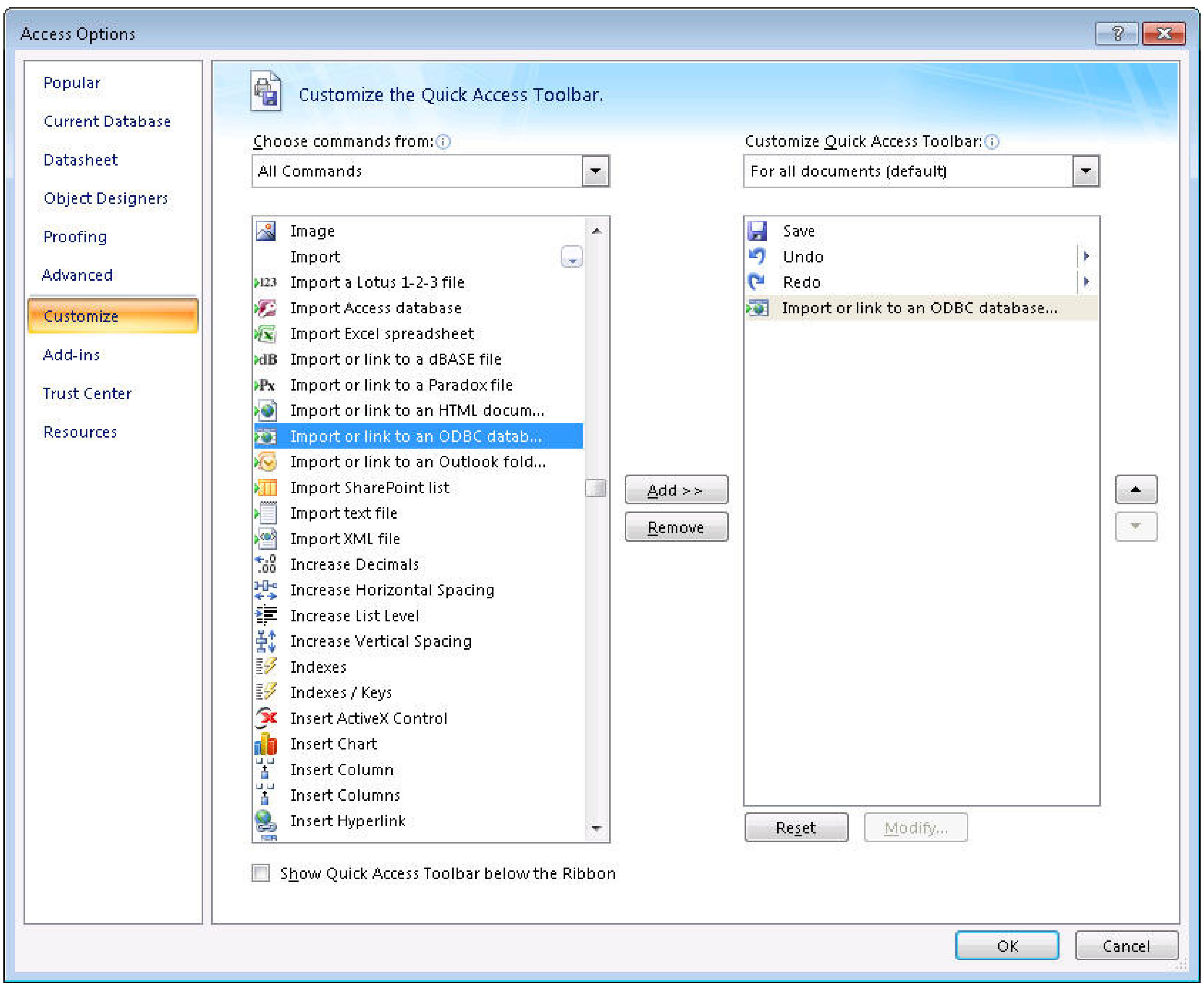


Figure 7.13 Access Toolbar Options

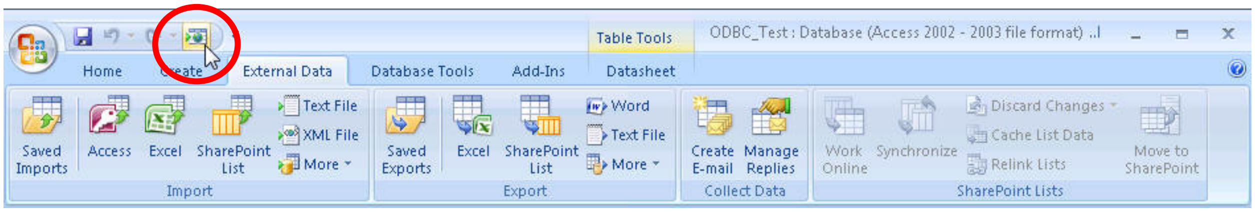


Figure 7.14 Adding *Import or link to an ODBC database* Icon

Click on the newly added *Import or link to an ODBC database* button in the Access toolbar as seen in Figure 7.14 (circled in red) to get external data. In the Get External Data – ODBC Database dialog, select the radio dial for "Import the source data into a new table in the current database" and click **OK**.

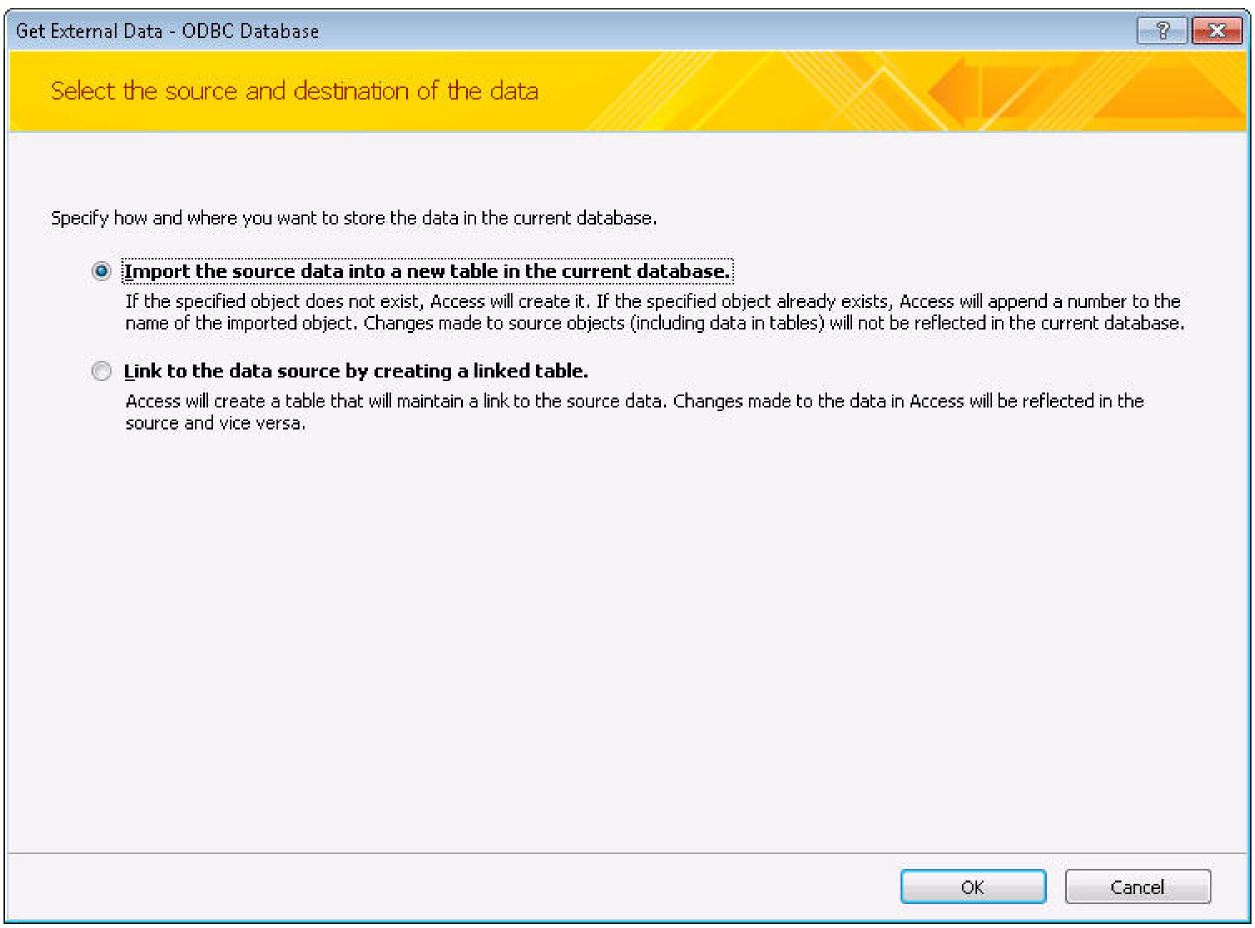


Figure 7.15 Importing an ODBC Database

In the resulting dialog, titled "Select Data Source", select the *Machine Data Source* tab and click the **New** button (circled in red in Figure 7.16).

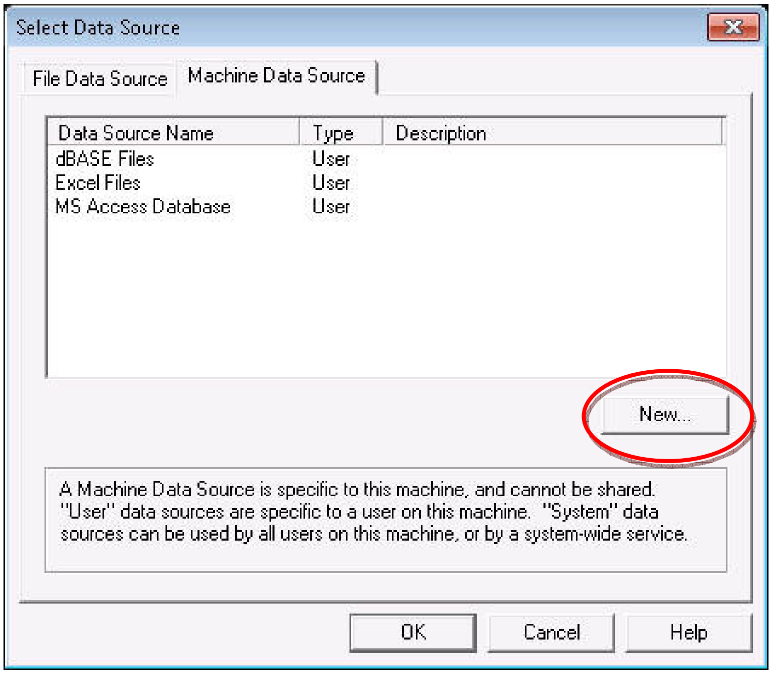


Figure 7.16 ODBC: Machine Data Source

In the Create Data Source dialog, select "System Data Source (applies to this machine only)" radio dial, and the **Next** button.

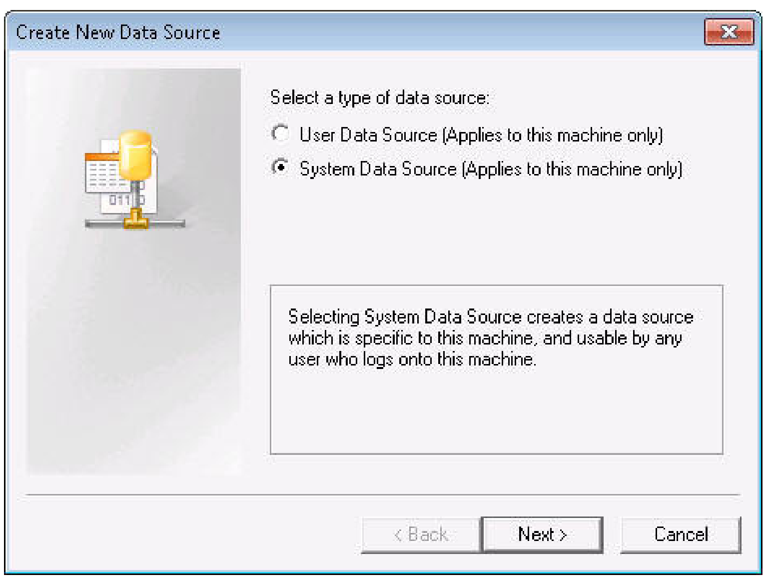


Figure 7.17 ODBC: New Data Source Type

The resulting dialog asks to select the data source driver. Scroll to the bottom, select **SQL Server** and click the **Next** button, as seen in Figure 7.18. On the next dialog, click **Finish**.

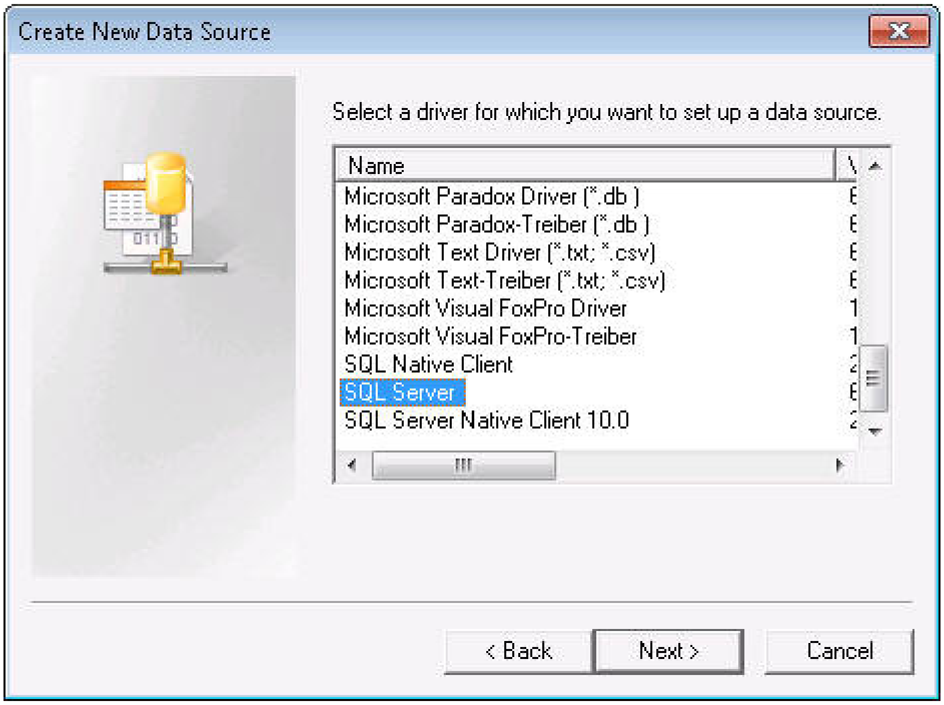


Figure 7.18 ODBC: New Data Source Server

The next few dialogs of the Create New Data Source wizard will prompt you for details about the new ODBC source. First you will enter the connection and server names in Figure 7.19. Keep the **Name**, short (preferably no spaces or special characters). A good choice for the name is that of your study region. The **Description** is optional, but here you can add a more descriptive name. In the **Server** combo box, select your MS SQL Server name. If your MS SQL Server name is not shown in the combo box, type your machine name followed by (no spaces) **"\HAZUSPLUSSRVR**". Then click the **Next** button.

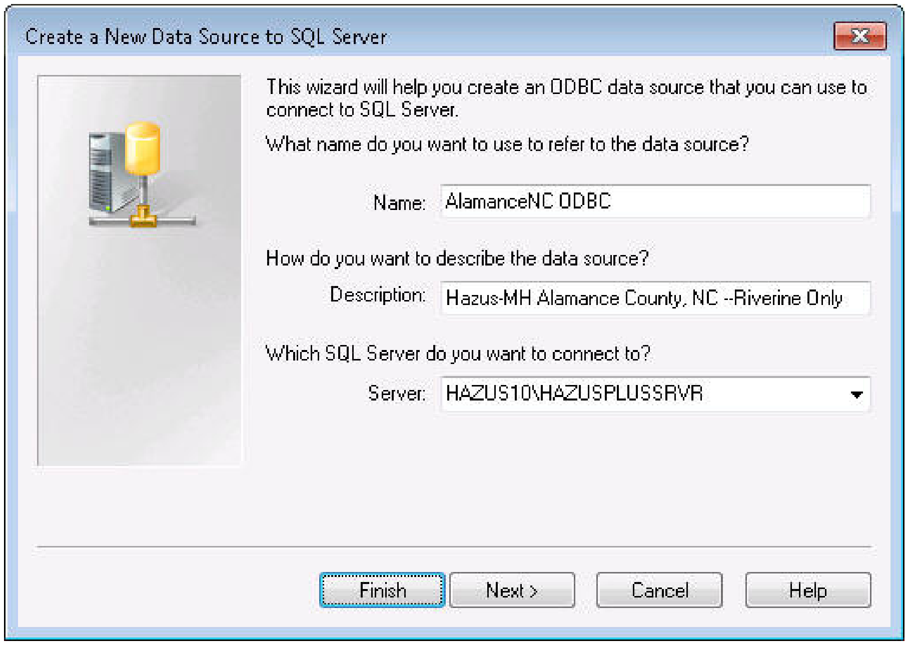


Figure 7.19 ODBC: Connection and Server Names

The wizard next asks for login authenticity information. For simplicity, use Windows authenticity. However, you may also use SQL Server authenticity with a login ID of **hazuspuser** and a password of **gohazusplus_01**. Click the **Next** button.

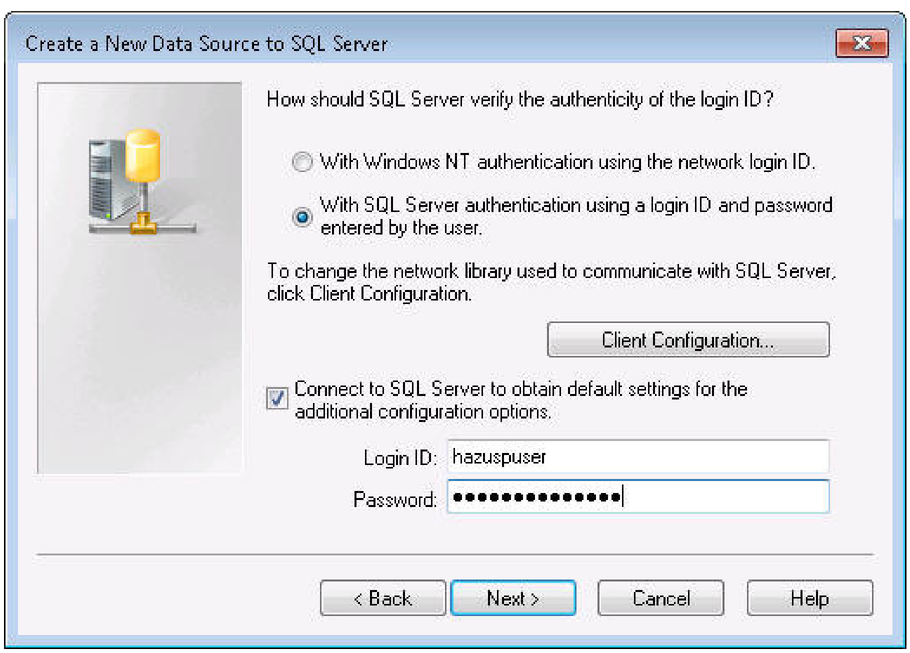


Figure 7.20 ODBC: Login Authenticity

The next dialog asks information about the SQL Server database. To avoid connecting to the MS SQL Server master database, **Change the default database**. In the combo box, select or type the name of your study region database (same as the study region name). Click the **Next** button. In the next dialog, use the defaults and click the **Finish** button.

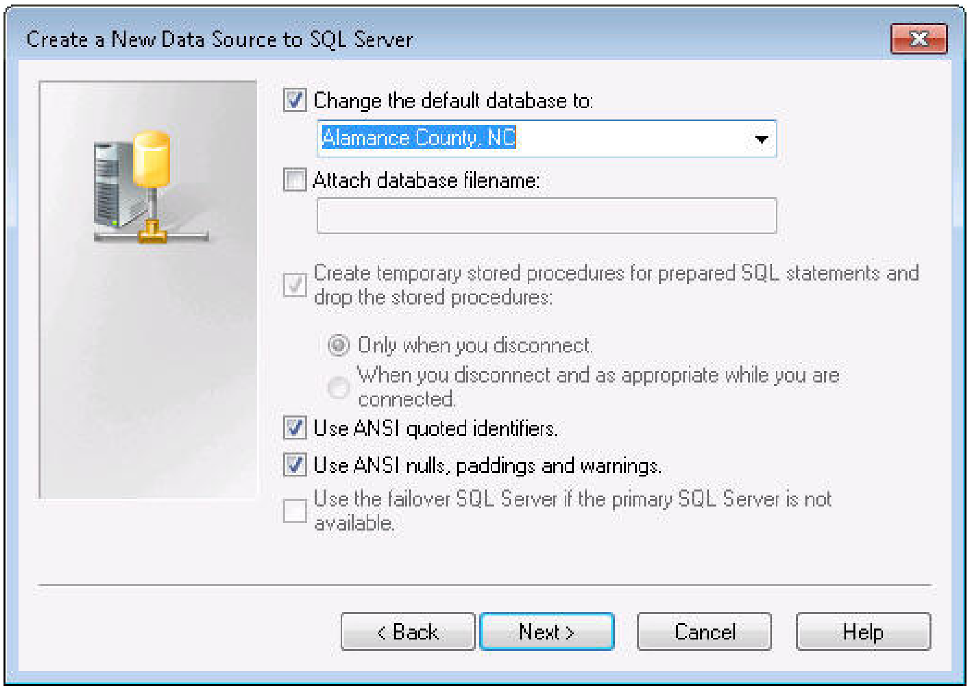


Figure 7.21 ODBC: SQL Server Default Database

At this point, the ODBC wizard has collected the required information and displays it. Before dismissing the dialog, click on the **Test Data Source** button to verify the study region's connectivity parameters. Then click the **OK** button.

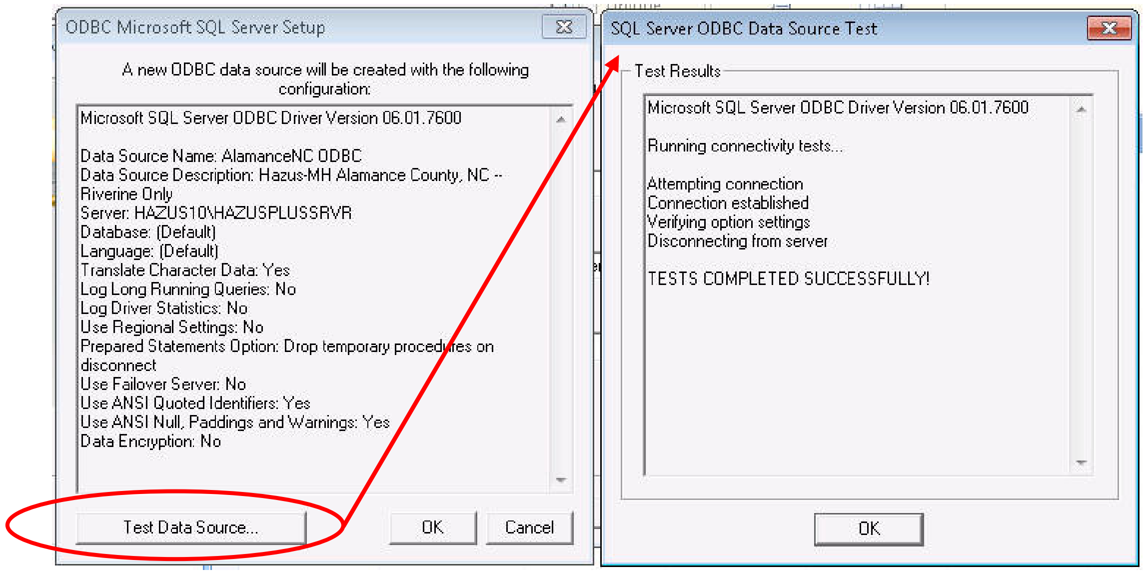


Figure 7.22 ODBC: Connectivity Parameters

Now we return to the Select Data Source dialog we saw earlier, but this time our new System Data Source is added. Select the newly added data source and click the **OK** button.

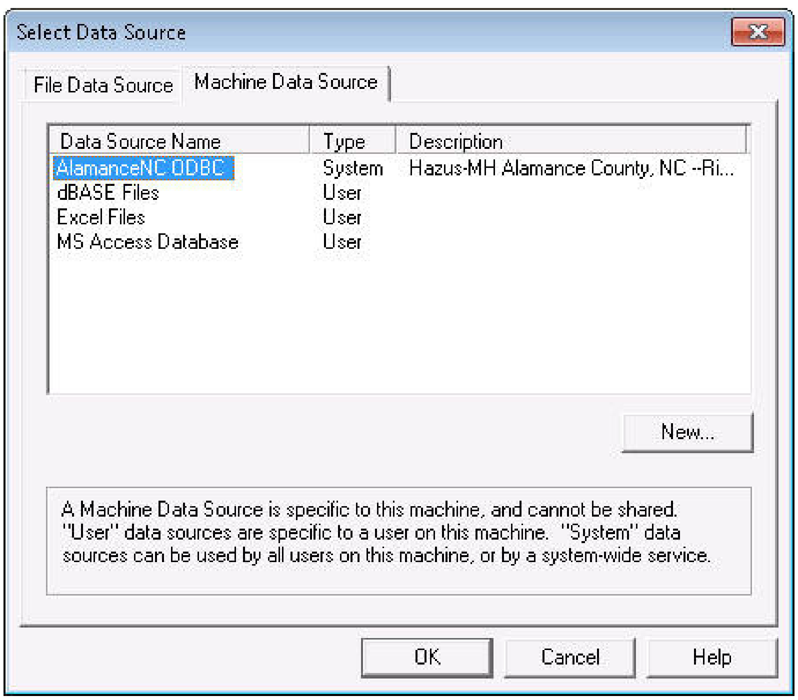


Figure 7.23 ODBC: Select Added Data Source

All of the SQL server tables are now available to be imported. The dialog shows the name of every element in the database.

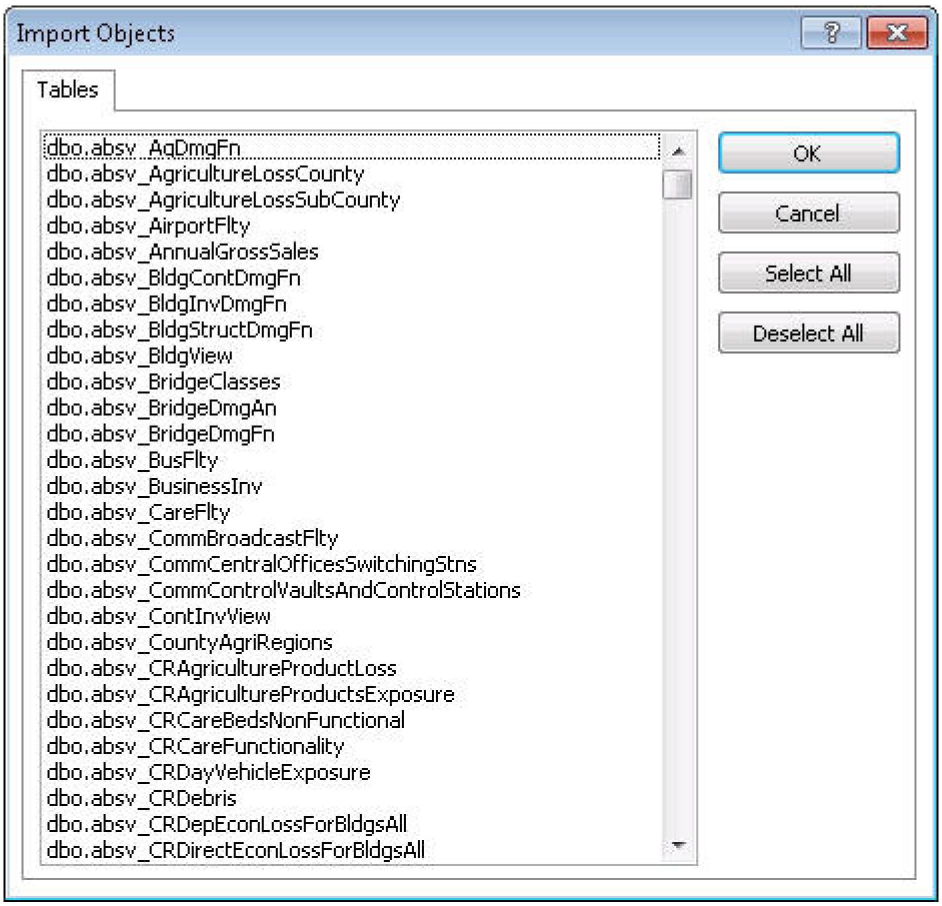


Figure 7.24 ODBC: Import Objects

Here are some notes regarding the nomenclature:

- Common hazard tables have HZ prefix (common to all 3 hazards -- earthquake, flood, hurricane)
- Flood-specific tables have FL prefix (EQ, HU respectively for earthquake, hurricane)
- Flood-specific views have an absv_ prefix. Views are a particular query of the database. Views are what are shown when you view any inventory or results table in HAZUS.
- Flood-specific procedures have ABSP_ prefix (don't import procedures!)
- Flood-specific triggers have ABST_ prefix (don't import triggers!)

In order to import the table or view of interest, you'll need to know its name in the SQL Server database. To determine this, open the inventory or results table of interest in the Flood Model. In any blank area on the dialog (not on the table itself), use CTRL + SHIFT + left mouse click to see the source table name:

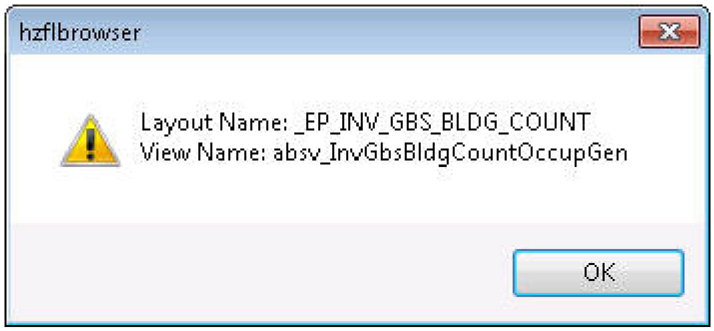


Figure 7.25 ODBC: Source Table Name

In the figure, using CTRL + SHIFT + left click indicates that the active table is a view (ABSV_ prefix) and the name is InvGbsBldgCountOccupGen (inventory general building stock, building count, general occupancy). If you wish to import this table into MS Access, select this name from the Import list. Here are some examples of view (table query) names:

- absv_CareFlty – for medical care facilities
- absv_EmergencyCtr – for emergency centers
- absv_PoliceStation – for police stations
- absv_School – for schools
- absv_UserDefinedFlty – for user defined facilities

Navigate through the Flood Model to determine the names of the views of interest. Then select those names on the Import list. Click the OK button to import the views to your MS Access database. You now have tables of interest with the field definitions required by the Flood Model.

Importing Flood Model SQL Server information through ODBC creates a copy of the data. The default data provided with **Hazus** is now imported in a local MS-Access database and can now be edited or viewed locally without impacting the data in **Hazus**.

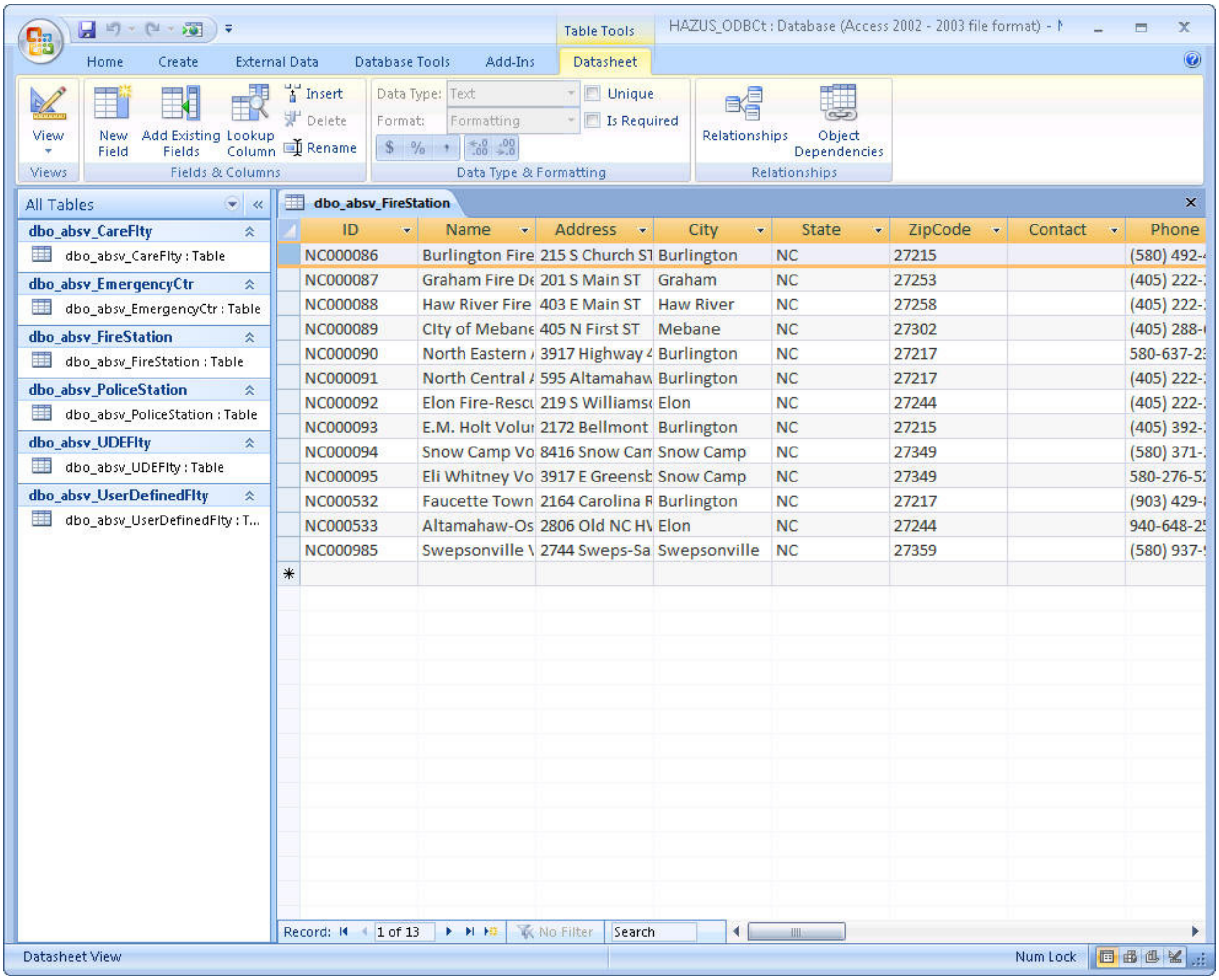


Figure 7.26 ODBC: Import Complete

7.2.3 Import Data File to Hazus

The user should have a Microsoft Access database containing the data of interest. Begin by opening the inventory table that contains the data. The import functionality allows import to the hz table and associated fl table. For example, for schools data, click on the **Inventory/Essential Facilities** menu item. Click on the **Schools** tab, right-click the mouse button within the table, and select **Import**.

Chapter 8 Overview of the Flood Information Tool (FIT) Process

The Flood Information Tool (FIT) is an ArcGIS extension designed to process user-supplied flood hazard data into the format required by **Hazus** Flood Model. The FIT, when given user-supplied inputs (e.g., ground elevations, flood elevations, and floodplain boundary information), computes the extent, depth and elevation of flooding for riverine and coastal hazards. The information below is a brief overview of the riverine and coastal methodologies. For more detailed information, please refer to the Flood Information Tool (FIT) User Manual.

8.1 Riverine Methodology

8.1.1 Input Floodplain Boundary

The user is required to identify up- and downstream limits of study and the feature class field(s) that contains the elevation data in the polyline feature class. If the floodplains are represented by more than one polygon, the user is required to identify the polygon associated with the study area. The floodplain boundary polygon need not be associated with any particular flood. It is used by the FIT only to define a "smooth" line representing the general flow path of floodwater. Only one polygon can be associated with a study reach. Floodplains that are disconnected (by a road crossing, for example) must be somehow connected (merged) or studied as two reaches.

8.1.2 Centerline of Flow

Once the stream limits have been chosen, the program will define a polyline from the upstream limit to the downstream limit. That polyline is, in a sense, the centerline of the floodplain. It is the aforementioned smooth line representing the general flow path of floodwater. Note that the program uses the centerline to identify cross sections within the reach. Specifically, only cross section lines that cross the centerline are considered in subsequent analyses. It is important to ensure that all cross sections within a reach cross the centerline. Note that lines that cross the floodplain polygon necessarily cross the centerline.

8.1.3 Bounding Polygon

An initial buffer is computed around the centerline and the user is prompted to increase and/or decrease the buffer until satisfied that the conveyance area of the floodplain of interest is contained within the buffer. The chosen buffer defines the extent to which flood depths will be calculated and, therefore, is referred to as the bounding polygon. The extent of the floodplain boundary feature class may help in guiding the decision on how large to make the bounding polygon.

The lengths of the cross section lines and the limits do not restrict the size of bounding polygon. If necessary, the program will extend cross-section lines to the bounding polygon. If necessary, the cross-section lines are extended in a manner that preserves a sense of alignment perpendicular to flood flow. The limits are extended in a straight line following the alignment at the ends of each respective limit. Users should try to avoid drawing stream limits that cross each other, intersect cross sections, or otherwise cut off portions of the bounding polygon pertinent to describing the floodplain.

8.1.4 Non-Conveyance Areas

Certain low-lying areas adjacent to the floodplain, such as tributary streams, that do not convey but, rather, retain floodwater (pond) at the flood elevation in the conveyance part of the floodplain, need not be included within the bounding polygon. The FIT provides an analysis option for including such areas inside and outside of the bounding polygon. The ideal bounding polygon contains all portions of (different frequency) floodplains being analyzed and, also, minimizes the areas subject to ponding.

8.1.5 Interpolation of Additional Hazard Grids

If the cross sections are attributed with multiple flood elevations, the FIT uses the information supplied for the initial analyses to develop subsequent flood depth grids. That is, subsequent flood depth grids can be developed without re-entering reach limits and choosing bounding polygons. If cross sections are attributed with at least three flood elevations and corresponding discharge values, the FIT offers an option to interpolate other flood depth grids.

8.1.6 Modeling Tips

The study reach is defined by the choice of up- and downstream limits. In some situations, subdividing a reach into shorter reaches can improve the efficiency (run time) of the FIT. Subdividing a reach into reaches covered by bounding polygons of different sizes will yield results quicker than using the largest bounding polygon for the entire reach. In general, reaches should be chosen to include relatively homogeneous floodplain widths. Reaches should overlap enough to ensure that there are no gaps in coverage of the floodplain.

Highly meandering floodplain configurations may warrant special attention. If the flow centerline (not the stream) has a horseshoe-shaped meander, increasing the buffer will, at some distance, create a discontinuity in the bounding polygon. An “island” will form within the bounding polygon somewhere within the meander (inside the horseshoe). The interpolation algorithm in the FIT does not operate properly in such situations. Increasing the bounding polygon beyond that limiting size will result in error messages. If the bounding polygon must be increased beyond that limit, the meander should be analyzed piece-wise, thereby removing the “horseshoe” shape within any reach.

8.2 Coastal Methodology

8.2.1 Shoreline Characterization

The user is required to identify all coastal flood sources that will be considered by **Hazus**, and to draw a shoreline associated with each flood source. The shoreline drawn by the user should be a general depiction of the shoreline, and should not be a detailed rendering. In tidal areas, the shoreline drawn should represent the approximate mean sea level shoreline; in the Great Lakes the shoreline should be drawn at approximately the International Great Lakes Datum (IGLD) chart datum. If the user has a local map layers depicting the water line, this can be used as a guide when drawing the generalized shoreline.

The user must then divide each shoreline into segments of common physical characteristics and wave exposure. The shoreline types available for user selection include: rocky bluff; sandy bluff, little beach; sandy beach, small dune; sandy beach, large dune; open wetland; erosion protection structure. If the user selects an erosion protection structure (e.g., seawall or revetment) for a shoreline segment, the user must assign a level of protection afforded by the structure (i.e., a flood return period, below which the structure will not fail, and below which the structure will protect the uplands from flooding and erosion).

The user must provide the 100-year stillwater elevation at each shoreline segment, along with any contribution from wave setup (the stillwater elevation and wave setup information are published by FEMA in the Flood Insurance Study report -- FIS-- for each coastal community). The FIT relies upon the 100-year stillwater elevation (without setup) to calculate 10-year, 50-year and 500-year stillwater elevations. The user can edit or replace these elevations with values taken directly from the FIS, if available; otherwise, the FIT will use the calculated values, which are based on nationwide default data. Ultimately, the FIT can use the stillwater elevation values -- calculated or input by the user – to calculate 10-year, 50-year, 500-year and interpolated flood elevation grids.

The FIT relies upon the user segmentation to differentiate between those segments that will be subject to flood-induced erosion and those that won't. The FIT will generate shore-perpendicular transects from each shoreline segment. The transects are located at a pre-determined spacing and extend inland from the shoreline. The user is free to add and delete new transects if so desired.

8.2.2 Frontal Dune Erosion

The FIT will create a profile (of ground elevation versus distance inland from the shoreline) for each transect crossing an erodible shoreline segment, and with sufficient wave action to cause erosion of dunes and bluffs or failure of erosion protection devices during the base flood. The user may select the peak and toe of the dune/bluff, or accept the FIT selections. The FIT will then calculate an eroded ground profile along each transect, and interpolate an eroded ground elevation grid.

8.2.3 Output Hazard Grids

The FIT will calculate the flood depth grid (i.e., the difference between the flood elevation grid and the eroded ground elevation grid) for the 100-year flood and for other return periods selected by the user. This information will be passed to **Hazus**, along with other data (shoreline characteristics, transect data, stillwater elevations, flood hazard zone information, etc.). **Hazus** will use the flood depth grids created by the FIT with a suite of flood depth-damage functions to calculate flood damage. The vertical erosion grid calculated by the FIT (i.e., the vertical difference between the original ground elevation grid and the eroded ground elevation grid) will also be passed to **Hazus**, for use with an erosion depth-damage function to calculate erosion damage.

Chapter 9 Running Hazus Flood with User Supplied Data

This chapter provides a step-by-step discussion of how to perform an analysis if you wish to modify the hazard definition, default analysis parameters, or analysis options. Before attempting an analysis that will incorporate user-supplied data, follow the steps in Chapter 3 for running an analysis using only default data.

9.1 Defining the Study Region

The first step in any analysis is defining a study region. Please refer to Section 3.1 for a complete description of this process.

9.2 Defining the Inventory Data

The second step is to review the inventory data and modify the data, as necessary. Please refer to Chapter 4 through Chapter 7 for information on how to define the inventory data.

9.3 Defining the Hazard

In order to apply user-supplied flood hazard data to the Flood Model, use of the Flood Information Tool (FIT) is required (unless a depth grid or .FLT grid will be used instead). The FIT was discussed previously in Section 4.2 and Section 8. For detailed information, please refer to the *FIT User Manual*. To import FIT results to **Hazus**, click on the **Hazard/User Data** menu item. Select the appropriate FIT hazard (riverine or coastal) and use the resulting dialog (Figure 9.1) to browse to the FIT project folder on disk.

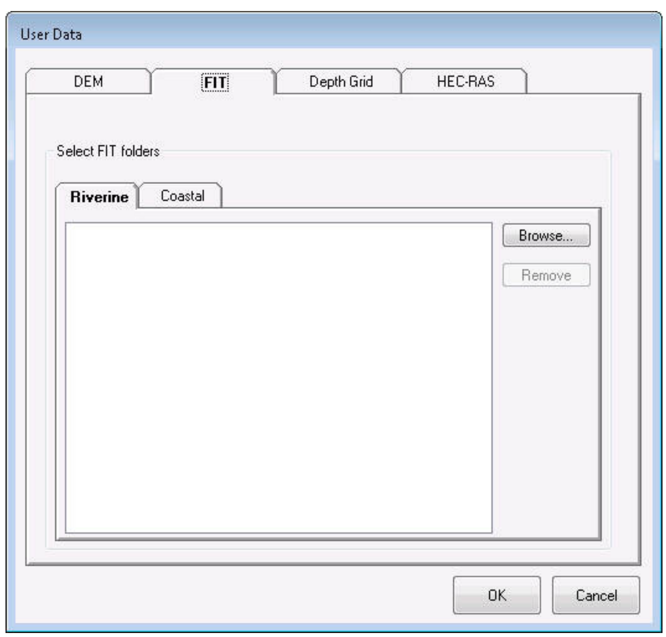


Figure 9.1 FIT Working Directory Selection

Click OK when finished and the FIT project data are imported to **Hazus**. Continue with other hazard menu items, and upon reaching the **Hazard/Scenario New** dialog, select FIT polygons of interest using the select tool. The selected FIT data will be used in the hazard computation.

9.4 Damage Functions

The Flood Model default data includes over 700 depth-damage functions that relate water depth to structure and content percent damage. The Damage Functions includes Buildings, Essential Facilities, Transportation Systems, Utility Systems, Agricultural Products, and Vehicles. All of these damage functions are very similar with the exception of the Agricultural Products. An example of a Damage Function can be viewed from the **Analysis/Damage Functions/Buildings** menu item (Figure 9.2). The functions can be viewed by hazard type and general occupancy.

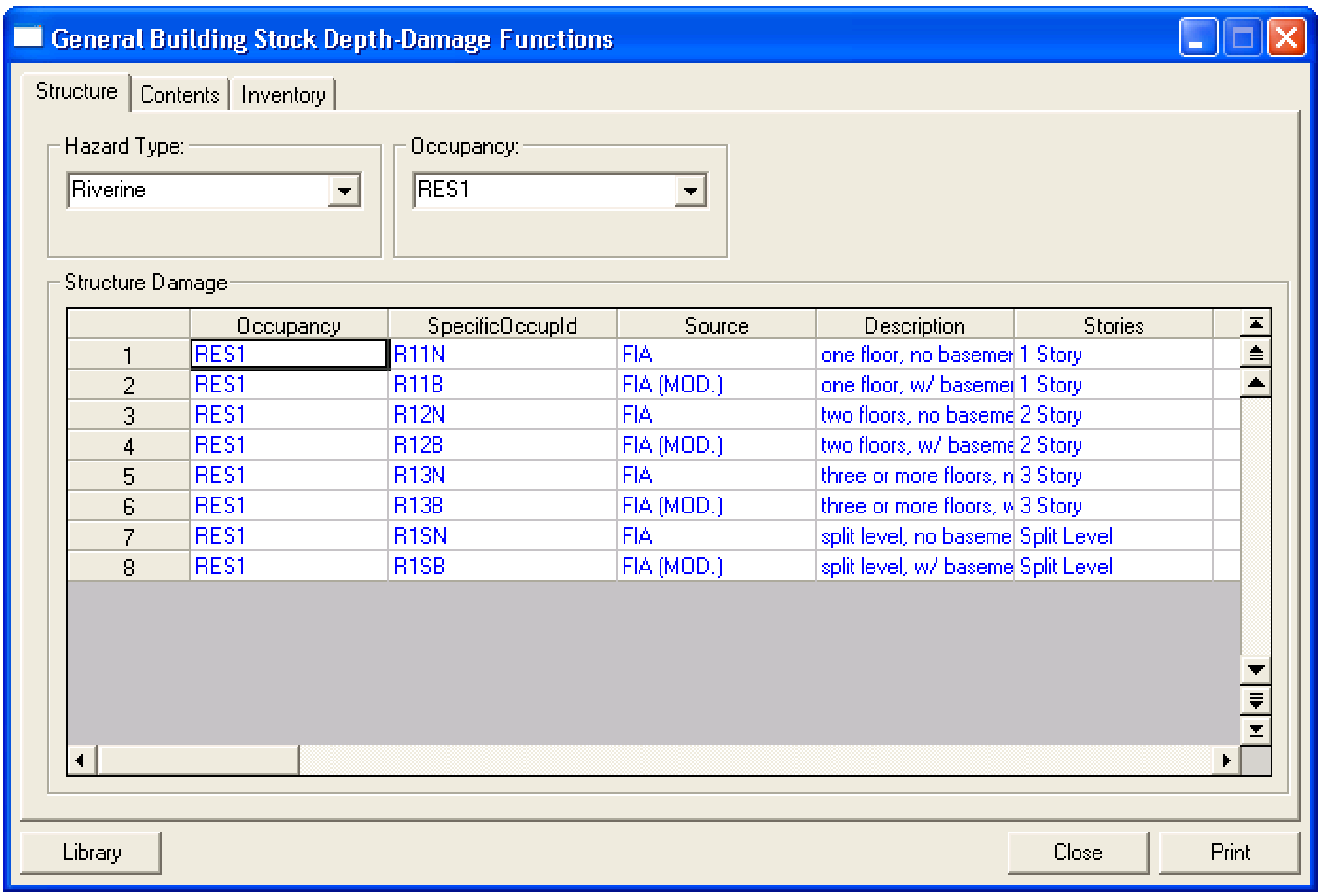


Figure 9.2 Building Damage Functions

To apply a user-defined damage function, click on the Library button on the bottom left hand corner of the dialog. The resulting dialog displays available damage functions for the selected specific occupancy (Figure 9.3).

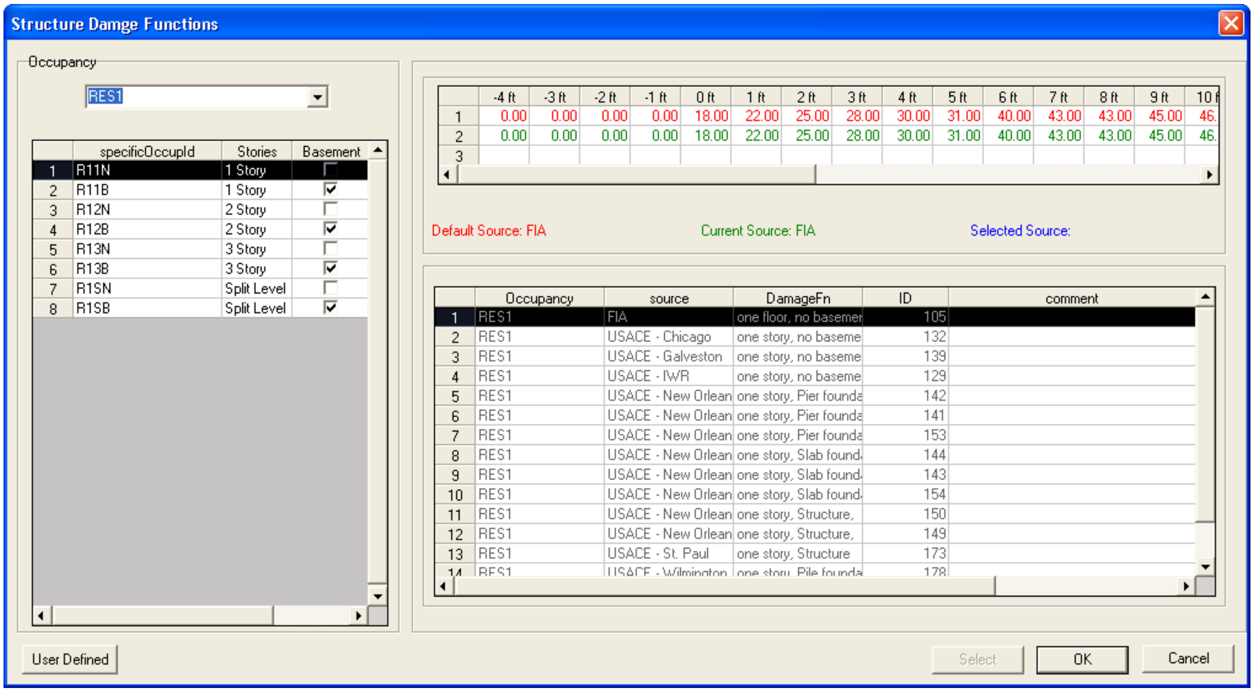
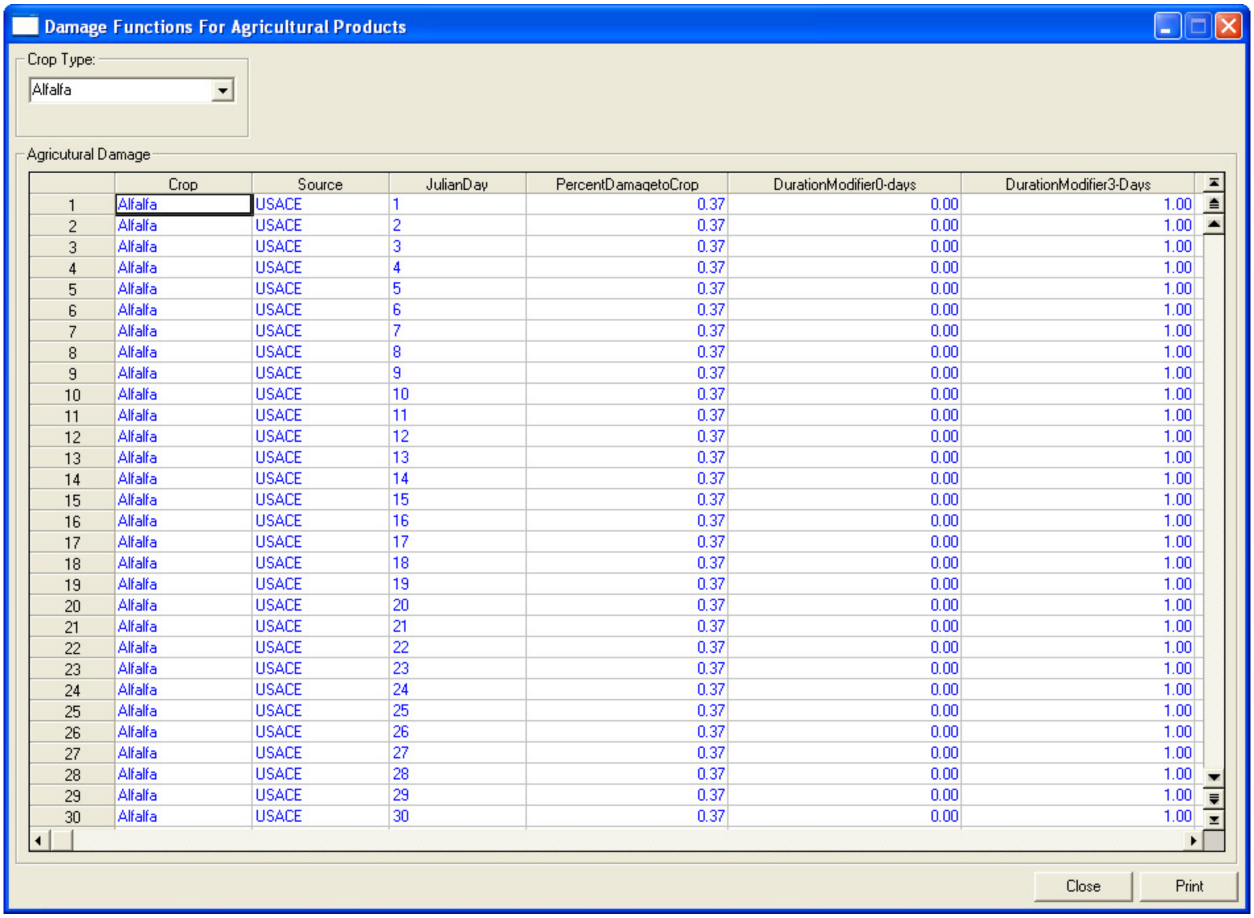


Figure 9.3 Damage Functions by Specific Occupancy

Click on the *User Defined* button in the dialog's bottom left hand corner to add a new damage function for the indicated specific occupancy. An example of the Damage Function for Agricultural Products can be seen in Figure 9.4.



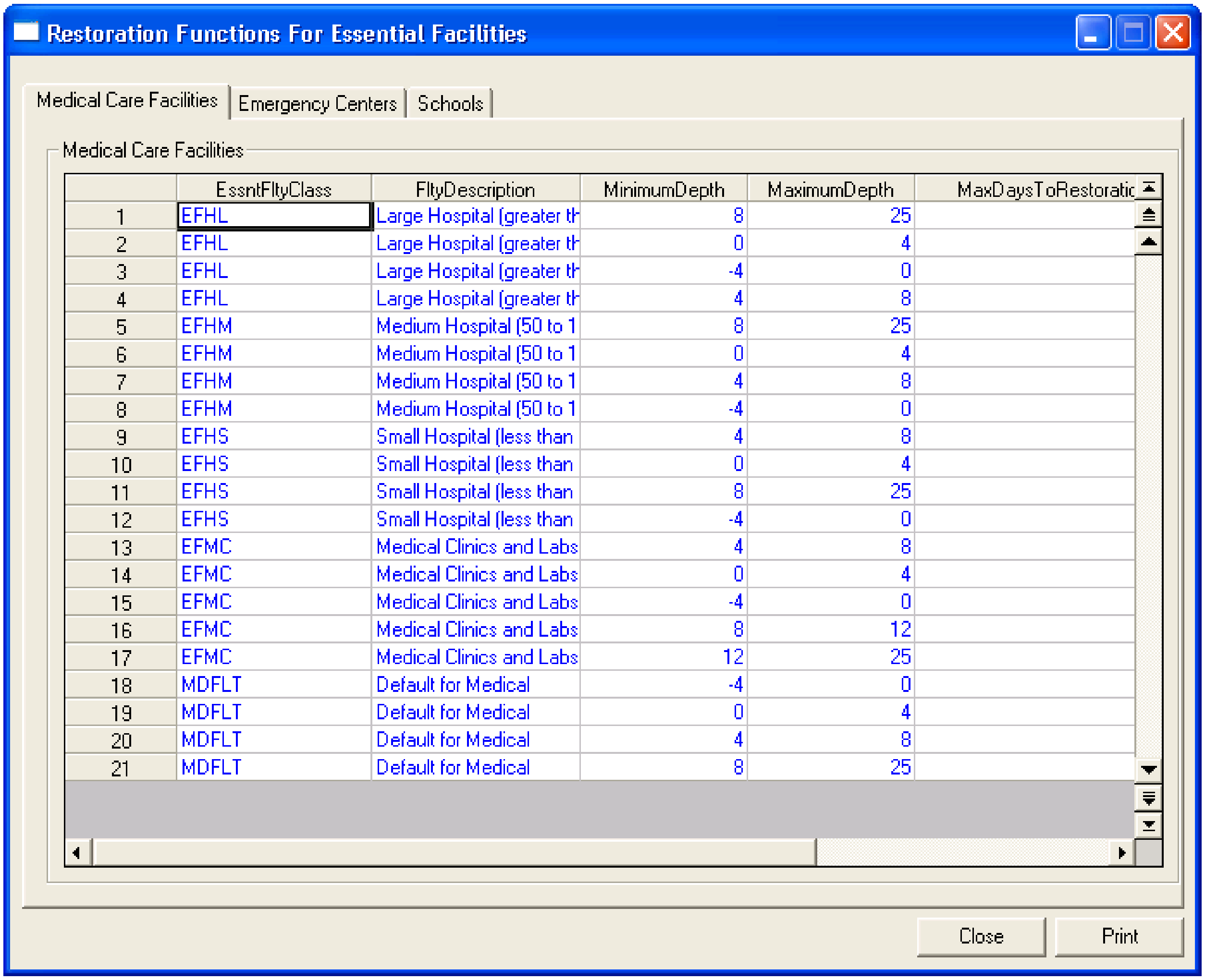
	Crop	Source	JulianDay	PercentDamagetoCrop	DurationModifier0-days	DurationModifier3-Days
1	Alfalfa	USACE	1	0.37	0.00	1.00
2	Alfalfa	USACE	2	0.37	0.00	1.00
3	Alfalfa	USACE	3	0.37	0.00	1.00
4	Alfalfa	USACE	4	0.37	0.00	1.00
5	Alfalfa	USACE	5	0.37	0.00	1.00
6	Alfalfa	USACE	6	0.37	0.00	1.00
7	Alfalfa	USACE	7	0.37	0.00	1.00
8	Alfalfa	USACE	8	0.37	0.00	1.00
9	Alfalfa	USACE	9	0.37	0.00	1.00
10	Alfalfa	USACE	10	0.37	0.00	1.00
11	Alfalfa	USACE	11	0.37	0.00	1.00
12	Alfalfa	USACE	12	0.37	0.00	1.00
13	Alfalfa	USACE	13	0.37	0.00	1.00
14	Alfalfa	USACE	14	0.37	0.00	1.00
15	Alfalfa	USACE	15	0.37	0.00	1.00
16	Alfalfa	USACE	16	0.37	0.00	1.00
17	Alfalfa	USACE	17	0.37	0.00	1.00
18	Alfalfa	USACE	18	0.37	0.00	1.00
19	Alfalfa	USACE	19	0.37	0.00	1.00
20	Alfalfa	USACE	20	0.37	0.00	1.00
21	Alfalfa	USACE	21	0.37	0.00	1.00
22	Alfalfa	USACE	22	0.37	0.00	1.00
23	Alfalfa	USACE	23	0.37	0.00	1.00
24	Alfalfa	USACE	24	0.37	0.00	1.00
25	Alfalfa	USACE	25	0.37	0.00	1.00
26	Alfalfa	USACE	26	0.37	0.00	1.00
27	Alfalfa	USACE	27	0.37	0.00	1.00
28	Alfalfa	USACE	28	0.37	0.00	1.00
29	Alfalfa	USACE	29	0.37	0.00	1.00
30	Alfalfa	USACE	30	0.37	0.00	1.00

Figure 9.4 Agricultural Products Damage Functions

9.5 Restoration Time

Modification of restoration time regards to the loss of function and repair time of facilities. A distinction should be made between loss of function and repair time. In this methodology, loss of function is defined as the time that a facility is not capable of conducting business. This, in general, will be shorter than repair time because businesses will rent alternative space while repairs and construction are being completed. Loss of function (restoration time) is estimated in the methodology only for essential facilities, transportation lifelines and utility lifelines. Default restoration functions are provided with the methodology for essential facilities, transportation lifelines and utility lifelines. An example of a set of restoration functions is found in Figure 9.5. Restoration curves describe the fraction of facilities (or components in the case of lifelines) that are expected to be open or operational as a function of time following the earthquake. For example, looking at the curves shown in Figure 9.5, 10 days after the earthquake, about 20% of the facilities that were in the extensive damage state immediately after the earthquake and about 60% of the facilities that were in the moderate damage state immediately after the earthquake, are expected to be functional. Each curve is based on a Normal distribution with a mean and standard deviation. The parameters of the restoration functions are accessed through the

Analysis|Restoration Function menu and can be viewed and modified in a window such as the one shown in Figure 9.5.



	EssntFltyClass	FltyDescription	MinimumDepth	MaximumDepth	MaxDaysToRestoratic
1	EFHL	Large Hospital (greater th	8	25	
2	EFHL	Large Hospital (greater th	0	4	
3	EFHL	Large Hospital (greater th	-4	0	
4	EFHL	Large Hospital (greater th	4	8	
5	EFHM	Medium Hospital (50 to 1	8	25	
6	EFHM	Medium Hospital (50 to 1	0	4	
7	EFHM	Medium Hospital (50 to 1	4	8	
8	EFHM	Medium Hospital (50 to 1	-4	0	
9	EFHS	Small Hospital (less than	4	8	
10	EFHS	Small Hospital (less than	0	4	
11	EFHS	Small Hospital (less than	8	25	
12	EFHS	Small Hospital (less than	-4	0	
13	EFMC	Medical Clinics and Labs	4	8	
14	EFMC	Medical Clinics and Labs	0	4	
15	EFMC	Medical Clinics and Labs	-4	0	
16	EFMC	Medical Clinics and Labs	8	12	
17	EFMC	Medical Clinics and Labs	12	25	
18	MDFLT	Default for Medical	-4	0	
19	MDFLT	Default for Medical	0	4	
20	MDFLT	Default for Medical	4	8	
21	MDFLT	Default for Medical	8	25	

Figure 9.5 Restoration Functions for Essential Facilities

Typing in a new value and then clicking on the **Close** button will modify parameters for restoration curves. You will be asked to confirm that you want to save your changes. It is strongly recommended that you use the default parameters unless you have expertise in the development of restoration functions.

9.6 Analysis Parameters

The Analysis Parameters are factors or variables within the analysis that users can modify. The six factors that are available for modification are Debris, Casualties, Shelter, Agricultural, Direct Economic Loss, and Indirect Economic Loss. They are each detailed in the following pages.

9.6.1 Debris Parameters

The Debris Parameters are based on the depth of the flood within a structure by ranges. It shows the expected debris to be produced; the debris from a structure and footing or slab is only produced when the structure is demolished. This is based on dry wall and other components that are replaced in manageable units instead of the area of actual damage. Users can modify as desired. The weights are in tons per thousand square feet of the structure. Figure 9.6 is an example of the Debris Parameters window.

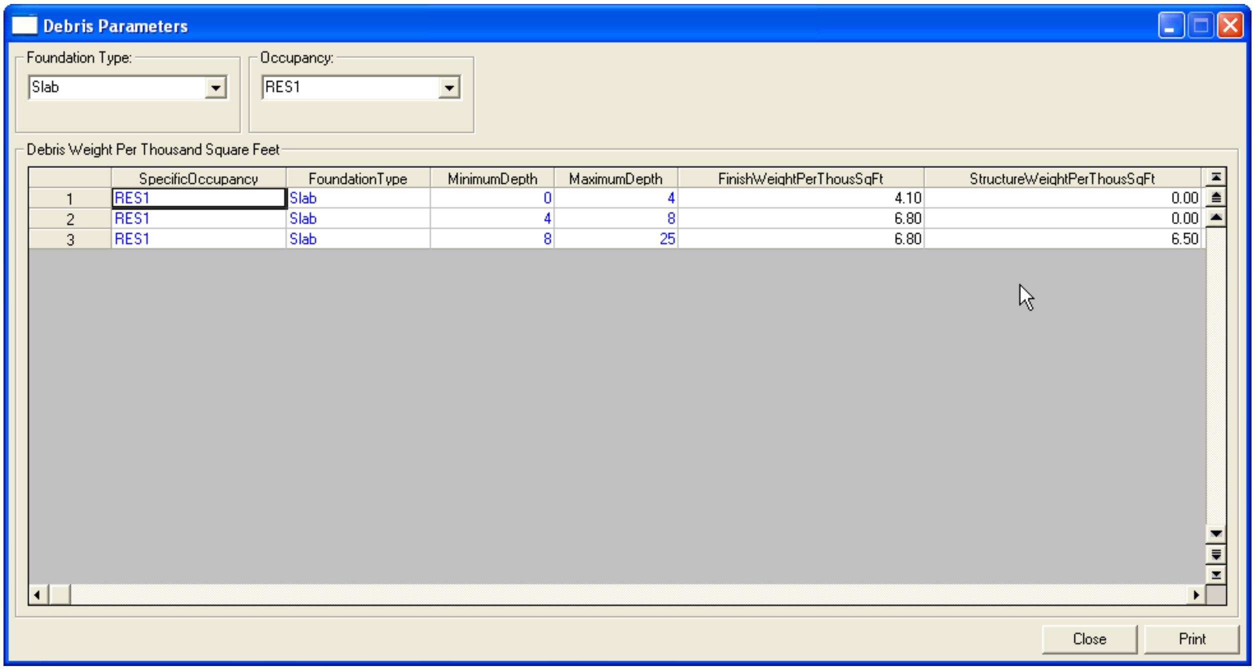
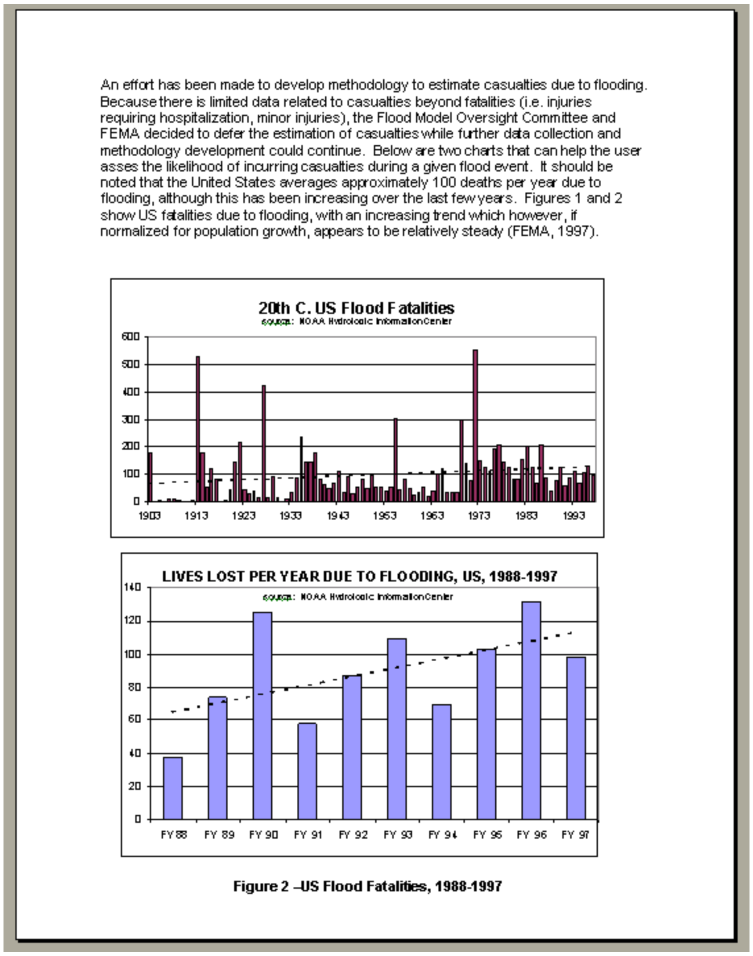


Figure 9.6 Debris Parameters

9.6.2 Casualties Parameters

Unfortunately, the Flood Model does not have Casualties Parameters. When a user selects the Casualties Parameters while in the Flood Model, the word document that opens can be seen in Figure 9.7.



An effort has been made to develop methodology to estimate casualties due to flooding. Because there is limited data related to casualties beyond fatalities (i.e. injuries requiring hospitalization, minor injuries), the Flood Model Oversight Committee and FEMA decided to defer the estimation of casualties while further data collection and methodology development could continue. Below are two charts that can help the user asses the likelihood of incurring casualties during a given flood event. It should be noted that the United States averages approximately 100 deaths per year due to flooding, although this has been increasing over the last few years. Figures 1 and 2 show US fatalities due to flooding, with an increasing trend which however, if normalized for population growth, appears to be relatively steady (FEMA, 1997).

Figure 2 –US Flood Fatalities, 1988-1997

Figure 9.7 Casualties Parameters

9.6.3 Shelter Parameters

Shelter Parameters depend on four factors: Evacuation, Utility Factors, Weighting Factors, and Modification Factors. Under the *Evacuation* tab, users are allowed to choose the depth at which ingress/egress is restricted (depth at which flood waters are considered dangerous to drive or walk through). It also allows the user to set the evacuation buffer that surrounds the flooded area for public safety. The *Utility Factors* accounts for the duration or lack of access caused by the utility factors. The *Weighting Factors* are based on income and age. These factors establish the assumed percentage of the population that will seek shelter based on their income and age. The *Modification Factors* adjust the population that will seek public shelter based on the range of their income and age. It allows the user to modify the range or income or age. Figure 9.8 shows the Shelter Parameters window.

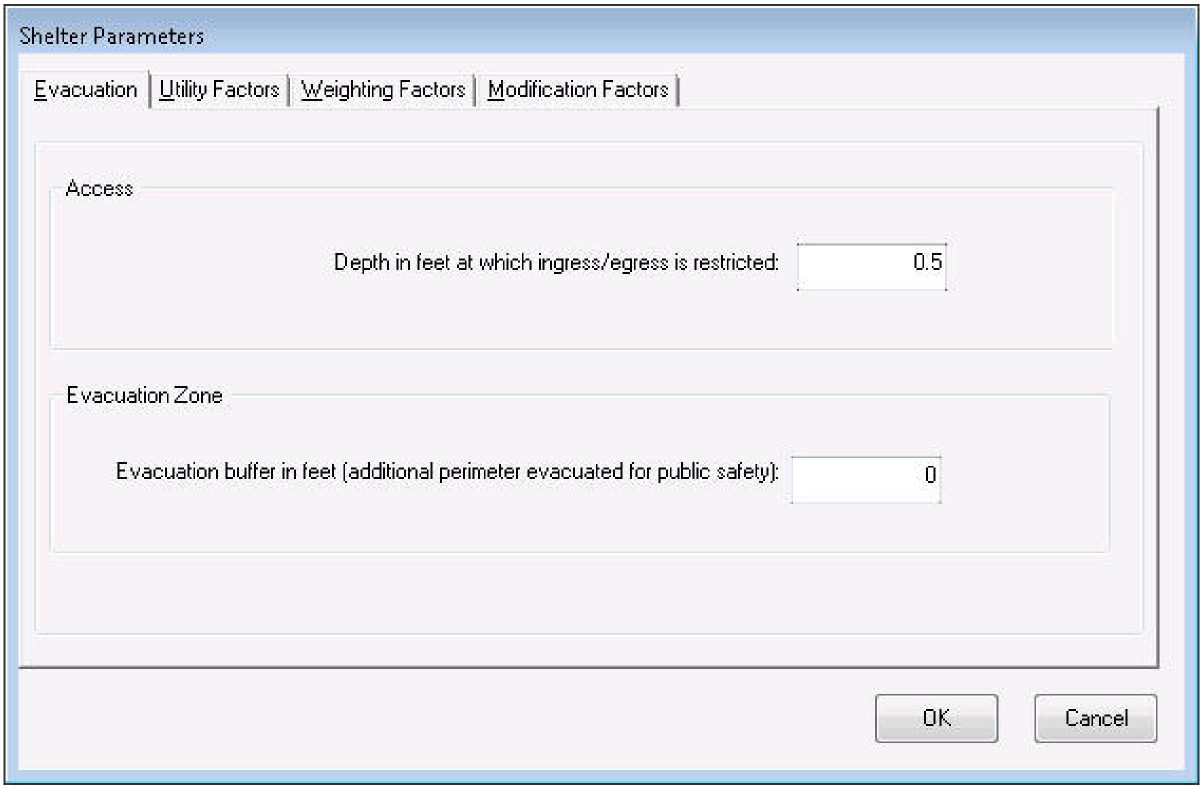


Figure 9.8 Shelter Parameters

9.6.4 Agricultural Parameters

The Agricultural Parameters asks the user to supply the day and month of the flood event. **Hazus** will then adjust the date to the Julian calendar, which is based on the growing season.

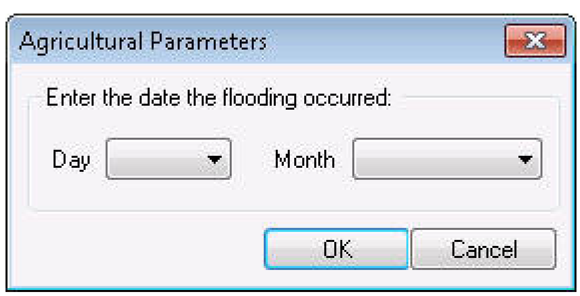
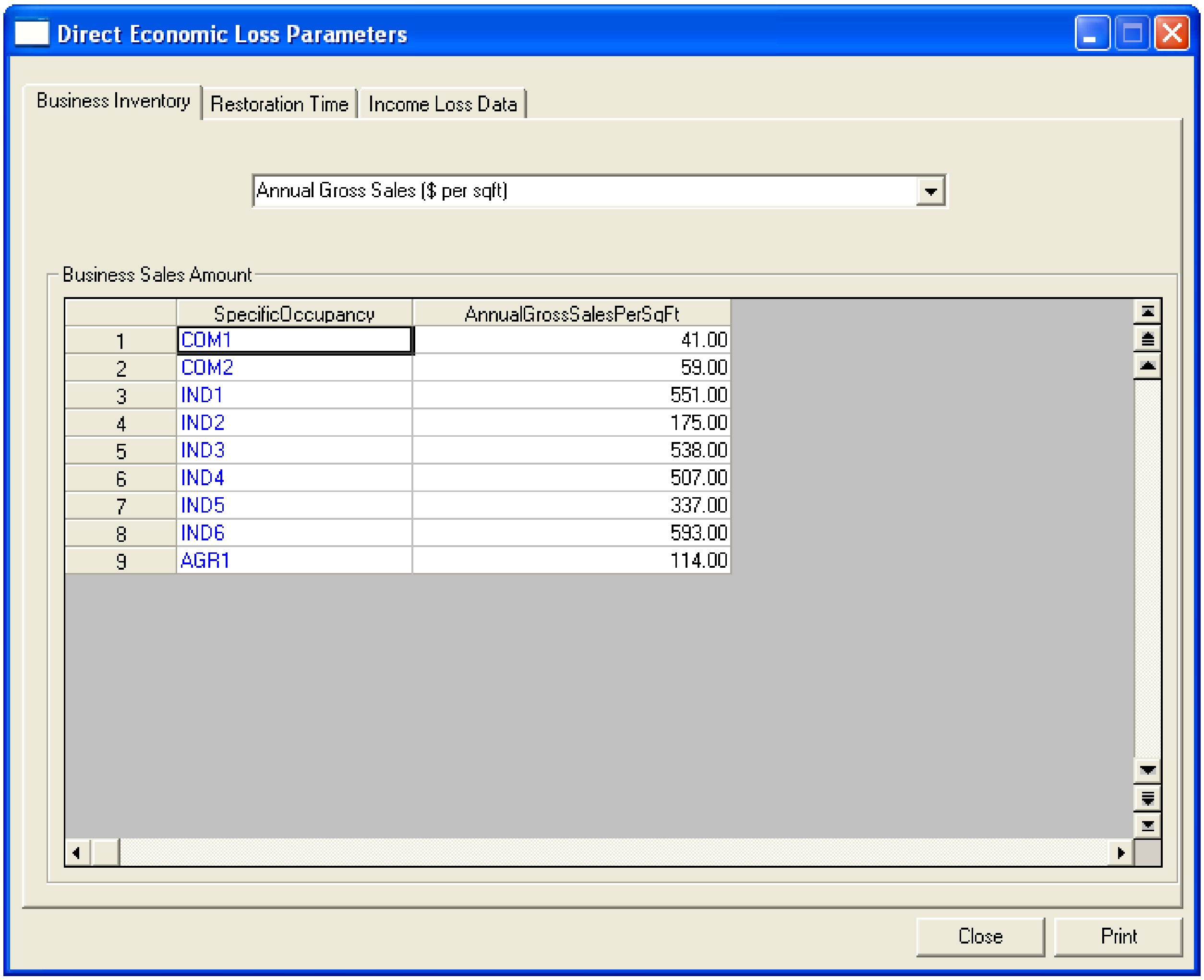


Figure 9.9 Agricultural Parameters

9.6.5 Direct Economic Loss Parameters

The Direct Economic Loss Parameters are based on three factors: Business Inventory, Restoration Time, and Income Loss Data. The *Business Inventory* tab can be viewed as the Annual Gross Sales in dollars per square foot or as the percentage of Gross Annual Sales for each specific occupancy. *Restoration Time* is the anticipated time for repair and restoration before the population can move back in. The *Income Loss Data* includes the relocation expenses and loss of income. An example of the Direct Economic Loss Parameters window can be seen in Figure 9.10.



	SpecificOccupancy	AnnualGrossSalesPerSqFt
1	COM1	41.00
2	COM2	59.00
3	IND1	551.00
4	IND2	175.00
5	IND3	538.00
6	IND4	507.00
7	IND5	337.00
8	IND6	593.00
9	AGR1	114.00

Figure 9.10 Direct Economic Loss Parameters

9.6.6 Indirect Economic Loss Module with a Synthetic Economy

Estimates of indirect losses can be calculated using a very simplified model of the regional economy. **Hazus** contains twelve built-in "synthetic" economies. These "synthetic economies" are based on aggregating characteristics from a number of regional economies around the country and creating three typical economy types:

- Primarily manufacturing
- Primarily service with manufacturing as the secondary sector
- Primarily service with trade as the secondary sector

Each economy is broken into four size classifications:

- Super (greater than 2 million in employment)
- Large (greater than 0.6 million but less than 2 million in employment)
- Mid Range (greater than 30,000 but less than 0.6 million in employment)
- Low (less than 30,000 in employment)

The indirect economic impact module selects the most appropriate synthetic economy to use for the study region based on user inputs describing the size of the economy (number of employees) and the type of economy. In order to run the module using a synthetic economy, you must identify the type and size of economy using the window shown in Figure 9.11. To access the screen, select the **Indirect economic** option in the **Analysis|Parameters** menu.

The default type of economy is "primarily manufacturing." You should overwrite this if "service/manufacturing" or "service/trade" is a more accurate characterization of your region. The economy type can be determined by evaluating the percent of regional employment in each of the major industries. For further guidance, consult the *Technical Manual*.

Figure 9.11 Setting Parameters for Synthetic Economy

Hazus provides a default employment figure based on the counties in the study region. The source of this default data is the Bureau of Economic Analysis. You should review this number against available local information and overwrite it if appropriate. Employment should be measured by place of *work* rather than by place of *residence*. This distinction is especially significant when there is substantial commuting across the region's borders. In addition to employment, the default figure provided for regional income should be reviewed and overwritten if appropriate. After you have defined the synthetic economy and clicked on the **<Next>** button in Figure 9.11 the window in Figure 9.12 will appear. Figure 9.13 through Figure 9.15 allow you to modify economic factors that relate to the general capacity and the economy's ability to restore itself following the earthquake. Default values for all of the factors are provided for use in analysis. However, you should still review at the least the following factors and replace the default values as appropriate:

- Unemployment rate
- Level of outside aid and/or insurance
- Interest rate on loans

Figure 9.12 Setting the Indirect Economic Factors

Default values are provided for four global factors as shown in Figure 9.12. The **Percentage of rebuilding** is used by the module to estimate the size of the reconstruction stimulus to the economy. The **Unemployment rate at the time of the disaster** serves as an indicator of excess capacity or slack in the economy; the indirect losses are generally higher when the economy has low unemployment because there is less unused capacity that can help make up for capacity lost due to earthquake damage. The **Level of outside aid and/or insurance** is a major determinant of the long-term income effects of the disaster since the amount of reconstruction funded by borrowing within the region will in the long term cause indebtedness. The **Interest rate on loans** also affects the amount of indebtedness arising from reconstruction financing.

Again, these should be reviewed and modified where appropriate. In some cases you may wish to run several analyses using different values, such as **Level of outside aid and/or insurance**, to investigate the effect of this parameter on indirect economic impacts. When you have finished with the **Factors** tab, click on the **Restoration & Rebuilding** tab to view the screen in Figure 9.13.

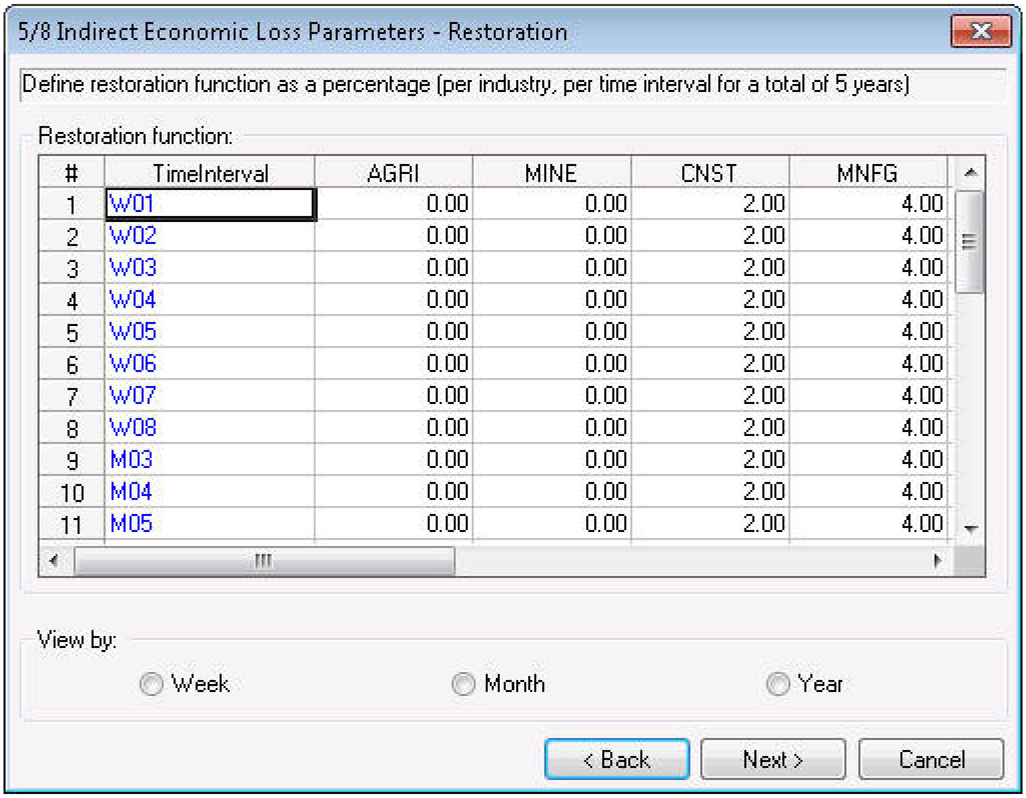


Figure 9.13 Setting the Indirect Economic Restoration and Rebuilding Factors

The dialog shows default values for industry restoration functions for each of the first 5 years. Units are in percentage points of industry *loss* of function or production capacity in each year. Default values may be overwritten for consistency with results related to physical damage (See section 16.5.2.2 in the *Earthquake Technical Manual*). The rebuilding factors as shown in Figure 9.14 has default values for "% of Total Rebuilding Expenditures" in each of the first 5 years for buildings and lifelines, respectively. In general, most of the rebuilding is expected to occur in the first 1-2 years after the disaster. Lifeline reconstruction expenditures are expected to be made proportionately earlier than buildings reconstruction. Default values can be overwritten for consistency with results on physical damage (See the *Technical Manual* for more information).

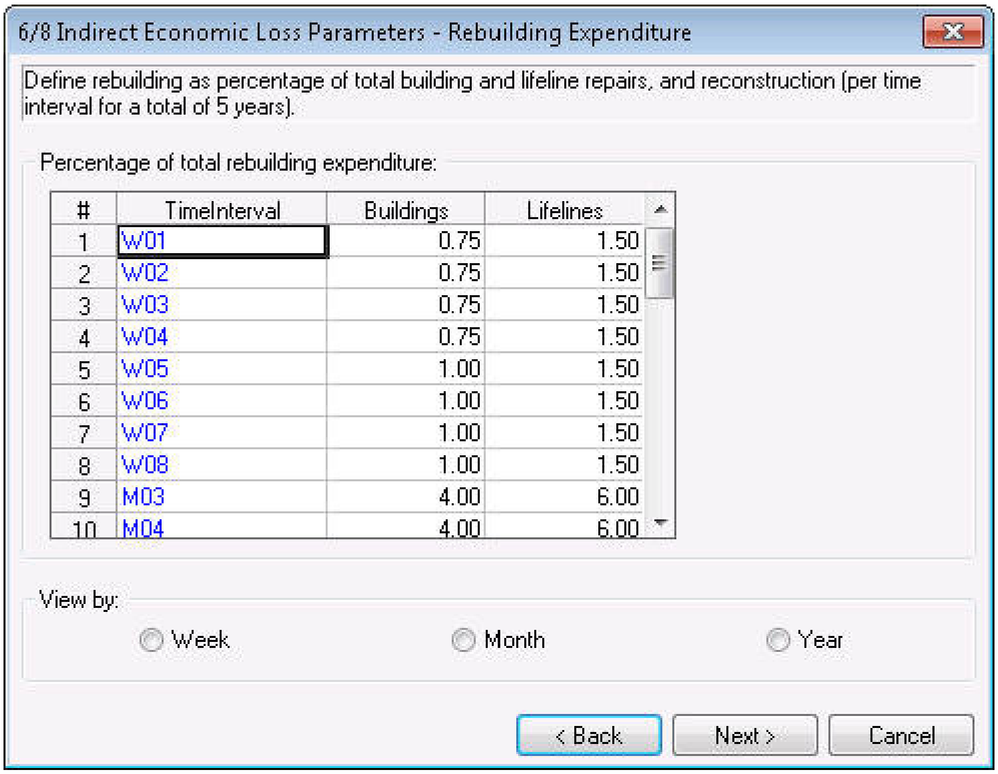


Figure 9.14 Setting the Indirect Economic Rebuilding Factors

The last factors that can be altered are the Stimulus Values. By clicking on the Stimulus Values tab, you can access the screen shown in Figure 9.15.

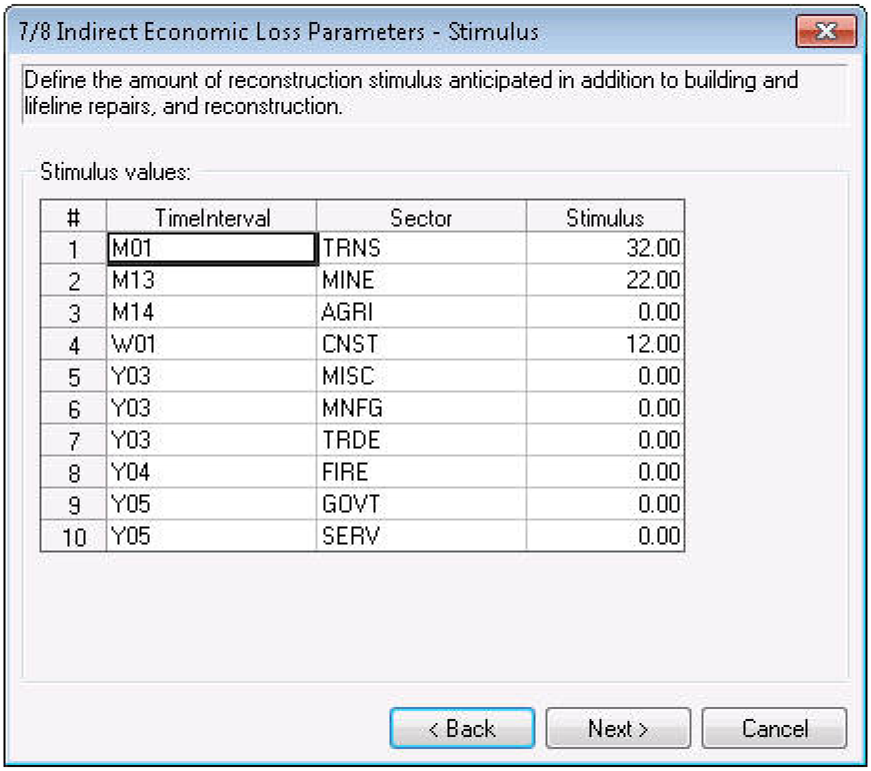


Figure 9.15 Setting the Stimulus Values

The parameters in Figure 9.15 represent an anticipated stimulus to the economy in addition to repair and reconstruction of buildings and lifelines. The defaults are all zero. **Hazus** includes the capability of inputting a higher resolution timeframe for the restorations factors, the rebuilding factors and the stimulus values. In **Hazus** the factors can be specified on a weekly basis for the first 2 months (8 weeks), on a monthly basis for the first 2 years (month 3 through 24), and yearly thereafter (year 3 through 5.) Click **OK** after completing selections on this screen. This completes the user input requirements. The module can be run by clicking on the **Indirect economic loss** option in the **Analysis|Run...** menu.

9.6.7 Running the Indirect Economic Loss Module with IMPLAN Data

For a more realistic analysis the indirect economic module can use IMPLAN data for modeling the economy. Select **Use IMPLAN data files** from the **Indirect Economic Analysis Type** screen. The default employment and income figures on the screen will not be used. Instead, the module will automatically pick off more accurate data from the IMPLAN data files you provide (see the *Technical Manual*). You do not have to make a selection under **Type of Synthetic**

Economy. Click **OK** after completing selections on this screen and the **IMPLAN** Files screen shown in Figure 9.16 will appear.

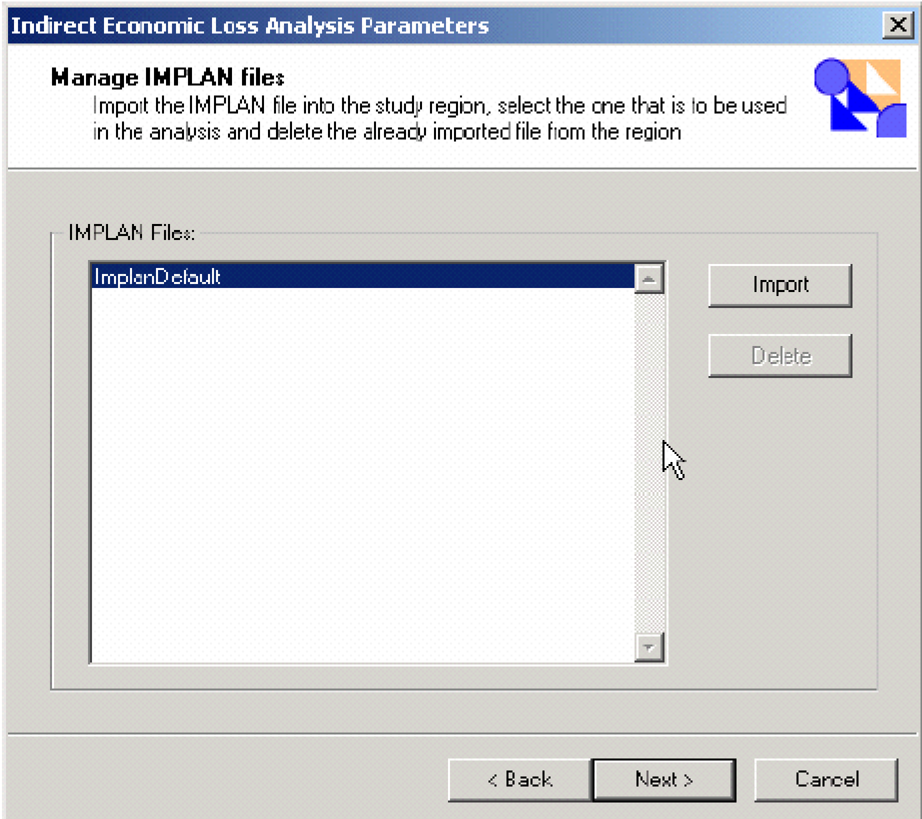


Figure 9.16 Screen for Importing IMPLAN Files

The screen contains a box listing available **IMPLAN** files. If the user has not imported any files, only one file labeled **IMPLANDF** (for IMPLAN default) is listed. This indicates the default synthetic economy.

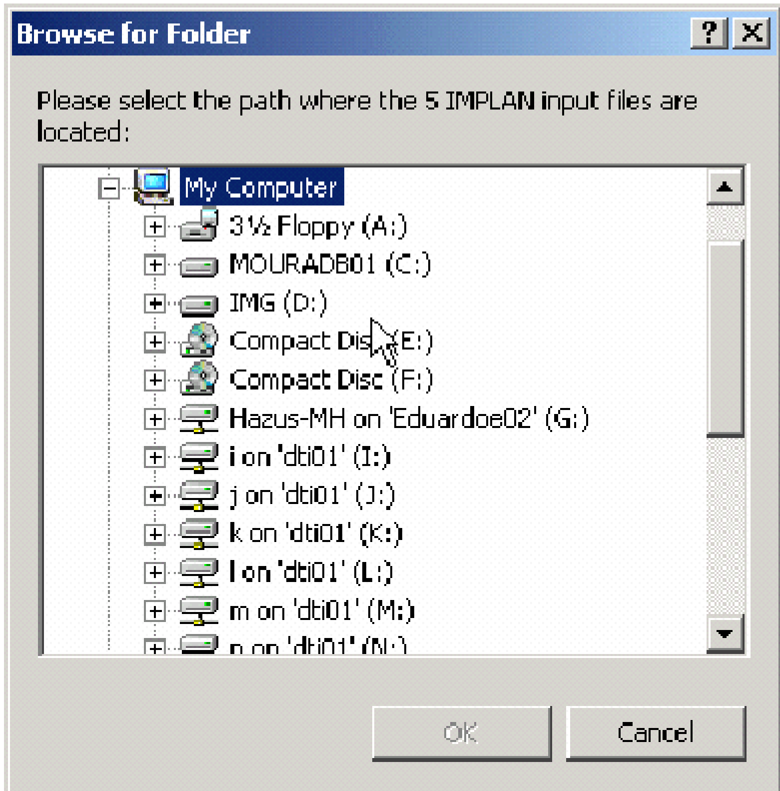


Figure 9.17 Locating IMPLAN Files

Use the **Import** button to import **IMPLAN** files into **Hazus**. Note that **Hazus** only prompts you for the directory that contains the required files. All five files should be located in the same directory. Chapter 16 of the **Hazus** Earthquake Technical Manual provides the information of the files required by the module. The newly imported **IMPLAN** file name now appears underneath **IMPLANDF**. Use the mouse to highlight the new **IMPLAN** file, thus selecting it for use in the analysis. Click **OK** and the Indirect Economic Analysis Factors screen will appear.

If you have previously imported an **IMPLAN** data file(s), its name(s) will appear on the list. Remember to highlight the correct file each time before clicking **OK** to ensure that **Hazus** does not return to using the default **IMPLANDF** file. Follow the steps outlined in Section 10.6.6 for specifying indirect economic analysis factors. Run the **Analysis|Run...** menu.

This feature is currently disabled.

Chapter 10 Viewing and Reporting the Results

This chapter describes the results tables, maps, and reports produced by the Flood Model. The items discussed are accessed via the **Results** menu after performing an analysis.

10.1 Guidance for Reporting Loss Results

There is no single format that is appropriate for presentation of loss study results. The format will depend on the use of the results and the intended audience. The audience can vary from the general public to technical experts. Decision makers such as city council members and other government officials may require only summaries of losses for a region. Emergency response planners may want to see the geographical distribution of all losses and damage for several different flood scenarios. **Hazus** provides a great deal of flexibility in presenting results. Results can be presented in a tabular or map form. The users of the results should be involved from the beginning in determining the types and formats of the results that best suit their needs.

In previous loss studies, authors of reports have had the difficult task of trying to combine the study results with the theory of how they were calculated. Consequently, reports often seemed overly technical, reducing their readability and usefulness for many audiences. **Hazus** users can refer to the *Technical Manual*, which describes all of the theories and equations that provide the basis of any loss estimate. Thus, reports do not need to, and probably should not include technical discussions of theory. Instead, reports should focus on describing results in non-technical language that is easily understood by the intended audience.

While no particular format for presenting results can be recommended, several general statements about reporting of results can be made. Reports should serve to clarify the meaning of the loss estimates. For example, the report should indicate whether losses are due only to building and contents damage or if they also include monetary losses resulting from loss of function. It should be clarified that losses are not calculated for individual buildings, but instead are based on the performances of entire classes of buildings. These are just a few examples of the types of clarifications that should appear in reports.

Reports should also clarify for the reader what assumptions were made in developing the scenario and inventory and in calculating losses. For example, were losses based on default inventories or were default inventories augmented? Were default analysis parameters used? If not, what values were used? What assumptions were made in selecting the scenario flood? Is it based on an historical event? Is it based on an expected probability of occurrence (e.g., a 100-year return period event)? What types of assumptions were made about the building stock?

A criticism of past studies is that there has been little qualitative or quantitative treatment of uncertainty. Discussions with users of previous studies have indicated that users need information about where errors in prediction are most likely to occur. While this methodology does not explicitly include a technique for carrying the uncertainty of each variable through the entire set of calculations, sensitivity analyses are useful for providing bounds on loss estimates. At a minimum, reports should make some statement about the uncertainty of the input values.

10.2 Hazard Results

The **Results | Flood Hazard Maps | Thematic Map of Depth** command allows you to map the flood depth grid and floodplain boundary for the current scenario and return period/discharge(s). The flood depth grid has vertical units of feet and is displayed in blue. The floodplain boundary is displayed in orange.

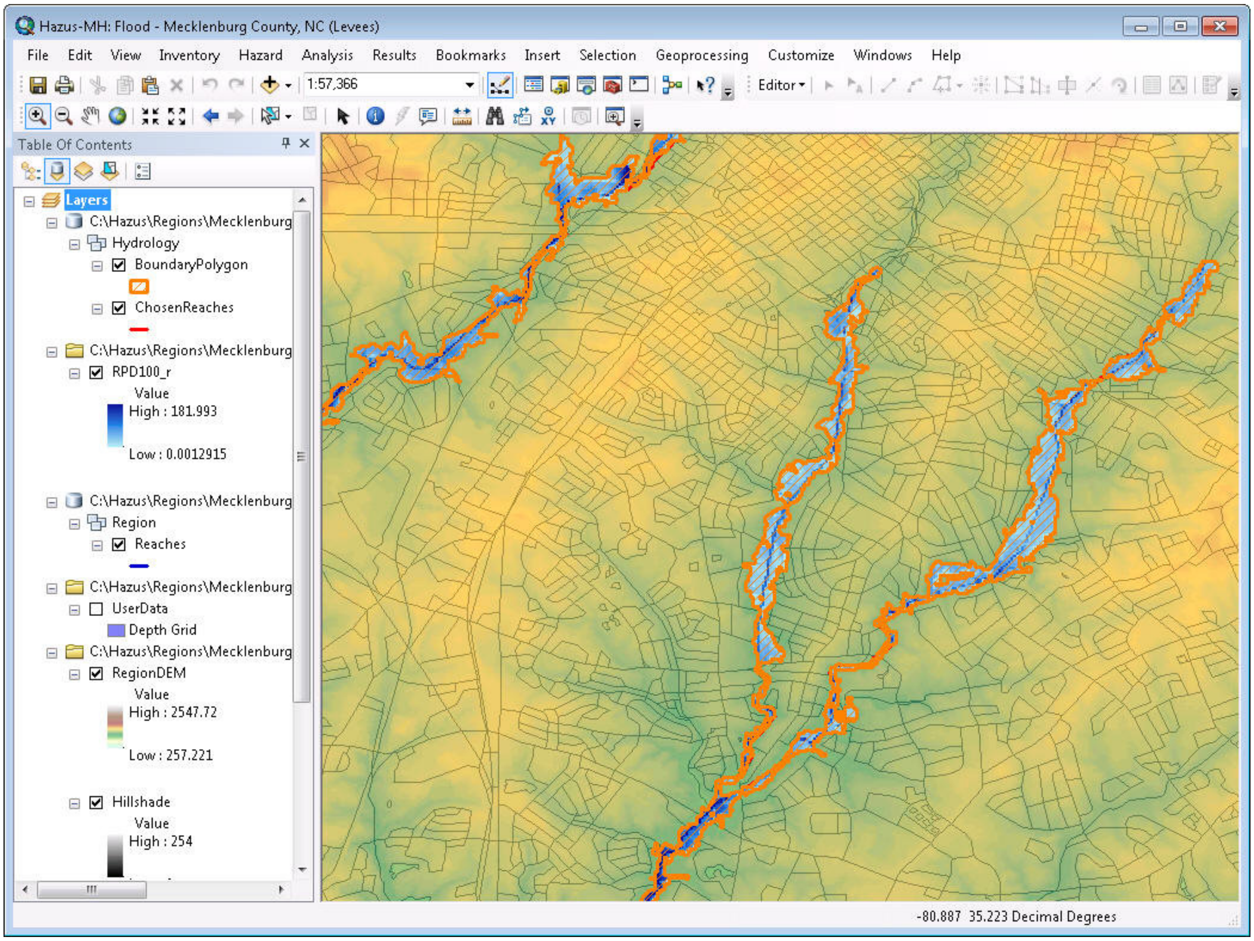


Figure 10.1 Flood Depth Grid and Floodplain Boundary

Hazus automatically maps the flood depth grid and floodplain boundary when the hazard is computed, but it is still available for other flood depth grids that may have been computed.

10.3 General Building Stock

The **Results | General Building Stock Damage** command allows you to view and map the general inventory damage results by occupancy, building type, and building count. The values in the table represent the expected fraction of building square footage in each damage state. The drop-down boxes allow you to select the occupancy type and pre-/post- FIRM status.

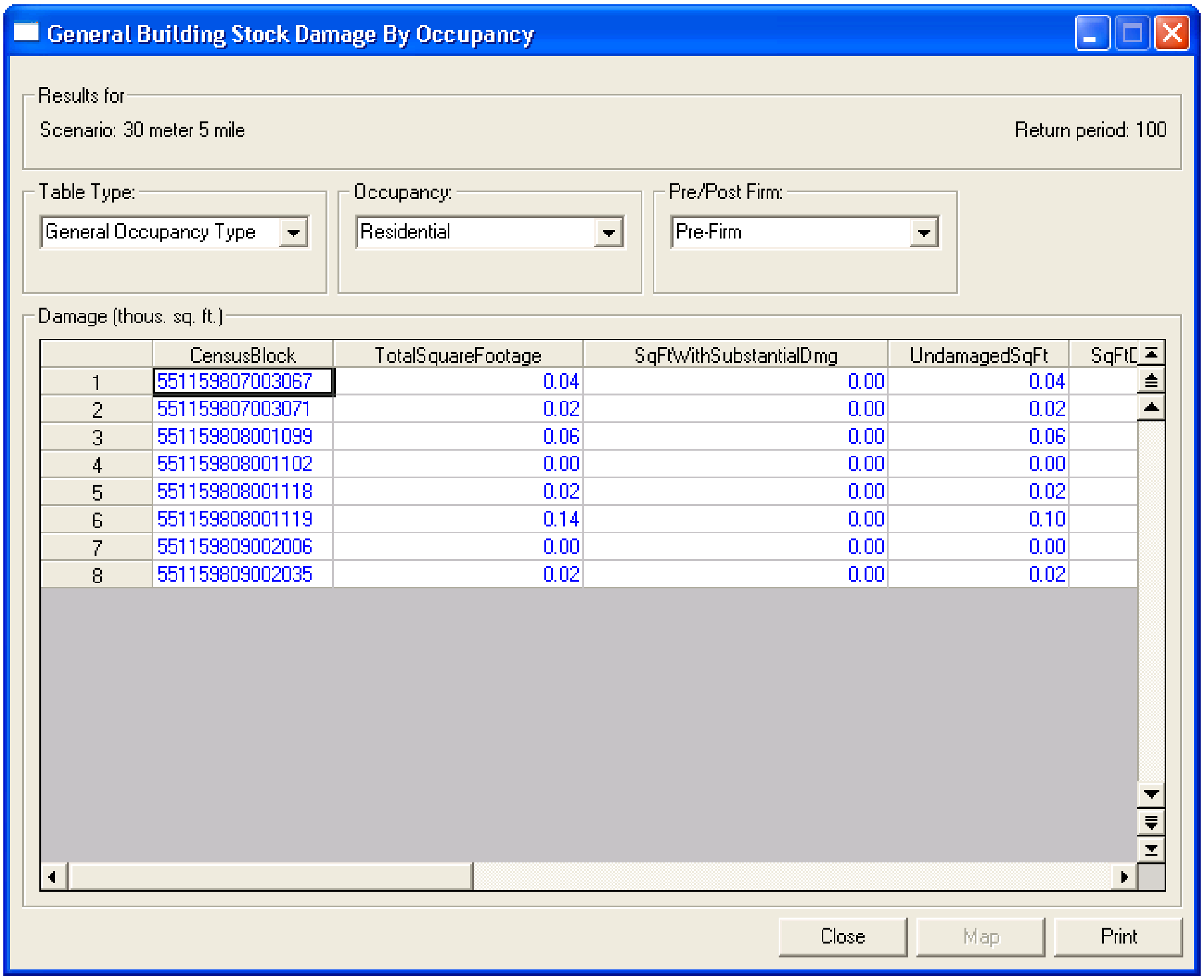


Figure 10.2 General Building Stock Damage Results

10.4 Essential Facilities

The **Results | Essential Facilities** command allows you to view and map the damage and loss of use results for hospitals, police stations, fire stations, emergency operations centers, and schools.

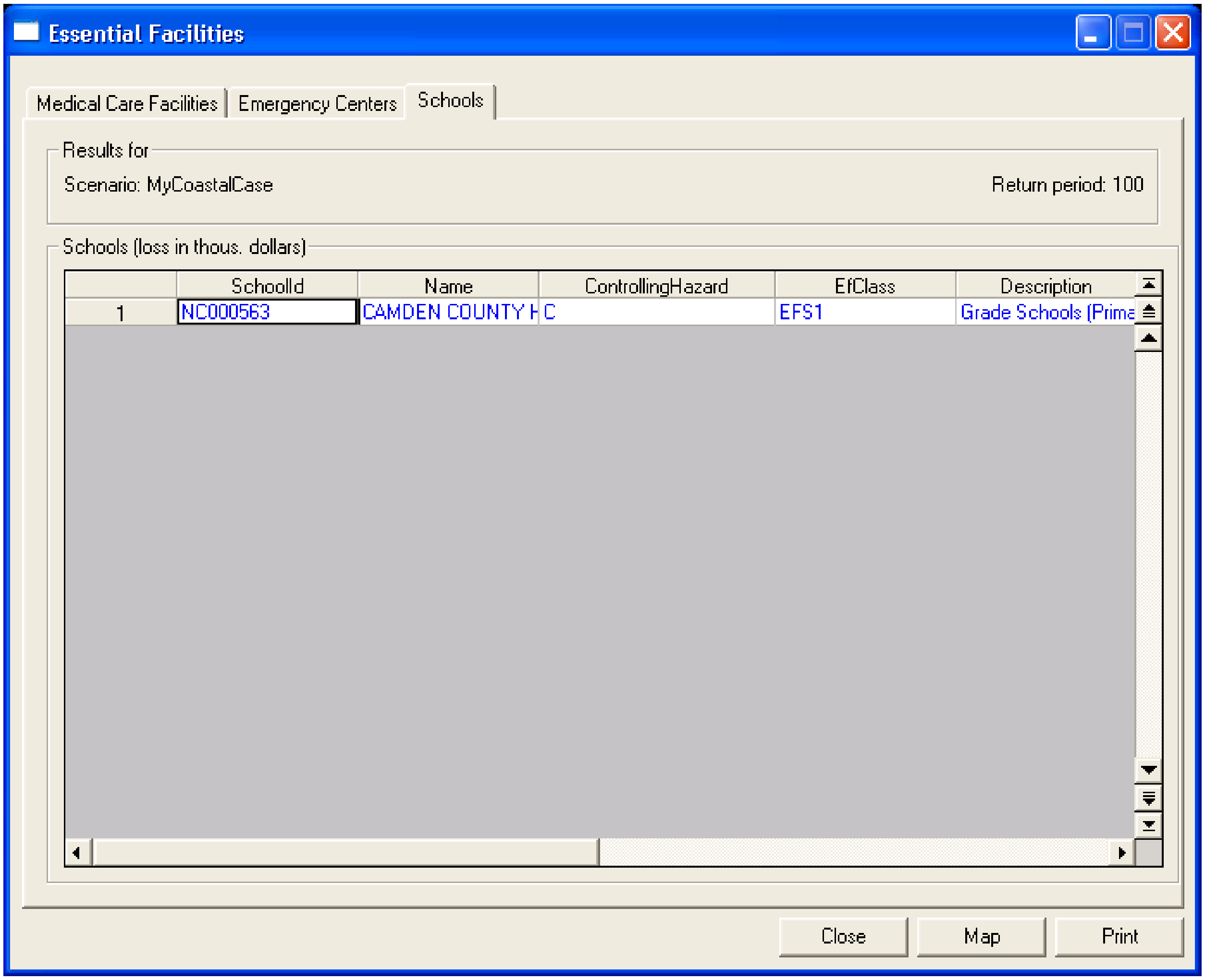


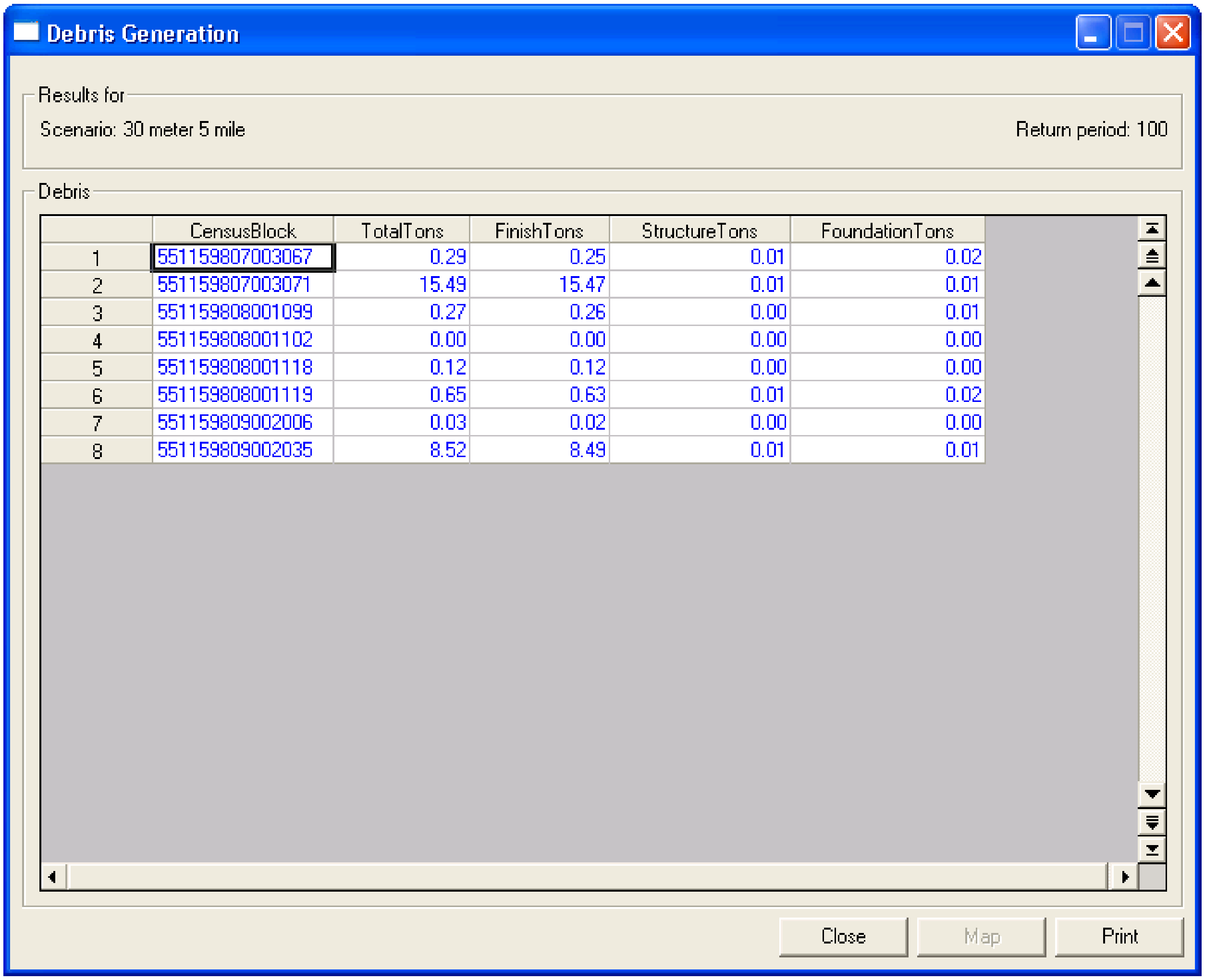
Figure 10.3 Essential Facilities Damage Results

10.5 User-Defined Facilities

The **Results | User-Defined Facilities** command allows you to view the damage results for individual, user-specified facilities. Damage probabilities are provided for overall building damage.

10.6 Debris

The **Results | Debris Generation** command allows you to view and map building and tree debris results by census block.

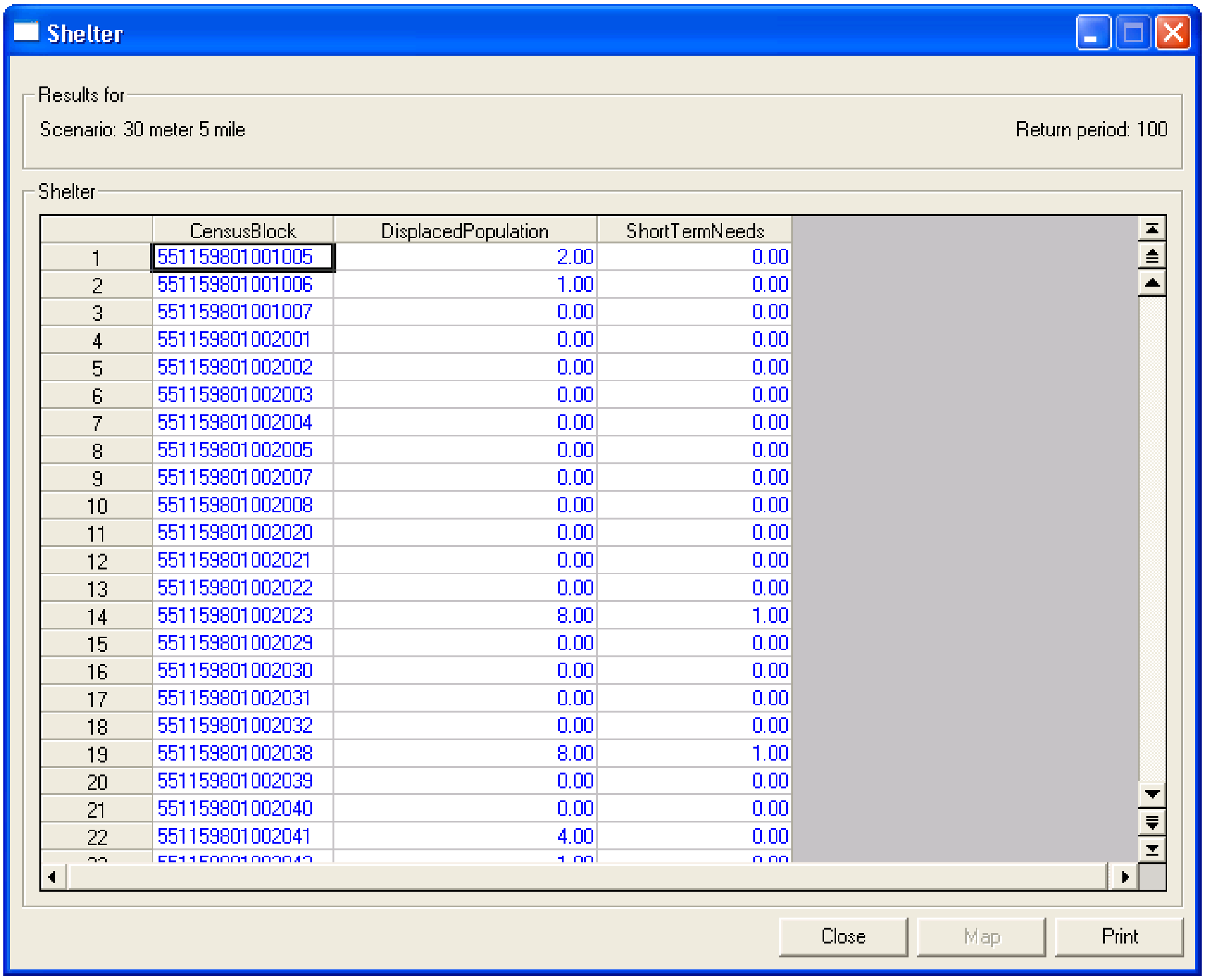


	CensusBlock	TotalTons	FinishTons	StructureTons	FoundationTons
1	551159807003067	0.29	0.25	0.01	0.02
2	551159807003071	15.49	15.47	0.01	0.01
3	551159808001099	0.27	0.26	0.00	0.01
4	551159808001102	0.00	0.00	0.00	0.00
5	551159808001118	0.12	0.12	0.00	0.00
6	551159808001119	0.65	0.63	0.01	0.02
7	551159809002006	0.03	0.02	0.00	0.00
8	551159809002035	8.52	8.49	0.01	0.01

Figure 10.4 Debris Results

10.7 Shelter

The **Results | Shelter** command allows you to view and map the estimated number of displaced households and the estimated short-term shelter needs by census block.

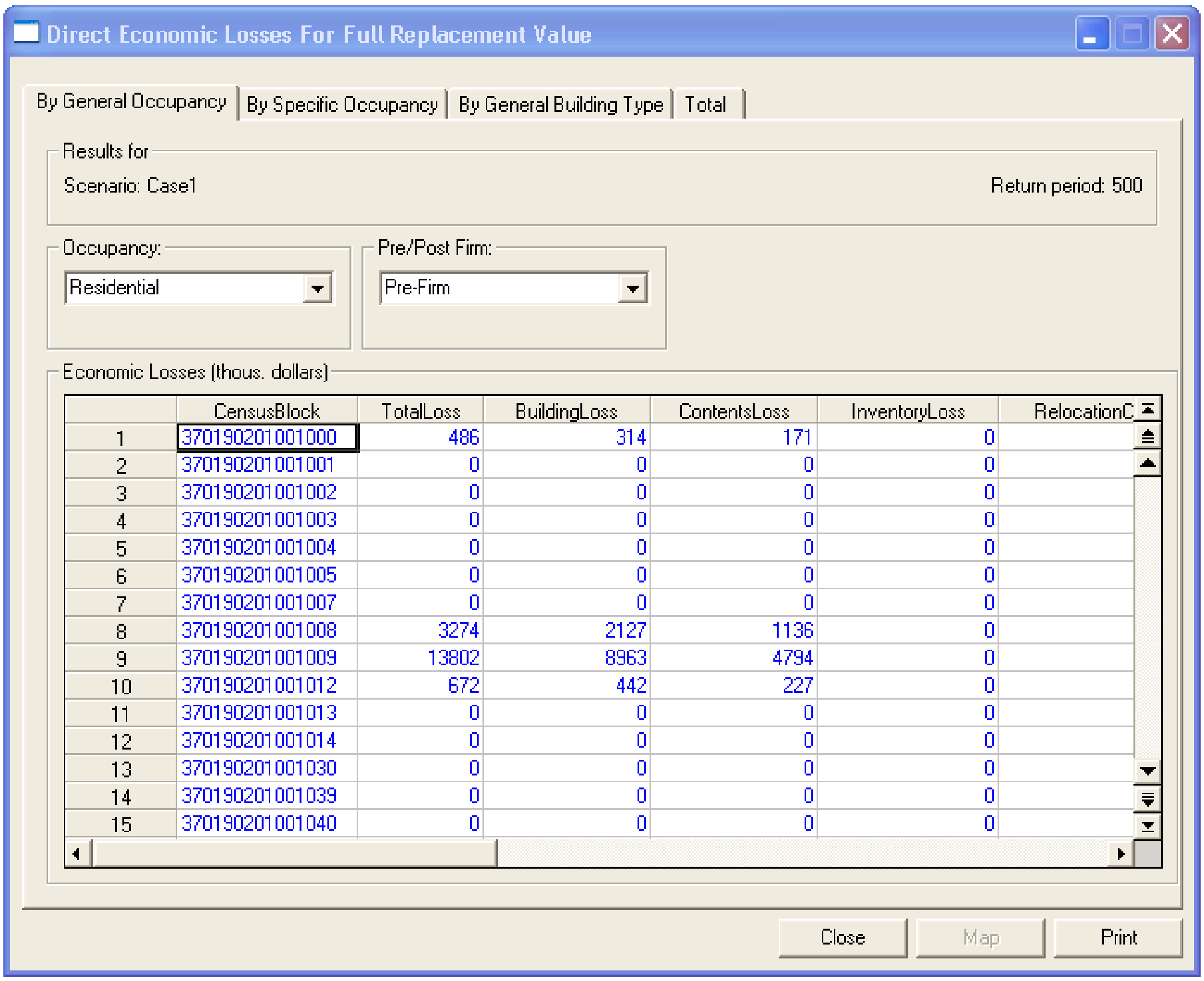


	CensusBlock	DisplacedPopulation	ShortTermNeeds
1	551159801001005	2.00	0.00
2	551159801001006	1.00	0.00
3	551159801001007	0.00	0.00
4	551159801002001	0.00	0.00
5	551159801002002	0.00	0.00
6	551159801002003	0.00	0.00
7	551159801002004	0.00	0.00
8	551159801002005	0.00	0.00
9	551159801002007	0.00	0.00
10	551159801002008	0.00	0.00
11	551159801002020	0.00	0.00
12	551159801002021	0.00	0.00
13	551159801002022	0.00	0.00
14	551159801002023	8.00	1.00
15	551159801002029	0.00	0.00
16	551159801002030	0.00	0.00
17	551159801002031	0.00	0.00
18	551159801002032	0.00	0.00
19	551159801002038	8.00	1.00
20	551159801002039	0.00	0.00
21	551159801002040	0.00	0.00
22	551159801002041	4.00	0.00

Figure 10.5 Shelter Results

10.8 Buildings Economic Loss

The **Results | General Building Stock Economic Loss** command allows you to view and map economic losses for the general building stock by census block by full replacement value and depreciated replacement value.



	CensusBlock	TotalLoss	BuildingLoss	ContentsLoss	InventoryLoss	RelocationC
1	370190201001000	486	314	171	0	
2	370190201001001	0	0	0	0	
3	370190201001002	0	0	0	0	
4	370190201001003	0	0	0	0	
5	370190201001004	0	0	0	0	
6	370190201001005	0	0	0	0	
7	370190201001007	0	0	0	0	
8	370190201001008	3274	2127	1136	0	
9	370190201001009	13802	8963	4794	0	
10	370190201001012	672	442	227	0	
11	370190201001013	0	0	0	0	
12	370190201001014	0	0	0	0	
13	370190201001030	0	0	0	0	
14	370190201001039	0	0	0	0	
15	370190201001040	0	0	0	0	

Figure 10.6 Buildings Economic Loss Results – Full Replacement Value

10.9 Summary Reports

The **Results | Summary Reports** command allows you to select one of several summary reports for viewing and printing. The reports will be generated using the Crystal Reports report engine.

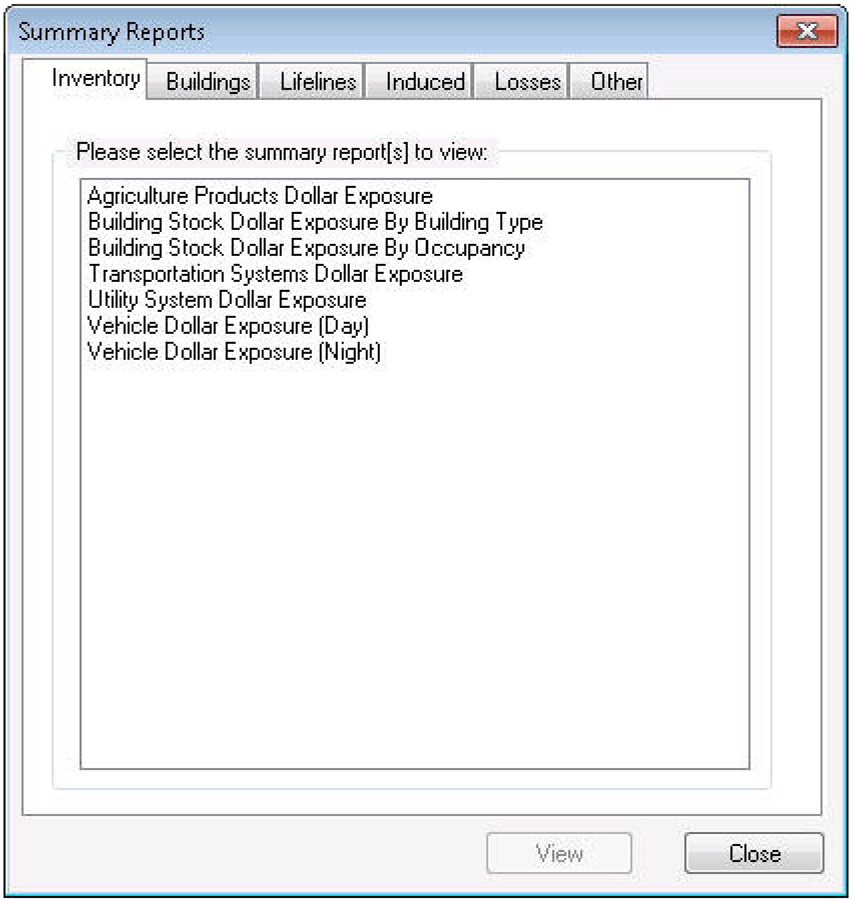
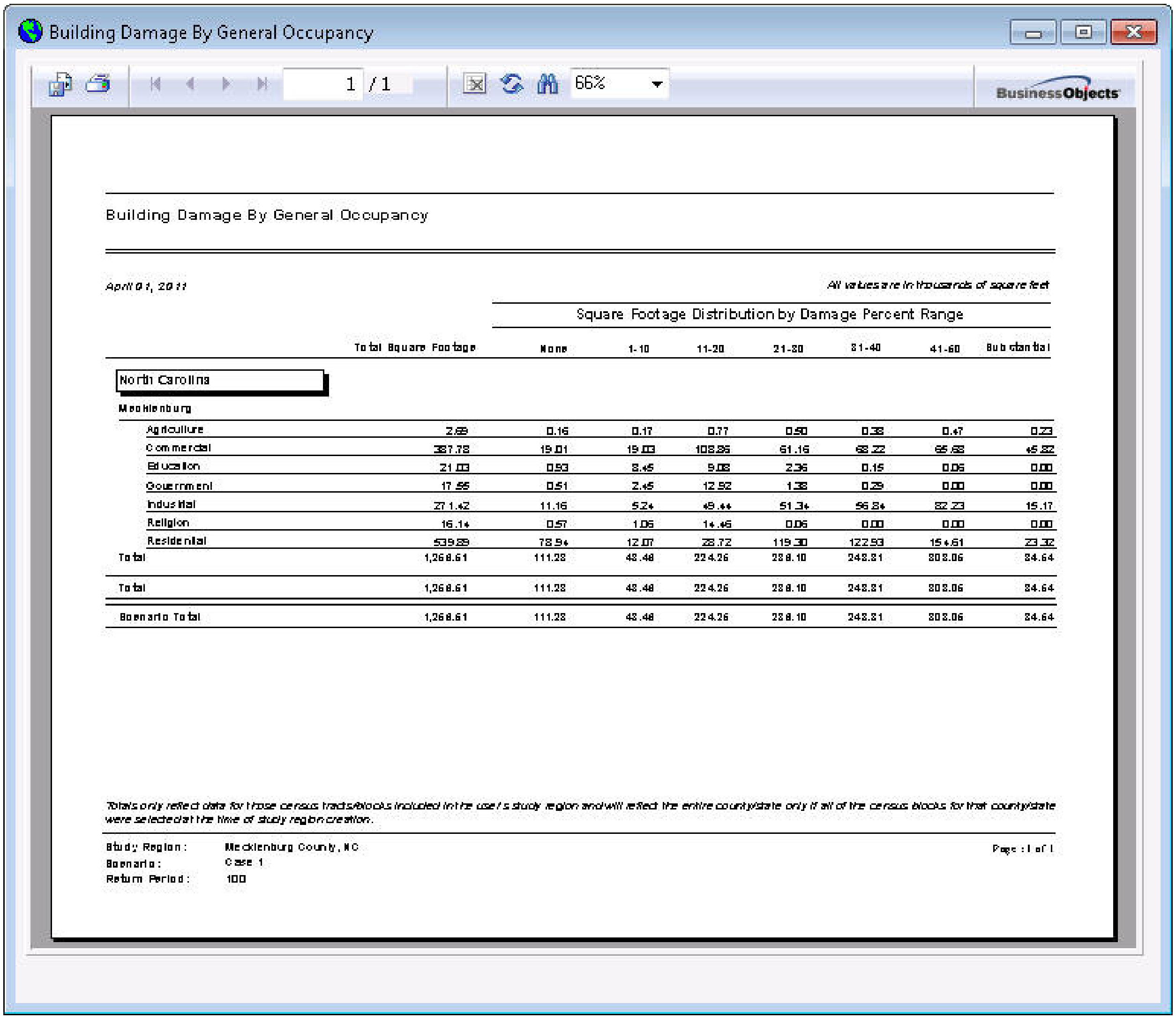


Figure 10.7 Summary Reports Dialog

Crystal Reports must be installed (comes with ArcView) for this option to be available.



Building Damage By General Occupancy

Building Damage By General Occupancy

April 01, 2011

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
North Carolina								
Mecklenburg								
Agriculture	2.69	0.16	0.17	0.77	0.50	0.38	0.47	0.23
Commercial	387.78	19.01	19.03	108.86	61.16	68.22	65.68	45.92
Education	21.03	0.93	8.45	9.08	2.36	0.15	0.06	0.00
Government	17.55	0.51	2.45	12.92	1.38	0.29	0.00	0.00
Industrial	271.42	11.16	5.24	49.44	51.34	56.84	82.23	15.17
Religion	16.14	0.57	1.06	14.46	0.06	0.00	0.00	0.00
Residential	539.29	78.94	12.07	28.72	119.30	122.93	154.61	23.32
Total	1,268.61	111.28	48.48	224.26	238.10	248.81	303.06	84.64
Total	1,268.61	111.28	48.48	224.26	238.10	248.81	303.06	84.64
Scenario Total	1,268.61	111.28	48.48	224.26	238.10	248.81	303.06	84.64

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: Mecklenburg County, NC

Scenario: Case 1

Return Period: 100

Page : 1 of 1

Figure 10.8 Sample Summary Report: Building Damage by General Occupancy

Table 10.1 has a brief description of the different types of reports available.

Table 10.1 List of Summary Reports

Tab	Report	Description
Inventory	Agricultural Products Dollar Exposure	Dollar exposure (in thousands of dollars) of the agricultural products in the study region.
Inventory	Building Stock Dollar Exposure by Building Type	Dollar exposure (in thousands of dollars) of the building stock by building type in the study region.
Inventory	Building Stock Dollar Exposure by Occupancy	Dollar exposure (in thousands of dollars) of the building stock by occupancy in the study region.
Inventory	Transportation Systems Dollar Exposure	Dollar exposure (in thousands of dollars) of the transportation systems in the study region.
Inventory	Utility System Dollar Exposure	Dollar exposure (in thousands of dollars) of the utility system in the study region.
Inventory	Vehicle Dollar Exposure (Day)	Dollar exposure (in thousands of dollars) of vehicles (during the day) in the study region.
Inventory	Vehicle Dollar Exposure (Night)	Dollar exposure (in thousands of dollars) of vehicles (during the night) in the study region.
Buildings	Building Damage by Building Type	Building damage (square footage distribution by percent damage) by building type caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy	Building damage (square footage distribution by percent damage) by general occupancy caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Post-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Pre-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage Count by General Building Type	Building damage (building count by percent damage) by general building type caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy	Building damage (building count by percent damage) by general occupancy caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy (Post-FIRM)	Building damage (building count by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy (Pre-FIRM)	Building damage (building count by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario.

Table 10.1 List of Summary Reports (Continued)

Tab	Report	Description
Buildings	Emergency Operation Center Damage & Functionality	Damage and functionality of Emergency Operation Center caused by the hazard in the scenario.
Buildings	Fire Station Damage & Functionality	Damage and functionality of Fire Stations caused by the hazard in the scenario.
Buildings	Hospital Damage & Functionality	Damage and functionality of Hospitals caused by the hazard in the scenario.
Buildings	Police Station Damage & Functionality	Damage and functionality of Police Stations caused by the hazard in the scenario.
Buildings	School Damage & Functionality	Damage and functionality of Schools caused by the hazard in the scenario.
Lifelines	Highway Bridge Damage & Functionality	Damage and functionality of Highway Bridges caused by the hazard in the scenario.
Lifelines	Light Rail Bridge Damage & Functionality	Damage and functionality of Light Rail Bridges caused by the hazard in the scenario.
Lifelines	Potable Water Facility Damage	Damage to Potable Water Facilities caused by the hazard in the scenario.
Lifelines	Railroad Bridge Damage & Functionality	Damage and functionality of Railroad Bridges caused by the hazard in the scenario.
Lifelines	Wastewater Facility Damage	Damage to Wastewater Facilities caused by the hazard in the scenario.
Induced	Debris Generated	Estimated total of debris generated (in tons) by the hazard in the scenario.
Losses	Annualized Direct Economic Losses for Buildings	Annualized direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Depreciated Direct Economic Losses for Buildings	Depreciated direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Agricultural Products	Direct economic losses (in thousands of dollars) for agricultural products resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Buildings	Direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Transportation	Direct economic losses (in thousands of dollars) for transportation resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Utilities	Direct economic losses (in thousands of dollars) for utilities resulting from the hazard in the scenario
Losses	Direct Economic Losses for Vehicles (Day)	Direct economic losses (in thousands of dollars for vehicles (during the day) resulting from the hazard in the scenario.

Table 10.1 List of Summary Reports (Continued)

Tab	Report	Description
Losses	Direct Economic Losses for Vehicles (Night)	Direct economic losses (in thousands of dollars) for vehicles (during the night) resulting from the hazard in the scenario.
Losses	Indirect Economic Impact with Aid	Income and Employment impact (in millions of dollars) with outside aid due to the hazard in the scenario.
Losses	Indirect Economic Impact without Aid	Income and Employment impact (in millions of dollars) without outside aid due to the hazard in the scenario.
Losses	Shelter Requirements	Estimated number of households that are expected to be displaced; and of those households, estimated number of people to seek temporary shelter in public shelters due to the hazard in the scenario.
Other	Global Summary Report	Includes general description of the region, building exposure by occupancy type (one for the study region and another for the scenario), expected building damage by occupancy and expected building damage by building type, expected damage to essential facilities, debris generated, shelter requirements, building-related economic loss estimates, and regional population and building value data.
Other	Quick Assessment	Includes regional statistics (area in square miles, number of census blocks, number of buildings, number of people in the region, building exposure) and scenario results (shelter requirements and economic loss)

Chapter 11 References

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U.S. Army Corps of Engineers (USACE), 1984. "Flood Emergency Preparedness System: Passaic River Basin, New Jersey and New York, Detailed Project Report and Environmental Assessment", USACE New York District.

Appendix A. Verifying Hazus Installation

A.1 Purpose

With the completed installation of **Hazus**, it is wise to walk through the following section to determine if the installation completed successfully and all of the baseline data is available for use. Following the suggested procedures will demonstrate that the product can successfully generate results immediately. By following the step-by-step procedure below, the user will end up with populated results tables and Crystal summary reports.

A.2 Scope

This verification process will validate only the Flood Model. It does not address installation of any of the other hazards. Since the verification process intent is to show that the user will get the same answer as the development team, the test case has been established as Alamance County, North Carolina for the Riverine analysis and Brunswick County, North Carolina for the Coastal analysis.

A.3 Operations Timing

For the user's reference, in many steps an estimated processing time has been provided such as "…this process may take between 5 and 10 minutes…" although the processing time is extremely dependent on the user's operating system. This information is provided to give the user some indication on what to expect from each operation for this scenario only. For comparison purposes, the timing reported here is based on a personal computer with a 3.2 GHz processor and 2 GB of RAM. Your times will either be faster or slower accordingly.

A.4 Study Region Creation Verification Procedure

This section describes the Treaty Reinsurance Module and how it fits into the overall WorldCat Product Line assumes **Hazus** has been successfully installed. The data path pointers must point to where the DVD data was copied to the hard drive. The region path needs to point to a folder where regions should be created. These steps will demonstrate that a flood study region can be created. This process may take between 5 and 15 minutes.

A.4.1 Select “Create a new region”

Start **Hazus**. Use the region wizard to create a study region.

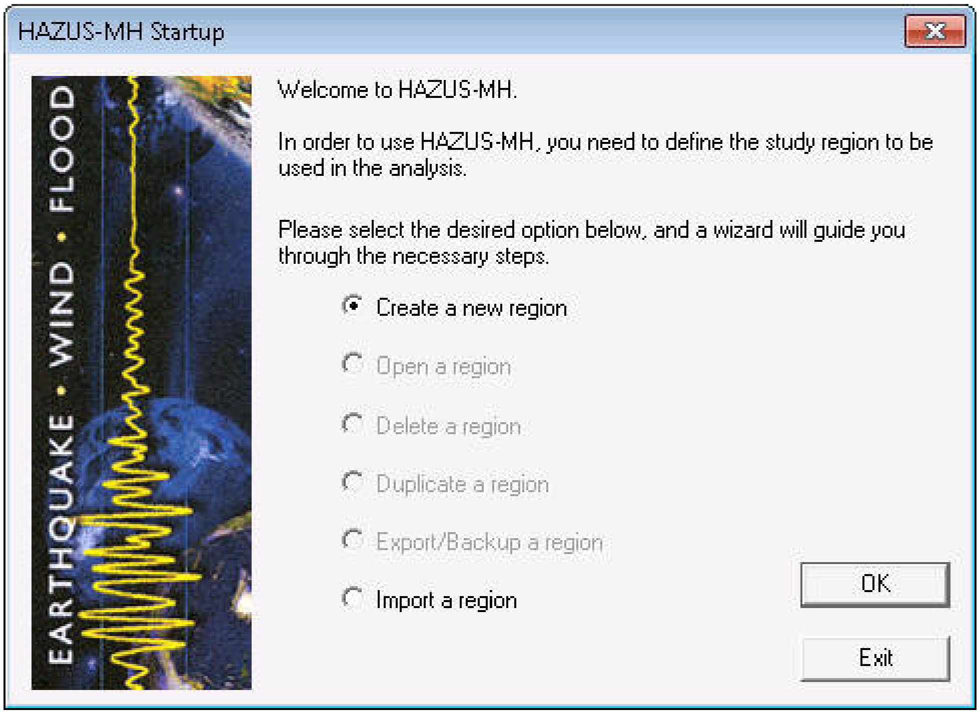


Figure A.1 Hazus Start-up Wizard

A.4.1.1 Enter a Name

Users may want to set up their study region names that will allow things to naturally order themselves. It is recommended that users include the county and state name in the study region name. The county for the verification procedure is Alamance County, NC for riverine and Brunswick County, NC for coastal.

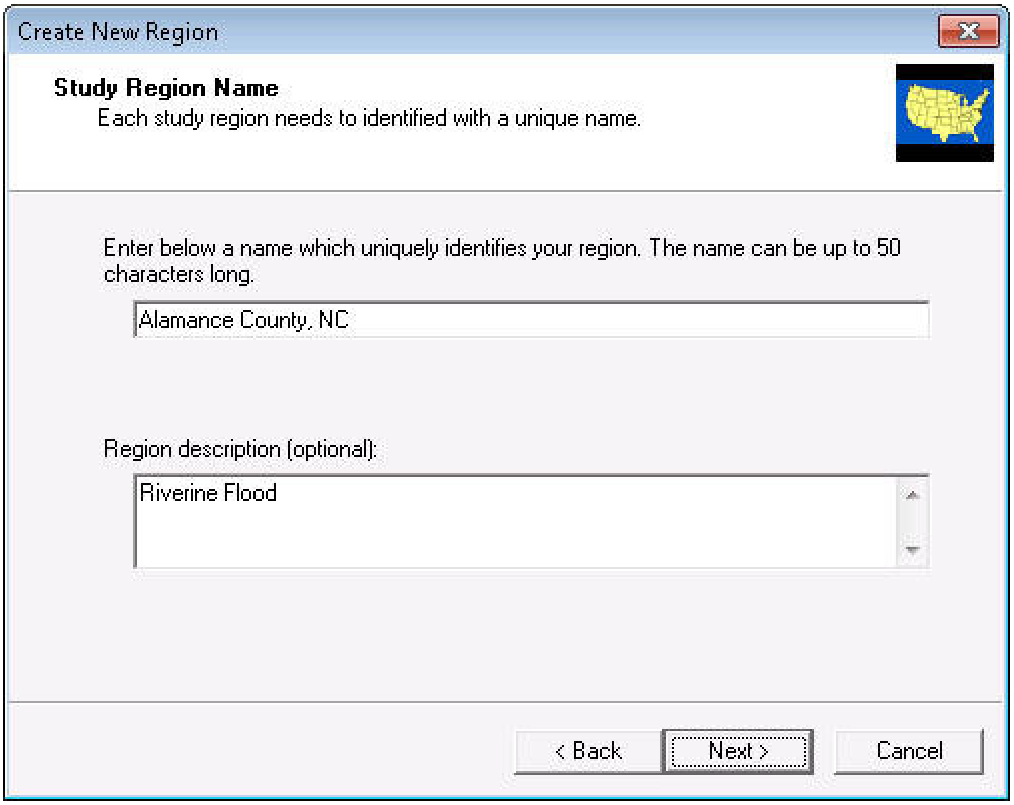


Figure A.2 Inputting the Hazus Study Region Name

A.4.1.2 Select Flood Hazard

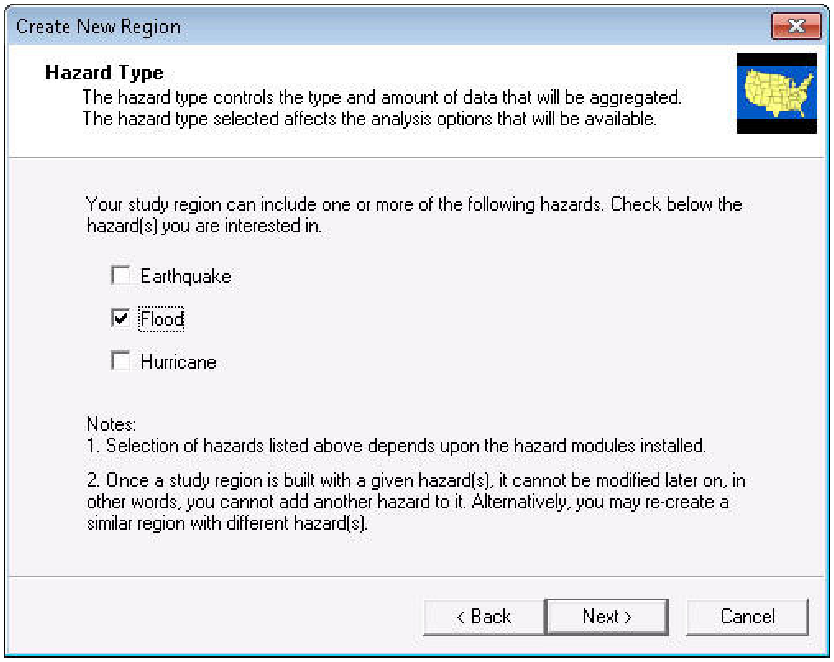


Figure A.3 Selecting a Hazard Model in the Hazus Start-up Wizard

A.4.2 Select Aggregation at County Level

A.4.2.1 Select North Carolina

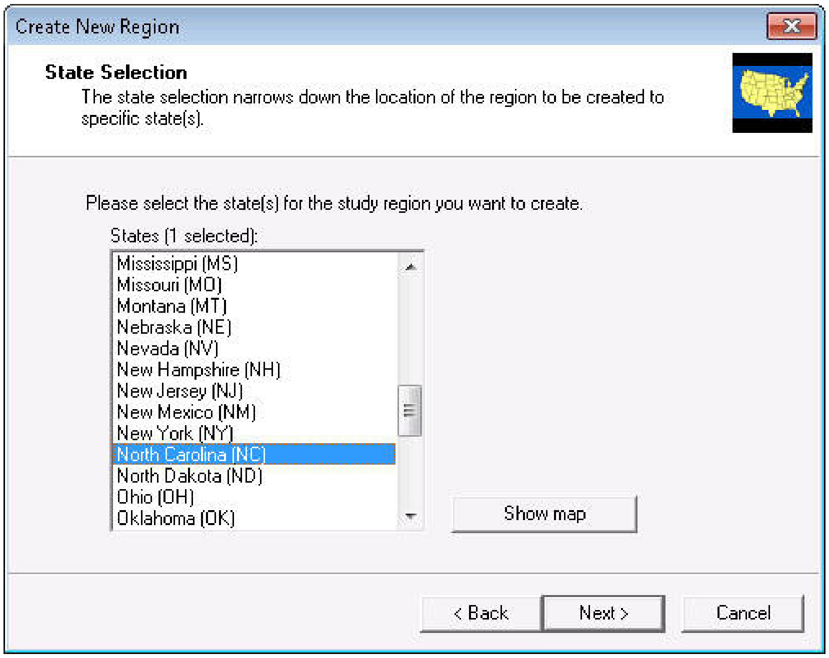


Figure A.4 Selecting the Study Region State in the Hazus Start-up Wizard

A.4.2.2 Select Alamance County (Riverine)

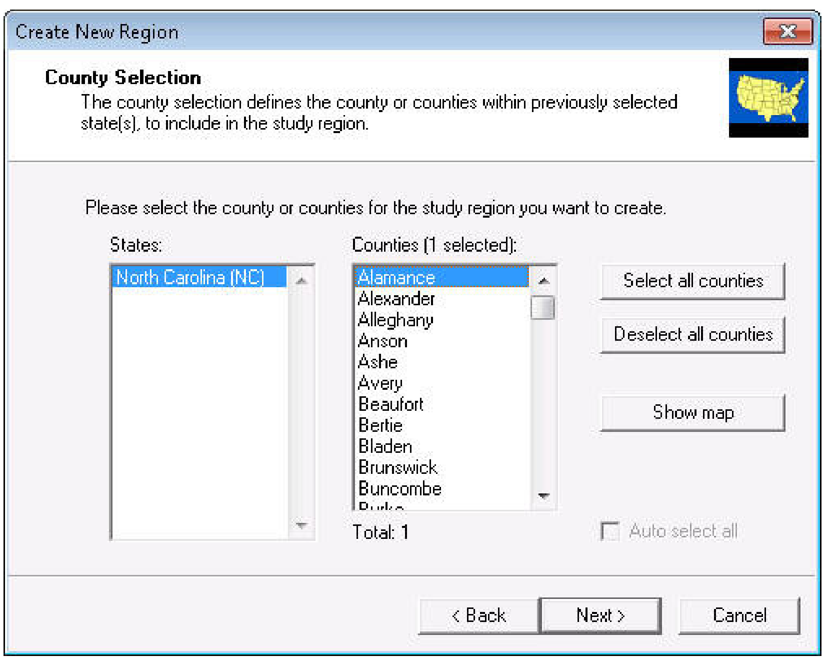


Figure A.5 Selecting the Study Region County in the Hazus Start-up Wizard

A.4.2.3 Select Brunswick County (Coastal)

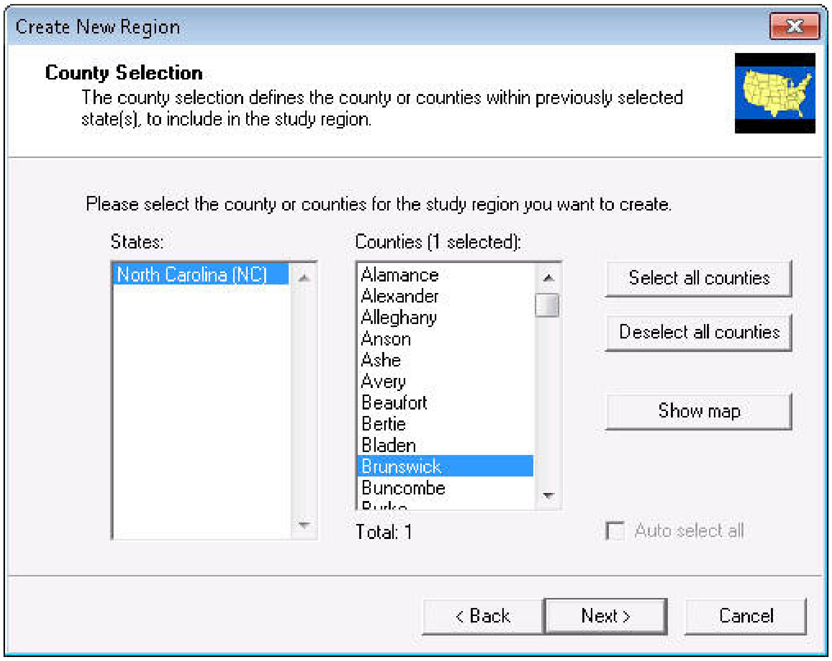


Figure A.6 Selecting the Study Region County in the Hazus Start-up Wizard

A.4.2.4 Wait for Region to be created

Completing the selection process in the Start-up Wizard, the user will select **Finish** and a progress bar will be displayed as the **Hazus** "shell" will aggregate the baseline data and import the data into the study region database. When completed, the user should see a folder with the study region name created underneath the folder where regions are kept (in this case C:\Hazus-Data\Regions). There will be a large number of files in that folder, but there are three files of interest: to the user in this verification process

HazusFl.mxd: This file should have a time stamp of roughly 6-8 minutes later than whatever time the region creation process was started and be approximately 190 KB in size.

DTSLog.txt: This file contains the **Hazus** shell's log of the creation process. Should anything not work properly, this will be a key file to examine and this will be one of the files the product support team will request from the user.

flDtsLog.txt: This file contains the creation process log for the Flood Model and the unique databases and components associated with the model. Should anything not work properly, this will be a key file to examine and this will be one of the files the product support team will request from the user.

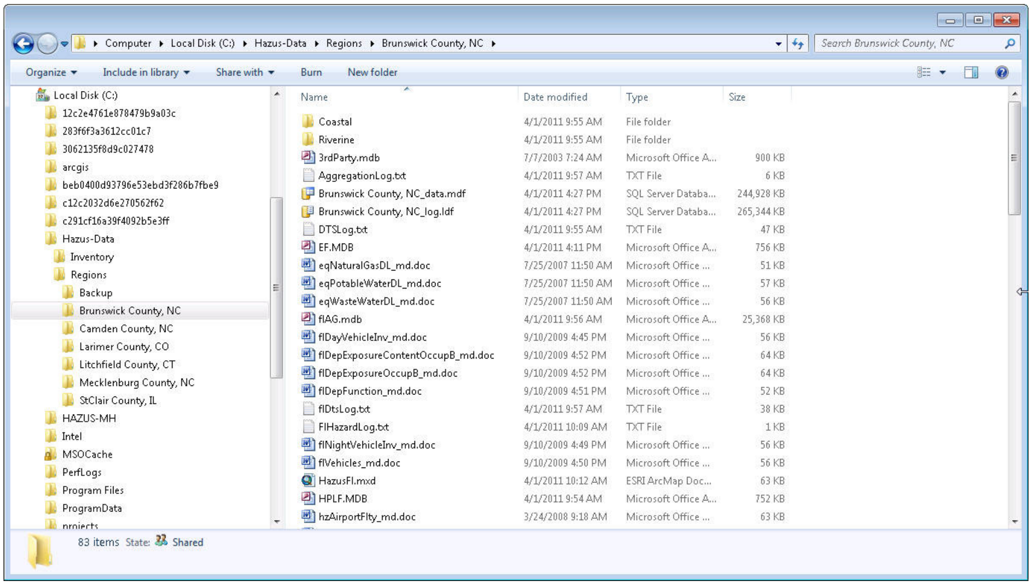


Figure A.7 Snapshot of the Hazus Flood Model Study Region Files and Folders

A.4.3 Study Region Open Verification Procedure

The following sections will allow the user to demonstrate that a flood study region can be opened and that the correct version of the Flood Model is installed.

A.4.3.1 Open the New Region

When the creation process ended and the progress and creation dialogs have closed the region wizard dialog should remain on screen as shown in Figure A.8 below. Select "Open a region" option button and click **OK**.

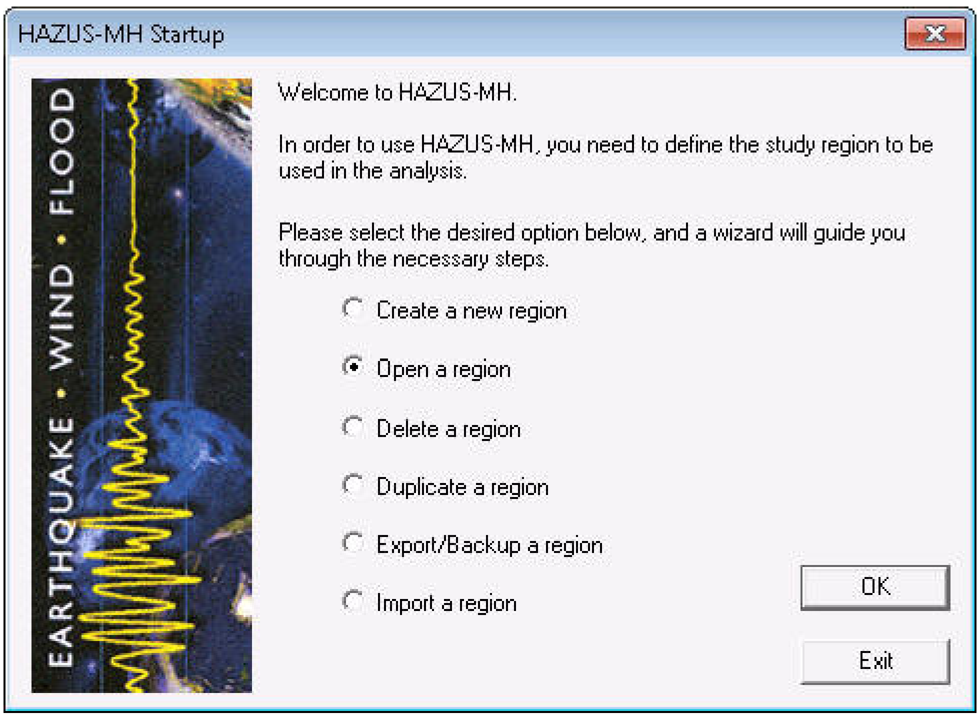


Figure A.8 Opening the Flood Model through the Hazus Study Region Wizard

A.4.3.2 Open the New Region

Figure A.9 shows the dialog where the user can select a study region to open. The dialog should display any study regions created by the user. As this process is intended to occur after the user has just completed installation of the software and created their first study region, this dialog should have only one region for selection. Figure A.9 shows how the dialog will appear should the user have created several regions. Figure A.10 shows the same selection with the coastal region in the list of regions to select from. Highlight the study region and select **Next**.

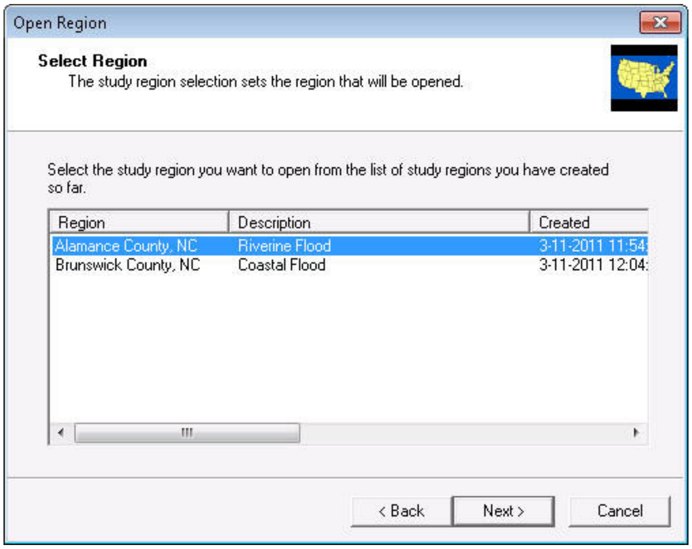


Figure A.9 Riverine Study Region Selection in the Hazus Study Region Wizard

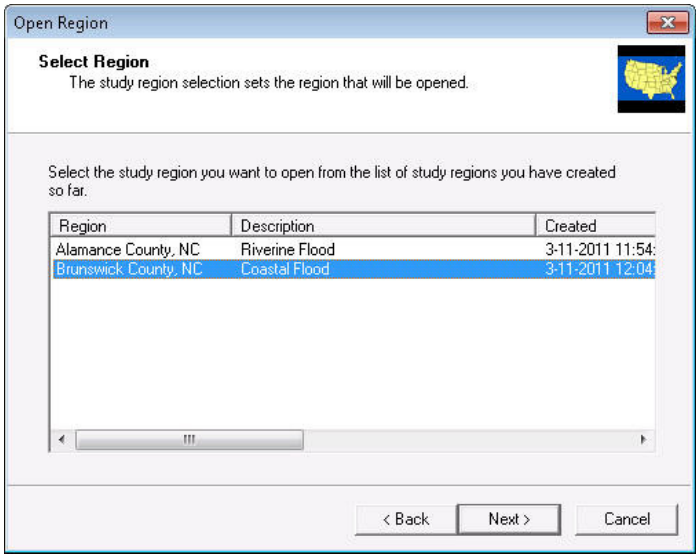


Figure A.10 Coastal Study Region Selection in the Hazus Study Region Wizard

A.4.3.3 Initial Display

Figure A.11 shows how the Alamance County (riverine verification) study region should appear when opened. Ensure that the study region name is in the title bar, menu items: Inventory, Hazard, Analysis, and Results exist in the toolbar, and that the three layers boundary, tract, and block have loaded in the ArcMap table of contents.

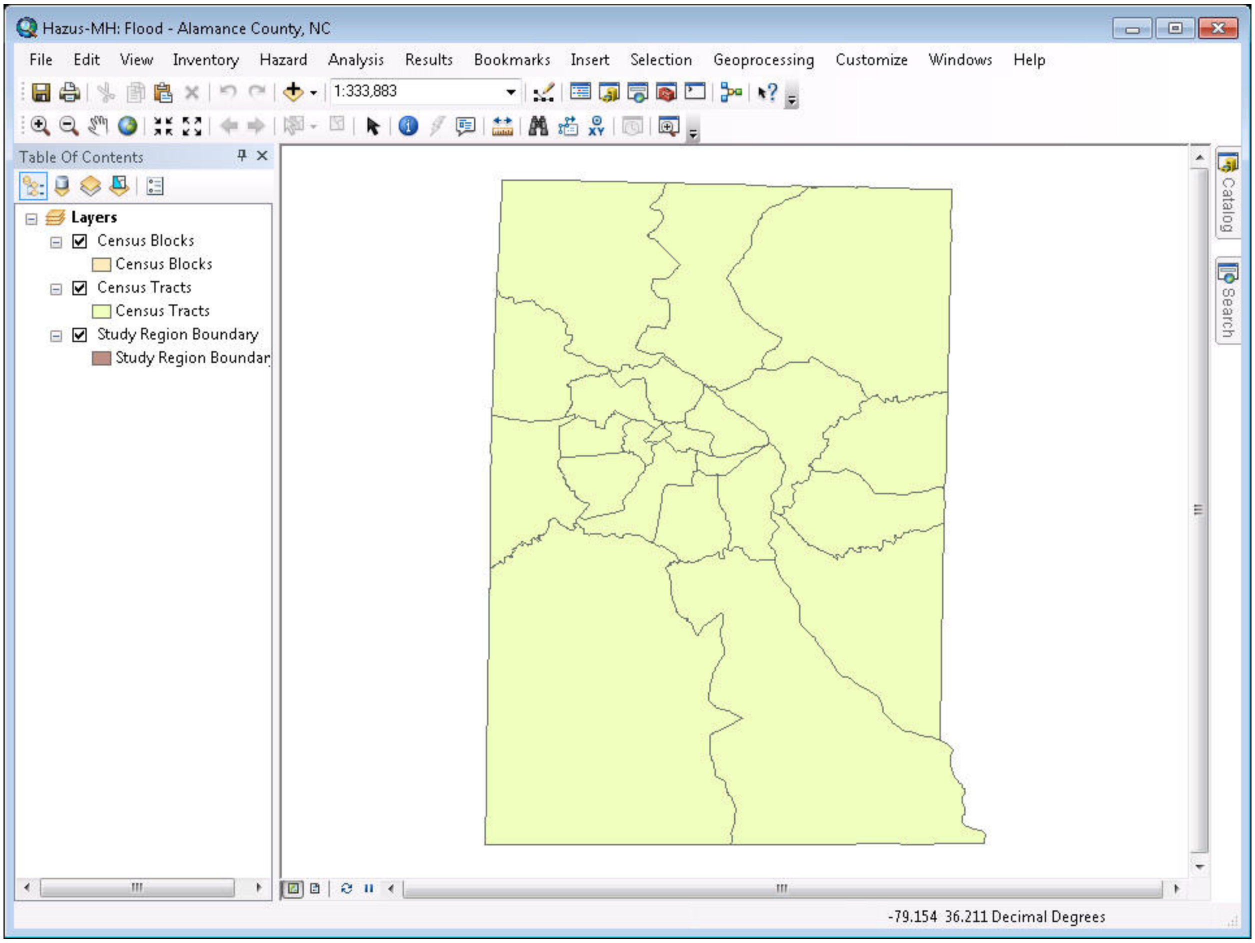


Figure A.11 Alamance County as Seen in the Hazus Flood Model

Figure A.12 shows how the Brunswick County (coastal verification) study region should appear when opened. Ensure that the study region name is in the title bar, menu items: Inventory, Hazard, Analysis, and Results exist in the toolbar, and that the layers boundary, tract, block, and Region Shore have been loaded in the ArcMap table of contents.

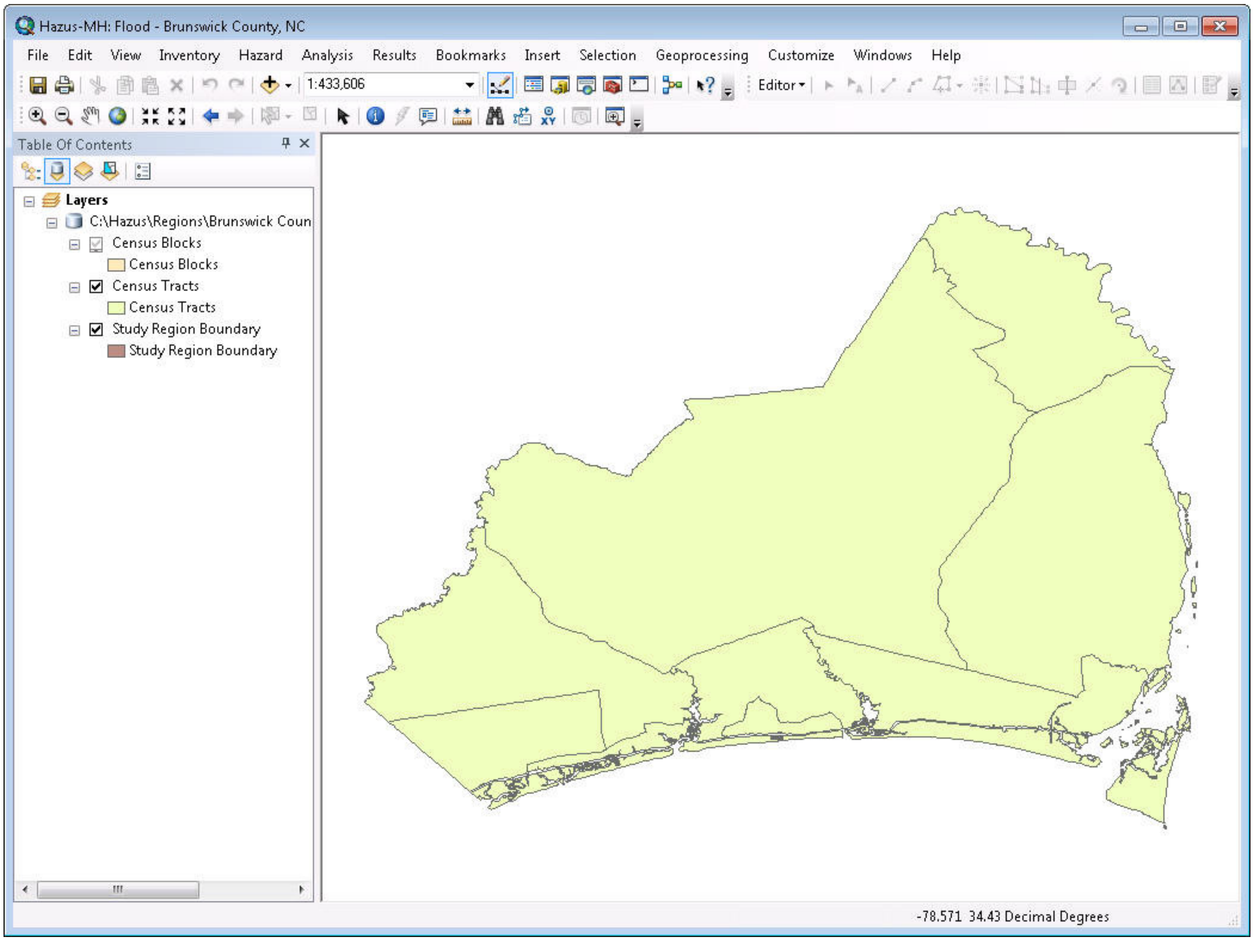


Figure A.12 Brunswick County as Seen in the Hazus Flood Model

A.4.3.4 Version Check

The first step will be to ensure the version is correct. Use menu *Help\About Hazus-MH* and verify this displays:

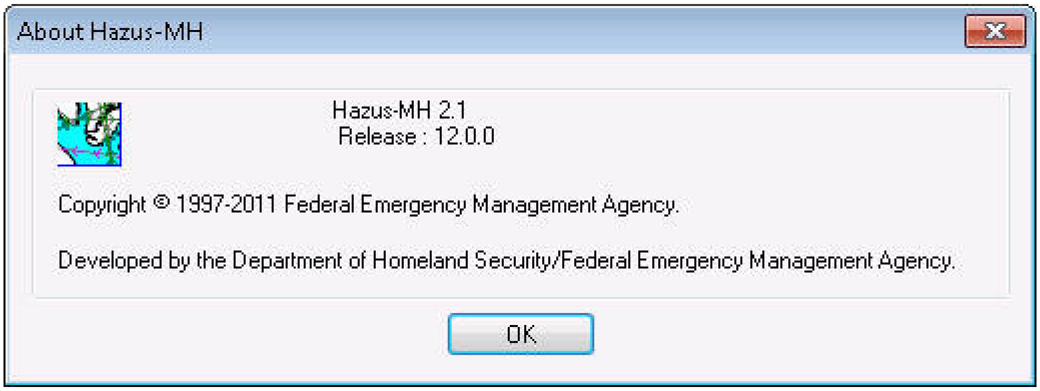


Figure A.13 Hazus Flood Model Version in Help/About

A.4.4 Inventory Verification

These steps will demonstrate that the Inventory menu items are functional and that inventory and certain occupancy mapping data were created.

A.4.4.1 General Build Stock Check

Use menu item *Inventory\General Building Stock\Square Footage* and ensure this displays.

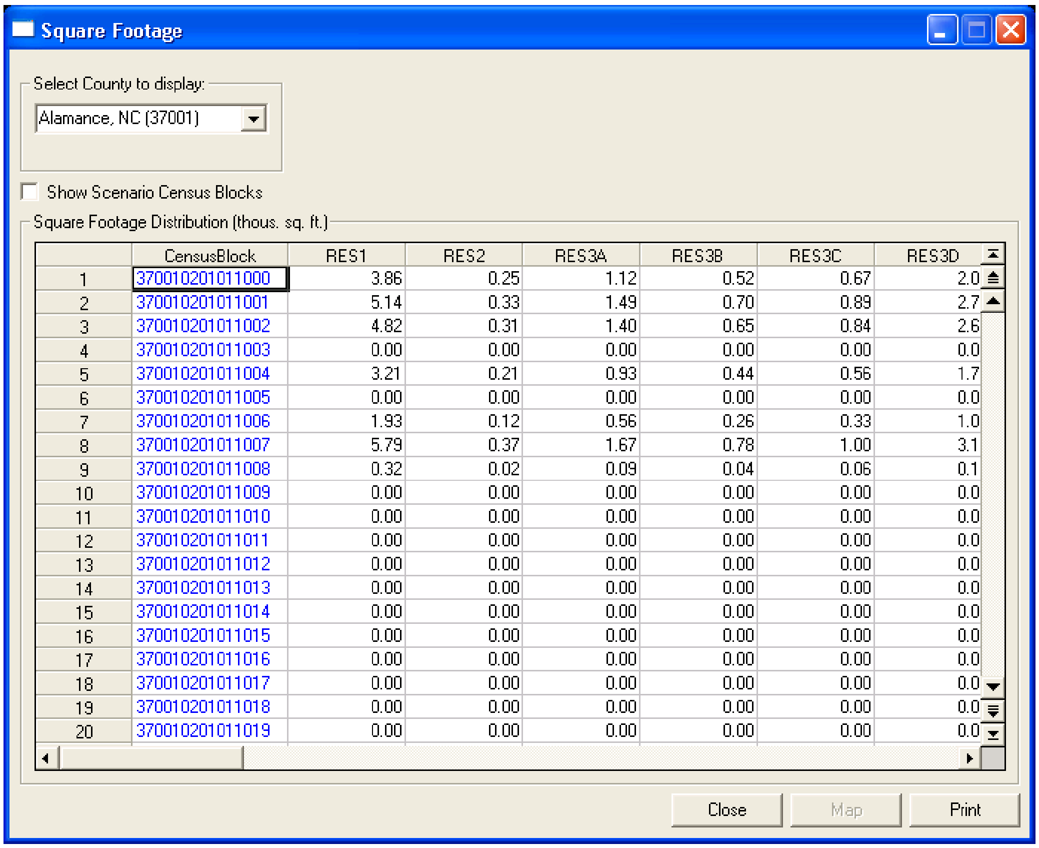


Figure A.14 Square Foot Occupancy Dialog Validation

A.4.4.2 Shade by Res1

Click on the RES1 column header to select column RES1. The Map button (circled) should become enabled. Press **Map**. A new shaded layer should add to the map and show the distribution of RES1 occupancies. Close the dialog when finished.

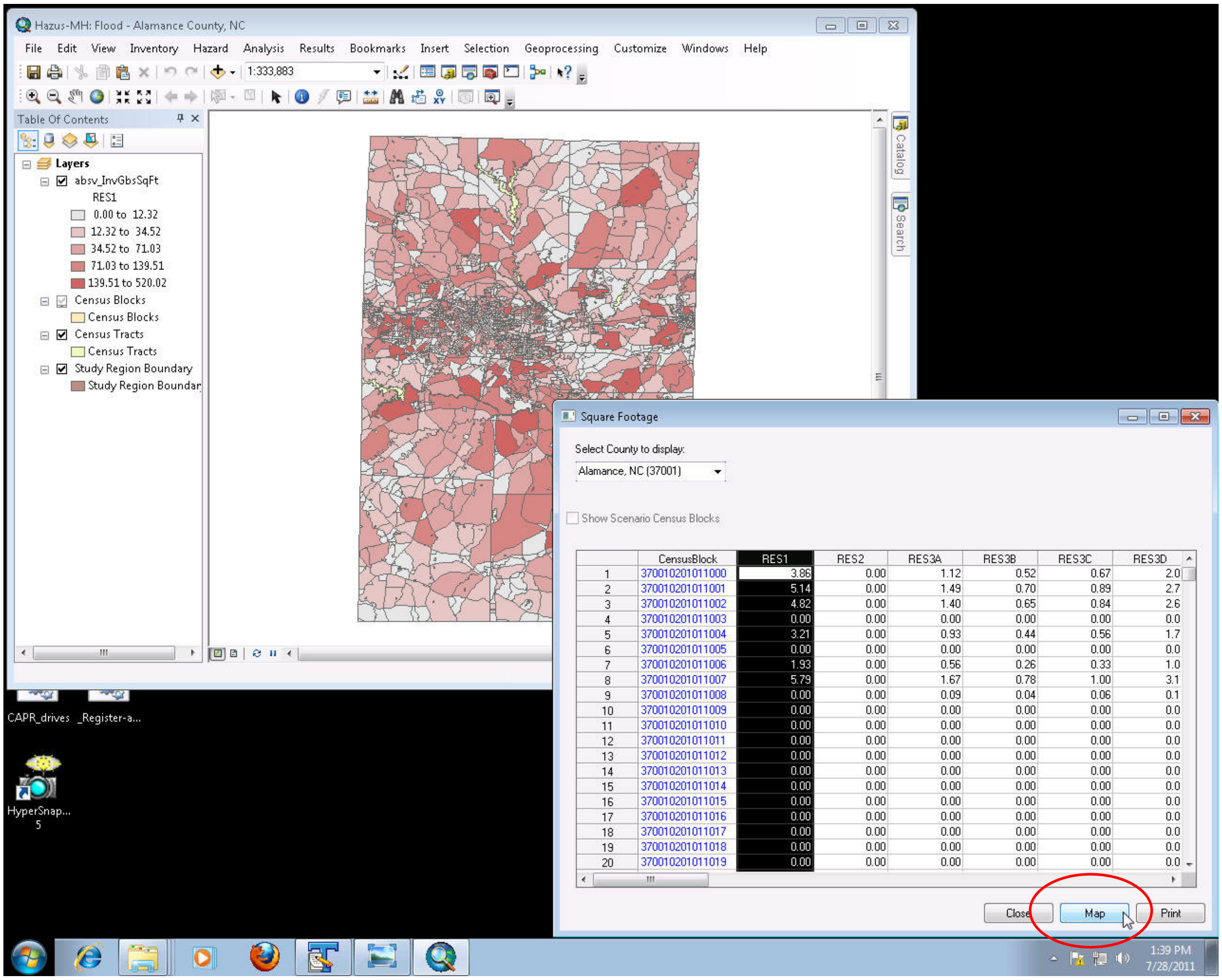


Figure A.15 RES1 Square Foot Occupancy Thematic Map

A.4.4.3 General Occupancy Mapping Check

Use menu item *Inventory\General Building Stock\General Occupancy Mapping* and ensure this displays. Close the dialog when finished.

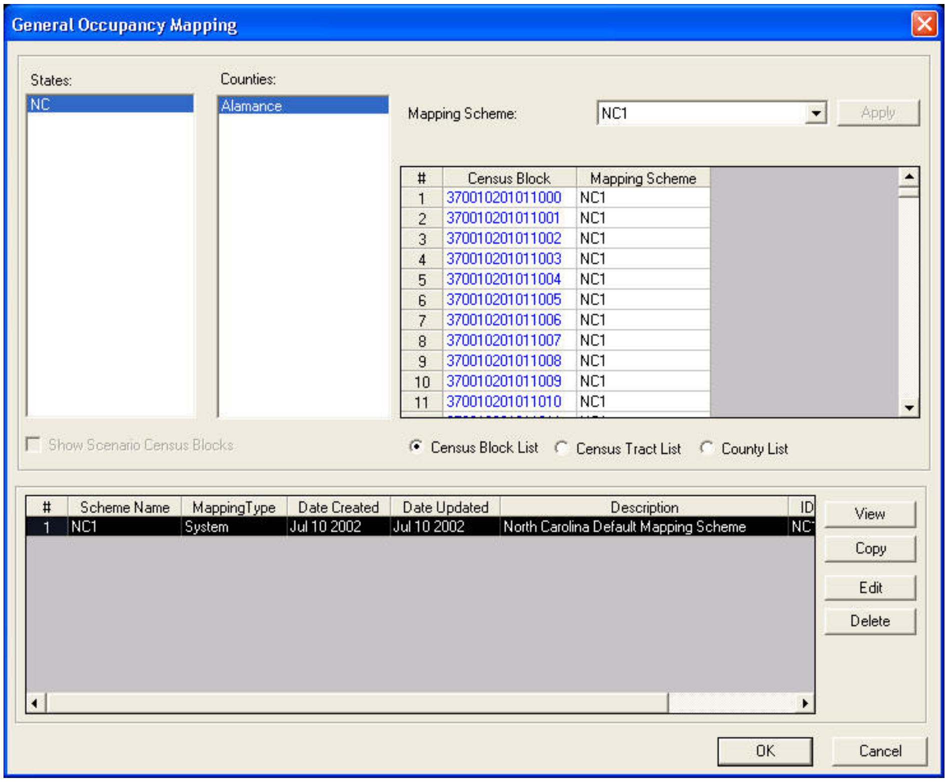


Figure A.16 General Occupancy Mapping Scheme Dialog

A.4.4.4 Flood Specific Occupancy Mapping Check

Use menu item *Inventory\General Building Stock\Flood Specific Occupancy Mapping* and ensure this displays. Each study region will have three default occupancy mapping schemes: Coastal, Great Lakes and riverine. The block type defines whether the census block is assigned the coastal, Great Lakes or riverine default.

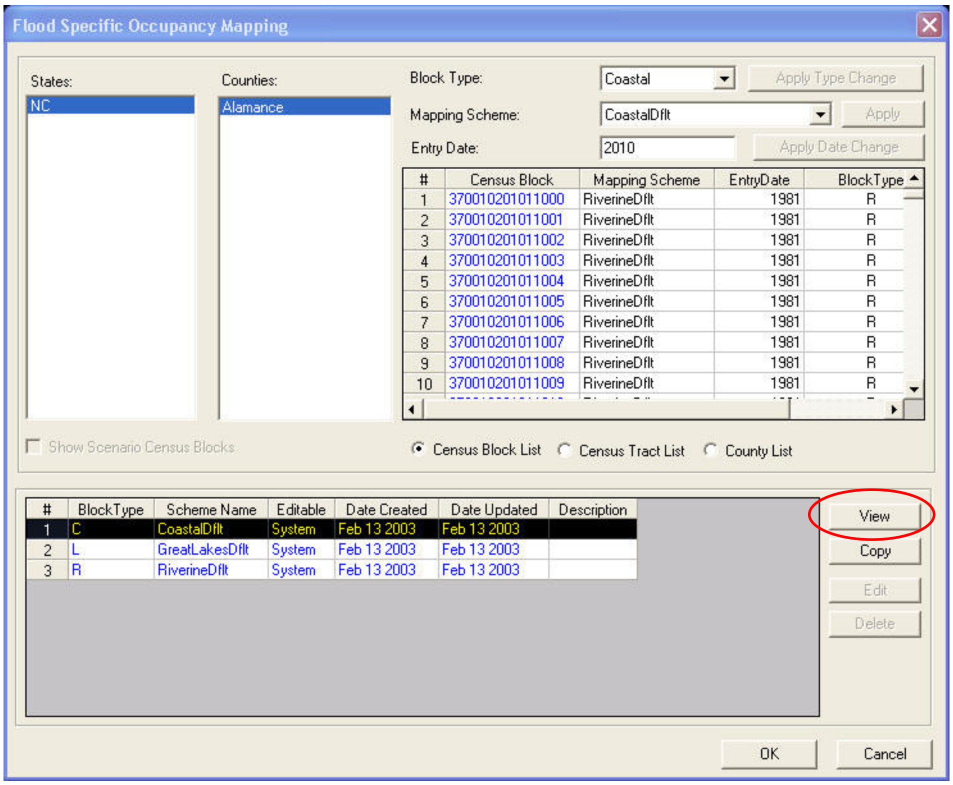


Figure A.17 Flood Occupancy Mapping Scheme Dialog

A.4.4.5 Flood Specific Occupancy Details Check

Select the third row in the lower grid. The first row may appear to be highlighted at the same time. Press the **View** button (circled), expand the tree on the left, select RES1, and ensure the image in Figure A.18 displays. Close the dialog when finished (**OK** or **Cancel**) to return to the Flood Specific Occupancy Mapping scheme dialog.

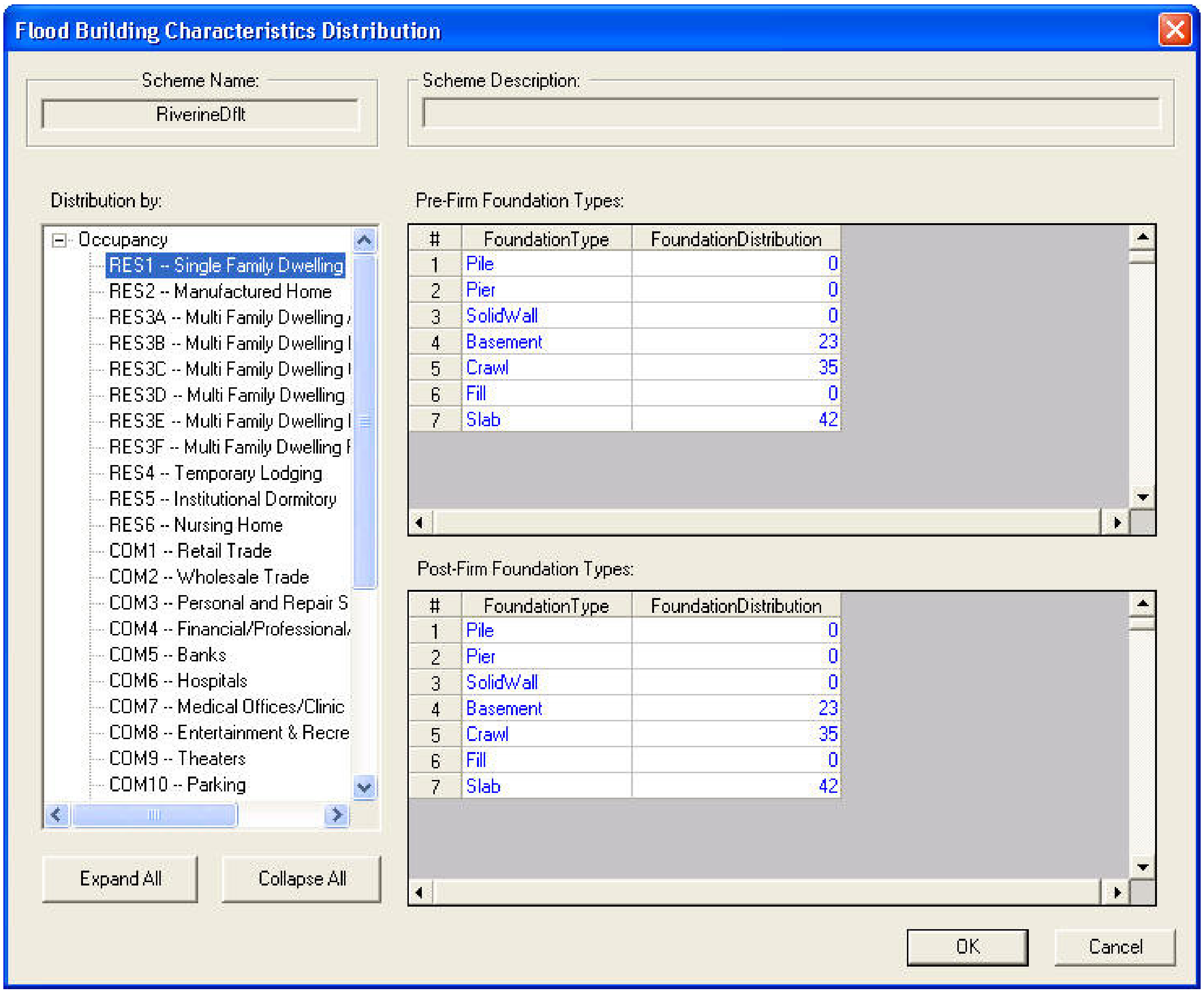


Figure A.18 Riverine Default Flood Occupancy Mapping Scheme Details Dialog

Select the first row in the lower grid. Press the view button (Figure A.17 circled button), expand the tree on the left and select RES1, and ensure the view in Figure A.19 displays. Close the dialog (**OK** or **Cancel**) when finished and close the flood-mapping dialog.

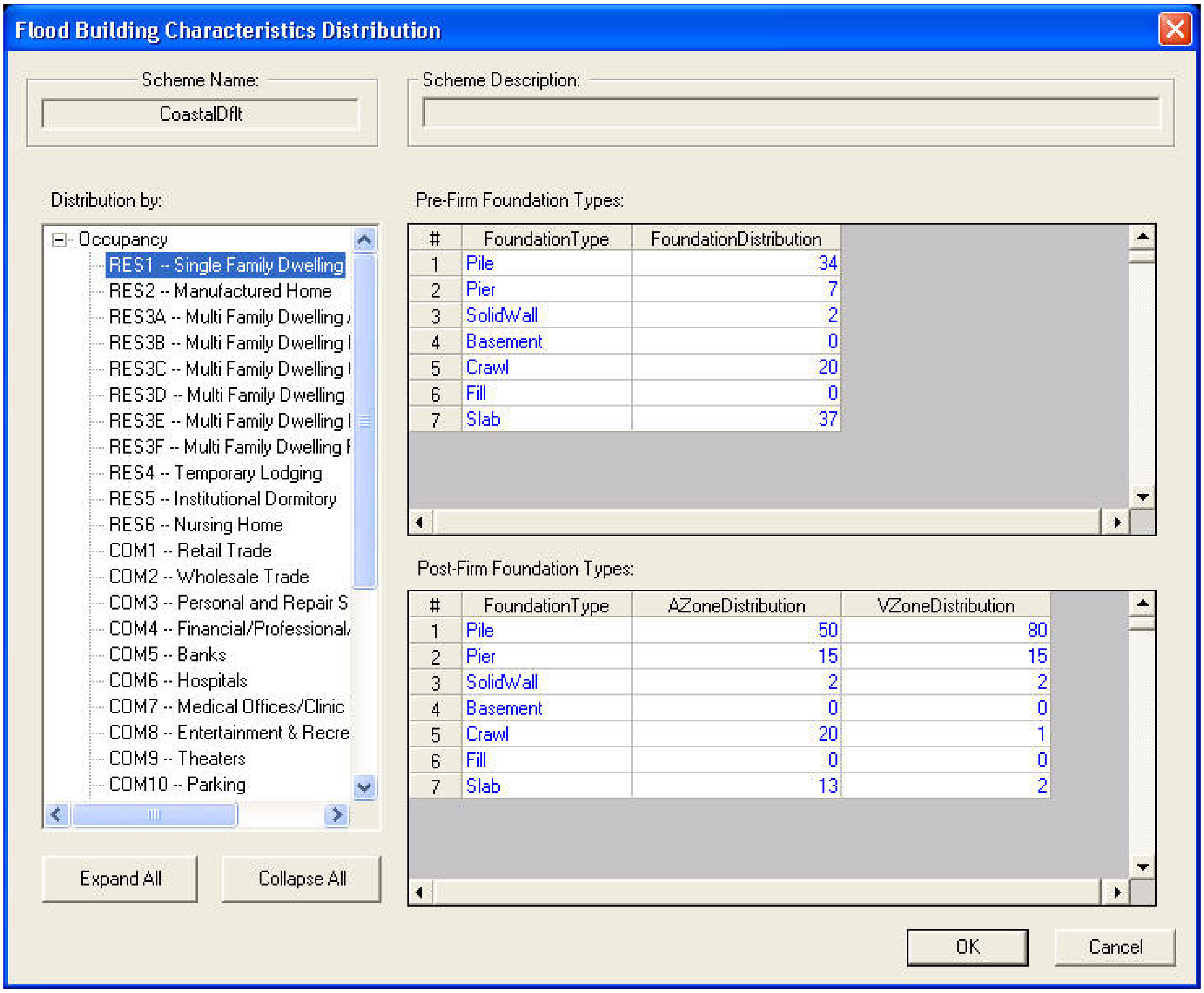


Figure A.19 Coastal Default Flood Occupancy Mapping Scheme Details Dialog

A.4.4.6 Essential Facilities Check

For the next step it will be useful to turn off the RES1 map layer from the table of contents. This can be done by un-checking the show layer button, or highlight the layer name and use the right mouse button (right click) to remove the layer from the table of contents – remove is the second option on the pop-up menu. Then use menu item *Inventory\Essential Facilities*, then click on the Schools tab, and ensure this displays.

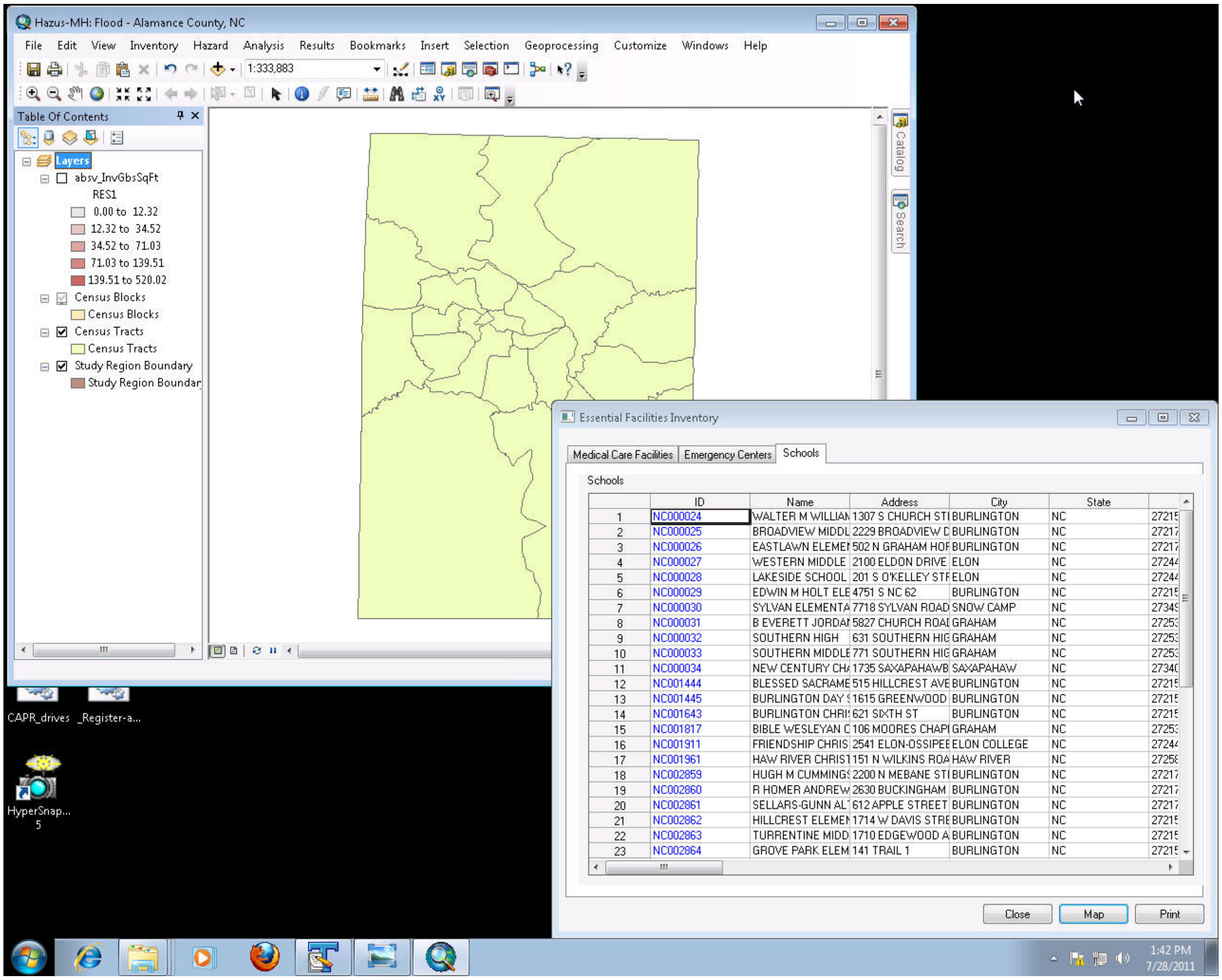


Figure A.20 Essential Facilities Dialog Displaying the Schools Tab

A.4.4.7 Plot the Schools

The **Map** button should be automatically enabled. Press **Map** (circled) and a new point layer should add to the map and show the placement of schools. Close the dialog when finished.

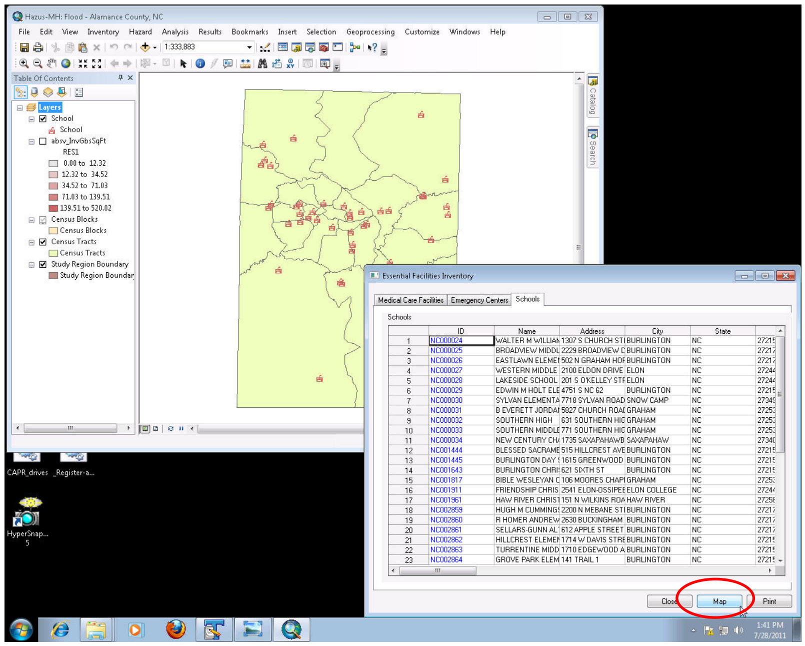


Figure A.21 Mapped Schools for Alamance County

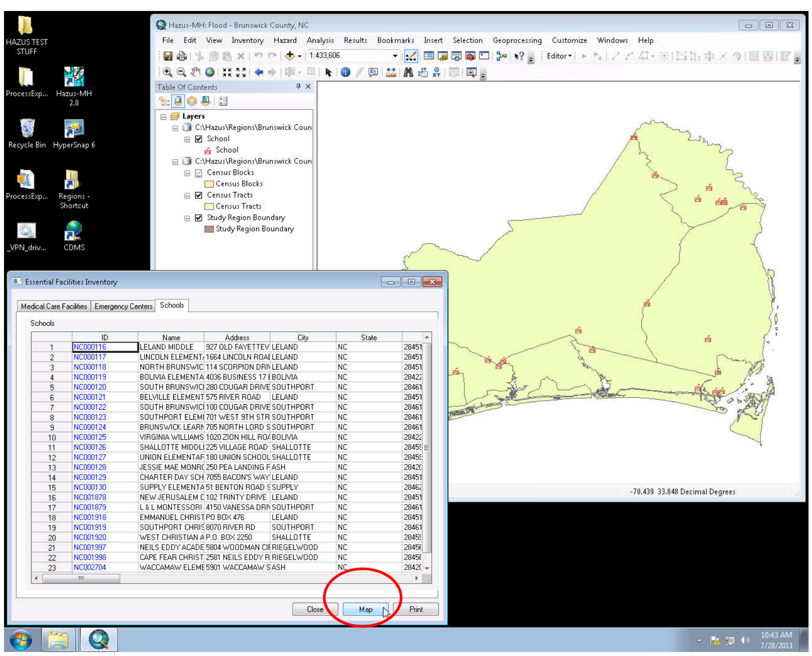


Figure A.22 Mapped Schools for Brunswick County

A.4.4.8 Classification Check

Use menu item *Inventory\View Classification\Buildings and Facilities* and ensure this displays. Close the dialog when finished. This completes the Inventory

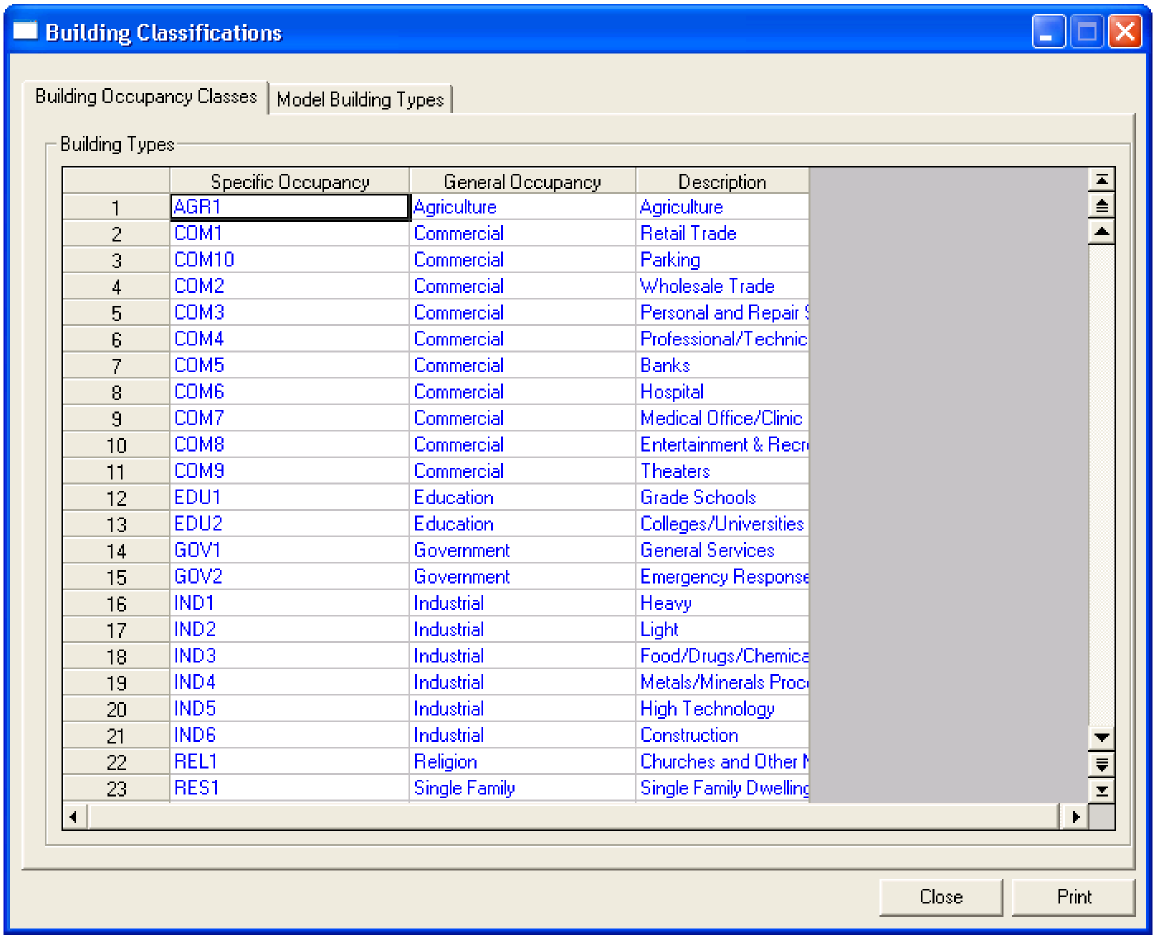


Figure A.23 View Classifications Dialog

A.4.5 Determine Flood Hazard Type

The first submenu item on the Hazard menu is the *Flood Hazard Type*. The selection of the hazard type has a direct impact on the size of the DEM required for the analysis. The riverine analysis requires a DEM that covers the study region and all adjacent watersheds conveying water into the study region, The Coastal analysis requires a DEM that covers the study region and all shorelines available for selection. Selecting "Riverine and Coastal" will create a DEM requirement that satisfies both of the above conditions.

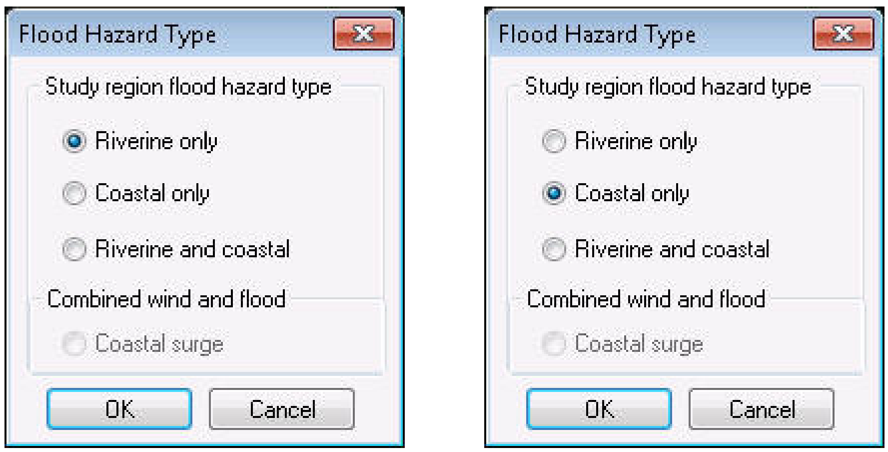


Figure A.24 Select Flood Hazard Type – Riverine for Alamance and Coastal for Brunswick

A.4.6 Determine DEM Coordinates

Use the *Hazard\User Data* menu item and select *Determine required DEM extent* button and ensure this display. Verify all four latitude and longitude numbers are as shown here.

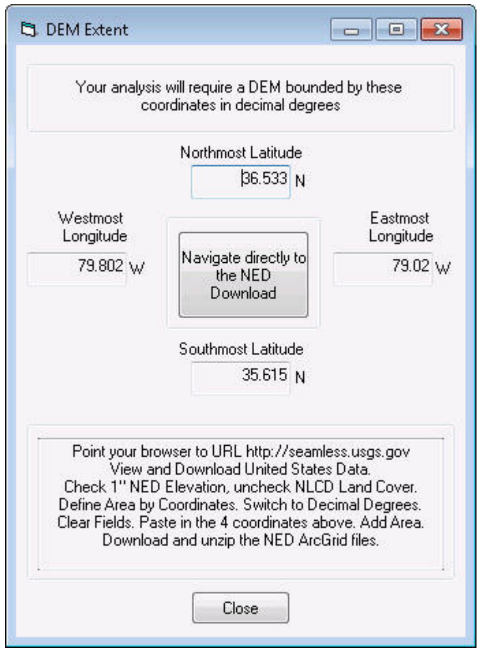


Figure A.25 DEM Extent Dialog – Alamance County

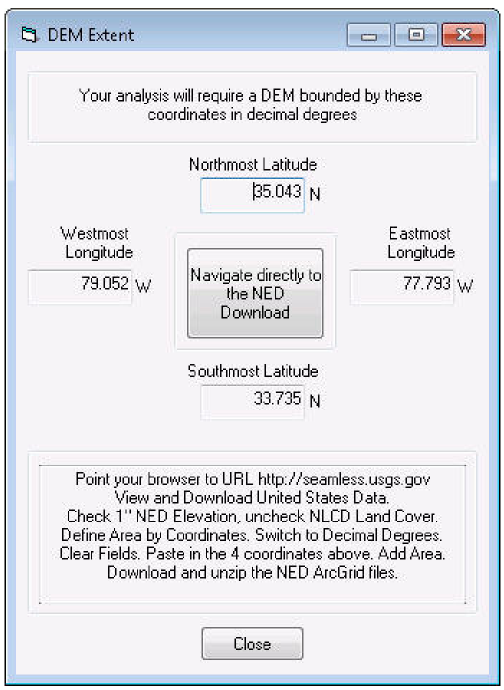


Figure A.26 DEM Extent Dialog – Brunswick County

A.4.7 Download the DEM

Click on “Navigate directly to NED Download” button. This will open up a web browser and take you to the USGS website. Click on “Download” link and wait for “File Download” prompt. Save the zip file somewhere on your hard disk. Once you have it, unzip it to some known place on your hard drive. One recommendation is to create a series of folders by State and county so that you can keep them and find them. The number the USGS gives you is a random number and you eventually could forget what is where.

Remember to unzip the DEM data once it has been downloaded. It is suggested that you might want to establish a standard location for all of your DEM data.

- **USERS WITH WINZIP**
    - After downloading the DEM, right-click on the zip file and select “Open with WinZip.”

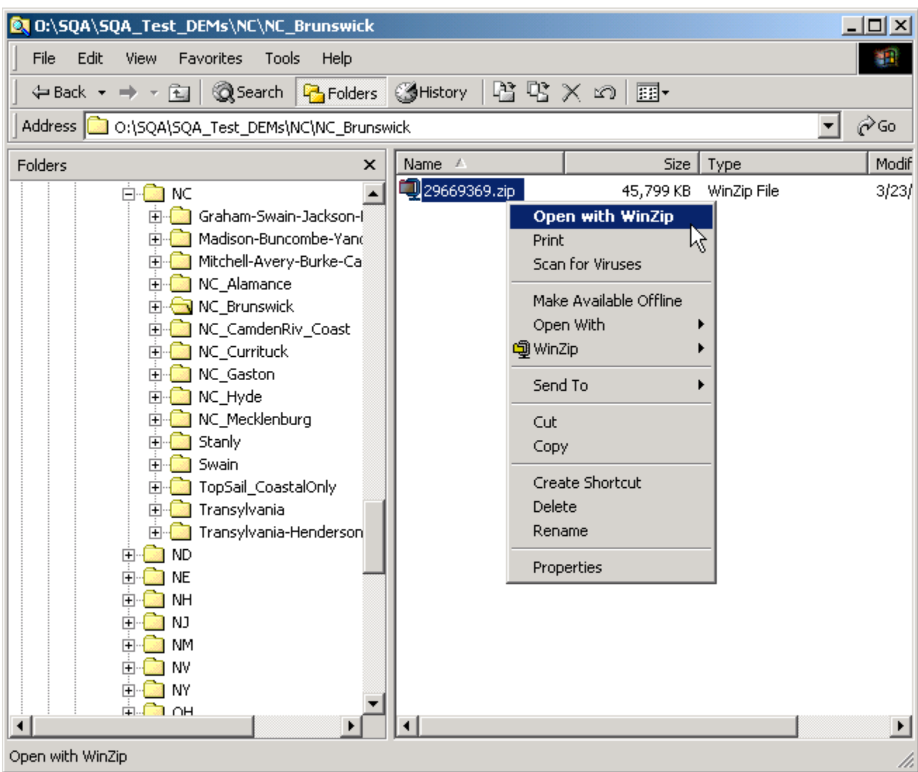


Figure A.27 Windows Explorer view of Zip File

- From there, the WinZip utility opens and click on "Extract" (circled below in Figure A.28).

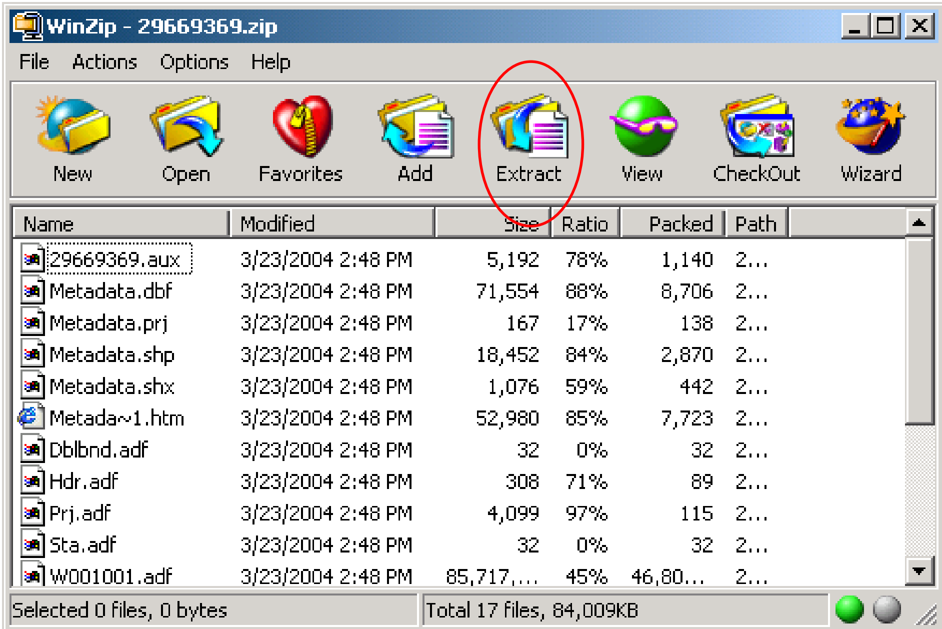


Figure A.28 Winzip with Zip File Opened

- To select the location where the zip file will be extracted to, browse through the "Folders/drives" browser window. It would be best to select the same folder in which the zip file is contained. Once the location is selected, click on "Extract."

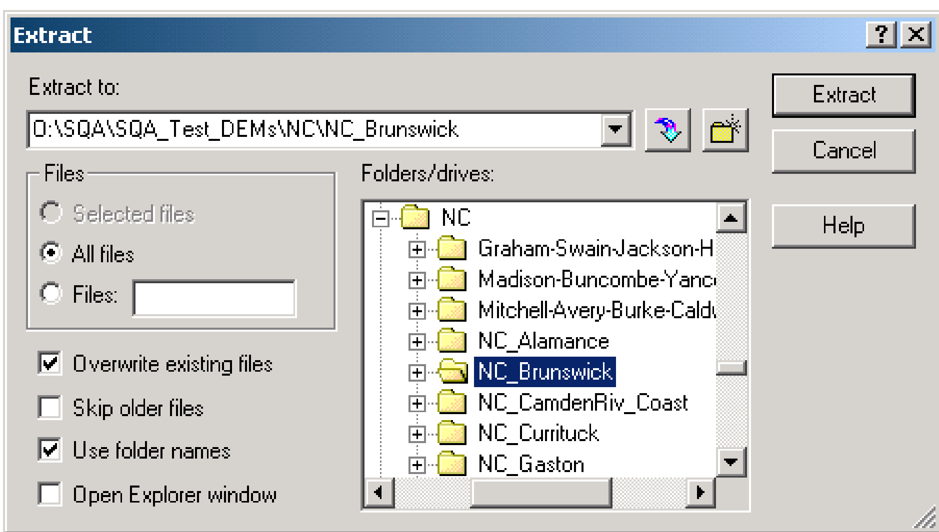


Figure A.29 Selection of Location for File Extracted

- **USERS WITHOUT WINZIP**
  - After downloading the DEM, right-click on the compressed zip file and click on "Extract All."

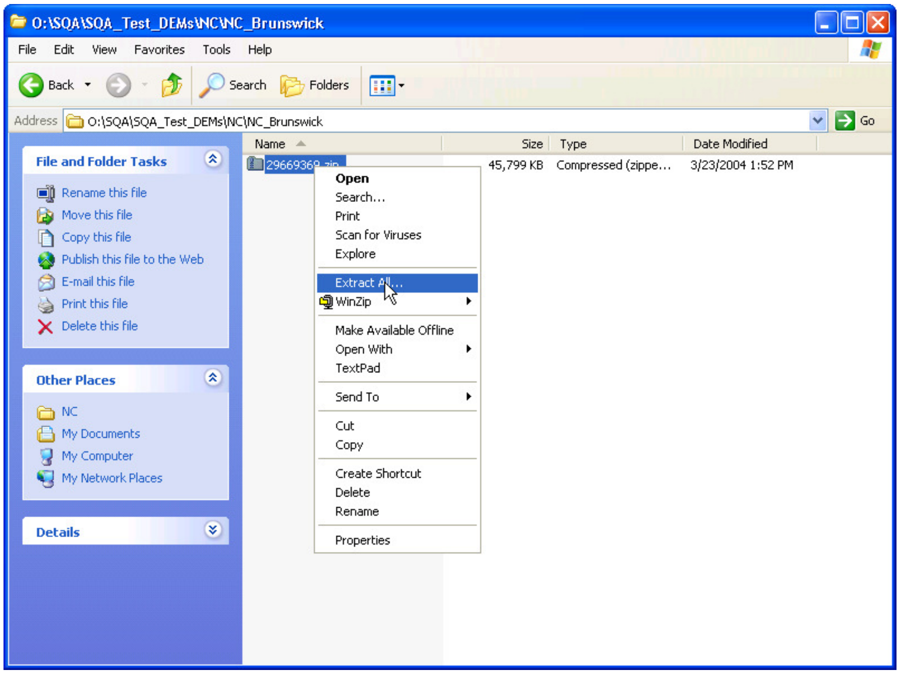


Figure A.30 Folder View of Compressed (Zipped) Folder

  - The "Extraction Wizard" utility will pop up. Click on "Next."

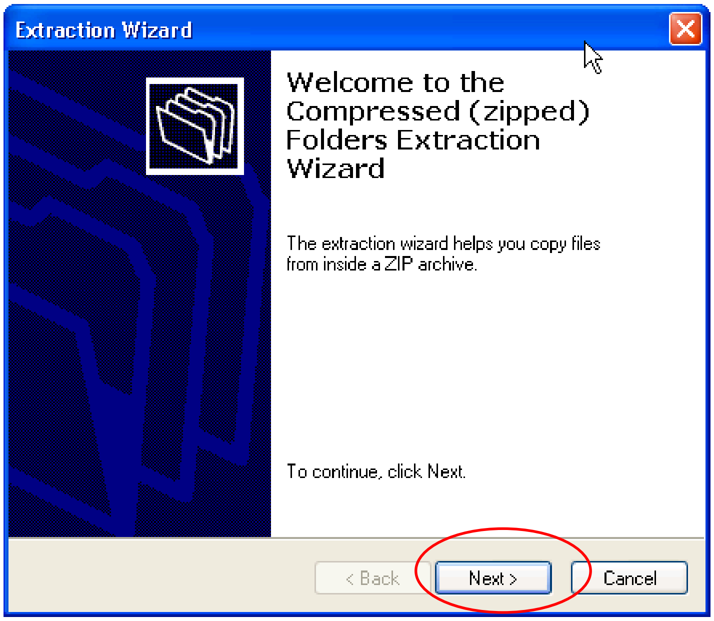


Figure A.31 Extraction Wizard

- The location of the extraction will be defaulted to the folder that contains the zip file. The location of the extracted file can be changed by clicking on the "Browse" button, however, it is highly suggested to use the default folder. Once the location is selected, click on "Next."

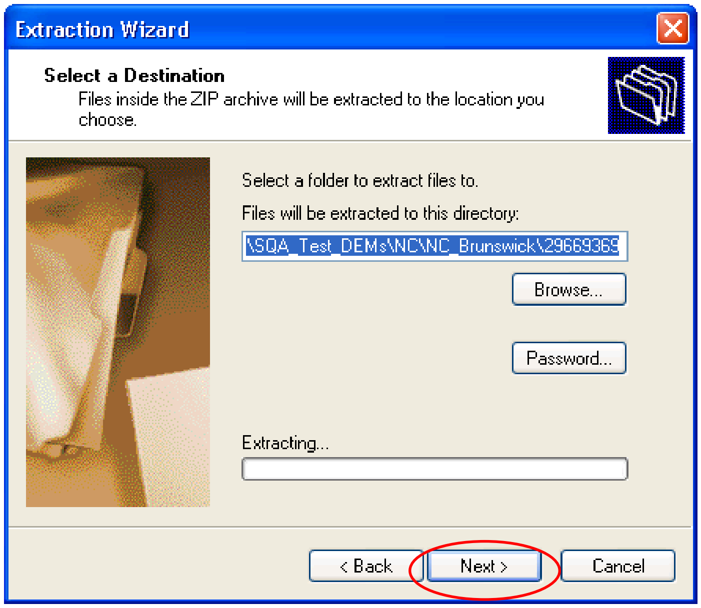


Figure A.32 Selection of Location for File Extracted

- Once the extraction is complete, the following dialog will appear. Click "Finish." The extracted files will show in a new window if it is selected as shown below. However, it is not necessary to see your extracted files.

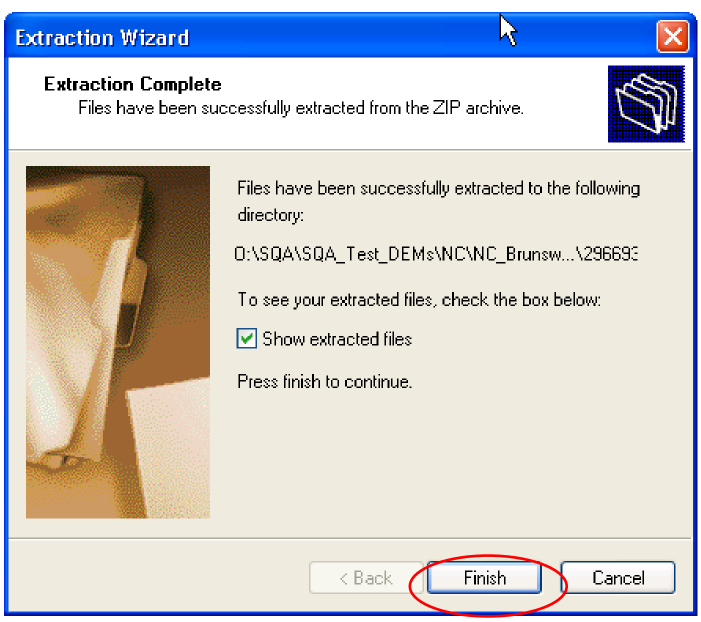


Figure A.33 Confirmation of Extracted File

A.4.8 Select the DEM

Use the *Hazard\User Data* menu item and ensure this displays. Set Datum to NAVD88 and units to Meters. Click on Browse (open folder icon/button). Navigate to the place where you unzipped the USGS DEM file. When you select it, the DEM layer name and path will be added to the list box. Click on **OK**. At that time, the raw DEM will be merged (if necessary), clipped, and projected. This may take 2 – 5 minutes. When it is done, you should see the Region DEM layer and its hillshade loaded.

Note: The Flood Model will merge DEM data automatically if more than one DEM file has been added to the dialog.

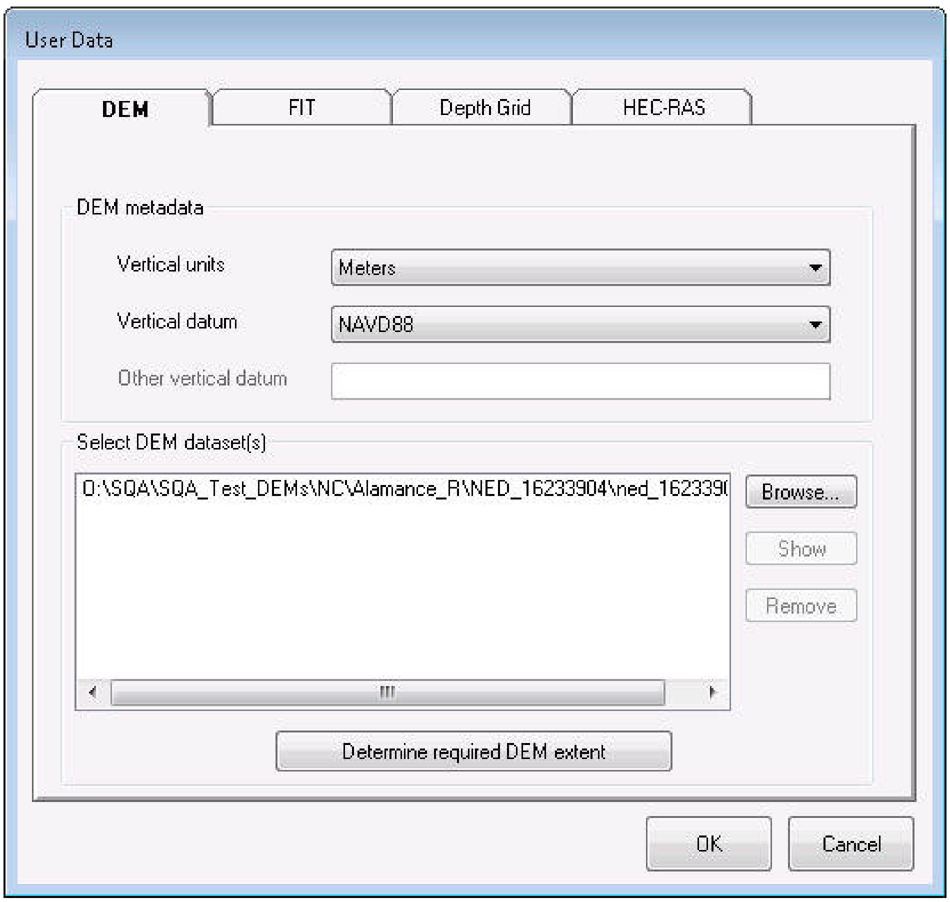


Figure A.34 Selecting the DEM Datasets

At this point, the processes for the hazards, riverine and coastal, diverge. Sections A.4.10 through A.4.13 cover the riverine hazard development for the installation verification. Sections A.4.14 through A.4.16 cover the coastal hazard development for the installation verification.

A.4.9 Stream Network Creation Check (Riverine Only)

Use the *Hazard\Develop Stream Network* menu item and ensure this display. The default is 10.0 miles, change to 2.0 miles. For now leave it at that. Click **OK**.

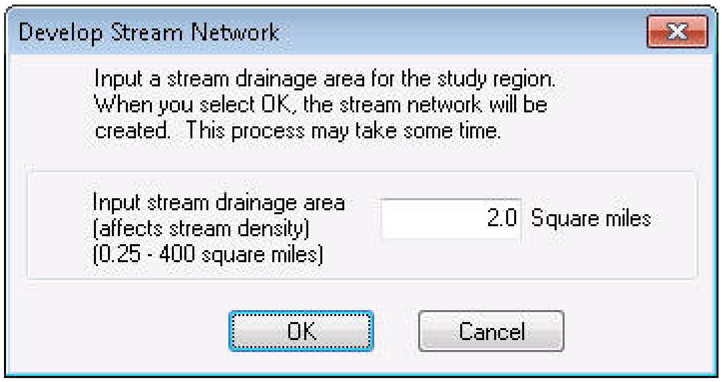


Figure A.35 Developing a Stream Network

At that time, the stream network will get created. This process may take from 10 to 30 minutes or more depending on the density of the river network selected (i.e., setting the drainage area to 1 mile will result in a denser stream network and will take more time). When it is done, you should see this:

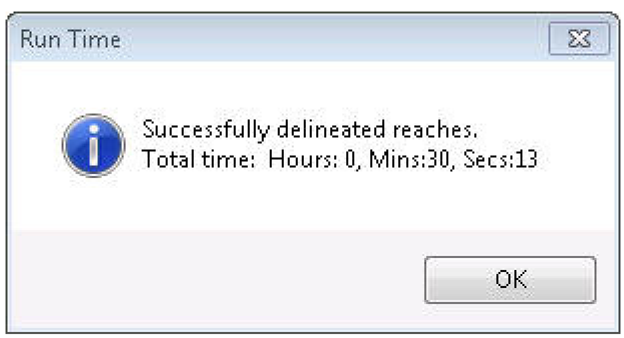


Figure A.36 Stream Network Completion Message Box

Underneath the message box, the river network will be drawn. Closing the message box, the user should see the following:

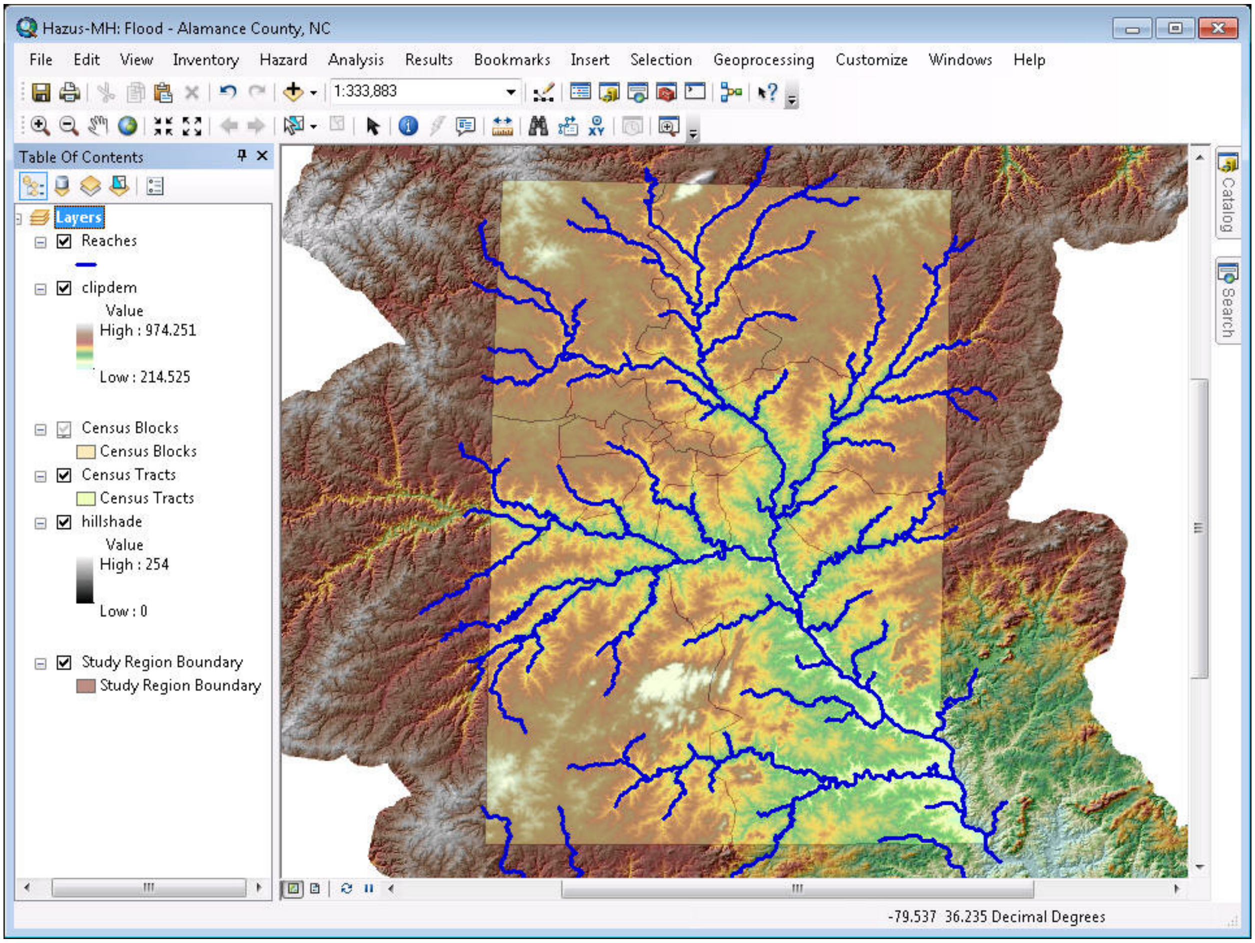


Figure A.37 The ArcMap Window Displaying the Completed Stream Network

A.4.10 Scenario Creation Check (Riverine Only)

Use the *Hazard\Scenario\New* menu item and ensure this display. Enter a name and a description that is meaningful to you. For this test we will select a few reaches. Click **OK**.

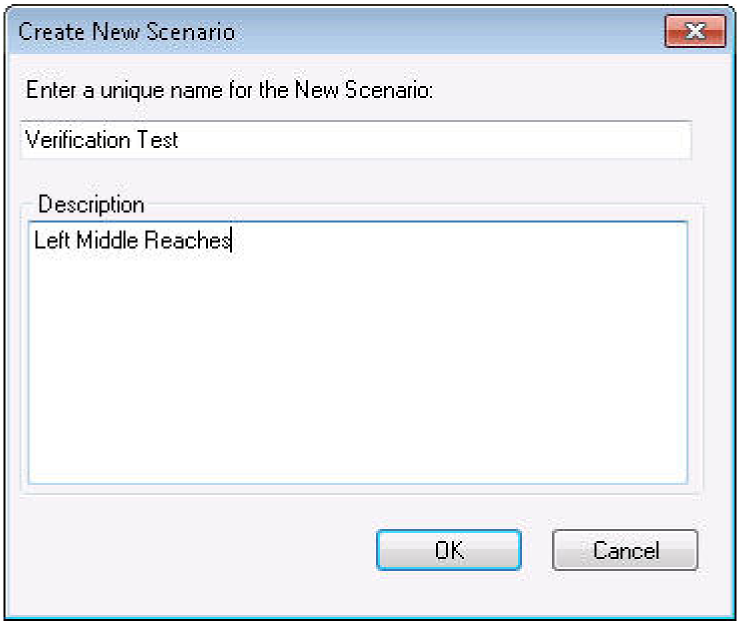


Figure A.38 Entering A Scenario Name (Riverine)

When the user has completed entering the Scenario name and selecting **OK**, the following dialog will display with the stream network visible in the map document.

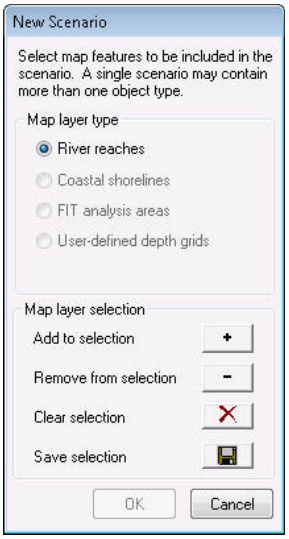


Figure A.39 New Scenario Selection Tools

Click on the **Select** (+) symbol and select the reaches shown. Note they are close to a school so we can get results. Click on "**Save selection**". Then click **OK**.

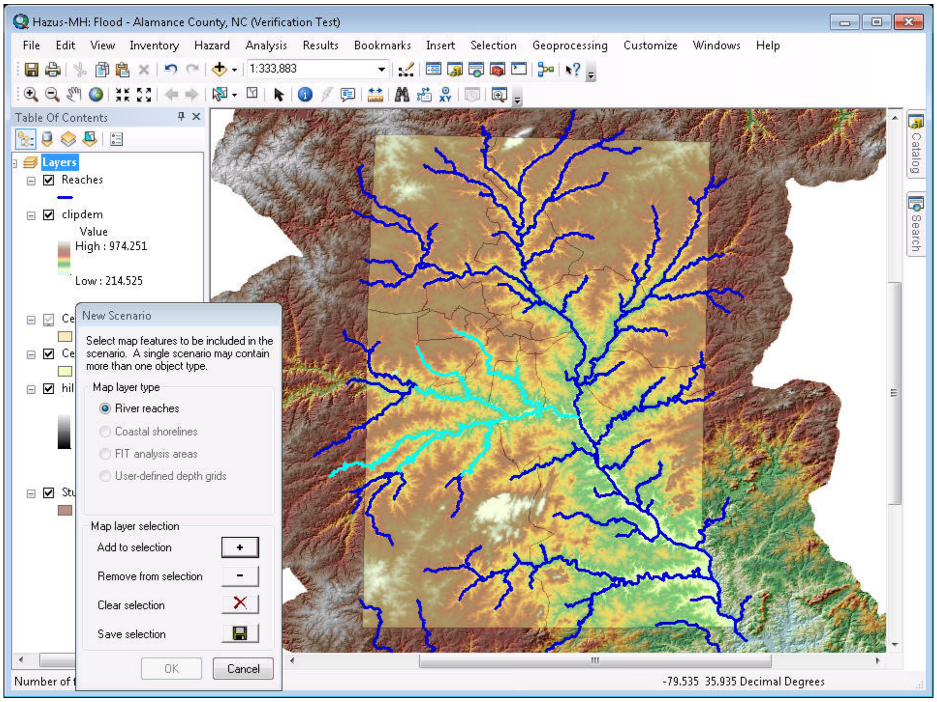


Figure A.40 Example of Selected Stream Reaches

The selected reaches will be displayed in light blue when they are highlighted but they are displayed in red after they are saved.

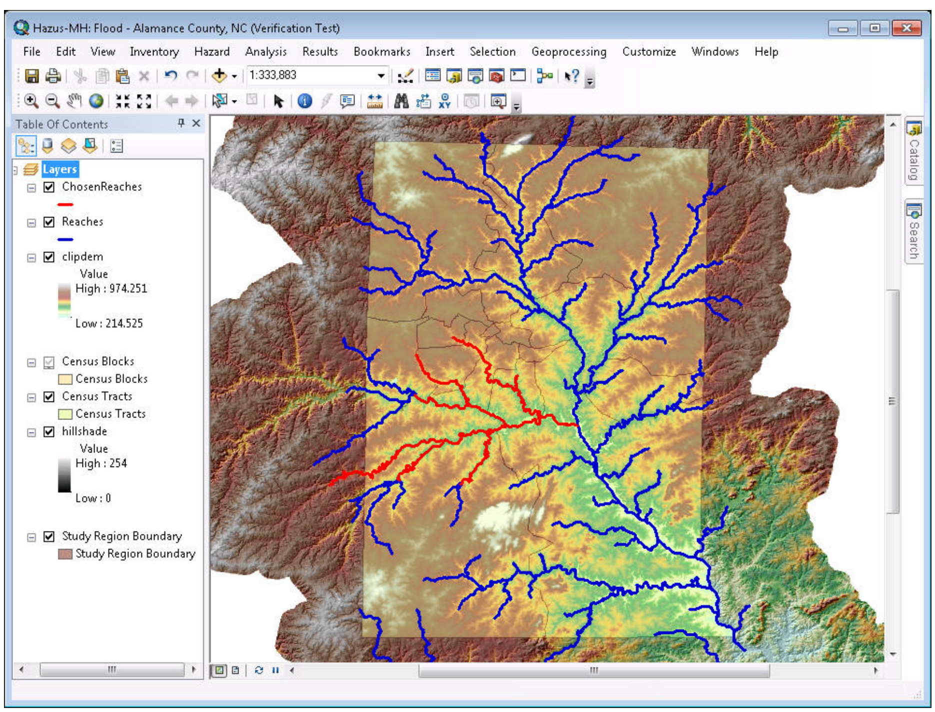


Figure A.41 Selected Stream Reaches Displayed After User Acceptance

A.4.11 Hydrology Check (Riverine Only)

Select the *Hazard\Riverine\Hydrology* menu item and hydrology calculations will begin. As it progresses, intermediate layers will be added to the map. The status bar globe will be spinning. This step may take 20 - 30 minutes. When it is done, you will see a dialog identifying successful completion and the processing time.

Note that the highlighted watersheds seen in the screen shot below will be automatically removed from your table of contents when the processing is completed.

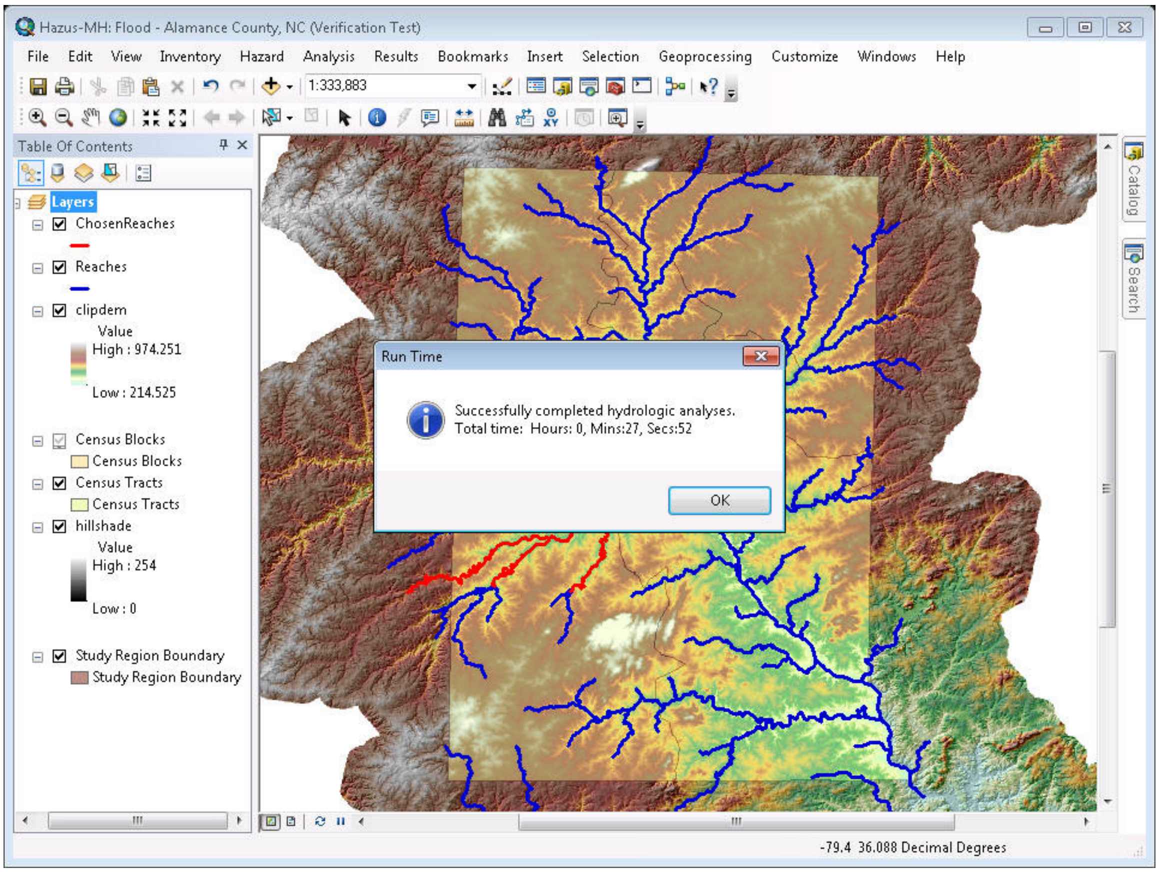


Figure A.42 SAMPLE Image, the Hydrology Analysis Successfully Completed

A.4.12 Delineate Floodplain – Riverine

Select the *Hazard\Riverine\Delineate Floodplain* menu item and ensure this dialog shows. Change the combo box to “Single Discharge”. Change the top Discharge cell in the grid to 1,200 cfs (cubic feet per second). Click the Fill Down (circled) button to set all reaches (if more than one reach was selected) to 1,200 cfs discharge.

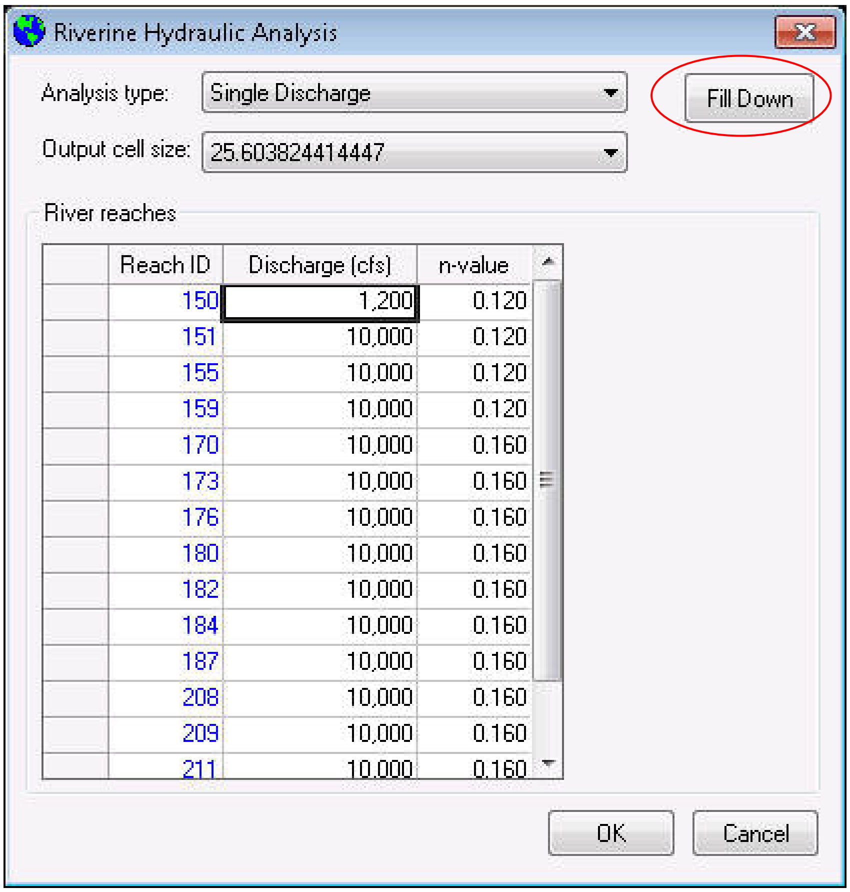


Figure A.43 Setting the Hydraulic Analysis Parameters

Click on **OK**. Hydraulics will begin. The status bar globe will be spinning. This step may take 1 – 2 hours. Once completed, you should see two new layers, BoundaryPolygon and mix0 (flood depth grid), as shown below:

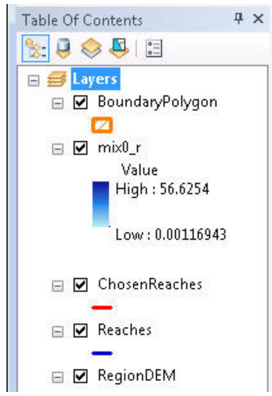


Figure A.44 Flood Depth Grid and Boundary Polygon in Table of Contents Following Successful Hydraulic Analysis

This completes the development of the riverine flood hazard.

A.4.13 Scenario Creation Check (Coastal Only)

Use the *Hazard\Scenario\New* menu item and ensure Figure A.45 displays. Enter a name and a description that is meaningful to you. As Brunswick County has a single shoreline (i.e. no islands or complex bays) you will select the visible shoreline. Click **OK**.

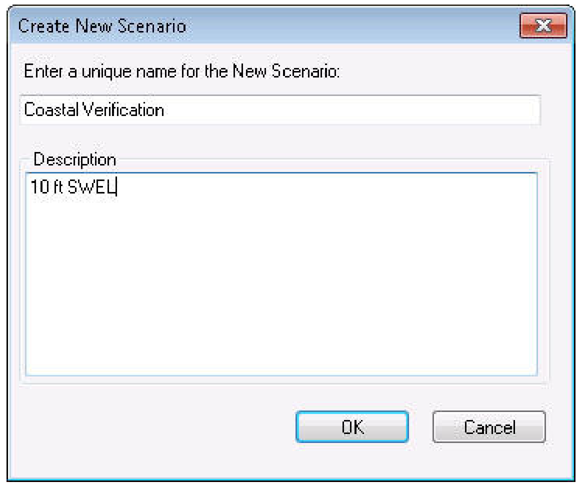


Figure A.45 Entering A Scenario Name (Coastal)

When the user has completed entering the Scenario name and selecting **OK**, the following dialog will display with the shorelines visible in the map document.

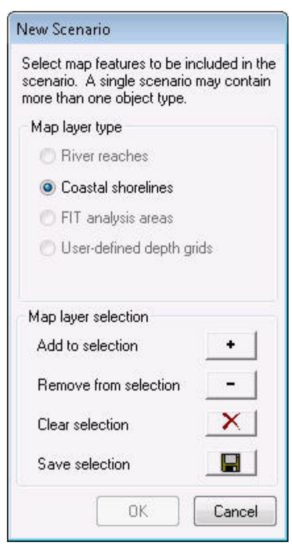


Figure A.46 New Scenario Selection Tools (Coastal)

Click on the **Select** symbol and select the shoreline shown. Click on "**Save selection**". Then click **OK**.

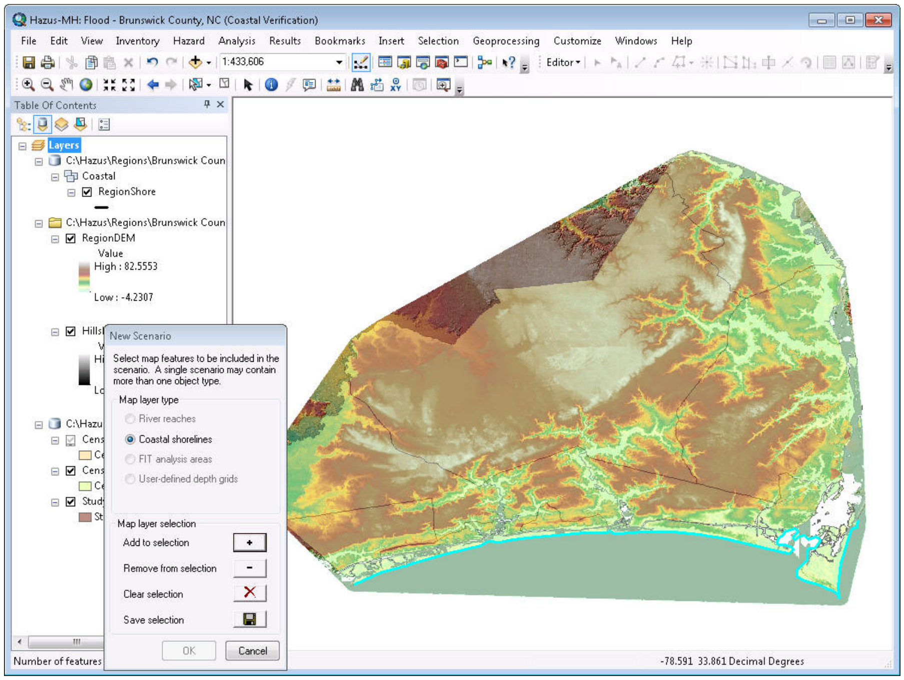


Figure A.47 Example of Selected Shoreline

The selected shoreline will be displayed in light blue, but it will be displayed in green after it is saved.

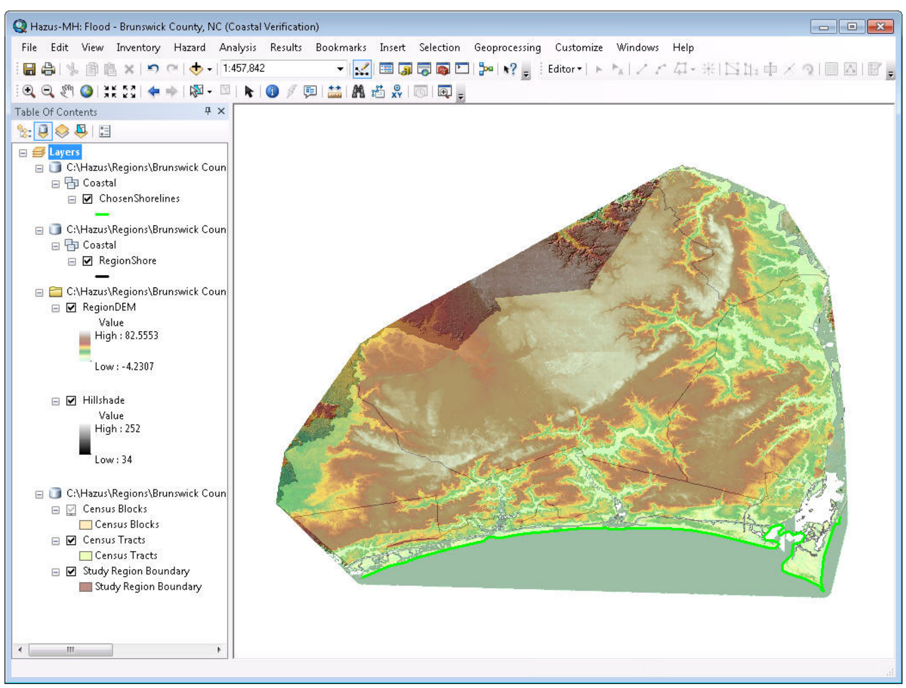


Figure A.48 Selected Shoreline Displayed After User Acceptance

A.4.14 Shoreline Characterization (Coastal Only)

After the scenario is defined and shoreline(s) are selected, the Shoreline Characterization automatically starts a series of interactive steps required to define the shoreline thereby allowing the Flood Model to perform the proper hazard analysis to develop the flood depth grids. The first step is to identify the starting and ending points of your analysis. In this case we will shift the start and end points in from the defaults shown on the map. The shoreline characterization dialog should appear as follows.

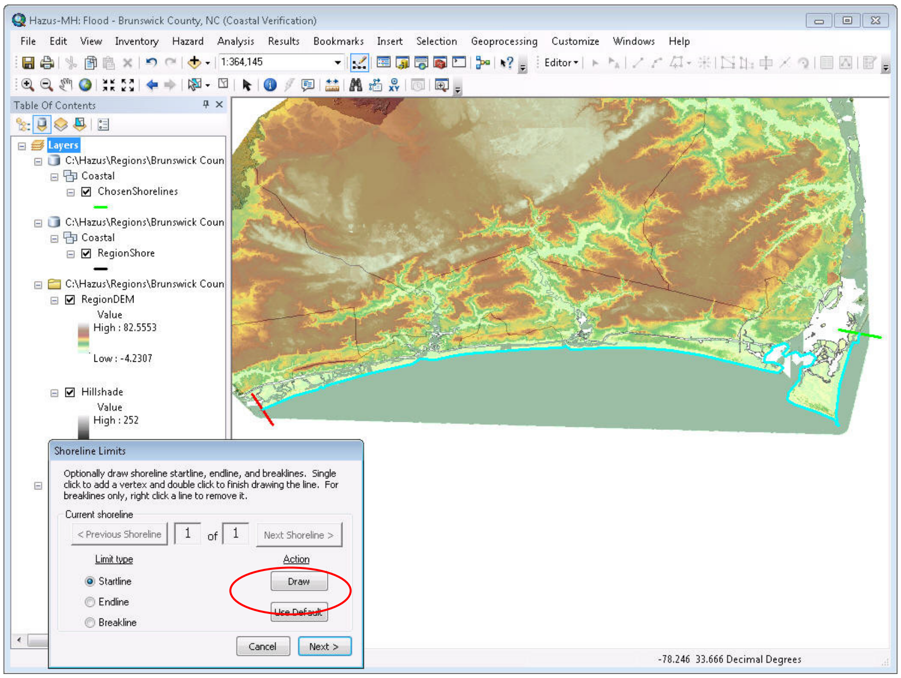


Figure A.49 Selected Shoreline Displayed After User Acceptance

The shoreline limits dialog allows the user to modify the limits of the analysis from the default start and end to one of their own selection. In this case, we will shift the shoreline start and end to reduce the overall area being analyzed. Ensure that the radio button **Startline** is selected and click on the **Draw** button (circled). The cursor will change into a draw tool (looks like a crosshair) and you can start the line inland approximately where the line (circled) is shown in Figure A.50 and complete the line in the ocean by double clicking. There is no need to hold the mouse buttons while drawing. You should see the image in Figure A.50.

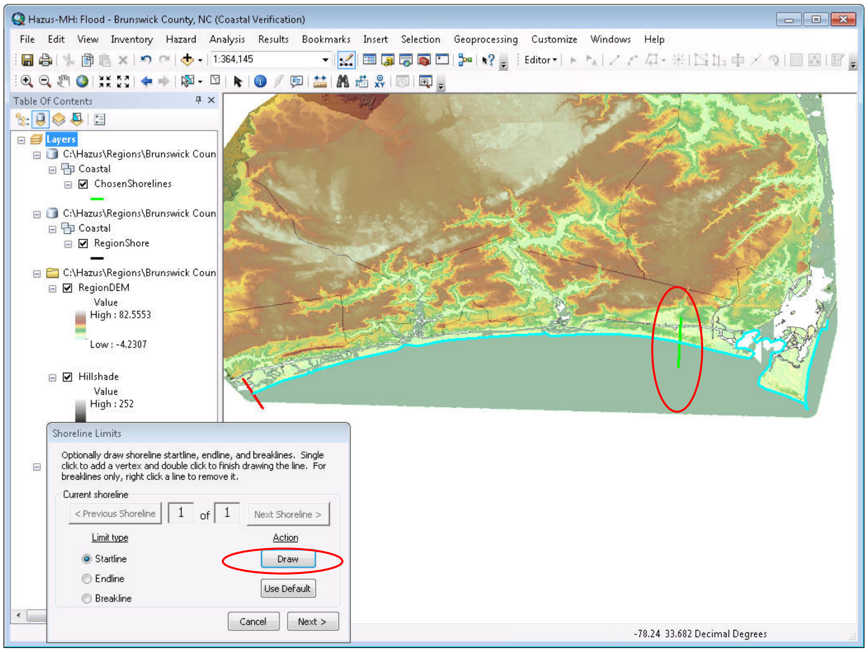


Figure A.50 Revised Shoreline Start

Ensure that the radio button **Endline** is selected and click on the **Draw** button (circled). Follow the same process of starting the line inland of the shoreline and extending the line into the ocean (circled) completing the process by double clicking on the mouse. The results should be similar to that seen in Figure A.51 below.

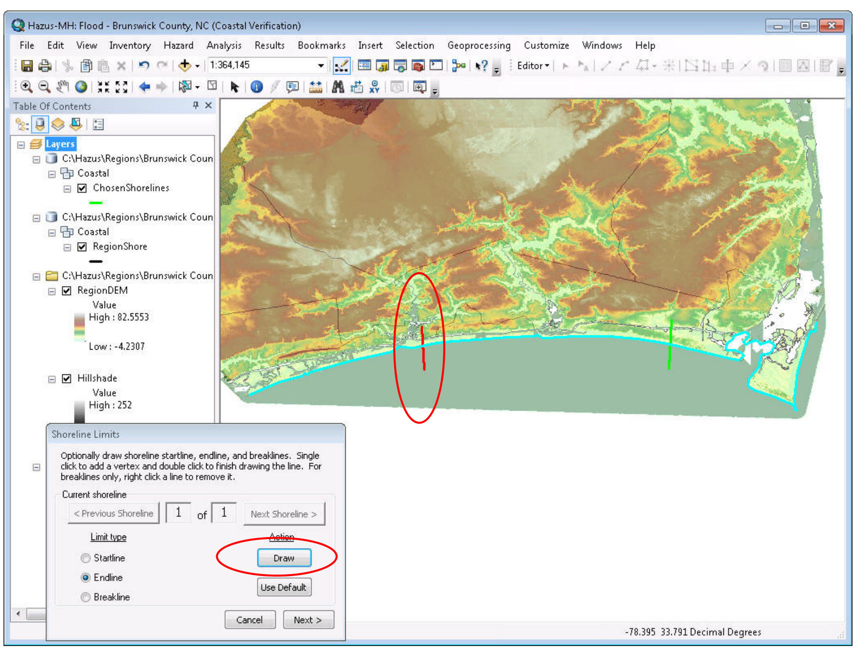


Figure A.51 Revised Shoreline End

To add another shore segment, ensure that the radio button **Breakline** is selected and click on the **Draw** button. Follow the same process of starting the line inland of the shoreline and extending the line into the ocean (circled), completing the process by double clicking on the mouse. The results should be similar to that shown in Figure A.52 below.

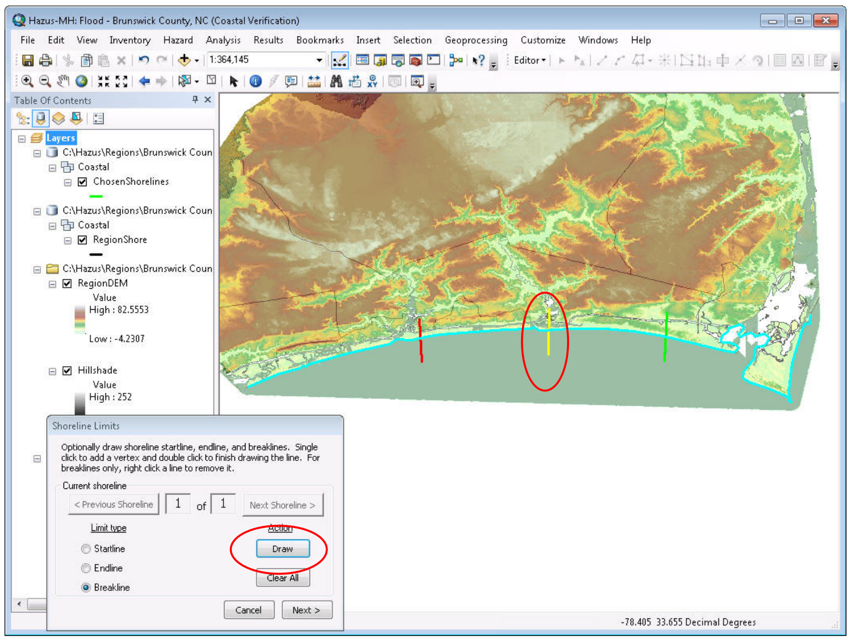


Figure A.52 Added Shoreline Segment (Breakline)

Selecting **<Next>** on the Shoreline Limits dialog (circled above) opens the next step in the process where the user is required to provide some basic shoreline characterization that defines the internal models that will be run during the hazard development process.

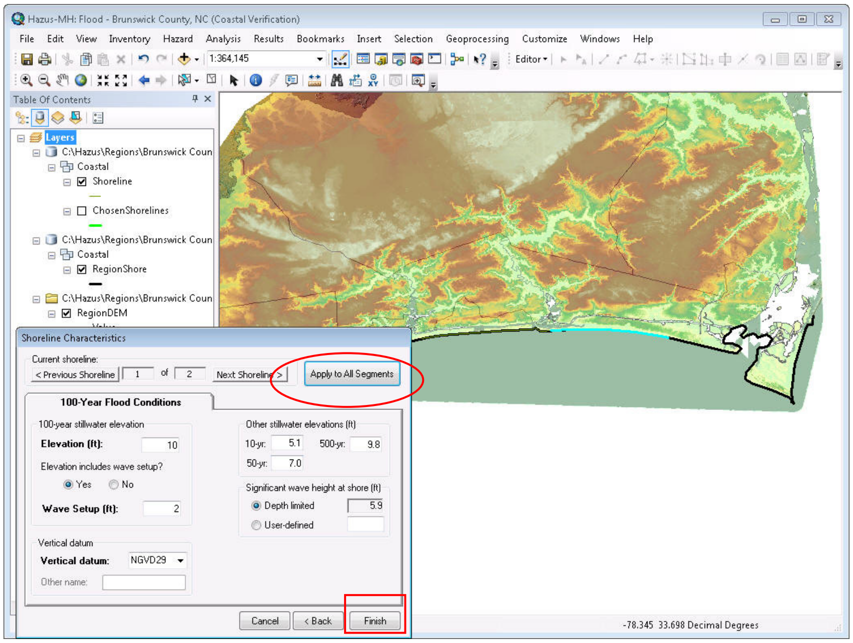


Figure A.53 Shoreline Segment Characterization 100-Year Flood Conditions Tab

For this example, please enter a 100-year Stillwater elevation of 10ft (Note: this is an approximate number picked for simplicity, normally user should check FIS), click “Yes” to Elevation includes wave setup, set the wave setup to 2ft (arbitrary number for the sake of this example) and remember to set the Vertical datum to NAVD88 to match the DEM input earlier. Normally, the user may perform this process for each shoreline segment, 2 segments in this case. For validation purposes, please use the **Apply to All Segments** Button (circled). And click on the **Finish** button (rectangle). This completes the shoreline characterization.

A.4.15 Delineate Floodplain - Coastal

From the menu *Hazard\Coastal\Delineate Floodplain*, the dialog seen in Figure A.54 should appear. In this dialog, select the Single Return Period option in the combo box and enter 500 in the editable field for shoreline segment 1. The second shoreline segment will automatically be filled since shorelines cannot have different return intervals.

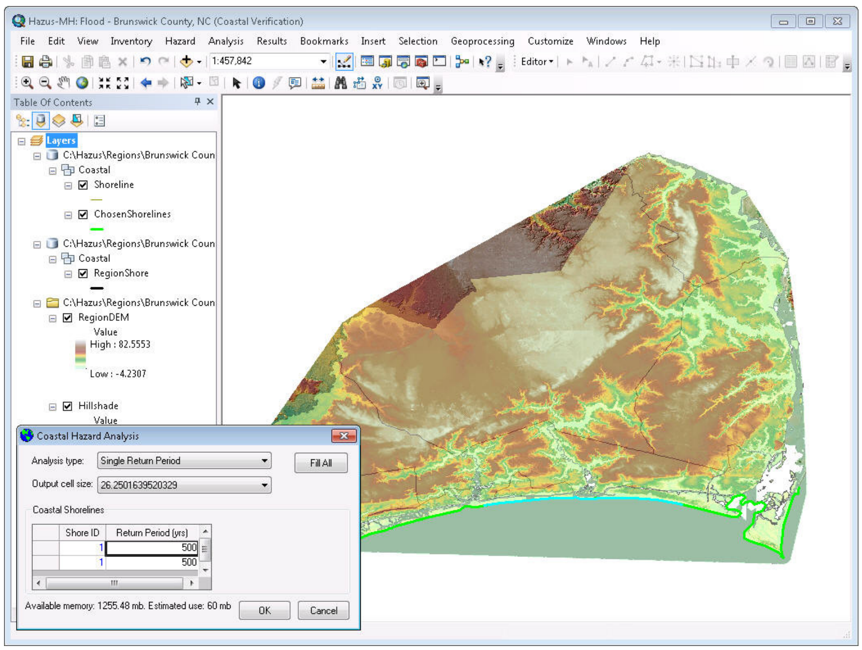


Figure A.54 Compute Flood Hazard – Coastal Hazard

Once you have set the return period, click on **OK** to start the coastal hazard processing. This process may take about an hour.

Upon completion, the coastal flood hazard depth grid and the floodplain polygon should be added to the table of contents and appears as seen in Figure A.55.

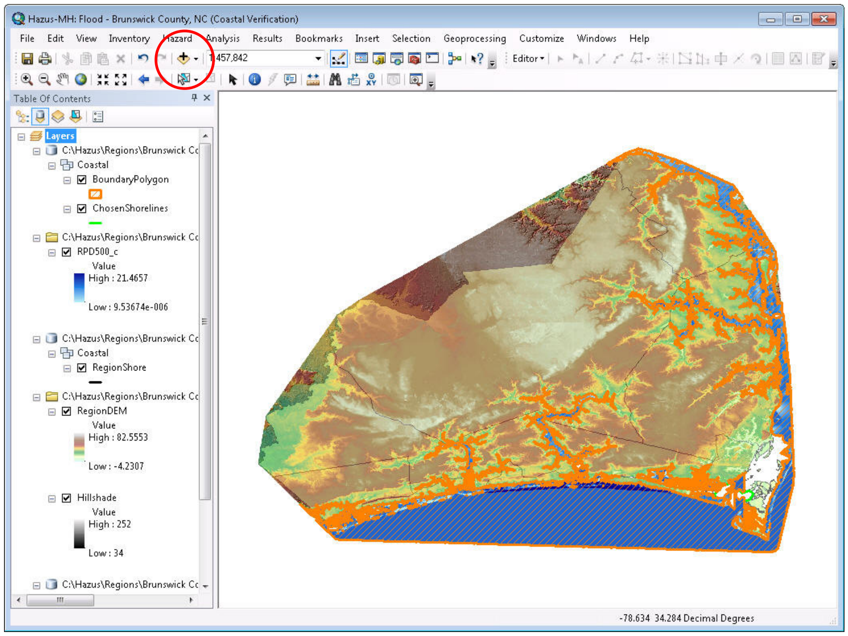
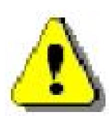


Figure A.55 The Completed Coastal Flood Hazard



Note: If the user removes the depth grid and/or floodplain polygon layers, the user can add them back manually.

Click on the **Add Data** button (circled above). Navigate to the scenario folder. Browse through the Coastal folder, double-click on CaseOutput.mdb, double-click on Coastal, click on BoundaryRP500, and click on the **Add** button (circled in Figure A.56). The following images will walk the user through the process.

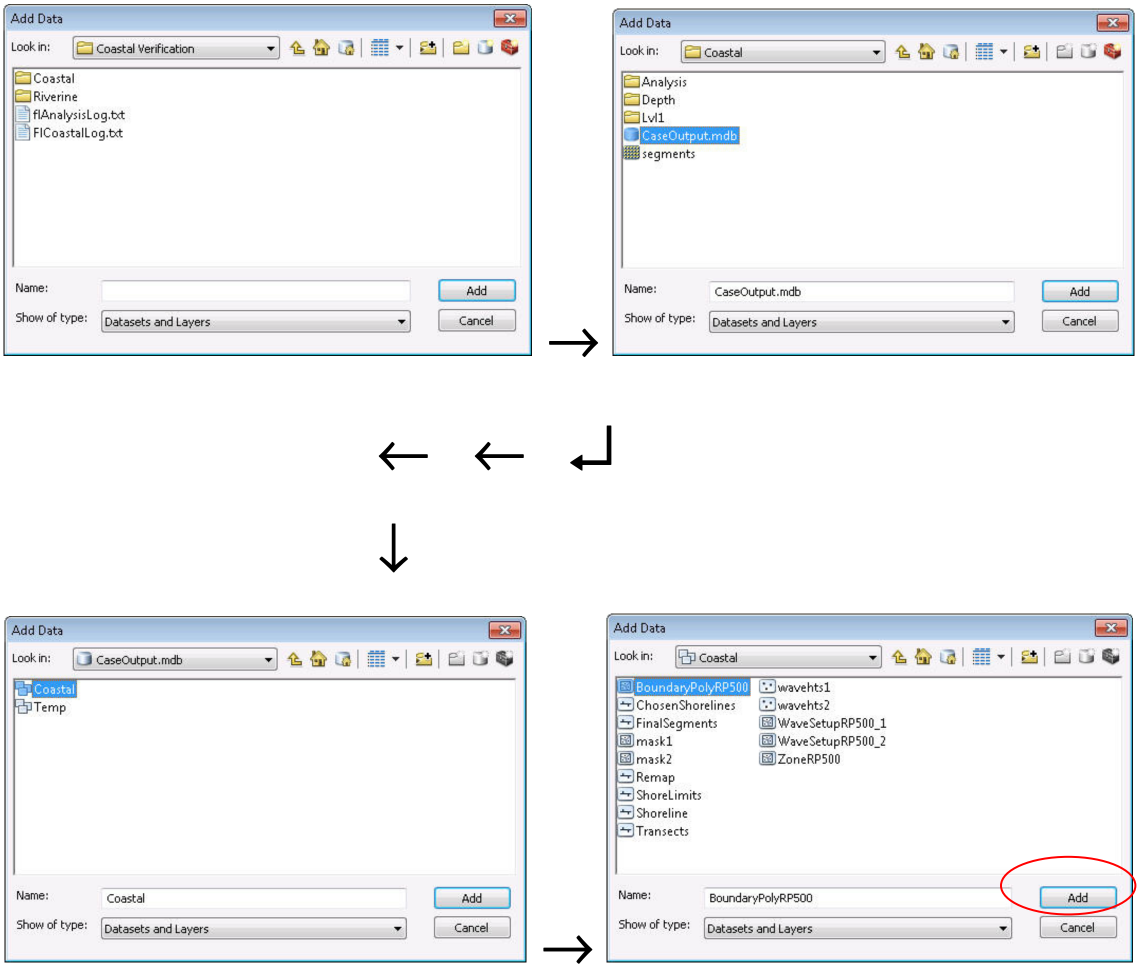


Figure A.56 Browsing for the Floodplain Boundary within the Scenario Folder

Add the flood depth grid to the table of contents by clicking on **Add** button in the dialog (circled in Figure A.55). In the scenario folder, double-click on the Coastal folder, double-click on the Depth folder, click on rpd500, and click on the **Add** button (circled below). The flood depth grid can be found within Depth folder seen below:

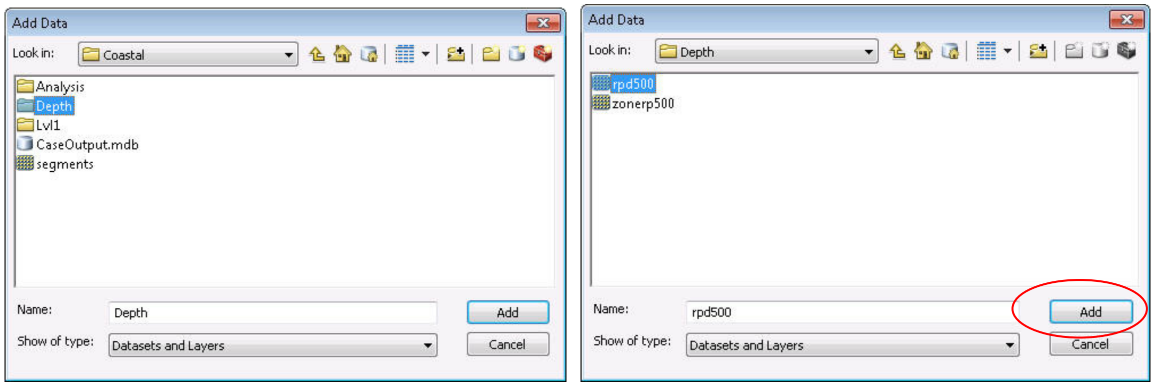


Figure A.57 Browsing for the Flood Depth Grid within the Scenario Folder

The flood depth grid is labeled by the return period of our analysis (rpd500). Adding these layers will be performed automatically in the final release of the Flood Model.

This completes the development of the Coastal Flood Hazard.

A.4.16 Analysis Verification

These steps will demonstrate that a flood scenario that has a calculated hazard can have an analysis run against it.

A.4.17 Damage Function Check

Select the *Analysis\Damage Functions\Buildings* menu item and ensure this dialog shows. To view the Coastal damage functions, change the Hazard Type to Coastal A-zone or Coastal V-zone. In both cases, the functionality described below is consistent between the dialogs.

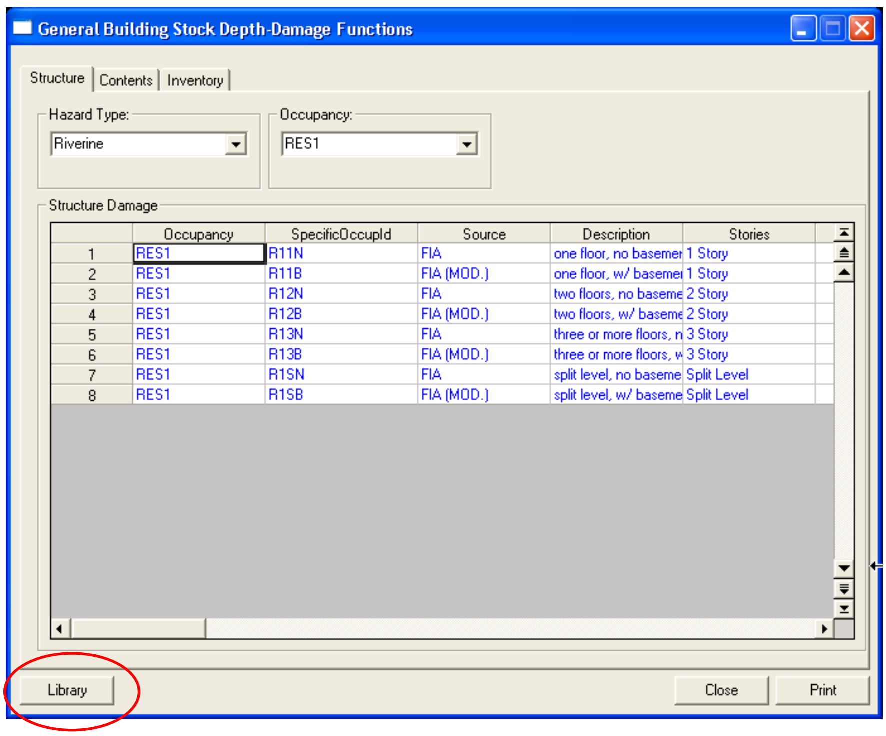


Figure A.58 General Building Stock Depth Damage Function Dialog

A.4.18 Damage Library Check

Click the **Library** button (circled in Figure A.58) and ensure this dialog shows. Close the dialog when finished. Click **Close** to close the Damage dialog too.

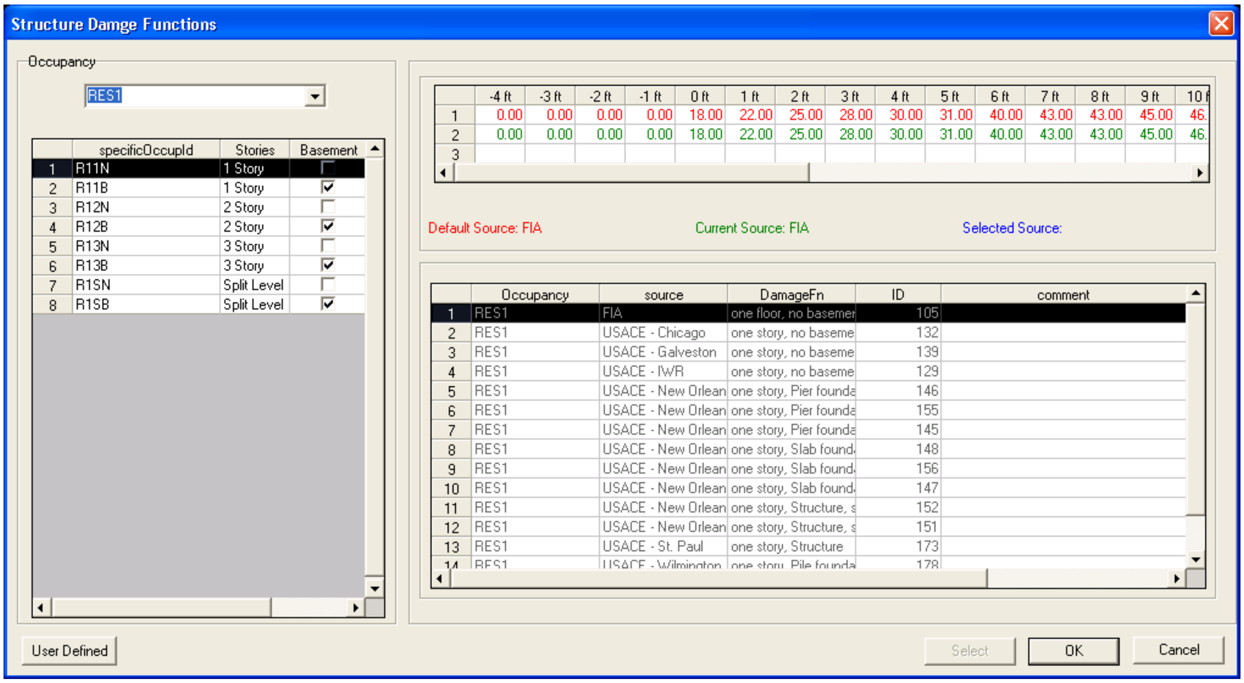


Figure A.59 General Building Stock Depth Damage Function Library

A.4.19 Run Analysis

Select the *Analysis\Run* menu item and ensure this dialog shows. Check both the General Building Stock and Essential facilities to expand the tree and select the following analyses as shown in Figure A.60.

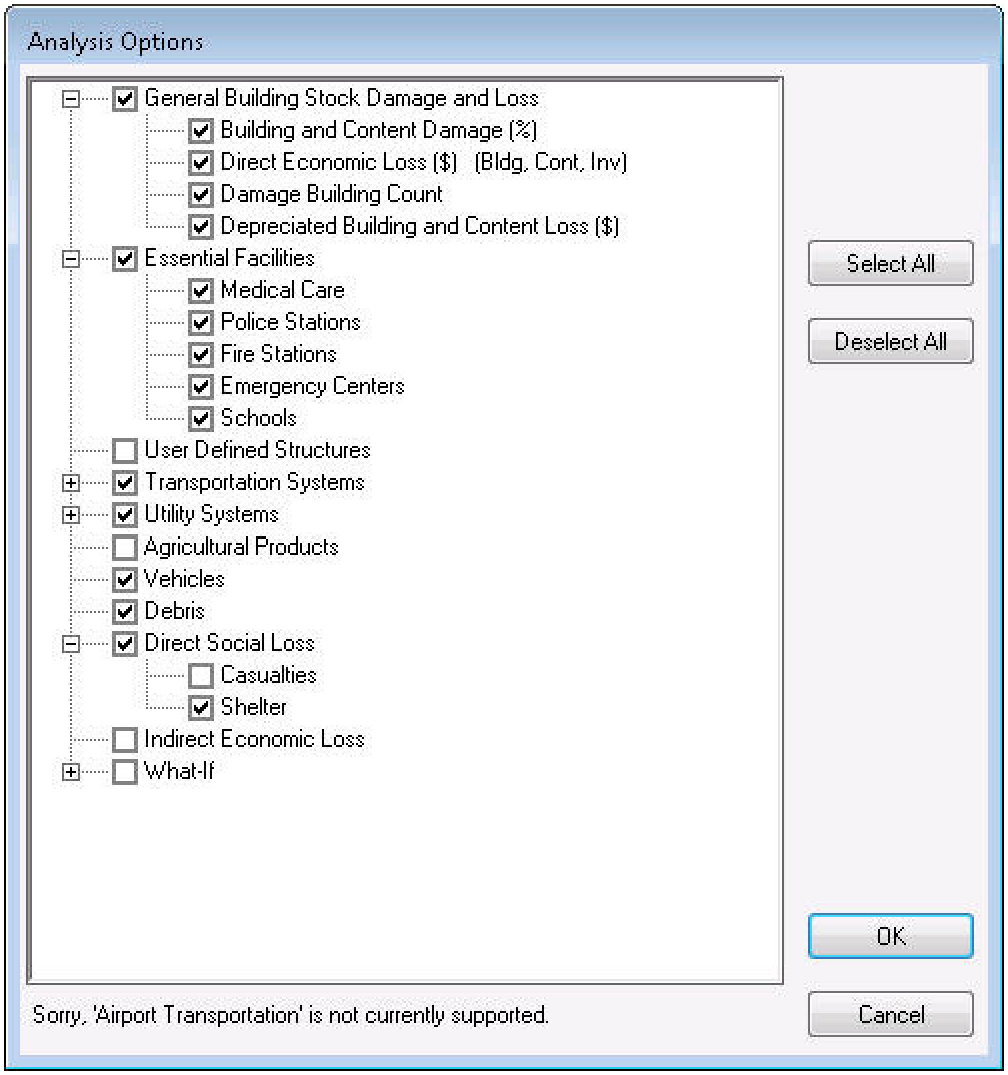


Figure A.60 Analysis Options Dialog with Validation Selections

Click **OK** and the analysis should commence.

A.4.20 Results Verification

These steps will demonstrate that a flood scenario that has been analyzed can show both browser based results and Crystal Summary reports.

A.4.21 Select the Results to View

Select the **Results\View Current Scenario Results By** menu item and ensure this dialog shows.

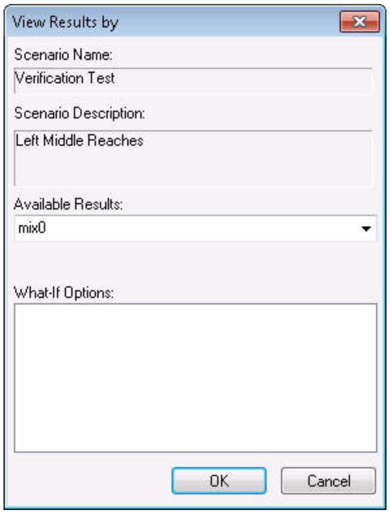


Figure A.61 View Results by dialog (Riverine)

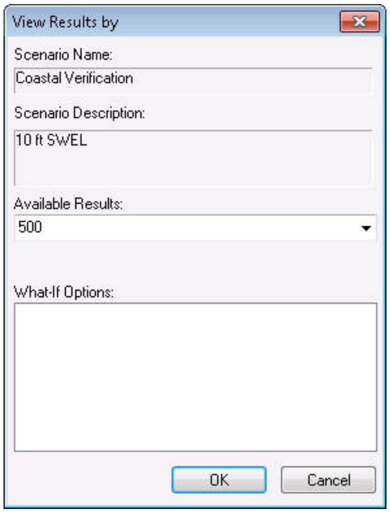


Figure A.62 View Results by Dialog (Coastal)

Use the combo box to select the return period of interest. We will assume you accept the default in the remaining screen shots. Click **OK** to close the dialog.

A.4.22 Show the Results for Schools

Select the *Results\Essential Facilities* menu item and ensure this dialog shows. Note that in many cases, essential facilities do not fall within the floodplain. If the dialog appears to have no data (as shown below) the user may want to return to the *Inventory menu\Essential Facilities* submenu and press the map button to view the locations of the essential facilities of concern. Click **Close** to close the dialog.

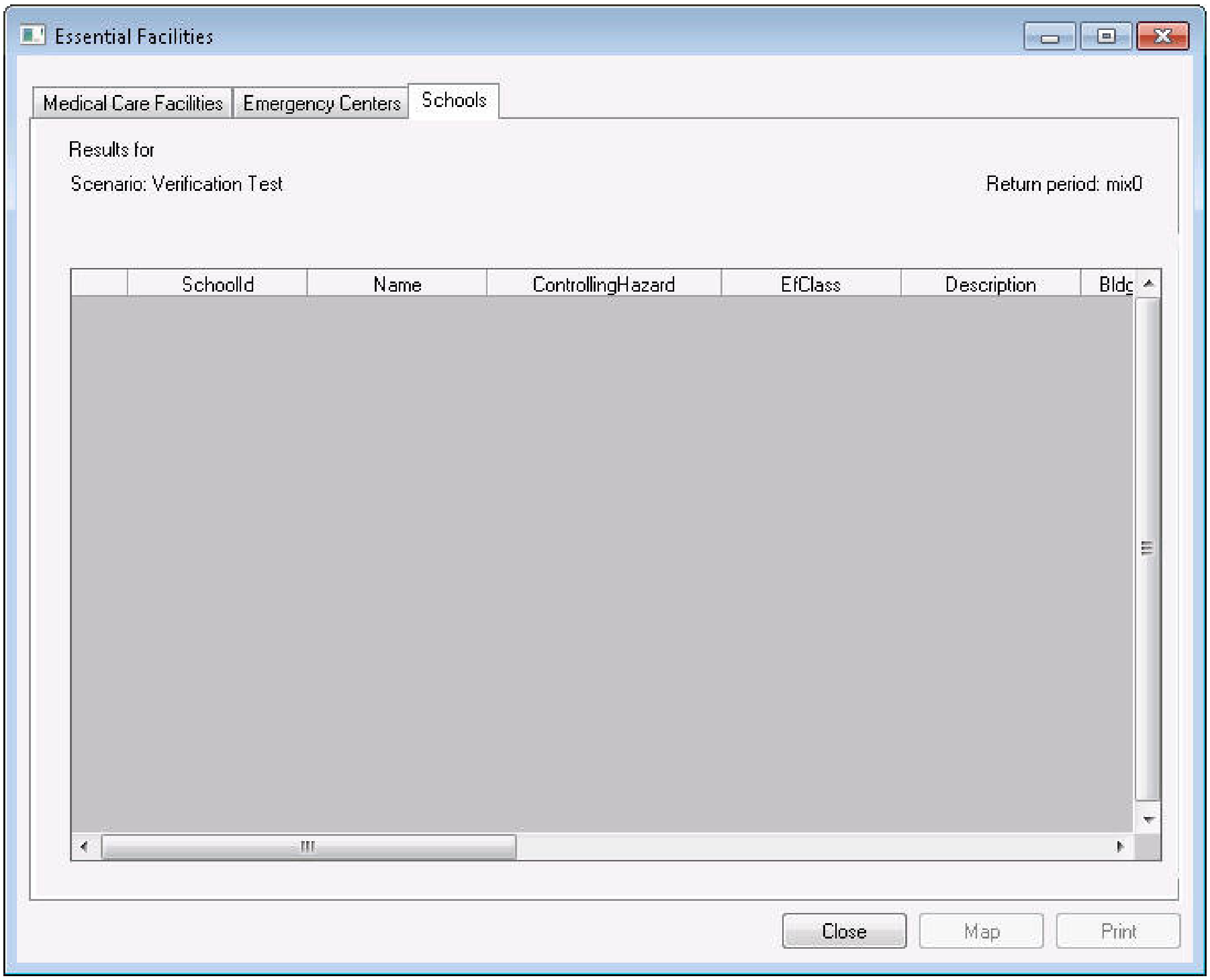


Figure A.63 Essential Facilities Results Dialog

A.4.23 Show the Summary Reports

Select the *Results\Summary Reports* menu item and ensure this dialog shows.

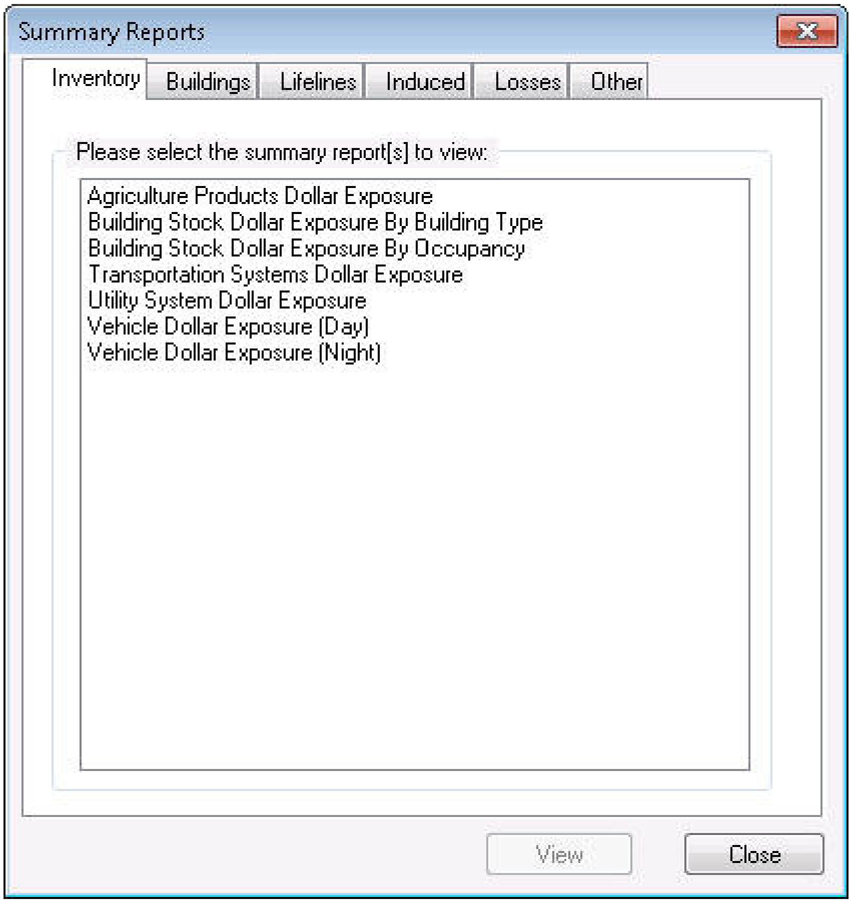


Figure A.64 Summary Reports Dialog

Click on the Building tab and select the top row as below:

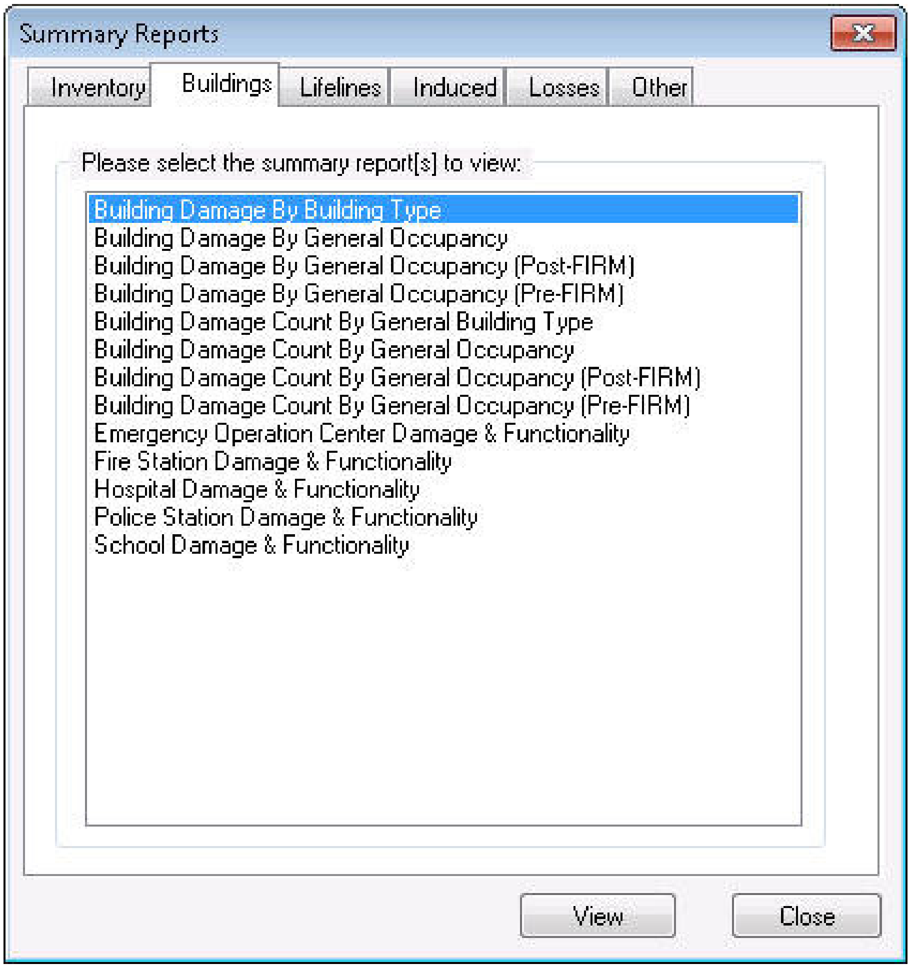
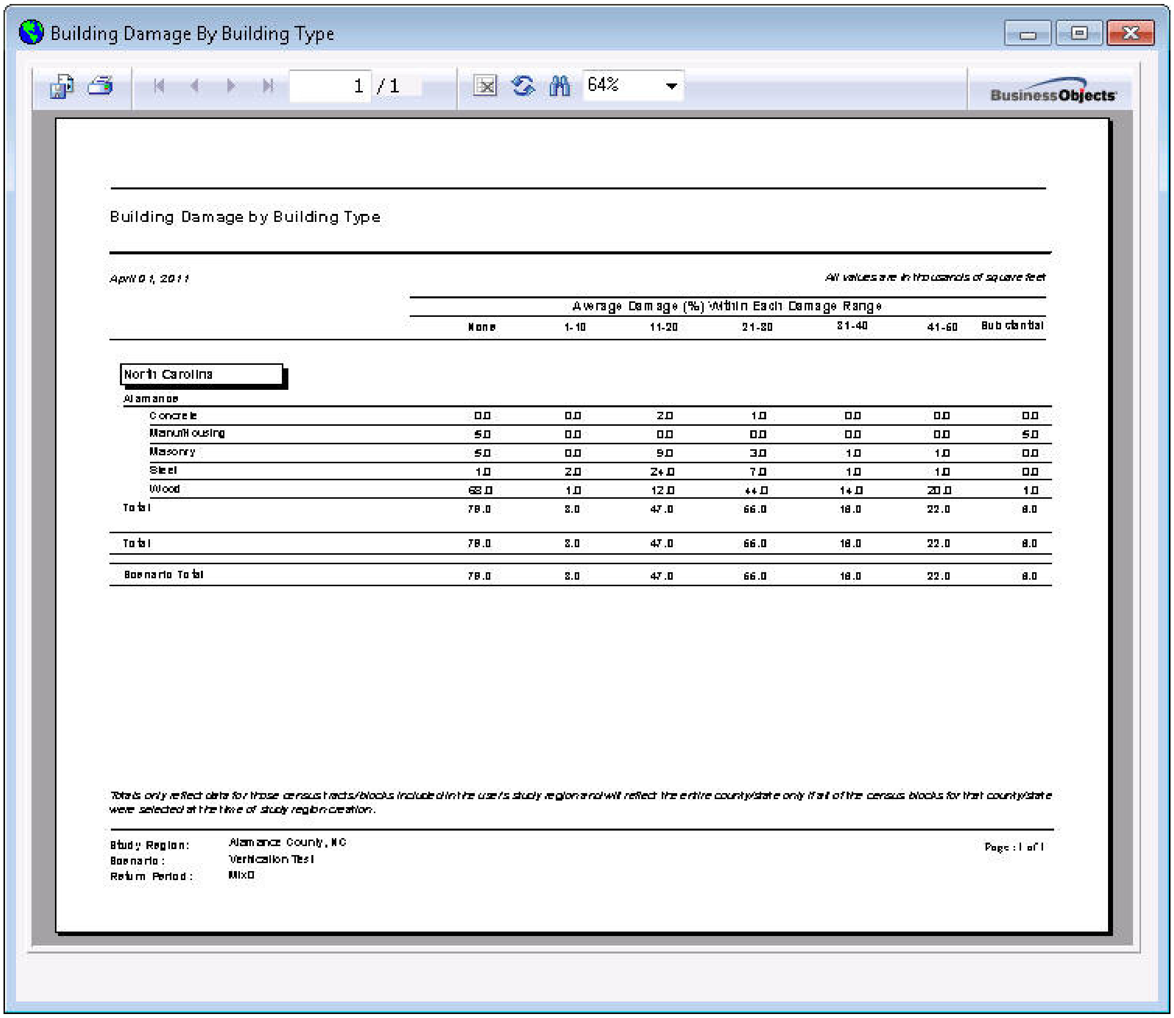


Figure A.65 Summary Reports Dialog, Buildings Tab

Click **View** and the following Crystal report should appear.



Building Damage By Building Type

Building Damage by Building Type

April 01, 2011 *All values are in thousands of square feet*

	Average Damage (%) Within Each Damage Range						
	None	1-10	11-20	21-30	31-40	41-50	Substantial
North Carolina							
Alamance							
Concrete	0.0	0.0	2.0	1.0	0.0	0.0	0.0
ManufHousing	5.0	0.0	0.0	0.0	0.0	0.0	5.0
Masonry	5.0	0.0	9.0	3.0	1.0	1.0	0.0
Steel	1.0	2.0	24.0	7.0	1.0	1.0	0.0
Wood	63.0	1.0	12.0	44.0	14.0	20.0	1.0
Total	78.0	3.0	47.0	66.0	18.0	22.0	8.0
Total	78.0	3.0	47.0	66.0	18.0	22.0	8.0
Scenario Total	78.0	3.0	47.0	66.0	18.0	22.0	8.0

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: Alamance County, NC
Scenario: Verification Test
Return Period: Mix0

Page : 1 of 1

Figure A.66 Sample Building Damage by Building Type Summary Report

A.4.24 Final Verification

This concludes the installation verification process. Close all dialogs and print windows that may be open and close ArcMap. You should get a final message similar to this:

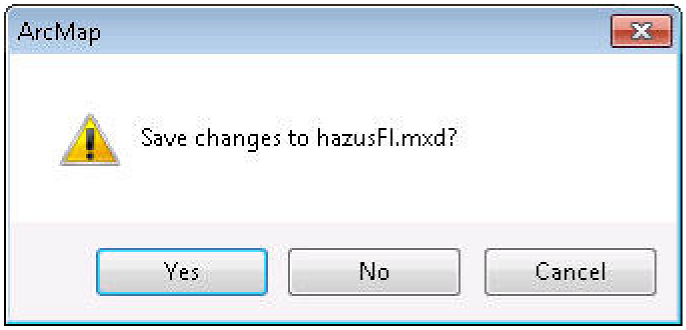


Figure A.67 Save HAZUS Flood MXD Document

This allows the user to save the settings (table of contents, etc) currently active in the map document. The user can chose to save these or rely on the model to reopen the layers when opening a scenario when needed. In this case, select **No**. Your ArcMap session will conclude and you can then re-open **Hazus** and develop your own study regions.

A.4 Freeing Memory Using SQL Server Manager

SQL Server can often lock memory as a working set. Because memory is locked, **Hazus** or other applications might receive out of memory errors or run slower. To work around this problem, restart the SQL Server service as follows:

1. Restart your computer by clicking **Start,** and then click **Shut Down.** In the "**What do you want the computer to do?"** list, click **Restart.** NOTE: Restarting will close all open applications, so be sure to save your work before choosing to re-start.

2. Restart SQL Server using the SQL Service Manager. Use the following process to open SQL Server Service Manager (SQL SSM) and restart the service:

   a. Close **Hazus** and related applications, if they are running.

   b. Open a Command window (Start | Run | Cmd)

   c. Type NET STOP MSSQL$HAZUSPLUSSRVR and hit Enter. You should see a message about the service stopped successfully.

   d. Type NET START MSSQL$HAZUSPLUSSRVR and hit Enter. You should see a message about the service started successfully.

   e. Close the Command window by typing Exit.

A.4.1 Increasing Virtual Memory to Run Large Study Regions

An "out of memory" error might occur when running a flood analysis for a large study region. This occurs if the current page file size is not enough to carry out updates to the SQL Server database. To work around this problem increase the page file size. See page xi for instructions in Windows XP.

A.5 Setting the Hazus-MH Default Data On The Local Hard Drive

The following procedure was developed to allow the user to improve the study region processing time by taking the data off the DVD, where DVD read time may negatively impact the study region processing time, and loading the data onto a local hard drive or network drive.

To set up this effort, please create a folder on the hard drive of the target computer. It is suggested that you use a name that can be quickly recognized such as Data Inventory under the HAZUS-MH folder on the C drive (as suggested during installation). Copy the syBoundary.mdb from the Application DVD under the “prereqs” folder to the root of this directory. Then copy the state(s) of interest into the directory (the state files are executables that need to be run after they are copied) from the Data DVD. Figure A.68 shows the arrangement currently used by ABS Consulting. In Figure A.68, please note the location of syBoundary.mdb in relation to the state data folder.

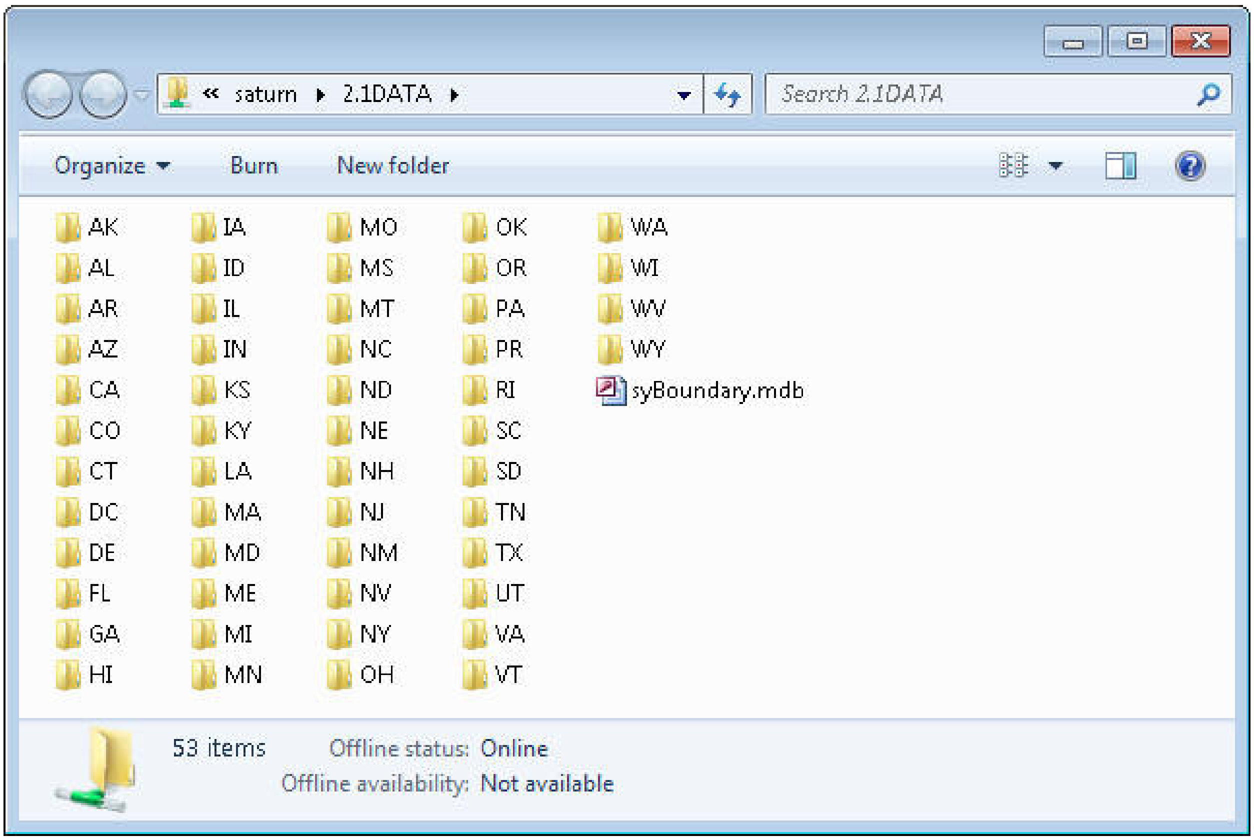


Figure A.68 Suggested Set-up for DVD Data on a Hard Drive

Once the DVD data is located onto the hard drive (and this can be a network drive as ABS Consulting has done in Figure A.68 above) you need to modify the registry to point to the file. This is easily accomplished through the use of regedit. To launch regedit go the Windows Start button, and type "regedit" in the search box…as seen in Figure A.69 and Figure A.70 below.

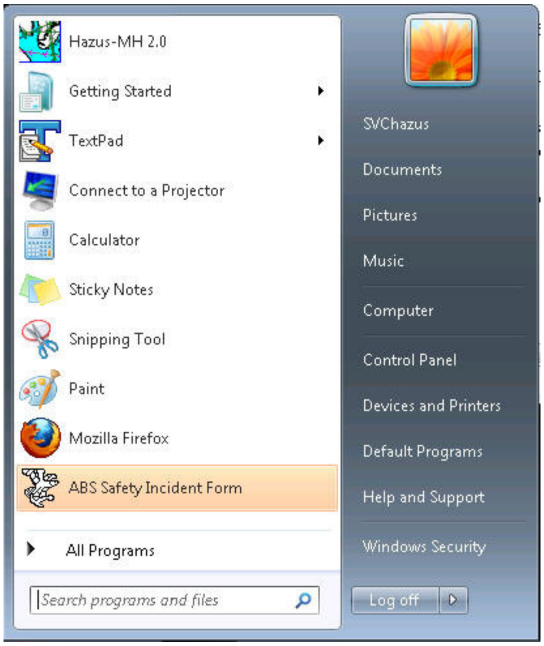


Figure A.69 Search Box Option on the Start Menu

The dialog seen if Figure A.70 should open and you will need to enter regedit as shown.

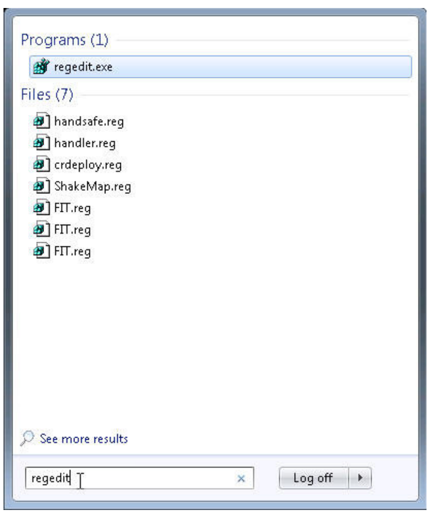


Figure A.70 "regedit" Input

Upon selection of **OK**, you should see the dialog shown in Figure A.71 below.

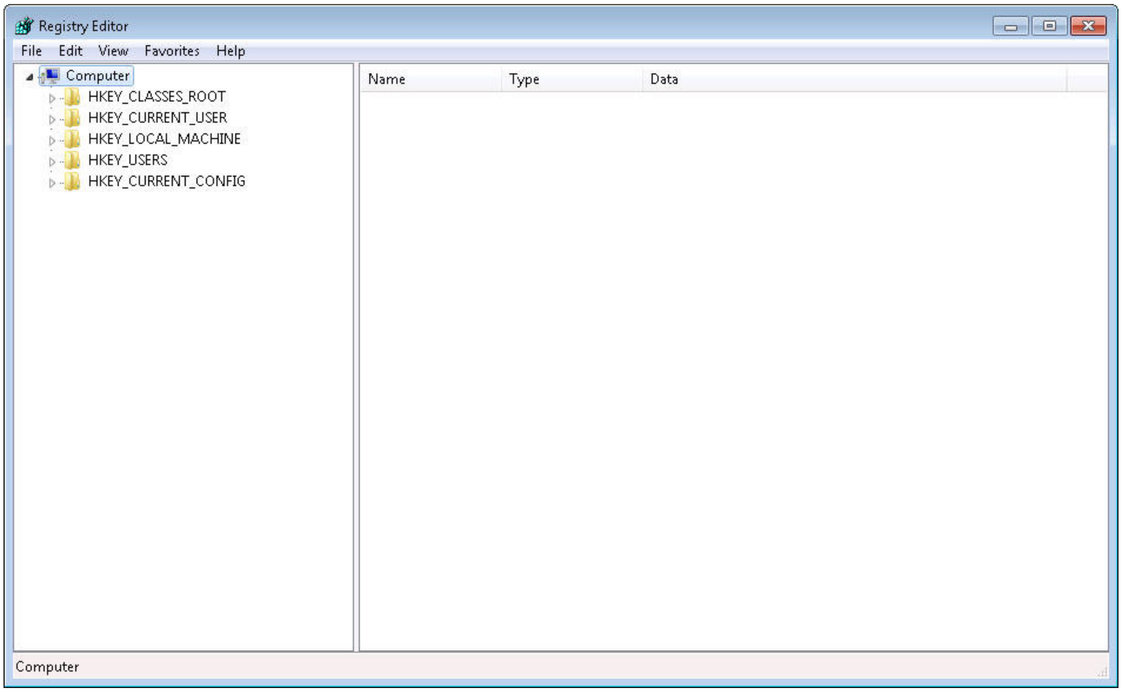


Figure A.71 The regedit Dialog

You should expand the folder HKEY_LOCAL_MACHINE. This will allow you to view another layer of folders to navigate through as seen in Figure A.72.

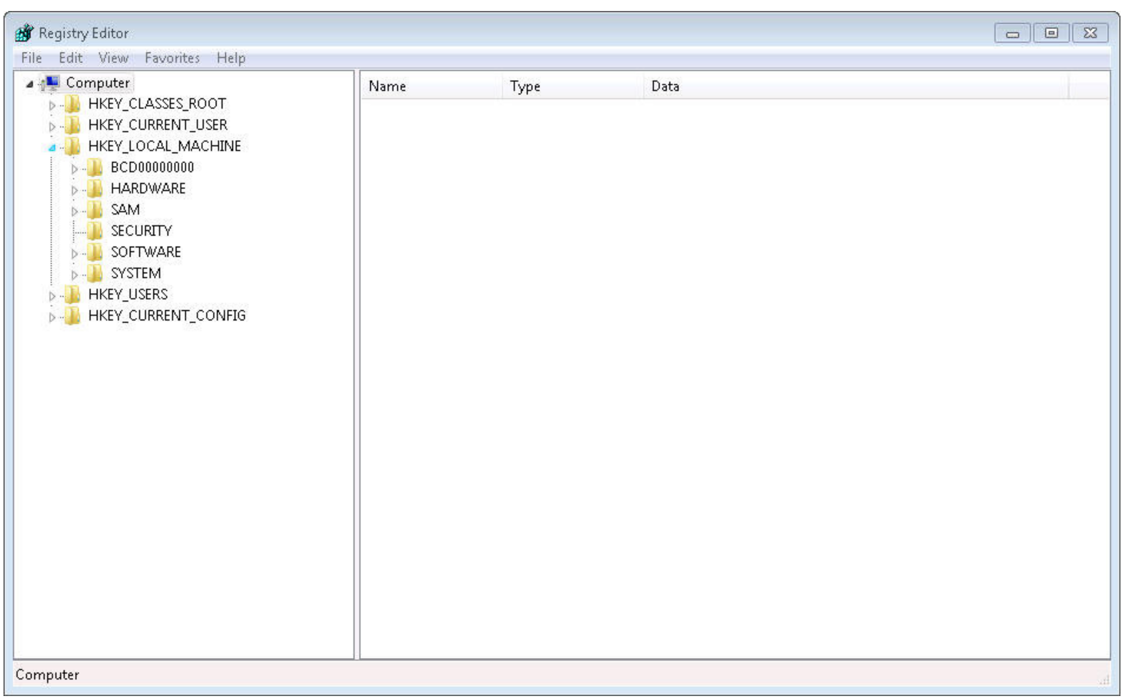


Figure A.72 Expanded View of the HKEY_LOCAL_MACHINE Folder

At this point, expand the SOFTWARE Folder to view all of the local software packages on the machine in question. Specifically you are looking for the FEMA folder seen in Figure A.73 below.

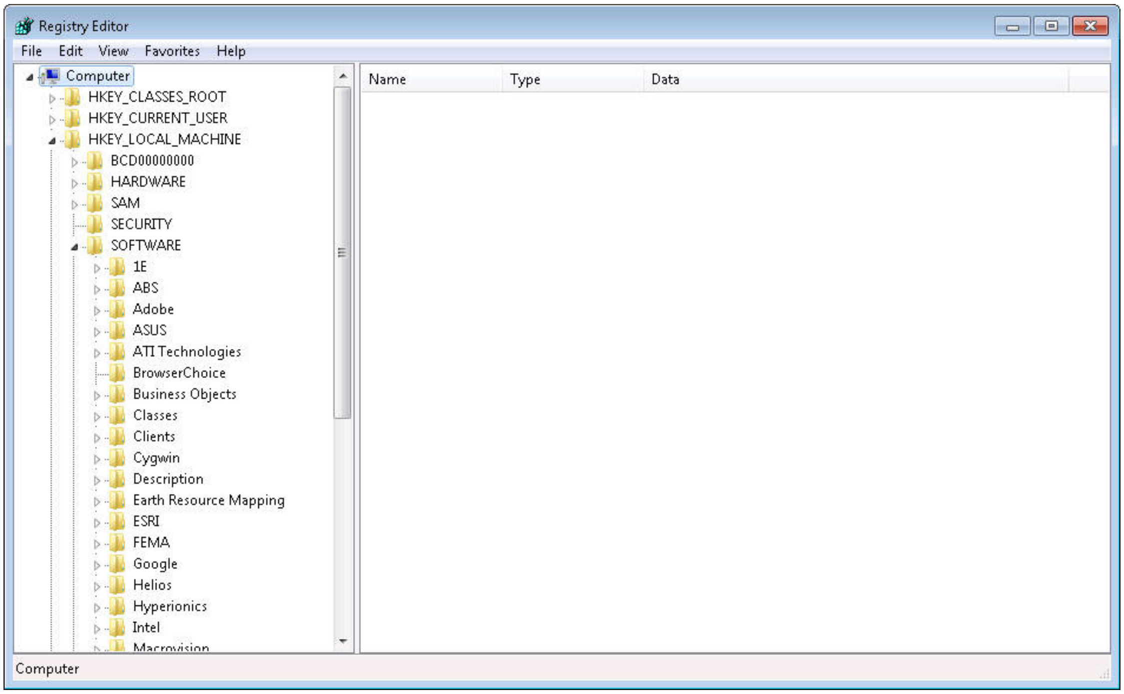


Figure A.73 Expanded View of the SOFTWARE Folder

Expanding the FEMA folder, you will see the folders seen in Figure A.74. The folder of choice is the General Folder, which contains the registries of interest.

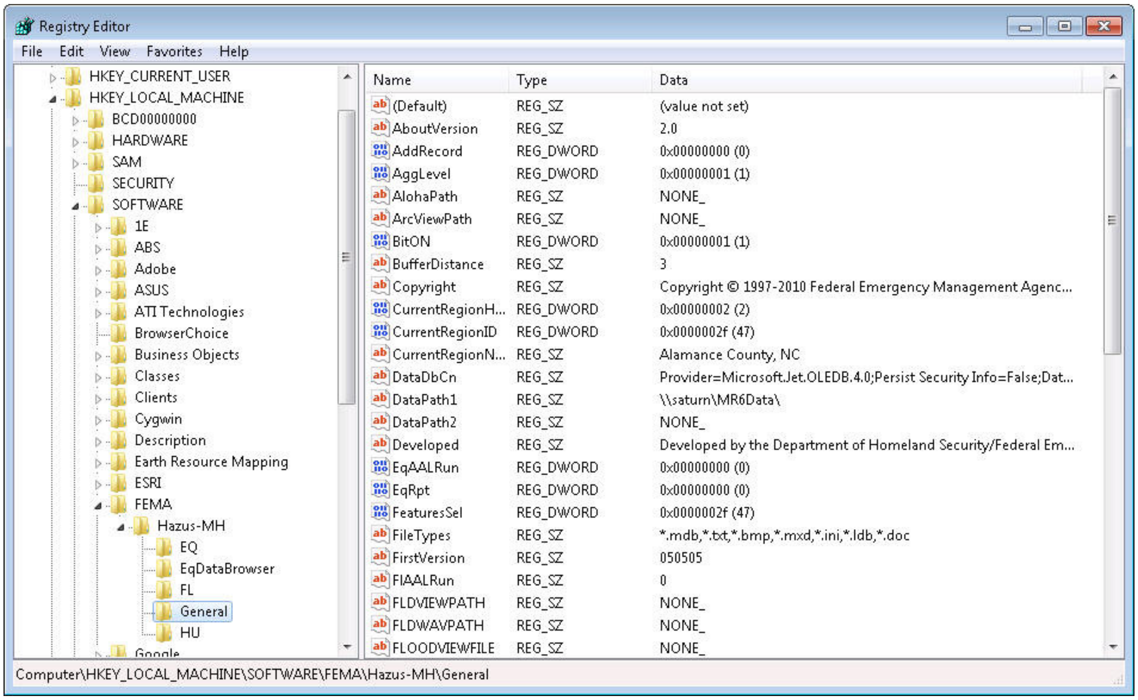


Figure A.74 Expansion of the FEMA Folder and Selection of the General Folder

As seen in Figure A.74, there is a field labeled DataPath1. This is the registry that must be changed to reflect the desired data location. Double clicking on the name DataPath1 will open the dialog seen in Figure A.75.

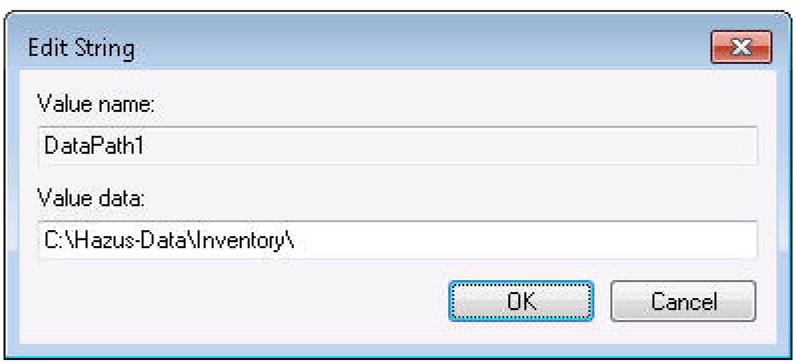


Figure A.75 Changing the DataPath1 Registry

NOTE: It is very important to place the ***trailing backslash*** on the end of the path name otherwise the program will not look inside the folder for your data.

Click **OK** then exit regedit and you are ready to use the data on the network or the hard drive of choice.

Appendix B. Flood Specific Building Classification System

For the application of the building damage functions, the Flood Model expands the 33 specific occupancies into a distribution that accounts for the number of stories and the foundation types (33 Specific Occupancies x 3 or 4 Number of Stories x 7 Foundation Types). These specific building classes used in the Flood Model are listed and briefly described in Table B.1. Each identifier begins with the 2-3 character abbreviated Specific Occupancy (i.e., C10 for COM10, R1 for RES1, R3A for RES3A, RE1 for REL1, etc.), 1 letter for number of stories (e.g., 1, or 2, for residential or L, M for non-residential), and 1 letter for basement or no basement (B, N).

To modify these distributions, the Flood Model provides the user a dialog under the Inventory menu, General Building Stock submenu called the Flood Specific Occupancy Mapping Scheme. The user can change the parameters in this dialog for use throughout the model. Default mapping schemes are provided for the states covered by the Flood Model, but these can be modified on a state, county, or census tract basis if the user has access to more accurate information in his or her geographic area of interest.

Table B.1 Specific Occupancies

Specific Occupancy	Specific Occupancy Description
RES1	Single Family Dwelling
RES2	Manufactured Home
RES3A	Multi Family Dwelling A (Duplex)
RES3B	Multi Family Dwelling B (Triplex-Quad)
RES3C	Multi Family Dwelling C (5-9 units)
RES3D	Multi Family Dwelling D (10-19 units)
RES3E	Multi Family Dwelling E (20-49 units)
RES3F	Multi Family Dwelling F (50+ units)
RES4	Temporary Lodging (e.g., Hotel)
RES5	Institutional Dormitory
RES6	Nursing Home
COM1	Retail Trade
COM2	Wholesale Trade
COM3	Personal and Repair Service
COM4	Financial/Professional/Technical Services
COM5	Banks
COM6	Hospitals
COM7	Medical Offices/Clinic
COM8	Entertainment & Recreation
COM9	Theaters
COM10	Parking

Table B.1 Specific Occupancies (Continued)

Specific Occupancy	Specific Occupancy Description
IND1	Heavy
IND2	Light
IND3	Food/Drug/Chemical
IND4	Metals/Minerals Processing
IND5	High Technology
IND6	Construction
AGR1	Agriculture
REL1	Church
GOV1	General Services
GOV2	Emergency Response
EDU1	Schools
EDU2	Colleges/Universities
Number of Stories Residential	
1 Story	
2 Story	
3+ Story	
Split Level	
Number of Stories Non-Residential	
High Rise	
Low Rise	
Mid Rise	
Single Family	
RES1 1-Story	No Basement R11N
RES1 1-Story	Basement R11B
RES1 2-Story	No Basement R12N
RES1 2-Story	Basement R12B
RES1 3-Story	No Basement R13N
RES1 3-Story	Basement R13B
RES1 Split Level	No Basement R1SN
RES1 Split Level	Basement R1SB
Manufactured Housing	
RES2 1-Story	No Basement R21N
RES2 1-Story	Basement R21B
Multi-Family	
RES3A 1-2 Story	No Basement R3A1N
RES3A 1-2 Story	Basement R3A1B
RES3A 3-4 Story	No Basement R3A3N
RES3A 3-4 Story	Basement R3A3B
RES3A 5+ Story	No Basement R3A5N
RES3A 5+ Story	Basement R3A5B

Table B.1 Specific Occupancies (Continued)

Multi-Family	
RES3B 1-2 Story	No Basement R3B1N
RES3B 1-2 Story	Basement R3B1B
RES3B 3-4 Story	No Basement R3B3N
RES3B 3-4 Story	Basement R3B3B
RES3B 5+ Story	No Basement R3B5N
RES3B 5+ Story	Basement R3B5B
RES3C 1-2 Story	No Basement R3C1N
RES3C 1-2 Story	Basement R3C1B
RES3C 3-4 Story	No Basement R3C3N
RES3C 3-4 Story	Basement R3C3B
RES3C 5+ Story	No Basement R3C5N
RES3C 5+ Story	Basement R3C5B
RES3D 1-2 Story	No Basement R3D1N
RES3D 1-2 Story	Basement R3D1B
RES3D 3-4 Story	No Basement R3D3N
RES3D 3-4 Story	Basement R3D3B
RES3D 5+ Story	No Basement R3D5N
RES3D 5+ Story	Basement R3D5B
RES3E 1-2 Story	No Basement R3E1N
RES3E 1-2 Story	Basement R3E1B
RES3E 3-4 Story	No Basement R3E3N
RES3E 3-4 Story	Basement R3E3B
RES3E 5+ Story	No Basement R3E5N
RES3E 5+ Story	Basement R3E5B
RES3F 1-2 Story	No Basement R3F1N
RES3F 1-2 Story	Basement R3F1B
RES3F 3-4 Story	No Basement R3F3N
RES3F 3-4 Story	Basement R3F3B
RES3F 5+ Story	No Basement R3F5N
RES3F 5+ Story	Basement R3F5B
Other Residential	
RES4 Low Rise	No Basement R4LN
RES4 Low Rise	Basement R4LB
RES4 Mid Rise	No Basement R4MN
RES4 Mid Rise	Basement R4MB
RES4 High Rise	No Basement R4HN
RES4 High Rise	Basement R4HB
RES5 Low Rise	No Basement R5LN
RES5 Low Rise	Basement R5LB
RES5 Mid Rise	No Basement R5MN
RES5 Mid Rise	Basement R5MB
RES5 High Rise	No Basement R5HN
RES5 High Rise	Basement R5HB

Table B.1 Specific Occupancies (Continued)

Other Residential	
RES6 Low Rise	No Basement R6LN
RES6 Low Rise	Basement R6LB
RES6 Mid Rise	No Basement R6MN
RES6 Mid Rise	Basement R6MB
RES6 High Rise	No Basement R6HN
RES6 High Rise	Basement R6HB
Non-Residential	
COM1 Low Rise	No Basement C1LN
COM1 Low Rise	Basement C1LB
COM1 Mid Rise	No Basement C1MN
COM1 Mid Rise	Basement C1MB
COM1 High Rise	No Basement C1HN
COM1 High Rise	Basement C1HB
COM2 Low Rise	No Basement C2LN
COM2 Low Rise	Basement C2LB
COM2 Mid Rise	No Basement C2MN
COM2 Mid Rise	Basement C2MB
COM2 High Rise	No Basement C2HN
COM2 High Rise	Basement C3HB
COM3 Low Rise	No Basement C3LN
COM3 Low Rise	Basement C3LB
COM3 Mid Rise	No Basement C3MN
COM3 Mid Rise	Basement C3MB
COM3 High Rise	No Basement C3HN
COM3 High Rise	Basement C3HB
COM4 Low Rise	No Basement C4LN
COM4 Low Rise	Basement C4LB
COM4 Mid Rise	No Basement C4MN
COM4 Mid Rise	Basement C4MB
COM4 High Rise	No Basement C4HN
COM4 High Rise	Basement C4HB
COM5 Low Rise	No Basement C5LN
COM5 Low Rise	Basement C5LB
COM5 Mid Rise	No Basement C5MN
COM5 Mid Rise	Basement C5MB
COM5 High Rise	No Basement C5HN
COM5 High Rise	Basement C5HB
COM6 Low Rise	No Basement C6LN
COM6 Low Rise	Basement C6LB
COM6 Mid Rise	No Basement C6MN
COM6 Mid Rise	Basement C6MB
COM6 High Rise	No Basement C6HN
COM6 High Rise	Basement C6HB

Table B.1 Specific Occupancies (Continued)

Non-Residential	
COM7 Low Rise	No Basement C7LN
COM7 Low Rise	Basement C7LB
COM7 Mid Rise	No Basement C7MN
COM7 Mid Rise	Basement C7MB
COM7 High Rise	No Basement C7HN
COM7 High Rise	Basement C7HB
COM8 Low Rise	No Basement C8LN
COM8 Low Rise	Basement C8LB
COM8 Mid Rise	No Basement C8MN
COM8 Mid Rise	Basement C8MB
COM8 High Rise	No Basement C8HN
COM8 High Rise	Basement C8HB
COM9 Low Rise	No Basement C9LN
COM9 Low Rise	Basement C9LB
COM9 Mid Rise	No Basement C9MN
COM9 Mid Rise	Basement C9MB
COM9 High Rise	No Basement C9HN
COM9 High Rise	Basement C9HB
COM10 Low Rise	No Basement C10LN
COM10 Low Rise	Basement C10LB
COM10 Mid Rise	No Basement C10MN
COM10 Mid Rise	Basement C10MB
COM10 High Rise	No Basement C10HN
COM10 High Rise	Basement C10HB
IND1 Low Rise	No Basement I1LN
IND1 Low Rise	Basement I1LB
IND1 Mid Rise	No Basement I1MN
IND1 Mid Rise	Basement I1MB
IND1 High Rise	No Basement I1HN
IND1 High Rise	Basement I1HB
IND2 Low Rise	No Basement I2LN
IND2 Low Rise	Basement I2LB
IND2 Mid Rise	No Basement I2MN
IND2 Mid Rise	Basement I2MB
IND2 High Rise	No Basement I2HN
IND2 High Rise	Basement I2HB
IND3 Low Rise	No Basement I3LN
IND3 Low Rise	Basement I3LB
IND3 Mid Rise	No Basement I3MN
IND3 Mid Rise	Basement I3MB
IND3 High Rise	No Basement I3HN
IND3 High Rise	Basement I3HB

Table B.1 Specific Occupancies (Continued)

Non-Residential	
IND4 Low Rise	No Basement I4LN
IND4 Low Rise	Basement I4LB
IND4 Mid Rise	No Basement I4MN
IND4 Mid Rise	Basement I4MB
IND4 High Rise	No Basement I4HN
IND4 High Rise	Basement I4HB
IND5 Low Rise	No Basement I5LN
IND5 Low Rise	Basement I5LB
IND5 Mid Rise	No Basement I5MN
IND5 Mid Rise	Basement I5MB
IND5 High Rise	No Basement I5HN
IND5 High Rise	Basement I5HB
IND6 Low Rise	No Basement I6LN
IND6 Low Rise	Basement I6LB
IND6 Mid Rise	No Basement I6MN
IND6 Mid Rise	Basement I6MB
IND6 High Rise	No Basement I6HN
IND6 High Rise	Basement I6HB
REL1 Low Rise	No Basement RE1LN
REL1 Low Rise	Basement RE1LB
REL1 Mid Rise	No Basement RE1MN
REL1 Mid Rise	Basement RE1MB
REL1 High Rise	No Basement RE1HN
REL1 High Rise	Basement RE1HB
AGR1 Low Rise	No Basement A1LN
AGR1 Low Rise	Basement A1LB
AGR1 Mid Rise	No Basement A1MN
AGR1 Mid Rise	Basement A1MB
AGR1 High Rise	No Basement A1HN
AGR1 High Rise	Basement A1HB
GOV1 Low Rise	No Basement G1LN
GOV1 Low Rise	Basement G1LB
GOV1 Mid Rise	No Basement G1MN
GOV1 Mid Rise	Basement G1MB
GOV1 High Rise	No Basement G1HN
GOV1 High Rise	Basement G1HB
GOV2 Low Rise	No Basement G2LN
GOV2 Low Rise	Basement G2LB
GOV2 Mid Rise	No Basement G2MN
GOV2 Mid Rise	Basement G2MB
GOV2 High Rise	No Basement G2HN
GOV2 High Rise	Basement G2HB

Table B.1 Specific Occupancies (Continued)

Non-Residential	
EDU1 Low Rise	No Basement E1LN
EDU1 Low Rise	Basement E1LB
EDU1 Mid Rise	No Basement E1MN
EDU1 Mid Rise	Basement E1MB
EDU1 High Rise	No Basement E1HN
EDU1 High Rise	Basement E1HB
EDU2 Low Rise	No Basement E2LN
EDU2 Low Rise	Basement E2LB
EDU2 Mid Rise	No Basement E2MN
EDU2 Mid Rise	Basement E2MB
EDU2 High Rise	No Basement E2HN
EDU2 High Rise	Basement E2HB

Appendix C. Using Hazus for Specific Policy Applications

Hazus can be used to aid decision makers in managing floodplains. This appendix provides six examples of using **Hazus** to estimate the impacts of various floodplain regulations.

C.1 Impacts of Construction Regulations in Floodplains

This example demonstrates how the user can determine the impacts of the creation of modification of the floodplain regulatory requirements. The example analyzes the impact of requiring that every house within the floodplain be either built or retrofitted to BFE+1 foot. The example includes a Level 1 analysis using the baseline general building stock data, and a Level 2 analysis using site-specific user-defined building inventory data.

In order to start the process, the user can run an analysis using the default mapping scheme to determine a baseline. For example, a community that is trying to identify the losses avoided from joining the NFIP program in 1980, could run the analysis with the default pre-FIRM settings and develop losses. To then determine the losses avoided, the Level 1 user should adjust the foundation heights using the *Flood Mapping Scheme* dialogs to simulate the implementation of floodplain regulations. The Flood Mapping Scheme dialogs are as appears in Figure C.1 below.

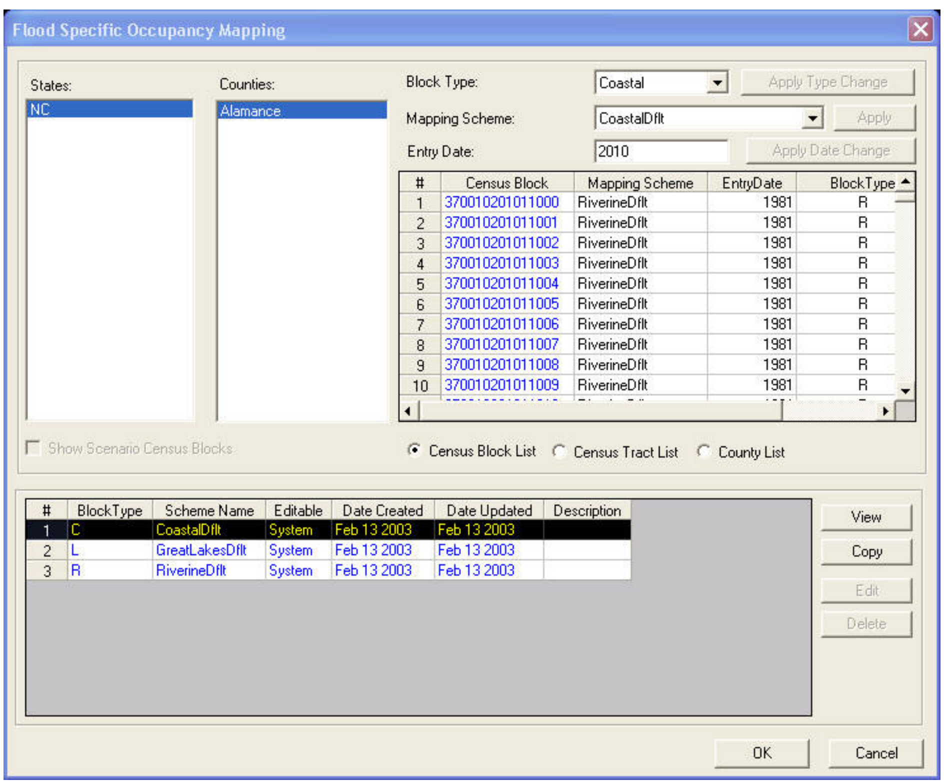


Figure C.1 Flood Specific Occupancy Mapping

Once the user defined occupancy mapping has been created, as seen in Figure C.2 below, the user should edit the foundation heights to meet the BFE to which they are interested in regulating, or are regulating to.

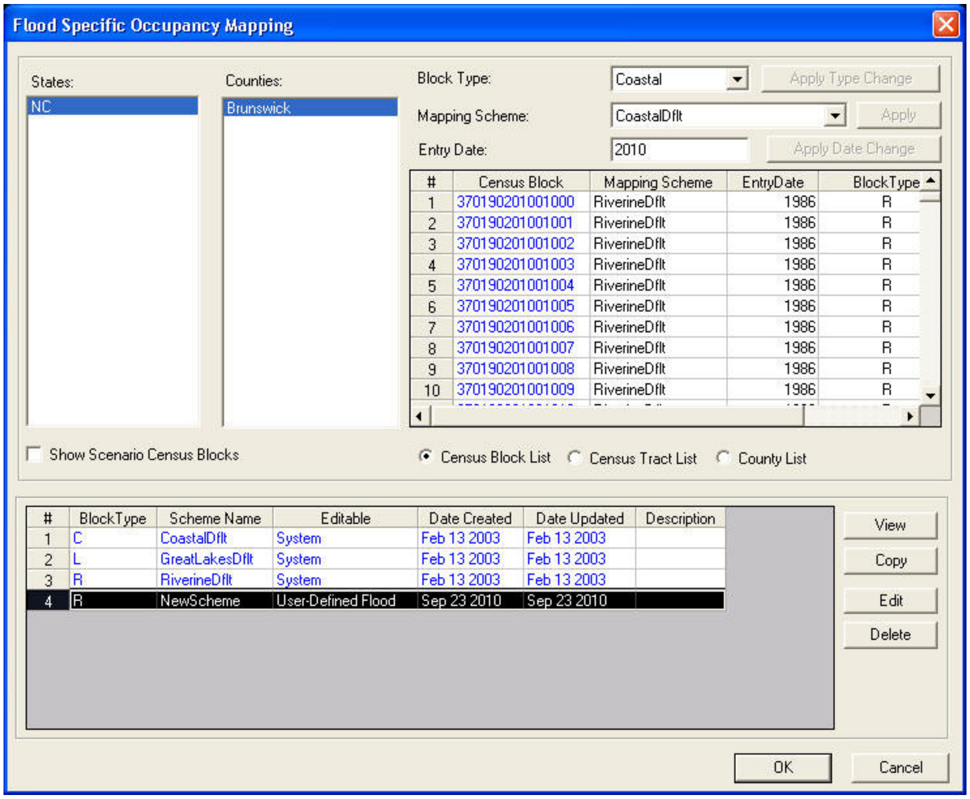


Figure C.2 Flood Specific Occupancy Mapping Characteristics User Copy

For example in Figure C.3 below the user has changed the Post-FIRM foundation heights to closely reflect a requirement to exceed a BFE of 4-feet by one foot. The user should also be aware to ensure that foundation types that become restricted because of this requirement are set to zero. In other words, the requirement to have a first floor height of at least 5-feet indicates that slab on grade foundations are not likely to be used, and other foundation types such as fill are limited in their use.

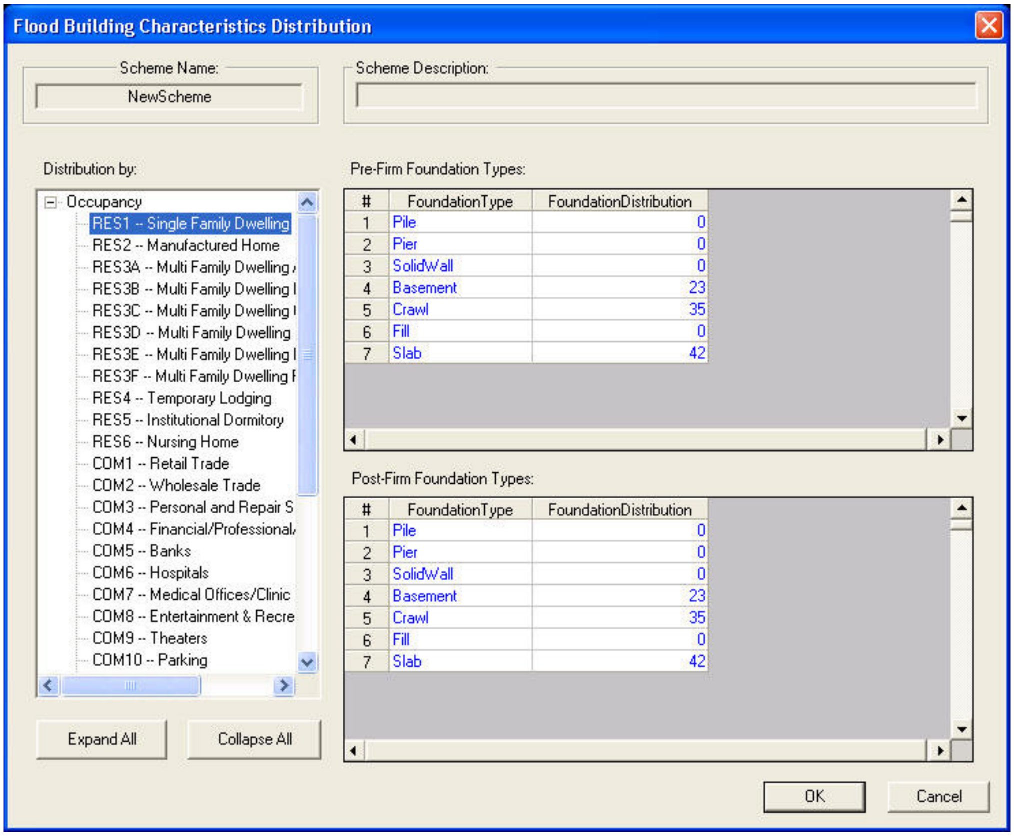


Figure C.3 Building Characteristics

The user would then create or duplicate the previous scenario (where the user calculated all Pre-FIRM foundations) and re-run the analysis using the user defined *Flood Mapping Occupancy Scheme* and compare the results. This can be done by exporting the results into Excel or MS Access.

The Level 2 user has the advantage of using the *User Defined* data with the associated detailed information such as foundation height. As with the Level 1 user, the user would start by running a baseline analysis using the data as brought into **Hazus.** This could be done using Comprehensive Data Management System (CDMS) or by importing a dataset previously formatted with the necessary information into the *User Defined* facility tables. The reader should refer to the CDMS User Manual for directions on how to use that tool. The baseline analysis will later be compared to results with using the modified inventory.

The modification is simple. The user can either perform a query in the initial database and create a duplicate database with the foundations elevated to meet the BFE+1-foot requirement. The revised data will then be analyzed and the results compared and the results can be defined as the losses avoided by the modification of the inventory.

C.4 Impacts of Remapping Studies

This example demonstrates the use of **Hazus** to analyze losses through the use of updated floodplain boundaries that result from floodplain mapping re-studies. The purpose is to demonstrate the value of re-mapping in land use planning and the resultant reduction in flood losses. The use of **Hazus** to analyze potential losses under current and future land use scenarios is a valuable tool for policy makers.

For this analysis, the user would utilize the Flood Information Tool (FIT) to prepare their new study for use in the Flood Model. If possible, the user should also prepare the previous flood study for use in the Flood Model. If the original floodplain is in hardcopy or paper format, the user will need to digitize the maps. When digitizing, the user should ensure that the floodplain boundary is saved as an ArcGIS polygon and the Base Flood Elevation (BFE) lines are digitized as ArcGIS polylines attributed with the BFE elevation.

The process would be as follows:

1. Create one study region and duplicate the region, or create two duplicate regions where the user is interested in studying the differences between the two studies.

2. Prepare the original flood study (if the data is available) or digitize the flood maps as noted above using the FIT.

3. Prepare the restudy for use in the Flood Model. If the data is available in digital format, the user should ensure that the data is registered and process it through the FIT in preparation for use in the Flood Model.

4. Once the two datasets are prepared, the user can use the *Hazard* Menu, *User Data* submenu, and *FIT* tab to point to the created FIT areas. It is suggested that the user assign one region to the original study and another region to the restudy.

5. Analyze the original flood study, either with the default **Hazus** data, or with local input data such as a county assessor data processed through Comprehensive Data Management System (CDMS). This analysis should occur in one of the study regions created in the Step 1 above. The user should make sure that the inventories analyzed within the two regions are the same in order to ensure that the results represent the difference in the studies.

6. Analyze the restudy using study region 2 created in Step 1. The inventories should be the same inventory used in Step 5 above.

7. The user can use an ODBC connection through MS Access and link to the two databases and query the two results tables to draw a direct comparison. The tables to be linked are

identified as flFRGBSEcLossTotal. The tables contain the total loss by census block for the two regions. Other tables provide the user with differences by occupancy and by building type, but the initial assessment should be based on the total difference. Other tables can be found in Appendix D.

There is no duplicate process for the Level 1 user. For assistance in processing the flood study data through the Flood Information Tool, the user should refer to the Flood Information Tool User Manual.

C.5 Impacts of Structure Acquisition and Removal

In this example the effects of the acquisition and removal of a single structure or a small number of structures on flood losses will be analyzed. The example discusses how the user prepares the flood hazard data within the FIT, utilizes Comprehensive Data Management System (CDMS) to prepare the inventory data, and imports the data into **Hazus**. The example also demonstrates estimating annualized losses in the study area within and without the targeted structures.

Buyout and acquisition programs are one of the leading approaches for reducing a community flood risk. The buyout program is most effective after a flood event, when people are more willing to relocate away from the floodplain, but communities should be mindful that a buyout program could occur at any time should the homeowner be willing to sell. The Flood Model will provide the user with an opportunity to identify those structures that are the best candidates for acquisition based on their exposure to flooding of different return periods or repetitive loss nature. For example one home that has the possibility of flooding from a 50-year flood and higher is a better candidate for acquisition than a home that is not likely to flood until the 100-year event.

While the user can use the Level 1 hazard for this analysis (i.e. using the default DEM, hydrology and hydraulics), it is not recommended that this analysis be the basis for determining the best candidates for an acquisition program unless no other studies are available. It is recommended that the user utilize the FIT tool and bring in a more accurate flood study to perform this analysis.

Recommendations for this analysis include: 1) using a high quality DEM and not the default USGS 1 arc-second data, 2) use a high quality flood study, preferably one done with the same DEM noted previously and it is preferred to use an HEC analysis, and 3) use GPS technology to identify the locations of the structures.

The user should use the Comprehensive Data Management System (CDMS) to capture the location, structure types, and occupancies of all structures of interest. In order to ensure the most accurate assessment of the losses and potential exposure to flooding, it is recommended that a Global Positioning Unit (GPS) be used to identify the location of the building within its parcel. With this location, the Flood Model can determine the depth of flooding at the location. It is also important to note the foundation type and subsequent first floor height. NOTE: CDMS has a field for first floor elevation. The user will need to convert this to a height (either using a DEM or by also capturing the height at the time of the site visit). With the buildings loaded into the

User Defined facility tables, the user should create a study region and select the FIT areas of interest.

The user then has two options that are really driven by the availability of data. Assuming that the user has been able to process their FIT analysis has three return periods and the associated discharge values, the user can compute perform an annualized loss estimate and develop their "benefit/loss" based on the annualized loss. To do this, the user must first perform the hazard assessment with enough return periods for the annualized loss. Under the *Hazard* menu, *Riverine* or *Coastal* submenu, *Delineate Floodplain* submenu, the user would select the Annualized Loss hazard assessment. Once this has been completed, the user may the select the *Annualized Loss* submenu on the *Analysis* menu. The final results present to the user the probable annualized loss that might be exceeded in a given year.

If the user does not have multiple return periods and/or discharges, it is recommended that the user perform a similar analysis for the available return period (most likely 100-year) and determine the loss for the structures. The results of this analysis will become the baseline for the analysis of the benefits of acquisition.

The user can return to the *Inventory* Menu, *User Defined Facilities* submenu, and either delete the structures targeted for the acquisition program, or reduce the square footage to 1-foot thereby leaving the facility in the database. The user can then create a new scenario and reselect the FIT areas for a repeat of the previous analysis. Comparison of the results will provide the user with the necessary information to determine if an acquisition program has a potential positive benefit.

C.6 Impacts of Regulating Stream Flow

The default hydrologic analyses apply to unregulated drainage areas. Regulation, through diversions and/or storage, changes the flood frequency curves downstream. **Hazus** provides a tool for incorporating the downstream effects of flow regulation. The tool allows users to modify the unregulated flood frequency curve at a specific location by entering one or more pairs of recurrence intervals and discharge values. **Hazus** identifies downstream reaches affected, and modifies the corresponding flood frequency curves as appropriate.

Users identify, with the mouse, the location of a regulating structure, such as a flood control reservoir. The algorithm finds the drainage area upstream of that location and defines the unregulated flood frequency curve. The curve is plotted and a table of recurrence intervals and associated discharge values is presented for the user to peruse and modify.

As the user enters and/or modifies values in the table, both the curve and the table are revised to reflect the changes. The first modification results in revising all discharge values associated with recurrence intervals (frequencies) less (greater) than the user supplied recurrence interval to be no greater than the modified discharge value. Graphically, the curve is revised by drawing a horizontal line from the modified point to the point where that line intersects the unregulated curve. The curve is not revised for recurrence intervals greater than recurrence interval of the user supplied point. Thus, graphically, a vertical line is drawn from the modified point to the point where that line intersects the unregulated curve.

For example, Figure C.4 shows the unregulated flood frequency curve associated with the most downstream reach of the North Fork of the Shenandoah River. The drainage area there is approximately 1320 square miles.

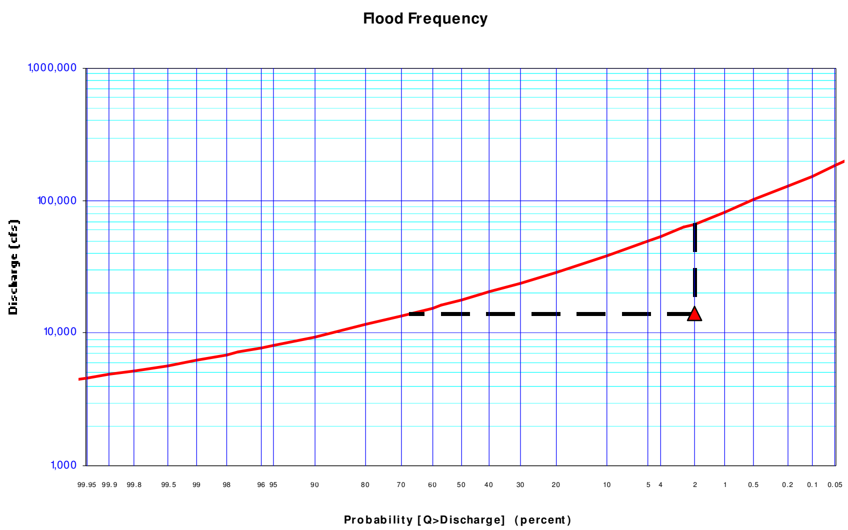


Figure C.4 Flood Frequency Curve

Consider the ramifications of placing a dam within the reach and controlling the outflow at 14,000 cubic feet per second (cfs). The dam would be large enough to control up to a 50-year flood. The regulated flood frequency curve at the outflow point is shown on Figure C.4. The revised part is shown as the dashed line. The modification was accomplished by entering a 50-year discharge value of 14,000 cfs, shown as the triangle on the curve.

Subsequent modifications are incorporated by assuming a lognormal distribution (straight line on the graph) between points. Again, the point associated with the smallest modified recurrence interval is connected to the unregulated flood frequency curve with a line of constant discharge value (horizontal line). The point associated with the greatest modified recurrence interval is connected to the unregulated curve with a line of constant frequency (vertical line).

The algorithm translates the effects downstream by assuming that the contribution to the unregulated flow at some point coming from any portion of the drainage area is proportional to the size of that portion. That is, a 132 square-mile area contributes 10 percent of the flow to our example reach. For a given recurrence interval, the reduction in flow at some point resulting from upstream regulation is determined as follows:

- The unregulated flow value is determined at the point.
- That value is multiplied by the ratio of the drainage areas of the regulated site and the point. The product is the unregulated contribution from the regulated site.

- The frequency associated with that unregulated contribution is determined.
- The regulated flow value associated with that frequency is determined and subtracted from the unregulated value.

That difference is the reduction in flow at the point resulting from the upstream regulation.

The South Fork of the Shenandoah River joins the North Fork to form the Shenandoah River at the downstream node of our example reach. The drainage area there is approximately 3000 square miles. The 100-year flood discharge is approximately 142,750 cfs. In the algorithm, the contribution from the North Fork is 62,810 cfs, a little less than the 50-year flood discharge value. The regulated flow at the potential dam site is 14,000 cfs and, therefore the reduction is 48,810 cfs. The effects of the dam downstream at the upstream node of the Shenandoah River would be to reduce the 100-year flood discharge value from 142,750 to about 93,940 cfs.

Such an analysis including the accompanying loss estimation in **Hazus** can be used to justify a more detailed investigation into regulating the flow some upstream.

C.7 Impacts of Building Levees

In general, DEMs are not reliable for identifying a continuous embankment with relatively little width. Because grid cells are connected at the corners as well as the sides, an embankment that is not a straight line, in the strictest sense, must be at least two cells wide to be treated as a barrier to flow. A tool is available in **Hazus** to add a levee alignment, attribute the levee with a level of protection and, for Level 1 analyses determine (within the limits of a level 1 analysis) the effects of a levee on flood depths within the unprotected portion of the floodplain.

In areas identified as protected by a levee, flood depths are zero for frequencies up to the recurrence interval of the level of protection provided by the levee. For recurrence intervals exceeding the level of protection, flood depths are those computed without consideration of the levee. Similarly, if the option to determine the ramifications of a levee is chosen, two sets of flood depth grids are created: one with the levee and one without the levee reflected in the DEM.

The levee option is applied by drawing a polyline with the mouse. Flood depth grids have been created for the reach and the user chooses a grid on which to draw the levee alignment. The alignment should cross the floodplain twice. The user is prompted to supply the recurrence interval, in years, corresponding to the level of protection provided by the levee.

If a flood depth grid has been created corresponding to the level of protection or if enough grids have been created to interpolate that particular grid, the floodplain associated with that grid is determined. The levee alignment and section of that floodplain between the points where the alignment crosses the floodplain are used to define a polygon. If the floodplain associated with the recurrence interval cannot be determined, the floodplain associated with the flood depth grid chosen to draw the alignment is used to define the polygon.

If the levee alignment does not cross the floodplain twice the user is notified and cautioned that the floodplain information and supplied levee alignment indicate that the levee does not provide the entered level of protection.

If flood depth grids were developed with Level 1 analyses, the user may choose to re-create the depth grids with the levee represented in the DEM. Note that because the default hydraulic analyses are performed using normal depth calculations (*i.e.*, no consideration of backwater effects), flood elevations and, consequently, flood depths and the extent of floodplains will change only at cross sections within the levied portion of the reach. The effects of the levee on upstream cross sections will not be reflected.

If the user chooses to investigate the local increases in flood depths resulting from a levee alignment, a buffer is created one cell size around the user-supplied polyline. The resulting polygon is attributed with a high elevation value and a grid is created from the polygon. Note that the grid, or levee, is everywhere at least two cells wide. That grid is merged with the DEM creating a new DEM that reflects a continuous levee. The protected area is then treated as a "pool" and, consequently not included in the water surface elevation computations. Figure C.6 shows a (buffered) levee alignment supplied by a user and upstream portion of the "without" levee flood depth grid shown in Figure C.5.

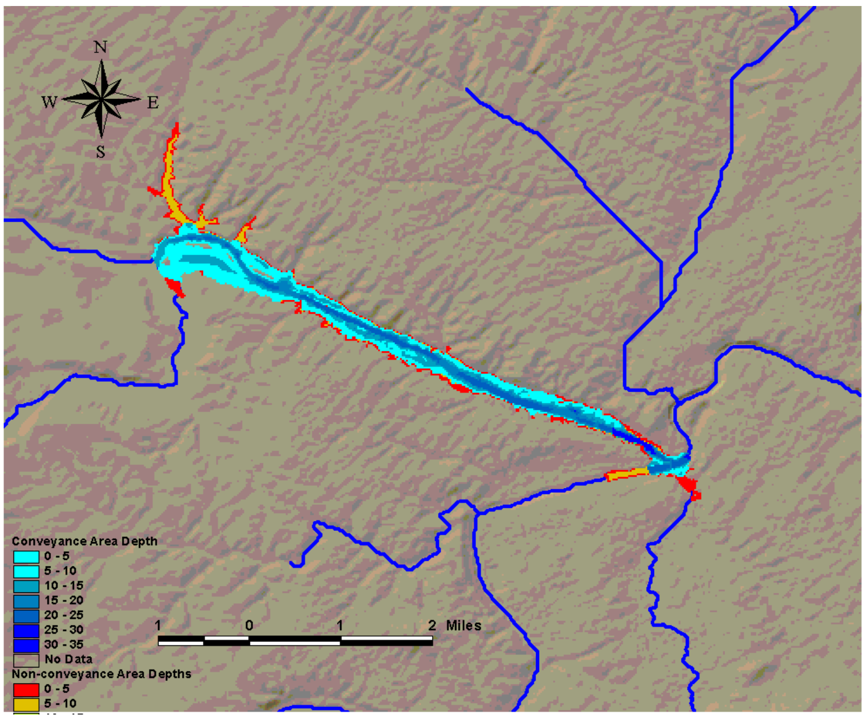


Figure C.5 Flood Depths in Non-conveyance Areas

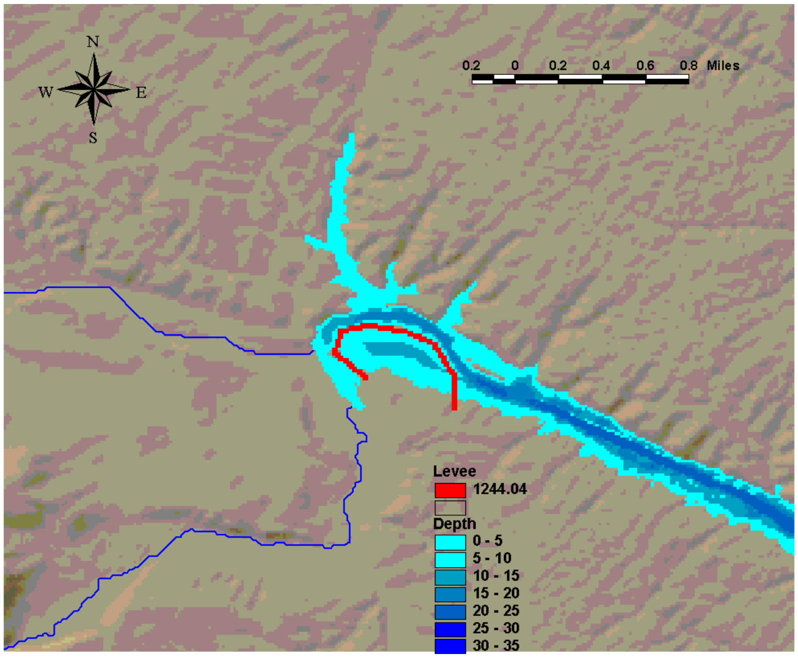


Figure C.6 User-supplied Levee Alignment

Figure C.7 shows the affects of the levee on the flood depth grid. Note the increase in the non-conveyance areas across the stream from the levee.

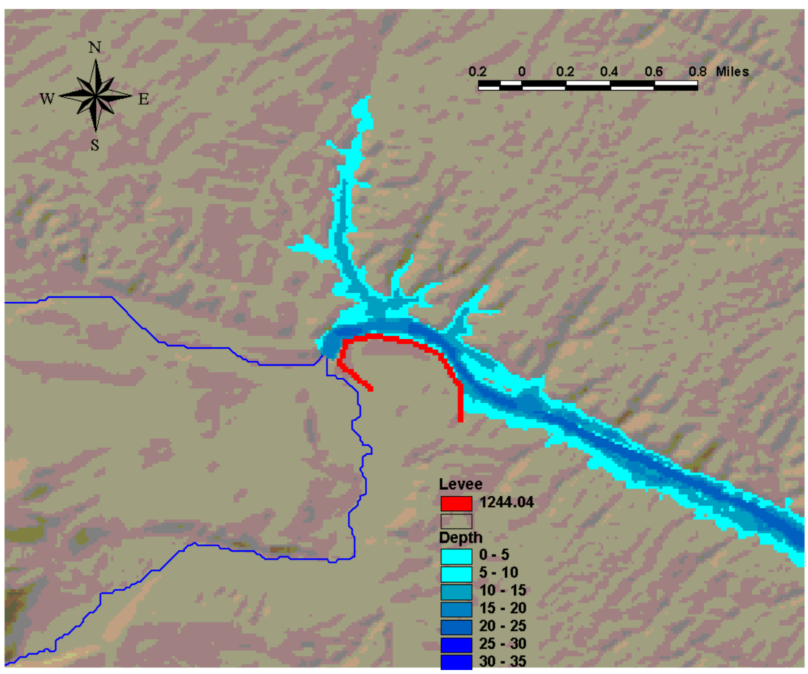


Figure C.7 Affects of Levee on Flood Depths

C.8 Impacts of Flood Warning Systems

The current methodology allows the user to estimate the potential reduction in flood losses due to flood forecasting or warning. The current methodology uses the Day Curves developed by the Chicago District of the US Army Corps of Engineers. The user should review the Flood Model User Manual to see how the dialog is used to modify the damage associated with any given flood. The user, however, should review the Day curves in the Technical Manual to estimate the amount of damage reduction that might be afforded for their community. For example, if the community has historically received only 15 minutes of flood warning, the user can view the curve and estimate the total expected damage reduction based on effective warning and effective response.

The effectiveness of the warning and the effectiveness of the response should drive the users' selection of the expected warning reduction. For example, if the user believes that they can effectively warn the population, either via radio, TV, and perhaps police/fire notification (such as reverse 911) and the user also believes the population understands the notification and effectively responds, then they should select the value provided by the Day Curve. If the user believes there are limitations to this warning and response, then they should select a lower value.

Appendix D. Flood Specific Table Data Dictionary

Table of Contents

Tables (continued)

D.1 High Level List of Flood Specific Tables

Table D.1 Table List

Name	Description
flSqFootageGBldgTypeB	Square footage by general building type by census block (thousands of square feet)
flDepExposureOccupB	Depreciated exposure by occupancy by census block ($ thousands)
flExposureOccupTotal	GBS total valuation or total exposure ($ thousands)
flDepFunction	Depreciation functions by specific occupancy
flDepExposureOccupTotal	Depreciated exposure by occupancy
flDepExposureGBldgTypeB	Depreciated exposure by general building type by census block ($ thousands)
flExposureGBldgTypeTotal	GBS total valuation or total exposure by general building type ($ thousands)
flDepExposureGBldgTypeTotal	Depreciated exposure by general building type ($ thousands)
flUserDefinedFlty	Flood specific fields for user defined facilities
flCareFlty	Flood specific fields for care facilities
flEmergencyCtr	Flood specific fields for emergency centers
flPoliceStation	Flood specific fields for police stations
flFireStation	Flood specific fields for fire stations
flSchool	Flood specific fields for schools
flHighwayBridge	Flood specific fields for highway bridges
flRailwayBridge	Flood specific fields for railway bridges
flLightRailBridge	Flood specific fields for light rail bridges
flPotableWaterFlty	Flood specific fields for potable water facilities
flPotableWaterPl	Flood specific fields for potable water pipelines (placeholder)
flWasteWaterFlty	Flood specific fields for wastewater facilities
flWasteWaterPl	Flood specific fields for wastewater pipelines (placeholder)
flOilFlty	Flood specific fields for oil facilities
flOilPl	Flood specific fields for oil pipelines (placeholder)
flNaturalGasFlty	Flood specific fields for natural gas facilities
flNaturalGasPl	Flood specific fields for natural gas pipelines (placeholder)
flElectricPowerFlty	Flood specific fields for electric power facilities
flExposureUtil	Summary table of exposure for utility systems ($

Name	Description
flSqFootageGBldgTypeB	Square footage by general building type by census block (thousands of square feet)
	thousands)
flExposureTransport	Summary table of exposure for transportation facilities ($ thousands)
flAgricultureInventory	Agriculture products inventory table
flDayVehicleInv	Daytime vehicle inventory by census block
flNightVehicleInv	Night time vehicle inventory
flBldgStructDmgFn	Building damage function (structure)
flBldgInvDmgFn	Building damage function (inventory)
flBldgContDmgFn	Building damage function (contents)
flEssntFltyContDmgFn	Essential facilities content damage function
flBridgeDmgFn	Bridge damage functions (all)
flUtilFltyDmgFn	Utility damage function
flVehDmgFn	Vehicle damage function
flRsFnEssntFlty	Essential facilities restoration functions
flRsFnGBS	General building stock restoration
flDebris	Analysis parameters for debris
flShelterParams	Analysis parameters for shelter requirements
flBldgEconParamSalesAndInv	Analysis parameters Sales and inventory
flBldgEconParamOwnerOccupied	Analysis parameters owner occupied units
flBldgEconParamRecaptureFactors	Analysis parameters direct economic recapture factors
flBldgEconParamRental	Analysis parameters building economic rental income
flBldgEconParamWageCapitalIncome	Analysis parameters building economic wage and capital income
flIELMParamsByTime	Analysis parameters for IELM by time
flIELMSectorOutput	Analysis parameters for IELM sector output
flIELMStimulus	Analysis parameters for IELM stimulus by sector
flIELMImplanData	IELM Implan table for user import
flIELMParamsByTimeOrder	IELM parameters by time order

D.2 Data Dictionary by Flood Specific Table

Table D.2 Square Footage by General Building Type by Census Block

Table flSqFootageGBldgTypeB

Name	Description	Format	Default Value
CensusBlock	Census block number	char (15)	not null
TotalSqft	Total square footage by census block	real	null (autosum)
WoodF	Total wood building square footage	real	null
SteelF	Total steel building square footage	real	null
ConcreteF	Total concrete building square footage	real	null
MasonryF	Total masonry building square footage	real	null
ManufHousingF	Total manufactured housing square footage	real	null

Table D.3 Building and Content Exposure by Occupancy by Census Block (Full Replacement and Depreciated Replacement Values)

Tables
flExposureOccupB,
flDepExposureOccupB,
flExposureContentOccupB,
flDepExposureContentOccupB,
flExposureOccupTotal, and
flDepExposureTotal

Name	Description	Format	Default Value
CensusBlock	Census block number	char(15)	not null
TotalExp	Total depreciated exposure by census block	int	null (autosum)
RESI	Total residential exposure ($ thousands)	int	null (autosum)
COMI	Total commercial ($ thousands)	int	null (autosum)
INDI	Total industrial ($ thousands)	int	null (autosum)
AGRI	Total agriculture building ($ thousands)	int	null (autosum)
RELI	Total religious ($ thousands)	int	null (autosum)
GOVI	Total government ($ thousands)	int	null (autosum)
EDUI	Total education ($ thousands)	int	null (autosum)
RES1I	Total single family ($ thousands)	int	null
RES2I	Total manufactured housing ($ thousands)	int	null
RES3AI	Total multi-family (duplex) ($ thousands)	int	null
RES3BI	Total multi-family (triplex/quad) ($ thousands)	int	null
RES3CI	Total multi-family (5-9 units) ($ thousands)	int	null
RES3DI	Total multi-family (10-19 units) ($ thousands)	int	null
RES3EI	Total multi-family (20-49 units) ($ thousands)	int	null
RES3FI	Total multi-family (50+ units) ($ thousands)	int	null
RES4I	Total temporary lodging (hotel) ($ thousands)	int	null
RES5I	Total group housing (barracks) ($ thousands)	int	null

Name	Description	Format	Default Value
RES6I	Total nursing home ($ thousands)	int	null
COM1I	Total commercial (retail sales) ($ thousands)	int	null
COM2I	Total commercial (wholesale trade) ($ thousands)	int	null
COM3I	Total commercial (repair services) ($ thousands)	int	null
COM4I	Total commercial (professional services) ($ thousands)	int	null
COM5I	Total commercial (banks) ($ thousands)	int	null
COM6I	Total commercial (hospital) ($ thousands)	int	null
COM7I	Total commercial (clinic) ($ thousands)	int	null
COM8I	Total commercial (entertainment) ($ thousands)	int	null
COM9I	Total commercial (theater) ($ thousands)	int	null
COM10I	Total commercial (parking) ($ thousands)	int	null
IND1I	Total industrial (light) ($ thousands)	int	null
IND2I	Total industrial (heavy) ($ thousands)	int	null
IND3I	Total industrial (food/drug) ($ thousands)	int	null
IND4I	Total industrial (mineral processing) ($ thousands)	int	null
IND5I	Total industrial (high technology) ($ thousands)	int	null
IND6I	Total industrial (construction) ($ thousands)	int	null
AGR1I	Total agriculture building ($ thousands)	int	null
REL1I	Total religious ($ thousands)	int	null
GOV1I	Total government (general services) ($ thousands)	int	null
GOV2I	Total government (essential response) ($ thousands)	int	null

Name	Description	Format	Default Value
EDU1I	Total education (K-12) ($ thousands)	int	null
EDU2I	Total education (college) ($ thousands)	int	null

Table D.4 Building and Content Exposure by General Building Type (Full Replacement and Depreciated Replacement Values)

Tables
flExposureGBldgTypeB,
flDepExposureGBldgTypeB,
flContentExposureGBldgTypeB,
flDepExposureGBldgTypeOccupB,
flExposureGBldgTypeTotal, and
flDepExposureGBldgTypeTotal

Name	Description	Format	Default Value
CensusBlock	Census block number	char(15)	Not null
TotalExp	Total exposure by census block	real	null (autosum)
WoodF	Total wood building ($ thousands)	real	null
SteelF	Total steel building ($ thousands)	real	null
ConcreteF	Total concrete building ($ thousands)	real	null
MasonryF	Total masonry building ($ thousands)	real	null
ManufHousingF	Total manufactured housing ($ thousands)	real	null

Table D.5 General Building Stock Depreciation Function

Table

flDepFunction

Name	Description	Format	Default Value
Age	Average age of the structures in study region	int	not null
RES1Good	Depreciation curve for single-family in good condition	float	null
RES1Average	Depreciation curve for single-family in average condition	float	null
RES1Poor	Depreciation curve for single-family in poor condition	float	null
RES2	Depreciation curve for manufactured housing	float	null
RES3A	Depreciation curve for multi-family (duplex)	float	null
RES3B	Depreciation curve for multi-family (triplex/quad)	float	null
RES3C	Depreciation curve for multi-family (5-9 units)	float	null
RES3D	Depreciation curve for multi-family (10-19 units)	float	null
RES3E	Depreciation curve for multi-family (20-49 units)	float	null
RES3F	Depreciation curve for multi-family (50+ units)	float	null
RES4	Depreciation curve for temporary lodging	float	null
RES5	Depreciation curve for group housing	float	null
RES6	Depreciation curve for nursing homes	float	null
COM1	Depreciation curve for commercial (retail sales)	float	null
COM2	Depreciation curve for commercial (wholesale)	float	null
COM3	Depreciation curve for commercial (repair services)	float	null
COM4	Depreciation curve for commercial (professional services)	float	null
COM5	Depreciation curve for commercial (banks)	float	null
COM6	Depreciation curve for commercial (hospital)	float	null
COM7	Depreciation curve for commercial (clinics)	float	null
COM8	Depreciation curve for commercial (entertainment)	float	null
COM9	Depreciation curve for commercial (theater)	float	null
COM10	Depreciation curve for commercial (parking)	float	null
IND1	Depreciation curve for light industrial	float	null

Name	Description	Format	Default Value
IND2	Depreciation curve for heavy industrial	float	null
IND3	Depreciation curve for food/drug industrial	float	null
IND4	Depreciation curve for mineral processing industrial	float	null
IND5	Depreciation curve for high technology industrial	float	null
IND6	Depreciation curve for construction industrial	float	null
AGR1	Depreciation curve for agriculture	float	null
REL1	Depreciation curve for religious	float	null
GOV1	Depreciation curve for government (general services)	float	null
GOV2	Depreciation curve for government (emergency response)	float	null
EDU1	Depreciation curve for education (K-12)	float	null
EDU2	Depreciation curve for education (college)	float	null

Table D.6 User Defined Facilities

Table
flUserDefinedFlty

Name	Description	Format	Default Value
UserDefinedFltyI	User defined facility unique id	char(8)	not null
Occupancy	GBS Specific Occupancy Type	char(5)	null
BldgType	User defined facility building type	varchar(15)	null
DesignLevel	User defined facility design level (Pre/Post FIRM)	char(1)	null
FoundationType	Foundation type (e.g. slab on grade)	char(1)	null
FirstFloorHt	User defined facility first floor height	float	null
BldgDamageFnId	Default building damage function id	varchar(10)	null
ContDamageFnId	Default content damage function id	varchar(10)	null
FloodProtection	Flood protection (return period)	int	null

Table D.7 Care Facilities
Table
flCareFlty

Name	Description	Format	Default Value
CareFltyId	Care facility unique id	char(8)	not null
BldgType	Care facility building type	varchar(15)	null
DesignLevel	Care facility design level (Pre/Post FIRM)	char(1)	null
FoundationType	Foundation type (e.g. slab on grade)	char(1)	null
FirstFloorHt	Care facility first floor height	float	null
BldgDamageFnId	Default building damage function id	varchar(10)	null
ContDamageFnId	Default content damage function id	varchar(10)	null
FloodProtection	Flood protection (return period)	int	null

Table D.8 Emergency Center
Table
flEmergencyCtr

Name	Description	Format	Default Value
EocId	Emergency center unique id	char(8)	not null
BldgType	Emergency center building type	varchar(15)	null
DesignLevel	Emergency center design level (Pre/Post FIRM)	char(1)	null
FoundationType	Foundation type (e.g. slab on grade)	char(1)	null
FirstFloorHt	Emergency center first floor height	float	null
BldgDamageFnId	Default building damage function id	varchar(10)	null
ContDamageFnId	Default content damage function id	varchar(10)	null
FloodProtection	Flood protection (return period)	int	null

Table D.9 Police Stations

Table
flPoliceStation

Name	Description	Format	Default Value
PoliceStationId	Police station unique id	char(8)	not null
BldgType	Police station building type	varchar(15)	null
DesignLevel	Police station design level (Pre/Post FIRM)	char(1)	null
FoundationType	Foundation type (e.g. slab on grade)	char(1)	null
FirstFloorHt	Police station first floor height	float	null
BldgDamageFnId	Default building damage function id	varchar(10)	null
ContDamageFnId	Default content damage function id	varchar(10)	null
FloodProtection	Flood protection (return period)	int	null

Table D.10 Fire Stations

Table
flFireStation

Name	Description	Format	Default Value
FireStationId	Fire station unique id	char(8)	not null
BldgType	Fire station building type	varchar(15)	null
DesignLevel	Fire station design level (Pre/Post FIRM)	char(1)	null
FoundationType	Foundation type (e.g. slab on grade)	char(1)	null
FirstFloorHt	Fire station first floor height	float	null
BldgDamageFnId	Default building damage function id	varchar(10)	null
ContDamageFnId	Default content damage function id	varchar(10)	null
FloodProtection	Flood protection (return period)	int	null

Table D.11 Schools

Table
flSchool

Name	Description	Format	Default Value
SchoolId	School unique id	char(8)	not null
BldgType	School building type	varchar(15)	null
DesignLevel	School design level (Pre/Post FIRM)	char(1)	null
FoundationType	Foundation type (e.g. slab on grade)	char(1)	null
FirstFloorHt	School first floor height	float	null
BldgDamageFnId	Default building damage function id	varchar(10)	null
ContDamageFnId	Default content damage function id	varchar(10)	null
FloodProtection	Flood protection (return period)	int	null

Table D.12 Highway Bridges

Table
flHighwayBridge

Name	Description	Format	Default Value
HighwayBridgeId	Highway bridge unique id	char(8)	not null
Elevation	Bridge elevation above surface of normal flow (not used)	float	null

Table D.13 Railway Bridges

Table
flRailwayBridge

Name	Description	Format	Default Value
RailwayBridgeId	Railway bridge unique id	char(8)	not null
Elevation	Bridge elevation above surface of normal flow (not used)	float	null

Table D.14 Light Rail Bridges

Table

flLightRailBridge

Name	Description	Format	Default Value
LightRailBridgeId	Light rail bridge unique id	char(8)	not null
Elevation	Bridge elevation above surface of normal flow (not used)	float	null

Table D.15 Transportation Facilities Exposure Totals

Table

flExposureTransp

Name	Description	Format	Default Value
CountyFips	Study region county FIPS	char(5)	not null
HighwayRoads	Total exposure highway segments	money	null
HighwayBridges	Total exposure highway bridges	money	null
HighwayTunnels	Total exposure highway tunnels	money	null
RailwayTracks	Total exposure railway tracks	money	null
RailwayBridges	Total exposure railway bridges	money	null
RailwayFacilities	Total exposure railway facilities	money	null
RailwayTunnels	Total exposure railway tunnels	money	null
LightRailTracks	Total exposure light rail tracks	money	null
LightRailBridges	Total exposure light rail bridges	money	null
LightRailFacilities	Total exposure light rail facilities	money	null
LightRailTunnels	Total exposure light rail tunnels	money	null
Ports	Total exposure ports	money	null
FerrySystems	Total exposure ferry systems	money	null
AirportFacilities	Total exposure airport facilities	money	null
AirportRunways	Total exposure airport runways	money	null

Table D.16 Potable Water Facilities

Table
flPotableWaterFlty

Name	Description	Format	Default Value
PotableWaterFltyId	Potable water facility unique id	char (8)	not null
UtilIndicator	Utility type (unused)	int	null
FoundationType	Foundation type	char(1)	null
EquipmentHt	Height of critical equipment above grade	float	null
FloodProtection	Flood protection	int	null
UtilDamageFnId	Default utility facility damage function id	varchar(10)	null

Table D.17 Potable Water Pipeline Segments

Table
flPotableWaterPl

Name	Description	Format	Default Value
PotableWaterPlId	Potable water pipeline unique id	char(8)	not null
SystemId	Potable water system component id (placeholder)	varchar(5)	null
VulnbltyToScour	Pipeline vunerability to scour (placeholder)	varchar(10)	null
IDUpperJunction	Unique id of the upper junction (placeholder)	smallint	null
IDLowerJunction	Unique id of lower junction (placeholder)	smallint	null
DamageFnId	Default damage function id (placeholder)	varchar(10)	null

Table D.18 Wastewater Facilities
Table
flWasteWaterFlty

Name	Description	Format	Default Value
WasteWaterFltyId	Wastewater facility unique id	char (8)	not null
UtilIndicator	Utility type (unused)	int	null
FoundationType	Foundation type	char(1)	null
EquipmentHt	Height of critical equipment above grade	float	null
FloodProtection	Flood protection	int	null
UtilDamageFnId	Default utility facility damage function id	varchar(10)	null

Table D.19 Wastewater Pipeline Segments
Table
flWasteWaterPl

Name	Description	Format	Default Value
WasteWaterPlId	Wastewater pipeline unique id	char(8)	not null
SystemId	Wastewater system component id (placeholder)	varchar(5)	null
VulnbltyToScour	Pipeline vunerability to scour (placeholder)	varchar(10)	null
IDUpperJunction	Unique id of the upper junction (placeholder)	smallint	null
IDLowerJunction	Unique id of lower junction (placeholder)	smallint	null
DamageFnId	Default damage function id (placeholder)	varchar(10)	null

Table D.20 Oil Facilities

Table
flOilFlty

Name	Description	Format	Default Value
OilFltyId	Oil facility unique id	char (8)	not null
UtilIndicator	Utility type (unused)	int	null
FoundationType	Foundation type	char(1)	null
EquipmentHt	Height of critical equipment above grade	float	null
FloodProtection	Flood protection	int	null
UtilDamageFnId	Default utility facility damage function id	varchar(10)	null

Table D.21 Oil Pipeline Segments

Table
flOilPl

Name	Description	Format	Default Value
OilPlId	Oil pipeline unique id	char(8)	not null
SystemId	Oil system component id (placeholder)	varchar(5)	null
VulnbltyToScour	Pipeline vunerability to scour (placeholder)	varchar(10)	null
IDUpperJunction	Unique id of the upper junction (placeholder)	smallint	null
IDLowerJunction	Unique id of lower junction (placeholder)	smallint	null
DamageFnId	Default damage function id (placeholder)	varchar(10)	null

Table D.22 Natural Gas Facilities

Table
flNaturalGasFlty

Name	Description	Format	Default Value
NaturalGasFltyId	Natural gas facility unique id	char (8)	not null
UtilIndicator	Utility type (unused)	int	null
FoundationType	Foundation type	char(1)	null
EquipmentHt	Height of critical equipment above grade	float	null
FloodProtection	Flood protection	int	null
UtilDamageFnId	Default utility facility damage function id	varchar(10)	null

Table D.23 Natural Gas Pipeline Segments

Table
flNaturalGasPl

Name	Description	Format	Default Value
NaturalGasPlId	Natural gas pipeline unique id	char(8)	not null
SystemId	Natural gas system component id (placeholder)	varchar(5)	null
VulnbltyToScour	Pipeline vunerability to scour (placeholder)	varchar(10)	null
IDUpperJunction	Unique id of the upper junction (placeholder)	smallint	null
IDLowerJunction	Unique id of lower junction (placeholder)	smallint	null
DamageFnId	Default damage function id (placeholder)	varchar(10)	null

Table D.24 Electric Power Facilities

Table
flElectricPowerFlty

Name	Description	Format	Default Value
ElectricPowerFltyId	Electric power facility unique id	char (8)	not null
UtilIndicator	Utility type (unused)	int	null
FoundationType	Foundation type	char(1)	null
EquipmentHt	Height of critical equipment above grade	float	null
FloodProtection	Flood protection	int	null
UtilDamageFnId	Default utility facility damage function id	varchar(10)	null

Table D.25 Utility Exposure Totals

Table
flExposureUtil

Name	Description	Format	Default Value
CountyFIPS	Study region county FIPS	char(5)	not null
PotableWaterFclties	Total exposure potable water facilities	money	null
PotableWaterPipes	Total exposure potable water pipelines	money	null
WasteWaterFclties	Total exposure wastewater facilities	money	null
WasteWaterPipes	Total exposure wastewater pipelines	money	null
OilFlties	Total exposure oil facilities	money	null
OilPipes	Total exposure oil pipelines	money	null
NGFlties	Total exposure natural gas facilities	money	null
NGPipes	Total exposure natural gas pipelines	money	null
PowerFlties	Total exposure electric power facilities	money	null
CommFclties	Total exposure communication facilities	money	null

Table D.26 Agriculture Inventory and Valuation

Table

flAgricultureInventory

Name	Description	Format	Default Value
CountyFips	Study region county FIPS	char(5)	not null
CropType	Crop type (e.g. corn)	varchar(50)	not null
PolygonId	Sub-county area where agriculture crops have been identified in NASS and NRI	varchar(25)	not null
AvgAnnualYield	Average annual yield based on the NASS dataset	float	null
Unit	Crop unit of measure (e.g. bushel)	char(10)	null
UnitPrice	Price per unit of measure (e.g. $ per bushel) from NRI	float	null
HarvestCost	Harvest cost or the farmers investment into the crop	float	null

Table D.27 Vehicle Inventory and Valuation

Table
flDayVehicleInv, and
flNightVehicleInv

Name	Description	Format	Default Value
CensusBlock	Study region CensusBlock	char(15)	not null
TotalVehicle	Total vehicles within the census block	int	null (autosum)
Cars	Total cars within census block	int	null
LightTrucks	Total light trucks within census block (e.g. 1/4 ton pickup)	int	null
HeavyTrucks	Total heavy trucks within census block (e.g. 18-wheeler)	int	null
TotalExp	Total exposure of vehicles in the census	float	null
TValNewCar	Total value of new cars within the census block	float	null
TValUsedCar	Total value of used cars within the census block	float	null
TValNewLightTrucks	Total value of new light trucks within the census block	float	null
TValUsedLightTrucks	Total value of used light trucks within the census block	float	null
TValNewHeavyTrucks	Total value of new heavy trucks within the census block	float	null
TValNewUsedTrucks	Total value of used heavy trucks within the census block	float	null

Table D.28 Building, Content and Inventory Damage Functions for General Building Stock and Essential Facilities

Tables
flBldgStructDmgFn,
flBldgContDmgFn,
flBldgInvDmgFn,
flEssntStructDmgFn,
flEssntContDmgFn

Name	Description	Format	Default Value
BldgDmgFnID	Damage function unique id	numeric	not null
Occupancy	Flood specific occupancy with stories and foundation (e.g. COM10LN)	char(5)	null
Source	Damage function source (e.g. USACE)	varchar(50)	null
Description	Damage function description	varchar(100)	null
ft04m	Percent damage at -4 ft	float	null
ft03m	Percent damage at -3 ft	float	null
ft02m	Percent damage at -2 ft	float	null
ft01m	Percent damage at -1ft	float	null
ft00	Percent damage at 0 ft	float	null
ft01	Percent damage at 1 ft	float	null
ft02	Percent damage at 2 ft	float	null
ft03	Percent damage at 3 ft	float	null
ft04	Percent damage at 4 ft	float	null
ft05	Percent damage at 5 ft	float	null
ft06	Percent damage at 6 ft	float	null
ft07	Percent damage at 7 ft	float	null
ft08	Percent damage at 8 ft	float	null
ft09	Percent damage at 9 ft	float	null
ft10	Percent damage at 10 ft	float	null
ft11	Percent damage at 11 ft	float	null
ft12	Percent damage at 12 ft	float	null
ft13	Percent damage at 13 ft	float	null
ft14	Percent damage at 14 ft	float	null
ft15	Percent damage at 15 ft	float	null
ft16	Percent damage at 16 ft	float	null

Name	Description	Format	Default Value
ft17	Percent damage at 17 ft	float	null
ft18	Percent damage at 18 ft	float	null
ft19	Percent damage at 19 ft	float	null
ft20	Percent damage at 20 ft	float	null
ft21	Percent damage at 21 ft	float	null
ft22	Percent damage at 22 ft	float	null
ft23	Percent damage at 23 ft	float	null
ft24	Percent damage at 24 ft	float	null
Comment	Comment	varchar(255)	null

Table D.29 Bridge Damage Functions for Highway, Railway, and Light Rail

Table

flBridgeDmgFn

Name	Description	Format	Default Value
BridgeDmgFnId	Bridge damage function unique id	numeric	not null
Occupancy	Bridge specific occupancy	char(7)	null
Source	Damage function source	char(16)	null
Description	Damage function description	varchar(50)	null
RP0	Percent damage for return period 0-years	real	null
RP25	Percent damage for return period 25-years	real	null
RP50	Percent damage for return period 50-years	real	null
RP75	Percent damage for return period 75-years	real	null
RP100	Percent damage for return period 100-years	real	null
RP125	Percent damage for return period 125-years	real	null
RP150	Percent damage for return period 150-years	real	null
RP175	Percent damage for return period 175-years	real	null
RP200	Percent damage for return period 200-years	real	null
RP225	Percent damage for return period 225-years	real	null
RP250	Percent damage for return period 250-years	real	null
RP275	Percent damage for return period 275-years	real	null
RP300	Percent damage for return period 300-years	real	null
RP325	Percent damage for return period 325-years	real	null
RP350	Percent damage for return period 350-years	real	null
RP375	Percent damage for return period 375-years	real	null
RP400	Percent damage for return period 400-years	real	null
RP425	Percent damage for return period 425-years	real	null
RP450	Percent damage for return period 450-years	real	null
RP475	Percent damage for return period 475-years	real	null
RP500	Percent damage for return period 500-years	real	null
RP525	Percent damage for return period 525-years	real	null
RP550	Percent damage for return period 550-years	real	null
RP575	Percent damage for return period 575-years	real	null
RP600	Percent damage for return period 600-years	real	null
RP625	Percent damage for return period 625-years	real	null
RP650	Percent damage for return period 650-years		

Name	Description	Format	Default Value
RP675	Percent damage for return period 675-years	real	null
RP700	Percent damage for return period 700-years	real	null
RP725	Percent damage for return period 725-years	real	null
RP750	Percent damage for return period 750-years	real	null
RP775	Percent damage for return period 775-years	real	null
RP800	Percent damage for return period 800-years	real	null
RP825	Percent damage for return period 825-years	real	null
RP850	Percent damage for return period 850-years	real	null
RP875	Percent damage for return period 875-years	real	null
RP900	Percent damage for return period 900-years	real	null
RP925	Percent damage for return period 925-years	real	null
RP950	Percent damage for return period 950-years	real	null
RP975	Percent damage for return period 975-years	real	null
RP1000	Percent damage for return period 1000-years	real	null
Comment	Comment	varchar(255)	null

Table D.30 Utility Facility Damage Functions for Potable Water, Wastewater, Oil, Natural Gas, and Electric Power

Table
flUtilFltyDmgFn

Name	Description	Format	Default Value
UtilFltyDmgFnID	Utility facility damage function id	numeric	not null
Occupancy	Occupancy	char(5)	null
Source	Source	varchar(50)	null
Description	Description	varchar(100)	null
ft00	Percent damage 0 ft	float	null
ft01	Percent damage 1 ft	float	null
ft02	Percent damage 2 ft	float	null
ft03	Percent damage 3 ft	float	null
ft04	Percent damage 4 ft	float	null
ft05	Percent damage 5 ft	float	null
ft06	Percent damage 6 ft	float	null
ft07	Percent damage 7 ft	float	null
ft08	Percent damage 8 ft	float	null
ft09	Percent damage 9 ft	float	null
ft10	Percent damage 10 ft	float	null
Comment	Comment	varchar(255)	null

Table D.31 Agriculture Damage Functions

Table

flAgDmgFn

Name	Description	Format	Default Value
Crop	Crop name or crop type	varchar(150)	not null
FunctionSource	Damage function source (e.g. USACE)	varchar(150)	null
CalendarDate	Calendar date (standard calendar)	varchar(15)	null
JulianDay	Julian calendar date	varchar(5)	null
PctCropLoss	Maximum potential percent crop damage by Julian date	float	null
PctLossDuration0_days	0-Day flood duration damage modifier	float	null
PctLossDuration3_days	3-Day flood duration damage modifier	float	null
PctLossDuration7_days	7-Day flood duration damage modifier	float	null
PctLossDuration14_days	14-Day flood duration damage modifier	float	null
SortOrder	Sort order field used to display Julian day in proper order	int	null

Table D.32 Vehicle Damage Functions

Table
flVehicleDmgFn

Name	Description	Format	Default Value
VehDmgFnID	Vehicle damage function unique id	numeric	not null
Occupancy	Specific occupancy	char(5)	null
Source	Damage function source (e.g. USACE)	varchar(50)	null
Description	Damage function description	varchar(100)	null
ft04m	Percent damage at 0 ft	float	null
ft03m	Percent damage at 0.5 ft	float	null
ft02m	Percent damage at 1.0 ft	float	null
ft01m	Percent damage at 1.5ft	float	null
ft00	Percent damage at 2.0 ft	float	null
ft01	Percent damage at 2.5 ft	float	null
ft02	Percent damage at 3.0 ft	float	null
ft03	Percent damage at 3.5 ft	float	null
ft04	Percent damage at 4.0 ft	float	null
ft05	Percent damage at 4.5 ft	float	null
ft06	Percent damage at 5.0 ft	float	null
ft07	Percent damage at 5.5 ft	float	null
ft08	Percent damage at 6.0 ft	float	null
ft09	Percent damage at 6.5 ft	float	null
ft10	Percent damage at 7.0 ft	float	null
ft11	Percent damage at 7.5 ft	float	null
ft12	Percent damage at 8.0 ft	float	null
ft13	Percent damage at 8.5 ft	float	null
ft14	Percent damage at 9.0 ft	float	null
ft15	Percent damage at 9.5 ft	float	null
ft16	Percent damage at 10.0 ft	float	null
ft17	Percent damage at 10.5 ft	float	null
ft18	Percent damage at 11.0 ft	float	null
ft19	Percent damage at 11.5 ft	float	null
ft20	Percent damage at 12.0 ft	float	null
ft21	Percent damage at 12.5 ft	float	null
ft22	Percent damage at 13.0 ft	float	null

Name	Description	Format	Default Value
ft23	Percent damage at 13.5 ft	float	null
Comment	Comment	varchar(255)	null

Table D.33 Restoration Functions for General Building Stock and Essential Facilities

Tables
flRsFnGBS and
flRsFnEssntFlty

Name	Description	Format	Default Value
SOccup	Specific occupancy id	char(5)	not null
Min_Depth	Minimum depth for restoration parameter range	int	null
Max_Depth	Maximum depth for restoration parameter range	int	null
Min_Restor_Months	Minimum restoration timeline (months)	int	null
Max_Restor_Months	Maximum restoration timeline (months)	int	null
Min_Restor_Days	Minimum restoration timeline (days)	int	null
Max_Restor_Days	Maximum restoration timeline (months)	int	null
SortOrder	Unique field used to sort occupancies for viewing	int	not null

Table D.34 Debris Parameters

Table
flDebris

Name	Description	Format	Default Value
SOccup	Specific occupancy id	char(5)	not null
FoundType	Foundation type, basement/no basement	varchar(10)	null
MinFloodDepth	Minimum flood depth for debris estimation	int	null
MaxFloodDepth	Maximum flood depth for debris estimation	int	null
FinishWt	Total weight for finishes	float	null
StructureWt	Total structure weight for debris	float	null
FoundationWt	Total foundation weight for debris	float	null

Table D.35 Shelter Parameters
Table
flShelterParams

Name	Description	Format	Default Value
ParamClass	Shelter parameter classification (e.g. income)	char(3)	not null
Description	Parameter description	char(150)	null
Factors	Shelter modification factors	float	null
SortOrder	Field for sorting classifications in view	int	null

Table D.36 Direct Economic Parameters Sales and Inventory
Table
flBldgEconParamSalesAndInv

Name	Description	Format	Default Value
Occupancy	Specific occupancy	char(5)	not null
AnnualSalesPerSqFt	Annual sales by occupancy per square footage	float	null

Table D.37 Direct Economic Parameters Owner Occupied Buildings
Table
flBldgEconParamOwnerOccupied

Name	Description	Format	Default Value
Occupancy	Specific occupancy	char(5)	not null
PctOwnerOccupied	Percent of square footage that is owner occupied	float	null

Table D.38 Direct Economic Parameters Recapture Factors
Table
flBldgEconParamRecaptureFactors

Name	Description	Format	Default Value
Occupancy	Specific occupancy	char(5)	not null
PctWageRecapture	Percentage of wages recaptured	float	null
PctEmploymentRecapture	Percentage of employment recaptured	float	null
PctIncomeRecapture	Percentage of income recaptured	float	null
PctOutputRecapture	Percentage of economic output recaptured	float	null

Table D.39 Direct Economic Parameters Rental Costs
Table
flBldgEconParamRental

Name	Description	Format	Default Value
Occupancy	Specific occupancy id	char(5)	not null
RentalCostsPerSqFtPerMonth	Rental costs per square footage per month	float	null
RentalCostsPerSqFtPerDay	Rental costs per square foot per day	float	null
DisruptionCostsPerSqFt	Disruption costs per square foot	float	null

Table D.40 Direct Economic Parameters Wage and Capital Income
Table
flBldgEconParamWageCapitalIncome

Name	Description	Format	Default Value
Occupancy	Specific occupancy	char(5)	not null
IncomePerSqftPerYear	Owners income per square footage per year	float	null
IncomePerSqftPerDay	Owners income per square footage per day	float	null
WagePerSqftDay	Wages per square foot per day	float	null
EmployeesPerSqft	Employees per square footage	float	null
OutputPerSqftDay	Employee output per square footage per day	float	null

Table D.41 IELM Time Parameters by Sector

Table

flIELMParamsByTime

Name	Description	Format	Default Value
TimeInterval	Analysis time interval (week, month, year)	char(3)	not null
AGRI	Agriculture IELM parameter	real	null
MINE	Mining IELM parameter	real	null
CNST	Construction IELM parameter	real	null
MNFG	Manufacturing IELM parameter	real	null
TRNS	Transportation IELM parameter	real	null
TRDE	Trade IELM parameter	real	null
FIRE	Financial, insurance, real estate IELM parameter	real	null
SERV	Services IELM parameter	real	null
GOVT	Government IELM parameter	real	null
MISC	Miscellaneous IELM parameter	real	null
ExpBldg	Building exposure	real	null
ExpLL	Lifeline exposure	real	null

Table D.42 IELM Sector Output

Table

flIELMSectorOutput

Name	Description	Format	Default Value
Sector	IELM Market Sector	char(4)	not null
Output	Market sector output	real	null

Table D.43 IELM Economic Stimulus Factors

Table

flIELMStimulus

Name	Description	Format	Default Value
TimeInterval	Analysis time interval (week, month, year)	char(3)	not null
Sector	IELM market sector	char(4)	not null
Stimulus	Parameter for the impact of stimulus on the market sector	real	null

Table D.44 IELM Implan (Level 2) Import Table

Table

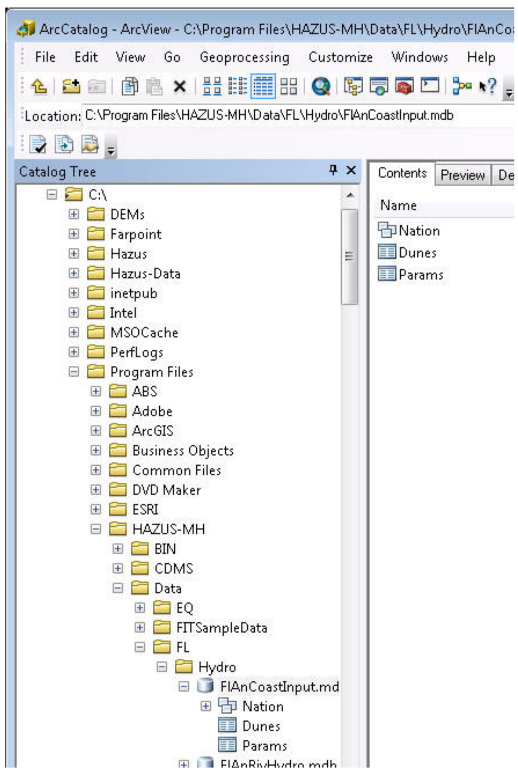
flIELMImplanData

Name	Description	Format	Default Value
ImplanId	IMPLAN Data table id	smallint	not null
ImplanSetName	IMPLAN data set name	varchar(30)	null
SetType	IMPLAN data economy set type	char(1)	null
Sector	IELM market sector	char(4)	null
Imports	Economy import parameter	real	null
Supplies	Economy supply parameter	real	null
Demands	Economy demand parameter	real	null
NewExports	Economy exports parameter	real	null
AGRI	Agriculture sector parameter	real	null
MINE	Mining sector parameter	real	null
CNST	Construction sector parameter	real	null
MNFG	Manufacturing sector parameter	real	null
TRNS	Transportation sector parameter	real	null
TRDE	Trade sector parameter	real	null
FIRE	Financial, insurance, real estate sector parameter	real	null
SERV	Services sector parameter	real	null
GOVT	Government sector parameter	real	null
MISC	Miscellaneous sector parameter	real	null
ConsumLow	Low consumption factor	real	null
ConsumMedium	Medium consumption factor	real	null
ConsumHigh	High consumption factor	real	null
DomesticExport	Market domestic exports	real	null
ForeignExport	Market foreign exports	real	null
InitialDemand	Initial demand surge	real	null
FinalDemand	Final demand	real	null
IndustryOutput	Total industry output	real	null
EmplCompen	Total employment compensation	real	null
PropIncome	Property income	real	null
OthPropIncome	Other property income	real	null
Employment	Market employment	real	null
TotalImports	Total market imports	real	null
TotFinalPayment	Total payment for imports	real	null

Appendix E. GIS Data Dictionary

PATH: C:\Program Files\HAZUS-MH\DATA\FL\Hydro\

NAME: FlAnCoastInput.mdb
GIS DATA TYPE: Personal Geodatabase
USE: Coastal Hazard



Feature Datasets:

Name	Description	Source
Nation	Container to hold feature classes with common spatial references	N/A

Feature Classes:

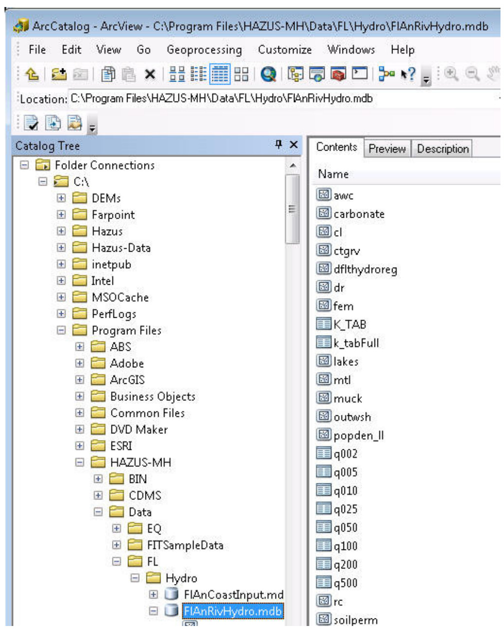
Name	Type	Description	Source
Shoreline	Polyline	National smoothed shoreline	U.S. Census Bureau, 2000 TIGER dataset (processed by ABS Consulting, 2003)
TIGER_Land	Polygon	Coastal states and territories	U.S. Census Bureau, 2000 TIGER dataset (processed by ABS Consulting, 2003)

Tables:

Name	Description	Source
Dunes	Threshold reservoir volumes for dunes to withstand being removed by erosion per return period per geographic area	Chris Jones & Associates (2003)
Params	Parameters (transect lengths, wave periods) for coastal calculations per coastal county	Chris Jones & Associates (2003)

PATH: C:\Program Files\HAZUS-MH\DATA\FL\Hydro\

NAME: FlAnRivHydro.mdb
GIS DATA TYPE: Personal Geodatabase
USE: Riverine hydrologic computations



Feature Classes:

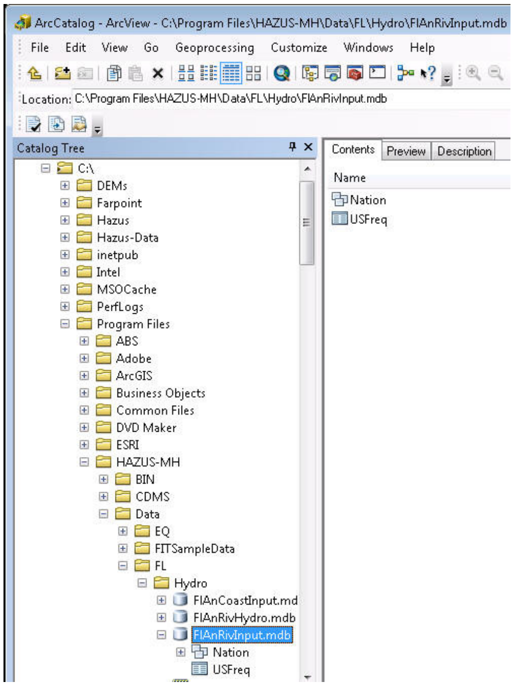
Name	Type	Description	Source
cl	Polygon	Clay and silt	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
ctgrv	Polygon	Coarse-textured glacial till	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
dflthydroreg	Polygon	Default hydrologic regions	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
fem	Polygon	End moraines of fine-textured till	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
mtl	Polygon	Medium-textured glacial till	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
muck	Polygon	Peat and muck	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
outwsh	Polygon	Outwash	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
popden_ll	Polygon	Population density	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
rc	Polygon	Runoff coefficient	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
soilperm	Polygon	Soil permeability	Earth System Science Center at Penn State, 2004 Water-Resources Investigations Report 94-4002, 1994
strdft	Polygon	Percent stratified drift	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
strp_ll	Polygon	Percent basin storage	U.S. Environmental Protection Agency, 1994
tr	Polygon	Thin glacial till over bedrock	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).

Tables:

Name	Description	Source
K_TAB	Table of normalized random variables. Variables are Pearson Type III distributed, covering a range of skew coefficients	Guidelines for Determining Flood Flow Frequency Bulletin #17B of the Hydrology Subcommittee, 1982
q002	Hydrologic region identifiers and regression equation parameters for computation of 2-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q005	Hydrologic region identifiers and regression equation parameters for computation of 5-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q010	Hydrologic region identifiers and regression equation parameters for computation of 10-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q025	Hydrologic region identifiers and regression equation parameters for computation of 25-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q050	Hydrologic region identifiers and regression equation parameters for computation of 50-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q100	Hydrologic region identifiers and regression equation parameters for computation of 100-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q200	Hydrologic region identifiers and regression equation parameters for computation of 200-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
q500	Hydrologic region identifiers and regression equation parameters for computation of 500-year discharges	Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994

PATH: C:\Program Files\HAZUS-MH\DATA\FL\Hydro\

NAME: FlAnRivInput.mdb
GIS DATA TYPE: Personal Geodatabase
USE: Riverine hydrologic computations



Feature Datasets:

Name	Description	Source
Nation	Container to hold feature classes with common spatial references	N/A

Feature Classes:

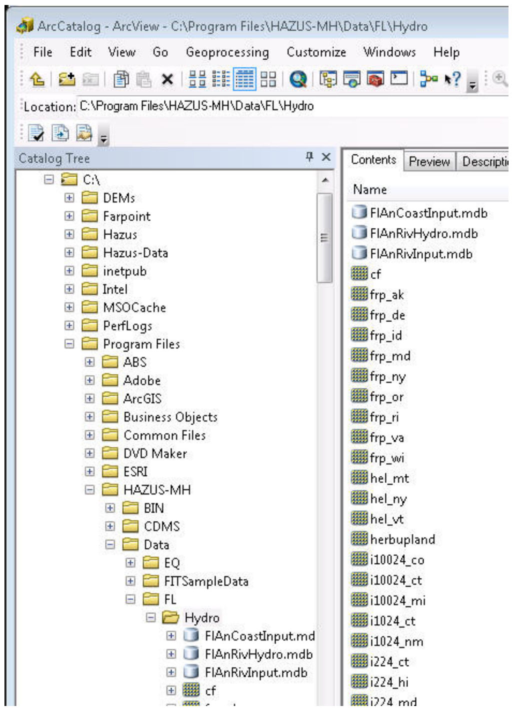
Name	Type	Description	Source
Basinnet	Polyline	Default river reaches draining 100-square miles based on a 400-meter DEM	National Operational Hydrologic Remote Sensing Center, (developed by Baker), 1998
Gages	Point	Default stream gage locations attributed with total and contributing drainage areas, and the mean, standard deviation, and coefficient of skew of the flood frequency curve at the gage	U.S. Geological Survey WATSTORE Database, 1998
watersheds	Polygon	Default watersheds draining 100-square miles based on a 400-meter DEM	National Operational Hydrologic Remote Sensing Center, (developed by Baker), 1998

Tables:

Name	Description	Source
USFreq	Frequency-based discharge data associated with the default reaches	National Operational Hydrologic Remote Sensing Center, (developed by Baker), 1998 Water-Resources Investigations Report 94-4002, 1994

PATH: C:\Program Files\HAZUS-MH\DATA\FL\Hydro\

GIS DATA TYPE: Raster Dataset
USE: Riverine hydrologic computations



Raster Datasets:

Name	Description	Source
frp	Percent forest cover	The Center for Advanced Spatial Technologies at University of Arkansas, Fayetteville. Cited in "Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
geofact	Wyoming geographic factor	
hel	High elevation indices	Water-Resources Investigations Report 94-4002, 1994
i10024	100-year, 24-hour precipitation in inches	Water-Resources Investigations Report 94-4002, 1994
i1024	10-year, 24-hour precipitation in inches	Water-Resources Investigations Report 94-4002, 1994
i244	2-year, 24-hour precipitation in inches	Water-Resources Investigations Report 94-4002, 1994
i2524	25-year, 24-hour precipitation in inches	Water-Resources Investigations Report 94-4002, 1994
i5024	50-year, 24-hour precipitation in inches	Water-Resources Investigations Report 94-4002, 1994

Name	Description	Source
jantemp	Mean minimum January temperature (degrees Fahrenheit)	The National Summary of US Geological Survey Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
martemp	Normal daily maximum March temperature (degrees Fahrenheit)	The National Summary of US Geological Survey Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
meanannprec	Average precipitation index	The National Summary of U.S. Geological Survey Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
meanannrunoff	Mean annual runoff (inches)	Water-Resources Investigations Report 94-4002, 1994
snowfall	Average seasonal snowfall	The National Summary of U.S. Geological Survey Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993 Water-Resources Investigations Report 94-4002, 1994
soila	Soil type A	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).
soild	Soil type D	"Compilation of GIS Data Layers For Flash Flood Forecasting," Michigan Technological University for the National Weather Service (date unknown).

Appendix F. Running Hazus-MH with SQL Server 2008 R2

F.1 Introduction

Hazus-MH uses SQL Server 2008 R2 Express edition as the database engine. The express edition is a free and lightweight version of SQL Server 2008 R2, and therefore has several limitations including a 8-GB database-size limit.

The purpose of this document is to show how **Hazus-MH** can be configured to run with a full version of SQL Server 2008 R2 and also how to configure **Hazus-MH** back to run with the SQL Server Express-based default installation.

There are several[1] *full* editions of SQL Server 2008 R2 that lift the 8-GB database limit. A special Developer edition is also available (refer to Microsoft's web site for the differences between the different editions).

Hazus-MH has been tested to run with the ***Express Edition and SQL Server 2008 R2 Developer Edition*** only. **Hazus-MH** has not been explicitly tested to run with the other editions of SQL Server 2008 R2 (Enterprise, Workgroup, Standard and others).

Hazus-MH neither does it install nor does it include any of the full versions of SQL Server 2008 R2. Before **Hazus-MH** can be configured to run with any of the full editions of SQL Server, the user needs to purchase and install SQL Server 2008 R2 separately.

F.2 Purpose

This document describes all the steps[2] that the user needs to perform to configure **Hazus-MH** to run with SQL Server 2008 R2. This document doesn't explain how to install and run **Hazus-MH**. For that, refer to the Chapter 2 of the User's Manual.

F.3 Steps to Configure Hazus-MH to Run with SQL-Server 2008 R2

1. Install **Hazus-MH** then launch it at least one time and close it.

2. Open the windows registry. To do this, click the "Start" button and type "regedit" in the Run window edit box (Figure F.1) and click the "OK" button to open the Registry Editor.

[1] As of September 2011, Microsoft had no less than 9 other different editions of SQL Server 2008 R2 in addition to the Express edition.
[2] Steps detailed in this document apply to Windows 7. Instructions should be very similar under Windows XP.

Figure F.1

3. Navigate through the folders listed in the Registry Editor to the location: [HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\HAZUS-MH\General] in Registry Editor Window (Figure F.2).

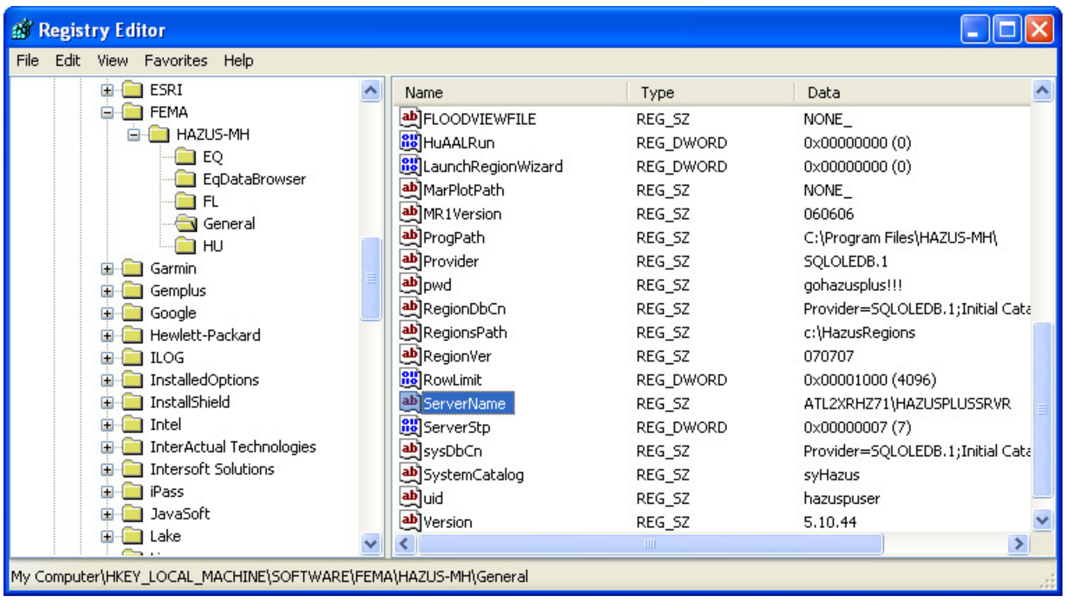


Figure F.2

4. Double click on “ServerName” (shown highlighted above in Figure F.2) and enter the name of the new SQL Server 2008 R2 instance. The name is in the format <computername>/<instancename>. For example, if the machine name is ATLHW32P91 and the instance name is SQL2008[3], then the registry enter should show ATLHW32P91 \SQL2005. Open the SQL Server Management Studio from Start|Programs|Microsoft SQL Server 2008|SQL Server Management Studio on windows menu.

5. Under SQL Server double click Security folder and select Logins and right click the mouse. From the Popup menu select New Login as shown in Figure F.3.

[3] The instance name is specified during the SQL Server 2008 R2 installation.

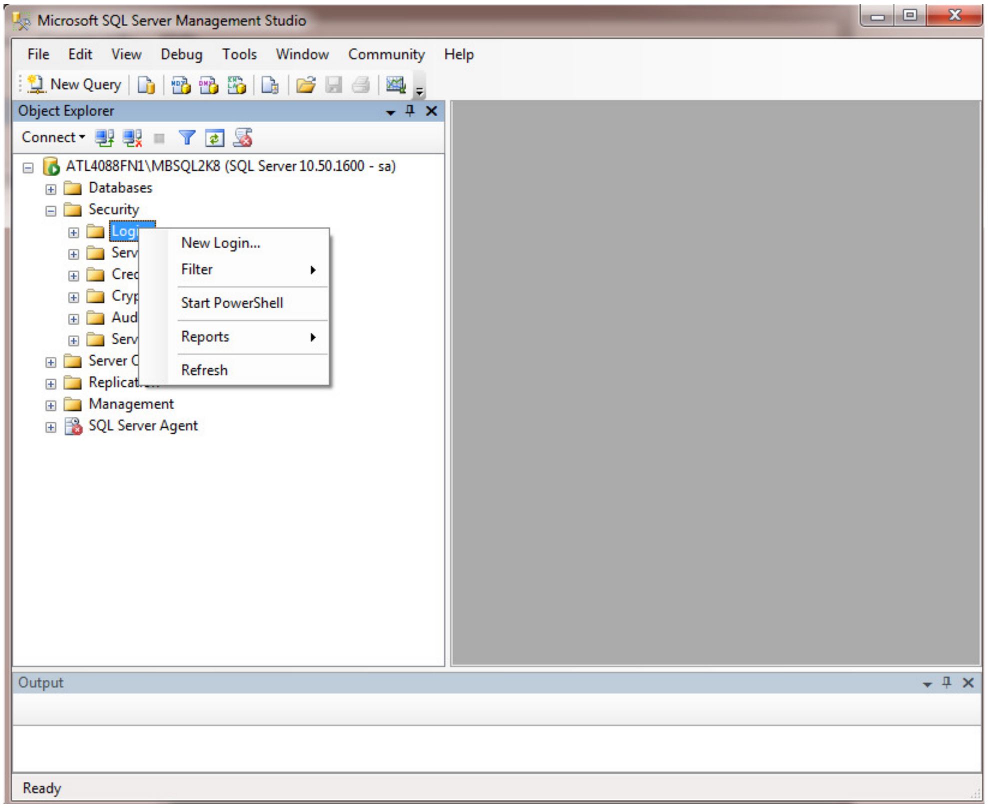


Figure F.3

6. In “SQL Server Properties – New Login” dialog, enter “hazuspuser” in the name field without parentheses as shown in Figure F.4.

7. Click SQL Server Authentication option. Enter the password "gohazusplus_01" without parentheses. Click OK.

8. Uncheck the “User must change password at next login” option if it is checked.

You can get the names in 7 and 8 above by copying them from registry [HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\HAZUS-MH\General] (see Figure F.2).

a. For Name field copy it from **uid** in the registry and paste it in the appropriate field.
b. For Password copy it from **pwd** in the registry and paste it in the appropriate field.
c. It's better to copy these values from registry to avoid typos.

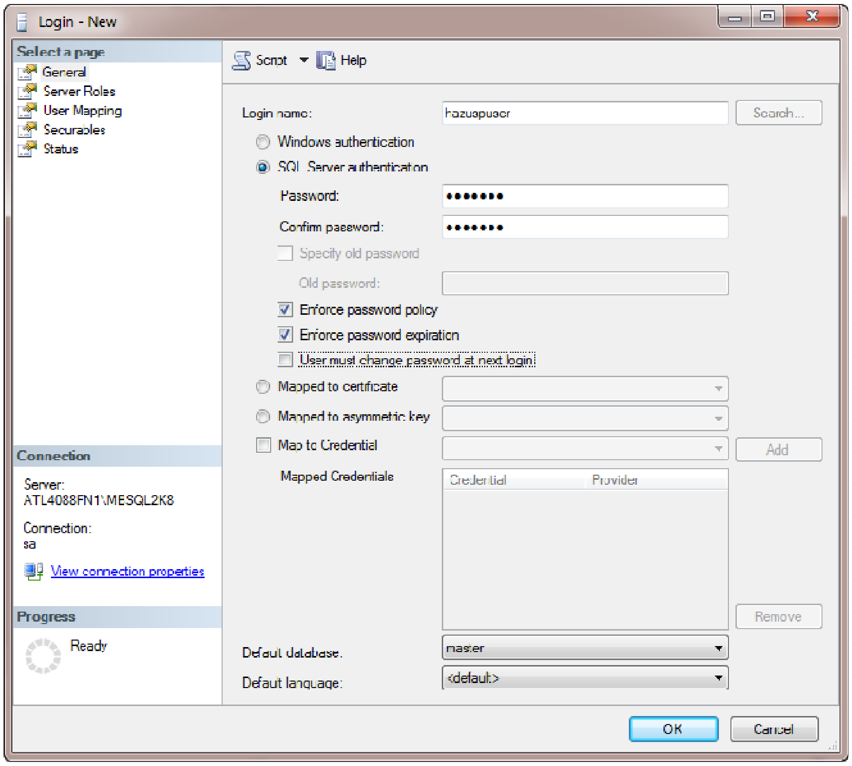


Figure F.4

9. After that Click Server Roles Tab and check sysadmin. Click OK (Figure F.5).

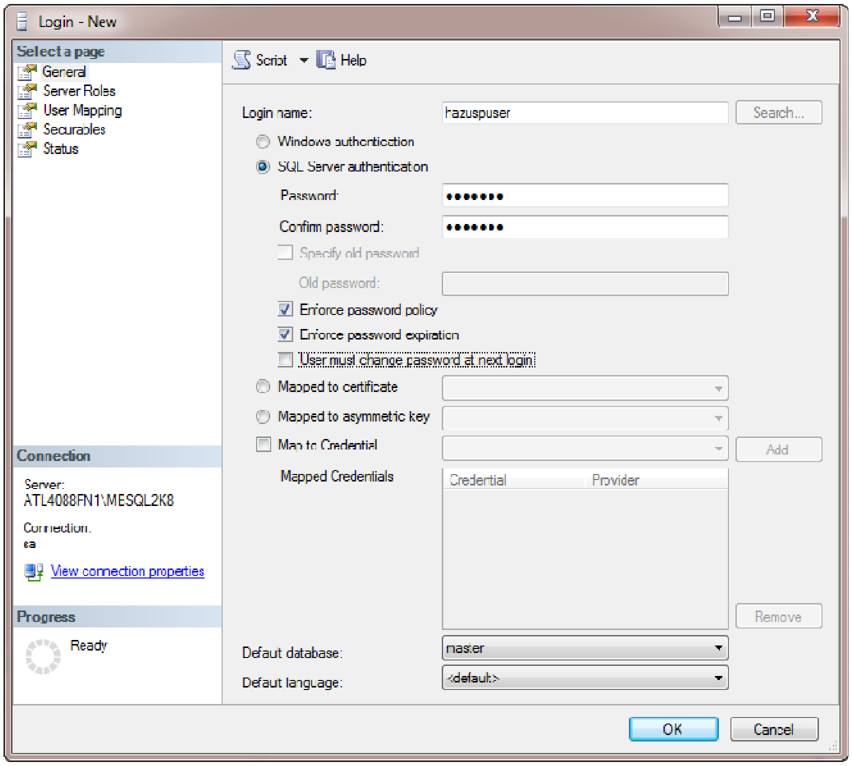


Figure F.5

10. Confirm password "gohazusplus_01" and Click OK.

11. Now connect the HAZUSPLUSSRVR installed by **Hazus** via the Management studio. To do that, Click the "Connect" button at the top left corner of the SQL Server Management Studio and select Database Engine… option (Figure F.6).

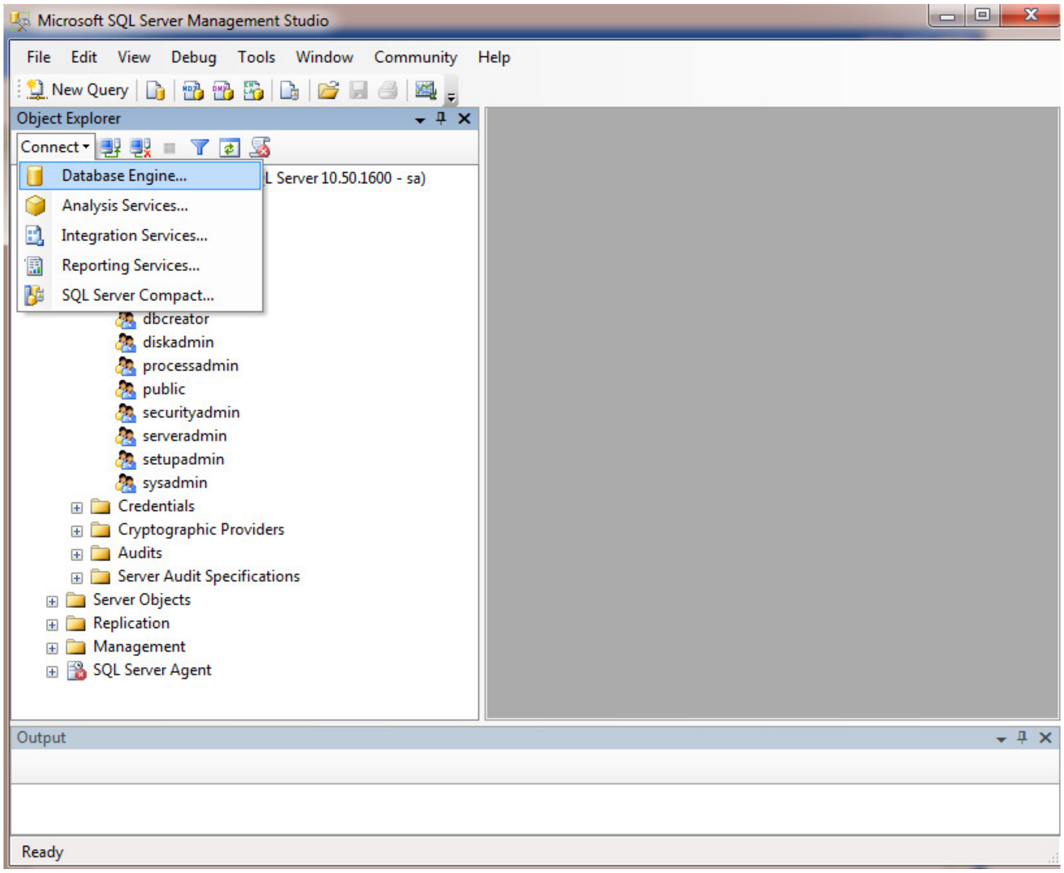


Figure F.6

12. For **Server name** select or type in YourComputerName\HAZUSPLUSSRVR.

13. Select Windows Authentication for the **Authentication**.

14. Click on the **Connect** button.

Figure F.7

15. Now, the new database server will be visible on the Management Studio as shown in Figure F.8.

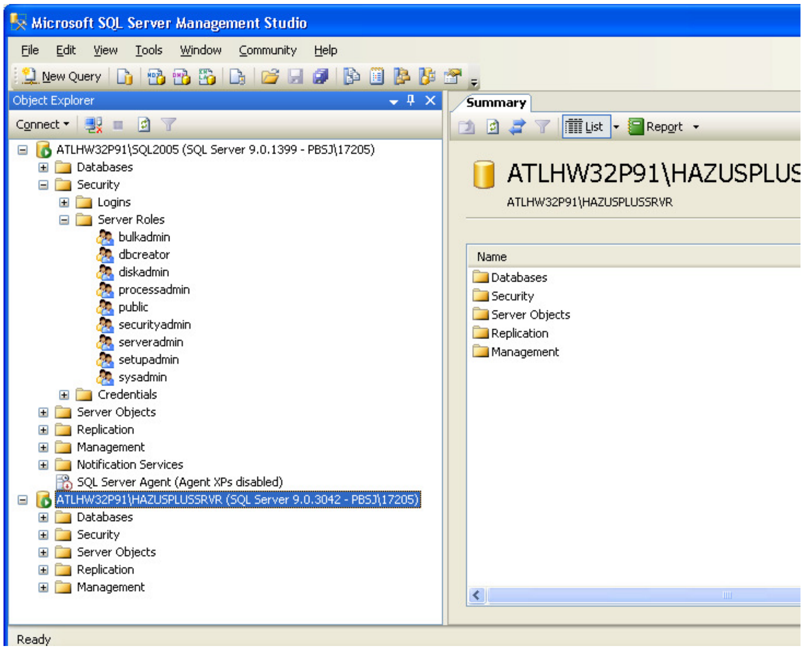


Figure F.8

16. Next, navigate to Databases folder under HAZUSPLUSSRVR Server and expand it. Select syHazus database, Right click on it and Task | Detach and click OK (Figure F.9).

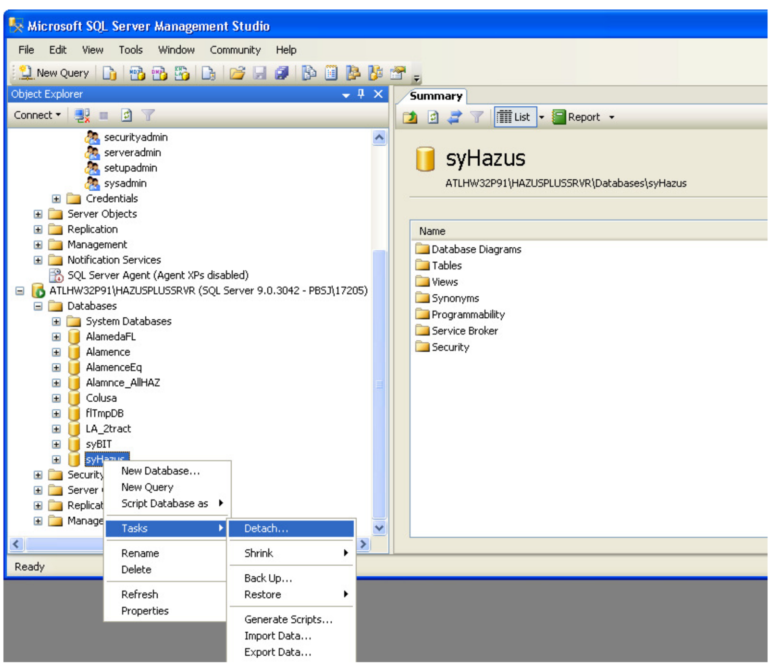


Figure F.9

17. Navigate to the folder that represents the new server (ATLHW32P91 in Figure F.10). Select Database folder and Right click the mouse, Select Attach… database… option as shown in Figure F.10.

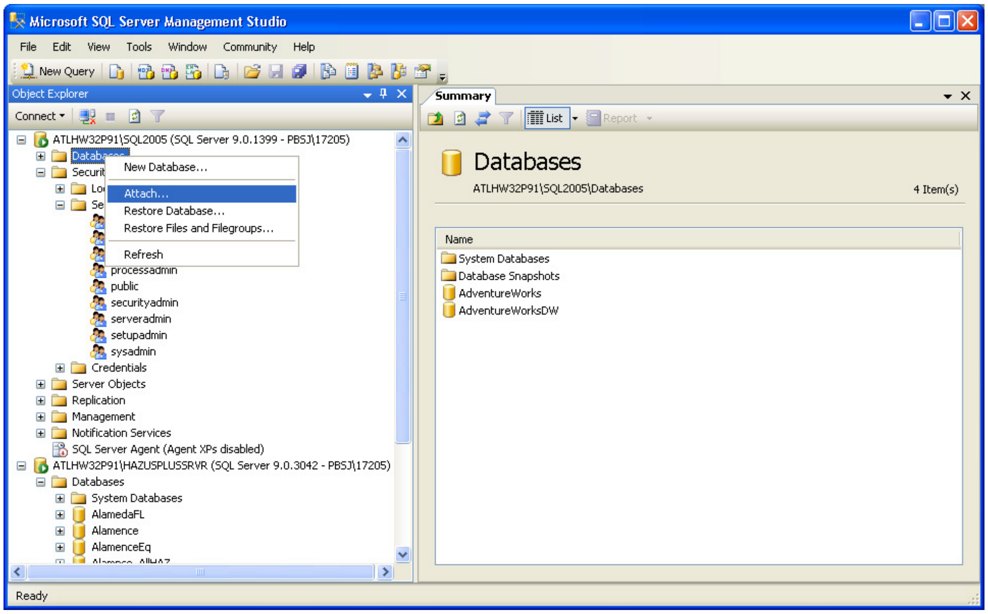


Figure F.10

This will launch the **Attach Database** dialog as shown in Figure F.11.

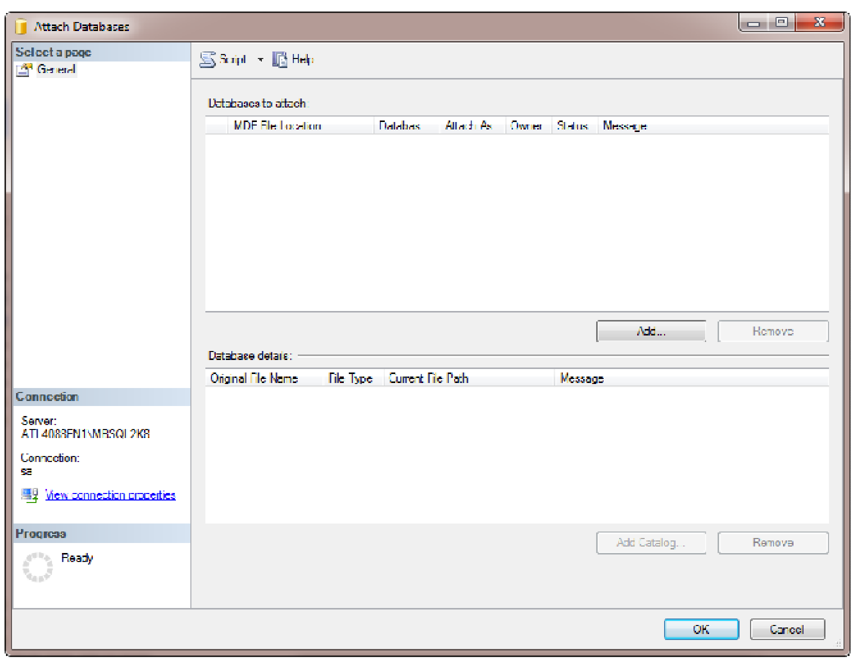


Figure F.11

18. Click Add button and browse to the folder where **Hazus-MH** is installed. Within **HAZUS-MH** folder, open Data folder (Figure F.12).

19. Select syHazus_Data.MDF and click OK.

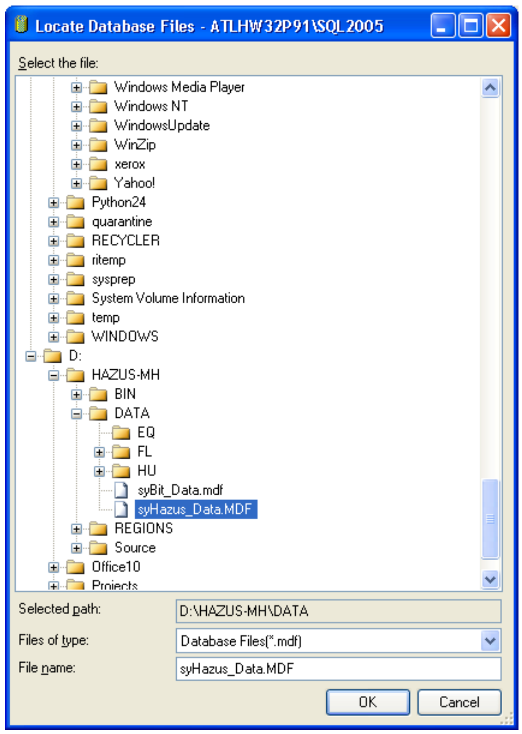


Figure F.12

20. Click Add button and browse to the folder where **Hazus-MH** is installed. Within **HAZUS-MH** folder, open Data\FL folder (Figure F.12).

21. Select flTmpDB_data.MDF and click OK.

22. Finally, click OK in the 'Attach Databases' window to attach both syHazus_Data and flTmpDB_data simultaneously.

23. Right click the mouse on New Server (**ATLHW32P91** in Figure F.13) in the Management Studio. Select **Properties** from the short cut menu. This will launch the **Server Properties** dialog. Click on **Security** option, and make sure that Server Authentication is set to **SQL Server and Windows Authentication Mode** as shown in Figure F.13.

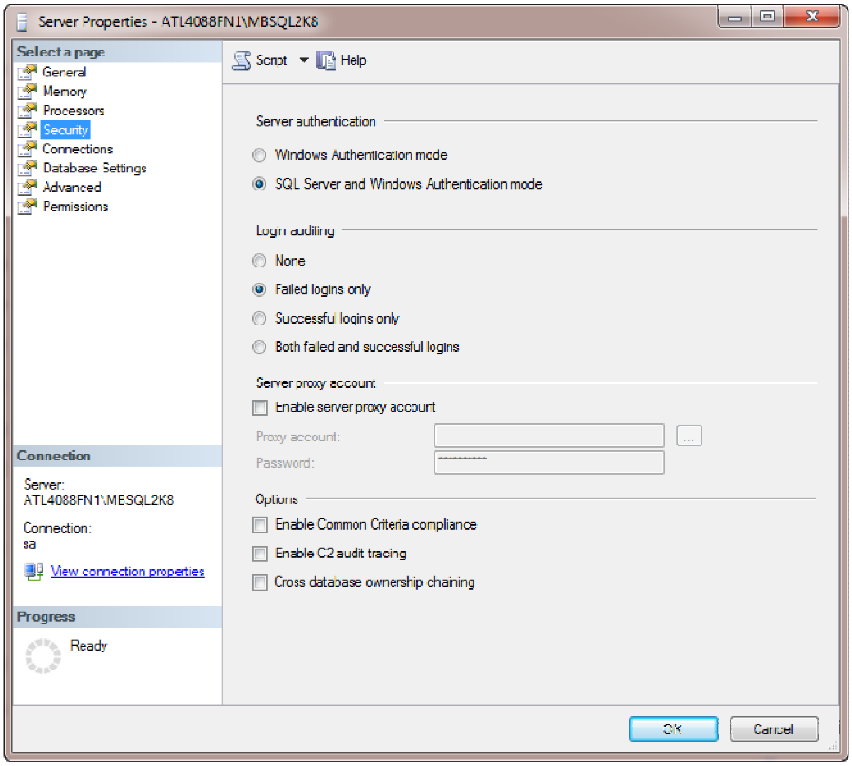


Figure F.13

Hazus is ready to be run from the New SQL Server. Proceed with creating the desired new study regions.

IMPORTANT NOTE:

Steps above are valid if the re-connection from the SQL Server Express edition to the full version of SQL Server is done right after the **Hazus-MH** setup. If any number of study regions has been created already, then ALL those study regions must be also moved to the full SQL Server 2008 R2 (follow same process above as for syHazus database).

F.4 Steps to Re-configure Hazus-MH to User Original SQL Server Express

Once **Hazus-MH** has been configured to run with SQL Server 2008 R2 it cannot be uninstalled. Before uninstalling **Hazus-MH** it's necessary to reconfigure **Hazus-MH** to run with HAZUSPLUSSRVR, the way it was configured by the installation. Follow the steps outlined below to achieve this (basically, reversing the syHazus database move):

1. Launch SQL Server Management Studio Manager.

2. Detach syHazus database from SQL Server.

3. Attach syHazus to the HAZUSPLUSSRVR.

4. Detach flTmpDB_data database from SQL Server.

5. Attach flTmpDB_data to the HAZUSPLUSSRVR.

6. Launch the SQL Server Configuration Manager from **Start|Programs|Microsoft SQL Server 2008 R2|Configuration Tools|SQL Server Configuration Manager.** Select "SQL Server 2008 R2 Services" from the list on the left, then select the HAZUSPLUSSRVR instance, right-click, and select Restart.

7. Restart also the full SQL server instance by following the same steps.

After you are done with all the steps above, you need to do the following:

- Select the HAZUSPLUSSRVR instance in the SQL Server Management Studio
- Right-click and select Facets
- Make sure the the AdHocRemoteQuriesEnabled option is set to true under the Surface Area Configuration option as shown in Figure F.14.

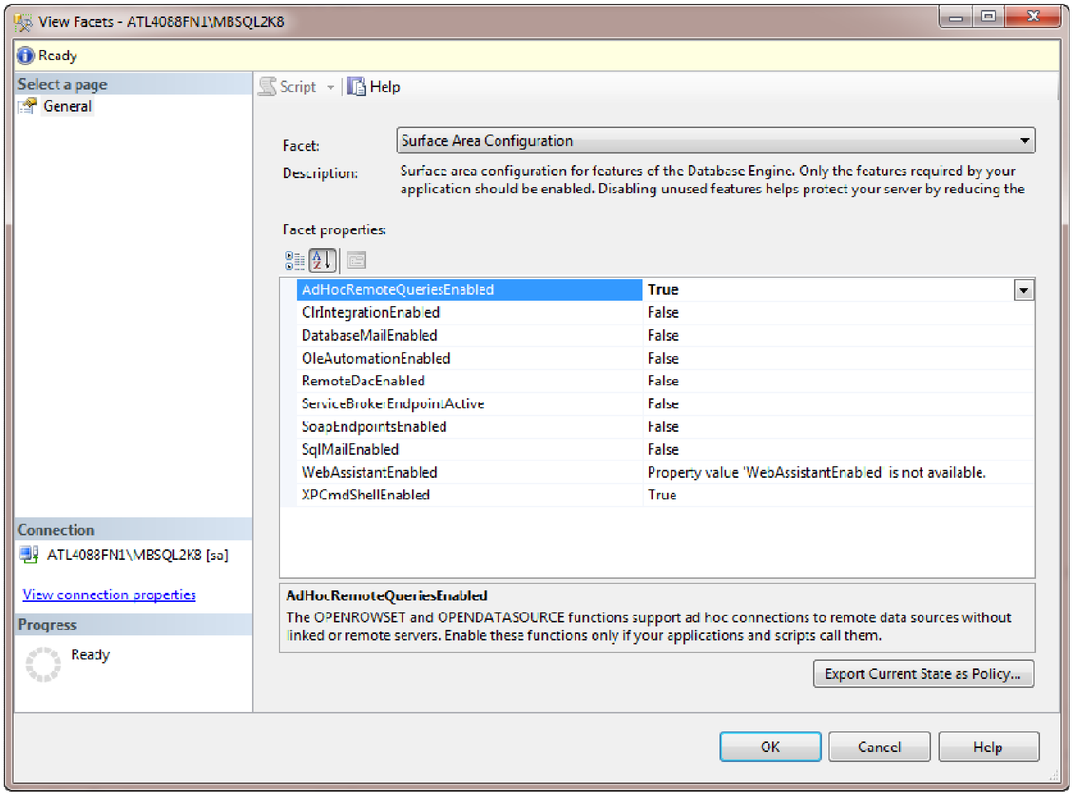

View Facets - ATL4088FN1\MBSQL2K8
Ready
Select a page
General
Script
Help
Facet:
Surface Area Configuration
Description:
Surface area configuration for features of the Database Engine. Only the features required by your application should be enabled. Disabling unused features helps protect your server by reducing the
Facet properties:
AdHocRemoteQueriesEnabled True
ClrIntegrationEnabled False
DatabaseMailEnabled False
OleAutomationEnabled False
RemoteDacEnabled False
ServiceBrokerEndpointActive False
SoapEndpointsEnabled False
SqlMailEnabled False
WebAssistantEnabled Property value 'WebAssistantEnabled' is not available.
XPCmdShellEnabled True
Connection
ATL4088FN1\MBSQL2K8 [sa]
View connection properties
Progress
Ready
AdHocRemoteQueriesEnabled
The OPENROWSET and OPENDATASOURCE functions support ad hoc connections to remote data sources without linked or remote servers. Enable these functions only if your applications and scripts call them.
Export Current State as Policy...
OK
Cancel
Help

Figure F.14