



**Technical Procedures & Issues:  
Importing User Defined Facilities into HAZUS**

**Midwest Flooding 2008  
Albion Township, Dane County, WI**

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# Technical Procedures & Issues: Importing User Defined Structures into HAZUS

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## 1.0 Introduction

This companion report is written for users who wish to replicate the steps that were used in the report entitled “*Structure Level Flood Damage Analysis: NFIP & HAZUS*”. This document provides the steps in order to run a HAZUS analysis using imported User Defined Structures (also called User Defined Facilities). These instructions are supplemental to and should not replace the HAZUS-MH MR3 Flood User Manual or MR3 Flood Technical Manual.

The procedure for a HAZUS analysis on User Defined Structures (UDS), as shown below in Figure 1, is to first delineate and format the data in ArcGIS, then prepare and import the UDS data into HAZUS, then run the analysis, and finally view the results.

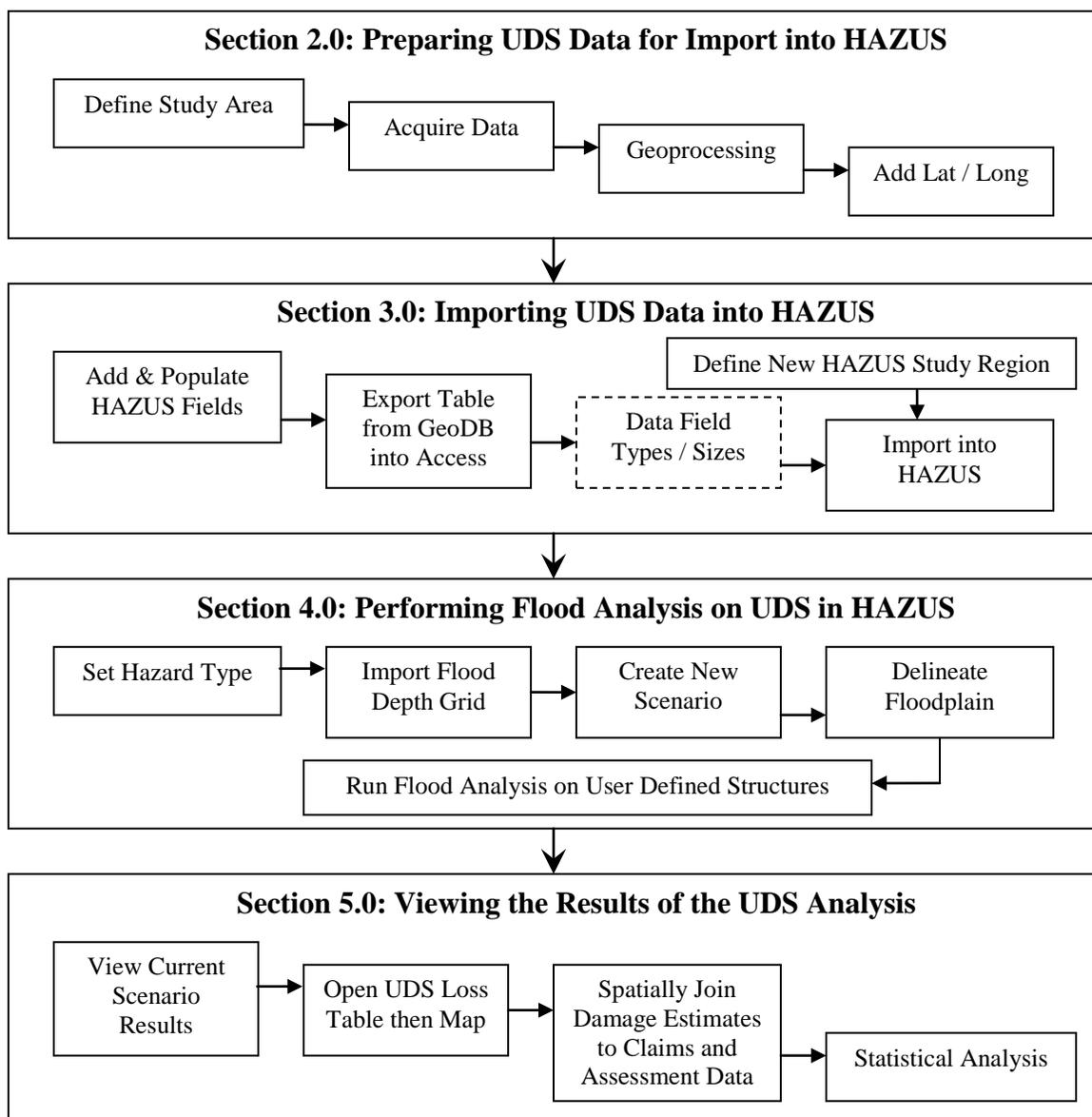


Figure 1: Procedure for Importing User Defined Structures & Running Flood Analysis in HAZUS

## **2.0 Preparing User Defined Structure Data for Import**

The first step to a HAZUS analysis on User Defined Structures is delineating the study area and gathering the necessary data. Chapter 5 of the HAZUS-MH MR3 User Manual details the reasons, procedures and potential sources for collecting additional data and Chapter 6 describes importing additional data into HAZUS, which will be discussed in Section 3.0 of this document. The goal of the analysis in the companion report was to compare HAZUS estimated flood damages against assessment values and against NFIP damage claims at the structure level from the June 2008 flooding in Dane County.

### **2.1 Study Area Delineation and Data Acquisition**

As discussed in the companion report, the Township of Albion in Dane County, Wisconsin was chosen as the study area. Section 2.2, Table 1 lists the data that HAZUS allows for import into the User Defined Facilities table; the more data that you can find and provide to HAZUS, the more complete your results.

Data acquired from Dane County Land Information Office (LIO) included parcels, building footprint centroids and digital elevation model. The footprint centroids layer defines the location of the User Defined Structures that are imported into HAZUS. The parcels layer not only contained the needed street address information for each parcel, but also had the assessment data (value of land and value of improvements) for each parcel. Aside from parcels and footprints, other useful data such as roads, hydrography, municipal civil divisions, building footprint polygons and orthophotography were also collected from the county for inclusion in mapping output.

Additional data for each structure, including year-built, number of stories and first floor square footage was obtained from the company contracted by the Town of Albion to do their assessments, Accurate Appraisal, LLC.

Fortunately for this analysis, the USGS Wisconsin Water Science Center provided the flood depth grids from this specific flooding event on its website as an accompaniment to its "Flood of June 2008 in Southern Wisconsin" (SIR 2008-5235) report. Please visit <http://wi.water.usgs.gov/surface-water/flood2008/> for more information.

For discussion on limitations of the data received and possible issues in the large scale application of these procedures, see Section 2.3 of this report.

### **2.2 Data Manipulation and Geoprocessing**

Data must first be aggregated together into one table before it can be imported into HAZUS. With the data being a mixture of GIS Shapefiles and database tables, a number of spatial joins and table joins will need to occur, as well as detective work to determine which structures are houses and not garages and therefore able included as a point in the feature class. First, all the GIS data layers were clipped to the extent of the township boundary in order decrease file sizes and therefore minimize processing times. Then each shapefile was imported into a Geodatabase for data consolidation and to synchronize the projections.

Before the data is aggregated, the fields that HAZUS allows data to be imported into should be identified. Figure 6.7 on page 6-7 of the HAZUS User Manual lists the Field Names, Data Types and Field Lengths for the fields that can be imported for a User Defined Structure analysis and is reproduced in the following table, which also includes where the data for this analysis originated as well as the section that describes how each field was assembled or defined.

<u>Field</u>	<u>Type</u>	<u>Size</u>	<u>Where Acquired or How Defined</u>	<u>Section</u>
<i>CONTACT</i>	Text	40	<i>Unnecessary</i>	-
<i>NAME</i>	Text	40	<i>Unnecessary</i>	-
ADDRESS	Text	40	Parcels from County, see also Section 3.6.2 in report	2.2.2
CITY	Text	40	Parcels from County	2.2.2
STATE	Text	2	Parcels from County	2.2.2
ZIPCODE	Text	40	Parcels from County	2.2.2
<i>PHONENUMBER</i>	Text	47	<i>Unnecessary</i>	-
OCCUPANCY	Text	5	Land Use from County	2.2.1
YEARBUILT	Integer	2	Township Assessor: Accurate Appraisal, LLC	2.2.4
COST	Currency	8	Parcels from County, see also Section 3.6.3 in report	2.2.3
<i>BACKUPPOWER</i>	Yes/No	1	<i>Unavailable</i>	-
NUMSTORIES	Byte	1	Township Assessor: Accurate Appraisal, LLC	2.2.4
AREA	Single	4	Township Assessor: Accurate Appraisal, LLC	2.2.4
<i>BLDGTYPE</i>	Text	15	<i>Unavailable</i>	-
LATITUDE	Double	16	ArcGIS, Hawth's Tools	2.2.6
LONGITUDE	Double	16	ArcGIS, Hawth's Tools	2.2.6
<i>COMMENT</i>	Text	40	<i>Unnecessary</i>	-
CONTENTCOST	Currency	8	HAZUS Default, defined by Cost and Occupancy	2.2.3
DESIGNLEVEL	Text	1	HAZUS Default, defined by Year Built	2.2.5
FOUNDATIONTYPE	Text	1	<i>Unavailable</i> , set to multiple variables for comparison	2.2.7
FIRSTFLOORHT	Double	8	HAZUS Default, defined by Foundation Type	2.2.7
<i>SHELTERCAPACITY</i>	Integer	2	<i>Unavailable</i>	-
<i>BLDGDAMAGEFNID</i>	Text	10	<i>Undefined in HAZUS User and Technical Manuals</i>	-
<i>CONTDAMAGEFNID</i>	Text	10	<i>Undefined in HAZUS User and Technical Manuals</i>	-
<i>INVDAMAGEFNID</i>	Text	10	<i>Undefined in HAZUS User and Technical Manuals</i>	-
FLOODPROTECTION	Long Int	4	HAZUS Default, page 6-9 HAZUS User Manual	2.2.5

**Table 1: HAZUS Required Data Fields and Descriptions**

### 2.2.1 Occupancy Type

The building footprint centroids feature class is the starting point for creating the User Defined Structures. Each point in the centroids layer possesses a Land Use Code, which is based on the Standard Industrial Classification (SIC) codes used by the Federal Government. The building footprint centroids layer is a byproduct of Dane County's Digital Land Use Inventory, so with that dataset's User Documentation and Table 3.1 found in the HAZUS Technical Manual on page 3-3, a lookup table was created and

joined to the footprint centroids layer. Table 2 below shows an example of the lookup table created.

The centroid layer gets joined to the lookup table with Land Use Code as the key. After the table join, each point in the data layer contains the Occupancy Class. It is very important to note here that the Occupancy Type field cannot be null when the import into HAZUS is attempted, or else an error will occur and HAZUS will crash.

LUCODE	INVENTORY_TEXT	OCC_TYPE
9	Shopping Center	COM1
21	Food and Kindred	IND3
22	Textile and Mill	IND1
23	Apparel and Related	IND2
24	Lumber and Wood Products Manufacturing	IND1
111	Single Family	RES1
113	Two Family	RES3A
115	Multiple Family	RES3B
116	Farm Unit	RES1
129	Group Quarters	RES5
140	Mobile Home	RES2
142	Mobile Home Park	RES2
190	Seasonal Residential	RES4

**Table 2: Example Portion of Occupancy Lookup Table**

### 2.2.2 Address, City, State, Zip Code

HAZUS uses the longitude and latitude to define the location of User Defined Structures, so address information is technically unnecessary for running the HAZUS analysis. But aside from the fact that humans use address information as a unique identifier, this analysis focuses on comparing the results from HAZUS to NFIP claims as well as assessment values. The NFIP data is listed by address, so it is necessary to have address information during the data assembly and analysis phase.

The building footprint centroids layer did not contain an address field so it needed to be spatially joined to the parcel layer which did contain address information. This task is one of the places where error and uncertainty can enter the analysis, as discussed in Section 2.3.1 of this report. Until these discrepancies are removed from underlying data, these types of error will need to be fixed one by one, as was the case with this pilot dataset.

Since the Dane County parcel data also included assessment values, this spatial join to parcels also allows for the comparison of HAZUS damage estimates to assessment values. The address information can now be used to table join the NFIP claims data which will allow the comparison of the HAZUS damage estimates to NFIP claims.

### 2.2.3 Cost and Content Cost

The Cost and Content Cost fields in HAZUS refer to the replacement cost of the structure and the contents, respectively. It is important to note that HAZUS requires these costs, as well as the area field, to be in terms thousands.

Replacement cost is determined by insurance companies using specialized software and its calculation is analogous to HAZUS in that the more accurate data that is input, the closer to reality the results are. Based on conversations with an insurance agent, a pretty close approximation of replacement cost without having the knowledge of each individual structure's building materials, finish materials and fixtures can be determined by adding together the assessment values of the land and the improvements. Since the assessment values were added to the building centroids layer in the spatial join with parcels, Cost can be populated by adding the Land Value to the Improvements Value and multiplying the sum by 0.001 with the *Field Calculator* in ArcGIS, as shown in Figure 2 below.

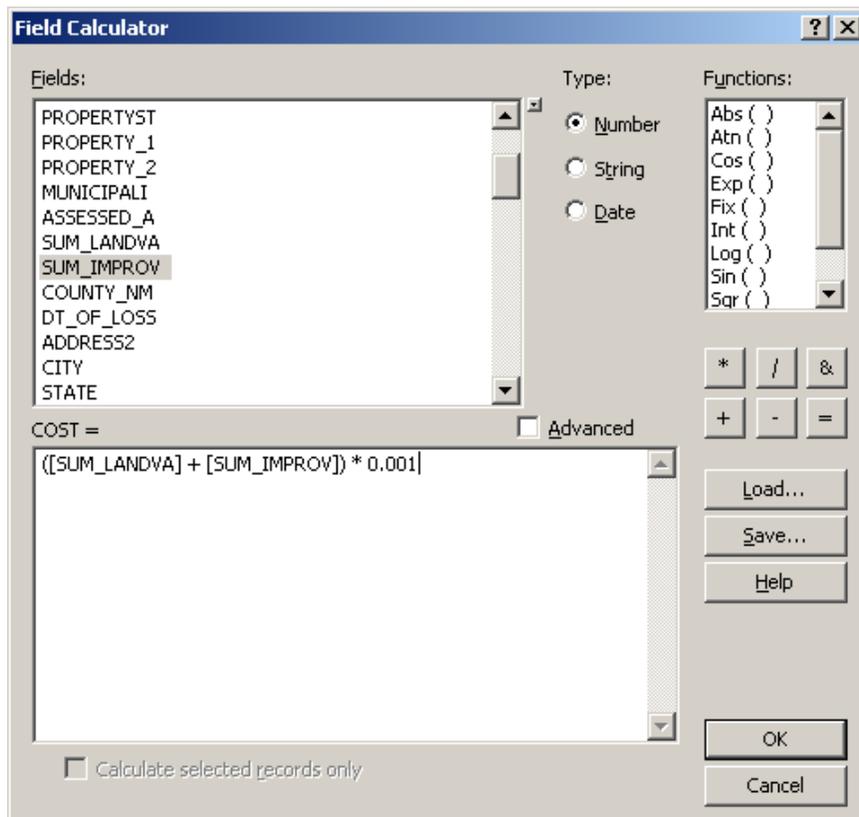


Figure 2: Defining "Cost" in thousands using Field Calculator

As for Content Cost, Table 6.5 on page 6-9 of the HAZUS User Manual shows that it is dependent on the Cost field and the occupancy type, so the Content Cost for a RES1 structure should be (Cost \* 0.5), while the Content Cost for a COM6 is (Cost \* 1.5). Another lookup table that contains the multipliers found in the User Manual can be created and joined to the centroids layer based on Occupancy Type, and then the *Field Calculator* in ArcGIS can easily be used to populate the Content Cost field. One time

saving technique would be to include the Content Cost modifier in the lookup table created in Section 2.2.1 for the Land Use Codes to Occupancy type.

#### 2.2.4 Year Built, Number of Stories and Area

These three fields are filled with the data acquired from the local assessor. Note that Area is the square footage of the building footprint and that HAZUS requires it to be in terms of thousands. The assessor data has the area of the first floor, which is a good approximation of the building footprint.

A table containing Address, Year Built, Number of Stories and Area can be table joined to the centroids layer provided that the address fields are standardized. As discussed above, the quality of the data determines the time and labor requirements of what should be relatively simple procedures. This assessor data can be joined to the address in the parcel data either before or after the parcels have been spatially joined to the building centroids layer, as described in Section 2.2.2.

#### 2.2.5 Design Level and Flood Protection

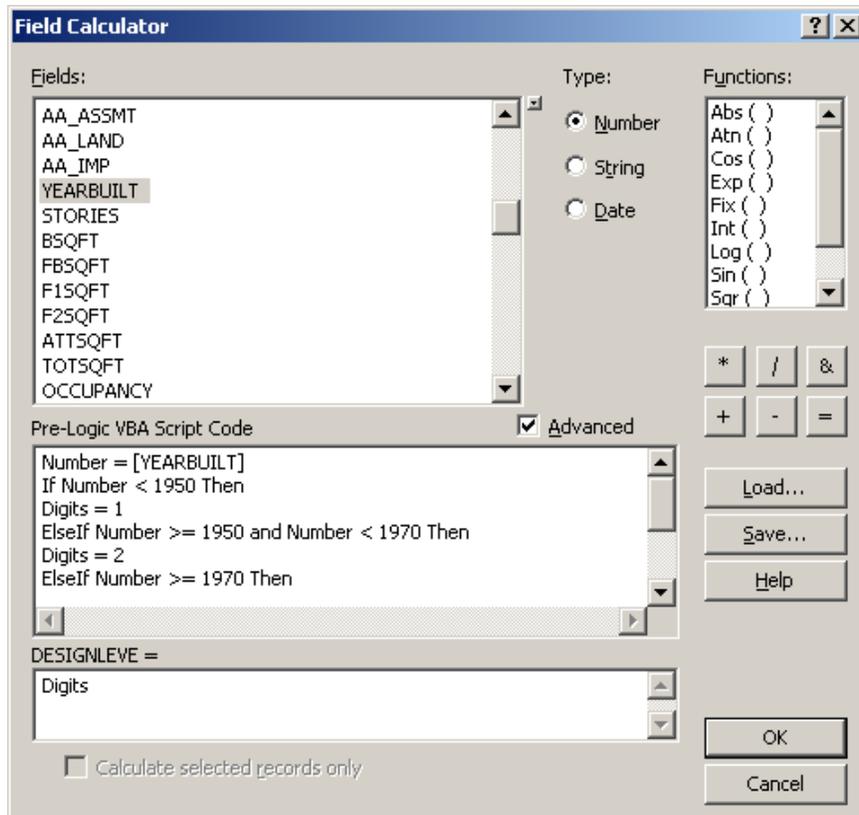
The Design Level field is defined in Table 6.2 on page 6-8 of the HAZUS User Manual and is dependent on the year that the structure was built. A structure built before 1950 has its design level set to 1, built between 1950 and 1970 is set to 2, and built after 1970 is set to 3. A null year is to be set 0 in the table, although it is stated in the User Manual on page 6-9 to set the year of a structure that has an unknown year to the local trend or to 1970, so therefore the Design Level is set accordingly.

To set the Design Level, the *Field Calculator* in ArcGIS is used with Pre-logic VBA Script Code by clicking the check box next to advanced, (Figure 3). In the text area for code, the following script can be used (where [YEARBUILT] is the field name containing the year data):

```
Number = [YEARBUILT]
If Number < 1950 Then
  Digits = 1
ElseIf Number >= 1950 and Number < 1970 Then
  Digits = 2
ElseIf Number >= 1970 Then
  Digits = 3
Else
  Digits = 0
End If
```

In the lower text box 'Digits' should typed (without the quotes) and then click OK. The field will populate with the Design Level.

As for the Flood Protection field, page 6-9 of the User Manual states to set it to the default of zero unless it is near a dam or dike, in which case it should be set to that level. For this project, Flood Protection was set to zero for all records.

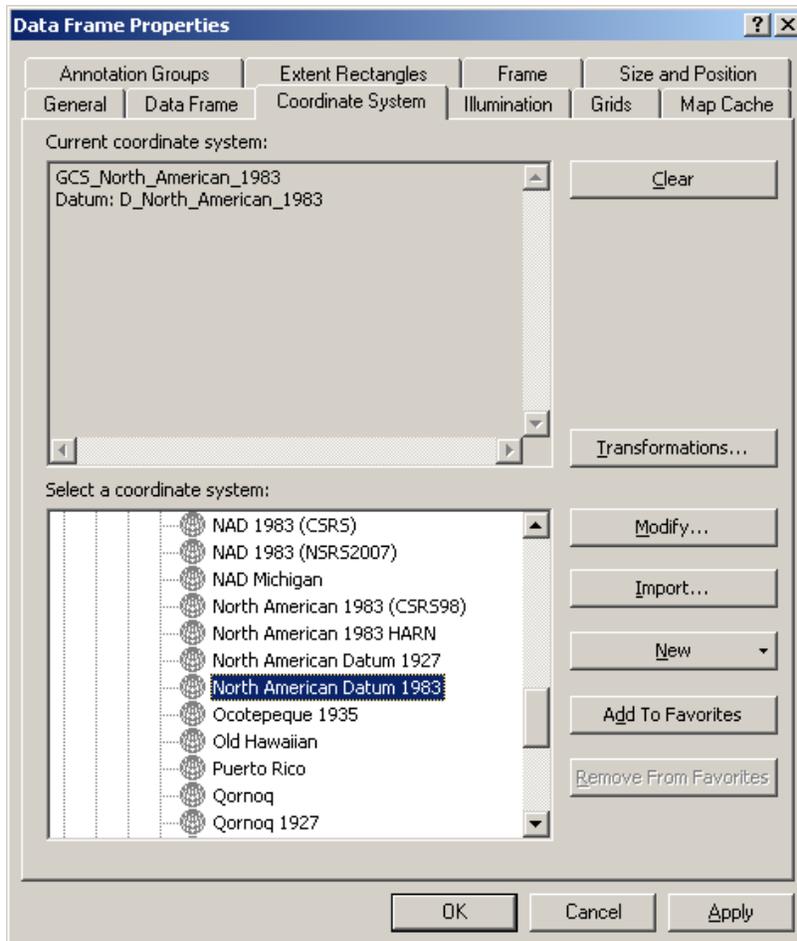


**Figure 3: Defining "Design Level" using Pre-Logic in Field Calculator**

### 2.2.6 Latitude and Longitude

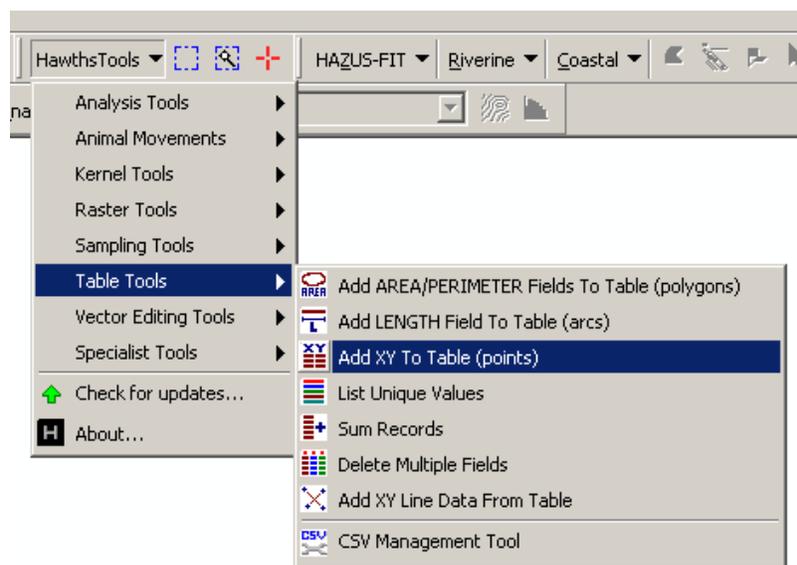
HAZUS uses the Latitude and Longitude when it performs a flood analysis on User Defined Structures. These values need to be in a field in the table in order to import them, and one easy way to get these values is to use a free extension written for ArcGIS named Hawth's Tools.

After downloading, installing and adding Hawth's Tools to the toolbar, the Latitude and Longitude can be added to a point layer in a few clicks. It is important to first change the coordinate system of the data frame in ArcGIS to something that uses decimal degrees, such as NAD83. To do this, go to *View > Data Frame Properties* and go to the *Coordinate System* tab. As shown in Figure 4 below, in the lower text area box, navigate to *Predefined > Geographic Coordinate Systems > North America > North American Datum 1983*, highlight it and hit *OK*.



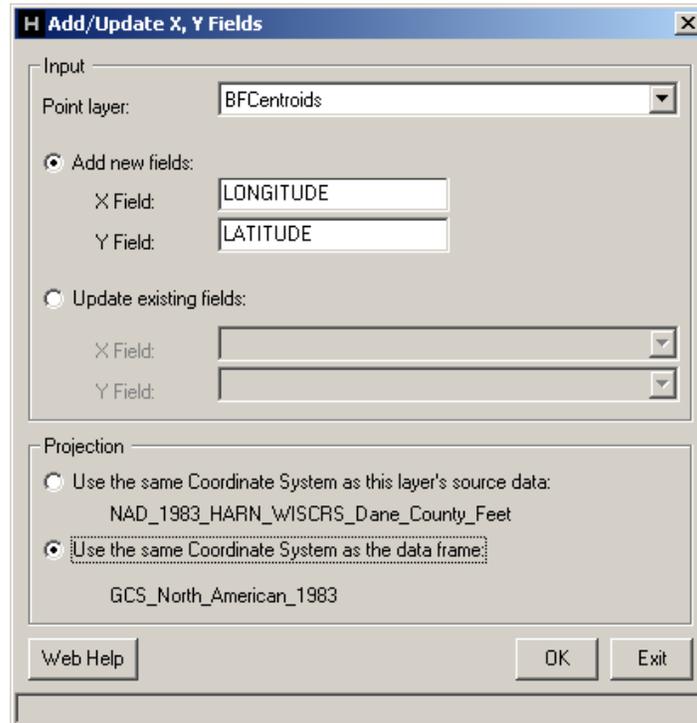
**Figure 4: Define the data frame Coordinate System**

Now that the data frame is in decimal degrees, the Latitude and Longitude can be added to the table. Go to *HawthsTools Menu > Table Tools > Add XY to Table* (Figure 5).



**Figure 5: Use Hawth's Tools to add Latitude/Longitude**

In the *Add/Update X,Y Fields* dialog box, select the building footprint centroids layer, and either *Add New Fields*, as shown in Figure 6, or select existing fields to update, then select the option to *Use the same Coordinate System as the data frame* and click *OK*. It is important remember that Longitude is the X coordinate (easting, westing) and Latitude is the Y coordinate (northing). The data table will now contain the decimal degrees coordinates as shown in Figure 7 below.



**Figure 6: Add new fields or update existing fields with Latitude/Longitude**

Occupanc_1	Cost_1	Area_1	Longitude	Latitude	County_1
RES1	168	1.19112	-89.103161	42.8587	DANE
RES1	90.4	0.716316	-89.020271	42.858413	DANE
RES1	0	0.382855	-89.01652	42.851706	DANE
RES1	152.7	0.093149	-89.017398	42.850547	DANE
RES1	55	0.523566	-89.055912	42.848082	DANE
RES1	11.8	0.811456	-89.061956	42.84825	DANE
RES1	79	0.331542	-89.062383	42.848236	DANE
RES1	112.4	0.261791	-89.062957	42.848175	DANE
RES1	124.3	0.951862	-89.064346	42.848222	DANE
RES1	184.7	2.37884	-89.082273	42.848057	DANE
RES1	236.6	1.61375	-89.068831	42.848255	DANE
RES1	236.6	0.734188	-89.068509	42.847991	DANE
RES1	236.6	1.04361	-89.068204	42.848073	DANE
RES1	236.6	1.71205	-89.068464	42.848164	DANE
RES1	0	0.177415	-89.061259	42.848051	DANE
RES1	147.5	1.96199	-89.058872	42.848168	DANE

**Figure 7: Table with Latitude/Longitude appended**

It is important to note that when Hawth's Tools creates coordinates from the spatial location of the points, the Latitude and Longitude fields are populated with numbers that have six decimal places. But after the data is imported into HAZUS, the analysis is run and the results are mapped, the original point layer will not line up with the HAZUS data because HAZUS truncates the Latitude and Longitude to only four decimal places. While this doesn't create major locational discrepancies, as the average distance difference between the original data and the imported data for this pilot project was less than 4 feet, it is important to document this fact when a comparison is being attempted between HAZUS damage estimates and another piece of data for each structure, for example, NFIP claim amounts.

### *2.2.7 Foundation Type and First Floor Height*

As discussed in this report, the HAZUS analysis was run four times on the same data but with different values for Foundation Type and First Floor Height. These two variables, when combined with the Flood Depth Grid, are integral to the damage estimates that HAZUS outputs. Part of this analysis became trying to determine which types and heights came closest to actual claims values because there was no data available for each of these fields.

Table 6.3 on page 6-8 of the User Manual shows the values that should be entered into the Foundation Type field for structures with various types of foundations, such as basement, crawl space or slab on grade. The manual also states on page 6-9 that the default Foundation Type should be 7, which corresponds to a structure with a slab on grade.

The defaults for First Floor height are found in Table 6.4 on page 6-9 of the User Manual and are dependent on the Foundation Type field. These defaults were used in three of the HAZUS analyses described in the companion report, while one analysis was performed where Foundation Type was set to basement but the First Floor Height was set to 2 feet instead of the default 4 feet. The section cited in the last paragraph also discusses the First Floor Height field and the values that were used for each of the four HAZUS runs.

## **2.3 Data Problems and Limitations**

Problems with data inconsistency can arise when data from many locations and different creators are attempted to be merged together, as was the case with this analysis. Along with problems getting datasets to 'talk' to one another, it also happens that the only data available for an attempted task does not necessarily contain exactly what is needed to perform that specific analysis. This is not a critique, because data is usually created for a specific situation and there usually is no need to make a dataset do more than the specific role for which it was created, and the limitations are only discovered when an end user tries to use the only available data for purposes beyond the original scope of the dataset.

Extracting the best available data and reformatting it into a useable form can be a time consuming process that should be budgeted for when attempting this type of analysis.

Approximately 80 hours were spent working around the situations described below in this limited study area for the first phase of this analysis. Some of that time was extraneous since this is a pilot study and used unfamiliar data. Approximating the time necessary for an analysis at the county level is difficult because it is not a simple extrapolation. The data reconciliation tasks only took an additional 80 hours for the township of Albion, and if some of the recommendations of this report are implemented, the time required for this step could be reduced if not eliminated and a countywide analysis could be performed in a lot less time.

### *2.3.1 Building Footprint Polygons and Centroids*

Beyond an identification field and a Land Use Code, each footprint polygon and centroid does not contain additional data such as street address or parcel number. A spatial join to parcels is the workaround to get assessment values assigned to the centroids, which leads to a new problem of multiple points in one parcel being assigned the same replacement value. This problem is mostly due to the assumption of this analysis that uses the assessed value as an approximation of replacement cost. If data is available for the replacement cost of each individual structure on a parcel, then it is possible to use more than one point per parcel.

The first phase of this analysis was completed before receiving the building footprint data with the primary or accessory structure attribute, but it was possible to determine the type of building using a combination of orthophotography, Google Street View and Bing Maps 3D. A building that was found to be a garage or auxiliary structure was removed from the point dataset to ensure only one structure was assigned the assessment value as the replacement cost and so HAZUS calculated the damage estimates correctly. The Dane County Land Information Office later took over 40 hours to add an attribute to building centroids in Albion that defines a structure as primary or accessory using the visual method described above. This work allowed the second phase of this analysis to proceed for the entire township of Albion. As stated previously, an additional 40 hours were spent in the second phase cleaning up the data to ensure only one structure was assigned the value of the assessment for each parcel, as well as determining which parcel belonged with which centroid as described in the following section.

### *2.3.2 Parcels*

The parcel layer provided by the county generally matched well with the building footprint locations in the Township of Albion. But the specific area around Lake Koshkonong where the June flooding occurred had numerous examples of mismatches between parcel boundaries and building footprints. For example, there are houses on two parcels that had different owners so it was difficult to determine which parcel data belonged with which building footprint and which parcel's address was the correct address of the building. There are several reasons for possible errors with the parcel features, such as: many structures on the parcel but only one house; many parcels individually assessed with the same owner but only one structure; or no structure but the parcel has an assessment value for both land and improvements. In Figure 8 below, parcels have been dissolved based on the field '*Owner Name*' and shown with building footprints and the original parcel layer as dashed lines.



**Figure 8: Example where building footprints span multiple parcels with different owners**

There are also examples of the centroids falling outside the boundaries of the parcel polygons, see Figure 9 below, which can lead to errors when attempting to assign addresses or assessment values to those structures. A *'Nearest to'* spatial join may work for these errors, but the accuracy of this type of join is uncertain when data doesn't line up exactly.



**Figure 9: Area where footprint centroids are selected that fall outside of parcels**

Additionally, areas can be found where it seems a subdivision was platted out differently from how it was actually built so the road can be seen on the orthophotography running through parcels (Figure 10).



**Figure 10: Area of Dane County, WI where parcels do not line up with orthophotography**

These examples indicate that the parcel spatial accuracy, data completeness and data currency need to be considered when utilizing parcel boundaries within this context. These issues may lead to the problem of quantifying a level of certainty for errors in HAZUS damage estimates that were run with data from this feature class.

### 2.3.3 Assessment Data

The parcel data contained both the assessment value of the land and the assessment value of the improvements. The parcel metadata claims “it is not intended for site specific analysis” and the intent of this analysis is site specific, so additional assessment data was located for the Township of Albion from the company Accurate Appraisal, LLC. The first phase was completed before the assessor data for the township was received, but a table was created from their website with the assessment values, year built, square footage and number of stories and was joined via address to the data to be imported into HAZUS. A simple table join on address was used during this analysis, but a better procedure would be to geocode<sup>1</sup> the NFIP claims to a known point address layer or a streets layer. The second phase of this analysis used the data received from Accurate Appraisal and geocoded the address data to the county’s parcel layer.

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<sup>1</sup> “Geocoding is the process of finding associated geographic coordinates from other geographic data, such as street addresses.” via <http://en.wikipedia.org/wiki/Geocoding>

The county parcel layer contained the previous year's assessment data while the data from Accurate Appraisal contained the most recent assessments taken after the flooding event in 2008. HAZUS damage estimates should be determined using the assessment data prior to the flooding event because post-flooding assessment values are useless for comparison between the HAZUS estimates and the claim amounts.

#### 2.3.4 *NFIP Claims*

The NFIP Claims data was received as a spreadsheet with a list of addresses and the claim amounts. The minor reason that this is in the Data Problems section is because of address standardization. Lack of address standardization can introduce errors that may have to be manually fixed, such as these three neighbors:

xxx Lakeshore Dr  
yyy Lakeshore  
zzz Lake Shore Dr

The last address is correct and matches the parcel layer, the first address should be Lake Shore not Lakeshore, and the second address is missing the street type identifier. With a small dataset this problem is easily fixed, but as a dataset gets larger, the task of fixing minor errors can take a significant amount of time.

As mentioned earlier, using a geocoding tool on the NFIP claims data would be a good way to find the point locations of the structures with claims, and in the process the software would attempt to standardize the addresses. When geocoding software cannot assign a location because of an incomplete address, protocols are defined to place the address in the best location, either by automatically putting it in the center of a zip code or street segment, or reconfiguring the address to conform to the base data, or manually placing the point. Also notable is the fact that the geocoding process tends to have better results in urban areas compared to rural areas. Other potential problems can occur if there is poor quality, accuracy or currency in the streets layer being used to geocode the address.

### 3.0 Importing User Defined Structure Data into HAZUS

At this point, the data table for the building footprint centroids feature class can be a bit unwieldy with all the tables that have been appended and the new fields that have been created. The data fields discussed in the last section and found in Table 1 are the only fields that actually get imported into HAZUS for the number crunching, but some of the data that does not get imported is still needed for comparing and analyzing the results that HAZUS estimates. The procedures in this section outline the steps taken with this pilot dataset to prepare it for import into the User Defined Facilities table in HAZUS.

#### 3.1 Add & Populate HAZUS Fields

Table 1 in Section 2.2 contains the data fields, along with their corresponding data types and precision lengths, which need to be added to the building centroids layer and then populated with data as described in the previous sections. It is very important to get the data types correct as HAZUS will not allow the importation of data that is in an incompatible data type to what it is programmed to expect. If the length is wrong, HAZUS will give a warning that the field is too long, Figure 8, and will still import the field, but when the data type is wrong, it will display the error shown in Figure 9 and not allow the import.

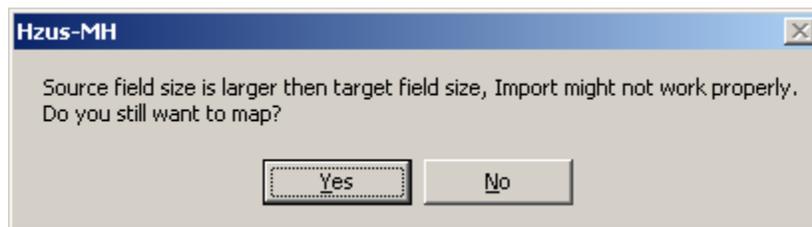


Figure 11: Importing error when field length is too long



Figure 12: Importing error when data types are incompatible

Section 6.1.3, starting on page 6-5 of the User Manual, discusses importing User Defined Facilities and was the basis for the procedures described in this appendix. The specifics found there, especially the tables cited in the previous sections, are necessary to create a User Defined Structures dataset that has the correct nomenclature and defaults that will allow HAZUS to properly process the data and produce more accurate results. When the procedures detailed throughout Section 2.2 are concluded, the User Defined Structure data can be imported into HAZUS.

### 3.2 Export table from Geodatabase into Access

The *Field Mapping* dialog box is used to map the fields from the incoming data table to the corresponding field in HAZUS and requires an .mdb file. Geodatabases are of the file type .mdb, so when the User Defined Structures import tool opens a Geodatabase and a feature class is selected, the *Field Mapping* dialog looks like Figure 14 on the following page. But it seems that any attempt to use this import tool with a Geodatabase is met with the error message shown in Figure 13, and furthermore, clicking *OK* or cancelling the error box is followed by a hard crash of HAZUS (technically ArcGIS) where Windows Task Manager must be used to terminate the application or process.

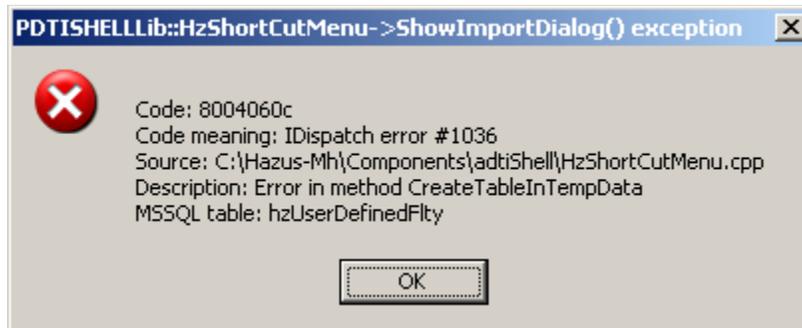


Figure 13: Error when using a Feature Class from a Geodatabase causes a hard crash

But when an .mdb created with Access is used as the source data instead of a Geodatabase, the *Field Mapping* dialog box looks like Figure 14 on the following page. The difference between these figures is noticeable in two areas. First, when an Access database is used, there is a message at the top of the dialog box that states “*OK button will remain disabled until Latitude and Longitude fields are mapped.*” The other difference is that the Latitude and Longitude fields are not listed on the Target side of the *Field Mapping* dialog when a Geodatabase is used, but when an Access created .mdb is used, Latitude and Longitude are available in the list.

Since the User Defined Structures import tool seems to be unable to use Geodatabases, the feature class table must be exported to Access. One method to do this is first open Access to create a new blank database (*Ctrl+N*, select *Blank Database*, then name it and click *Create*) and then open the Geodatabase with all the data in Access (*Ctrl+O*, navigate to Geodatabase). After the Geodatabase is open in Access, all the feature class tables in the Geodatabase are displayed, along with a number of other tables that define the Geodatabase. Note that each feature class has a table with “\_Shape\_Index” appended to it. Do not select one of those in the next step. Right click on the centroids layer, select *Export...* from the menu and a dialog box similar to *Open* will display. Select the .mdb created in the first step and the table from the Geodatabase will now export to the new database.

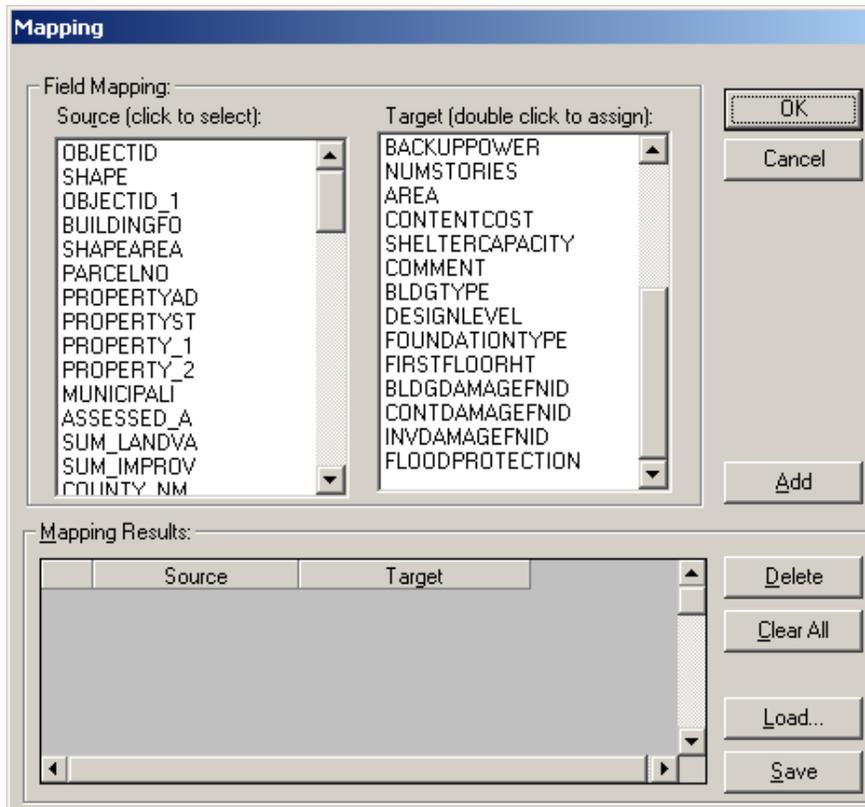


Figure 14: Field Mapping dialog using a Feature Class from a Geodatabase

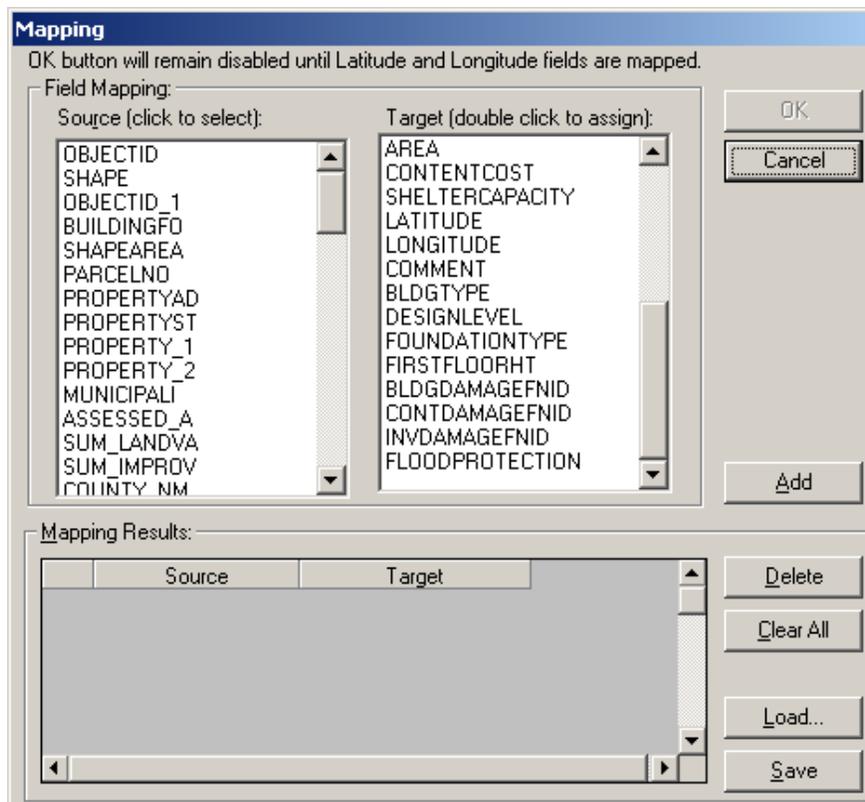


Figure 15: Field Mapping dialog using an Access created .mdb file

### 3.3 Checking Data Field Types and Sizes

With the data now in a readable format, it should simply be able to be imported into HAZUS. But it was found in this pilot project that some of the field types and lengths were altered throughout the process. Granted, many things were attempted along the way to understand how this process operates and to get it to work, so this problem may not occur for every dataset.

It is a fairly simple task to double check the field types so problems will not occur when the User Defined Structures are imported. Open the database that the Geodatabase table was exported into and click the *Design* button, seen in Figure 16 below. The *Field Properties* for the table will be displayed and each field type can be cross-referenced against Table 1 in this document and can be modified towards the bottom of that window if found to be altered.

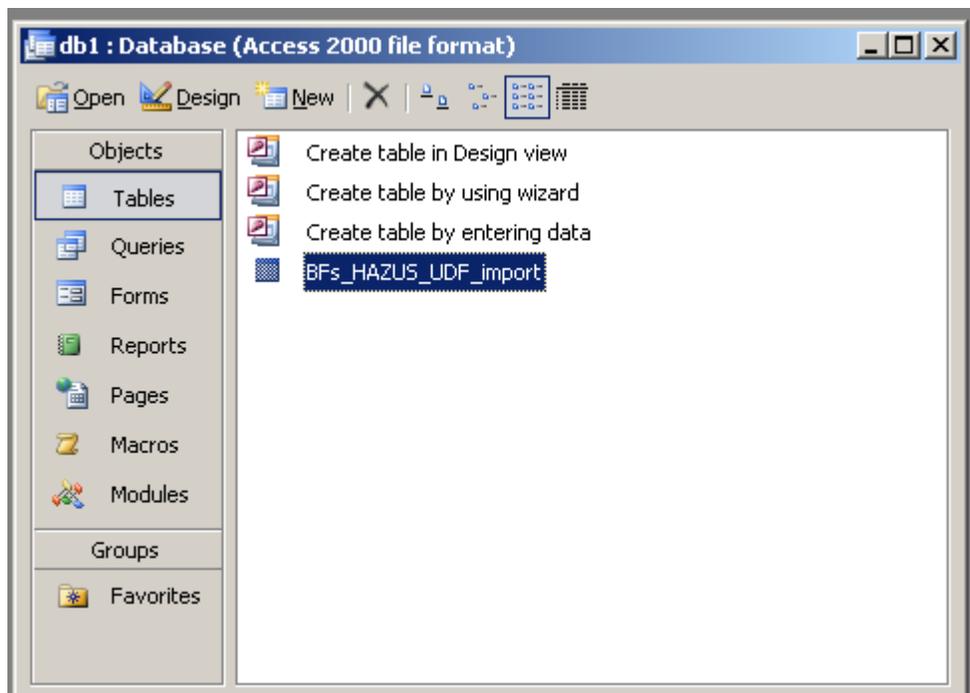
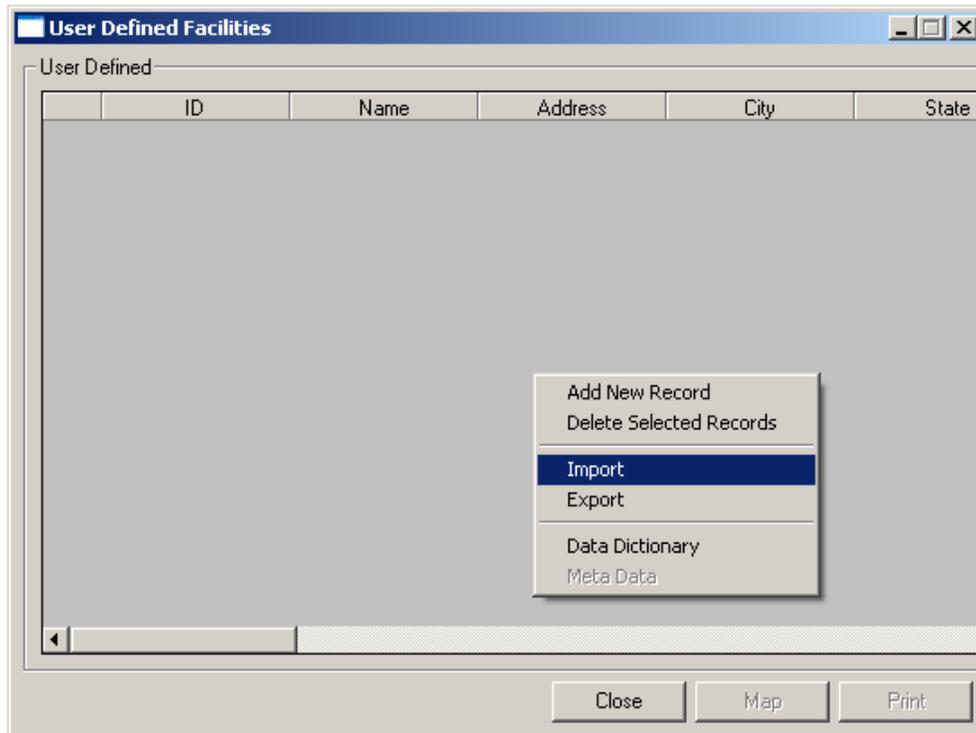


Figure 16: MS Access database with table exported from Geodatabase

### 3.4 Importing User Defined Structures into HAZUS

The User Defined Structures import utility in HAZUS is accessed through *User Defined Facilities* under the *Inventory* menu. After the User Defined Facilities window opens, right click in the blank field and the menu shown in Figure 17 below will appear.



**Figure 17: Right-click to find the *Import* menu item in *User Defined Facilities* window**

Select *Import* and then the *Field Mapping* dialog box, discussed previously in Figure 15, will open. Select each field in the left *Source* list and then double click on the corresponding field in the *Target* list until all the necessary fields are mapped. There is also a *Save* function that should be used to store the mapped fields when the same data fields will be used for future User Defined Structures analysis. More detail can be found on page 6-3 and 6-4 of the HAZUS User Manual.

The time required to import the User Defined Structures will be based on the size of the dataset and the specifications of the computer. The 18 structures imported for the pilot project took very little time to import. A test run of about 2,500 records only took around 15 minutes.

After the importation has finished, the *User Defined Facilities* dialog box must be closed and reopened before the imported data will appear in the list. Figure 18 below shows imported data in the *User Defined Facilities* window. At this time the structures can be turned into a point layer by clicking the *Map* button and can be exported from ArcGIS and saved as a shapefile.

User Defined Facilities					
User Defined					
	ID	Name	Address	City	
1	US000001		360 LAKE SHORE DI	EDGERTON	WI
2	US000002		342 LAKE SHORE DI	EDGERTON	WI
3	US000003		82 OAK ST	EDGERTON	WI
4	US000004		78 WALNUT ST	EDGERTON	WI
5	US000005		83 LAKEVIEW AVE	EDGERTON	WI
6	US000006		390 LAKE SHORE DI	EDGERTON	WI
7	US000007		370 LAKE SHORE DI	EDGERTON	WI
8	US000008		78 OAK ST	EDGERTON	WI
9	US000009		357 LAKE SHORE DI	EDGERTON	WI
10	US000010		358 LAKE SHORE DI	EDGERTON	WI
11	US000011		346 LAKE SHORE DI	EDGERTON	WI
12	US000012		88 BEACH AVE	EDGERTON	WI
13	US000013		362 LAKE SHORE DI	EDGERTON	WI
14	US000014		400 LAKE SHORE DI	EDGERTON	WI
15	US000015		87 BEACH AVE	EDGERTON	WI
16	US000016		367 LAKE SHORE DI	EDGERTON	WI
17	US000017		69 BEACH AVE	EDGERTON	WI
18	US000018		354 LAKE SHORE DI	EDGERTON	WI

**Figure 18: User Defined Structures imported into HAZUS**

## 4.0 Performing Flood Analysis on User Defined Structures

The steps to running the HAZUS flood analysis on User Defined Structures are very similar to running a regular HAZUS analysis. The main difference is that the results will be displayed in a table for each of the individual structures but not in the reports section where normally the results of the analysis are found. This section will briefly go over the steps taken during the pilot analysis to run the HAZUS analysis on User Defined Structures.

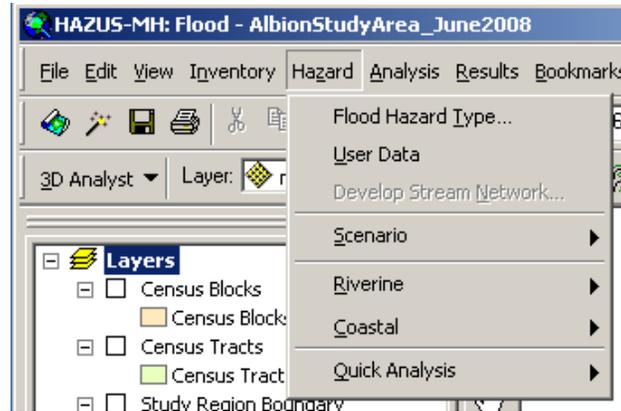


Figure 19: HAZUS *Hazard* menu is the first step of running analysis

### 4.1 Set Hazard Type

*Flood Hazard Type* is the first item in the *Hazard* menu, shown in Figure 19 above. Figure 20 below shows the *Flood Hazard Type* input box where the type of analysis, *Riverine only* for the pilot study, is chosen.

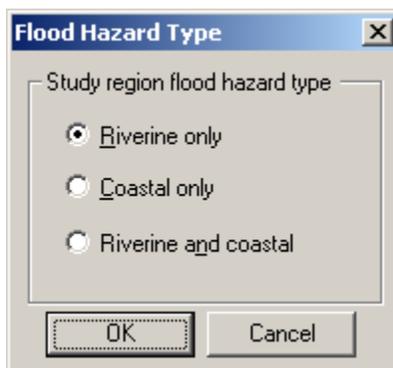


Figure 20: Select Flood Hazard Type for analysis

## 4.2 Import Flood Depth Grid

The *Hazard* menu's second item, *User Data*, is where the Flood Depth Grid is imported. Click to the tab *Depth Grid* and use *Browse* to navigate to the location of the depth grid.

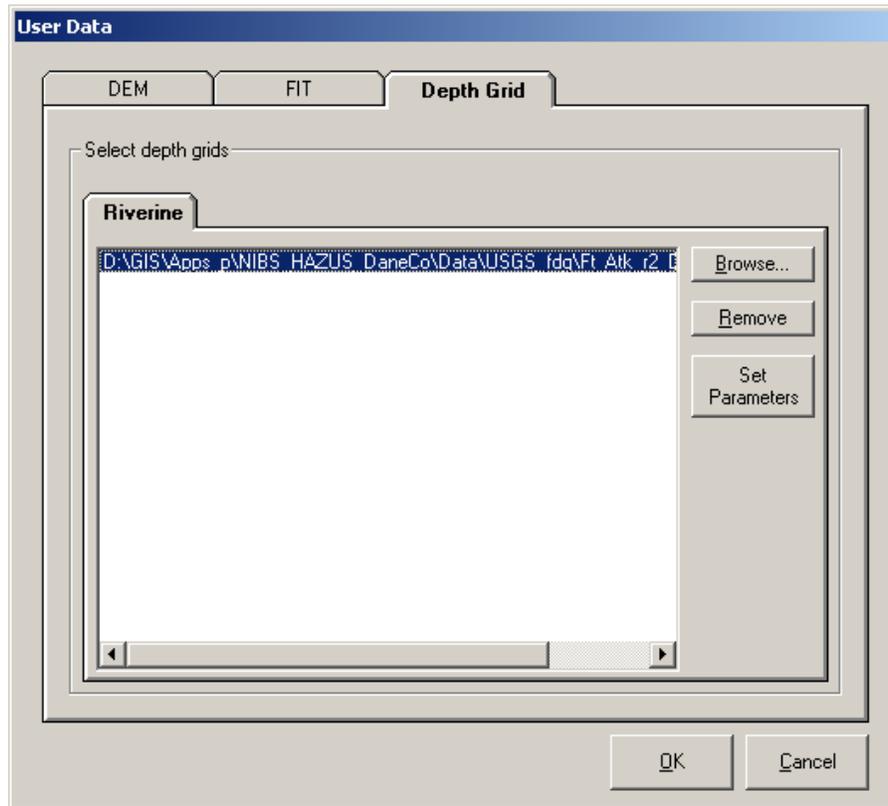
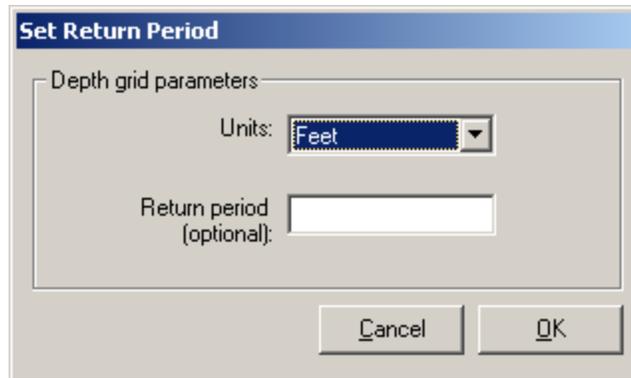


Figure 21: Import Flood Depth Grid

After the depth grid is listed in the display, select the depth grid, like in Figure 21 above, and use the *Set Parameters* button to choose the units of the imported depth grid. This USGS flood depth grid was produced from the Dane County DEM so searching the metadata reveals the units are in feet, which is selected, as shown in Figure 22 below. Return period was left empty, as this analysis is looking at a single flooding event.



**Figure 22: Set Units of the imported Flood Depth Grid**

### **4.3 Create New Scenario**

After HAZUS takes a short time to import the user defined depth grid, select *Hazard > Scenario > New* and give a name to the analysis, as seen in Figure 23 below.



**Figure 23: Name new scenario**

Enter the name and click OK. The New Scenario dialog box will open, seen in Figure 24 below, then click the plus button next to *Add to selection*. The cursor will turn into the select tool and then click on the polygon for the depth grid that HAZUS imported. After it is selected and highlighted, click on the *Save* button and click *OK*.

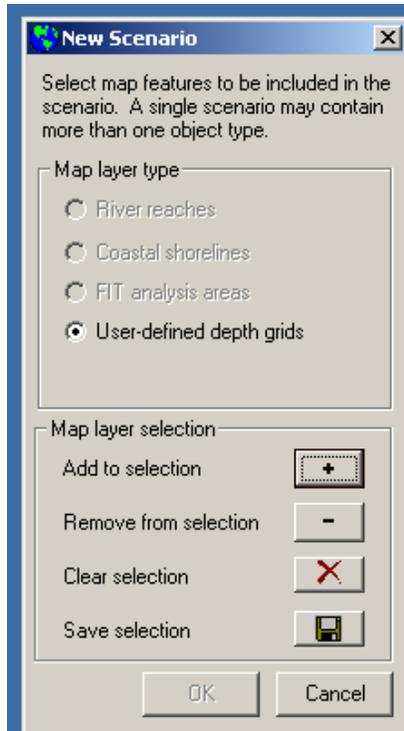


Figure 24: Add the depth grid and Save

#### 4.4 Delineate Floodplain

The final step under the *Hazard* menu is to go to *Riverine* and then *Delineate Floodplain*, which brings up the dialog box shown in Figure 25 below. These settings are correct for this analysis, click *OK* and then *Yes* to the raster processing warning. HAZUS will take a short time to do the raster processing and the only thing left to do is run the analysis.

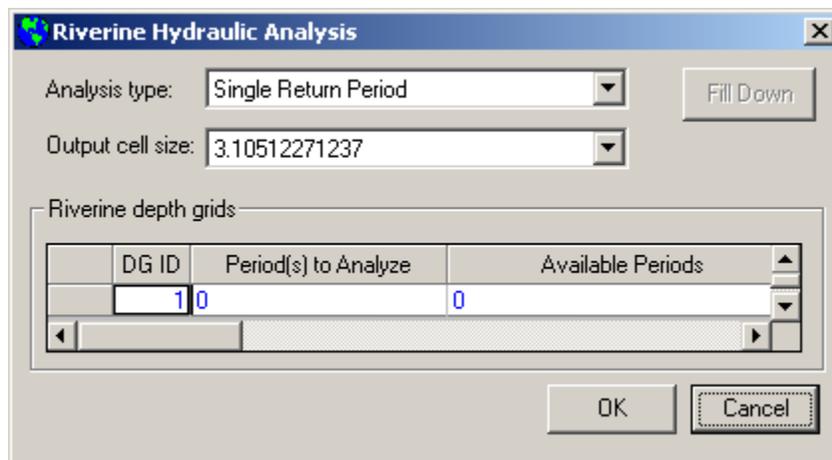
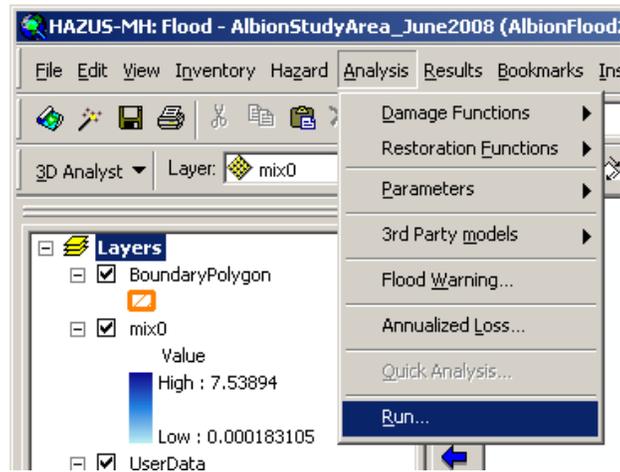


Figure 25: Last step before running the analysis

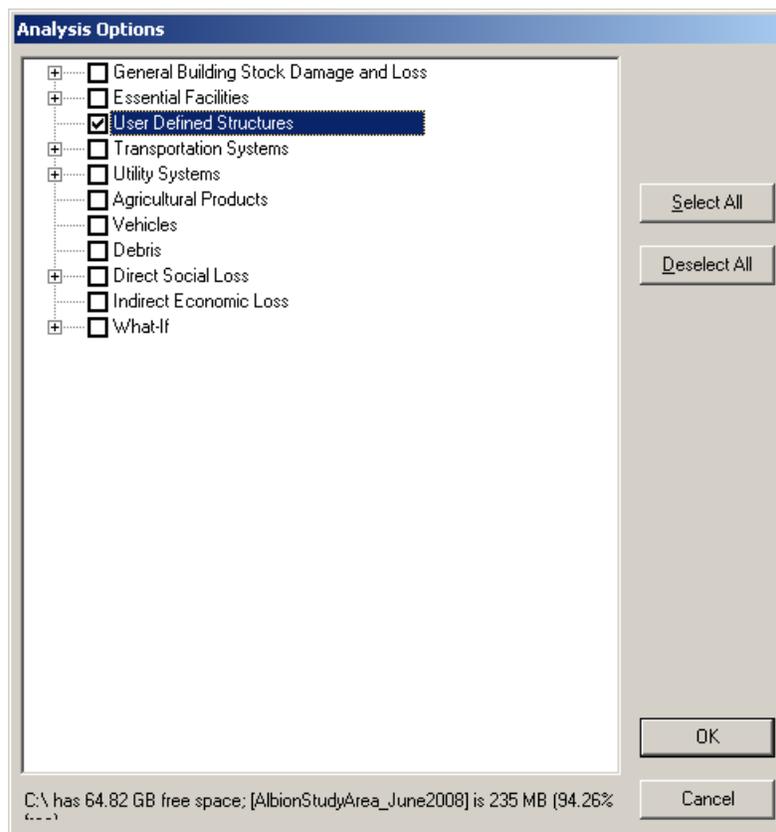
#### 4.5 Run Flood Analysis on User Defined Structures

Finally, go to the *Analysis* menu and choose *Run* as seen in Figure 26 below.



**Figure 26: Running the analysis**

Check *User Defined Structures* as shown in Figure 27 below and click *OK*.



**Figure 27: Select User Defined Structures from the Analysis Options**

HAZUS will run the analysis at this time.

## 5.0 Viewing the Results of the User Defined Structure Analysis

On a normal Level 1 HAZUS run it is possible to view the results through the built in reporting mechanism that uses Crystal Reports. When doing an analysis using the User Defined Facilities as described throughout this document, the normal reporting method is not used. The following steps show how to find and map the results, join the results back to the original data for evaluation, and briefly describe some of the ways the flood estimates were compared to NFIP claim amounts and assessment values.

### 5.1 View Current Scenario Results

Before the results can be seen, go to the *Results* menu and choose *View Current Scenario Results By...* as shown in Figure 28 below.

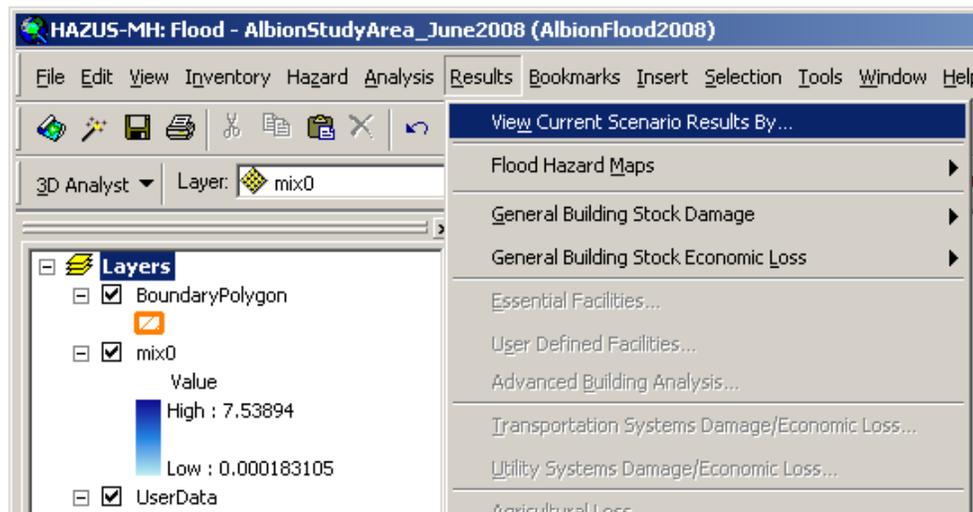


Figure 28: Step 1 of viewing results for User Defined Structures analysis

The window below will appear, Figure 29, and then click *OK*. The results can now be examined.

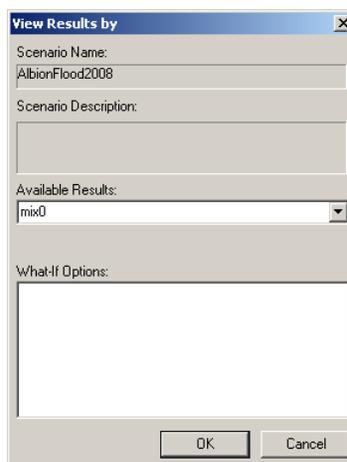


Figure 29: View Results By window - Click OK

## 5.2 Open User Defined Structures Loss Table and Map

The rest of the menu items under *Results* will now become available. As mentioned above, in a regular HAZUS analysis, the *Summary Reports* would be used at this time. For this type of analysis, the results will be found in the *User Defined Facilities...* item of the *Results* menu, shown in Figure 30 below.

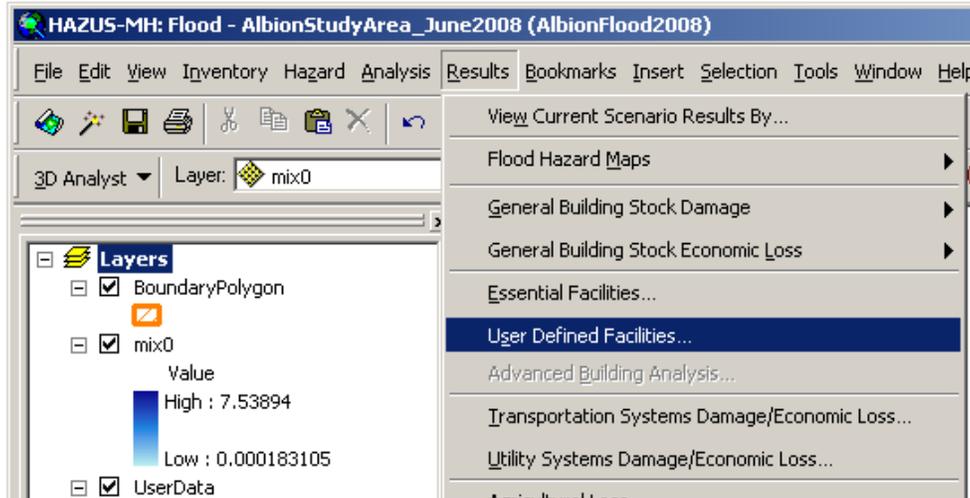


Figure 30: Viewing the results of User Defined Structures analysis

The screenshot shows the 'User Defined Facilities Loss' dialog box. It displays results for Scenario: AlbionFlood2008. The table below shows the results for 18 user-defined facilities, with columns for Facility ID, County (Co), Building Damage Percentage (BldgDmgPct), Building Loss (BldgLossUSD), Content Damage Percentage (ContDmgPct), and Content Loss (ContentLossUSD).

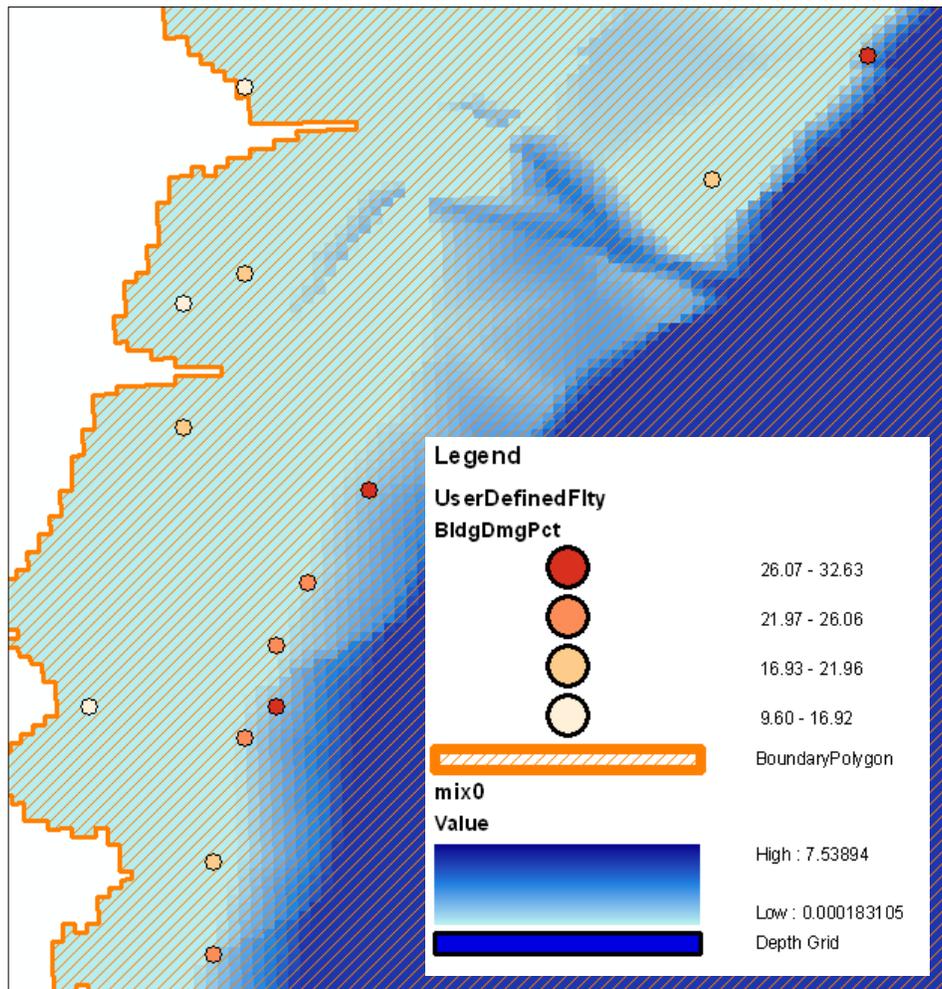
	Co	BldgDmgPct	BldgLossUSD	ContDmgPct	ContentLossUSD
1	R	24.54	29.47	20.88	12.54
2	R	26.01	17.16	21.25	7.01
3	R	10.06	12.32	7.76	4.76
4	R	9.60	13.36	7.27	5.05
5	R	18.70	12.42	17.70	5.88
6	R	21.75	31.04	20.19	14.40
7	R	30.00	49.95	23.20	19.31
8	R	18.93	10.16	17.93	4.81
9	R	11.93	6.34	9.25	2.45
10	R	26.71	51.79	25.94	25.15
11	R	21.96	19.98	20.24	9.21
12	R	16.92	15.94	15.89	7.49
13	R	26.06	24.86	21.26	10.14
14	R	32.63	25.32	26.35	10.23
15	R	16.70	15.10	15.60	7.05
16	R	17.10	11.18	16.10	5.26
17	R	31.59	21.79	31.07	10.72
18	R	26.04	20.91	21.26	8.54

Buttons at the bottom: Close, Map, Print.

Figure 31: The individual results of the UDF analysis

The *User Defined Facilities Loss* table will open and each of the imported User Defined Structures will be listed. Scrolling to the right will show the damage estimates that HAZUS has calculated for each structure, Figure 31 above. A structure will have a *Building Damage Percent* and a *Building Loss in U.S. Dollars* as well as a *Content Damage Percent* and a *Content Loss in U.S. Dollars*.

Click the *Map* button then the *Close* button and the structures will be plotted based on the latitude and longitude coordinates as discussed earlier. The *Symbology of the Layer Properties* can also be adjusted to create different maps, shown in Figure 32 below is a simple map where color symbols show ranges of Building Damage Percentiles for each structure overlaid on the flood depth grid.



**Figure 32: Map showing differences in Damage Percentage for User Defined Structures**

At this time, the Damage Estimates exist in a table in a database inside the HAZUS folder of Program Files. The results can easily be exported to a shapefile, shown in Figure 33 below, and then imported into the Geodatabase that contains the rest of the data for this project. The layer can then be used for making maps or joined back to the original data to make comparisons between the damage estimates and other data, such as NFIP claims.

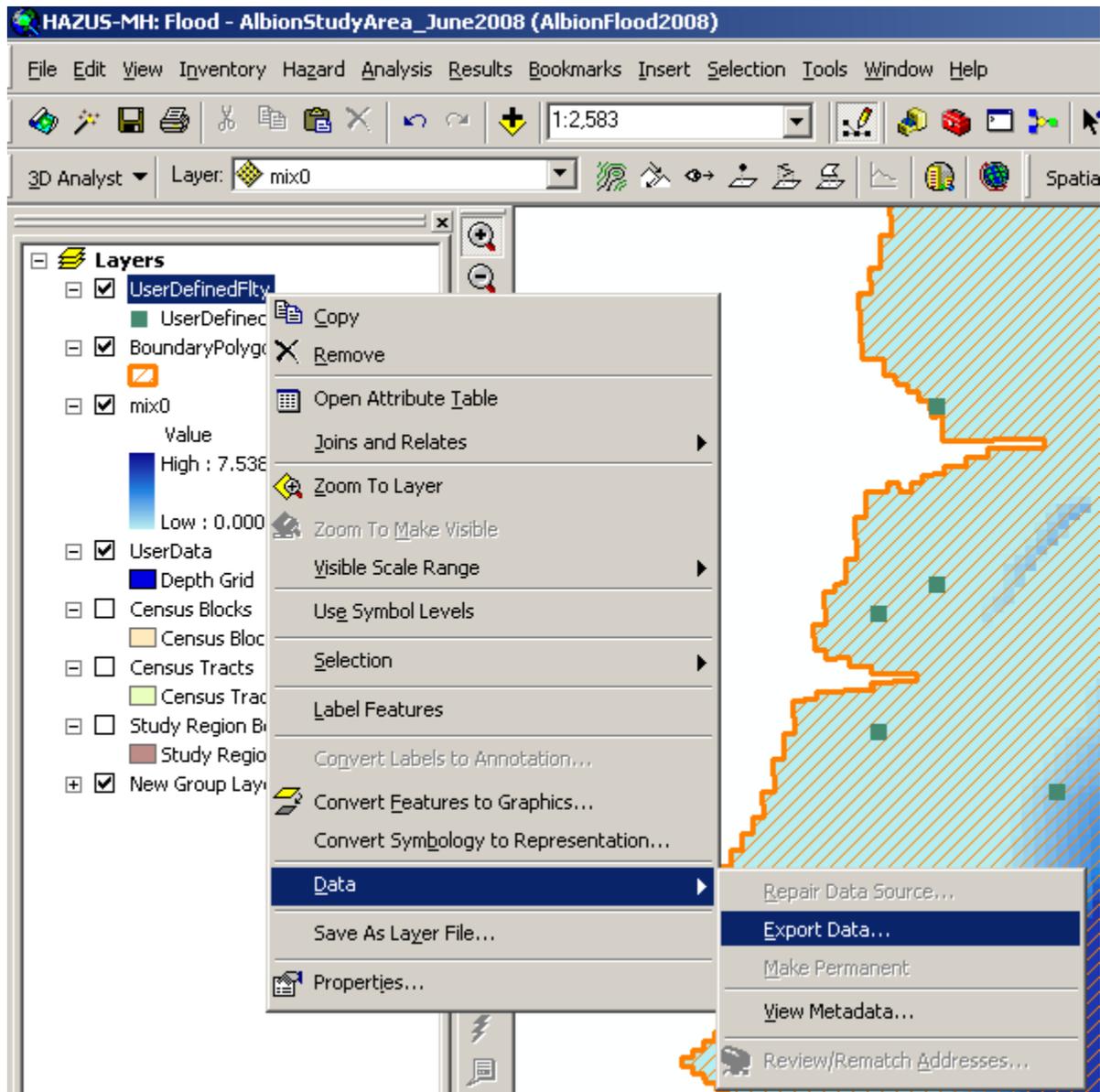


Figure 33: Exporting the User Defined Structure Damage Estimate results to a shapefile

### 5.3 Spatially Joining Damage Estimates to Claims and Assessment Data

The fact that HAZUS truncates the Latitude and Longitude numbers to four decimal places upon import was discussed earlier. It is at this point in the analysis that something must be done to get the damage estimates joined back to the data so conclusions can be drawn. Since HAZUS does not include any of the fields from the original data in the results output, a table join is not possible. Even before the analysis is run, when viewing the imported User Defined Structures, there is no field available to join back to the data that it was created from. See Figure 34 below to see the discrepancies between the before and after locations.



**Figure 34: Original Locations of Building Footprint Centroids (Star Symbol) vs. HAZUS Locations after import (Plus Symbol) – with parcels, building footprints and flood hazard boundary.**

A spatial join will have to suffice for this operation, but it is reasonable to think that in a large dataset with structures that may be very close together, an error could occur that would result in a damage estimate getting spatially joined to the structure next door and therefore inaccuracies would be introduced into the conclusions of the analysis.

Since more than likely the results for individual structures will want to be mapped at the actual location of those structures, the HAZUS results should be spatially joined to the original dataset. Both feature classes should be brought into ArcGIS and the centroids layer that was used for importing into HAZUS should be the one that gets right clicked on to start the join. As shown in Figure 35 below, in the *Join Data* dialog box, *Join data from another layer based on spatial location* should be chosen from the drop down menu at the top. The next drop down menu should contain the exported layer from HAZUS that contains the damage estimate results. The second radio button should be chosen. This will join only one point from the results layer to the only point that it is closest to in the centroids layer. This option will also append a field that contains the distance between the two joined points, which will allow the quantification of the locational error that was created when HAZUS truncated the Latitude and Longitude fields to only 4 decimal places. The location of the file to be created after the spatial join goes in the last text field and finally *OK* can be clicked.

The result will be a layer containing the actual locations of the User Defined Structures, all the fields that were joined and created before the import into HAZUS, and the damage estimates for each structure.

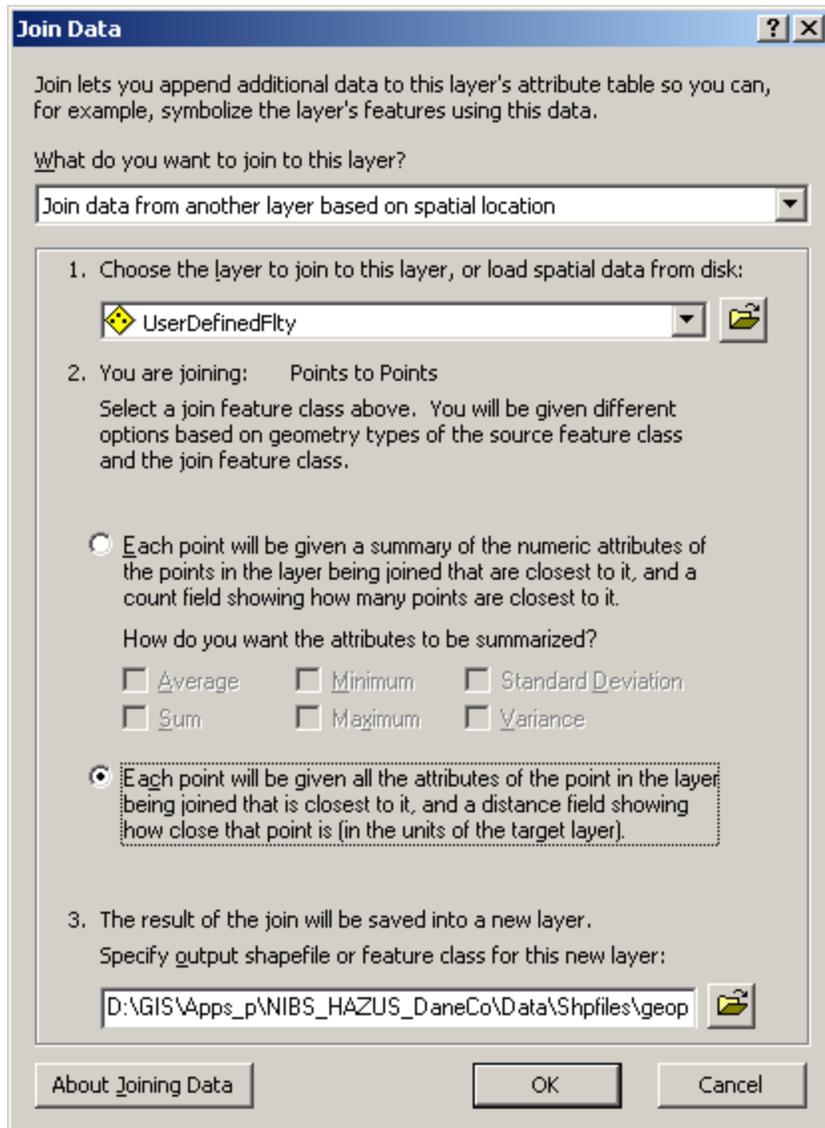


Figure 35: Spatially Joining the HAZUS results back to original data for analysis

#### 5.4 Statistical Analysis

With the HAZUS damage estimates in the same table as the assessment values and NFIP claims data, it is a simple procedure to get sums, means, medians and standard deviations for each of the fields. These sums and averages can then be compared to each other to draw conclusions. This report contains conclusions drawn in terms of the percentage of the actual claims that HAZUS was able to estimate and what percent of the assessment value was the claim or the estimated damage.

With individual structure data, it is also possible to find outliers in the data, such as a structure that had a very high damage ratio with a relatively low claim value, or even the opposite, a high claim value on a structure that was estimated to have little or no damage. Each of these findings can be used to draw conclusions from the dataset that may not have been able to be seen prior to mapping the results.