Guidance for Flood Risk Analysis and Mapping

Flood Risk Assessments

May 2016

Requirements for the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) Program are specified separately by statute, regulation, or FEMA policy (primarily the Standards for Flood Risk Analysis and Mapping). This document provides guidance to support the requirements and recommends approaches for effective and efficient implementation. Alternate approaches that comply with all requirements are acceptable.

For more information, please visit the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage (www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping). Copies of the Standards for Flood Risk Analysis and Mapping policy, related guidance, technical references, and other information about the guidelines and standards development process are all available here. You can also search directly by document title at www.fema.gov/library.

Document History

Affected Section or Subsection	Date	Description
First Publication	May 2014	Initial version of new transformed guidance. The content was derived from the Guidelines and Specifications for Flood Hazard Mapping Partners, Procedure Memoranda, and/or Operating Guidance documents. It has been reorganized and is being published separately from the standards.
Multiple	May 2016	Updated guidance to reflect change in risk assessment approach, where depth grids from various sources (new analysis, Automated Engineering, etc.) are now combined into a “composite” depth grid prior to calculating the losses within Hazus, as opposed to combining the census block loss results for each scenario (refined, AAL, etc.) post-Hazus. This update also reflects a shift away from the use of the 2010 FEMA Hazus Average Annualized Loss (AAL) Study, which stored results at the 2000 census block level. The guidance recommends that the AAL depth grids are the only aspect of that study that should be considered when performing the flood risk assessments, and even then, that the AAL depth grids should only be used as a last resort supplement to the depth grids from new analyses if other, better, project-wide depth grids are not available (such as from Automated Engineering data).

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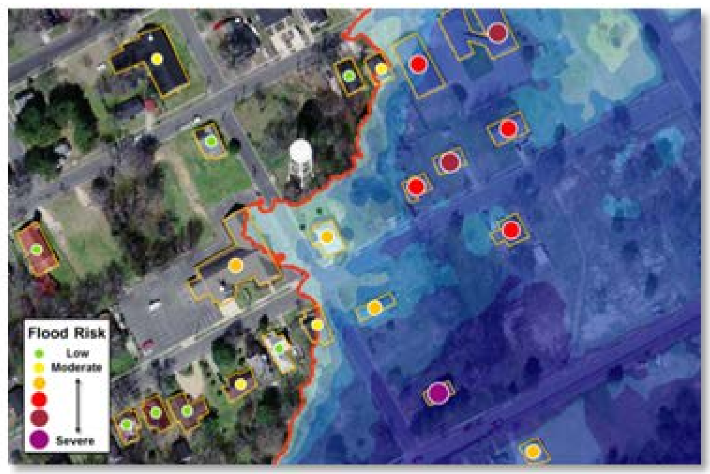
1.0 Definitions

The Flood Risk Assessment dataset reflects potential loss estimates (damages) resulting from floods of various magnitudes. These loss estimates can be derived at the individual building/structure level or aggregated to US Census block areas (see Figure 1). Flood Risk Assessment loss estimates generally vary by structure type (residential, commercial, industrial, etc.) and are based on a relationship between the flood depth and the associated percentage of damage for each structure type. Therefore, a flood risk assessment can be estimated for typical building types during any flood event, flood scenario, or flood frequency where flood depth information is available.

As outlined in the Flood Risk Database Technical Reference, the Flood Risk Assessment dataset consists of several spatial and lookup tables that communicate the overall flood risk exposure and damage estimates within the project area.

Figure 1: Census Block-based (left) and Structure-Specific (right) Flood Risk Assessments



2.0 General Overview

The Flood Risk Assessment dataset is meant to go beyond the simple identification of the flood hazard by allowing a community to better understand risks due to flooding. These assessments show not just where flooding can happen, but also how deep the water will get and how that depth will affect the structures and cause economic and social losses. By providing this information, the risk can be made more real, more attention may be called to the potential consequences, and there is an increased likelihood that appropriate mitigation actions will be taken.

These risk assessments are used in reporting annualized losses in the Flood Risk Report, and have potential application in rapidly estimating flood losses during actual events. There are other uses for these assessments as well, and they are most effective when they are included in a community engagement strategy that explains their usefulness, what they portray, and how to best use them for planning and communication.

Included within the Flood Risk Assessment dataset are tables that store the loss estimate results at either the census block or individual structure level. Typically these results are calculated by using a composite of the best available depth grids within the study area.

Additional tables that summarize inventory and loss data at the community level, and within the overall Flood Risk Project area, are also considered part of the Flood Risk Assessment dataset. The inventory data, within the Flood Risk Assessment dataset, are based on estimates of total inventory values for building and contents replacement values. These replacement values typically are used by loss estimation models, such as Hazus, to derive loss values. Losses can be estimated for three general categories as follows:

- **Building** losses are those losses associated with damage to the fixed elements of a structure, such as the foundation, walls, or floors.

- **Contents** losses are those losses associated with damage to structural elements not permanently fixed within a structure, such as furniture, appliances, and personal possessions.

- **Business Disruption** losses are additional losses not included in the building and contents losses, most commonly associated with businesses. These losses can include the costs of temporary displacement or disruption while flood repairs are being performed. It can also include business losses during the disruption. From Hazus, business disruption costs should include the sum of Inventory Loss, Relocation Cost, Income Loss, Rental Income Loss, Wage Loss, and Direct Output Loss.

In addition to these three categories of loss, the Flood Risk Assessment dataset also provides loss estimates divided into three categories of building use or general occupancy. The three categories of general occupancy to be used for the Flood Risk Assessment dataset are as follows:

- **Residential** occupancy as defined by Hazus, including single family dwellings, mobile homes, apartment buildings, and dormitories

- **Commercial** occupancy as defined by Hazus, including retail and wholesale trade, repair services, banks and hospitals

- **Other** occupancy not included in Residential or Commercial occupancy as defined by Hazus, which include Hazus occupancy categories of industrial, agricultural, education, religious, and government structures

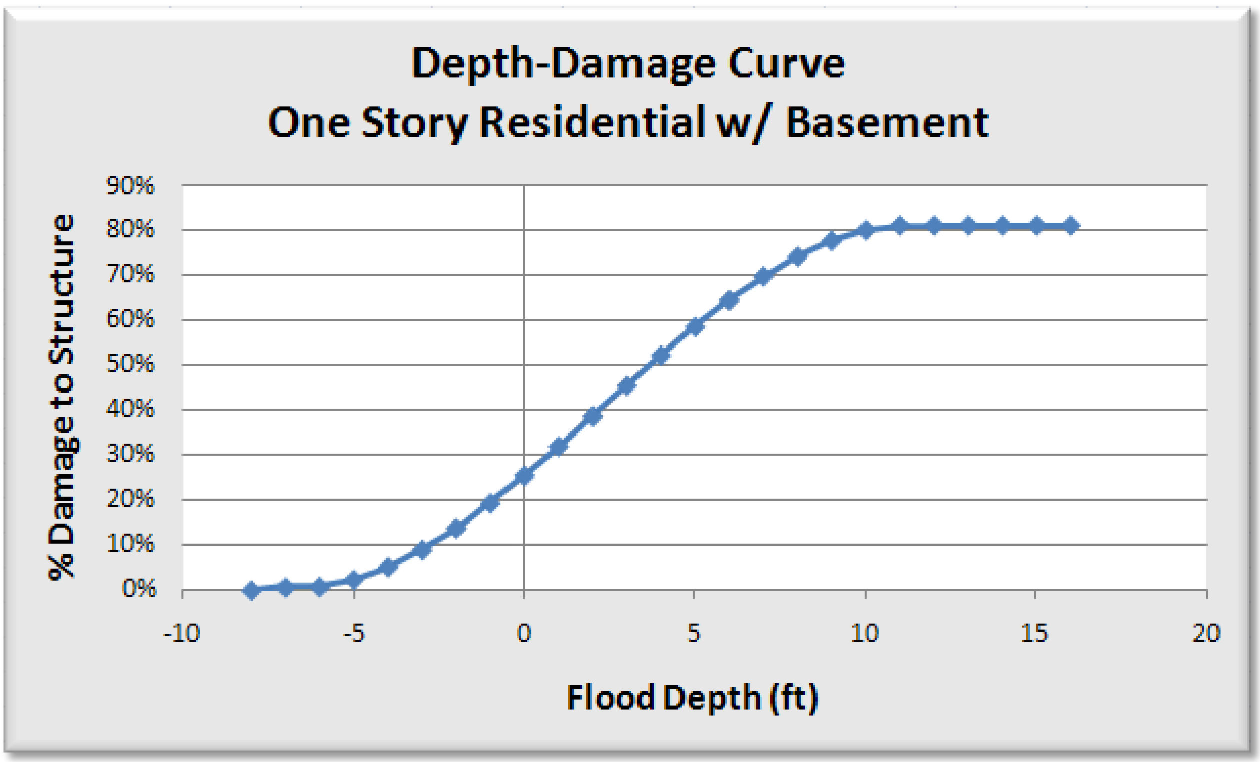
3.0 The "Composite" Flood Risk Assessment Depth Grid

Flood risk assessments, whether estimated at the structure level, or aggregated at the census block level, are most commonly performed by calculating the flood losses/damages at a given depth of flooding. The US Army Corps of Engineers (USACE) and other local, State, and Federal agencies have developed depth-damage functions for various building types, which relate a depth of flooding to the percent damage that the structure (or its contents) is likely to experience. See Figure 2 for an example.

Therefore, once the depth of flooding is known for a particular flood event or scenario, flood losses for that structure or within that census block can be estimated. These depth-damage curves vary based on building type (residential, commercial, etc.), building use (single family home, apartment, department store, hardware store, etc.), and other building specifics (number of stories, presence of a basement, foundation type, etc.) Some depth-damage functions also vary depending on whether the structure is located within a coastal V zone as opposed to an A zone.

The Hazus Flood Model User Manual provides details on how census block-based and User Defined Facility (UDF) risk assessments can be performed within Hazus, which has published depth-damage relationships already built into the software. General information regarding the creation of flood depth grids can also be found in the Flood Depth and Analysis Grids Guidance document.

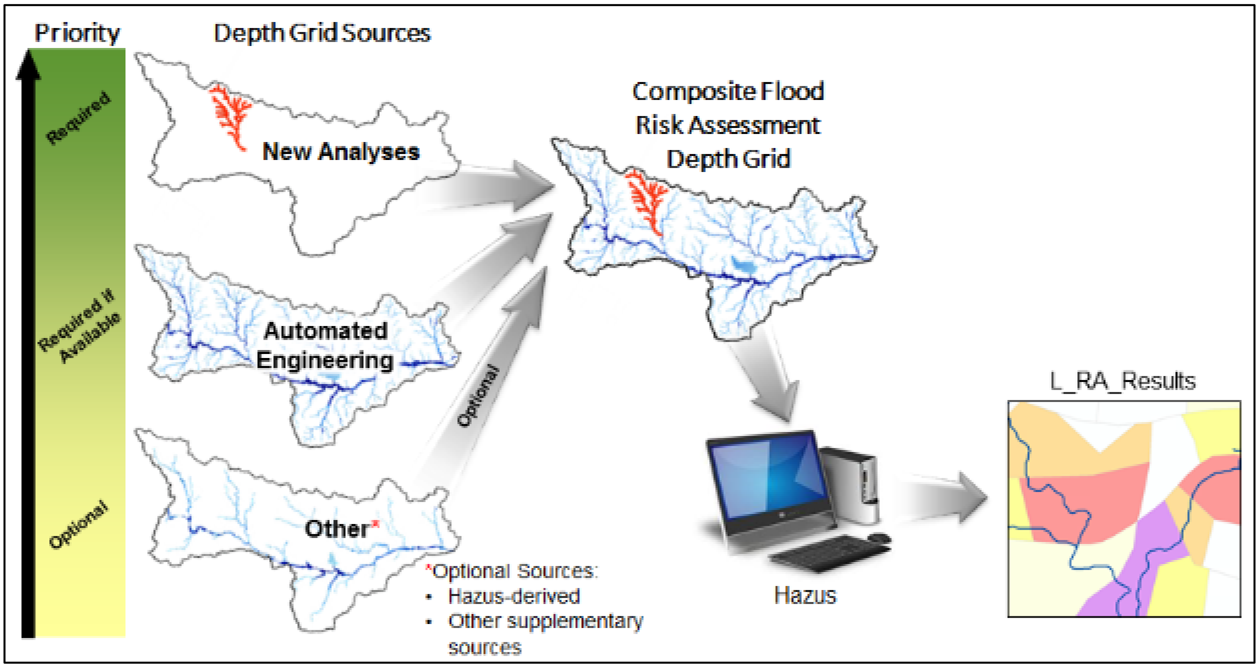
Figure 2: Example depth-damage relationship:
USACE, Economic Guidance Memo #04-01, October 2003



Flood risk assessments performed for a Flood Risk Project will utilize the best available depth grids to calculate the loss estimates that are stored within the Flood Risk Database (FRD). Depending on the type and coverage of available depth grids within the project area, this pre-risk assessment process involves the creation of a "composite" depth grid for each flood frequency being analyzed. Each composite flood risk assessment depth grid is then used within Hazus (or similar) software to perform a risk analysis and estimate flood losses.

Figure 3 provides a high-level overview of how the Flood Risk Assessment dataset is produced, utilizing this composite depth grid.

Figure 3: Overview of Composite Risk Assessment Depth Grid Creation Process



3.1 Depth Grid Sources

The composite risk assessment depth grid (the RAdpth_xxxxxx raster in the FRD) can be created from several different depth grid sources. The project area coverage and extent of each source's depth grids will likely vary, as may the flood events that were modeled (e.g. just the 1-percent-annual-chance, multiple frequencies, etc.) These depth grid sources have been organized into three categories for the purpose of this guidance:

1. New Analyses
2. Automated Engineering
3. Other

3.1.1 New Analysis Depth Grids

As outlined in the Standards for Flood Risk Analysis and Mapping (Standard ID 417), each flooding source receiving new analyses within the project area will have depth grids created for various flood frequencies (e.g. 10 percent, 4 percent, 2 percent, etc.). These depth grids will represent the highest quality data source available to use in the creation of the composite depth grid. However, unless all flooding sources are receiving new or updated regulatory-level analyses, these depth grids will typically only be available for a portion of the project area.

3.1.2 Automated Engineering Depth Grids

Automated Engineering depth grids may also be available. In cases where Automated Engineering depth grids are available, they will most often cover all flooding sources within the project area. Automated Engineering depth grids generally represent the second-highest priority source to use in the creation of the composite depth grid. Although the 1 percent-annual-chance Automated Engineering depth grid is typically produced, additional Automated

Engineering depth grids may be developed for other flood events. Each percent-annual-chance Automated Engineering flood depth grid available should be used to supplement the corresponding new analyses depth grids in the creation of the composite depth grid. For more information regarding the Automated Engineering process, refer to the Automated Engineering Guidance document.

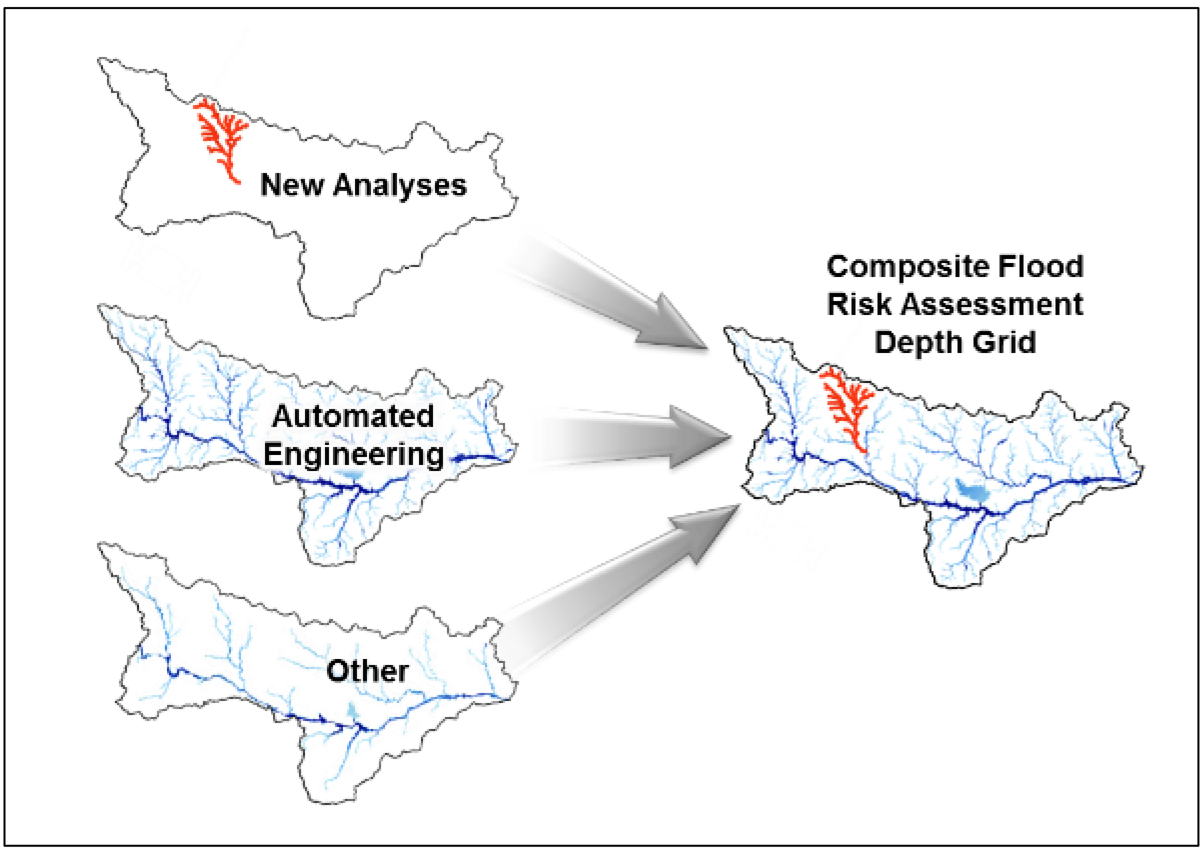
3.1.3 Other Depth Grids

Some project areas may also have access to other depth grid data. These could include new Hazus-derived depth grids (such as from a basic Hazus analysis from the latest version of Hazus) or from some other supplementary source that use analysis methods less accurate than Automated Engineering. Generally speaking, this type of data should only be used in the creation of the composite depth grid if Automated Engineering data is not available.

3.2 Depth Grid Availability Scenarios

It is important to be consistent in how data sources are combined to create the composite depth grid for each recurrence interval. The general rule is that the same depth grid source (new, Automated Engineering, other) should be used to perform all risk analyses along a given reach of stream for each associated flood event, rather than mixing sources. The following scenario examples reference Figure 4, and will help identify some of the specifics that may be encountered during the creation of the composite grid, depending on the flood events available, and guidance for each scenario.

Figure 4: Example Composite Depth Grid Creation Scenarios



Scenario 1

Percent-annual-chance depth grids available:

- New Analyses: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chances
- Automated Engineering: 1 percent and 0.2 percent
- Other: None

Percent-annual-chance depth grids used for flood risk analyses:

- 0.2 percent – composite of new analyses, supplemented with Automated Engineering everywhere else
- 1 percent – composite of new analyses, supplemented with Automated Engineering everywhere else
- 2 percent – no composite needed; depth grid from new analysis can be used as-is; therefore, risk assessment results for this event would only be available in areas where new analysis was performed
- 4 percent – no composite needed; depth grid from new analysis can be used as-is; therefore, risk assessment results for this event would only be available in areas where new analysis was performed
- 10 percent – no composite needed; depth grid from new analysis can be used as-is; therefore, risk assessment results for this event would only be available in areas where new analysis was performed

Scenario 2

Percent-annual-chance depth grids available:

- New Analyses: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chances
- Automated Engineering: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chances
- Other: None

Percent-annual-chance depth grids used for flood risk analyses:

- 0.2 percent – composite of new analyses, supplemented with Automated Engineering everywhere else
- 1 percent – composite of new analyses, supplemented with Automated Engineering everywhere else
- 2 percent – composite of new analyses, supplemented with Automated Engineering everywhere else
- 4 percent – no flood risk analysis would be performed for this event in the areas where new analyses had been performed; optionally, the Automated Engineering depth grid could be used in the remainder of the watershed to generate risk assessment results for this flood event
- 10 percent – composite of new analyses, supplemented with Automated Engineering everywhere else

Scenario 3

Percent-annual-chance depth grids available:

- New Analyses: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chances
- Automated Engineering: 1 percent
- Other: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chances (new Hazus Level 1)

Percent-annual-chance depth grids used for flood risk analyses:

- 1 percent – composite of new analyses, supplemented with Automated Engineering everywhere else
- For all remaining flood events (10-, 4-, 2-, 1-, and 0.2-percent) depth grids from new analysis can be used as-is; therefore, risk assessment results for these events would only be available in areas where new analysis was performed

As always, variations to the above scenarios, and others that may be similar, may be appropriate if doing so would provide a greater value in communicating risk more broadly and accurately within the project area. Those decisions are left to the discretion of the FEMA Regional Project Officer and Mapping Partner producing this dataset.

3.3 Geographic Information Systems (GIS) Considerations

When combining multiple raster or depth grid sources into one raster, the following GIS technical considerations should be taken into account:

- If raster cell sizes are different between the sources being combined, use the smaller cell size of the two when creating the composite depth grid. This may mean that the depth grid source with the larger cell size will need to be resampled to the smaller cell size prior to combining or mosaicking.
- If the origins of the raster datasets are different, they will need to be realigned to the same origin. Use the origin of the higher quality source when combining.
- If the depth grid source along a particular reach of stream changes (for example from new analysis to Automated Engineering), take special care that no gaps in the depth grid data exist where that transition occurs.
- The flood depth grids should be projected into the same Universal Transverse Mercator (UTM) horizontal coordinates as the Hazus project (e.g., NAD_1983_UTM_Zone_18N, NAD_1983_UTM_Zone_17N, etc.) with corresponding horizontal units in feet (Foot_US) prior to importing them into Hazus.
- Prior to creating the composite depth grid, it should be confirmed that the flood depths utilize (or, if needed, are converted to) the same vertical units (e.g. feet).

4.0 Census Block-based Flood Risk Assessments

Flood loss data calculated within Hazus can be aggregated and reported at the census tract (largest) and census block (smallest) level (see Figure 5). Of the two, the Flood Risk Database (FRD) has been designed to have its risk assessment data delivered at the census block level.

To determine flood losses, the census block-based approach in Hazus applies a weighting methodology to assume a uniform distribution of census demographics and structures across the census block geometry. As such, this type of approach generally produces conservative loss estimates (often overestimating what the true losses might be). However, beginning with Hazus version 2.2 SP1, the Hazus model provides two types of census block data.

The first type, homogenous census blocks, represents the "full' census blocks traditionally used for risk assessment where only open water areas have been clipped out of the original census block boundaries from the US Census Bureau.

The second type, dasymetric census blocks, have had additional "undeveloped" land areas clipped out of the original census block boundaries based on Land Use-Land Cover (LULC) data from the USGS. With the assistance of the U.S. Army Corp of Engineers Flood Impact Assessment Team (USACE FIA), the Hazus Census Blocks were clipped to remove areas identified as water, wetlands and forest.

Starting with Hazus version 3.0, dasymetric census blocks are the default geometry used in the analysis. However, when producing census-block-based flood risk assessments, the decision to use homogenous or dasymetric census block data is left to the discretion of the FEMA Regional Project Officer and Mapping Partner producing this dataset.

Figure 5: Flood Risk Assessment Results by Census Block

4.1 Flood Risk Database (FRD) Related Guidance for Census Block-based Risk Assessments

For census block-based flood risk assessments, the Flood Risk Assessment dataset is made up of the following tables in the FRD:

- S_CenBlk_Ar
- L_RA_Results
- L_Exposure
- L_RA_Summary
- L_Local_GBS (only populated if local General Building Stock data was updated and used in Hazus to perform a census block-based flood risk assessment)

Additional guidance on these tables is found in the sections below.

4.1.1 S_CenBlk_Ar

The census block polygons in S_CenBlk_Ar should not be clipped to the project area footprint (S_FRD_Proj_Ar). Section 9.0 of this document outlines additional guidance for the S_CenBlk_Ar spatial layer, as it relates to aligning it to the footprint of the project area.

As the first step towards populating the Hazus-derived fields in S_CenBlk_Ar, Table 1 outlines the tables that should be exported from Hazus:

Table 1: Hazus Tables to be Exported for S_CenBlk_Ar

Menu	Item	Sub-item	Tab	Table Type Selections
Inventory	General Building Stock	Dollar Exposure (Replacement Value)	By Occupancy	Table Type: General Occupancy Exposure Type: Building
Inventory	General Building Stock	Dollar Exposure (Replacement Value)	By Occupancy	Table Type: General Occupancy Exposure Type: Contents

Once that has been complete, Table 2 explains how the values in the S_CenBlk_Ar building and contents fields are derived from these exported Hazus tables. Each census block within the project area should be populated with this information.

All attributes that report dollar values and losses (e.g. ARV_BG_TOT, ARV_CN_TOT, etc.) should have their whole dollar values populated, rather than reported in thousands of dollars. All losses less than $100,000 should be rounded to the nearest $10,000 in these fields. All losses greater than $100,000 should be rounded to the nearest $100,000.

Within the FRD, there are database relationships setup that facilitate being able to join the S_CenBlk_Ar to the flood risk assessment results table (L_RA_Results). This can be used to help depict the flood risk assessments results on the Flood Risk Map (FRM) and within a Geographic Information System (GIS).

4.1.2 L_Exposure

The total building and contents values (i.e. exposure) within each community in the Flood Risk Project footprint, and within the project area as a whole, are stored within the L_Exposure table. This information is derived from the asset replacement value attributes within the S_CenBlk_Ar table. Since census block boundaries (S_CenBlk_Ar) do not always align with community boundaries (S_FRD_Pol_Ar), the L_Exposure values for each community should be area-weighted based on the intersection of the two spatial layers. For example, if a census block has a total building asset replacement value (S_CenBlk_Ar: ARV_BG_TOT) of $1 million, and 60% of the census block lies within the political area of the community, and 40% lies outside, then that census block would in essence only contribute $600,000 to the overall total building asset replacement value (ARV_TOT) of that community. These same area-weighting principles apply to the L_RA_Summary table as well.

All attributes that report dollar values and losses (e.g. ARV_TOT, ARV_RES, etc.) should have their whole dollar values populated, rather than reported in thousands of dollars (note that the values exported out of Hazus are in $1,000s). All losses less than $100,000 should be rounded to the nearest $10,000 in these fields. All losses greater than $100,000 should be rounded to the nearest $100,000.

Table 2: Derivation of S_CenBlk_Ar Fields from Exported Hazus Tables

S_CenBlk_Ar FIELD	Description	Hazus Derivations
ARV_BG_TOT	Total building value for all structure types	Hazus Inventory: GBS Dollar Exposure (Building Exposure Type, Total Exposure Field)
ARV_CN_TOT	Total contents value for all structure types	Hazus Inventory: GBS Dollar Exposure (Contents Exposure Type, Total Exposure Field)
ARV_BG_RES	Total building value for residential structure types	Hazus Inventory: GBS Dollar Exposure (Building Exposure Type, Residential Field)
ARV_CN_RES	Total contents value for residential structure types	Hazus Inventory: GBS Dollar Exposure (Contents Exposure Type, Residential Field)
ARV_BG_COM	Total building value for commercial structure types	Hazus Inventory: GBS Dollar Exposure (Building Exposure Type, Commercial Field)

S_CenBlk_Ar FIELD	Description	Hazus Derivations
ARV_CN_COM	Total contents value for commercial structure types	Hazus Inventory: GBS Dollar Exposure (Contents Exposure Type, Commercial Field)
ARV_BG_OTH	Total building value for other structure types	Hazus Inventory: GBS Dollar Exposure (Building Exposure Type, Total Exposure minus Residential and Commercial Fields)
ARV_CN_OTH	Total contents value for other structure types	Hazus Inventory: GBS Dollar Exposure (Contents Exposure Type, Total Exposure minus Residential and Commercial Fields)

4.2 Calculation of Flood Risk Assessment Results (Census Block)

For Hazus-based analyses, the latest version of the Hazus Flood Model User Manual should be referenced for the specific steps on how to perform flood risk assessments. The general steps, however, for a census block-based flood risk assessment within Hazus are outlined below.

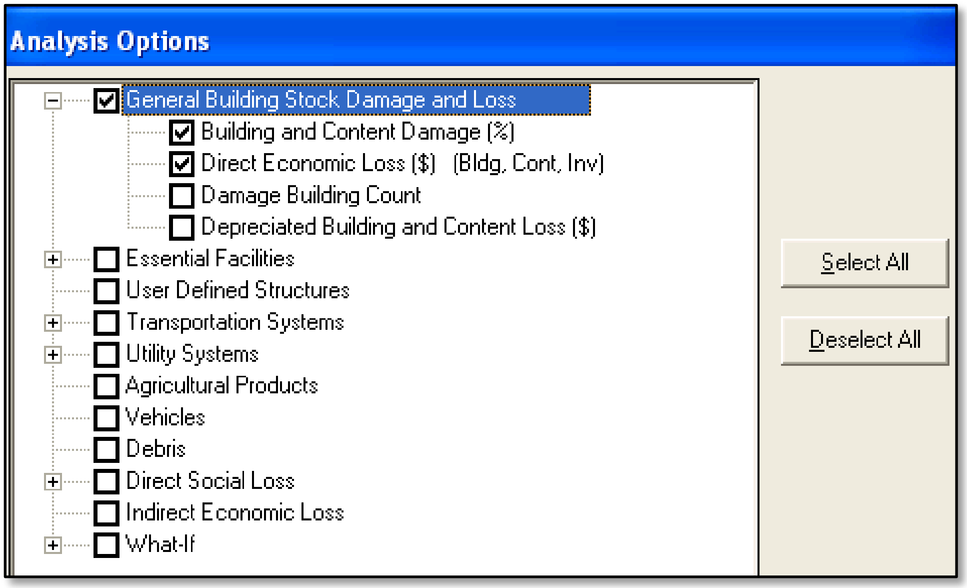
4.2.1 Import User-Defined Flood Depth Grids

Once the composite flood risk assessment depth grids have been compiled, they are used as the primary input for conducting the census block-based loss analyses. Hazus allows the user to import the flood depth grids generated for flooding sources within the Flood Risk Project. There should be one depth grid for each flood event being assessed (0.2 percent, 1 percent, etc.).

4.2.2 Loss Calculation

Once each of the composite depth grids have been imported, the user will need to conduct single event Hazus runs for each of the corresponding flood events (e.g. 10 percent-annual-chance, 1 percent-annual-chance, etc.). Hazus Analysis Options (see Figure 6) should only include “General Building Stock Damage and Loss”, specifically “Building and Content Damage” and “Direct Economic Loss”. Other analysis options may also be computed, but are not required to be delivered as part of the Flood Risk Database.

Figure 6: Hazus Analysis Options



4.2.3 L_RA_Results

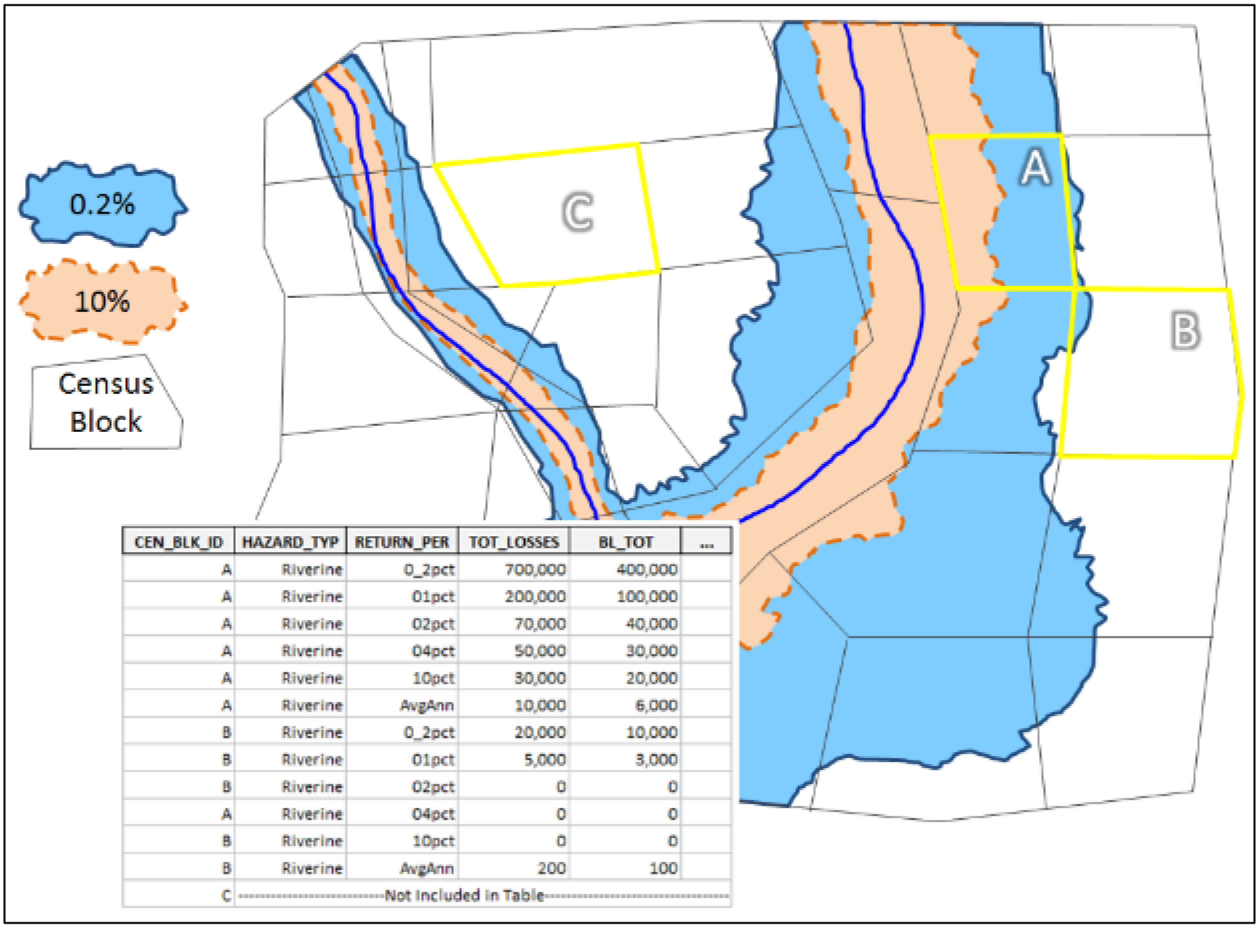
The results from the loss analyses are stored in the L_RA_Results table of the FRD. The RETURN_PER field of this table should be populated with results from the following frequencies, where available:

- 10 percent-annual-chance (10-yr)
- 4 percent-annual-chance (25-yr)
- 2 percent-annual-chance (50-yr)
- 1 percent-annual-chance (100-yr)
- 0.2 percent-annual-chance (500-yr)
- Annualized

There should be one record in the table that represents each combination of census block, hazard type, and flood frequency for the risk assessment performed. There should also be one record that stores the annualized losses. Therefore, there should generally be up to six entries (10-, 4-, 2-, 1-, 0.2 percent, and Annualized) in this table for each census block where flood losses were calculated, depending on the extent and coverage of the composite depth grid for each event.

In the example shown in Figure 7, three census blocks are highlighted. The example represents an area where depth grids for five flood events (10-, 4-, 2-, 1-, and 0.2-percent-annual-chance) are available for both streams. The table shown in the figure provides guidance as to how the records for each of three census blocks would be populated in L_RA_Results. Census block “A” is intersected by the depth grids for all five flood events, and would store losses for each in the table. Census block “B” contains flood loss estimates for the 0.2 percent and 1 percent-annual-chance events, but no loss estimates for the other flood frequencies. However, there should still be six table records for that census block; the 2 percent, 4 percent, and 10 percent-annual-chance loss estimates would simply show zero in this case. As represented by census block “C”, the L_RA_Results table does not need to include records for census blocks for which flood loss calculations were not performed.

Figure 7: Example Showing how L_RA_Results is Populated based on Hazus Results



CEN_BLK_ID	HAZARD_TYP	RETURN_PER	TOT_LOSSES	BL_TOT	...
A	Riverine	0_2pct	700,000	400,000	
A	Riverine	01pct	200,000	100,000	
A	Riverine	02pct	70,000	40,000	
A	Riverine	04pct	50,000	30,000	
A	Riverine	10pct	30,000	20,000	
A	Riverine	AvgAnn	10,000	6,000	
B	Riverine	0_2pct	20,000	10,000	
B	Riverine	01pct	5,000	3,000	
B	Riverine	02pct	0	0	
A	Riverine	04pct	0	0	
B	Riverine	10pct	0	0	
B	Riverine	AvgAnn	200	100	
C	---------------------Not Included in Table---------------------				

If the example in Figure 7 had represented a case where only the 0.2 percent and 10 percent–annual-chance composite depth grids were available, then census blocks “A” and “B” would only have records for those two flood events in L_RA_Results. This situation will most often be encountered for flooding sources where depth grids from new analyses were not produced, such as for areas where only the 1 percent-annual-chance Automated Engineering depth grid is available.

As the first step towards populating the Hazus-derived fields in L_RA_Results, Table 3 (below) outlines the tables that should be exported from Hazus.

Table 3: Hazus Tables to be Exported for L_RA_Results

Menu	Item	Sub-item	Tab	Table Type Selections
Results	General Building Stock Economic Loss	By Full Replacement	Total	Pre/Post Flood Insurance Rate Map (FIRM): Total
Results	General Building Stock Economic Loss	By Full Replacement	By General Occupancy	Occupancy: Residential Pre/Post FIRM: Total
Results	General Building Stock Economic Loss	By Full Replacement	By General Occupancy	Occupancy: Commercial Pre/Post FIRM: Total

Once the export has been completed, Table 4 explains how the values in certain L_RA_Results fields are derived from these exported Hazus tables.

Table 4: Derivation of L_RA_Results Fields from Exported Hazus Tables

L_RA_Results FIELD	Description	Hazus Derivations
TOT_LOSSES	Total losses	Hazus Results: GBS Economic Loss Full Replacement: Total (Total Loss Field)
BL_TOT	Total building losses	Hazus Results: GBS Economic Loss Full Replacement: Total (Building Loss Field)
CL_TOT	Total contents losses	Hazus Results: GBS Economic Loss Full Replacement: Total (Contents Loss Field)
BL_RES	Total building losses for residential structures	Hazus Results: GBS Economic Loss Full Replacement: Residential (Building Loss Field)
CL_RES	Total contents losses for residential structures	Hazus Results: GBS Economic Loss Full Replacement: Residential (Content Loss Field)

L_RA_Results FIELD	Description	Hazus Derivations
BL_COM	Total building losses for commercial structures	Hazus Results: GBS Economic Loss Full Replacement: Commercial (Building Loss Field)
CL_COM	Total contents losses for commercial structures	Hazus Results: GBS Economic Loss Full Replacement: Commercial (Contents Loss Field)
BL_OTH	Total building losses for other structures	Total building losses minus building losses for residential structures and building losses for commercial structures
CL_OTH	Total contents losses for other structures	Total contents losses minus contents losses for residential structures and contents losses for commercial structures
BUS_DISRPT	Business disruption costs	Total losses minus Total buildings losses and Total contents losses

Hazus reports loss values by the thousands (e.g. a loss of $10,000 is exported as 10 by Hazus). All attributes that report dollar values in this table (e.g. TOT_LOSSES, BL_TOT, etc.) should have their whole dollar values populated, rather than reported in thousands of dollars. Loss values populated in this table should also not be rounded.

4.2.4 Hazus General Building Stock Updates (Enhancement)

Other enhancements exist within Hazus to improve the flood loss calculation estimates, such as updating the building inventory data (General Building Stock) used by Hazus with more accurate local data. Details on how to incorporate this type of data into the analysis within Hazus can be found within the Hazus Flood Model User Manual.

4.2.4.1 L_Local_GBS

If the general building stock data is updated for certain census blocks within the Flood Risk Project footprint and used as part of the flood risk assessment, the L_Local_GBS table should be created and populated. The values within the L_Exposure table should also be updated accordingly. For example, if there are 100 census blocks within a community, and local building stock data was available and updated in the flood risk assessment for 40 of those census blocks, then the L_Exposure values for that community should be reflective of the sum totals of the 40 updated census blocks and the 60 default census blocks.

4.2.5 Variations for Coastal Flooding

Since flood risk assessments generally rely on the availability of depth grids, analyses for coastal studies are limited to the percent annual chance floods for which depth grids were produced as part of the flood study. This is usually only the 1 percent-annual-chance flood, although if the depth grids for other frequencies were able to be produced, a corresponding flood risk assessment can be produced.

4.2.6 Variations for Flooding Affected by Levees

Depending on a levee's accreditation status, levee risk assessments may be performed riverward or landward of the levee, or both. Flood risk assessments riverward or seaward of the levee can be performed exactly as they would be for a typical scenario for any levee scenario or flood event for which depth grids have been developed.

In the case of an accredited levee, there may be no Special Flood Hazard Area (SFHA) boundary on the landward side of the levee (unless from another flooding source). If there is still a desire by the community to generate a flood risk assessment associated with the residual risk landward of the levee, the elevations used to map the shaded Zone X can be used to produce a depth grid, from which the risk assessment can be performed. When communicating this data to the community, however, references to a particular percent chance or likelihood of flooding should be avoided so as to prevent any confusion.

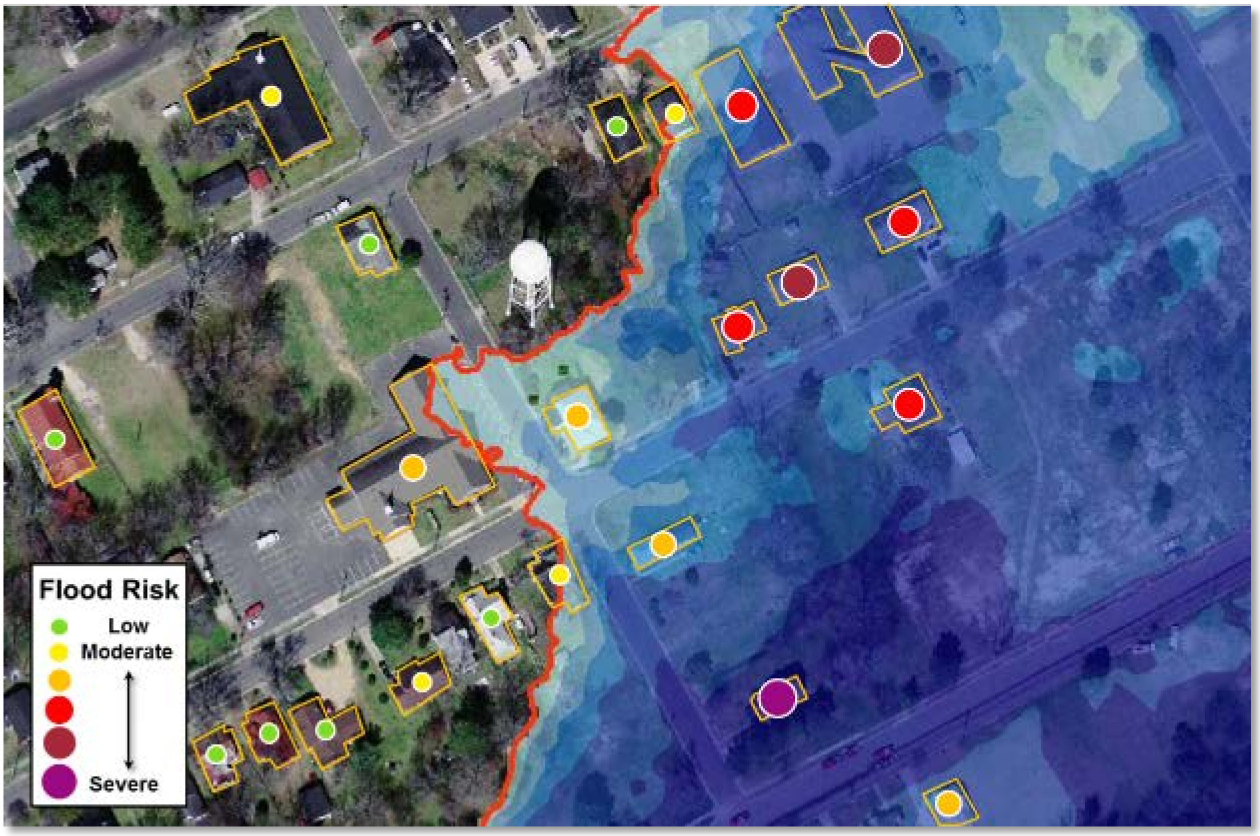
4.2.7 Variations for Flooding Downstream of Dams

If flood risk assessments are performed for areas downstream of a dam, the flood losses may be based on a particular dam failure scenario (and its associated depth grid) as opposed to a percent annual chance of flooding. The methodology to calculate the loss estimates, however, would be the same as for a typical riverine scenario – the flood risk assessment is performed using available depth grids as input. If Hazus is used, it should be noted that it does not take velocities into account to calculate the potential loss estimates. Other datasets (such as velocity grids) should be used to help communicate the hazards downstream of dams associated with high velocities.

5.0 Structure-Specific ("User-Defined Facility") Flood Risk Assessments

An alternative to the census block-based flood risk assessments are structure-specific (called "User-Defined Facilities", or UDFs, in Hazus) flood risk assessments (see Figure 8). This level of risk assessment produces results and loss estimates at the building or structure level, and can often help facilitate flood risk discussions with individual home- or business-owners in a community. These types of risk assessments can provide valuable information to communities to help pre-screen properties and projects before going through a more in-depth Benefit-Cost Analysis (BCA). This is generally the best and most accurate approach to analyzing and communicating flood risk, but often requires gathering additional data to support such analyses. Although the process through which these risk assessments are determined can vary, and may take a variety of factors into account, the outputs must result in the required data tables being delivered and populated as outlined in the Flood Risk Database Technical Reference. It should be noted, however, that the information and attributes captured within the Flood Risk Database for structure-level risk assessments purposely avoid the storage of personally-identifiable information (PII), such as property address, name of owner, etc. Care must be taken to make sure that PII data is not added into the FRD if the FRD is customized beyond what is defined in the Technical Reference.

Figure 8: Structure-specific (UDF) Risk Assessments



5.1 FRD-Related Guidance for Structure-Specific Risk Assessments

For structure-specific flood risk assessments, the Flood Risk Assessment dataset is made up of the following tables in the FRD, which should be produced:

- S_UDF_Pt
- L_RA_UDF_Results

5.1.1 S_UDF_Pt

Unlike building values aggregated at the census block level, the asset replacement value for each individual structure assessed (ARV_BLDG), and its contents (ARV_CNTNT), can be rounded to the nearest $1,000. The ARV_BLDG and ARV_CNTNT attributes represent "replacement" values, rather than "appraised" values – in other words, the cost to replace or rebuild the structure, as opposed to its resell value. The value of the land on which the building resides should not be included in this cost. Replacement value data for structures, however, may be difficult to obtain. Therefore, the ARV_BLDG value for each structure may be estimated based on available appraisal data if necessary. In discussions with the community where site-specific flood risk assessments are performed, it may be appropriate to decide on a factor to apply to the appraised values of the buildings being analyzed to estimate their replacement values. Depending on the local market, the replacement cost for a structure may be more or less than its current appraised value.

The content value for each structure can be estimated if unknown, by treating the contents value as a percentage of the overall structure value. The Hazus Flood Model Technical Manual estimates the following, depending on structure type (see Table 5).

Table 5: Hazus Default Contents Value as a Percentage of Structure Value

Building Occupancy Type	Occupancy Class	Contents Value as a % of Structure Value
Residential	• Single Family Dwelling • Mobile Home • Multi-Family Dwelling • Temporary Lodging • Institutional Dormitory • Nursing Home	50%
Commercial	• Hospital • Medical Office/Clinic	150%
Commercial	• Retail Trade • Wholesale Trade • Personal and Repair Services • Professional/Technical/Business Services • Banks • Entertainment & Recreation • Theaters	100%
Commercial	• Parking Structure	50%
Industrial	• Heavy • Light • Food/Drugs/Chemicals • Metals/Minerals Processing • High Technology	150%
Industrial	• Construction	100%
Agriculture	• Agriculture	100%
Religion/Non-Profit	• Church/Membership Organization	100%
Government	• Emergency Response	150%
Government	• General Services	100%
Education	• Colleges/Universities	150%
Education	• Schools/Libraries	100%

Various methods exist in GIS for how the S_UDF_Pt layer can be symbolized to highlight individual and concentrations of structures that have the highest risk. The S_UDF_Pt data can be joined to the L_RA_UDF_Results results and symbolized on the flood loss fields. As the previous example in Figure 8 showed, this data can be rendered by color and/or point size to draw attention to those areas that warrant the most discussion and outreach.

5.1.2 L_RA_UDF_Results

Flood loss estimates for structure-specific risk assessments are stored within the L_RA_UDF_Results table. Dollar losses (BLDG_LOSS, CNT_LOSS, etc.) do not need to be rounded, although it is generally good practice to round losses using no more than two significant digits (e.g. a calculated loss of $2,563 would be shown as $2,600, a calculated loss of $528 could be shown as $500 or $530, etc.).

5.2 Flood Risk Assessment Methodologies (Structure-Specific)

If risk assessments will be performed at the structure level as part of the Flood Risk Project, the Mapping Partner should contact the State, County, or local Hazus user groups, or any other local entity to determine if structure-specific data or localized changes to methodology are available that should be incorporated before performing the analysis.

As discussed in Section 3.0, flood damages for a particular structure or building are estimated based on the type and value of the structure, along with the flood depth at that structure. Therefore, in order to perform structure-specific flood risk assessments, the user must generally know, or be able to appropriately estimate, the following information for each structure assessed:

- Structure type and use
- Structure replacement value
- Contents replacement value
- Structure’s lowest finished or first floor elevation (FFE)
- Flood elevation(s) – used to calculate the depth of flooding in the structure (flood elevation minus FFE)

The Hazus Flood Model User Manual provides details on how UDF risk assessments can be performed within Hazus, which has published depth-damage relationships already built into the software. The variations to consider when performing structure-specific risk assessments for coastal, levee, or dam-related flooding are similar to those outlined in Sections 4.2.5, 4.2.6, and 4.2.7 respectively of this guidance.

5.3 Selection of Structures to Receive Flood Risk Assessments

Whereas new flood risk assessments, when conducted at the census block level, are performed for all flooding sources where new or updated flood hazard analyses have been performed, structure-specific flood risk assessments may be conducted within more isolated areas. Depending on data availability, level of anticipated flood risk, or other factors of concern for a community, there may be certain areas within the community, or within a particular neighborhood in the community, where there is a desire to be able to understand and communicate flood risk at a more precise level than by census blocks.

As part of a Flood Risk Project, new flood risk assessments at the structure level do not have to be produced for every structure within the floodplains that have been restudied. However, in order to use site-specific in lieu of census block-based new flood risk assessments, a sufficient number of structures should be analyzed to support risk communications and to help the community prioritize mitigation actions. The decision on where and how many structure-specific risk assessments to perform should be made in discussions between FEMA, the community, and the Mapping Partner, taking into consideration these objectives.

If all of the structures in the floodplain within a particular census block have had a flood risk assessment performed, then the flood losses for those structures can be aggregated at the census block level and included within the L_RA_Results table of the FRD. However, this should not be done if all of the affected structures within that census block have not been analyzed.

6.0 Annualized Loss Calculations

Whether calculated structure-by-structure, or aggregated at the census block level, annualized losses are helpful when comparing the magnitude or impacts of one hazard against another, and in estimating the potential flood losses over a defined period of time. For census blocks where losses for all five flood events were not analyzed, it may not be appropriate to calculate the annualized losses; however, that decision should be made in consultation with the FEMA Regional Project Officer, depending on the flood events that were modeled.

Although current and/or future versions of Hazus may have the ability to calculate annualized flood losses from within the software directly, the annualized loss formula is included below. This formula should be used individually for every loss calculation, such as residential structure losses or commercial contents losses.

Annualized Loss = (10% – 4%) *(Loss 10% + Loss 4%) / 2 +

(4% – 2%) * (Loss 4% + Loss 2%) / 2 +

(2% – 1%) * (Loss 2% + Loss 1%) / 2 +

(1% – 0.2%) * (Loss 1% +Loss 0.2%) / 2 +

0.2% * Loss 0.2%

Where “Loss 10%” equals the flood loss value associated with the 10 percent-annual-chance flood event, “Loss 4%” equals the flood loss value associated with the 4 percent-annual-chance flood event, and so on.

For example, assume a census block or structure has the following loss values:

- 10% annual chance event = $0
- 4% annual chance event = $0
- 2% annual chance event = $2,000
- 1% annual chance event = $30,000
- 0.2% annual chance event = $80,000

The annualized loss would be calculated as follows:

Annualized Loss = (0.10 – 0.04) * (0 +0) / 2 +

(0.04 – 0.02) * (0 + 2000) / 2 +

(0.02 – 0.01) * (2000 + 30000) / 2 +

(0.01 – 0.002) * (30000 + 80000) / 2 +

0.002 * 80000

Annualized Loss = 0 + 20 + 160 + 440 + 160 = $780/yr

Annualized losses can also be communicated in terms of estimated damages over a period of time. Using the example above of $780/year in annualized flood losses, one could estimate that over the period of 30 years, the total damages could generally be expected to be in the neighborhood of $23,000 (i.e. $780 * 30, and then rounded).

If more than the standard five annual chance events are modeled, the equation can be expanded where the first line includes the two most frequent events and the last two lines use the two least frequent events.

7.0 Flood Risk Assessment Information on the Flood Risk Map

Flood risk assessment information is generally included on the FRM. The FRM Guidance provides additional information related to how this information may be depicted.

8.0 Flood Risk Assessment Information in the Flood Risk Report

Flood risk assessment results are also included in the Flood Risk Report (FRR), and are based on the entries in the L_RA_Summary table. The FRR Guidance provides additional information related to how this data is calculated and reported. Although the spatial data in the FRD is not clipped to the project footprint, the risk assessment summary tables in the FRR should only report on the extent of the flood risk data that is within the project area and within each community respectively.

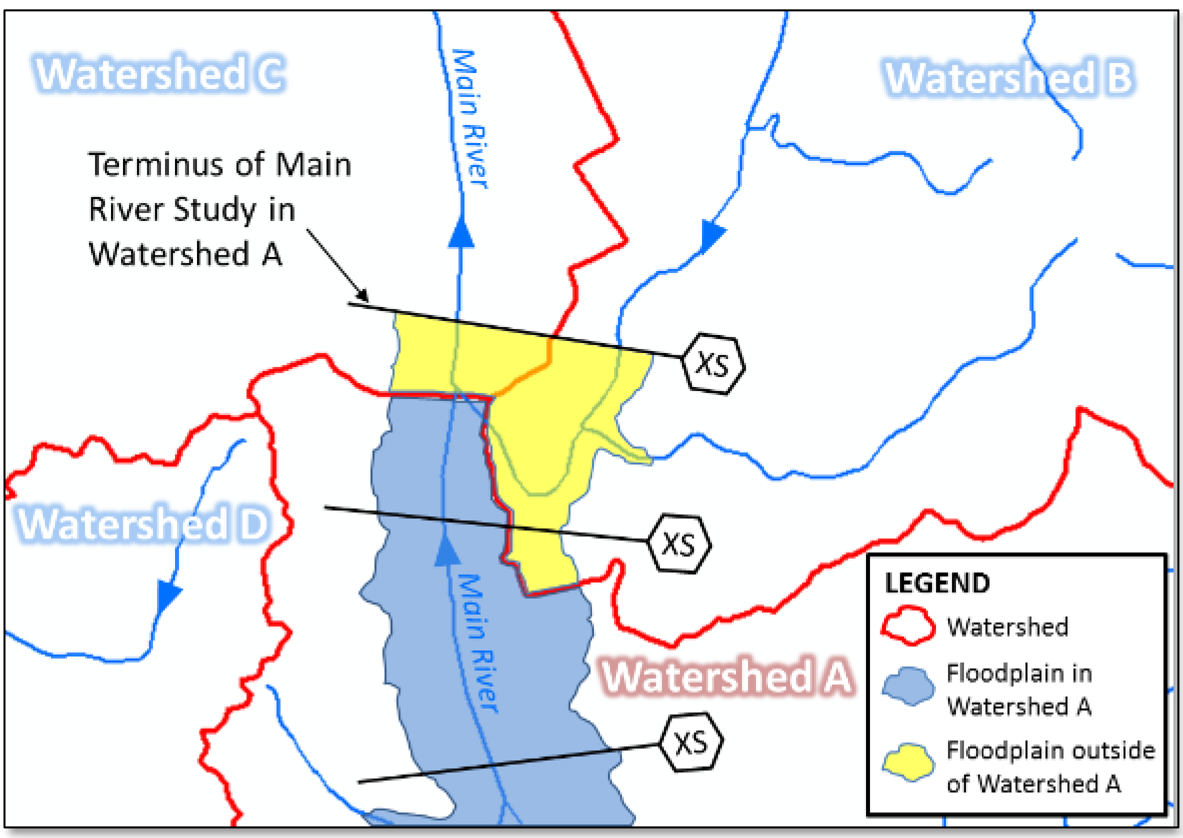
9.0 Dataset Spatial Extents

Certain flood risk datasets will naturally extend beyond the limits of the Flood Risk Project footprint. This additional data may be needed to ensure a complete picture of flood risks within the project area. Figure 9 provides an example of a typical scenario that will regularly occur at the outlet of watersheds that are being studied.

The Flood Risk Assessment dataset should include all census blocks that are entirely or partially within the Flood Risk Project area boundary (or project footprint). The spatial census block table (S_CenBlk_Ar) should be kept in its entirety and should not be clipped to the project footprint. However, some of the FRD tables that are used to populate the FRR should not include data outside of the project footprint. For example, the L_Exposure and L_RA_Summary tables will include inventory and loss data summarized at the overall Flood Risk Project area level. Since census block boundaries rarely align perfectly with watershed, coastal, or other project footprints, these result tables will need to be area-weighted.

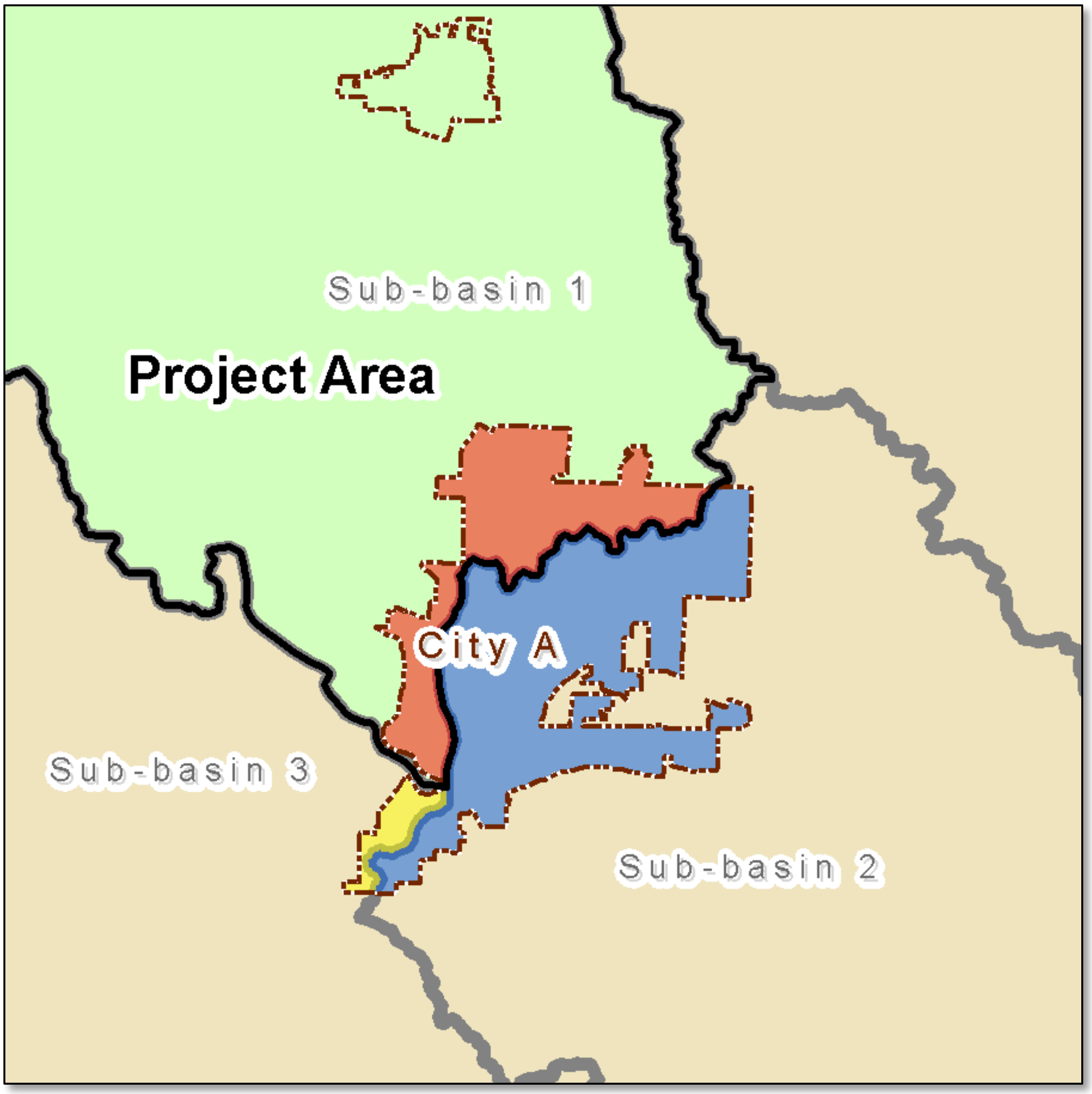
In order to derive appropriate loss values and summaries at the project level, the loss values for any census block that extends outside of the project footprint should be area-weighted. This is accomplished by intersecting census block boundaries with the project area boundary to derive the percent of the census block that is within the project area. This percentage is then multiplied by the values represented by the census block (such as total asset loss) to derive the values that apply to the overall project area.

Figure 9: Flood risk data outside of the project area



Similar area-weighting principles will need to be applied for the community summary records in L_Exposure and L_RA_Summary. Figure 10 shows an example of how a community (City A) is split between three different project areas (watersheds). When City A's information is shown in the FRD, FRR, and FRM for Sub-basin 1 (the project footprint), only the risk assessment results for the portion of the community within Sub-basin 1 would be included (the red portion of City A).

Figure 10: Example of community spanning multiple watersheds



10.0 Data Delivery Timeline

The Flood Risk Database Guidance provides recommendations as to when the Flood Risk Assessment dataset should generally be provided to communities during the life of a Flood Risk Project, and the conditions under which it should be updated after its initial delivery.

11.0 Uses in Outreach, Collaboration, and Flood Risk Communication

Wherever possible, flood risk information that is able to be calculated, displayed, and explained at the structure level provides a more actionable foundation for mitigation than aggregated at the census block level. However, both serve a purpose. The Flood Risk Assessment data helps when discussing the financial risk associated with flooding for business and home owners, and helps emphasize that they should take action to reduce that risk (e.g., elevate sensitive equipment such as heating and air conditioning units, purchase adequate flood insurance on building and contents). This data also helps communities make decisions regarding future land use and development.

Flood risk assessments can also directly support proposals for mitigation actions by communicating the financial risk associated with flooding and its potential effect on public buildings, utilities, and community infrastructure, thereby helping to justify where the community can take steps to reduce risk and further guard against future financial loss. This data also enables a high level quantification of potential flood losses to the built environment, which helps to justify building restrictions and regulations. The financial benefits of such actions are often more easily communicated and understood using this data than with other datasets.