Guidance for Flood Risk Analysis and Mapping

Flood Risk Assessments

February 2018

FEMA

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.

Table of Revisions

The following summary of changes details revisions to this document subsequent to it most recent version in May 2016.

Affected Section or Subsection	Date	Description
Multiple	February 2018	Updated guidance to reflect changes to Flood Risk Database tables associated with the Flood Risk Assessment dataset, which were consolidated into single spatial tables associated with census block and individual structure loss 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 U.S. 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 tables that communicate the overall flood risk exposure and damage estimates within the project area.

Figure 1: Flood Risk Assessments for Census Blocks (left) and Structures (right)

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 only where flooding can happen, but also how deep the water will get and how that depth will affect economic losses. By providing this information, the risk can be made more real, allowing more attention to be called to the potential consequences, and the increased likelihood that appropriate mitigation actions will be taken.

These risk assessments are used in reporting annualized losses 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 spatial 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. The inventory data 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. Most of the total losses calculated by models like Hazus are based on two 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.

In addition to building and contents losses, loss models may also include estimates of indirect damages or lost economic activity associated with the direct physical damages caused by the hazard event. For example, Hazus flood analysis for census blocks includes in the total loss estimate values associated with inventory loss, relocation cost, income loss, rental income loss, wage loss, and direct output loss.

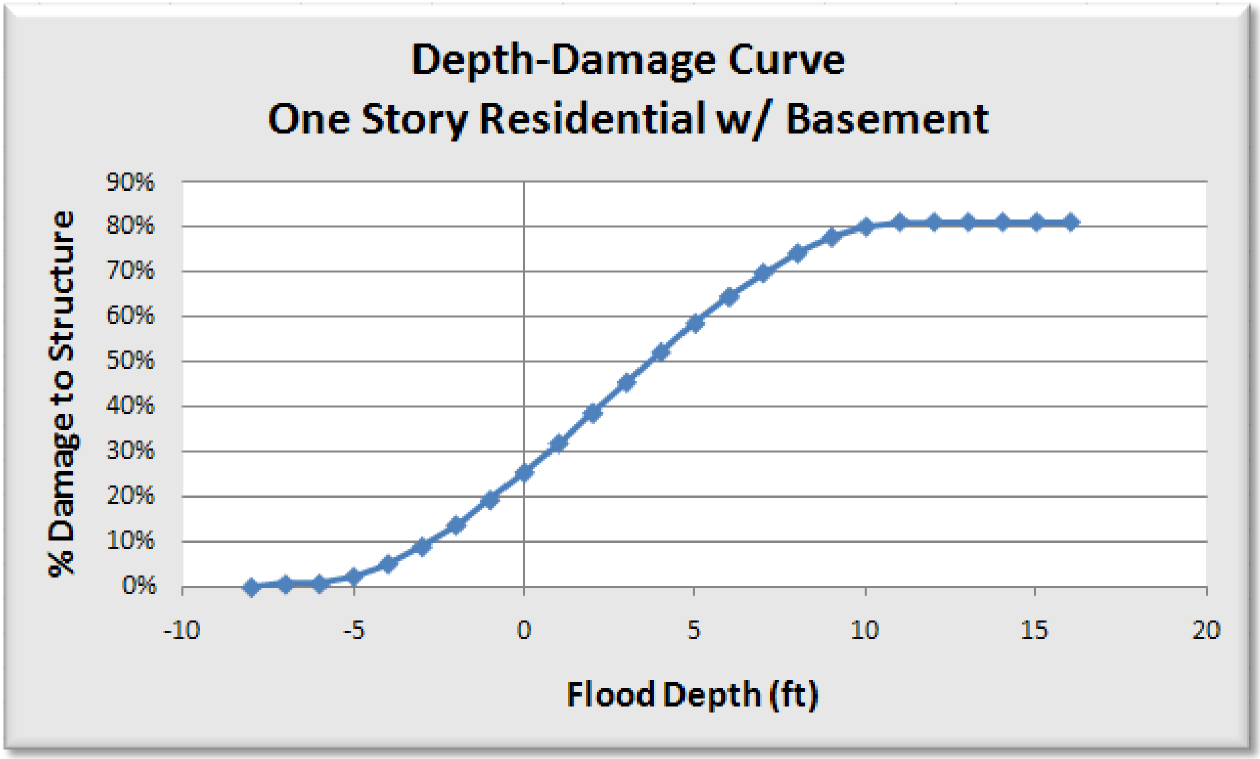
3.0 The "Composite" Flood Risk Assessment Depth Grid

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.

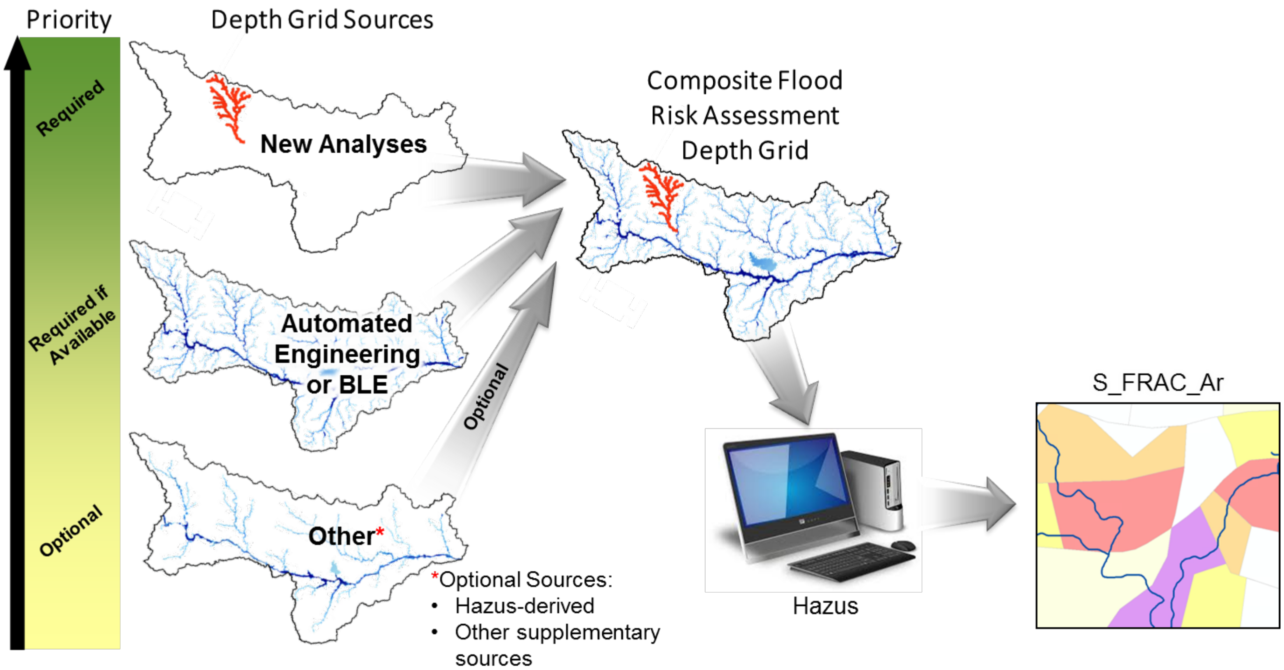
Figure 2: Example depth-damage relationship:
USACE, Economic Guidance Memo #04-01, October 2003



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 Flood Risk Database [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 or Base Level Engineering (BLE)
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 and BLE Depth Grids

Automated Engineering and BLE depth grids may also be available. In cases where Automated Engineering or BLE depth grids are available, they will most often cover all flooding sources within the project area. These 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 depth grid is typically produced, additional depth grids may be developed for other flood events depending on project scope. Each percent-annual-chance Automated Engineering or BLE 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 or Base Level Engineering process, refer to the Automated Engineering Guidance and Base Level Engineering Guidance documents, respectively.

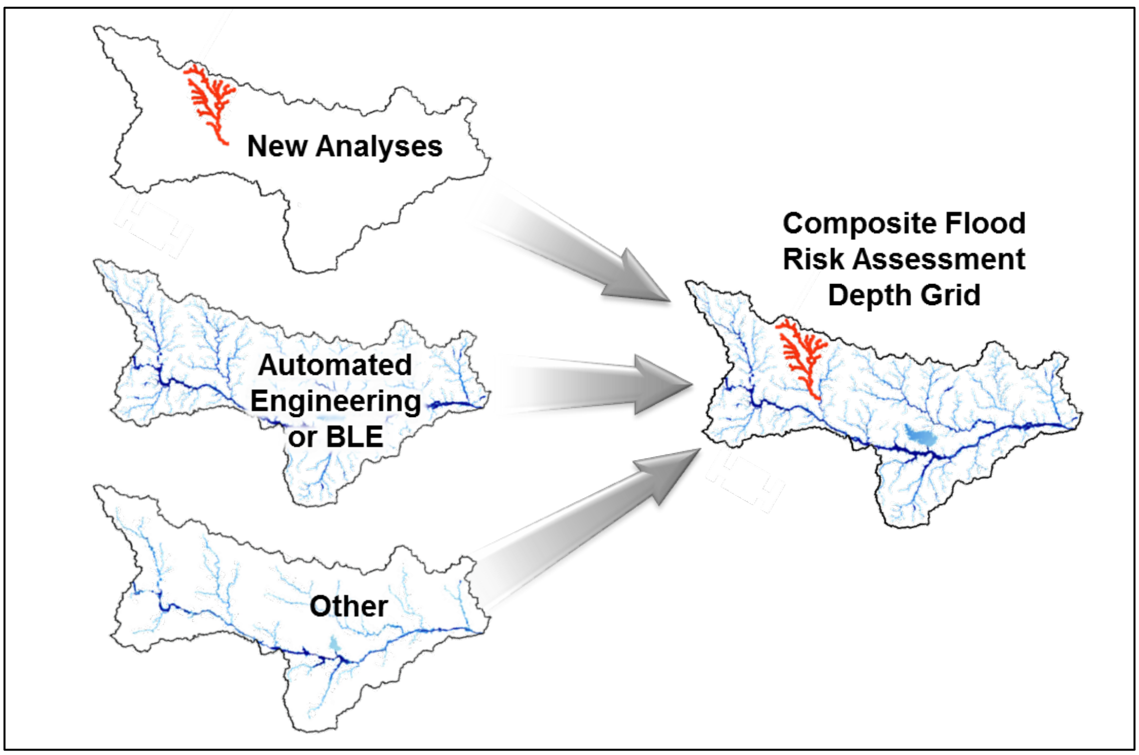
3.1.3 Other Depth Grids

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 and BLE. Generally speaking, this type of data should only be used in the creation of the composite depth grid if Automated Engineering and BLE data are 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 and BLE, 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
- BLE: 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 BLE everywhere else
- 1 percent – composite of new analyses, supplemented with BLE everywhere else
- 2 percent – composite of new analyses, supplemented with BLE 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 BLE 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 BLE everywhere else

Scenario 3

Percent-annual-chance depth grids available:

- New Analyses: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chances
- BLE: 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 BLE everywhere else
- For all remaining flood events (10-, 4-, 2-, 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. Another option would be to composite the depth grids from new analysis and Hazus Level 1 for these remaining flood events.

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 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 block level (see Figure 5).

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 U.S. 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 Calculation of Flood Risk Assessment Results

For census block-based flood risk assessments, the Flood Risk Assessment dataset is stored in the S_FRAC_Ar table in the FRD. 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.

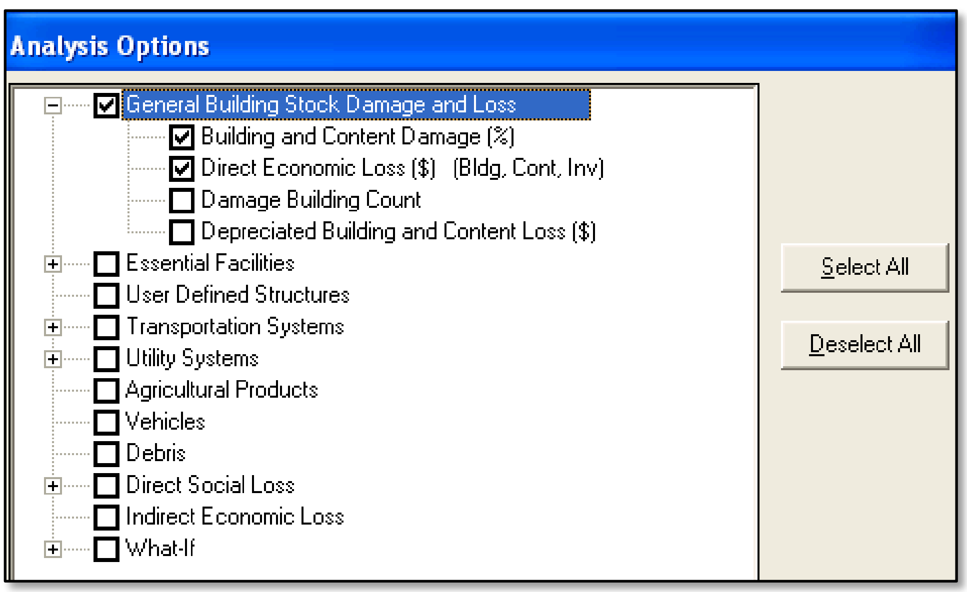
4.1.1 Import User-Defined Flood Depth Grids

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 that were 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.).

4.1.2 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 FRD.

Figure 6: Hazus Analysis Options



4.2 Populating S_FRAC_Ar

4.2.1 Exporting Data from Hazus

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

Table 1: Hazus Tables to be Exported for S_FRAC_Ar

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

The exported Hazus tables related to inventory should cover the entire project area footprint (S_FRD_Proj_Ar), but should not be clipped to the project area footprint. Section 7.0 of this document outlines additional guidance for the S_FRAC_Ar spatial layer, as it relates to aligning it to the footprint of the project area. There should only be one set of exported Hazus tables related to inventory, since these values will not change for different flood events.

For the exported Hazus tables related to flood losses, one results table will need to be exported for each flood event modeled within Hazus. Each exported Hazus results table will only include census blocks that intersect with the flood depth grid associated with that flood event.

4.2.2 Populating Inventory-Related Fields

Table 2 explains how the values in the S_FRAC_Ar fields are derived from these exported inventory-related Hazus tables. Each census block within the project area should be populated for the inventory-related fields. 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.

Table 2: Derivation of Inventory-Related S_FRAC_Ar Fields from Exported Hazus Tables

S_FRAC_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)

4.2.3 Populating Flood Loss-Related Fields

The S_FRAC_Ar table has default fields to store Hazus flood loss results corresponding to the following frequencies:

- 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

The losses associated with each individual flood event are included in flood loss-related tables exported from Hazus. The Annualized loss values will need to be derived separately, outside of Hazus (see Section 6.0 for more details). If a Flood Risk Project includes additional frequencies beyond those listed, additional supplemental fields may be added to the S_FRAC_Ar table to store these results.

For each frequency, S_FRAC_Ar includes default fields associated with total flood losses and the building and contents subtotal losses. FEMA Regions may decide to include additional Hazus outputs for each frequency associated with other subtotals, such as total residential losses. These supplemental subtotals may be either added to the S_FRAC_Ar table or saved in a supplemental FRD table which includes the CEN_BLK_ID field to allow database linking to the standard S_FRAC_Ar table.

Table 3 provides an example of how the values for S_FRAC_Ar fields associated with the 1 percent-annual-chance flood event are derived from these exported Hazus tables.

Table 3: Derivation of S_FRAC_Ar Fields from Exported Hazus Tables for 1 percent-annual-chance Flood Event

S_FRAC_Ar FIELD	Description	Hazus Derivations
TOT_LOSS01	Total losses	Hazus Results: GBS Economic Loss Full Replacement: Total (Total Loss Field)
BL_TOT01	Total building losses	Hazus Results: GBS Economic Loss Full Replacement: Total (Building Loss Field)
CL_TOT01	Total contents losses	Hazus Results: GBS Economic Loss Full Replacement: Total (Contents Loss Field)

For the fields associated with the other flood frequencies, the same Hazus derivations should be used for the specific Hazus exported tables associated with those frequencies.

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 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.

4.3 Other Census Block Considerations

4.3.1 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. The values found in S_FRAC_Ar should reflect the GBS version (Hazus default or updated) used for the Hazus analysis. Details on how to incorporate this type of data into the analysis within Hazus can be found within the Hazus Flood Model User Manual.

4.3.2 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 often 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.

4.3.3 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.

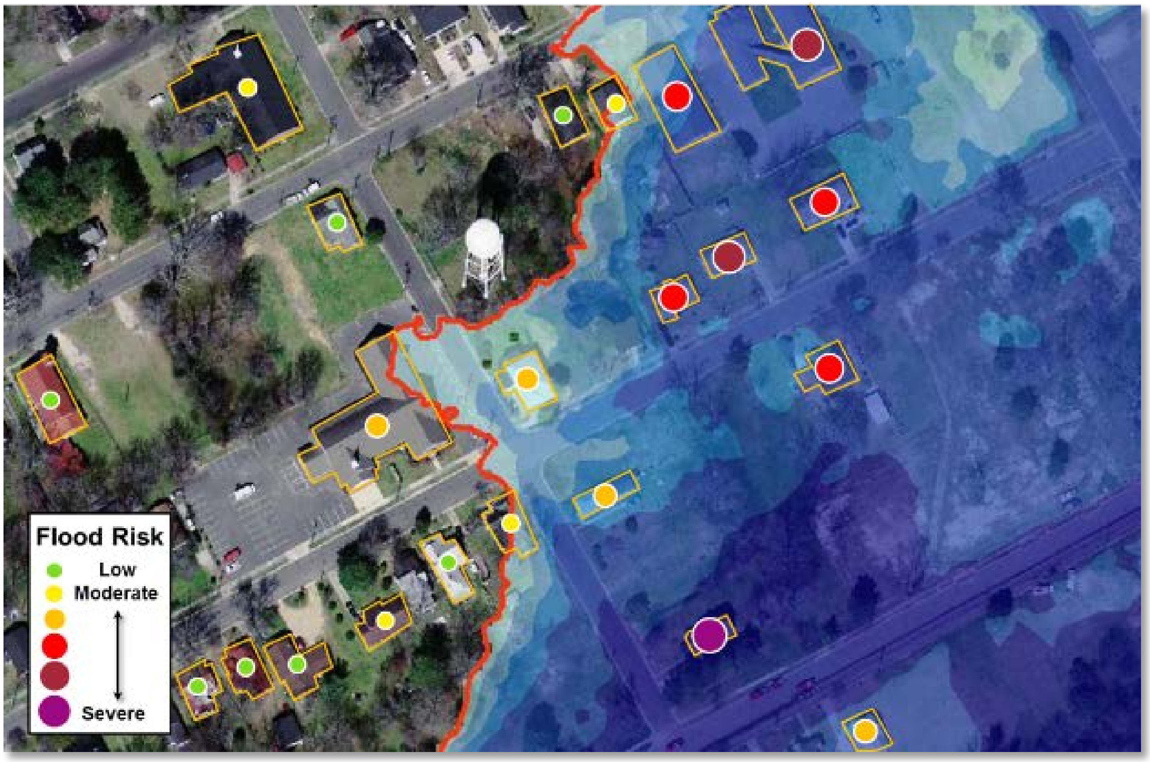
4.3.4 Variations for Flooding Downstream of Dams

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 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 7). 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 7: Structure-specific (Hazus UDF) Risk Assessments



5.1 Calculation of Flood Risk Assessment Results

For structure-specific flood risk assessments, the Flood Risk Assessment dataset is stored in the S_FRAS_Pt table in the FRD. 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 structure-specific flood risk assessment within Hazus are outlined below.

5.1.1 Selection of Structures to Receive Flood Risk Assessments

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, 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.

Another consideration for structure selection is data availability. To perform structure-specific flood risk assessments, the user must generally know the following critical structure characteristics for each structure assessed:

- Structure location
- Structure type and use
- Structure finished floor area (used to derive building replacement value)
- Structure number of stories (for residential)
- Structure's lowest finished or first floor elevation (FFE)

This list does not include all required inputs to Hazus, but highlights those structure characteristics that are most critical to allow Hazus to select the approximate flood damage relationships to model flood loss. If available structure-specific data is missing for one or more of these structure characteristics, then that may influence the selection of structures where Hazus-specific UDF data fields are derived.

5.1.2 Deriving Structure-Specific Hazus UDF Data

The Hazus Flood Model User Manual provides details on derivation of UDF data for a structure-specific flood analysis. The manual includes the specific field values and input data formats required by Hazus for each field of a Hazus UDF flood database file.

Hazus uses replacement values to estimate damages from hazard events. Therefore, values used for building replacement values and contents replacement values need to reflect the cost to replace elements in a structure, not the structure appraised or assessed value. The value of the land on which the building resides should not be included in the building replacement value. While there are available commercial replacement value costing publications, purchase and use of these publications may beyond scope of a given project. 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.

5.1.3 Import User-Defined Facilities and User-Defined Flood Depth Grids

Once the Hazus UDF flood database file and the composite flood risk assessment depth grids have been compiled, they are used as the primary inputs for conducting the structure-specific flood loss analyses. The same Hazus UDF flood database file can be used for each analysis. Similar to census block-based analysis, there should be one depth grid imported for each flood event being assessed (0.2 percent, 1 percent, etc.).

5.1.4 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.). The Hazus Analysis Options only need to include the

User Defined Facilities option. Other analysis options may also be computed, but are not required to be delivered as part of the FRD.

5.2 Populating S_FRAS_Pt

5.2.1 Exporting Data from Hazus

As the first step towards populating the Hazus-derived fields in S_FRAS_PT, Table 4 outlines the tables that should be exported from Hazus:

Table 4: Hazus Tables to be Exported for S_FRAS_Pt

Menu	Item
Inventory	User Defined Facilities
Results	User Defined Facilities

For the structure-specific inventory data, a user may also use the source Hazus UDF spatial database file rather the table exported from Hazus, since all spatial information and tabular values should be identical between the two sources. There should only be one set of exported Hazus tables related to inventory, since these values will not change for different flood events. For the exported Hazus tables related to flood losses, one results table will need to be exported for each flood event modeled within Hazus. Each exported Hazus results table will only include structures with losses associated with that flood event.

5.2.2 Populating Inventory-Related Fields

Table 5 explains how the values in the S_FRAS_Ar fields are derived from these exported inventory-related Hazus tables. Each structure modeled in Hazus within the project area should be populated for the inventory-related fields.

Table 5: Derivation of Inventory-Related S_FRAS_Ar Fields from Exported Hazus Tables

S_FRAS_Ar FIELD	Description	Hazus Derivations
OCCUP_TYP	Hazus specific occupancy type	“Occupancy” field in the Hazus flood UDF database
ARV_BG	Asset replacement value of building	“Cost” field in the Hazus flood UDF database
ARV_CN	Asset replacement value of contents	“ContentCost” field in the Hazus flood UDF database

5.2.3 Populating Flood Loss-Related Fields

The S_FRAS_Pt table has default fields to store Hazus flood loss results corresponding to the following frequencies:

- 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

The losses associated with each individual flood event are included in flood loss-related tables exported from Hazus. The Annualized loss values will need to be separately derived outside of Hazus (see Section 6.0 for more details). If a Flood Risk Project includes additional frequencies beyond those listed, additional supplemental fields may be added to the S_FRAS_Pt table to store these results.

For each frequency, S_FRAS_Pt includes default fields associated with flood losses associated with building loss, contents loss, and inventory loss. Table 6 provides an example of how the values for S_FRAS_Pt fields associated with the 1 percent-annual-chance flood event are derived from these exported Hazus tables.

Table 6: Derivation of S_FRAS_Pt Fields from Exported Hazus Tables for 1 percent-annual-chance Flood Event

S_FRAC_Ar FIELD	Description	Hazus Derivations
BLD_LOSS01	Asset building value loss	"BldgLossUS" field in the exported Hazus results UDF database
CNT_LOSS01	Asset contents value loss	"ContentLos" field in the exported Hazus results UDF database
INV_LOSS01	Asset inventory value loss	"InventoryL" field in the exported Hazus results UDF database

For the fields associated with the other flood frequencies, the same Hazus derivations should be used for the specific Hazus exported tables associated with those frequencies.

The variations to consider when performing structure-specific risk assessments for coastal, levee, or dam-related flooding are similar to those outlined in Sections 4.3.2, 4.3.3, and 4.3.4 respectively of this guidance.

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 individual structure losses or census block total building 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-percent-annual-chance event = $0
- 4-percent-annual-chance event = $0
- 2-percent-annual-chance event = $2,000
- 1-percent-annual-chance event = $30,000
- 0.2-percent-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).

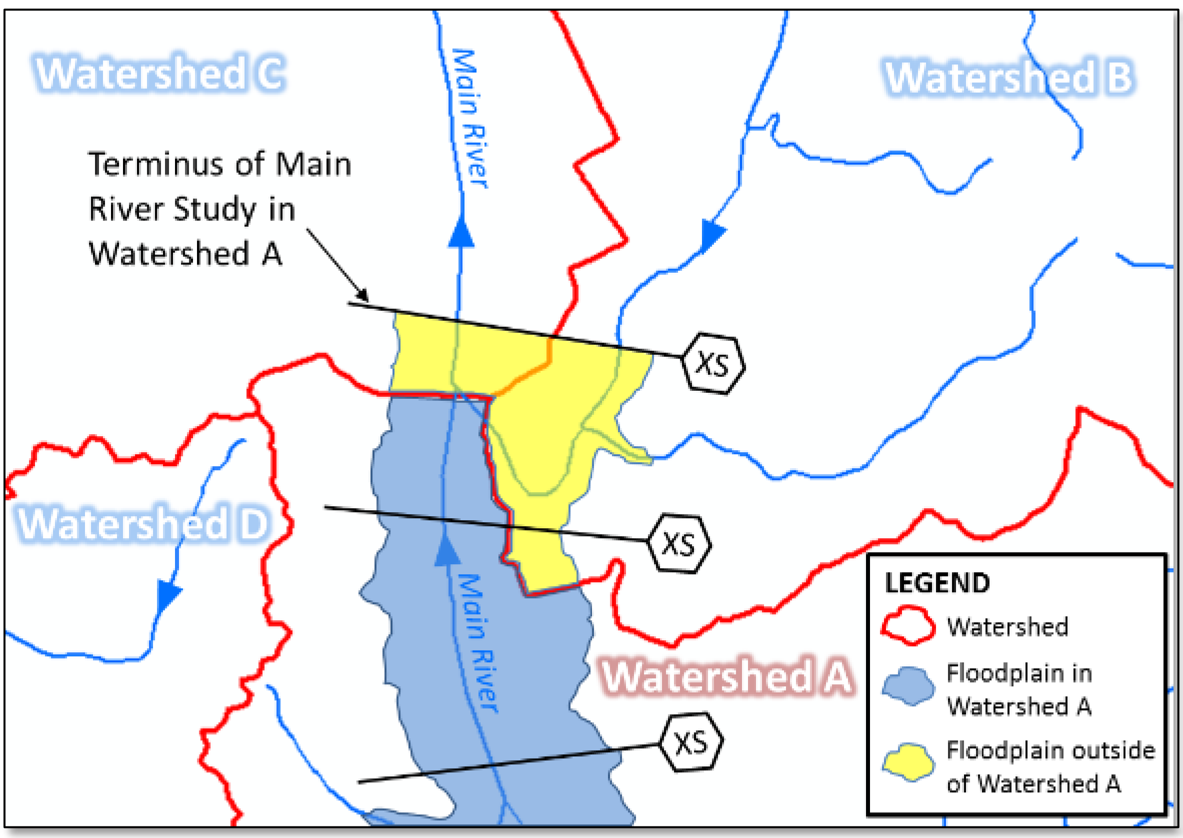
If more than the standard five annual chance events are modeled, the equation can be expanded where the first line includes the two most frequent events and the last two lines use the two least frequent events.

7.0 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 8 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_FRAC_Ar) should be kept in its entirety and should not be clipped to the project footprint

Figure 8: Flood risk data outside of the project area



8.0 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.

9.0 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). By comparing losses at varying lowest floor elevations for the same structure, savings per foot of elevation can be calculated to help convince owners to elevate and to decide how high above the minimum requirement to elevate. 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. For example, by comparing overall losses at varying requirements for lowest floor elevations, communities can calculate the losses avoided by increasing the lowest floor elevation requirement. Losses avoided could also be calculated by comparing losses based on restrictions on building in certain areas of the floodplain. The financial benefits of such actions are often more easily communicated and understood using this data than with other datasets.