RIVER BASIN FLOOD STUDY

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Report

Texas GLO River Basin Flood Study

Standard Operating Procedures for Hot Spot Analysis 100% Submittal Report

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1 Purpose

This *Regional Hot Spot Analysis (HSA) Standard Operating Procedures (SOP*) is provided as a *guidance* document to facilitate *rapid* geospatial flood risk assessments, as it pertains to the identification of localized flood prone areas with notable flood damage potential (or "hot spots"). The methodology underpinning this SOP was developed as a generalized suite of steps that can be applied uniformly across the study regions at the HUC-10 level. A key product of the HSA is the development of hot spot maps that identify flood prone areas that are in likely need of further analysis, thus warranting these areas' additional consideration in the alternatives formulation process that comprise Phase 4.

It is worth emphasizing this SOP is provided as a *guidance* document, and that products stemming from the HSA are not intended to replace or supersede a region's consideration for established flood risk alternatives already conceptualized to mitigate known flood risks; or feedback gathered and assimilated as part of regional stakeholder engagement efforts that may simultaneously be used to inform regional hot spots. Moreover, regions that have better available data and models are encouraged to utilize these datasets as appropriate to inform their regional HSA.

It is also recognized that this HSA is limited in application. For example, this SOP emphasizes the identification of flood prone areas that are highly populated with high flood damage potential. However, flood damage as it pertains to flooded agricultural lands is also a key factor. A consensus was reached in spring 2023 – as part of series of cross-regional coordination meetings – that noted the complexities of agriculture economics (coupled with the scarcity of application-ready agricultural models) were beyond the aims and scope of the HSA SOP and that doing so may impose substantial unintended efforts across regions in the Phase 4 process.

The SOP is provided in conformity with the East Region's Phase 3 Scope of Work, Work Order No. D494, GLO Contract No. 20-094-001 and is provided to the GLO study regions (i.e., East, Central, West, and Lower Rio Grande) as part of a collaborative exchange.

2 Definitions

The following terms are used in this SOP to establish a uniform application for rapid assessment. The terms have their fundamental origins in FEMA risk training but have been embellished in order to highlight important distinctions among the terms for this application.

2.1 Hazard: *Hazard* refers to the **threat** of an undesired consequence or event. Although hazards take many forms, this SOP addresses flooding from rainfall events, storm surge, or sea level rise (in coastal communities) as the hazard. Therefore, hazards analyzed in this application are limited to these flood threats.

2.2 Exposure: *Exposure* to hazards entails evaluating the extent to which populations and economic assets for an area of interest will **experience** flood hazards. Again, exposure to hazards in the population can cover almost every aspect of life; but this SOP approach is limited to the flooding hazard experience and represents the occurrence or actual event of the hazard such as depth of inundation, extent of inundation, and height of storm surge.

2.3 Consequences: *Consequences* are the **results** of the hazardous event. Consequences occur in the aftermath of the event and can fall anywhere between little or no impact to catastrophic impacts. Some consequences are quantifiable flood damages, such as number of flooded structures, miles of inundated roadways, acres of inundated agricultural lands, and impacted populations. This SOP does not preclude the four River Basin Flood Study (RFBS) regions from adopting additional or ancillary metrics they deem necessary for measuring consequences that represent the region's inherent traits and characteristics (e.g., urban versus rural and inland versus coastal).

2.4 Risk: *Risk* is the generalized expression of the probability that something "bad" will happen and the results of that bad thing happening. *Risk* is an expression of the potential loss caused by natural or man-made activities. *Risk* is commonly defined as the mathematical product of the *probability* of an event's occurrence and the *consequences* of that event. Risk can be categorized as high or low, great or small, depending on the probability of a hazardous event or the magnitude of its consequences or both. **Figure 1** provides an illustration of the gradations of risk based on the combination of probability and severity of consequences.

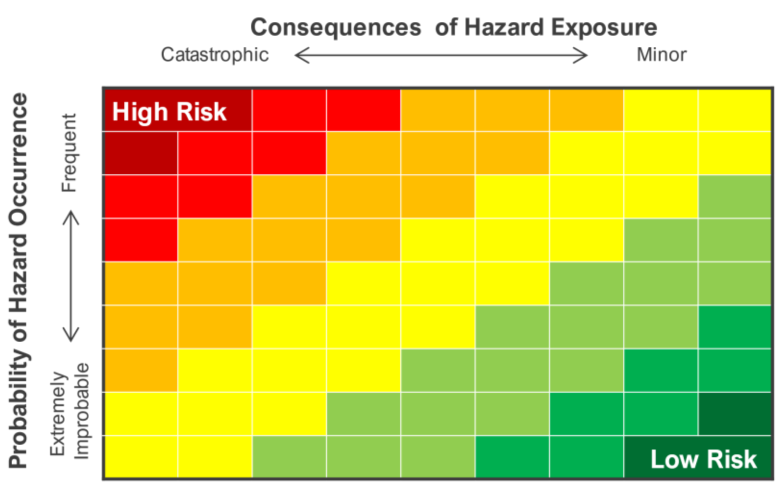


Figure 1. Risk Matrix

2.4.1 Probability of Hazard Occurring: In this document, the *probability* of hazard occurrence is measured in terms of annual exceedance probability (AEP). For example, the 1% AEP rainfall event has a 1 in 100 chance of occurring in any given 1-year period. For this analysis, the rainfall for a given AEP is applied to a watershed via hydrologic and hydraulic (H&H) modeling to determine watershed response (i.e., *hazard*) and the rainfall AEP is then associated with the resulting hazard. Joint *probability* analyses from bivariate evaluations of compound flooding (e.g., rainfall-runoff plus storm surge) are applied based on the location of the watershed. Eight event *probabilities* and associated flooding conditions (i.e., *exposure)* (50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% AEP) may be quantified in the Baseline Conditions modeling and utilized in the HSA. It is important to note that only the storm events created in the Baseline Conditions modeling effort will be used for the HSA SOP.

2.4.2 Consequences of Hazard Occurring: The *consequences*, as defined in this study and SOP, are those associated with quantifiable flood damages, as noted above. These consequences can be estimated using spatially referenced datasets of economic assets and population upon which exposure to probabilistic events can be assessed. Suggested datasets are outlined in the following section with the expectation that the teams will apply those datasets necessary to best estimate risk in their regions.

2.5 Vulnerability and Social Vulnerability: Determining vulnerability occurs in the aftermath of the exposure and is used to evaluate the *reaction* of the subject to the hazard exposure. For this analysis, social vulnerability is a metric developed to gauge a community's ability to recover from natural or man-made hazards. Populations which have historically struggled to overcome exposure to hazards or have disproportionately borne the consequences of exposure to hazards, are given special consideration for hazard mitigation through Justice 40 initiatives, Community Development Block Grant – Mitigation (CDBG-MIT) funds, and other governmental policies for social equity. Specifically, CDBG-MIT grants typically require a project to benefit households where 51% or more are considered Low-to-Moderate Income (LMI) which are identified as households that earn less than 80% of the Area-Median-Income. While LMI only considers annual income, the Social Vulnerability Index (SoVI) provided by GLO weighs several socioeconomic factors affecting a community's resiliency in the face of environmental disasters. Therefore, an SoVI factor should be considered when evaluating high flood risk hot spots to recognize more vulnerable communities.

3 Data Required for Identifying Risk

The following collection of data is recommended to evaluate and quantify risk, based on the definition of *risk* as the product of *probability* of a *hazard* and the *consequences* resulting from *exposure*.

3.1 Geospatial Maps of Probabilistic Events: Results and model outputs from Baseline Conditions modeling, as performed using HEC-RAS, will serve as the building blocks for conducting the Hot Spot Analysis, namely through utilizing water surface elevations (WSE) (for 1D/2D) or depth grids (for 2D) as calculated for selected AEP rainfall, compound, or surge events.

These WSE, which should relate to the terrain that was used while modeling, will be exported in raster format, collated with available LiDAR for subsequent use to estimate *exposure* (LiDAR is unnecessary when utilizing depth grids), and pre-processed to exclude those WSE that are less than or equal to 0.1 ft. The pre-processing of the WSE raster is meant to exclude any discrepancy in the data and also identify those areas that display a considerable depth of flooding.

3.2 Identifying or Quantifying Consequences:

3.2.1 Structure Inventory:

The National Structure Inventory (NSI) database (2022 NSI Database) can be used to identify structures within each region that may be impacted by flooding. A point layer can be created using the centroid of structure or parcel, depending on data availability, to identify if a structure is exposed to the flood extents (i.e., exposure) estimated for each AEP event modeled. This layer can be used to calculate and store the location, building area (ft^2), the total improvement value and estimated finished floor elevation (FFE (ft)) for each identified structure.

In the absence of reliable FFE data, a standard adjustment factor of 0.5 ft can be added to the LiDAR ground elevation or topographic survey to approximate the FFE of a given structure for this HSA. This adjustment assumes an average 0.5 ft flood clearance above ground based on a common minimum slab foundation thickness of 0.5 ft for residential and commercial building construction. However, in areas where buildings and houses may be on pier and beam (e.g., coastal communities), best engineering judgement or additional information may be required to estimate FFE. A general estimate of 8 ft above ground elevation is suggested in lieu of available FFE for structures located in a coastal zone (specifically those within the FEMA FIS Zone VE). Regions may refer to the FEMA BFE or other applicable local regulations for permitting structures to determine reasonable FFE estimates for structures located in coastal-inland transitional zones.

The means and methods for compiling a structure inventory (SI) that is provisioned with appraisal and FFE data are left to the respective regions to allow autonomy in maximizing best available datasets and resources. Documentation of procedures – and related assumptions – for compiling a functional SI comprising relevant attributes (e.g., FFE, building area, structure type) for performing a regional-level Hot Spot Analysis for flood-prone communities is required.

3.2.2 Number of Flooded Structures: A building's inundation depth can be estimated based on subtracting the estimated FFE from the modeled maximum WSE at that location for a given AEP event. A structure is considered "flooded" when the modeled WSE at that location is greater than the estimated FFE of the structure, or the building's inundation depth is greater than zero. For each AEP event, the total count of impacted structures can be estimated based on the number of structures with resulting inundation depths greater than zero.

3.2.3 Critical Infrastructure: All critical infrastructure (2020 TWDB Critical Infrastructure database), such as hospitals, nursing homes, daycare centers, schools, and power stations, inundated by flooding or within a floodplain should be reported.

3.2.4 Miles of Inundated Roadways: The TxDOT roadway inventory data (2021 TxDOT database) can be used for the Hot Spot Analysis. If data are available, location of low water crossings and miles of inundated roadways can be evaluated using depth grids (or a combination of WSE and LiDAR data) from Baseline Conditions modeling to identify roadways that experience an inundation greater than 0.5 ft. A flood depth of 0.5 ft at the crest of a road implies the roadway is impassable, affecting mobility and vehicular access and producing other potential cascading impacts on an area and its residents.

3.2.5 Social Vulnerability Index (SoVI): Social vulnerability refers to the ability of a community to recover from a natural or man-made disaster. The SoVI GIS database for Texas was developed for CBDG-MIT grants using census data to identify communities that will most likely need additional support during and after a hazardous event. This database is readily available through the CDBG Mitigation Viewer (CDBG Mitigation Viewer, updated 2022). For this HSA, a high-level recognition of vulnerable communities is accomplished by overlaying the SoVI census tract layer over the structural, roadway and agricultural hot spot maps to identify areas where high flood risk coincides with socially vulnerable communities. The values in the Texas SoVI database range from -14 to 14, with a mean of zero. The dataset also includes a 3-class and 5-class designation within the CDGB-MIT data, which ranges from Low to High. Including the SoVI Layer in the HSA can be used to recognize vulnerable communities intersected with high flood risk areas for subsequent action during alternatives development in Phase 4 and funding strategies in Phase 5. Please note, it is recommended to use the latest SoVI data and an additional update is expected June 2024.

3.2.6 Agricultural Flood Exposure: The National Cropland Data Layer from USDA (2022 USDA Agricultural Crop Data Layer) can be utilized to ascertain area used for agricultural purposes for intersection with flood risk to identify Agricultural flooding “hot spots”. These agricultural flood risk areas can be approximated based on the number of acres of agricultural lands inundated under Baseline Conditions modeling using LiDAR, WSE (or depth) rasters, and GIS tools. Additional tools and resources for estimating agricultural losses due to flooding are available to perform more in-depth analysis including TWDB’s preliminary Agricultural Flood Loss (AGFL) Tool (TWDB AGFL 2024). However, the variation due to seasonality and other uncertainties proposed in the detailed agricultural flood loss estimates are considered more detailed than the minimum level-of-effort prescribed in this document.

The extent of each region’s ability to quantify the full array of metrics noted above in **Section 3.2** is predicated on the quantity and quality of available datasets. Thus, the above metrics are documented as the minimum requirements for successful completion of a region’s Hot Spot Analysis. If more data are available, such as critical infrastructure (e.g., police station or power station locations) the regional team may decide to include it in the HSA to report a more accurate assessment of existing flood risk and hazard exposure.

4 Procedures for Analysis

It is recommended that each region use the Geographic Information System (GIS) procedures and tools outlined in this SOP (process described in **Section 6**, example GIS tools in **Appendix A**), in order to maintain consistency across all regions with the least amount of uncertainty in the results. However, with varying availability of data and physical qualities across the regions, each regional team should select an appropriate analytical approach for their watershed. The region should provide reasoning for the selected method if the region chooses not to follow the recommendation of the HSA SOP. Additionally, modifications to this SOP deemed prudent to accommodate physical and data variance of a region should be applied uniformly across watersheds within that region to promote consistency, if possible. A brief discussion of the methods used to calculate Structure Annualized Instance of Flooding, Roadway Flood Exposure, and Agricultural Flood Exposure prescribed to accomplish the HSA is presented below:

4.1 Structure Annualized Instances of Flooding: The Annualized Instances of Flooding (AIOF) is a simplified and rapid assessment to approximate flood risk to structures at a high-level. This method serves as a proxy for detailed expected annual damages for this HSA. WSE from the Baseline Conditions models (WSE raster grid) is overlaid with each structure's centroid; structure flooding depth is estimated as WSE minus FFE. The output from this exercise includes the flood depth for each AEP storm event for each structure from the NSI. A given structure is assumed "flooded" in the storm event if the flood depth is greater than zero. Instead of using depth-damage curves to determine flood damage to structures, the AIOF multiplies the AEP percentage by one (1) flood event for any event considered "flooded" or zero (0) for any considered "NOT flooded" and sums those resulting values across all storm events to determine the estimated structural annual instances of flooding (AIOF). An example calculation using the AIOF to approximate flood risk per structure is shown in ***Table 1.*** An example of the GIS (ArcMap) process used to calculate these values can be found in **Appendix A1** and the method used to validate the AIOF method for structures is described in **Appendix B**.

Table 1. Example Calculation of the Annualized Instance of Flooding

AEP Event Nominal Return Period (Years)	**Annual Probability of Occurrence** Discrete Probability of Event Occurring in Any Given Year	**Flood Depth (ft)** (WSE minus FFE)	**Flood Occurrence** If structure is assumed flooded in a given AEP	**Annualized Instance of Flooding** (Flood "occurrence" x Event AEP)
2	**0.5**	**-0.25**	**No**	**-**
5	**0.2**	**-0.09**	**No**	**-**
10	**0.1**	**0.01**	**Yes**	**0.10**
25	**0.04**	**0.08**	**Yes**	**0.04**
50	**0.02**	**0.1**	**Yes**	**0.02**
100	**0.01**	**0.52**	**Yes**	**0.01**
500	**0.002**	**1.02**	**Yes**	**0.002**
			Individual Annualized Instances of Flooding	**0.172**

To present these structural flood risk hot spots spatially, the annualized Instances of Flooding for each of the structures are aggregated to a watershed-wide hexagonal grid, where high flood risk centers can be displayed and grouped to find areas of concern for potential projects. To compare watersheds, the expected annual damages for all structures are displayed spatially for hot spot review and aggregated to compare total expected annual flood risk per HUC.

4.2 Roadway Flood Exposure Estimation: The roadway flood exposure is evaluated differently from the structural flood risk due to the difference in underlying data and ultimate application of roadway flood risk. A GIS process is used to isolate centerlines of roadway inundated greater than six (6) inches in each of the storm events evaluated. The roadway centerlines base shapefiles can be collected from various sources (including the latest TxDOT Roadway Inventory) and supplemented by manual entry, if necessary. These inundated roadway centerline segments will be overlayed spatially to create the roadway flood exposure hot spot map. The roadway flood inundation map resulting from this SOP will display impacted stretches of roadway across all storm events, highlighting areas with high frequency flooding issues. The hot spots can be used to inform decision makers of portions of roadway that may have potential damages, increased traffic time, or blocked access due to flooding. These roadway flood hot spots may be identified for a roadway project or combined with the agricultural and structural hot spot areas for potentially mutually beneficial projects targeting multiple hot spot types.

4.3 Agricultural Flood Exposure Estimation: In this SOP, for simplicity, agricultural flood exposure is evaluated independent of agricultural damages incurred based on economic value. The parcels of land identified as agricultural based on an associated land use category can be isolated and overlayed with flood inundation maps to determine the acres of agricultural land impacted per storm event. In the case that agricultural land use categories are not specified in the watershed, the most current National Land Cover Data ("NLCD") data should be used to estimate the base spatial layer outlining agricultural land in the given watershed. It should be noted that the categorization of "agricultural land" includes areas actively utilized for crops or livestock, but does not include undeveloped areas. The total number of acres of agricultural land expected to flood under the Baseline Conditions can be calculated for each HUC 10 watershed using the GIS process to identify the agricultural land that has a depth greater than 1 ft for the 1% AEP. In detailed evaluations of agricultural losses, the extent of crop loss varies per crop type depending on season, flood depth and flood duration. In an effort to include all crop types and different stages of the crops in this analysis, a 1 ft depth will be utilized to consider the agricultural land to be at risk. The method used to validate this simplified method of identifying agricultural flood risk is described in **Appendix B**.

5 Identification of Regional Hot Spots Process Overview

5.1 Exposure Map Generation: Teams will compile and catalog concentrations of exposure within each HUC 10 watershed in the study regions. First, baseline flood spatial data will be overlayed onto spatial coverages of the built environment and agricultural crops as noted above. Next, the teams will generate hot spots using hexagonal grids or roadway centerlines for each HUC 10 watershed. The Hot Spots will then be noted for each HUC 10 watershed considering high SoVI census tracts to draw attention to high flood risk in potentially socially vulnerable communities.

These layers will be clipped to the watershed boundary, and summary matrices will be created (***Table 2*** and ***Table 3***)**,** which will include annualized instances of flooding, an enumeration of structures and infrastructure impacted, miles of inundated roadway, and acres of agricultural land inundated. Recommendations for further analysis in Phase 4 will be made based on the results of the Hot Spot Analysis. ***Figure 2*** presents the proposed methodology for *Hot Spot Analysis*.

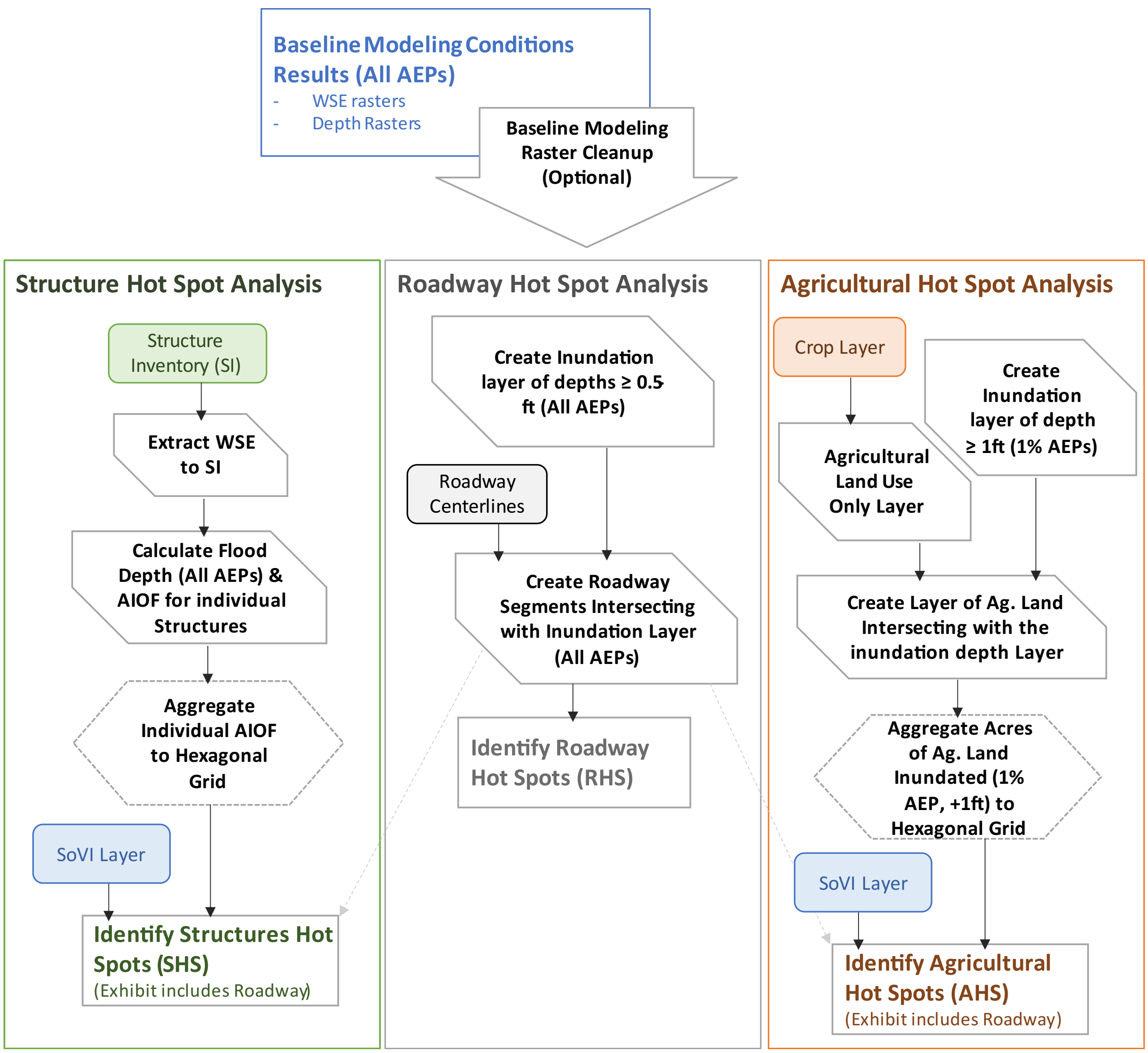


Figure 2. Regional Hot Spot Analysis Procedural Flow Chart

6 Hot Spot Analysis Detailed Methodology

The methodology in ***Figure 2*** outlines the steps to identify flood exposure Hot Spots for structures, roadways, and agricultural lands for baseline conditions used to inform recommendations for Phase 4 of the RBFS. The following section provides the standardized, GIS-based methodology to produce the recommended Hot Spot deliverables. While the following steps are tailored to ArcGIS Desktop software, they can be adapted to ArcGIS Pro with minimal deviation from the described steps.

6.1 Structure Flood Exposure Processing:

6.1 Structure Flood Exposure Processing: This section outlines the GIS-based method of calculating the flood risk Annual Instances of Flooding for structures (***Table 1***, **Section 4.1.1**). The result of this process will create the baseline heat or "Hot Spot" map to which the roadway (**Section 6.2**), and social vulnerability layers (SoVI), described in **Section 6.4**. This process uses WSE from Baseline Conditions and assumes an average finished floor height to estimate FFE (**Section 3.2.1**) and flooding depth.

The resulting maps spatially represent the Annualized Instances of Flooding to approximate flood risk to individual structures. The annualized instances of flooding data for individual are aggregated from the tables produced in these steps to calculate the total annualized instances of flooding per hexagonal area and for the HUC. ***Figure 3*** and ***Figure 4*** show structures "flooded" by a 1% AEP event based on the assumptions previously stated and are one output resulting from step 6.2.6, below. Please note, that when creating hot spot maps, all available storm events are used in this HSA.

1. Export WSE raster files from HEC-RAS model and import them into ArcMap.
2. Use the Clip (Data Management) tool to clip the National SI to the HUC 10 watershed [**Appendix A1 (a)**].
3. Use the Extract by Mask (Spatial Analyst) tool to clip the WSE raster to the HUC 10 watershed [**Appendix A1 (b)**].
4. Use Extract Multi Values to Points (Spatial Analyst) tool to extract the WSE values for all storm events and append them to the National SI layer. Assign each new field the name "WSE_XXAEP" where XX represents the frequency storm event being referenced [**Appendix A1 (c)**].
5. Use the Add field (Data Management) tool to add a new field named "FD_XXPCT" where XX represents the frequency storm event being referenced [**Appendix A1 (d)**].
6. Calculate the new field to determine the flood depth. If the WSE is greater than the estimated FFE, subtract the estimated FFE from the WSE to get the flood depth. If the WSE is less than the estimated FFE by more than 2 ft (i.e. flood depth = less than -2 ft), then the flood depth will be null or -9999 [**Appendix A1 (e)**].
   a. Please note that FEMA Hazus estimation of damages using depth-damage relationships which begin "percent structure damage" values at -2 ft or greater flood depth at a structure. While flood depths lower than 0 are not considered in this analysis, it may be useful to calculate the flood depths in the range -2 to 0 for future application of full economics calculations with this structure inventory data set, if needed.
7. Use the Add field (Data Management) tool to add a new field named "MULT_XXAEP" where XX represents the storm event being referenced [**Appendix A1 (f)**].
8. Calculate the new field to determine the multiplier. If the WSE is greater than the estimated FFE, the multiplier is equal to the percent AEP in the decimal form (50% AEP would have a multiplier of 0.5). If the WSE is less than the estimated FFE, then the multiplier will equal zero to represent those structures that do not flood for that specific storm event [**Appendix A1 (g)**].

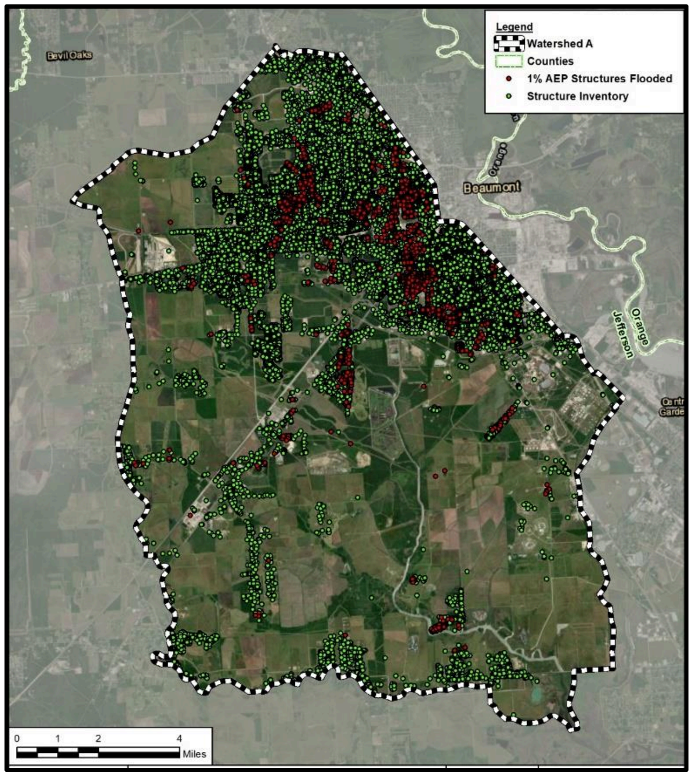


Figure 3. Example Watershed A Flooded Structures

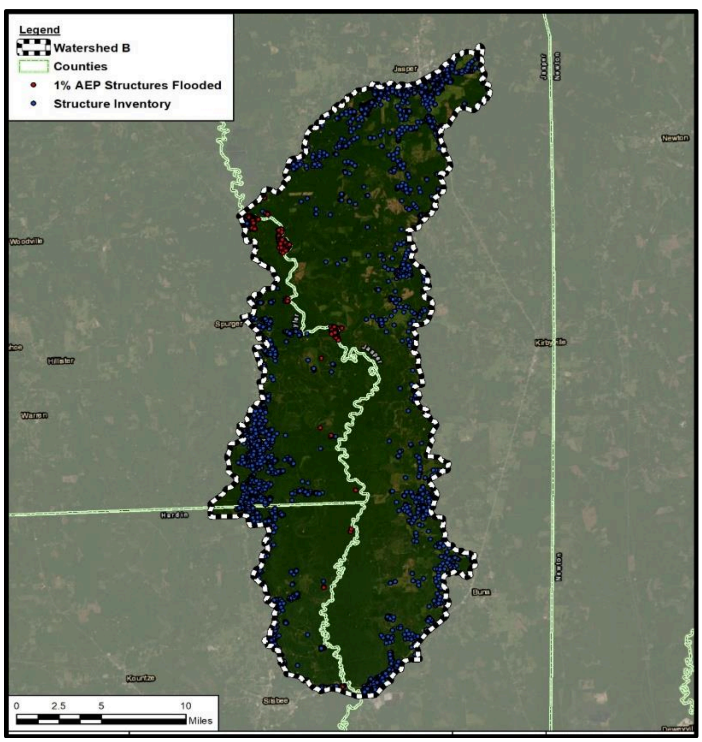


Figure 4. Example Watershed B Flooded Structures

9. Repeat steps 5 - 8 for all available frequency storm events (i.e. 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% AEP).
10. Open the Attribute Table and add a new field named "AIOF" which represents the Annualized Instances of Flooding per structure. Calculate the sum of the multipliers for each storm event available to determine the Annualized Instances of Flooding [**Appendix A1 (h)**].
11. Use the Spatial Join (Analysis Tools) tool to aggregate (sum) all the "AIOF" that intersect (with a distance of 200-ft) targeting a HUC10 Hexagonal Grid Layer using the "AIOF" field in the SI as the join field [***Figure 5***, **Appendix A1 (i)**].

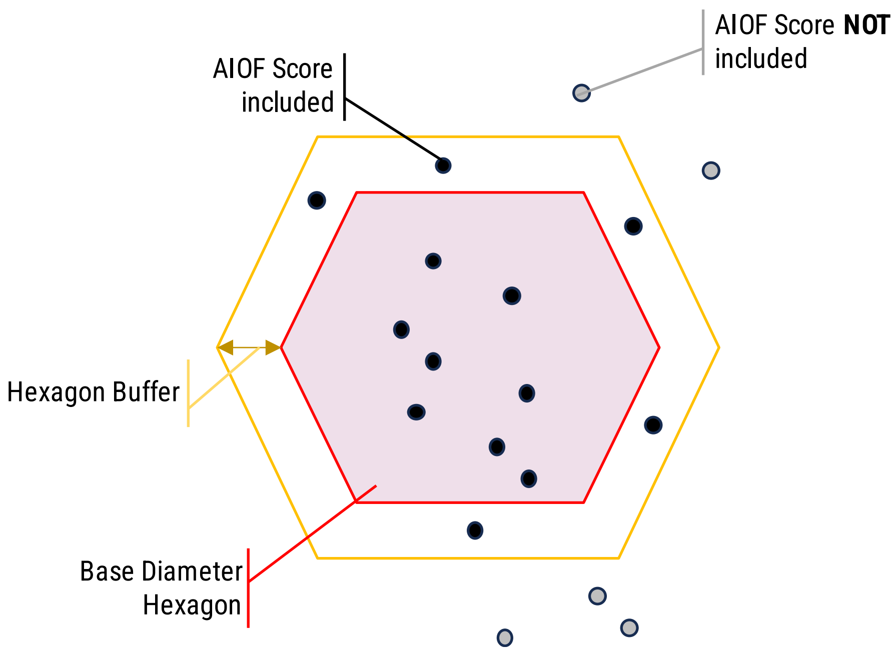


Figure 5. Aggregating Structures AIOF to Hexagonal Grid with Intersection Buffer

6.2 Roadway Flood Exposure: This section describes an approach for computing miles of inundated roadways for the baseline condition. This method utilizes rasterized depth grids generated as output from hydraulic models and roadway elevations associated with LIDAR to compute the miles of inundated roadway. ***Figures 6 and 7*** are the resulting examples which display both the roadways within the HUC 10 watershed and the inundated roadway for the 1% AEP storm event. Note: the inundated roadway segments are to be produced for all storm events.

1. Export Depth raster files from HEC-RAS model and import them into ArcGIS.
2. Use the Clip (Data Management) tool to clip the roadway layer to the HUC 10 watershed [**Appendix A2 (a)**].
3. Use the Extract by Mask (Spatial Analyst) tool to clip the depth raster to the HUC 10 watershed [**Appendix A2 (b)**].
4. Use the Conditional expression within the Raster Calculator (Spatial Analyst) to create another raster assigned a value of 1 to every cell that the water depth value is greater than 0.5 ft and 0 to any depth

less than 0.5 ft. [**Appendix A2 (c)**]. This creates an integer raster which can easily be converted to a polygon for the following steps.

   a. In some cases, it may be necessary to include a sub-step to create an "integer" format raster before converting the binary raster to a feature class polygon. The Int (Spatial Analyst) tool would be used to input the binary raster and create an integer raster which can be used in the following step.

5. Use the Raster to Polygon (Conversion) tool to convert the raster into a polygon [**Appendix A2 (d)**].
6. Use the Clip (Data Management) tool to clip the HUC 10 watershed roadway layer completed in Step 2 to the new Raster to Polygon shapefile completed in Step 5 [**Appendix A2 (e)**].
7. Open the Attribute Table and add a new field named "FloodRoad" [**Appendix A2 (f)**].
8. Use the Calculate Geometry tool for the "FloodRoad" field within the Attribute Table to calculate the length of the inundated roadway in miles. Use the statistics function to view the total miles of inundated roadways [**Appendix A2 (g)**].
9. Repeat steps 3 - 6 for the 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% AEP storm events, if available.
10. (Optional Additional Step) Aggregate the miles of inundated roadway by Spatial Join (Spatial Analyst) tool for inundated roadway during 10%, 2% and 1% AEPs to watershed hexagonal grid.

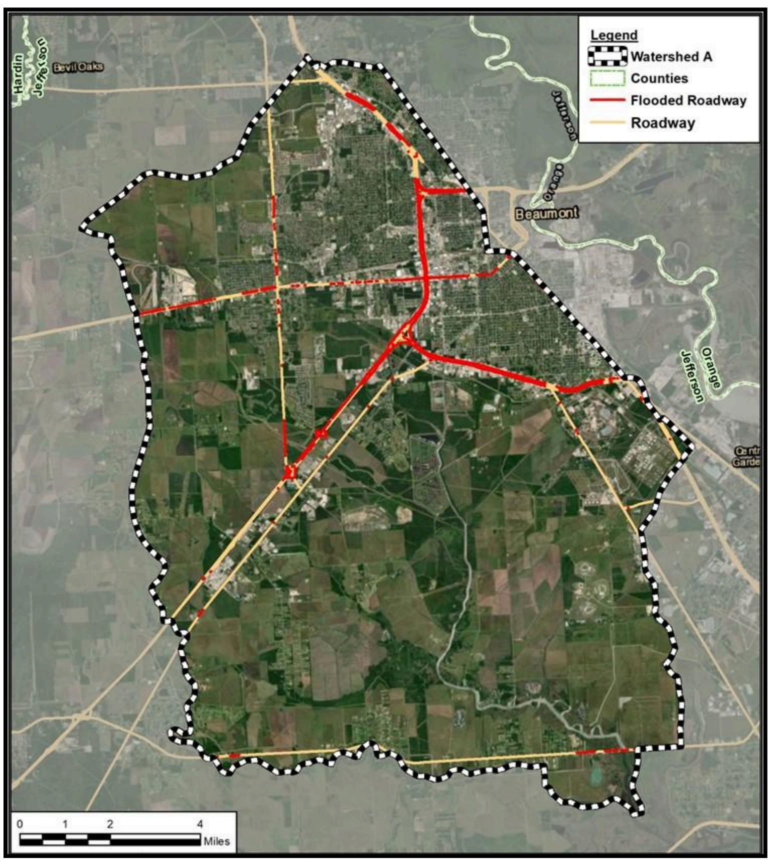


Figure 6. Example Watershed A Flooded Roadways for 1% AEP

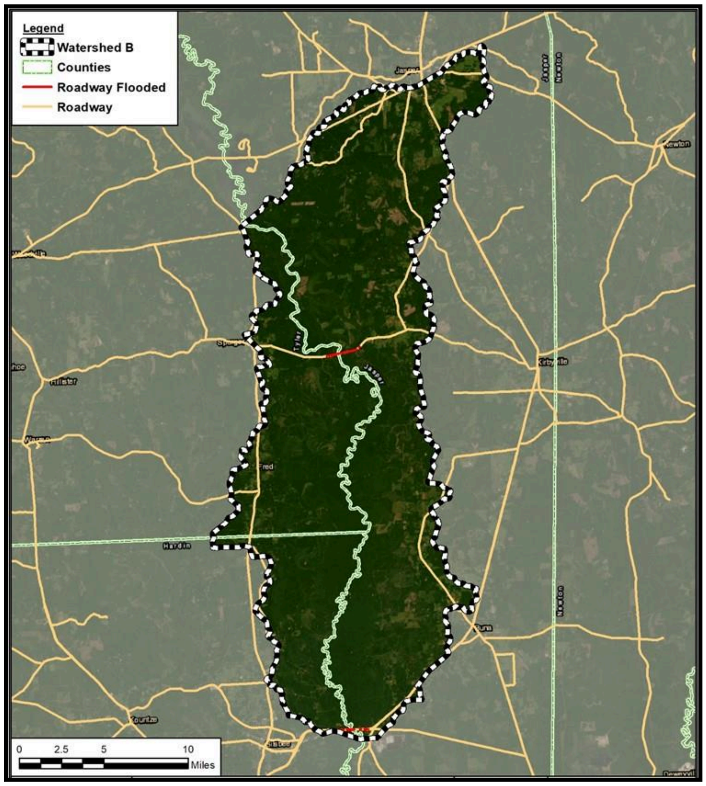


Figure 7. Example Watershed B Flooded Roadways for 1% AEP

6.3 Agricultural Flood Exposure: This section describes an approach for computing agricultural flood exposure for the baseline condition. This method identifies all areas inundated more than 1 ft of depth and then categorizes the area by type of land use, such as agricultural land by crop type. ***Figures 8 and 9*** are examples of the extent of agricultural flood exposure from a 1% AEP event, excluding developed land. The following GIS process shows how the agricultural flood exposure hot spot hexagonal grid base file is created.

1. Export Depth raster (1% AEP) from HEC-RAS model and import into ArcGIS.
2. Use the Extract by Mask (Spatial Analyst) tool to clip the Depth Raster to the HUC 10 watershed [**Appendix A-3 (a)**].
3. Use the Conditional expression within the Raster Calculator (Spatial Analyst) to create another raster assigned a value of 1 to every cell that the water depth value is greater than 1 ft and 0 to any depth less than 1 ft. This creates an integer raster which can easily be converted to a polygon for the following step [**Appendix A3 (b)**].
    a. In some cases, it may be necessary to include a sub-step to create an "integer" format raster before converting the binary raster to a feature class polygon. The Int (Spatial Analyst) tool would be used to input the binary raster and create an integer raster which can be used in the following step.

4. Use the Raster to Polygon (Conversion) tool to convert the raster into a polygon [**Appendix A3 (c)**].
5. Open the Attribute Table in the new depth polygon and add a new field named "Area_AC" [**Appendix A3 (d)**].
6. Use the Extract by Mask (Spatial Analyst) tool to clip the National Crop Data Layer to the HUC 10 watershed [**Appendix A3 (f)**].
7. Use the Raster to Polygon (Conversion) tool to convert the National Crop Data Layer into a polygon. Use the CLASS_NAME as the raster_field input in order to transfer the information of the agricultural and developed lands to the new shapefile [**Appendix A3 (g)**].
8. Open the Attribute Table in the new clipped NCLD polygon and add a new field named "Ag_Flag" [**Appendix A3 (h)**] and use Field Calculator to assign "1" to land considered Agricultural and "0" to all other land types [**Appendix A3 (i)**].
9. Create a new shapefile with all Ag. Lang combined using the Dissolve (Data Management) tool by setting the dissolve_field to "Ag_Flag" [**Appendix A3 (j)**].
10. Remove non-agricultural land cover remaining by Select by Attribute setting "Ag_flag" = 0, and deleting the selected features [**Appendix A3 (k)**].
11. Use the Intersect (Spatial Analyst) tool to combine the 1% AEP depth (+ 1 ft) layer (created in Step 6.3.5) with the agricultural land cover layer (created in Step 6.3.10) [**Appendix A3 (l)**]. Example resulting inundated Ag. Land for the 1% AEP are shown for example watersheds A and B in ***Figure 8*** and ***Figure 9***.

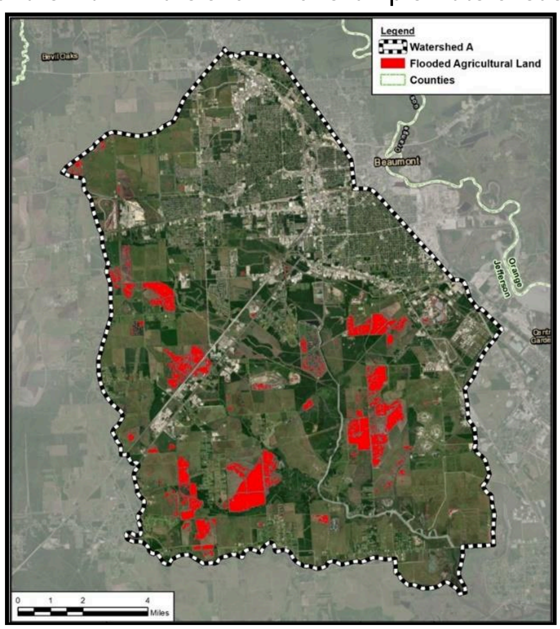


Figure 8. Example Watershed A Flooded Agricultural Land

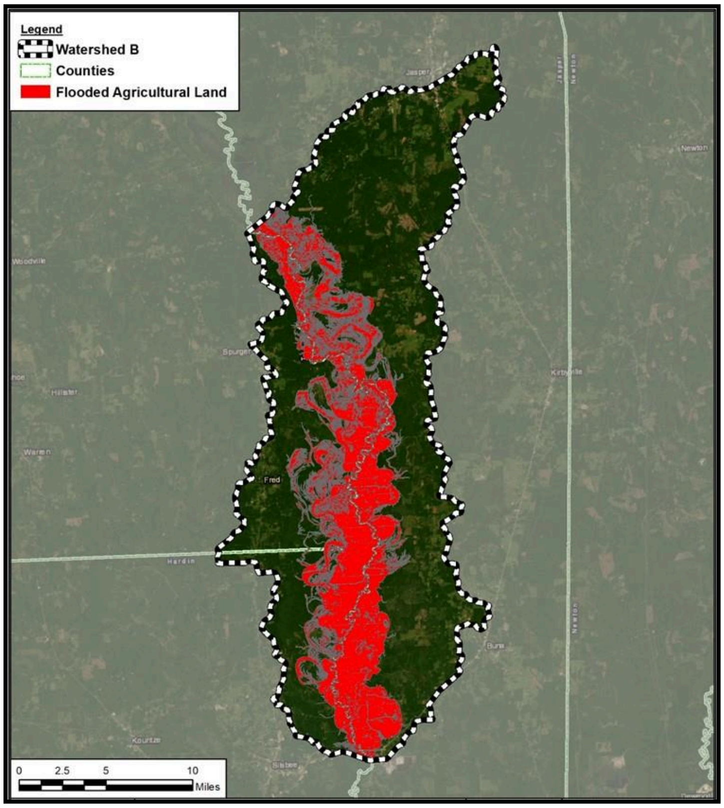


Figure 9. Example Watershed B Flooded Agricultural Land

12. Use the Intersect (Spatial Analyst) tool to divide the Ag. Land and flood intersection layer into the HUC Hexagonal grid [**Appendix A3 (m)**].
    a. Use the Calculate Geometry tool for the "Area_AC" field within the Attribute Table to calculate the area of the polygon in acres [**Appendix A3 (n)**].
13. Calculate the acres of inundated (by +1 ft) Agricultural Land per 1% AEP that intersect each hexagon (***Figure 10***) by using the Spatial Join (Spatial Analyst) tool [**Appendix A3 (n)**].
    a. The watershed wide Hexagonal grid with structural flood exposure values previously computed in **Section 6.1** is set to the target feature.
    b. The polygon created in the previous step with hexagons intersected with inundated Ag. Land will be used as the join features.
    c. An output field is created that Sums the "Area_AC" values calculated from the inundated Ag. Land layer intersecting each of the hexagons. Using "intersect" as the match option allows the inundated area of both the hexagon of interest and the areas surrounding the hexagon of interest (***Figure 10***) to create a visual "hot spot" effect.

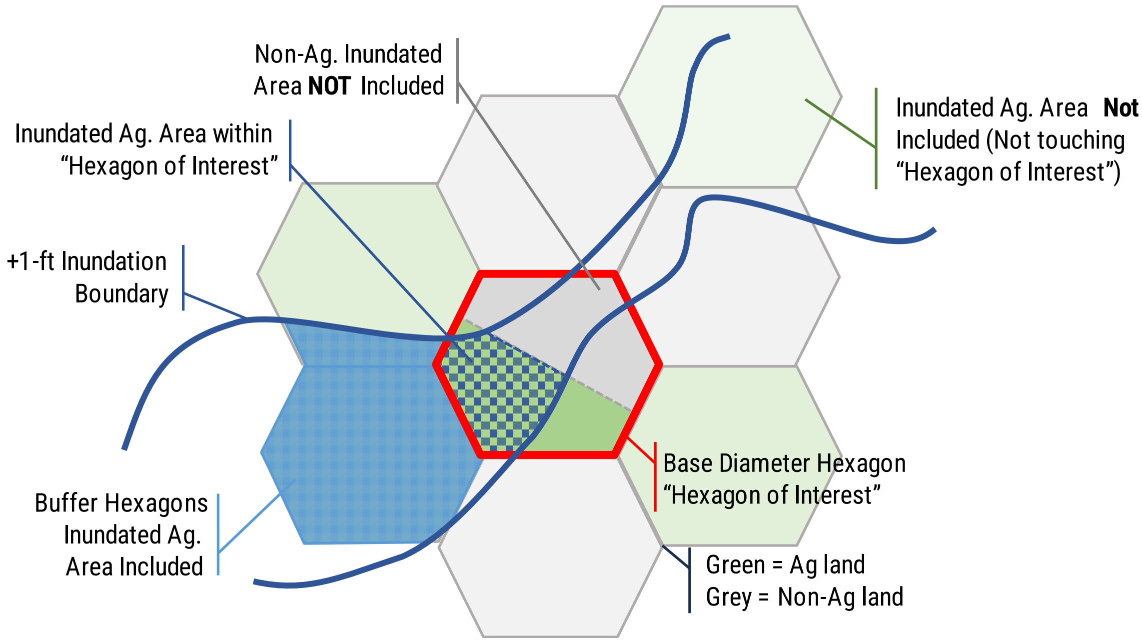


Figure 10. Aggregated Flooded Agricultural Land to Hexagonal Grid (including Buffer Hexagons)

6.4 Identify Hot Spots with GLO SoVI:

The final step of the methodology is to determine the Hot Spots for each of the categories (Structures, Roadway, and Agricultural) by overlaying the GLO SoVI layer on an exhibit created for each of the Hot Spot hexagons or roadway centerlines generated as a result of the previous steps. An example of this can be found in ***Figure 11*** through ***Figure 15*** show the resulting Hot Spots for Watersheds A for the Structures, Roadway, and Agricultural Exhibits, respectively.

1. Identify and present **Structure** Flood Exposure Hot Spots for each watershed.
    a. Display hexagons by the aggregated structure flood risk metric produced in step 6.1 Annualized Instances of Flooding (AIOF) per hexagon. Based on the sensitivity analysis [**Appendix C**], seven (7) classifications of aggregated AIOF values with ranges created by natural breaks (Jenks) were used to visually display "hot spots", ***Figure 11***.
    b. Add the SoVI layer (census tract) onto the Hot Spot heat map.
        i. Export all SoVI census tract polygons intersecting the HUC 10 watershed.
        ii. Add the SoVI (result from step 1.b.i) and use the 3 class ranking (Low, Medium, High)
    c. Overlay the roadway inundation centerlines for convenient comparison. Display the roadway centerlines with the highest frequency on top to lowest frequency inundation segments.
    d. Identify and assign structure specific ID numbers to label structural hot spots hexagons based on the displayed "hot spots".
2. Identify and present **Roadway** Flood Exposure Hot Spots for each watershed.
    a. Display the roadway centerlines with the highest frequency on top to lowest frequency inundation segments to display "hot spots", ***Figure 12***. Note, this display of inundated roadway is used for all exhibits.
    b. Add the watershed bound SoVI census tract layer (result from step 1.b.i) onto the Hot Spot heat map using the 3-class ranking (Low, Medium, High).
    c. Identify and assign roadway specific ID numbers to hexagons with significant roadway flood inundation "hot spots" roadway segments intersecting the hexagons.
3. Identify and present **Agricultural** Flood Exposure Hot Spots for each watershed.
    a. Display hexagons by the aggregated agricultural flood risk metric produced in step 6.3 acres of agricultural land inundated over 1 ft in the 1% AEP event per hexagon. Based on the sensitivity analysis [**Appendix C**], five (5) classifications of summed inundated Ag. Area were used to visually display "hot spots" with ranges created using standard deviations, ***Figure 13***.
    b. Add the watershed bound SoVI census tract layer (result from step 1.b.i) onto the Hot Spot heat map using the 3-class ranking (Low, Medium, High).
    c. Overlay the roadway inundation centerlines for convenient comparison. Display the roadway centerlines with the highest frequency on top to lowest frequency inundation segments.
    d. Identify and assign agricultural specific ID numbers to label agricultural hot spots hexagons based on the displayed "hot spots".
4. Make a note of all classification parameters used to create these exhibits in the documentation.
    a. Note: While the division method and number of classes was used for sample watershed A, with the variety of watershed characteristics across the regions may lead to the need for different classification parameters to create the most identifiable "hot spots". Please indicate classification parameters used to produce each of the exhibits for the watersheds and add any clarifications and justification to the memorandum, as needed.

5. Create an exhibit to show all hot spot types for the watershed, see ***Figure 14***. (Note, some of the lower classification hexagons for both agricultural and structures flood exposure values were removed from this exhibit for visual simplicity).
    a. Compare and note any areas that share boundaries or hexagon areas. This allows areas with multiple flood exposure types to be visually compared.
6. Create an exhibit to show all hot spot hexagons identified for the watershed.
    a. Label each of the hexagon hot spot groupings with a hot spot ID, use a type identifier in the ID to distinguish types. (*Note: these ID designations do not reflect priority and are only used for identification purposes. The lack of prioritization is due to the variety of potential funding sources, project sizes and benefits that may be considered when identifying project alternatives.*)
7. Record your Identified Hot Spots into the hexagonal grid GIS file:
    a. Create two new text attributes in the HUC 10 hexagonal grid shapefile "HSA_ID" and "HSA_TYPE".
    b. Create an ID number for your hexagons you would like to consider part of the "hot spot" the (if more than one hexagon is included in the same "hot spot", the same ID number will be used for all hexagons in that "hot spot")
    c. Update the hexagons considered with the type of hot spot (i.e. Agricultural, Structure, Roadway, None) for the HSA_TYPE.
    d. Create a new "double" attribute in the HUC 10 hexagonal grid shapefile "SoVI_2017"
        i. Note the SoVI year should reflect the date of the SoVI score used (e.g., 2017, 2024, etc.)
        ii. The SoVI value should be recorded from the census tract intersecting the hexagon, only filling in SoVI_2017 values from labeled hot spots are necessary.
8. Create a table with Hot Spot ID, Hot Spot type, Hot Spot area, calculated AOIF, Miles of inundated Roadway (can use three representative AEPs), Acres of inundated Ag. Land (1% AEP) and Average SoVI in a table. Indicate and discuss any qualifiers considered in identifying the hot spot in the memorandum.

Once all of the calculations are completed to identify the Hot Spots, a summary matrix of the flood metrics for each asset type (e.g. structures, roadways, and agricultural land) will be created and filled with all of the data found in the analysis (***Table 2*** and ***Table 3***). This data will then be used to highlight areas by severity of flood risk as Hot Spots at a high-level, which is conscious of budget provided to each region. Please keep in mind, it is recommended to indicate Hot Spots with high SoVI classifications and a large number of structures affected within the identified Hot Spot. The process of selecting which Hot Spots will be moved forward to the Alternative Analysis will be left to the discretion of each region.

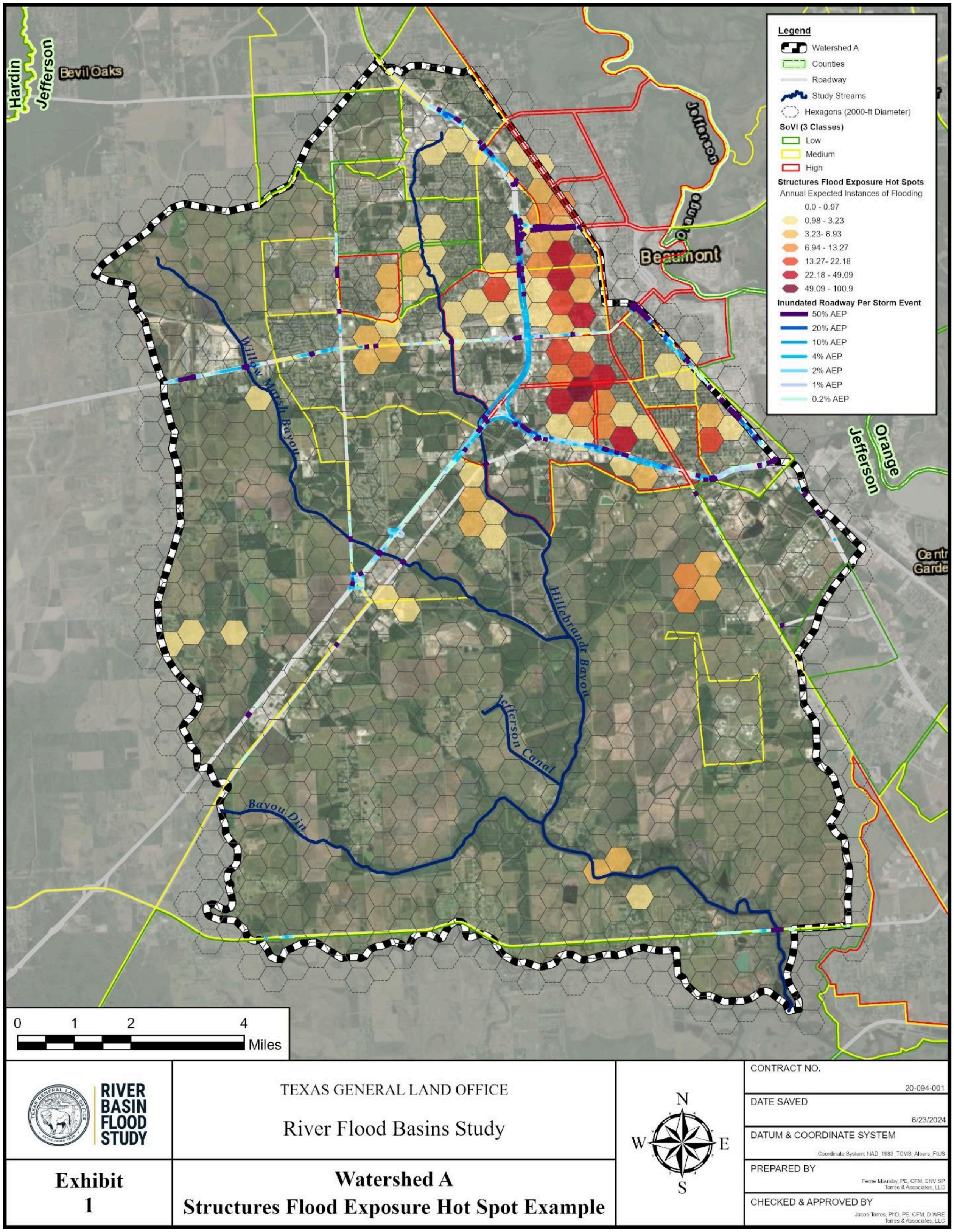
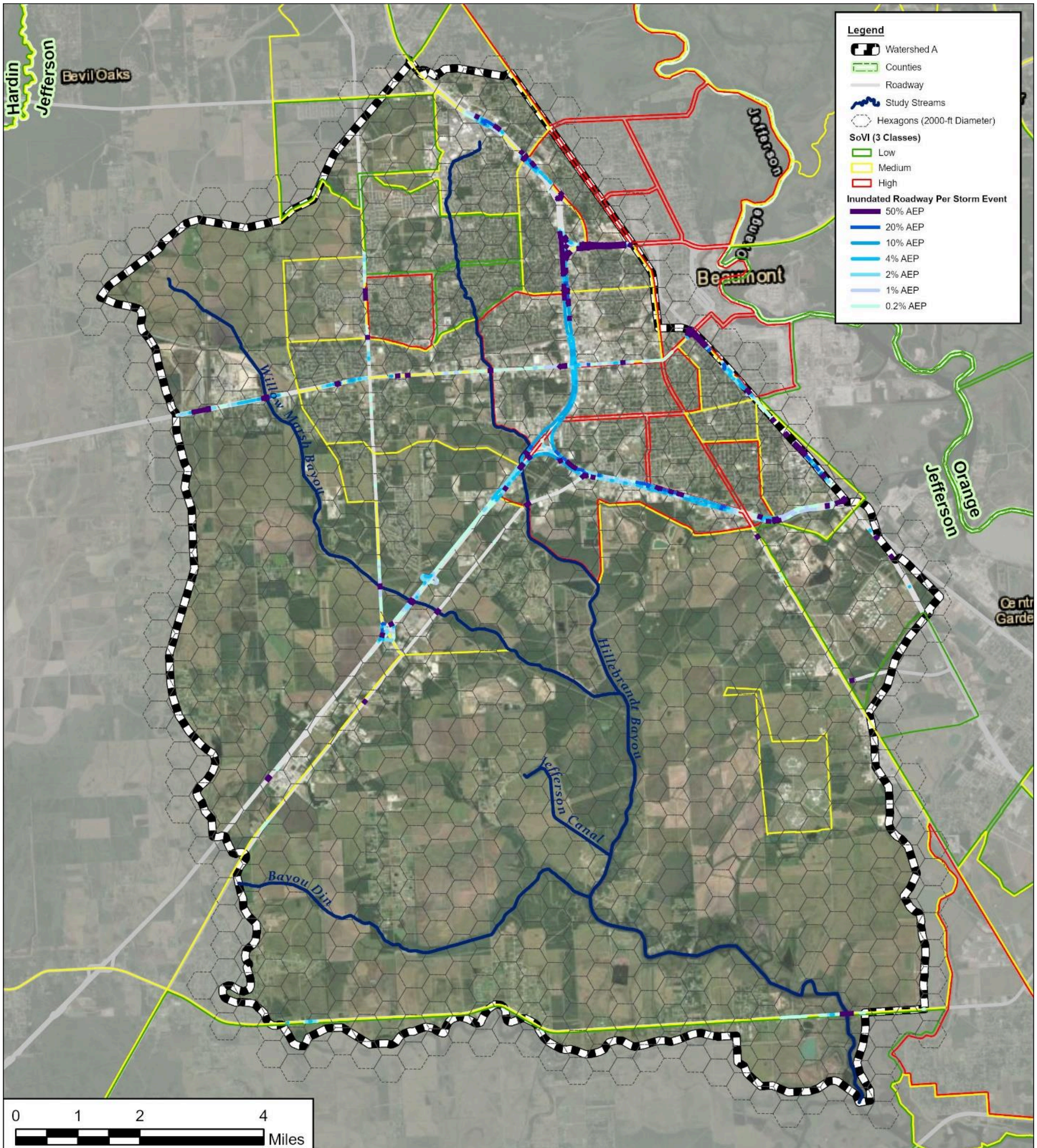


Figure 11. Structures Flood Exposure Hot Spot Exhibit - Example Watershed A



RIVER BASIN FLOOD STUDY	TEXAS GENERAL LAND OFFICE River Flood Basins Study	N W E S	CONTRACT NO. 20-094-001 DATE SAVED 6/23/2024 DATUM & COORDINATE SYSTEM Coordinate System: NAD_1983_TCMS_Albers_FtUS
Exhibit 2	**Watershed A Roadway Flood Exposure Hot Spot Example**		PREPARED BY Ferne Maulsby, PE, CFM, ENV SP Torres & Associates, LLC CHECKED & APPROVED BY Jacob Torres, PhD, PE, CFM, D.WRE Torres & Associates, LLC

Figure 12. Roadway Flood Exposure Hot Spot Exhibit - Example Watershed A

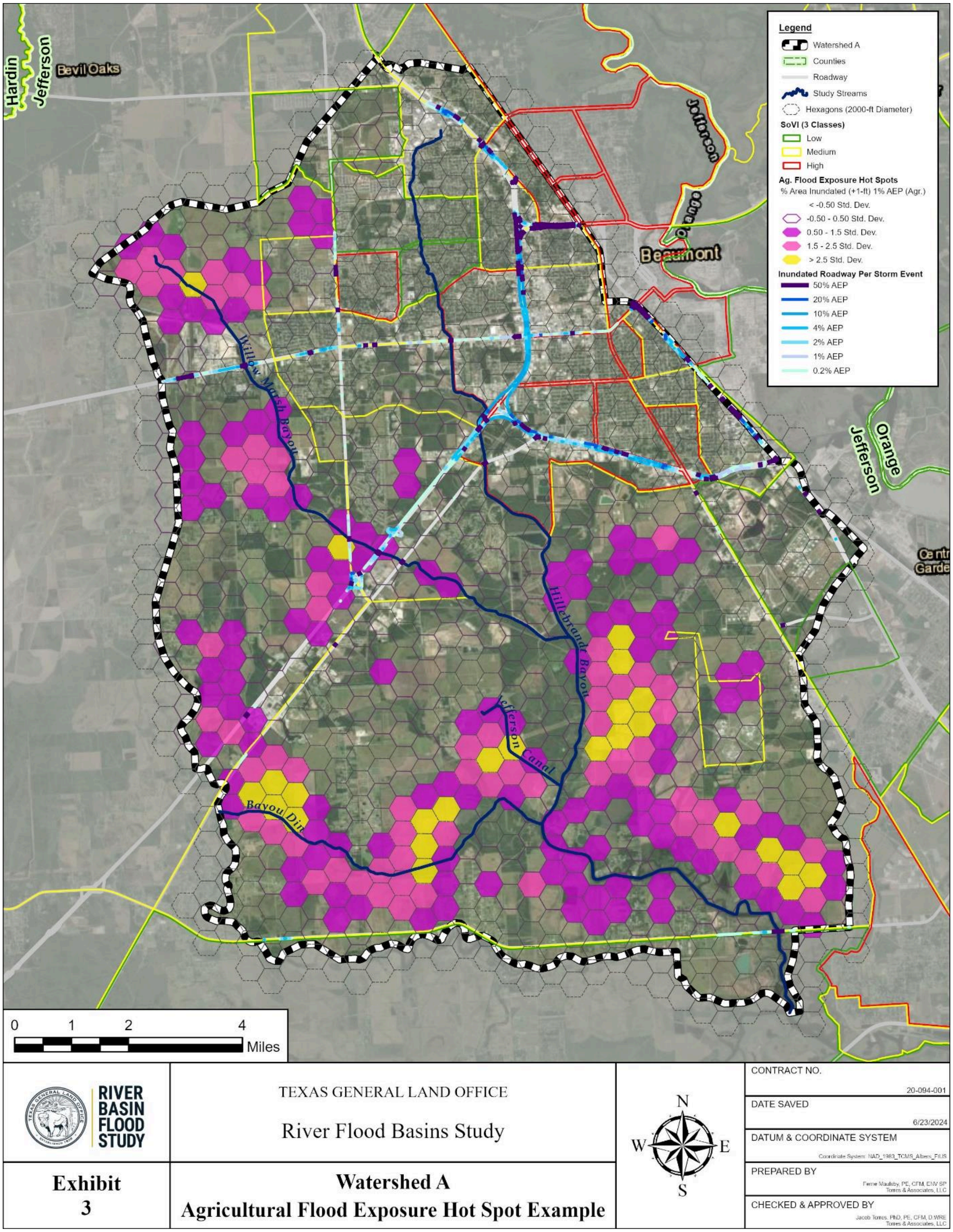


Figure 13. Agricultural Flood Exposure Hot Spot Exhibit - Example Watershed A

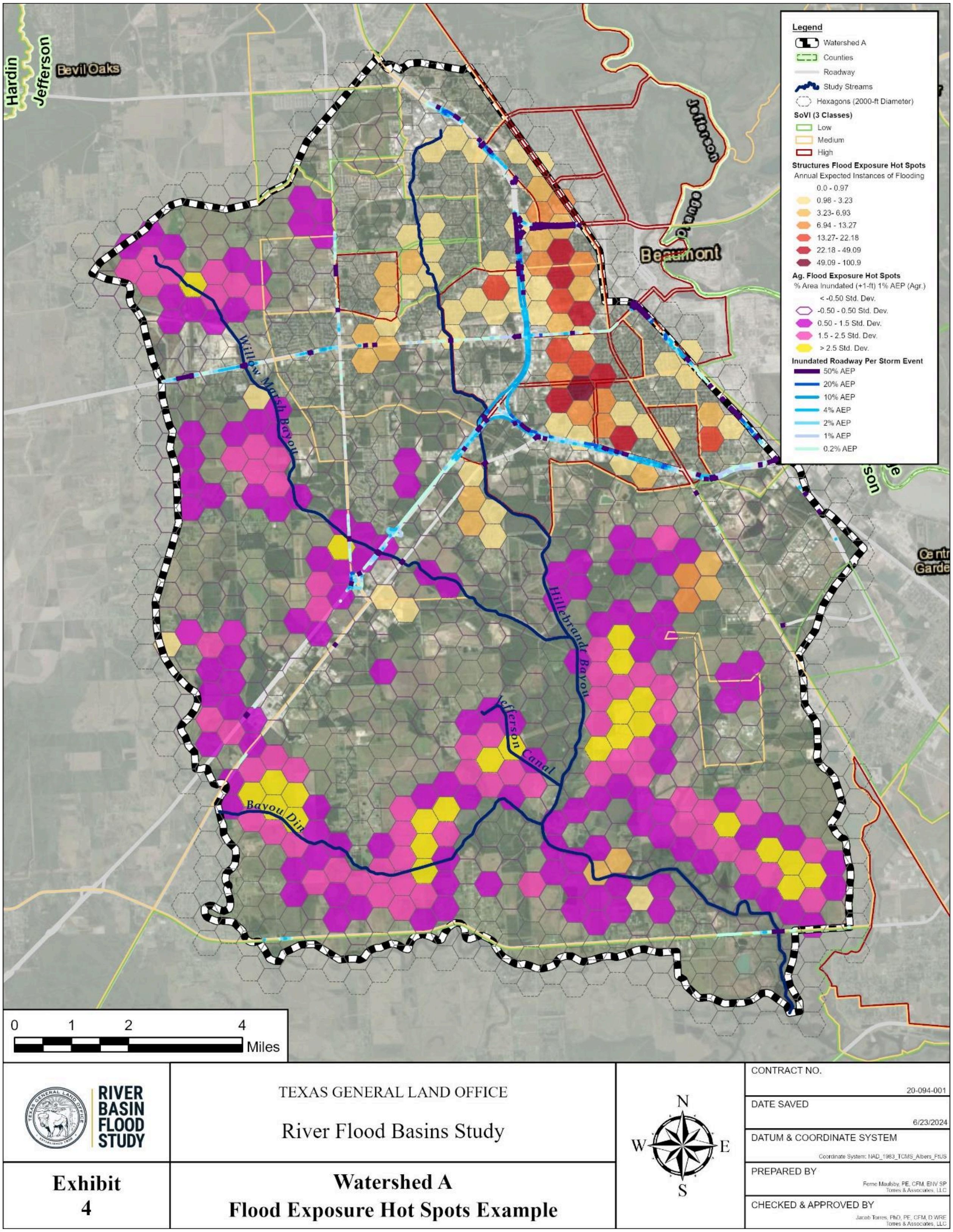


Figure 14. Flood Exposure Hot Spot Exhibit Including All Hot Spot Types - Example Watershed A

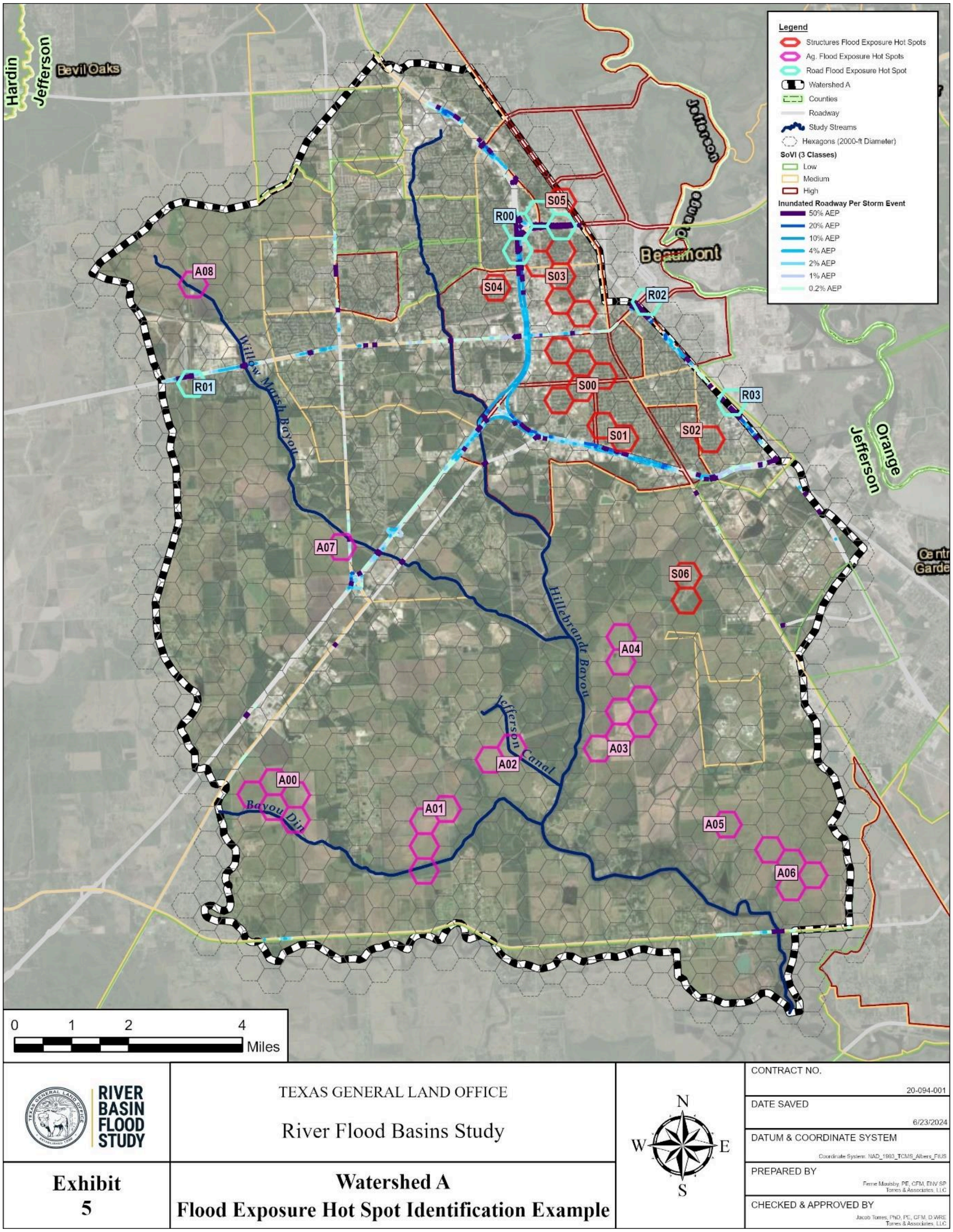


Figure 15. Flood Exposure Hot Spots Identification Exhibit - Example Watershed A

7 Summary of Deliverables

A brief technical memorandum and supporting GIS files are the suggested minimal deliverables for each of the watersheds. The following section describes the format of these deliverables.

7.1 Hot Spot Memorandum

The watershed Hot Spot memorandum is intended to list the contents of the final deliverables and describe any findings from the analysis, including descriptions of the Hot Spot areas with justification for their identification. Context for the Hot Spots can include a brief description of the watershed with any relevant regional qualifiers, justification for any deviations from the HSA SOP base data or methods, and post-processing (if any) of base WSE grids. Include summary tables (1) overall results aggregated to the watershed (***Table 2***) and (2) a table of the resulting hot spots identified with their respective attributes (***Table 3***). The exhibits for determining hot spots for each asset type (structures, roadway, and agricultural land), hot spot identified, and SoVI data from the Hot Spot Analysis methodology of the HUC 10 watershed evaluated should be included (***Figures 11, 12, 13, 14*** and ***15***). A discussion of the Hot Spots should include references to these tables and the flooding hot spot exhibits to substantiate the hot spots identified.

Table 2. Flood Metrics Table - Example Watershed A

Storm Event (AEP)	Flooded Structures Count	Inundated Agricultural Area* (acres)	Inundated Roadway (miles)
0.5	263	36172.8	1.83
0.2	288	47437	1.89
0.1	479	52846.6	1.92
0.04	1,195	59185.7	1.94
0.02	1,421	64884.8	1.98
0.01	1,841	70529.1	2.12
0.002	4,958	77947.6	3.68
TOTAL**	**250.8**	**23,584.2**	**0.95456**

*Acres of Agricultural land excludes undeveloped area. Flooded area computed for depths greater than 1ft.
**Totals are annualized using the trapezoidal method combining the flooding indicator and AEP interval for each category.

Table 3. Hot Spots Summary Table – Example Watershed A

Hot Spot ID	Hot Spot Type	Structure AIOF*	Ag. Land Flooded* [≥ 1ft, 1% AEP] (acres)	Flooded Roadway* [≥ 0.5ft, 50% AEP] (miles)
A00	Agricultural	0.0	490.6	0.0
A01	Agricultural	0.0	468.5	0.0
S00	Structures	87.7	0.2	0.0
S01	Structures	4.83	0.0	0.0
S02	Structures	26.8	0.4	0.0
R00	Roadway	6.65	4.0	0.93

*When multiple Hexagons are grouped, the highest (maximum) flood exposure metric is taken.

7.2 Hot Spot GIS Deliverables

GIS files produced as a result of this process (i.e. HUC hexagon grid, inundated roadway centerlines, processed SI points) with any base GIS data (e.g. output WSE rasters, depth rasters, and terrain) from the Baseline Conditions model can be added to a single geodatabase, which can be provided as supplemental data with the submittal. Detailed metadata is encouraged for shapefiles, geodatabases, rasters and other output files included in the submittal. Following the methodology described in **Section 6**, shapefiles are produced for each metric calculation for baseline conditions for each AEP storm event. Submit the shapefiles produced for the structures, roadway, and agricultural areas of inundation. ***Table 4*** provides a list of GIS files produced in the HSA with relevant attributes to be included.

Table 4. List of Hot Spot Geodatabase and GIS Deliverables

File	Format	Description
HUC Boundary	Feature Class (Polygon)	HUC Boundary used for analysis
Structure Inventory	Feature Class (Points)	Extents: Clipped to HUC Attributes Included: • Estimated FFEs, • XX% AEP WSE, • Annualized Instance of Flooding Value.
HUC Hexagons	Feature Class (Polygon)	Extents: Intersecting HUC Attributes Included: • Sum of Annualized Instance of Flooding Value, • Sum of Annualized Instances of Flooding with Buffer, • Sum of Agricultural Acres Inundated (with Buffer), • Hexagon ID, • HUC ID & HUC Name, • Hot Spot ID & Type.
Roadway Flood Exposure	Feature Class (Polylines)	Extents: Intersecting HUC Attributes Included: • Storm Inundated (AEP), • Miles_Inundated • HUC IC & HUC Name • Roadway Name & Class

8 References

Birch, C. P., Oom, S. P., & Beecham, J. A. (2007). Rectangular and hexagonal grids used for observation, experiment and simulation in ecology. *Ecological Modelling*, *206*(3–4), 347–359. https://doi.org/10.1016/j.ecolmodel.2007.03.041

CDBG Low- and Moderate-Income Data (By U.S. Department of Housing and Urban Development (HUD)). (n.d.). HUD Exchange. https://www.hudexchange.info/programs/cdbg/cdbg-low-moderate-income-data/

CDBG Mitigation Viewer (By Texas General Land Office (GLO)). (n.d.). https://gis-glo-cdr.hub.arcgis.com/pages/cdbg-mitigation-viewer

Create and enrich grids and hexagons—ArcGIS Pro | Documentation. (n.d.). https://pro.arcgis.com/en/pro-app/latest/help/analysis/business-analyst/generate-grids-and-hexagons.htm

Federal Emergency Management Agency. (2020). *Guidance for flood risk analysis and mapping*. https://www.fema.gov/sites/default/files/documents/fema_flood-risk-assessment-guidance.pdf

FEMA. (2022). Hazus Flood Model Technical Manual. In *Hazus Flood Technical Manual: Vol. Hazus 5.1* (pp. 1–13). https://www.fema.gov/sites/default/files/documents/fema_hazus-flood-model-technical-manual-5-1.pdf

Gulf Engineers & Consultants. (2006). *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Rations (CSVR) in Support of the Donaldsonville to the Gulf, Louisiana, Feasibility Study* (Contract No. DACW29-00-D-0001). U.S. Army Corps of Engineers. https://www.mvn.usace.army.mil/Portals/56/docs/PD/Donaldsv-Gulf.pdf

How Hot Spot Analysis (Getis-Ord GI) works—ArCGIS Pro | Documentation*. (n.d.). https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/h-how-hot-spot-analysis-getis-ord-gi-spatial-stati.htm

IDW (Spatial Analyst)—ArCGIS Pro | Documentation. (n.d.). https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/idw.htm

Index of GIS Resources (By Texas Water Development Board). (n.d.). https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/index

National Structure inventory (By U.S. Army Corps of Engineers). (n.d.). https://nsi.sec.usace.army.mil/downloads/

Roadway inventory (By Texas Department of Transportation). (n.d.). https://www.txdot.gov/data-maps/roadway-inventory.html

Texas Water Development Board. (n.d.). https://www.twdb.texas.gov/flood/research/Agricultural-Flood-Loss-2022/index.asp

USDA - National Agricultural Statistics Service- Research and Science - Cropland Data Layer releases (By USDA). (n.d.). https://www.nass.usda.gov/Research_and_Science/Cropland/Release/index.php

Why hexagons?—ArcGIS Pro | Documentation. (n.d.). https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/h-whyhexagons.htm

9 Appendices

Appendix A – Sample GIS Workflows for Baseline Condition Hot Spot Assessment
- A1 – Structures Flood Exposure GIS Process
- A2 – Roadway Flood Exposure GIS Process
- A3 – Agricultural Flood Exposure GIS Process

Appendix B – Structure and Agricultural Flood Exposure Methods Validation

Appendix C – Hexagonal Hot Spot Sensitivity Analyses

Appendix D – GLO Hot Spot Analysis 75% Submittal Comments and Responses

Appendix A

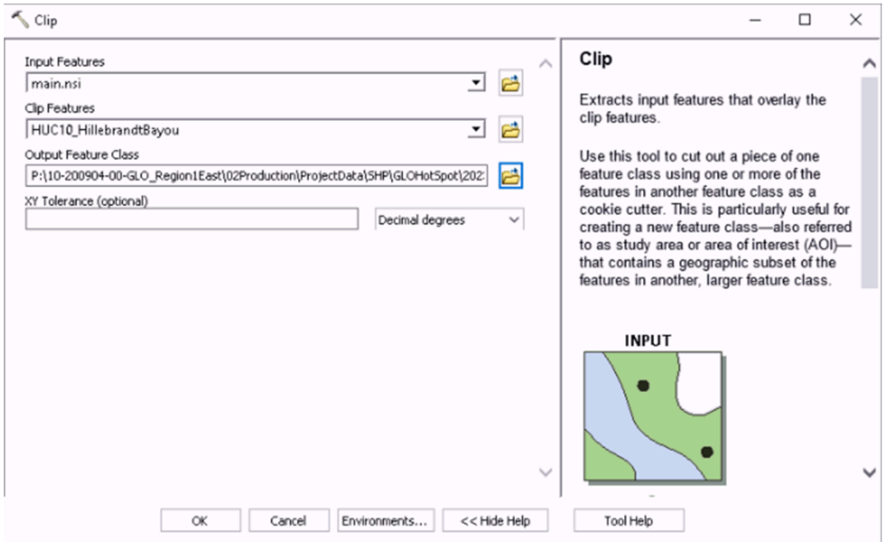
Sample GIS Workflows for Baseline Conditions Hot Spot Assessment

Appendix A1

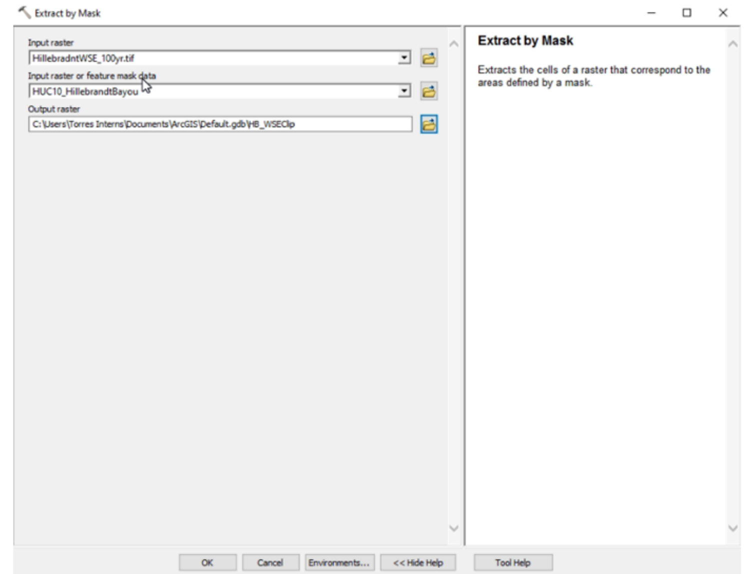
Structures Flood Exposure GIS Process

A1 – Structures Flood Exposure GIS Process

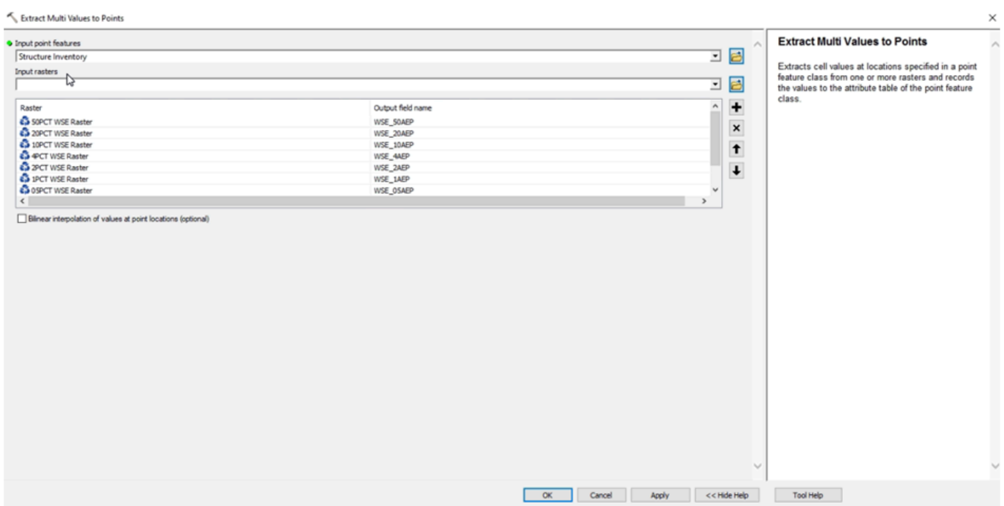
(a)



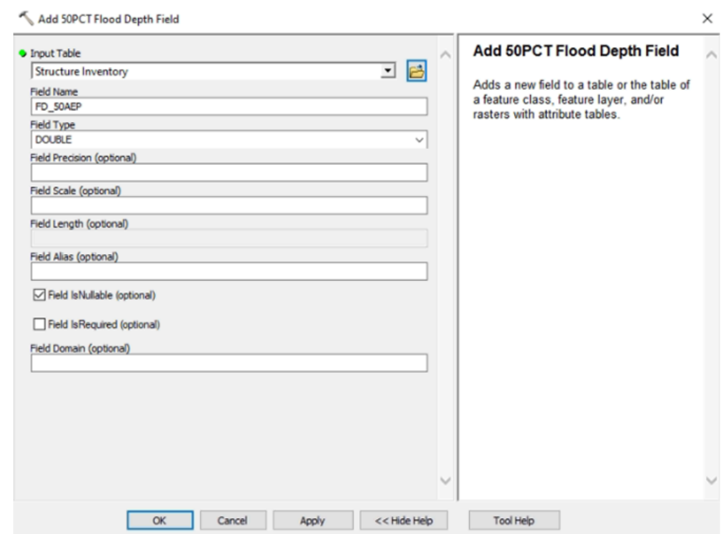
(b)



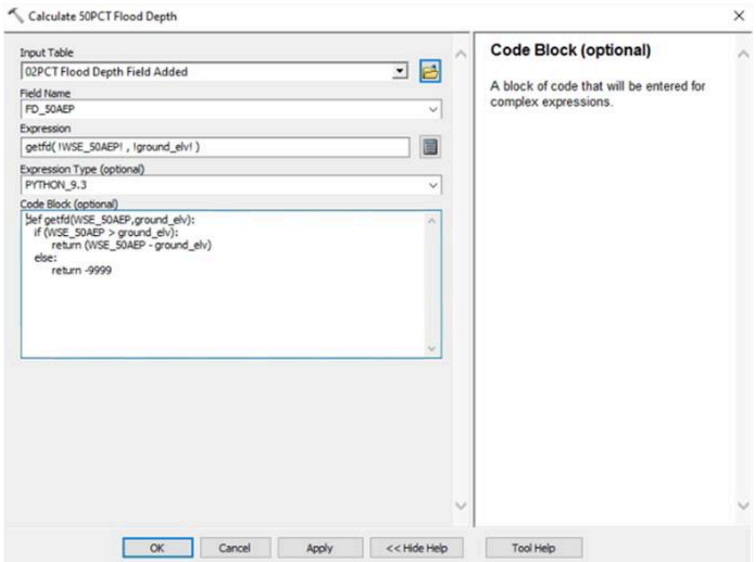
(c)



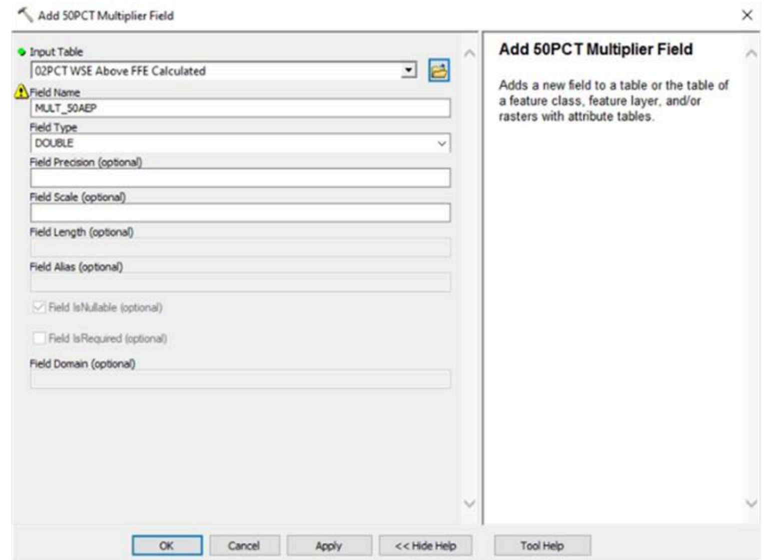
(d)



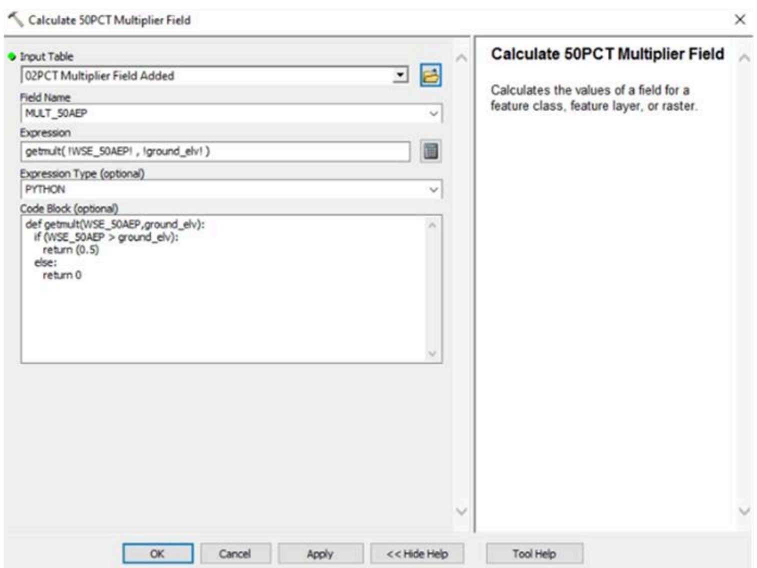
(e)


Calculate 50PCT Flood Depth
Input Table
02PCT Flood Depth Field Added
Field Name
FD_50AEP
Expression
getfd(!WSE_50AEP! , !ground_elv!)
Expression Type (optional)
PYTHON_9.3
Code Block (optional)
def getfd(WSE_50AEP,ground_elv):
if (WSE_50AEP > ground_elv):
return (WSE_50AEP - ground_elv)
else:
return -9999
Code Block (optional)
A block of code that will be entered for complex expressions.
OK
Cancel
Apply
<< Hide Help
Tool Help

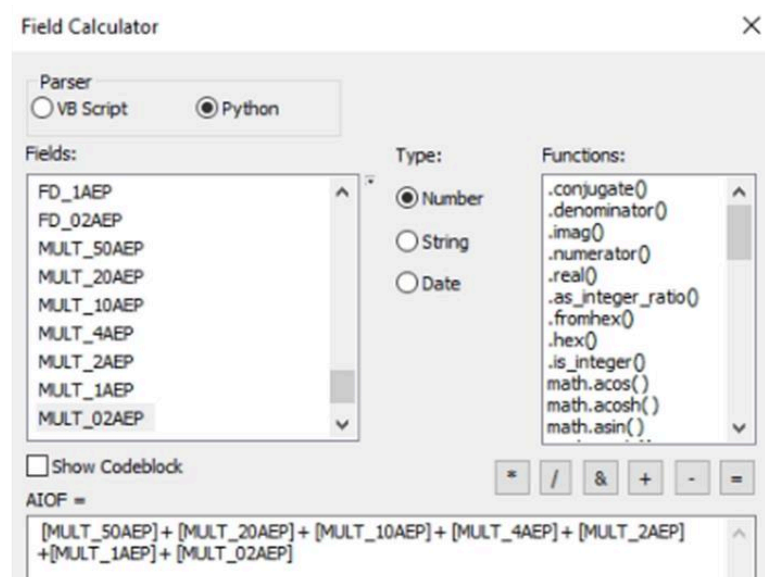
(f)


Add 50PCT Multiplier Field
Input Table
02PCT WSE Above FFE Calculated
Field Name
MULT_50AEP
Field Type
DOUBLE
Field Precision (optional)
Field Scale (optional)
Field Length (optional)
Field Alias (optional)
Field IsNullable (optional)
Field IsRequired (optional)
Field Domain (optional)
Add 50PCT Multiplier Field
Adds a new field to a table or the table of a feature class, feature layer, and/or rasters with attribute tables.
OK
Cancel
Apply
<< Hide Help
Tool Help

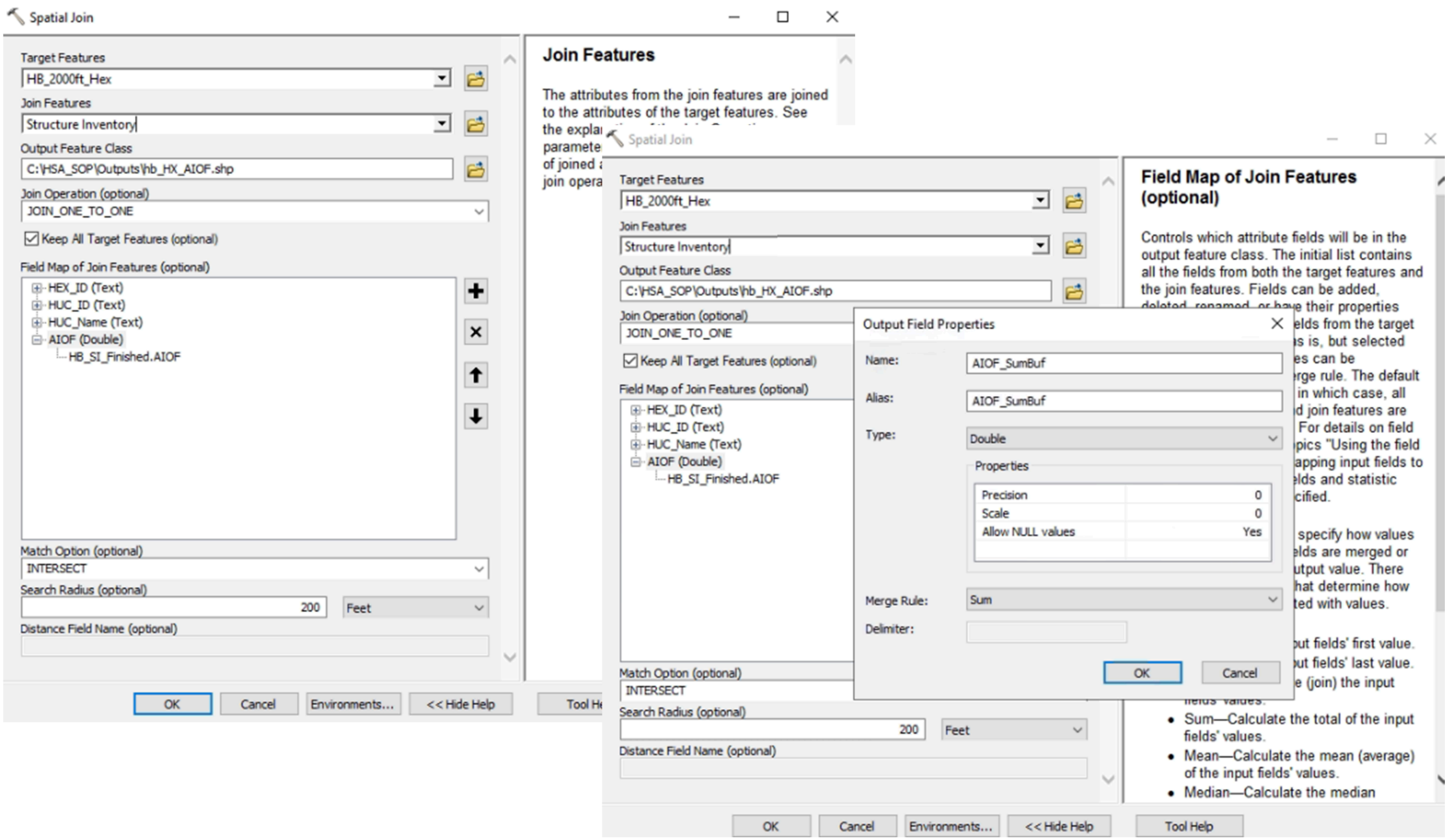
(g)


Calculate 50PCT Multiplier Field
Input Table
02PCT Multiplier Field Added
Field Name
MULT_50AEP
Expression
getmult(!WSE_50AEP! , !ground_elv!)
Expression Type (optional)
PYTHON
Code Block (optional)
def getmult(WSE_50AEP,ground_elv):
if (WSE_50AEP > ground_elv):
return (0.5)
else:
return 0
Calculate 50PCT Multiplier Field
Calculates the values of a field for a feature class, feature layer, or raster.
OK
Cancel
Apply
<< Hide Help
Tool Help

(h)


Field Calculator
Parser
VB Script
Python
Fields:
FD_1AEP
FD_02AEP
MULT_50AEP
MULT_20AEP
MULT_10AEP
MULT_4AEP
MULT_2AEP
MULT_1AEP
MULT_02AEP
Type:
Number
String
Date
Functions:
.conjugate()
.denominator()
.imag()
.numerator()
.real()
.as_integer_ratio()
.fromhex()
.hex()
.is_integer()
math.acos()
math.acosh()
math.asin()
Show Codeblock
AIOF =
[MULT_50AEP] + [MULT_20AEP] + [MULT_10AEP] + [MULT_4AEP] + [MULT_2AEP] +[MULT_1AEP] + [MULT_02AEP]

(i)

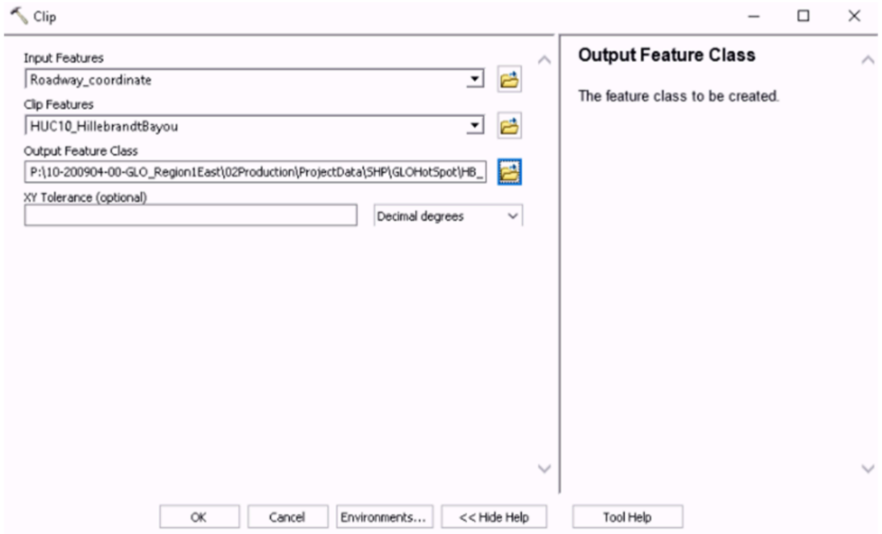

Spatial Join
Target Features
HB_2000ft_Hex
Join Features
Structure Inventory
Output Feature Class
C:\HSA_SOP\Outputs\hb_HX_AIOF.shp
Join Operation (optional)
JOIN_ONE_TO_ONE
Keep All Target Features (optional)
Field Map of Join Features (optional)
HEX_ID (Text)
HUC_ID (Text)
HUC_Name (Text)
AIOF (Double)
HB_SI_Finished.AIOF
Match Option (optional)
INTERSECT
Search Radius (optional)
200
Feet
Distance Field Name (optional)
OK
Cancel
Environments...
<< Hide Help
Tool Help
Join Features
The attributes from the join features are joined to the attributes of the target features.
Output Field Properties
Name:
AIOF_SumBuf
Alias:
AIOF_SumBuf
Type:
Double
Properties
Precision
0
Scale
0
Allow NULL values
Yes
Merge Rule:
Sum
Delimiter:
Field Map of Join Features (optional)
Controls which attribute fields will be in the output feature class. The initial list contains all the fields from both the target features and the join features.
Sum—Calculate the total of the input fields' values.
Mean—Calculate the mean (average) of the input fields' values.
Median—Calculate the median

Appendix A2

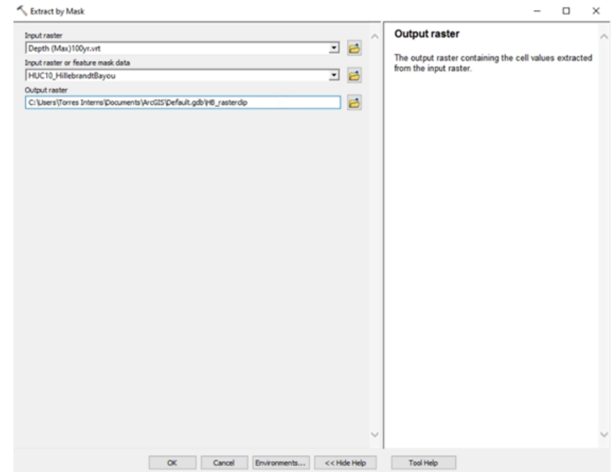
Roadway Flood Exposure GIS Process

A2 – Roadway Flood Exposure GIS Process

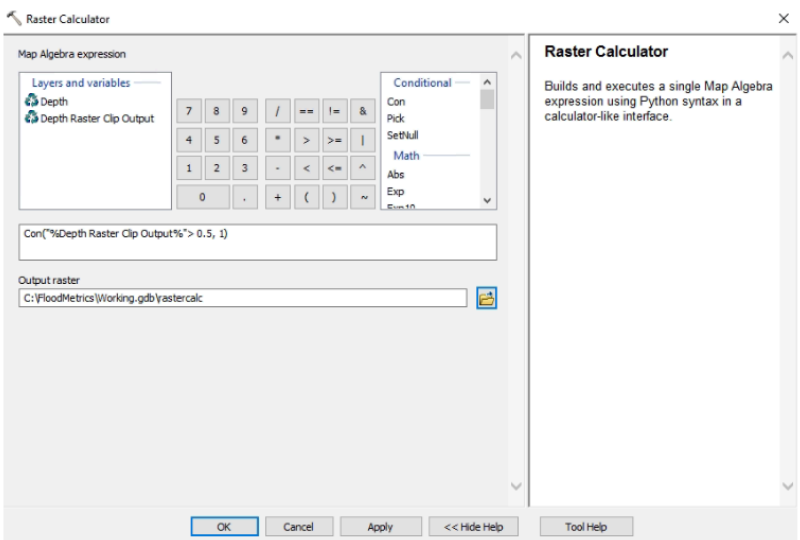
(a)



(b)



(c)



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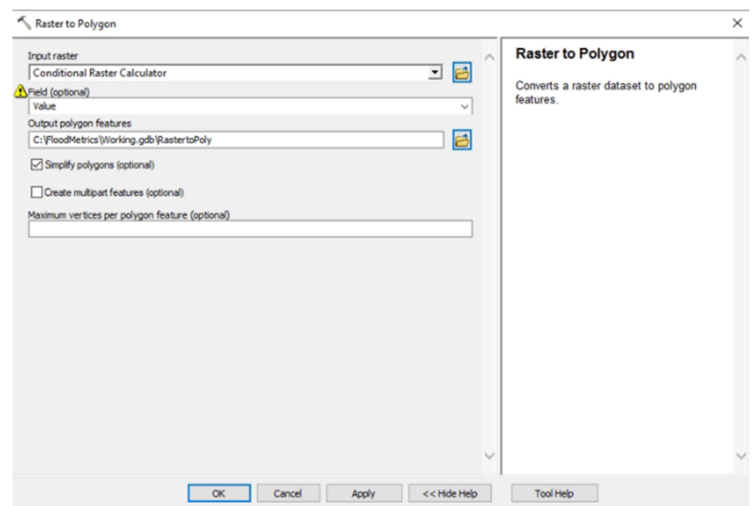
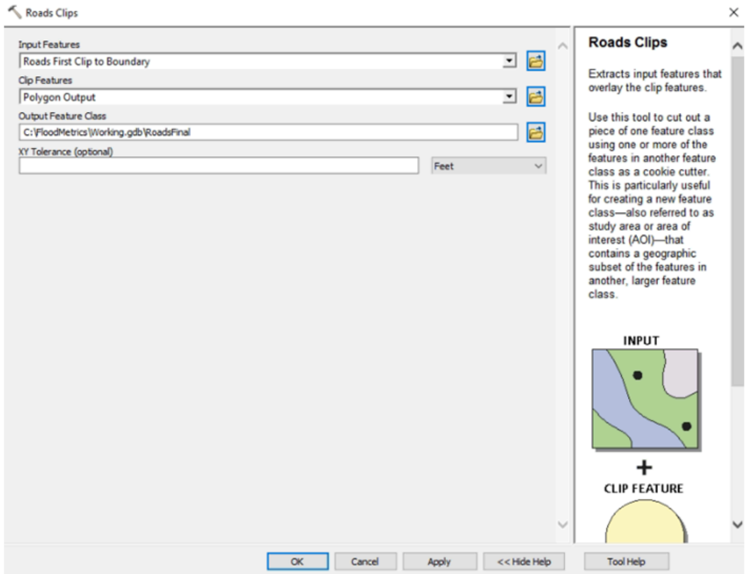
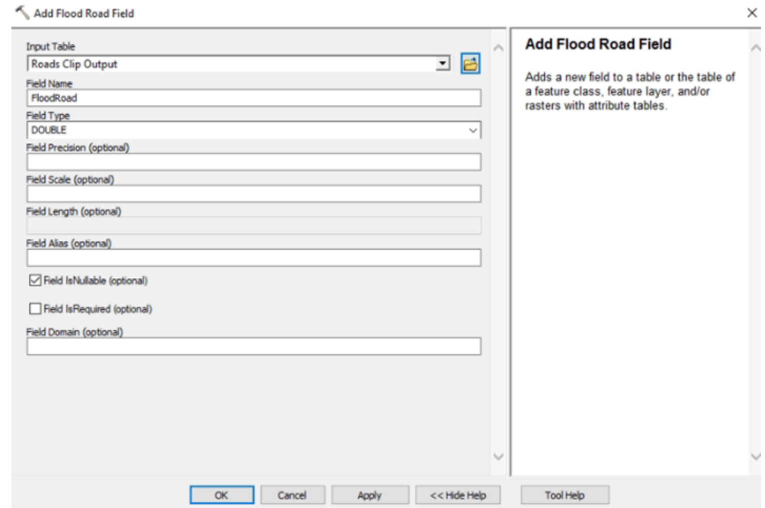


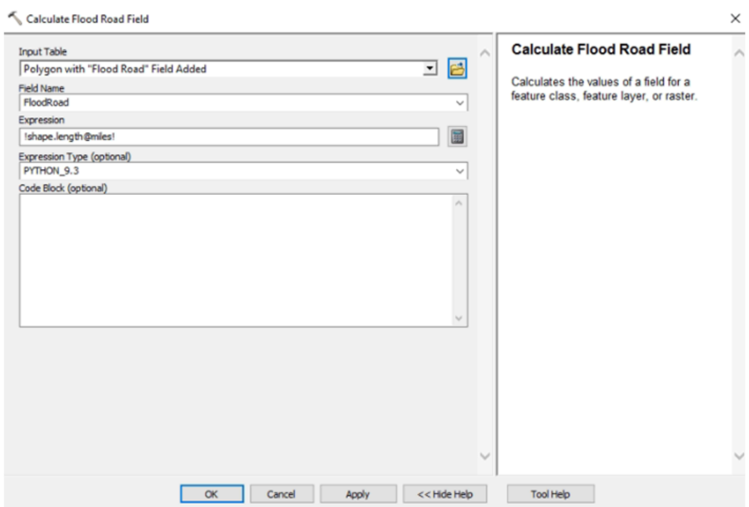
(e)


Roads Clips
Input Features
Roads First Clip to Boundary
Clip Features
Polygon Output
Output Feature Class
C:\FloodMetrics\Working.gdb\RoadsFinal
XY Tolerance (optional)
Feet
OK
Cancel
Apply
<< Hide Help
Tool Help
Roads Clips
Extracts input features that overlay the clip features.
Use this tool to cut out a piece of one feature class using one or more of the features in another feature class as a cookie cutter. This is particularly useful for creating a new feature class—also referred to as study area or area of interest (AOI)—that contains a geographic subset of the features in another, larger feature class.
INPUT
+
CLIP FEATURE

(f)


Add Flood Road Field
Input Table
Roads Clip Output
Field Name
FloodRoad
Field Type
DOUBLE
Field Precision (optional)
Field Scale (optional)
Field Length (optional)
Field Alias (optional)
Field IsNullable (optional)
Field IsRequired (optional)
Field Domain (optional)
OK
Cancel
Apply
<< Hide Help
Tool Help
Add Flood Road Field
Adds a new field to a table or the table of a feature class, feature layer, and/or rasters with attribute tables.

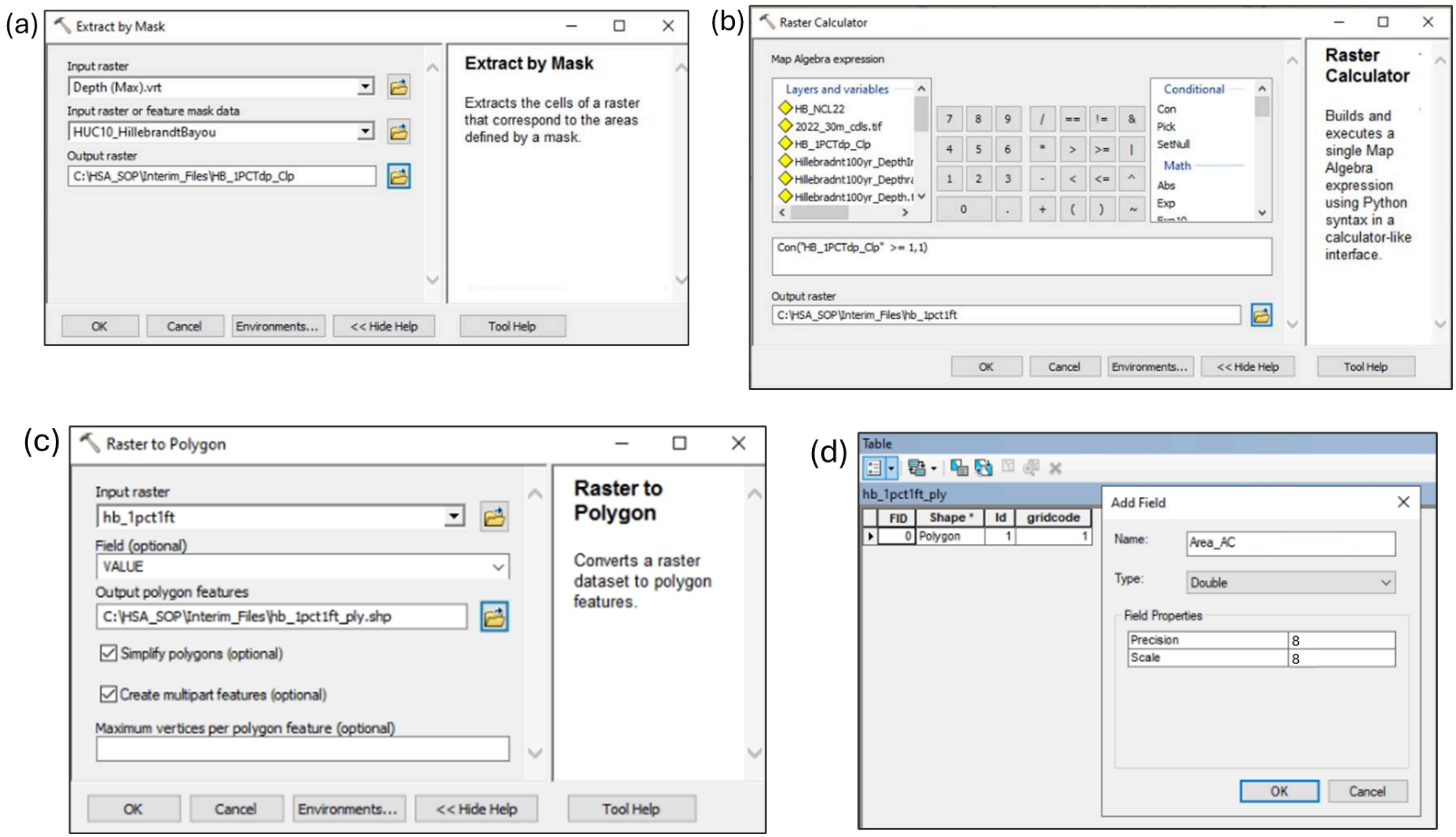
(g)


Calculate Flood Road Field
Input Table
Polygon with "Flood Road" Field Added
Field Name
FloodRoad
Expression
!shape.length@miles!
Expression Type (optional)
PYTHON_9.3
Code Block (optional)
OK
Cancel
Apply
<< Hide Help
Tool Help
Calculate Flood Road Field
Calculates the values of a field for a feature class, feature layer, or raster.

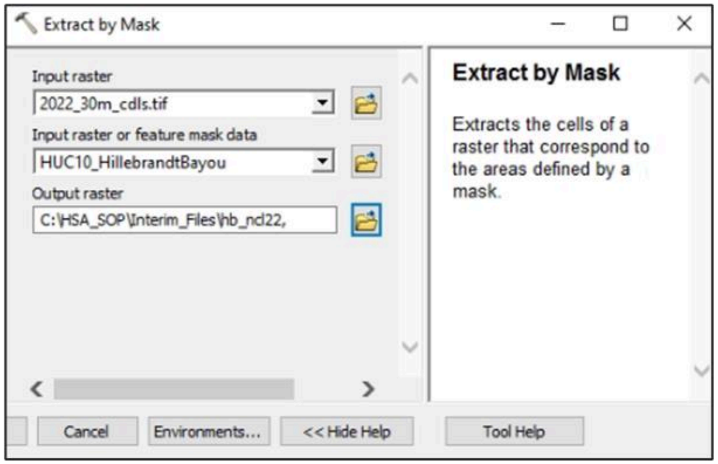
Appendix A3

Agricultural Flood Exposure GIS Process

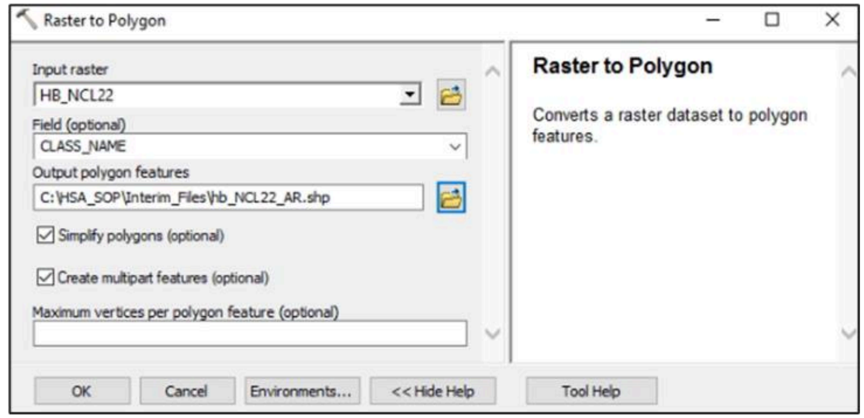
A3 – Agricultural Flood Exposure Hot Spot Process



(f)


Extract by Mask
Input raster
2022_30m_cdls.tif
Input raster or feature mask data
HUC10_HillebrandtBayou
Output raster
C:\HSA_SOP\Interim_Files\hb_ncl22,
Extract by Mask
Extracts the cells of a raster that correspond to the areas defined by a mask.
Cancel
Environments...
<< Hide Help
Tool Help

(g)


Raster to Polygon
Input raster
HB_NCL22
Field (optional)
CLASS_NAME
Output polygon features
C:\HSA_SOP\Interim_Files\hb_NCL22_AR.shp
Simplify polygons (optional)
Create multipart features (optional)
Maximum vertices per polygon feature (optional)
Raster to Polygon
Converts a raster dataset to polygon features.
OK
Cancel
Environments...
<< Hide Help
Tool Help

(h)

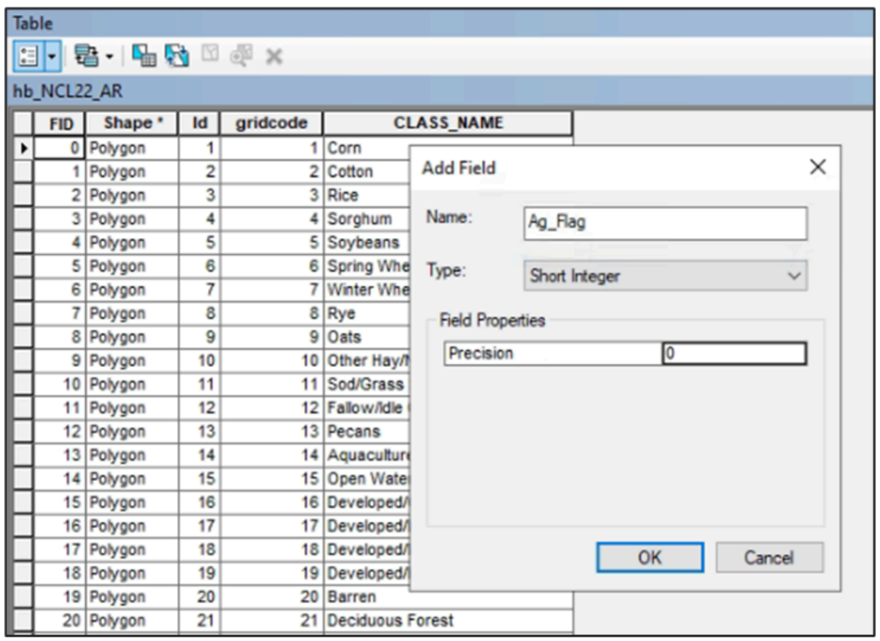
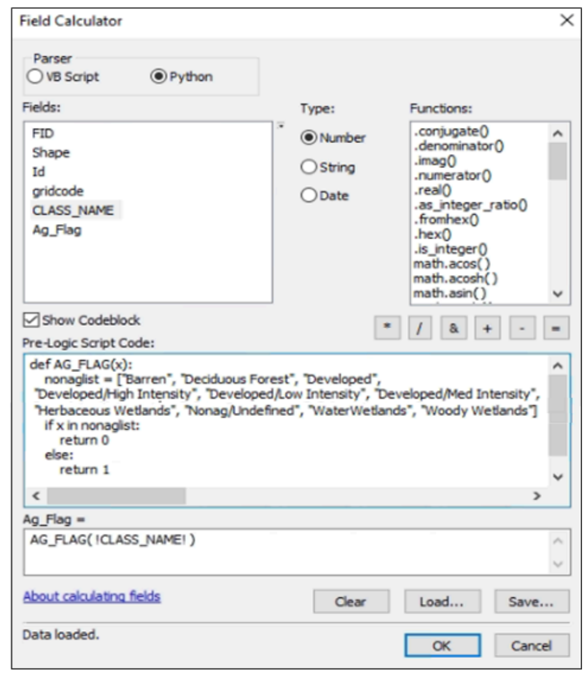
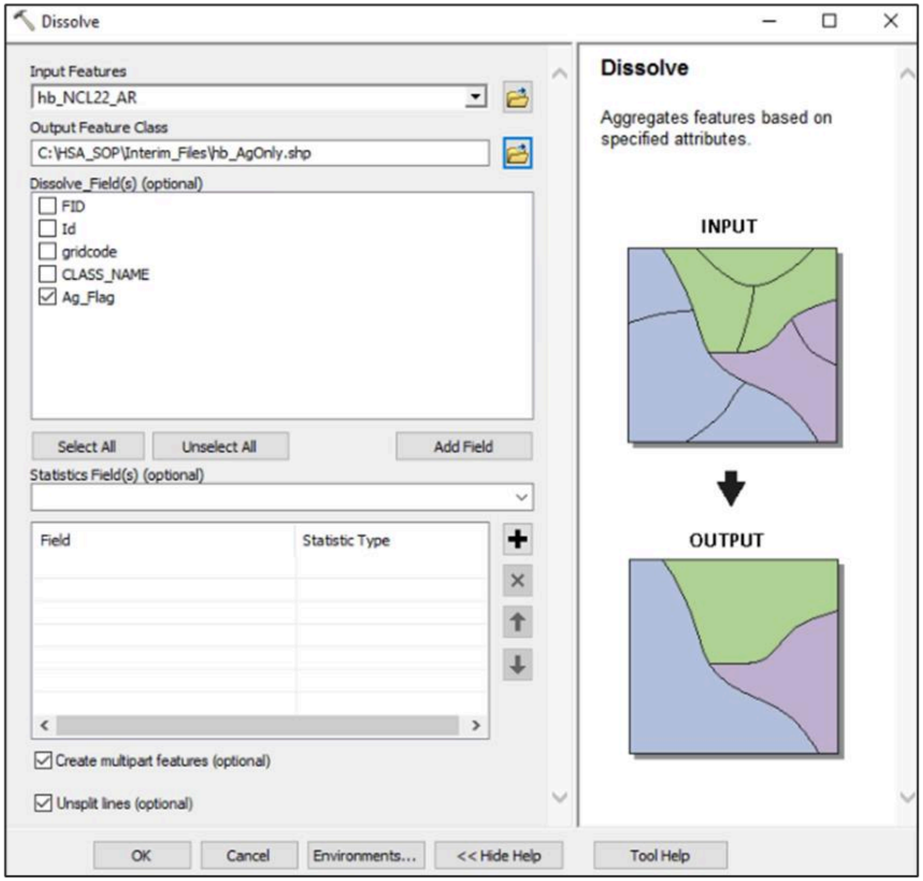


Table
hb_NCL22_AR
FID
Shape *
Id
gridcode
CLASS_NAME
Corn
Cotton
Rice
Sorghum
Soybeans
Oats
Rye
Sod/Grass
Pecans
Barren
Deciduous Forest
Add Field
Name:
Ag_Flag
Type:
Short Integer
Field Properties
Precision
0
OK
Cancel

(i)


Field Calculator
Parser
VB Script
Python
Fields:
FID
Shape
Id
gridcode
CLASS_NAME
Ag_Flag
Type:
Number
String
Date
Functions:
Show Codeblock
Pre-Logic Script Code:
def AG_FLAG(x):
nonaglist = ["Barren", "Deciduous Forest", "Developed", "Developed/High Intensity", "Developed/Low Intensity", "Developed/Med Intensity", "Herbaceous Wetlands", "Nonag/Undefined", "WaterWetlands", "Woody Wetlands"]
if x in nonaglist:
return 0
else:
return 1
Ag_Flag =
AG_FLAG(!CLASS_NAME!)
About calculating fields
Clear
Load...
Save...
Data loaded.
OK
Cancel

(j)


Dissolve
Input Features
hb_NCL22_AR
Output Feature Class
C:\HSA_SOP\Interim_Files\hb_AgOnly.shp
Dissolve_Field(s) (optional)
FID
Id
gridcode
CLASS_NAME
Ag_Flag
Select All
Unselect All
Add Field
Statistics Field(s) (optional)
Field
Statistic Type
Create multipart features (optional)
Unsplit lines (optional)
OK
Cancel
Environments...
<< Hide Help
Tool Help
Dissolve
Aggregates features based on specified attributes.
INPUT
OUTPUT

(k)

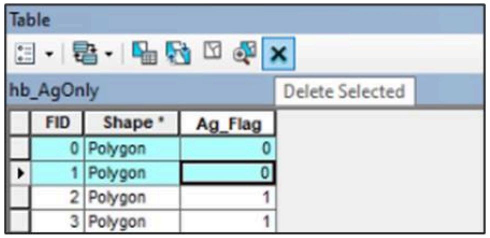
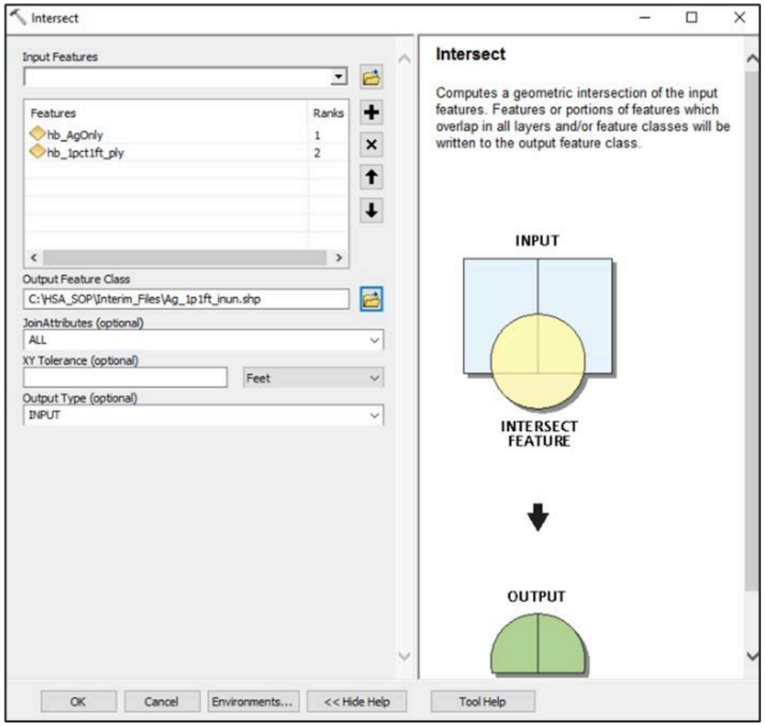
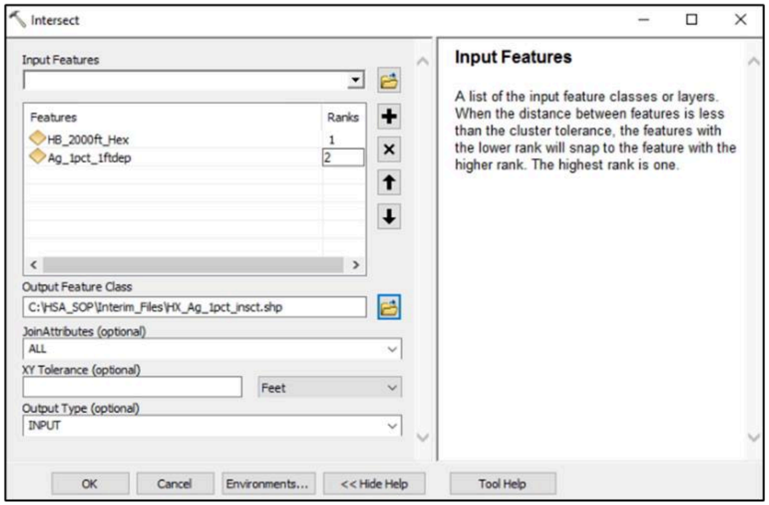


Table
hb_AgOnly
Delete Selected
FID
Shape *
Ag_Flag
0 Polygon 0
1 Polygon 0
2 Polygon 1
3 Polygon 1

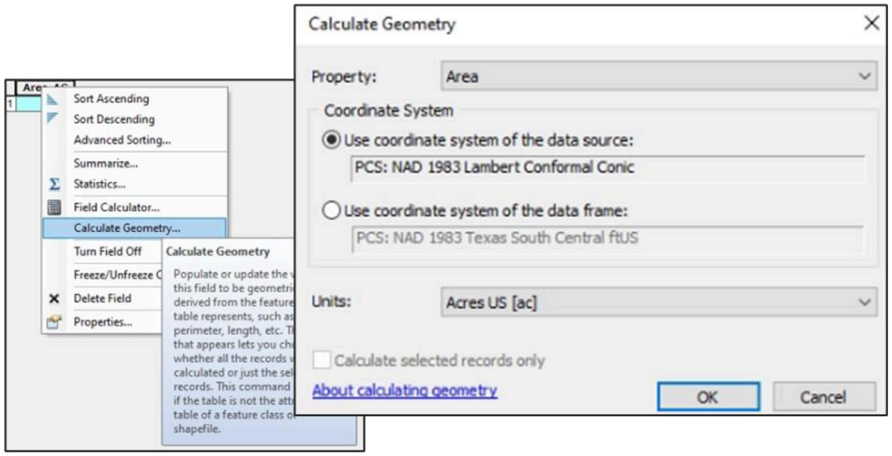
(l)


Intersect
Input Features
Features
Ranks
hb_AgOnly 1
hb_1pct1ft_ply 2
Output Feature Class
C:\HSA_SOP\Interim_Files\Ag_1p1ft_inun.shp
JoinAttributes (optional)
ALL
XY Tolerance (optional)
Feet
Output Type (optional)
INPUT
OK
Cancel
Environments...
<< Hide Help
Tool Help
Intersect
Computes a geometric intersection of the input features. Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class.
INPUT
INTERSECT FEATURE
OUTPUT

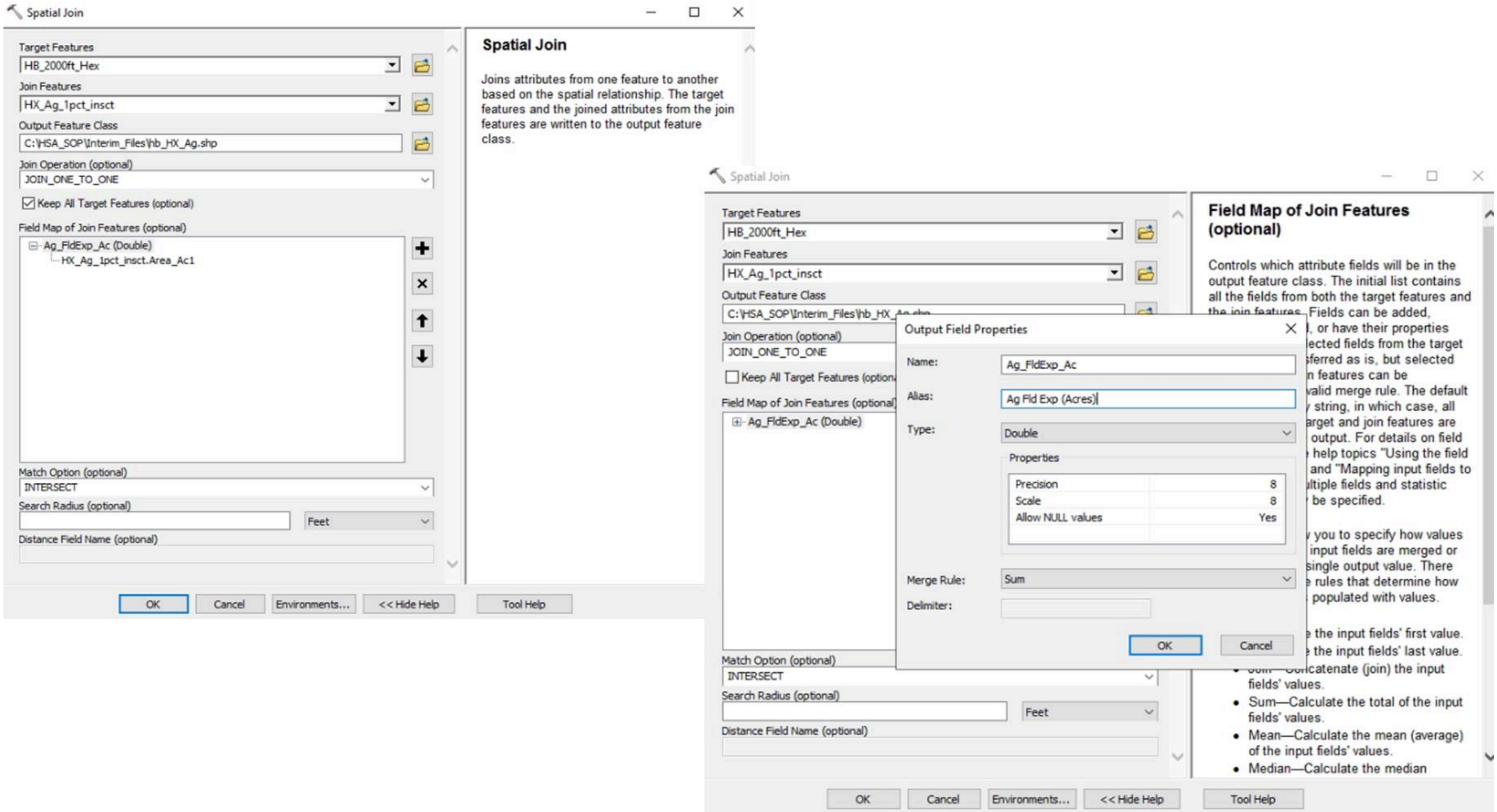
(m)


Intersect
Input Features
Features
Ranks
HB_2000ft_Hex
1
Ag_1pct_1ftdep
2
Output Feature Class
C:\HSA_SOP\Interim_Files\HX_Ag_1pct_insct.shp
JoinAttributes (optional)
ALL
XY Tolerance (optional)
Feet
Output Type (optional)
INPUT
Input Features
A list of the input feature classes or layers. When the distance between features is less than the cluster tolerance, the features with the lower rank will snap to the feature with the higher rank. The highest rank is one.
OK
Cancel
Environments...
<< Hide Help
Tool Help

(n)


Sort Ascending
Sort Descending
Advanced Sorting...
Summarize...
Statistics...
Field Calculator...
Calculate Geometry...
Turn Field Off
Delete Field
Properties...
Calculate Geometry
Property:
Area
Coordinate System
Use coordinate system of the data source:
PCS: NAD 1983 Lambert Conformal Conic
Use coordinate system of the data frame:
PCS: NAD 1983 Texas South Central ftUS
Units:
Acres US [ac]
Calculate selected records only
About calculating geometry
OK
Cancel

(o)


Spatial Join
Target Features
HB_2000ft_Hex
Join Features
HX_Ag_1pct_insct
Output Feature Class
C:\HSA_SOP\Interim_Files\hb_HX_Ag.shp
Join Operation (optional)
JOIN_ONE_TO_ONE
Keep All Target Features (optional)
Field Map of Join Features (optional)
Ag_FldExp_Ac (Double)
HX_Ag_1pct_insct.Area_Ac1
Match Option (optional)
INTERSECT
Search Radius (optional)
Feet
Distance Field Name (optional)
OK
Cancel
Environments...
<< Hide Help
Tool Help
Spatial Join
Joins attributes from one feature to another based on the spatial relationship. The target features and the joined attributes from the join features are written to the output feature class.
Field Map of Join Features (optional)
Output Field Properties
Name:
Ag_FldExp_Ac
Alias:
Ag Fld Exp (Acres)
Type:
Double
Properties
Precision 8
Scale 8
Allow NULL values Yes
Merge Rule:
Sum
Delimiter:
Sum—Calculate the total of the input fields' values.
Mean—Calculate the mean (average) of the input fields' values.
Median—Calculate the median

Appendix B

Structure and Agricultural Flood Exposure Methods Validation

Appendix B – Structure and Agricultural Flood Exposure Methods Validation

The methodology to determine structural and agricultural flood exposure metrics proposed in this Hot Spot Analysis (HSA) Standard Operating Procedure (SOP) are simplified from the more in-depth methods proposed such as HEC-FDA and HAZUS. The intention of this document is to describe the limited validation performed on the methodologies provided. The following sections describe the methods used as validation and compare the resulting flood exposure metrics proposed to more traditional analysis.

Establishing Flood Risk Validation Variables

Risk is defined as the product of the *probability* of a *hazard* and the *consequences* resulting from *exposure* to that hazard. **Section 2** of this HSA SOP defines the variables hazard, exposure, consequences, and risk as they relate to flooding. Traditionally, the flood risk metric has been defined in terms of expected annual losses which represents the average economic loss in dollars resulting from flooding each year. Based on the FEMA, the risk is typically evaluated for buildings, people and agriculture. The annualized damages for each of the categories can be calculated by combining the relationships outlined in **Figure B-1**.

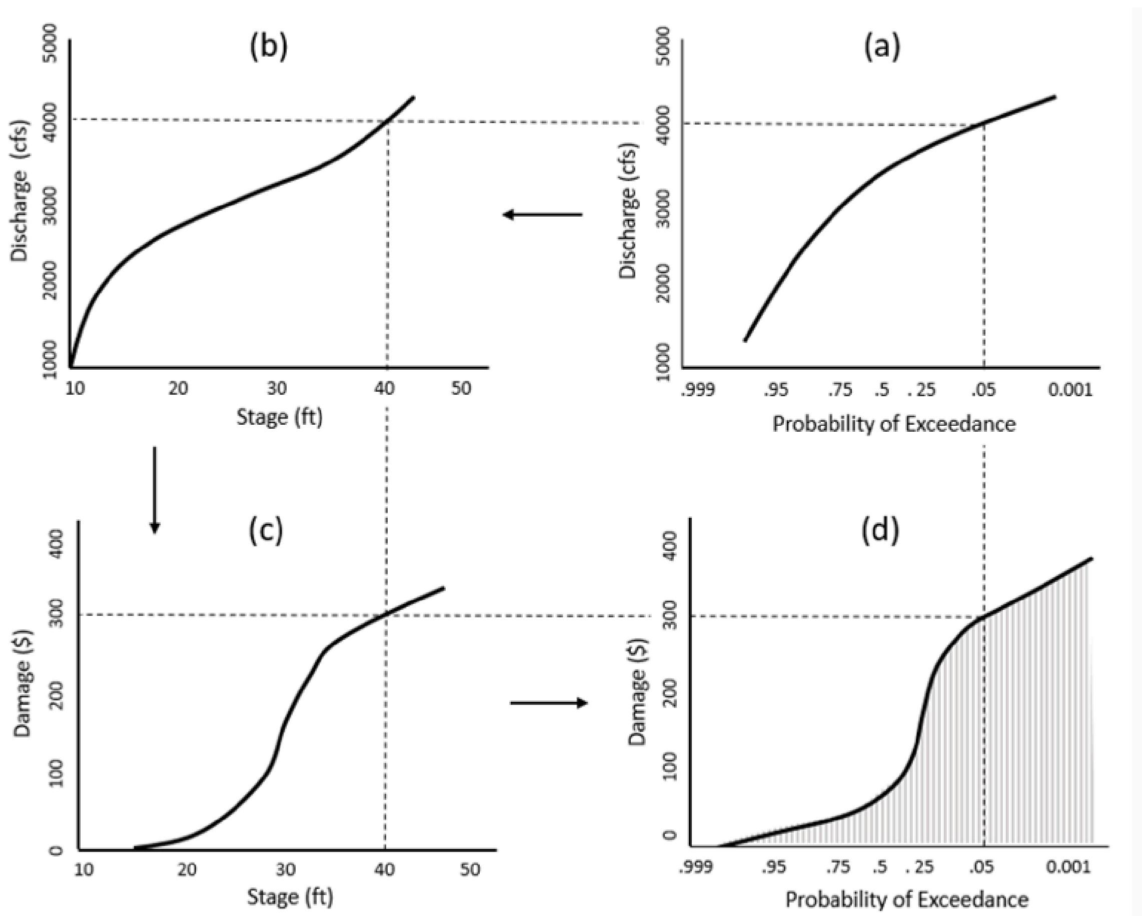


Figure B - 1. Economic Risk Relationship used to Calculate Expected Annual Damage (HEC-FDA Technical Reference)

For example, to establish an annual expected loss for a building the following process can be used. Rainfall or flows associated with an annual exceedance probability in a channel can be converted to a stage water surface elevation at that building in question using hydraulic modeling represented with the curve in **Figure B-1 (b).** This relates the rainfall or flow associated with an AEP with a water surface elevation by combining the relationships in curves (a) and (b) of **Figure B-1**. The water surface elevation can be converted to a flood depth, by establishing the depth of flooding per flood event by subtracting the first-floor elevation from the water surface elevation. There are several sources of published depth-damage relationships published for various structure types which can be used to relate the percent damage or damage value ($) of the structure to the depth of inundation (**Figure B-1 (c)**). The expected damage value produced for each event associated with a probability of exceedance can be plotted in the relationship shown in **Figure B-1 (d)**. The area under the curve (integral) is considered the expected annual damage for a given building. To approximate the integral, the trapezoidal method is typically applied to calculate the expected annual damage.

In the case of estimating flood risk for agricultural areas, a similar approach can be utilized to establish the expected annual damage due to losses of income due to reduced crop yield and livestock loss. Relating the process to Figure B-1, the function (c) would be agricultural damage ($) related to depth of flooding, depending on asset type of the agricultural area. In agriculture, the losses can vary dramatically depending on crop type, time of year and can depend on other flood-related variables (e.g. duration of flooding). Therefore, for more in-depth economic analyses the function (b) may consider duration of flooding, maximum velocity or some combination of flood variables related to the AEP. However, like with structure damages, the agricultural damages will produce a relationship like that of **Figure B-1 (d)** relating damages to the annual exceedance probability of that damage. Therefore, the expected annual damages for agriculture can be estimated using the trapezoidal method.

Structure Flood Exposure Validation Metric

While typical methods used by HEC-FDA and FEMA calculate full economic losses to determine flood risk in terms of expected annual loss, the method proposed to evaluate the validity of the "Annualized Instance of Flooding" method proposed in the SOP undergoes the partial HEC-FDA losses process. This partial HEC-FDA analysis, performed for validation, analyzes the flood risk minus the depth-damage relationship and value of the structure to remove potential bias towards expensive neighborhoods. The structure flood risk metric considers expected depth of inundation instead of expected damage as a monetary expense as the indicator of flood risk *severity*.

Figure B-2 shows a diagram of two example structures evaluated using the validation method. In this scenario, the maximum water surface elevation is assumed higher than the first-floor elevation (FFE) thereby assumed to be flooded for events at the 10-year (10% annual exceedance probability (AEP)). The flood depth is assumed to be higher (more severe) across all the storm events flooded for Structure A than Structure B.

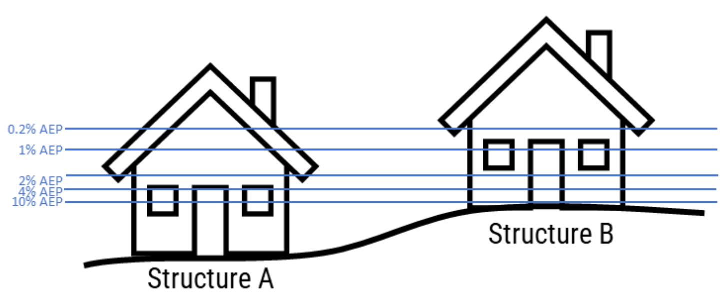


Figure B - 2. Example Structures Flood Inundation Depth Diagram

Using the methodology created for this flood risk metric, **Table B-1** and **Table B-2** demonstrate the calculation for determining the annualized flood risk value for Structures A and B, respectively. Note that using this method, the flood risk value establishes Structure A as higher flood risk than Structure B. This perceived flood risk comparison matches our perception of the flood risk as it relates to the *severity* of flooding. We would expect Structure A to have a higher depth-based flood risk than Structure B, which is reflected in this metric.

Table B - 1. Structure A Example Flood Risk Metric using the Annualized Expected Depth Calculation

AEP Event	**Annual Probability of Occurrence**	**Flood Depth (ft)**	**Annualized Flood Exposure Calculation**		
Nominal Return Period (Years)	Discrete Probability of Event Occurring in Any Given Year	(WSE - FFE)	Probability Interval (e.g. 1st interval =0.5 - 0.2 = 0.3)	Interval Average Depth (e.g. 3rd interval = (0.08+ 0.01)/2 = 0.045)	Interval Depth * Interval Probability (e.g. 3rd interval =(0.1-0.04)* (0.08+ 0.01)/2 = 0.0027)
2	**0.5**	**-0.2**	**0.3**	**0**	**0**
5	**0.2**	**0**	**0.1**	**0.015**	**0.0015**
10	**0.1**	**0.03**	**0.06**	**0.065**	**0.0039**
25	**0.04**	**0.1**	**0.02**	**0.12**	**0.0024**
50	**0.02**	**0.14**	**0.01**	**0.22**	**0.0022**
100	**0.01**	**0.3**	**0.008**	**1**	**0.008**
500	**0.002**	**1.7**	**0.002**	**1.7**	**0.0034**
			Individual Total Annualized Flood Risk		**0.021**

Table B - 2. Structure B Example Flood Risk Metric using the Annualized Expected Depth Calculation

AEP Event	**Annual Probability of Occurrence**	**Flood Depth (ft)**	**Annualized Flood Exposure Calculation**		
Nominal Return Period (Years)	Discrete Probability of Event Occurring in Any Given Year	(WSE - FFE)	Probability Interval (e.g. 1st interval =0.5 -0.2 = 0.3)	Interval Average Depth (e.g. 3rd interval = (0.08+ 0.01)/2 = 0.045)	Interval Depth * Interval Probability (e.g. 3rd interval =(0.1-0.04)* (0.08+ 0.01)/2 = 0.0027)
2	**0.5**	**-0.25**	**0.3**	**0**	**0**
5	**0.2**	**-0.01**	**0.1**	**0.005**	**0.0005**
10	**0.1**	**0.01**	**0.06**	**0.045**	**0.0027**
25	**0.04**	**0.08**	**0.02**	**0.09**	**0.0018**
50	**0.02**	**0.1**	**0.01**	**0.18**	**0.0018**
100	**0.01**	**0.26**	**0.008**	**0.88**	**0.00704**
500	**0.002**	**1.5**	**0.002**	**1.5**	**0.003**
			Individual Total Annualized Flood Risk		**0.017**

The resulting annualized expected damages for each of the structures were used to compare to the simplified flood risk metric Annualized Instance of Flooding which was proposed for this HSA SOP to serve as a rapid, high-level assessment tool. While this validation method does not capture full economics and cannot be used to establish a benefit-cost ratio of a potential project, it can be used as an indicator when compared across the watershed as a whole for the severity of flooding compared to other structures in the HUC. Therefore, it can be used to validate high flood risk areas within the watershed.

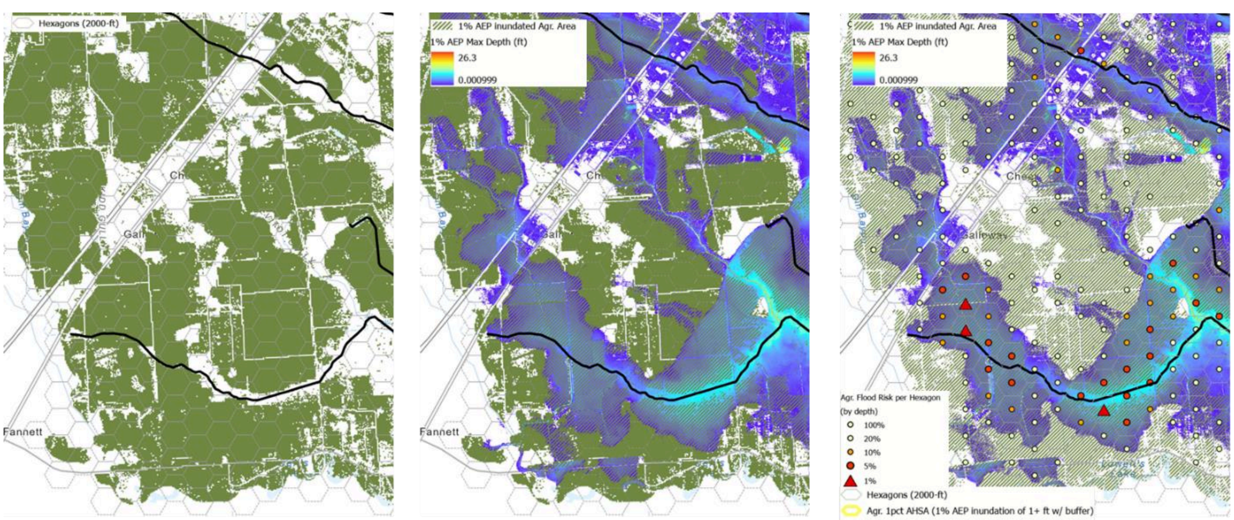
Agricultural Flood Risk Validation Metric

The validation flood risk metric used to evaluate the proposed simplified method from the HSA is based on the HEC-FDA full economic loss methodology, and was abridged similarly to the method applied to the structures. The overall equation to calculate the annualized expected flood depth over agricultural land remained the same, but the process was computed via rasters in GIS at a 3 ft x3ft grid level. Table B- 3 shows the calculation determined using each of the depth rasters, which intersected with land considered agricultural.

Table B - 3. Agricultural Flood Risk Calculation Applied to Raster Depth Grids

AEP Event Nominal Return Period (Years)	**Annual Probability of Occurrence** Discrete Probability of Event Occurring in Any Given Year	**Flood Depth (ft)** (Depth on Agricultural Land Only)	**Annualized Flood Exposure Raster Calculator Values**		
			Interval Raster Depth(i) + Depth (i-1)	Probability Interval (e.g. 1st interval = 0.5 -0.2 = 0.3)	Raster Multiplication Factor
2	**0.5**	**d(2)**	d(2)+d(5)	**0.3**	**0.15**
5	**0.2**	**d(5)**	d(5)+d(10)	**0.1**	**0.05**
10	**0.1**	**d(10)**	d(10)+d(25)	**0.06**	**0.03**
25	**0.04**	**d(25)**	d(25)+d(50)	**0.02**	**0.01**
50	**0.02**	**d(50)**	d(50)+d(100)	**0.01**	**0.005**
100	**0.01**	**d(100)**	d(100)+d(500)	**0.008**	**0.004**
500	**0.002**	**d(500)**	d(500)	**0.002**	**0.001**

The resulting weighted sum raster used to calculate the triangular method contained an expected annual depth weighted to the agricultural acreage was aggregated to each of the hexagons, which provided each with an agricultural flood risk value. These were compared across the hexagons and the top 1% were marked with red triangles. **Figure B-3** shows the agricultural land (a) overlayed with the 1% AEP depth grid (b) and the resulting flood risk by hexagons (c).



(a) Agricultural Land (b) 1% AEP Inundation Depth (c) Agr. Flood Risk – by Hexagon (annualized expected flood depth on Agricultural Land)

Figure B - 3. Agricultural Flood Risk Validation Metric Compared to the 1% AEP Flood Depth and Agricultural Areas

Simplified Flood Exposure Metric Validation

It is important to understand the base watershed used to determine the hot spot classification parameters, as these may not be applicable in every scenario. The example HUC10 which the sensitivity analysis has an

Structures Flood Risk Metric – Annualized Instances of Flooding (AIOF)

The flood risk metric of Annualized Instances of Flooding is a simplified methodology to identify structures of high flood risk at a high-level. A detailed account of the method, assumptions and calculations are described in Section 4.1 of the HSA SOP. The AIOF and the structure flood risk validation method were performed for the example watershed and the resulting "hot spots" based on points were evaluated to test the performance of the simplified AIOF method. **Figure B-4** through **Figure B-6** show the resulting comparison of three areas in the sample watershed.

Figure B - 4. Individual Structure Point Validation of Hot Spot Identification Areas for Sample Area 1

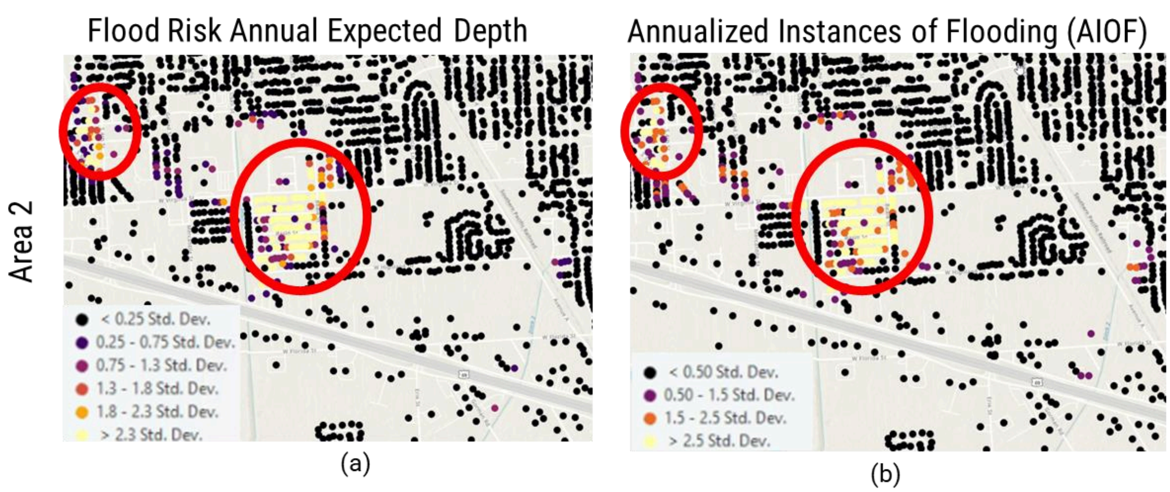


Figure B - 5. Individual Structure Point Validation of Hot Spot Identification Areas for Sample Area 2

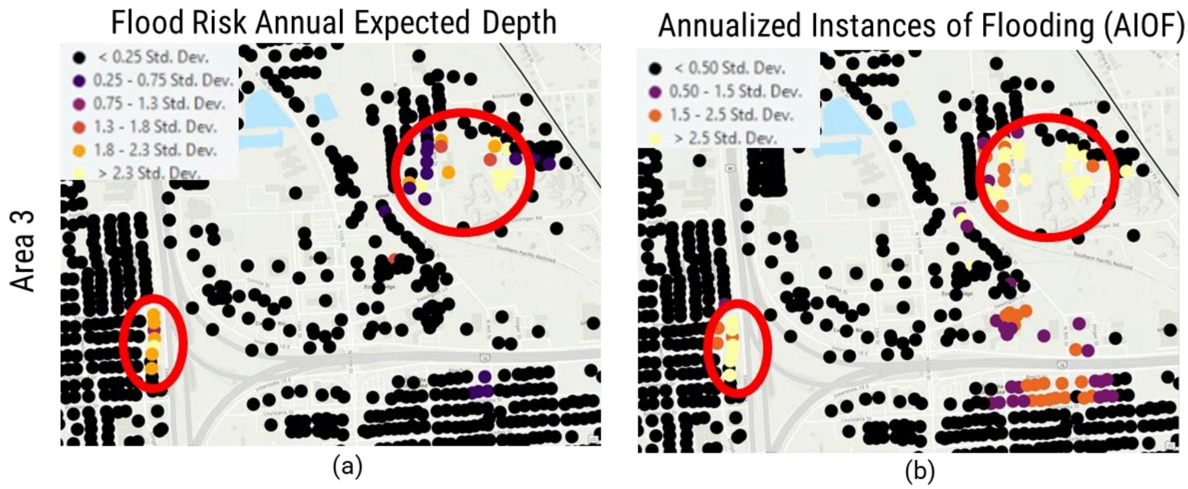


Figure B - 6. Individual Structure Point Validation of Hot Spot Identification Areas for Sample Area 3

Agricultural Flood Risk Metric –1% AEP Inundation of +1-ft

The flood risk metric method identified in HSA SOP to identify high flood risk agricultural areas uses the 1% AEP flood inundation layer, for any agricultural land with a maximum flood depth of 1-ft or greater as a base layer which is aggregated to the hexagonal grid for the watershed. A detailed account of the method, assumptions and calculations are described in Sections 4.3 and 6.3 of the HSA SOP. The Agricultural flood exposure metric proposed in the HSA SOP aggregated to the hexagonal grid were validated against a agricultural annualized expected depth for agricultural areas. **Figure B-7** shows the resulting comparison of a sample area with significant agricultural area within the example watershed.

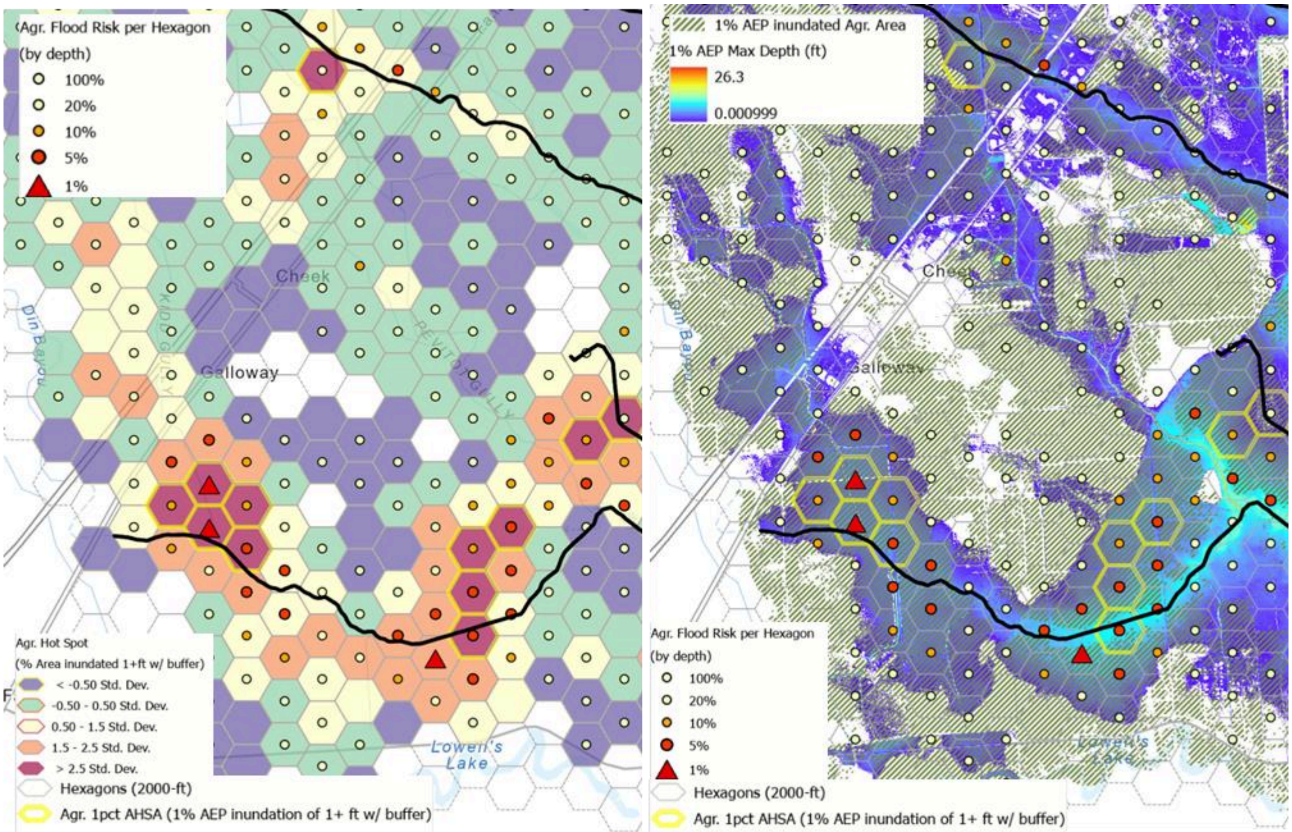


Figure B - 7. Agricultural Flood Risk Hot Spot Hexagons Validation

The method proposed in this HSA SOP produced the agricultural flood risk hot spots (yellow hexagons in both images) which tend to align with the "high flood risk" (by depth) agricultural areas which were aggregated to the hexagonal grid (red triangle in both images).

Conclusion

Figure B-4 through **Figure B-7** above are using standard deviation to identify outside of the normal distribution for each of the scoring systems. Because the scoring systems are not pertaining to a physical attribute but are used for comparing each of the risk values with others, it is appropriate to use the distribution of scores as the indicator instead of any specific value range (e.i evaluating the color classification ranges using standard deviation or natural breaks (jenks)). When evaluating these structures spatially, similar areas tend to remain high scoring and out of the standard deviation range of 2.3 and above, signifying "high flood risk" for both flood metrics. While the scores of induvial structures may vary, generally the high flood risk areas are captured using the simplified AIOF and Agricultural 1%AEP Agricultural 1+ ft inundation methods proposed in the HSA SOP.

Appendix C

Hexagonal Hot Spot Sensitivity Analyses

Appendix C - Hexagonal Hot Spot Sensitivity Analyses

The intention of this document is to explain the process used to determine the classification parameters for the Hot Spot Analysis (HSA) Standard Operating Procedures (SOP). At the release of this version of the HSA SOP, there are limited baseline models that can be used to test the SOP and thereby an understanding of the assumptions used to determine these HSA guidelines are paramount to applying the HSA appropriately to other study areas. Therefore, below describes the process, considerations and assumptions used to determine the classifications and spatial relationships for the structural, roadway, and agricultural hot spot exhibits.

Spatial Distribution of Hot Spots

In the process of creating the HSA SOP, several methods were tested over the versions of the document. Two major types of methods were tested – point based and spatially aggregated. The early versions of the document recommended using the inverse distance weighted (IDW) technique and later the Getis-Ord Gi* statistic to evaluate the point-based structure inventory flood risk variable. The point-based methods can evaluate point fields such as the structure inventory (SI) (structure centroids), but tend to show better results for dense point groupings. Inevitably, issues with evaluating additional metrics in which the inherent data is line or plane based, such as flooding impacts to agricultural land and roadway, encouraged use of spatially aggregated methods.

In this scenario, a spatial aggregated method allows the user to overlay a grid onto the watershed boundary and aggregate the resulting flood exposure metrics to that grid. There are several grid types that can be produced, (e.g. triangular, square, and hexagonal, etc.). Hexagons were chosen as the preferred grid type as they allow for a better representation of curves and makes it easier to evaluate relationships to neighboring grids, among other benefits.

Choosing Hexagon Diameter

The hexagon diameter chosen for this test case was the 2000-ft diameter. Several diameters were tested to determine their resulting structural hot spots. ***Figure C-1*** shows the resulting Hot Spots for various diameters tested. Each of the cases in ***Figure C-1*** are using 5 classification color scales, Natural Breaks using Jenks method to determine the break locations, and are only considering the sum of the AIOF scores of the structures in direct contact with the hexagon (no buffer applied). In ***Figure C-2***, the 1000 ft, 2000 ft and 3000 ft diameter hexagons are overlaid on the structure inventory in the dense neighborhood areas to show how well each of the sizes group areas together. While the 1000 ft showed the most detail, the 2000 ft showed groupings by a half to a whole neighborhood, which could serve as an indicator for smaller flooding projects (e.g. subdivision drainage improvements). Whereas the 3000 ft and up diameters start to lose the definition that occurs in the 2000 and 1000 ft diameters.

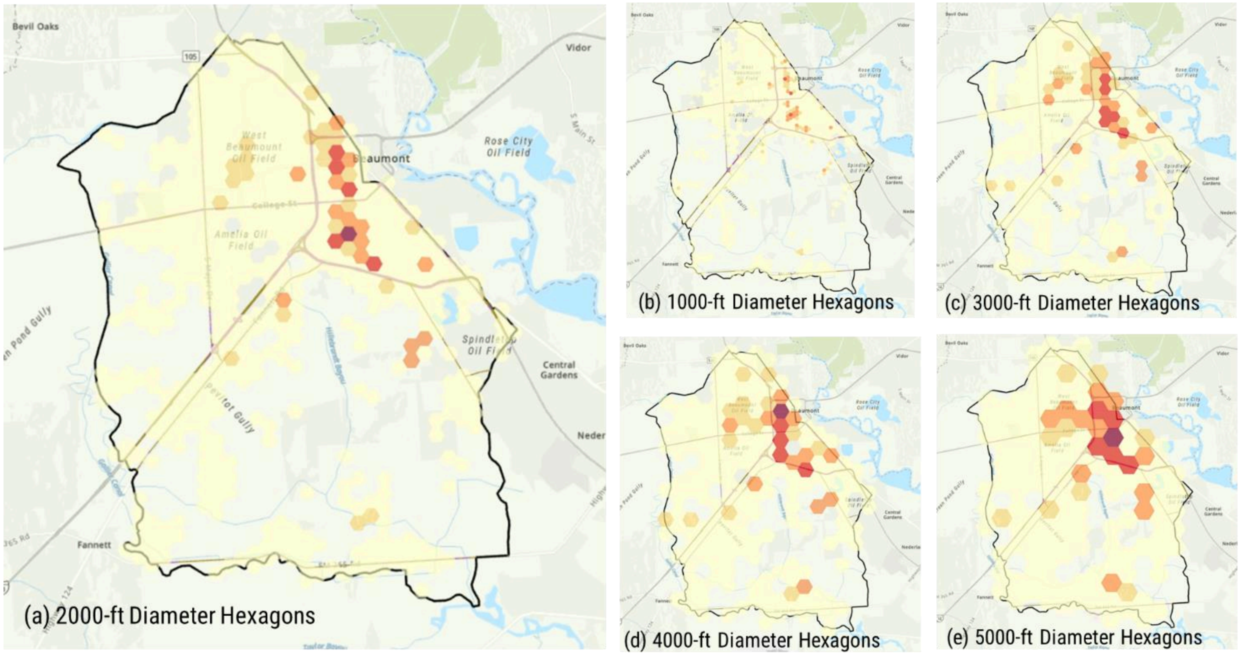


Figure C - 1. The Hexagon Diameter Comparison with (a) 2000-ft diameter, (b)1000-ft diameter, (c) 3000-ft diameter, (d) 4000-ft diameter, and (e) 5000-ft diameter.

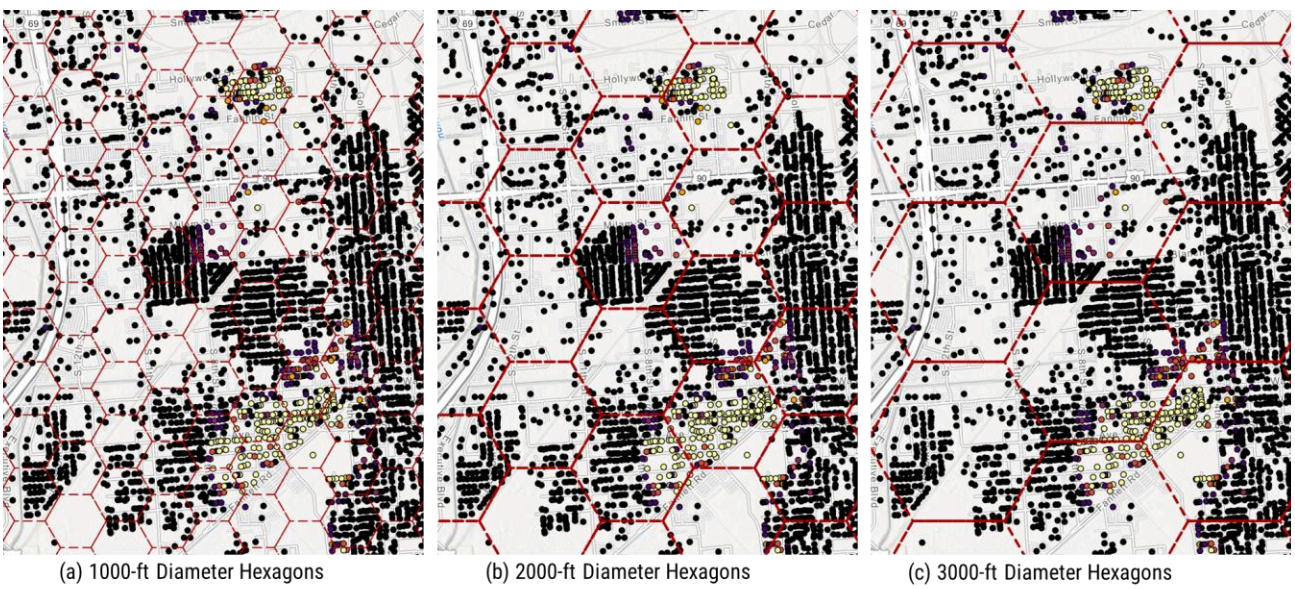


Figure C - 2. Example comparison of spread of structure inventory points within in the hexagons of various diameters including (a) 1000-ft, (b) 2000-ft, and (c) 3000-ft.

Choosing Aggregation Method

The method used to aggregate to the hexagon varied per input data type. Although the base data are different depending on category (i.e. structural Annualized Instances of Flooding (AIOF) data are points while agricultural flood extents layers evaluating area affected are 2D planes), similar aggregation methods can be similar (i.e. sum versus mean). The following ***Figure C-3*** and ***Figure C-4*** compare the aggregation by sum including no buffer around the hexagon, sum including a buffer, and other methods considered to calculate the hexagonal flood exposure scores. For both agricultural and structures flood exposure metric, the sum aggregate with a buffer region was chosen to highlight areas with high scores, which may also be surrounded by other high scoring hexagons as "hot spots".

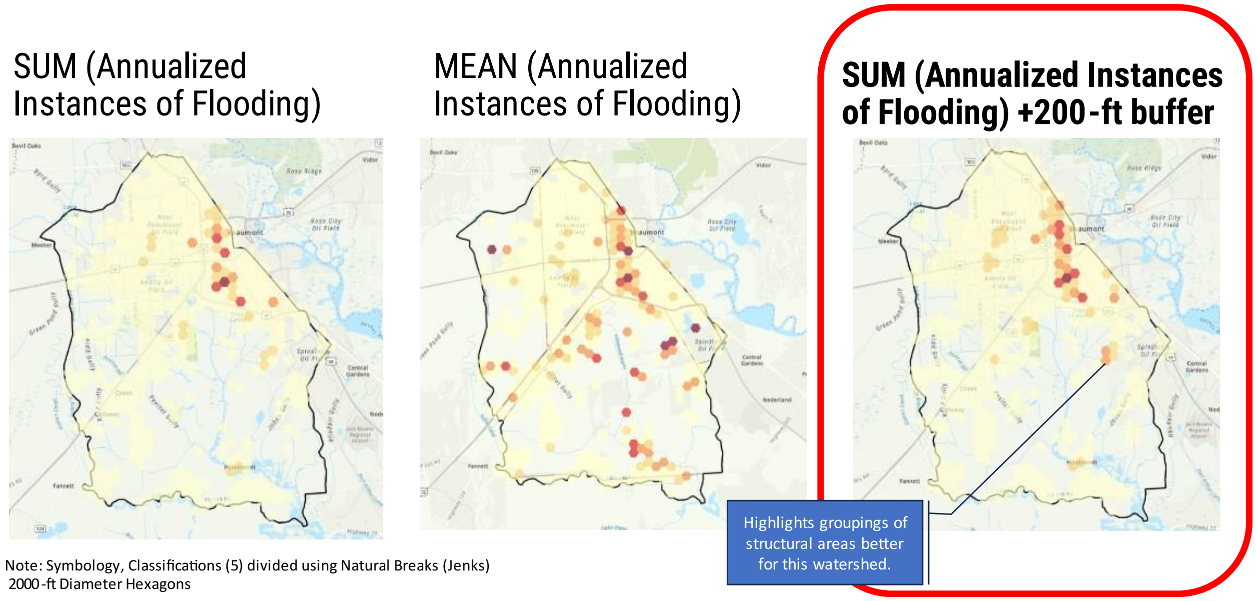


Figure C - 3. The aggregation methods considered to determine hexagon structures AIOF

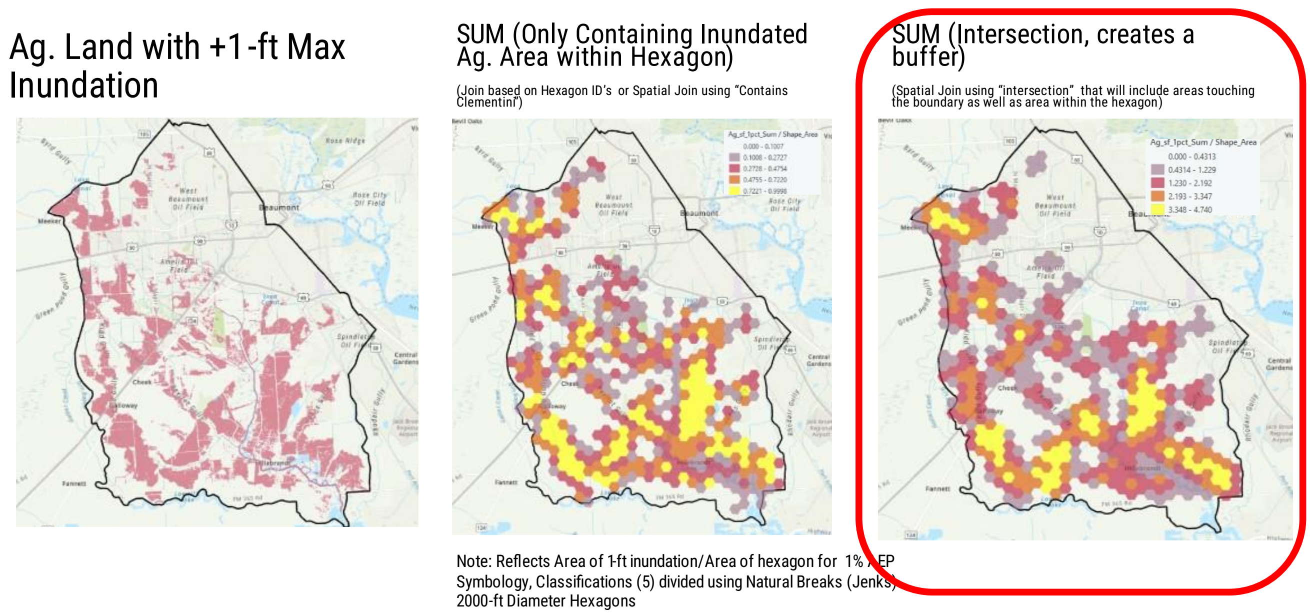
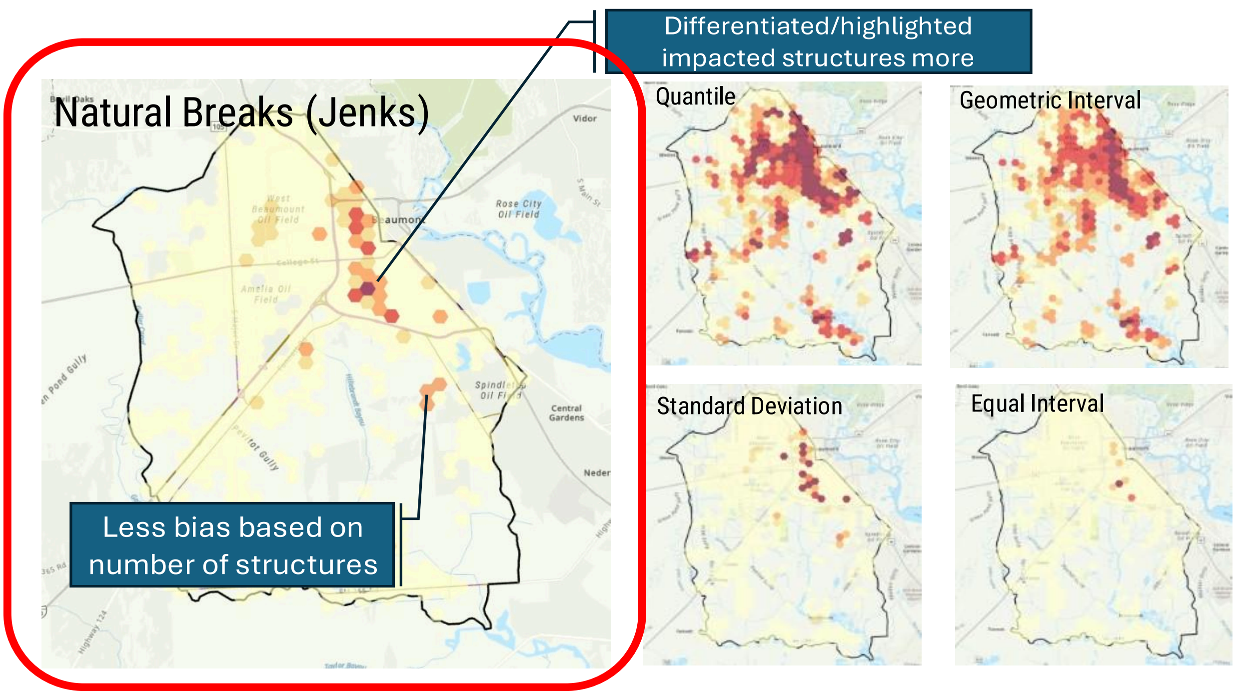


Figure C - 4. The aggregation methods considered to determine hexagon agricultural flood exposure scores

Classifications for Hot Spot Analysis

The following ***Figure C-5*** through ***Figure C-7*** show the classification number and method used to differentiate the data. This distribution of data identifies the "hot spots" in the region visually and may differ from watershed to watershed. The intent of the classification method was to highlight the highest scoring areas for each of the Hot Spot categories. ***Figure C-5*** shows the classification methods compared for structural AIOF scores within the watershed. Natural Breaks (Jenks) and Standard Deviation gleaned the most identifiable structures flood risk Hot Spots. ***Figure C-6*** shows the various number of classifications tested to determine which would visually create the most identifiable areas. Seven classes drew some attention to areas outside of the high density areas (as opposed to 5 classes), while not drowning out the definition of the densely populated areas (as opposed to less visible definition in color given with 9 classes). Finally, ***Figure C-7*** shows a similar process used for the Ag. Land flood exposure metrics.



2000-ft Diameter Hexagons
Symbology using 5 classes
Annual Instances of flooding structures aggregated using sum (with AIOF included within 200ft buffer outside of the hexagon)
note Standard dev. uses ½ standard dev. To achieve the ~2.3 std dev category.

Figure C - 5. The classification methods compared for Structures AIOF per hexagon in the Sample watershed.

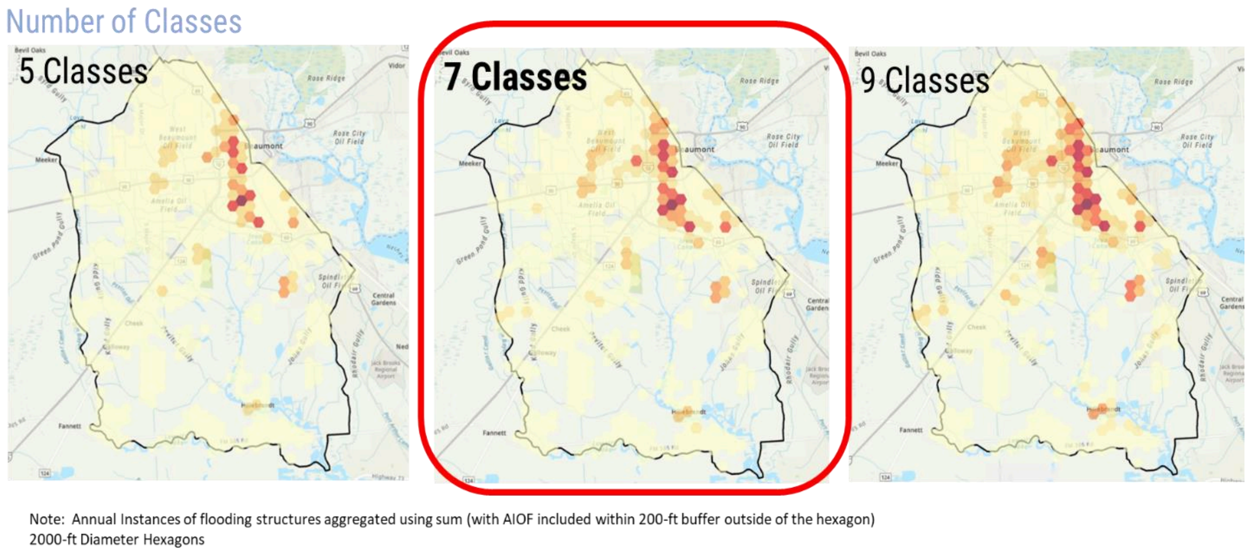


Figure C - 6. Number of classes compared for structures AIOF per hexagon in the sample watershed.

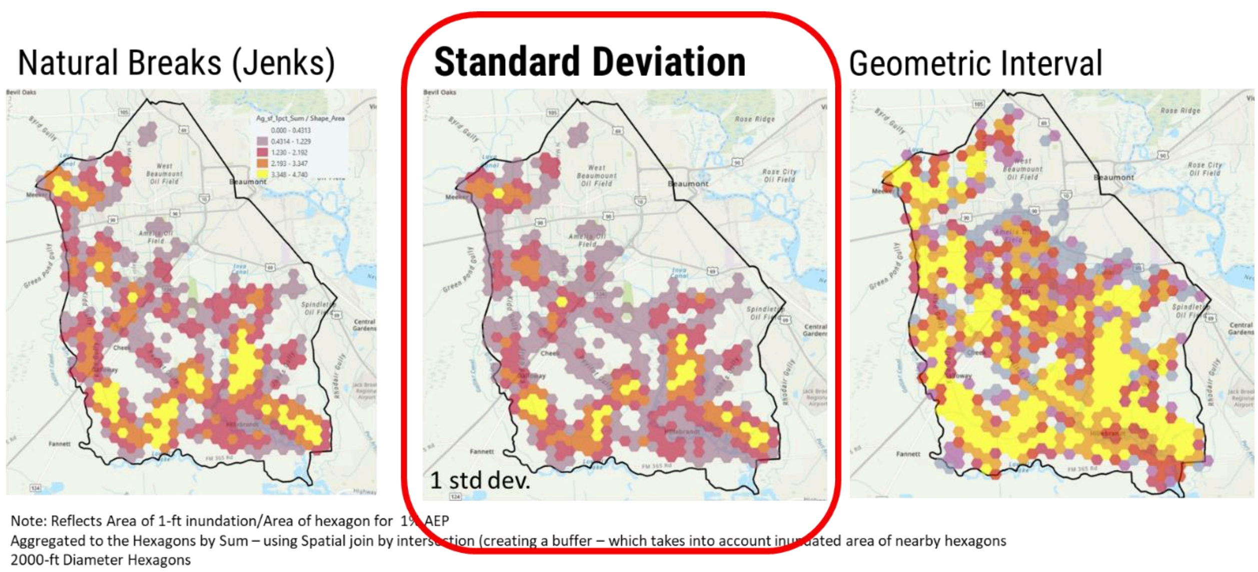


Figure C - 7. The classification methods compared for Ag. Land flood exposure per hexagon in the sample watershed.

Appendix D

GLO Hot Spot Analysis 75% Submittal Comments & Responses

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (AECOM)	Responses (Torres/Hollaway)
1	2.1	4	Vince DeCapio/Rusty Rex	Vince: Coastal flooding due to storm surge and/or sea level rise Rusty: Or are they saying combinations as in compound flooding. Either way, the sentence could use a revision.	Concur. Statement has been revised to reflect the inclusion of coastal commuties hazards
2	2.1	4	Rusty Rex	I am not sure I follow this so I'm flagging it	Concur. Statement has now been revised to provide further clarity of
3	2.4	5	Aaron Henderson	Improbable spelled incorrectly	Concur. Spelling has been corrected in table
4	2.4.1	5	Aaron Henderson/Rusty Rex	Aaron: Why 8 magnitudes? Is this necessary? Generally, modeling for flooding is done at the 10-, 50-, 100-, and 500- (plus the LOP of a solution if needed). The 2- and 5-year events seem as though they would essentially provided exteremely negligible impacts. Rusty: I think they are just saying 'this is what's available' via the modeling and not making a suggestion on what to use.	Clarification. The Hot Spot SOP does not declare to run all 8 magnitude storm events. If that information is avaiable, then it can be utilized for the Hot Spot SOP.
5	2.5	6	Aaron Henderson	Perhaps mention how you are measuring SV in this definition?	Concur. The paragraph has now been updated to include how the social vulnerability will be used in the HSA.
6	2.5	6	Vince DeCapio	This sentence was unclear, are we trying to say the GLO Program intends to align with Justice 40 and closely consider social vulnerability in the HSA?	Clarification. The GLO HSA does not intend to align with the Justice 40 initiative. The sentence was meant to state how current government policies take social equity into consideration and the HAS intends to do the same.
7	3.1	6	Rusty Rex	There was some talk on the group calls about a base cleanup of the flood grids. For example, removing all flooding less and 0.1ft.	Concur. A statement has now been added that discusses the cleanup of the data in this section and others following in the methodology section
8	3.2	6	Vince DeCapio	For each of the datasets listen in Section 3.2, do we want to be specific about the source and date of the data so that all regions are aligned and using the same and most current data?	Concur. The datasets will include links and date so all regions are aligned.
9	3.2.1	6	Aaron Henderson	Why do this data gathering if directly above you state the use of HAZUS-MH which provides this data fro you? You need to decide on an approach. These are two separate approaches.	Clarification. The data gathering is meant for the recommended GIS method due to not having as much uncertainty compared to the HAZUS method
10	3.2.1	6	Vince DeCapio	Would this be the buildings footprint dataset? It does have some limitations in rural areas, seems to be more accurate in urban areas.	Clarification. The building footprint dataset requirement has been removed since the GIS method does not utilize the footprint data. The NSI does provide the building footprint data if needed.

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (AECOM)	Responses (Torres/Hollaway)
11	3.2.1	6	Aaron Henderson	Understood. Then perhaps I would recommend the section be titled "Suggested Structure Inventory Development" and providing the above two paragraphs as example methodologies. With this said, why allow for different approaches? This will likely create significant variances in quality of inventories from structure types to valuations to FFE data. I understand wanting to use the best available data but isn't unilateral application of an SOP the goal?	Concur. The HSA SOP will now only include one recommended method to keep consistency across all regions when conducting a hot spot analysis.
12	3.2.3	7	Aaron Henderson	It would likely be necessary to provide a full list of what is deemed "critical" as this can vary to different people… An example is childcare centers.	Concur. The critical facilities section has now been altered to reflect what is believed to be important to be labeled as a critical facility and has data available.
13	3.2.3	7	Vince DeCapio	Water and wastewater facilities, evacuation centers, fire stations, police stations, emergency operation centers. Have noted that in some areas available spatial datasets are limited and this almost needs to be partial done manually.	Clarification. The critical facilities section reflects what is believed to be of importance and has data available. If other datasets are available, like police station locations, then it can be added into the HSA SOP
14	3.2.4	7	Rusty Rex	At what flood depth should we consider? Depends if our concern is damage to roadway or drivability. Doesn't seem like flooding less than 0.5ft would be a concern. Looks like this was essentially done in the step by step (sect 6.2) when rounding to get a whole number raster. But might discuss that it serves two purposes.	Concur. A statement has now been added that reflects the discussion of using 0.5 ft for roadways.
43	3.2.5	7	Aaron Henderson	...and provided to the region?	Clarification. Due to the difficulty of acquiring this data, RL and SRL structures have been removed from the HSA.
15	3.2.5	7	Vince DeCapio	Is this data available for all regions? Some communities do not maintain this data and FEMA most likely will not share as this is PII. We only have this data presently for each community; not property owner/address.	Clarification. Due to the difficulty of acquiring this data, RL and SRL structures have been removed from the HSA.
16	3.2.6	7	Aaron Henderson	Will this metric be used to meet the needs of Justice40? I would imagine these datasets are not one to one	Clarification. The metric will not be used to meet the needs of Justice40.
17	3.2.6	7	Vince DeCapio	and therefore should be considered for alternatives development in Phase 4 and funding strategies in Phase 5.	Concur. Statement has been added
18	3.2.7	7	Aaron Henderson	How? Based on crop type or by a standard value applied uniformly across crop land?	Clarification. According to the biweekly meetings, adding an
19	3.2.7	7	Rusty Rex	Ag damages seems complicated to take on. Maybe there is some extreme threshold(depth) that we know would be damaging to most all ag operations.	Clarification. Upon furher research, it seems that crops experience damage from a flooding
20	3.2.8	7	Vince DeCapio	Could we add any economic data that would consider the location of centers of employment or other types of assets that pertain to a communities economy?	Clarification. The HSA is meant to conduct a quick analysis for the different regions. The SoVI data should suffice on determining what areas are more vulnerable to hazards.
21	4.1.2	8	Rusty Rex	It seems like in this section there also needs to be an option for a binary, (e.g. structure 'in or out') for areas with limited data. I actually might make it a minimum requirement for all so at least for all studies we would have at least one consistent metric for comparison.	Clarification. The amount of structures flooded will be included in the deliverables table

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (AECOM)	Responses (Torres/Hollaway)
22	4.1.2.1	8	Aaron Henderson	I am still not understanding how this is simplified. I think the explanation should be rewritten.	Clarification. The Weighted Structural Flood Damage Estimate does not take the level of flooding depth into consideration. Instead, at any instance of flooding, it takes the total value of the flooding, the structure's value is used
23	4.1.2.2	8	Aaron Henderson	Based on what? Appraisal data? BRVs? I would include a section discussing the determination of a building's value.	Clarification, the structure's value can be found within the NSI
24	4.1.2.3	9	Aaron Henderson	Again...what is the value? How is it determined?	Clarification. The cost of agricultural crops will not be evaluated due to the bias towards high value crops.
25	4.1.2.3	9	Rusty Rex	Maybe get an example of this in the appendix?	Clarification. The Agricultural land damages has been

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (AECOM)	Responses (Torres/Hollaway)
26	5.1	10	Rusty Rex	Are we talking 'heat map' from just a visualization perspective or an actual map analysis of density or clustering?	Clarification. The heat map takes the clustering of structures into consideration.
27	5.1	10	Rusty Rex	Will this concentration identification just be qualitative based on visual clustering? Or do we have a spatial unit to complete the ratio… per sq mile, per census track, per basin, etc	Clarification. The identification is based on a visual clustering.
28	5.1	10	Vince DeCapio	Didn't see population listed in the data section, 3.x. Would need to align how population should be estimated, maybe number of people per residential structure? Or using Census Data?	Clarification. Population has been removed due to the level of detail that would be needed in order to calculate for all
29	5.1	10	Vince DeCapio	What would determine which path to take? How will the reviewers know when to accept a simple or more analysis heavy path? Would this raise a lot of questions from the review teams and result in a lot of back and forth to justify why a certain path was taken? Is the GLO accepting of having two paths as part of the program?	Clarification. The SOP will include one recommended method across all regions and keep consistency and avoid the confusion of choosing the appropriate
30	5.1	10	Vince DeCapio	Thought the SoVI / LMI would be on the heat maps?	Concur. The SoVI will be added onto the final heat map in the
31	6.3	17	Aaron Henderson	To do what? Now that you have this map, how are you calculating losses?	Clarification, the classification is already included in the attribute table. This is meant to double check that the developed land is not included in the agricultural land damages calculation.
32	6.3	17	Rusty Rex	If this is the 'final' output for this section, in the appendix you might include a screenshot of what this classified table looks like	Concur. A table will be added to the Appendix to show a sample table
33	6.4	20	Rusty Rex	Is there some significance to this number in the SoVI guidance or other literature?	Clarification. the SoVI value has been changed to reflect what is in the attribute table that labels those with a high to medium SoVI as priority.
34	8	22	Vince DeCapio	On Exhibits 1 and 2 in Appendix B, would have been nice to see example maps that showed the structure damages, flooded roadways, ag damages, and SoVI / LMI on one map. Would demonstrate the potential complexity and judgment required to determine the hot spot locations. Likely needs to be more discussion on how the heat maps are used to consistently identify hot spots for each region team, especially with multiple datasets shown along with SoVI and LMI data.	Clarification. The Exhibits will now include all assets except for structures flooded due to the privacy issue of showing structures at the individual level

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (FNI)	Responses (Torres/Hollaway)
1	General	1	Andrew Swynenberg	Should this be on a standard RBFS template instead of East Region specific? Baseline Conditions SOP did not use a region specific template.	Concur. The title page has not been changed to not be region specific.
2	Table of Contents	2	Andrew Swynenberg	Fonts don't follow most recent GLO branding guidelines.	Concur. Fonts have now been altered to follow the rest of the guidelines
3	1.1	4	Andrew Swynenberg	Where is the economics portion of this SOP?	Clarification. According to the biweekly meetings, emphasizing on the economics such as the cost portions of agriculture crops would emphasize on the more high valued crops. The HSA will still include some economic calculation for structures flooded but will focus more on identifying the hot spots.
4	1.1	4	Andrew Swynenberg	Any east region specific material should not be included in the final SOP document. Note East Region specific scope items in separate documentation or correspondence when submitting.	Concur. The SOP will no longer include any east egion specific material.
5	1.2	4	Andrew Swynenberg	Where is the economic portion of this SOP?	Clarification. Like stated previously in the biweekly meetings, emphasizing on the economics such as the cost portions of agriculture crops would emphasize more high valued crops. The HSA will still include some economic calculation for structures flooded but will focus more on identifying the hot spots.
6	1.2	4	Maggie Puckett	Objectively? Transparently? It may be appropriate to emphasize that this process serves as justification for how Phase 4 budget is spent understanding that there is a finite budget and not all damage areas can be advanced to Alternatives Analysis.	Concur. Statement now reflects the addition of an understanding that all projects may not move forward to the Alternative Analysis
7	1.2	4	Maggie Puckett	Suggest removing 'Phase 3'.	Concur. Phase 3 has been removed
8	1.2	4	Maggie Puckett	Is there a chance that damage areas identified through the Hot Spot Analysis won't determine areas advanced into Alternatives Analysis? Are there other considerations not listed? If so, please explain other considerations. Please consider expanding on the transition between HSA and AA and how hot spots can be used to drive the work performed in Phase 4.	Clarification. The Alternative Analysis will determine which Hot Spots from the Hot Spot Analysis will be evaluated. The Hot Spot Analysis is used to determine the hot spots in the different HUC 10 watersheds.
9	1.2	4	Andrew Swynenberg	Consider specifying, is there a reason to go smaller than HUC10?	Clarification. There is no specific reasoning to go smaller than HUC10 but is available if needed.
10	2.4	5	Andrew Swynenberg	This is a fine table, but does it get used anywhere else? It seems to set expectation that we will be assigning these values as a result of the analysis. Text only could be sufficient and would be in line with the rest of this section.	Clarification. The table is meant to provide context behind the thought process that goes behind moving project areas further to be selected for mitigation projects.
11	2.4	5	Maggie Puckett	Matrix?	Concur. Spelling has been fixed
12	2.4.1	5	Andrew Swynenberg	Coastal watersheds do not use a rainfall-runoff approach per Baseline Conditions SOP.	Clarification. The statement was presenting an example of a compound flooding.
13	2.4.1	5	Andrew Swynenberg	Riverine areas will have 7 events (not the 0.5%) but Coastal watersheds may only have 4 - 10%, 2%, 1%, 0.2%. Considering the intent of the HSA, using the 4 coastal events should be sufficient for all areas.	Clarification. The Hot Spot SOP does not mean to specify to have all storm events, but instead use all storm events that are available to the regions. Will provide clarification throughout document.
14	2.5	6	Andrew Swynenberg	I don't follow this closing statement..are we or aren't we considering Social Vulnerability in the HSA? If it's discussed later, then consider deleting this statement.	Clarification. The HSA will take SoVI into consideration for the Hot Spot Analysis
43	2.6	6	Garrett Johnson	Does this need to be included? I don't see resilience referred to elsewhere in the HSA SOP and I'm not sure we need to quantify it for the HSA	Concur. It is not used in the HSA, and therefore will be removed from the document
15	3	6	Andrew Swynenberg	The product of the probability of hazard and the consequences of exposure	Concur. The statement has now been replaced with the suggestion to provide clarity
16	3.1	6	Andrew Swynenberg	Specify one or the other, not both. Recommend using WSE, which will provide greater flexibility when considering various FFE options later.	Clarification. Both the WSE and Depth rasters are utilized based on the entities being evaluated.
17	3.1	6	Garrett Johnson	Specify that the WSE grids from each model should be related to the terrain used to build the model whenever possible	Concur. Statement has now been added to reflect this change
18	3.2	6	Maggie Puckett	Consider summarizing data in a table. Identify sources of data, general availability across regions, and minimum requirements for analysis.	Clarification. The sections are presented in a way that discussion on the importance of these factors are available.

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (FNI)	Responses (Torres/Hollaway)
19	3.2	6	Maggie Puckett	TWI - Should specifically mention Weighted Structural Flood Damage Estimate and EAD in this section	Concur. The Weighted Structural Flood Damage Estimate has been added due to it being the method being used in the methodology section
20	3.2.1	6	Andrew Swynenberg	Instead of phrasing as a hypothetical via "could", state plainly which structure database should be used in the HSA. Please review entire document for similar situations.	Concur. Document has now been revised to not be as suggestive
21	3.2.1	6	Andrew Swynenberg	Please make a recommendation on approach for consistency across analyses. Point layer at centroid, max value that touches polygon, etc.	Concur. The GIS method has been selected to become the recommended approach for the HSA SOP
22	3.2.1	6	Andrew Swynenberg	Paragraph above discusses NSI, which is already a point layer and already contains information on building area, number of stories, structure value, and FFE.	Concur. Statement has been altered to reflect this change
23	3.2.1	6	Maggie Puckett	Consider speaking to how using a higher adjustment factor may be appropriate for coastal communities.	Concur. A statement was added to reflect this difference in coastal communities.
24	3.2.1	6	Andrew Swynenberg	Consider how use of appraisal district data may be counter to equitable consideration of risk across a region. Standard values like 100/sqft or home values based on size (ex: TWDB uses small, medium, and large residential) could be utilized in lieu of detailed appraisal district data. NSI appears fairly complete across Texas, so filling in major gaps (e.g., new development) with standard values may be a suitable alternative.	Clarification. The current methodology does not require the use of the building footprint data due to not having that consistent data available for all regions.
25	3.2.2	6	Maggie Puckett	TWI - Direct flood damage is not mentioned as an output, but to the best of my knowledge building features like square footage are not needed if you are not using the HAZUS methodology for doing direct structure damage	Clarification. The GIS approach does not utilize building footprint in the HSA SOP.
26	3.2.3	7	Andrew Swynenberg/Maggie Puckett	Andrew: Please provide a clear recommendation on what is/isn't critical infrastructure and a data source. Maggie: RBFS regions should consider using critical facilities identified by flood planning regions, at a minimum, and can supplement from there as data is available.	Concur. The critical facilities section now includes those facilities that are deemed to be critical and are available. If a region deems another facility to be deemed as critical, they would provide the dataset that was used and reasoning for including it into their particular SOP.
27	3.2.4	7	Maggie Puckett	TWI - If the document is going to reference this, it needs to be consistent, either Depth or WSE or both	Clarification, the HSA uses both depth and WSE grids in the methodology.
28	3.2.5	7	Andrew Swynenberg/Garrett Johnson	Andrew: Are we specifically accounting for RL and SRL structures or not? Garrett: We likely won't be able to get the exact locations of RL/SRL structures from FEMA – at least not with consistent coverage that would effectively support this study. The only readily available claims dataset with good coverage that I'm aware of is the OpenFEMA dataset of NFIP claims. It is at a very coarse scale but can be disaggregated by census	Clarification. RL and SRL Structures have been removed from the HSA due to not having that data readily available
29	3.2.6	7	Andrew Swynenberg	Will be used.	Concur. Statement has now been added to reflect this change
30	3.2.6	7	Andrew Swynenberg	Do we need LMI too, or is the GLO's SoVI dataset sufficient on its own?	Clarification. The GLO's SoVI is sufficient on its own. LMI has not been removed from the HSA
31	3.2.7	7	Maggie Puckett	TWI - Revise to be 'Damage.' Damages is apparently a legal term. Damage is correct in the context of consequence modeling	Concur. Wording has now been corrected.

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (FNI)	Responses (Torres/Hollaway)
32	3.2.7	7	Garrett Johnson	Consider specifying a minimum depth, or better yet a minimum duration above a specified depth based on available USACE references (e.g. AGDAM, https://www.hec.usace.army.mil/confluence/agdocs/agriculture-damage-computation-proceedures-43820820.html, etc). This would require an extra duration raster export from HEC-RAS baseline models so we may want to limit this to one or two events (100-yr, 10-yr?). HAZUS also has agricultural damage function tables.	Clarification. Upon further research, there is insufficient data that can state what duration is best to use for all crop types to determine when they are damaged. In an effort to be more conservative, those areas that experience a depth greater than 1 ft would be considered flooded.
33	3	7	Andrew Swynenberg	Consider outlining the minimum data that is common across all regions and spell out the minimum required analysis that should be consistent across all regions. This closing statement leaves too much open to judgement.	Concur. The statement has now been updated to reflect the minimum requirements of data needed to perform a HSA.
34	4.1	8	Andrew Swynenberg	Recommend a single analytical method for consistency.	Concur. The GIS method has been declared as the recommended method for all regions to follow,
35	4.1	8	Andrew Swynenberg	This doesn't seem appropriate. All regions should aim for same level of precision, with deciding factors limited to available data.	Clarification. The GIS method will be declared as the recommended approach to keep consistency across all regions.
36	4.1	8	Andrew Swynenberg	Add something along the lines of "Each Region should select appropriate approach for their region, apply it consistently across their region, etc."	Clarification. A single recommended method has been selected for the HSA.
37	4.1.1	8	Andrew Swynenberg	Include link of where to download this software.	Clarification. The Hazus discussion has been removed due to the recommended method being the GIS method.
38	4.1.1	8	Andrew Swynenberg	Instead of an either/or for HAZUS vs GIS, consider prescribing HAZUS for ag damages, and GIS for everything else.	Clarification. The recommended approach will be the GIS methodology in order to keep consistency across all methodolody.
39	4.1.1	8	Andrew Swynenberg	Is the HSA phased/tiered? This statement suggests some additional analysis follows on after completing Level 1 HAZUS.	Clarification. The HSA is not phased. It is meant to emphasize the reasoning for using the GIS method as the appropriate method.
40	4.1.2	8	Andrew Swynenberg	Why is "with uncertainty" consistently noted in various parts of section 4?	Concur. The uncertainty statements have been removed where needed
41	4.1.2	8	Andrew Swynenberg	This doesn't agree with Depth Raster option noted in previous sections. Remove Depth raster option. See previous comment.	Clarification. The roadways and agricultural land use the depth rasters in their calculations.
42	4.1.2	8	Andrew Swynenberg	NSI?	Concur. Change has been made from SI to NSI
43	4.1.2.1	8	Andrew Swynenberg/Garrett Johnson	Andrew: Does this calculation serve a meaningful purpose if we are calculating Expected Annual Damages and considering items such as SoVi? This calculation could be potentially replaced with Instances of Flooding, instead of having two calculations that calculate a $ amount. TWDB's soon to be released approach to adjust damages based on income level could also reduce the need for this type of calculation. Garrett: Agree, this seems to have a lot of overlap with expected annual damage. Expected annual damage * 50 = accumulated damage over 50 years from multiple storm events. I don't think we need both this and EAD. To expand on "instances of flooding" – this is calculated similarly to damage over a set period of time (typical for benefit-cost analyses). It removes dollar value or square footage from consideration, simplifying the calculation. For example, instead of estimating $100k of accumulated damage over 50 years, you could use model results and an assumed FFE to estimate 12.3 instances of flooding over 50 years. We implemented this as part of the San Jacinto Regional Watershed Master Drainage Plan. Another option – Assume a specified/statewide value per square foot for all structures to improve equity. This way a $500/sqft house doesn't rack up 5x the damage of a $100/sqft house. This is the Expected Annual Structural Damage concept implemented by TWI in the Louisiana 2023 Coastal Master Plan.	Clarification. The current Hot Spot Analysis SOP is not calculating Expected Annual Damages. The Weighted Structural Flood Damage Estimate tool simplifies the EAD method by taking the structures value if damaged instead of using the depth damage curves to determine the level of damage. Also, the new Hot Spot Identifier tool now focuses more on the clusters of structures flooded.
44	4.1.2.2	8	Maggie Puckett	TWI - Is there a reason to not just move ahead with this approach? Getting depth-damage curves should not be a limiting factor. HAZUS has a methodology for getting replacement costs from sqft and building type.	Clarification. The Level 1 HAZUS software comes with high uncertainty outputs for a quick assessment of the GLO Hot Spot. Also, the compatible GIS software will be outdated beginning of 2024. The GIS method can still be used in the ArcGIS Pro version.

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (FNI)	Responses (Torres/Hollaway)
45	4.1.2.2	8	Garrett Johnson	TWI - As mentioned above, EASD [or other non-dollar option] might be a good inclusion to give equal weighting to structures regardless of their expense	Clarification. The new Hot Spot indentifier tool being utilized takes the clusters of structures into consideration instead of those structures with the highest value.
46	4.1.2.2	9	Andrew Swynenberg	Please provide a formula as well. See other comments regarding number of events.	Clarification. The new Hot Spot indentifier tool being utilized takes the clusters of structures into consideration instead of those structures with the highest value.
47	4.1.2.2	9	Garrett Johnson	I like the idea of integrating at the study area level – much simpler than the typical BCA approach of integrating at each individual structure. Do both approaches yield the same results?	Clarification. Whether one utilizes a study area or watershed level, the results should specify what hot spots need to be addressed within that area. In order to keep consistency across all regions, it is recommended to stick to the watershed level.
48	4.1.2.3	9	Maggie Puckett	Please confirm that, at a minimum, all ag land is being lumped together regardless of crop type. Consider adding justification for this approach and speak to some of the discussion in previous coordination meetings.	Concur. All ag land is being lumped together, regardless of crop type. Language will be adjusted to adress this confusion
49	4.1.2.3	9	Andrew Swynenberg	Andrew: Data source for this calculation? How does it compare with HAZUS? Garrett: Agree – see comment above about incorporating a minimum depth or duration above a minimum depth.	Clarification. The section for Agricultutral damages has now been changed to discuss the method that is being utilized in the methodology section for agricultutral damages. The previous risk formula was not being used in the methodology.
50	5.1	10	Maggie Puckett	Can a section be added where minimum asset types that should be analyzed are outlined in a table along with other considerations?	Concur. The asset types have been specified in the same section for the HSA.
51	5.1	10	Andrew Swynenberg	Is this a stated goal? Hot spots should not be limited to SoVI and LMI populations. SoVI should be used to "boost" areas that otherwise might rank lower.	Concur. Statement has been removed
52	5.1	10	Andrew Swynenberg	These aren't mentioned in the deliverables.	Concur. Deliverables section has now been updated to reflect this statement
53	5.1	10	Garrett Johnson	In line with previous comments, modify this flowchart to describe a single approach representing the minimum required analysis that should be consistent across all regions. We should limit ambiguity for that minimum required analysis while still providing some flexibility for region-specific considerations beyond the minimum.	Clarification. The SOP will now only include the recommended method in order to keep coinsistency across all regions. The flowchart has also been updated to reflect these changes.
54	6	11	Andrew Swynenberg/Maggie Puckett	Andrew: There are other ways to complete these calculations and arrive at a similar final product. Can this section be outlined as an example, with more emphasis placed on the outcome rather than steps 1 - 13 as "standardized methodology?" Maggie: TWI - Broad methodological question. Given that the geoprocessing is occurring in the Esri software environment, why is this analysis not taking advantage of the hot spot identification routines available in the spatial statistics toolbox? As far as I can tell, the steps detailed in this section don't output anything related to the statistical significance of clusters and there's no indication as to whether the observed spatial clustering of high/low values is more pronounced when compared against a random distribution of those same values. Application of a Getis-Ord Gi* hot spot analysis routine would give you the statistical measures (standard score and probability value) necessary to bin features into spatial clusters with associated confidence levels (e.g. a high z-score and small p-value for a feature would indicate a spatial clustering of high values).	Concur. The methodology section utilize the spatial statistics toolbox to have a greater focus on the clusters. The outcome of the HSA would also be decieded based on thebaseline conditions results that were calculated and compiled into the summary tables to determine whihc areas are in more need of a mitigation plan.
55	6.1	11	Andrew Swynenberg	Consider removing names from examples.	Concur. Example areas will be referred differently
56	6.1	11	Garrett Johnson	Consider ArcGIS Pro and associated tools since ArcMap has reached end of life	Clarification, ArcGIS or ArcGIS Pro can be utilized depending on the preference of the culsultant/region

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (FNI)	Responses (Torres/Hollaway)
57	6.1	11	Garrett Johnson	Consider keeping negative flood depths at this stage rather than forcing them all to null. The difference in risk between a flood depth of -2 and a flood depth of -0.01 is meaningful. USACE depth-damage curves for structures begin accumulating some damage when WSE is slightly below FFE. Negative flood depths can always be queried out for mapping purposes.	Concur. The flood depth has been changed to keep the depths that are less than zero.
58	6.1	11	Andrew Swynenberg	Baseline conditions SOP for coastal watersheds only specifies 10%, 2%, 1%, and 0.2% AEP. Some regions may have elected to simulate all of these events anyway, but maybe not.	Clarification. Only the storm events that each watershed has available from the baseline modeling will be evaluated.
59	6.1	11	Andrew Swynenberg	Please specify which events. There should be consistency for the entire RBFS study area as well as consistency within each region so that one region isn't skewed over another.	Clarification. Only the storm events that each watershed has available from the baseline modeling will be evaluated.
60	6.1	11	Garrett Johnson	This doesn't seem to be consistent with Table 1 which integrates damages at the study area level, not the individual structure level.	Clarification. The Hot Spot methodology being used focuses on thearea being analyzed. In this case, the watersehds are being used but may also be used for specific study areas if needed.
61	Figure 3	12	Andrew Swynenberg	Remove eastern region specific labels since this is RBFS SOP. Call these examples, consider removing stream and watershed names since flood risk analysis isn't complete yet.	Concur. All east regions labels have been removed from the SOP
62	Figure 3	12	Garrett Johnson	It appears the highest structural damages (red areas) are centered around single structures. Is that right? the clustered structures at the north end are obscuring the rest of the heat map. heat map symbology should be consistent between study areas. heat maps should also be evaluated at the region level in order to compare one study area to another. These maps are a useful qualitative way of evaluating damages. Consider also requiring tabulation of each hotspot metric by HUC and/or by concentrated damage area and providing an example table. Same for the following maps.	Clarification. The spatial statistics toolbox is now being utilized to create hot spots that take clustering into consideration.
63	6.2	14	Andrew Swynenberg	It should be preferable to only use WSE rasters for all HSA calculations, instead of depth for some and WSE for others.	Clarification. The WSE and Depth rasters will both be used for the HSA.
64	6.2	14	Andrew Swynenberg	There are other ways to complete this calculation, like doing this all with rasters, please outline this as an example.	Clarification. WSE Rasters were used for this calculation
65	6.2	14	Garrett Johnson	What is the basis for 0.5 ft? Is this consistent w/ TWDB criteria? Most roads are designed to convey 6 inches of water at the peak of the 1% AEP event. USBR Downstream Hazard Classification Guidelines indicate depths less than 1 ft are low danger to passenger vehicles.	Clarification. The 0.5ft was used for the HSA to reflect the depth that vehicles may begin to drift from their location due tovelocity. In order to complete a quick analysis. Velocity was not taken into consideration but instead only utilize the depth while being conservative.
66	6.3	17	Andrew Swynenberg	Previous meeting mentioned potential use of duration and various $ values per crop type, why the change to this simplified and coarser approach?	Clarification. According to the biweekly meetings, emphasizing on the economics such as the cost portions of agriculture crops would emphasize more high valued crops. At this moment, duration was also included due to insufficient andinconsistent data about the duration effects on different crop types
67	6.3	17	Andrew Swynenberg	If $ values aren't being applied to various crop types and only inundated area is being considered, why do we need to maintain the crop type designation? This would simplify this calculation.	Clarification. In the original crop type layer, developed land is also included. This was done in order to verify that only agricultural land is being evaluated and not the developed lands such as cities
68	6.3	17	Maggie Puckett	See comments above on available frequency events.	Clarification. The HSA SOP does not mean to model more storm events that have not already been completed from the GLO baseline modeling effort
69	6.4	20	Andrew Swynenberg	This methodology arrives at hotspots backwards. The HSA calculations should be completed normally, then supplemented with SoVI data so that no damage centers are "missed". SoVI should be a tool to elevate areas that might have lower $ values.	Concur. The Hot Spot has now been changed to use the SoVI to "uplift those areas" that are in need of greater assistance compared to those with a low SoVI score.
70	6.4	20	Andrew Swynenberg	Is this a stated goal of the RBFS?	Clarification. The SoVI is meant to boost areas that suffer more from flood hazard events.
71	6.4	20	Andrew Swynenberg	What about structural?	Clarification. The Hot spot that is overlayed is a a representation of the hot spots that were identified based on the structures within the watershed
72	6.4	20	Garrett Johnson	What is the basis for the 51% threshold? SoVI is a continuous range; a discrete cutoff is likely not appropriate.	Clarification, the SoVI will put an emphasis on those areas that have a score greater than zero.
73	6.4	20	Andrew Swynenberg	Why not keep SoVI on the maps?	Concur. SoVI will not be included in the final exhibit maps
74	7	21	Andrew Swynenberg	Is there a ranking process for HotSpots? Are they measured within HUC10s, within regions, etc.?	Clarification. The Hot Spots are measured between regions by using the HUC10 watersheds as the separating study areas.

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (FNI)	Responses (Torres/Hollaway)
75	7	21	Andrew Swynenberg	Should this all be in a single geodatabase? What about WSE rasters, terrain, etc?	Concur. The shapefiles will now be organized in a geodatabase, one for the results from the model and another for the results from the HSA.
76	7	21	Andrew Swynenberg	What about shapefiles that identify the hotspots?	Concur. Those shapefiles have been added to the deliverables section
77	7	21	Andrew Swynenberg	Is this a single map per HUC10? The examples suggest otherwise. If so, please show a single combined map with examples of where the "Hot Spots" actually are in the watershed. Current examples only present the data.	Concur. The examples show each asset being evaluated for the analysis. The final exhibit in the appendix will show the combined map of with all examples together.
78	7	21	Andrew Swynenberg	More guidance on the HSA report should be provided, with outlines of sections, summary tables, etc. See submittal and review process of the Baseline Conditions SOP as a reference. This final product should be consistent across all RBFS regions.	Concur. The HSA will now reflect more guidance on the submittal process.
79	7	21	Andrew Swynenberg	What's the relevance of rainfall region?	Clarification. The rainfall region is not needed and has been removed from the deliverables section
80	7	21	Andrew Swynenberg	Why is this needed?	Concur. It is not needed and has been removed.

Comment No:	Report Section:	Report Page:	Reviewer	Reviewer Comments (Halff)	Responses (Torres/Hollaway)
1	1.2	4	Saumya "Sam" Sarkar	We have found that the USGS HUC 10 and HUC 12 boundaries in the LRGV are not quite right. It would be nice to have flexibility in the spatial units by which the hot spot analyses are performed and not tying them specifically to HUC 10 or HUC 12 boundaries.	Clarification. In order to keep consistency across all regions, using the HUC 10 or HUC 12 watersheds would be ideal to compare projects within the same region and be able to decide which to move further into the alternative analysis.
2	3.1	6	Saumya "Sam" Sarkar	The baseline modeling SOP does not recommend any "cleanup" of the WSE or depth rasters. When producing hazard maps we generally perform cleanup of the hazard rasters (eliminating isolated islands, using a depth-cutoff threshold, etc). Assessment using "raw" outputs from the Hec-RAS models may show more areas at risk. Are the regional vendors suggested to exercise their own judgement with regard to cleanup of maps prior to use in risk assessment?	Clarification.According to the biweekly meetings, the WSE and depth grid cleanup is meant to get rid of the values that are miniscule such as anything less than 0.1ft to not be considered flooded. Also, the cleanup of the data is conducted
3	3.2.1	6	Saumya "Sam" Sarkar	Using centroids may exclude structures at the edges of the floodplains. Recommend a 2-step analysis wherein intersect is first done at the parcel level. Building footprints in the intersecting parcels ae subsequently intersected with the floodplain to determine the structures intersecting. Screening based on parcels is expected to reduce computational burden since the parcel dataset is likely smaller than the buildings dataset.	Clarification. Due to the data not being accurately available across all regions, the centroids of the structures will be utilized to keep the methodology consistent across the different regions.
4	3.2.1	6	Saumya "Sam" Sarkar	Assuming that this is referring to the TWDBs building footprints layer by flood planning regions. https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/fb15d02ff1864017bc066c6570f82403	Concur. However, the building footprint data will no longer be utlized for the Hot Spot Analysis.
5	3.2.4	7	Saumya "Sam" Sarkar	Should there be a way to quantify the severity based on depth and duration of flooding, and road type/functionality (interstate, state, etc.)	Clarification. The Hot Spot Analysis is meant to be conducted as a quick analysis, therefore, taking the conservative approach of determining flooded roadways seems best to identify for this asset.
6	3.2.7	7	Saumya "Sam" Sarkar	We may want to consider duration of inundation and seasonality in addition to WSE/depth.	Clarification. At the moment, the duration has not been included in the analysis due to the insufficient data to appply a general rule for both the duration and seasonality across all the different crop types.
7	4.1.2.3	9	Saumya "Sam" Sarkar	The HEC appears to have a more comprehensive procedure for computation of agricultural damages that accounts for seasonality (and growth stage) and duration of flooding. https://www.hec.usace.army.mil/confluence/agdocs/agriculture-damage-computation-proceedures-43820820.html	Clarification. At the moment, the duration has not been included in the analysis due to the insufficient data to appply a general rule for both the duration and seasonality across all the different crop types. In addition, the HEC-RAS link includes using the crop value in the calculation. According to the biweekly meetings, crop value would be excluded from the damages calculation due to the bias that would be created with those higher valued crops.
8	4.1.2.3	9	Saumya "Sam" Sarkar	What is the source of the risk formula?	Clarification. The risk formula has been removed. Instead, a discussion of the agricultural damages calculation has now been added to this section.
9	6.1	11	Saumya "Sam" Sarkar	Should the structural damages be normalized?	Concur. The Hot Spot Analysis now uses a different hot spot identifier tool that will focus more on the clusters of structures instead of the value of structures.
10	6.1	11	Saumya "Sam" Sarkar	Interpolation will assign values to areas that don't have structures. I assume that the raster will mostly serve as a visual aid?	Clarification. The new Hot Spot identifier tool will focus more on the clusters of structures than the value of said structures.
11	6.2	14	Saumya "Sam" Sarkar	Perhaps need a metric that scales the damages based on roadway type, disruption, etc.?	Clarification. The roadway damages calculation is meant to take a conservative approach on determining what roadways are damaged.

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12	6.3	17	Saumya "Sam" Sarkar	Perhaps adding duration of inundation into the assessment will scale damages spatially.	Clarification. At the moment, the duration has not been included in the analysis due to the insufficient data to appply a general rule for both the duration and seasonality across all the different crop types. Torres ill conduct further research to determine if the duration factor may be added during the 100% Hot Spot Analysis Submittal.

RIVER BASIN FLOOD STUDY REVIEWER

GLO RBFS

Study Vendor Name:	DCCM RBFS Reviewer
Deliverable Name:	SOP For Hot Spot Analysis
Contract Number:	GLO CONTRACT NO. 23-122-000-D964
Project Phase/Task:	75% Submittal Report
Date Received:	1/17/2024
Reviewed by:	DCCM RBFS Reviewer
Technical Approval Date:	
Program Approval Date:	
GLO Approval Date:	

Comment No.	Report Section:	Report Page:	Reviewer	COMMENT	EDITORIAL /RECOMMENDED /MANDITORY	HOW ADDRESSED BY VENDOR	BACKCHECK BY USACE	HOW ADDRESSED BY VENDOR2
1	List of Figures	3	DCCM	No reference of watershed names made in the document.	Editorial	Clarification. Because this document is meant to serve as a standard operating procedure and is not intended to spectifically document any single watershed. The content of the report refers to the item in the process being exemplified in the figures.		
2	1.2	4	DCCM	Section 1.2, Line 2: "HUC10" Please include a full form here before providing an abbreviation.	Editorial	Concur. Clarification of HUC full form provided.		
3	1.2	4	DCCM	Section 1.2, Line 4: "...tailored to each region's natural and built environments is the "essence" of this SOP." After reading the document, it was unclear which natural or built conditions in each region were given special attention. Please clarify with examples.	Editorial	Clarification. The sentence has be reworded for clarification, since the intent of the document was not to create an exhaustive list of each specific regional environment, but instead to be versatile enough to give general guidance which can be reasonably refined to suit a specific watershed. It is up to the engineers judgememt after becoming more familiar with the minutiae of said watershed after studing it, how to taylor this guidance to suit an individual region based on the exisitng data and regional context.		
4	1.2	4	DCCM	Section 1.2, Paragraph 3. Define stream level analysis in Section 2. The scope is mostly watershed level 2D.	Editorial	Concur. Clarification added to this sentence to describe the smaller analyses intended.		
5	2	4	DCCM	If definitions were taken from external sources, consider including citations/references for 6 definitions (section 2.1 through 2.6).	Editorial	Respectfuly Disagree. The terms have their fundamental origins in FEMA risk training but have been embellished in order to highlight important distinctions among the terms for this application. These definitions are a compilation of many sources and were included in order to clarify and offer structure to the use of the concepts. This section seeks to offer the Regions a unified approach to the lexicon of risk.		
6	2.4	5	DCCM	Section 2.4, Line 4: "judged" Consider changing the word to 'categorized' as Figure 1 is one of the many ways users can group risk for outcome from any hazard.	Editorial	Concur. The suggested editorial change has been updated in the report.		
7	Figure 1	5	DCCM	There is no reference of risk matrix in the remaining document. How are we utilizing the risk matrix in our hot spot analysis?	Recommended	Concur. The risk matrix figure has been updated for clarity to support the definition of risk by displaying the relationship between the consequences and probability. The categorizations that were previously in the figure have been removed since there were no references to the scoring system previously shown in the matrix.		
8	2.4.1	5	DCCM	Section 2.4.1 Title. Consider changing "Chances" word to 'Probability'	Editorial	Concur. Recommended rewording incorperated.		
9	2.4.1	5	DCCM	Rewrite the first few sentences in Section 2.4.1. e.g., For this study the probabilities of hazards occurrences are measured in terms of annual exceedance probabilities (AEP). For example, the 1-percent AEP flood has a 1 in 100 chance of being equaled or exceeded in any 1 year. Watershed response (i.e., rainfall-runoff) will be simulated in hydrologic and hydraulic (H&H) modelling. Joint probability analyses from bivariate evaluations of compound flooding (i.e., rainfall-runoff plus storm surge) will applied based upon the location of a watershed.	Editorial	Concur. Paragraph re-worded for claraficiation		
10	2.4.1	5	DCCM	Section 2.4.1, Line 5: "Annual Exceedance Probability" Delete, as AEP is already abbreviated in the previous sentence.	Editorial	Concur. Extra mention of "annual exceedence probability" removed.		
11	2.4.2	5	DCCM	Section 2.4.2, Line 4: "overlays" Change it to "exposure".	Editorial	Concur. The suggested change has been updated in the report.		
12	2.4.2	5	DCCM	Section 2.4.2, Line 4: "compared" consider changing it to "analyzed".	Editorial	Concur. The suggested change has been updated in the report.		
13	2.4.2	5	DCCM	Section 2.4.2, Line 5: "describe" consider changing it to "measure" or "estimate".	Editorial	Concur. The suggested change has been updated in the report.		

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14	2.5	5	DCCM	Section 2.5 Line 5. Please include reference(s)/citation(s) to validate this statement.	Editorial	Clarification. Reference to the GLO definition of the SoVI added.		
15	2	6	DCCM	LMI has been referenced in the report. In Section 2 Please add definition for LMI as well.	Editorial	Concur. Definition for LMI is referenced here, however since SoVI is the focus of this document, references to LMI have been removed everywhere but in this section.		
16	3.1	6	DCCM	Section 3.1, Line 5: "LiDAR for subsequent use..." Suggested to add at the end of sentence "to estimate exposure".	Editorial	Concur. The suggested change has been updated in the report.		
17	3.2.1	6	DCCM	Section 3.2.1, Paragraph 1, Line 3: "centroids" Using centroids may result in excluding structures at the edges of the floodplains. Utilize building footprint or parcel data to evaluate flooded structures.	Mandatory	Clarification. While in Harris County, the structure footprints are available, this is not the case for all regions. Addtionally, the structure inventory which contains the details such as value and FFE natively is in point format as an estimated centroid of the structure, making it preferable to handle in this format. For this hot spot analysis, this level of detail should accomplish the intended goal to highlight high flood risk areas.		
18	3.2.1	6	DCCM	Section 3.2.1, Paragraph 1, Line 3: "fall within floodplain of interest" Suggest to change - "are exposed to hazards estimated from modeled AEP events".	Recommended	Concur. Sentence updated for clarity		
19	3.2.1	6	DCCM	Section 3.2.1, Paragraph 2, Line 1: "adjustment factor of 0.5 ft to the LiDAR data" FFE data is a key metric for evaluating flooded structures and defining damage costs. Often 0.5 ft assumption doesn't yield correct results in residential buildings (old versus new), commercial areas & buildings with basements. Recommendation is that the flooded restructures should be compared with flood loss data and then adjustments to FFE made as deemed necessary. We understand that we are doing the analyses at HUC level, some sort of limited verification to FFE should be done.	Mandatory	Clarification. The section mentions the use of FFE data from TWDB if available, and suggests the structure height estimation when there is no reliable data available. The intent of the HSA SOP has been to create consistent guidelines that still allow for the flexibilty of the regions to address the variation in data and environments. In meetings with GLO (May 16th), it was agreed that 0.5-ft is would be the standard assumption in lieu of reliable data for the SOP in general based on minimum slab thickness requirements. Additionally, in response to the comments from the other regions, there is a want to have as much consistency across regions as is reasonable. With the variation of FFE available it was agreed that a simplified method would be sufficient for this level of analysis.		
20	3.2.1	6	DCCM	Section 3.2.1, Paragraph 2, Line 3: "general rule" If a rule can it be defended with a citation? If it is a practice or assumption for this project then clarify it.	Editorial	Clarification. The assumption has been clarified in the text as a general assumption specific to the SOP based on minimum slab thickness for foundations requirements.		
21	3.2.1	6	DCCM	Section 3.2.1, Paragraph 2, Line 5: "...FFE data..." Several structures in coastal areas or repetitive flooding areas are already elevated on piers. Include details on evaluating FFE of structures that have been elevated.	Recommended	Concur. A sentence was added to clarifiy that best engineering judgement may be required for coastal areas where the FFE data is not available. The intention for this document is to provide overall processes for the SOP, but does not have an exhaustive list of scenarios. Therefore, the SOP must be broad enough to allow enginneers to use their judgement when evaluating these data.		
22	3.2.2	6	DCCM	Section 3.2.2, Line 1: "depth" change it to "WSE", as comparisons between FFE and depth is not direct	Editorial	Concur. Depth changed to WSE		
23	3.2.2	6	DCCM	Section 3.2.2, Line 1: "selected event" suggest changing it to "modeled hazard at and around the structure"	Editorial	Concur. Paragraph revised		
24	3.2.2	6	DCCM	Section 3.2.2, Line 2: "The number of flooded structures" Consider changing - "A count of impacted structures at various flood depths"	Editorial	Concur. Paragraph revised		
25	3.2.2	6	DCCM	Section 3.2.2, Line 4: "resulting outputs." Add: "and the structure FFE?"	Editorial	Concur. Paragraph revised		
26	3.2.3	7	DCCM	No discussion of damage assessment to critical infrastructure has been done in hot spot analysis.	Recommended	Concur. This document does not contain a method for analyizing critical infrastructure which may be at high risk except to identify these assets specifically, since some areas may want to prioritize critical infrastructure		
27	3.2.5	7	DCCM	Social vulnerability (SV) is resiliency of communities when confronted with hazards. It is suggested to use CDC's definition of SV.	Recommended	Concur. Definition updated in this section, however the GLO definition and metric is used for this analysis.		

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28	4	8	DCCM	The procedures prescribed seem to measure direct damage to buildings, roads, and crops. It, however, does not account for indirect economic damages arising from road closures, health/safety issues, displaced population, sheltering etc. This I guess is okay as-long-as we understand the measuring scales/methods and apply it uniformly. Most important would-be community /stakeholder feedback. The process does not seem to involve communities to their say in the process.	Recommended	Concur. The Hot Spot SOP ("SOP") is a set of regional planning-level guidelines for identifying likely areas of flood vulnerability that can be advanced into Alternatives Analysis. Ultimately, the hot spots identified using the SOP analysis procedures are a guide for allowing flood vulnerabilities to be mapped. To that end, regions are encouraged to exercise discretion and supplement results from the Hot Spot SOP based on each regions' respective knowledge of the local communities, stakeholder engagement, flood hazards, available data, or similar information.		
29	4.1.1	8	DCCM	Section 4.1.1, Line 2: "[USACE] depth-damage curves" Include a reference	Editorial	Concur. However, section removed for so the recommended methodology is clear.		
30	4.1.1	8	DCCM	Section 4.1.1, Line 8: "NSI" Include a reference	Editorial	Concur. Link is included in section 3.2.1.		
31	4.1.1.1	8	DCCM	Provide a more clearer rationale behind the choice of assuming 100% damage for each flooding instance. Consider using damage grids or structure flooding depths. This can be also achieved by including guidance on calculating and weighting damage to critical infrastructure.	Recommended	Clarficiation was added to this section. This section specifically does not include the depth-damage curves as a simplified method that supports a rapid assessment, which is serving as a proxy for the full damage calculation at this stage. Detailed damages can be preformed for the Alternative analysis once high-risk areas are established and detailed modeling is performed.		
32	4.1.1.2	8	DCCM	Section 4.1.1.2, Line 1: "USACE or FEMA" Include a reference	Editorial	Concur. Reference to USACE depth-damage curves removed.		
33	4.1.1.2	8	DCCM	Section 4.1.1.2,Paragraph 2, Line 1: "The calculation of ..." Add word: "example" after "The"	Editorial	Concur. However, section removed for so the recommended methodology is clear.		
34	4.1.1.2	8	DCCM	Section 4.1.1.2,Paragraph 2, Line 1: "Aggregated ..." Add: "Table 1 shows that the" before the text.	Editorial	Concur. However, section removed for so the recommended methodology is clear.		
35	Table 1	9	DCCM	It would be beneficial to clarify how the values in the table were derived rather than showing an example calculation	Recommended	Concur. Table matrix and description have been updated for clarity.		
36	4.1.1.3	9	DCCM	Section 4.1.1.3, Line 7 Not all the undeveloped land is being used for agricultural purposes. Exclude developed land & non-agricultural land.	Recommended	Concur. Paragraph reworded for clarity, a sentence was added to clarify that the undeveloped land is not considered agricultural.		
37	5.1	10	DCCM	Section 5.1, Line 2: "Baseline H&H Maps" Revise "Baseline H&H maps to "baseline flood spatial data".	Editorial	Concur. Sentence updated.		
38	5.1	10	DCCM	Section 5.1, Paragraph 2, Line 1: "The Hot Spots will then…" Analyze hot spots with the flood loss data.	Recommended	Clarification added to this sentence.		
39	5.1	10	DCCM	Section 5.1, Paragraph 3, Line 1: "The data will be clipped…" Clipped to what? Watershed Boundary or inundation map. The language in section 5.1 is vague. Be specific.	Recommended	Concur. Sentence updated.		
40	5.1	10	DCCM	Section 5.1, Paragraph 4, Line 1. Remove: "The following chart", Add: "Figure 2"	Editorial	Concur. Sentence updated.		
41	6	11	DCCM	Section 6, Paragraph 1 Shouldn't identification of regional hot spots (Section 5) be after the hot spot analysis methodology (Section 6)?	Recommended	Clarification. This section contains the overall process as an outline to show how each of the steps detailed in section 6 are put together. The section names for 5 & 6 have been amended to reflect this.		
42	6.2	14	DCCM	Section 6.2, Point 4. At this step (with binary raster) weir depth information is lost which makes me feel that road overtopping depths are not being considered to estimate damages.	Mandatory	Respectfully Disagree. For both agricultural impacts and roadway impacts, we are only recommending calculating the flood exposure instead of the damages (i.e., concequences) of the flooded structures. The terms have been updated in these sections to clarify the difference. The roadway polyline shapefile used is along the centerline of the roads, which, in most cases, can be assumed to be the crest, the highest point in the road. If the flood depth is 6 inches above the crest of the road , it is assumed that the lower edges of the roadway will be experiencing flood depths of 1-ft or greater, depending on the road, which effectively makes the road impassable, i.e., the point that impacts mobility. Any depth higher than 0.5-ft would have the same impact on mobility, so using the binary dichotomy of a greater/lesser than 0.5-ft depth raster/polygon would be an effective threshold for highlighting areas of reduced mobility.		

Comment No.	Report Section:	Report Page:	Reviewer	COMMENT	EDITORIAL /RECOMMENDED /MANDITORY	HOW ADDRESSED BY VENDOR	BACKCHECK BY USACE	HOW ADDRESSED BY VENDOR2
43	6.2	14	DCCM	Further, all road type (Interstate, State Highways, County, City and private roads) are given equal weighting in calculating miles. If this is the project scope then should be clearly stated, otherwise it is suggested to consider road types in calculations.	Recommended	Respectfully Disagree. Considering all road types with the same weighting should be sufficient for this level of analysis.		
44	6.3	17	DCCM	Section 6.3, Point 4. Again at this step (with binary raster) depth of flooding data is lost and all inundation areas are treated the same. I feel higher depths in agricultural areas be given higher priorities.	Mandatory	Respectfully Disagree. The duration of inndation would have more impact on the level of damage. However, for this level of analysis the 1-ft depth was considered sufficient to highlight areas at risk of damage due to flooding.		
45	6.3	17	DCCM	Please discuss the source of the fixed threshold of 1-ft inundation for agricultural damage calculations. The duration of flooding may need to be considered especially for agricultural damage. Also encourage exploring alternative analyses, possibly incorporating a more detailed analysis to ensure accuracy in pinpointing areas of greatest agricultural damage.	Recommended	Respectfully Disagree. It was determined for simplicity and limited budget/time constaints this level of analysis considered sufficient to highlight agricultural at-risk of damage due to flooding.		
46	6.4	20	DCCM	Section 6.4, Point 5. Since the process involves visual reviews, we need to double check if subjectivity can be inadvertently induced in the process listed in these steps. What's our confidence level that 2 or more independent analysts will end up recommending the same Phase 4 areas to the region?	Recommended	Respectfully Disagree. It was agreed for simplicity and limited budget/time constaints, this level of analysis is considered sufficient to highlight high flood risk areas even with some variability. The is only to identify areas, which should be accomplished using these guidelines, but more detailed analysis in these areas will be conducted in Phase 4 for project selection.		
47	6.4	20	DCCM	Section 6.4, Points 6 and 7. SoVI values range between 0 and 1, with 0 representing lowest vulnerability and 1 representing highest vulnerability. All areas will have a SoVI greater than zero. Hot spots should be located with an SoVI score of 0.51? Please clarify.	Recommended	Clarification. All hot spots will be included, however special note should be taken if a hot spot intersects with an area that has an SoVI of 0 (above 50% of the population) or higher, since this likely could justify a project in this area to obtain grant funding. SoVI has a different rating than the LMI and values can range any where from -14 to 14. The data set has a mean of 0 for Texas, therefore any thing over 1 would be considered higher than 50% of the population (similar to that of using a 51% or higher for LMI). Section 3.2.5 has been updated with this information for clarity. Addtionally, some steps in this section have been clarified.		
48	7	21	DCCM	Section 7, Point 3. LMI data was not used for the hot spot analysis	Editorial	Concur. LMI was replaced by SoVI for consistency. The SoVI uses the LMI as one of the variables to determine SoVI.		
49	8	22	DCCM	Please also add: Appendix A-4: Sample workflow and diagrams for Baseline Conditions Identify Hot Spots with GLO SoVI	Editorial	Clarification. This step only requires adding the GLO SoVI data set, the SoVI is already exisitng and would not need a workflow. A link to the SoVI used in this step was added to section 3.2.5 for clarification.		
50	8	37	DCCM	Appendix C Keep the Appendix heading shown in Page 37 similar to the heading in Page 22.	Editorial	Concur. Headers for all appedicies updated for continuity.		
51	8	38	DCCM	Appendix C This summary matrix shown in Page 38 is for what watershed?	Editorial	Clarification. The Appendix C will be updated with the watershed identifier for continuity.		