Guidance for Flood Risk Analysis and Mapping

Flood Risk Database

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May 2014

FEMA

This guidance document supports effective and efficient implementation of flood risk analysis and mapping standards codified in the Federal Insurance and Mitigation Administration Policy FP 204-07801.

For more information, please visit the Federal Emergency Management Agency (FEMA) Guidelines and Standards for Flood Risk Analysis and Mapping webpage (http://www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping), which explains the policy, related guidance, technical references, and other information about the guidelines and standards process.

Nothing in this guidance document is mandatory other than standards codified separately in the aforementioned Policy. Alternate approaches that comply with FEMA standards that effectively and efficiently support program objectives are also acceptable.

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Document History

Affected Section or Subsection	Date	Description
First Publication	May 2014	Initial version of new transformed guidance. The content was derived from the *Guidelines and Specifications for Flood Hazard Mapping Partners*, Procedure Memoranda, and/or Operating Guidance documents. It has been reorganized and is being published separately from the standards.

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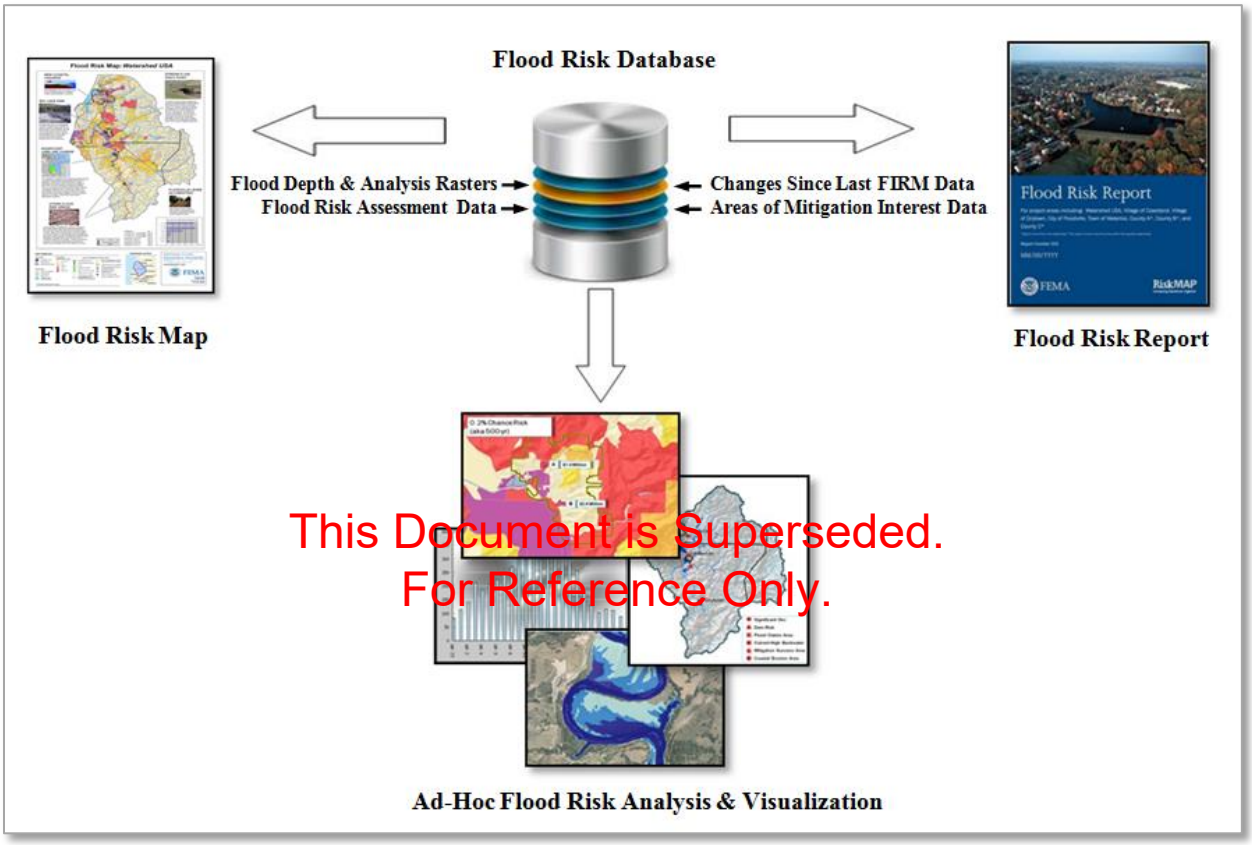
1.0 Overview

The Flood Risk Database (FRD) provides a standard, systematic method for FEMA to collect, store, and distribute comprehensive flood risk data to the public and others in a digital format. The FRD contains geospatial data layers, attribute lookup tables, supporting files, and other information necessary to create all the non-regulatory flood risk datasets t as well as the Flood Risk Report (FRR) and the Flood Risk Map (FRM) (see Figure 1).

Figure 1: Flood Risk Database-centric Products and Analysis



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The technical specifications and database schema of the FRD are outlined in the *Flood Risk Database Technical Reference*. The FRD deliverable formatting requirements are also specified in the *Data Capture Technical Reference*. It should be noted, though, that as long as the required formats are delivered, other formats of the data within the FRD can also be delivered to the community and end user if deemed valuable. For example, a Keyhole Markup Language (KML) file of the Changes Since Last FIRM (CSLF) dataset could be produced and delivered to the community who prefers to use Google Earth to view their data. Database tables could also be augmented with additional fields or aliases, provided that the required attributes are populated and the database schema is otherwise adhered to and documentation is provided to explain the additions. Acceptable documentation can be included in the required FRD metadata file or provided in a companion narrative. However, users should not change or make edits to the approved FRD fields or underlying attribute domains.

2.0 Data Accuracy and Integrity

In many cases, the core spatial data compiled for the FRD is derived from other FEMA datasets (e.g., the S_CSLF_Ar feature class is derived from the S_Fld_Haz_Ar feature class from the National Flood Hazard Layer (NFHL) and new Flood Insurance Rate Map (FIRM) databases, the S_FRD_Pol_Ar feature class is derived from the S_Pol_Ar feature class in the FIRM database, etc.). These FEMA datasets should have been compiled to FEMA specifications as described in the *FIRM Database Technical Reference* and other *FIRM Database Guidance*. In this regard, the flood risk datasets should inherit much of the quality and integrity with which their parent datasets were created.

The assigned Mapping Partner should perform a thorough Quality Control (QC) review before submitting data to FEMA, following the *Quality Management Guidance* specific to the non-regulatory products.

3.0 FRD Spatial Extents and Data Tiling

The S_FRD_Proj_Ar feature class in the FRD defines the extents of the project footprint, and also defines the geographic coverage of its companion FRR and FRM. The single "best" polygon that reflects the project area should be used. Generally, the project footprint will be defined at the Hydrologic Unit Code 8, or HUC-8, watershed level. However, there may be cases where the project area covers portions of multiple HUC-8 sub-basins, or only a portion of a single HUC-8. In each case, the project area should encompass all work elements as defined in the Statement of Work (SOW), Mapping Activity Statement (MAS), or Inter-Agency Agreement (IAA) and for which a Case Number has been assigned by FEMA. In the event that a Flood Risk Project is scoped to cover multiple HUC-8 watersheds (such as for coastal projects), the Project Team, as an outcome of the Discovery process, should determine if the project will be delivered as:

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1. A single suite of non-regulatory products for the entire project extents (i.e. a single FRD, FRR, and FRM), or

2. Multiple suites of products (i.e., an FRD, FRR, and FRM) that comprise the full project area. In this scenario, there would normally be a separate suite of products for each HUC-8, but there could be circumstances where this is not practical.

If the project footprint is not able to be defined at a watershed level, it is recommended that the project footprint align with Flood Insurance Rate Map (FIRM) panel boundaries to the extent possible, as shown in Figure 2, Figure 3, and Figure 4.

Guidance specific to the Changes Since Last FIRM (CSLF), Flood Depth and Analysis Grids, Flood Risk Assessments, and Areas of Mitigation Interest (AoMI) datasets, as it relates to the spatial extents of the data delivered in the FRD, should be referenced when producing each dataset. As a general rule, feature classes and associated tables should be delivered as single, complete layers at the project footprint level, rather than tiling them at a county, FIRM panel, or other tiling scheme level within the database. For example, the FRD for a watershed that covers portions of six counties should have only one CSLF layer (S_CSLF_Ar) covering all the changes within the watershed, rather than one separate S_CSLF_Ar data layer for each county. There should also only be one riverine 1% annual chance depth grid in the FRD, rather than separate depth grids for each flooding source.

Figure 2: Watershed-based FRD Project Area

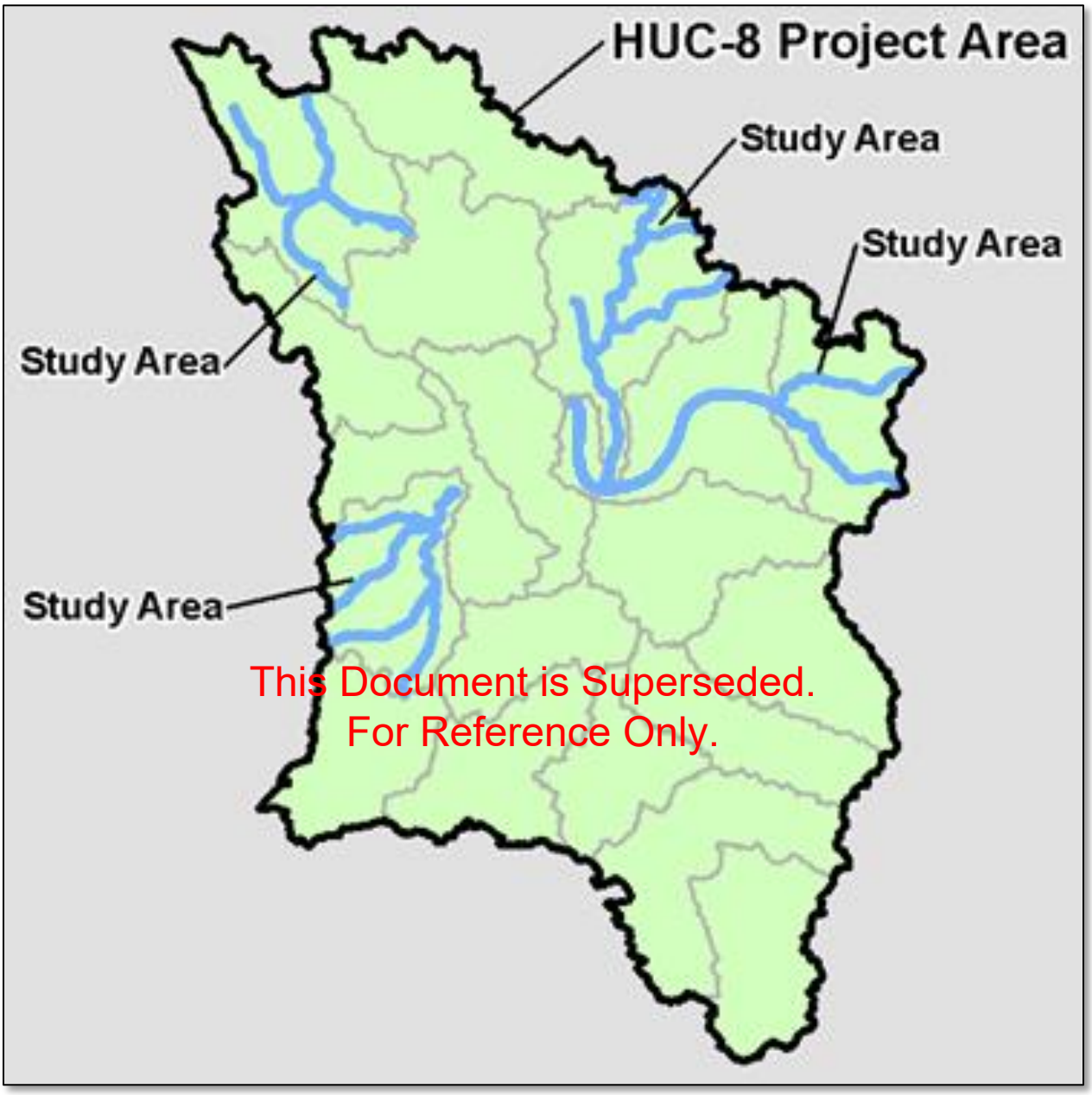

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Figure 3: Coastal FRD Project Area

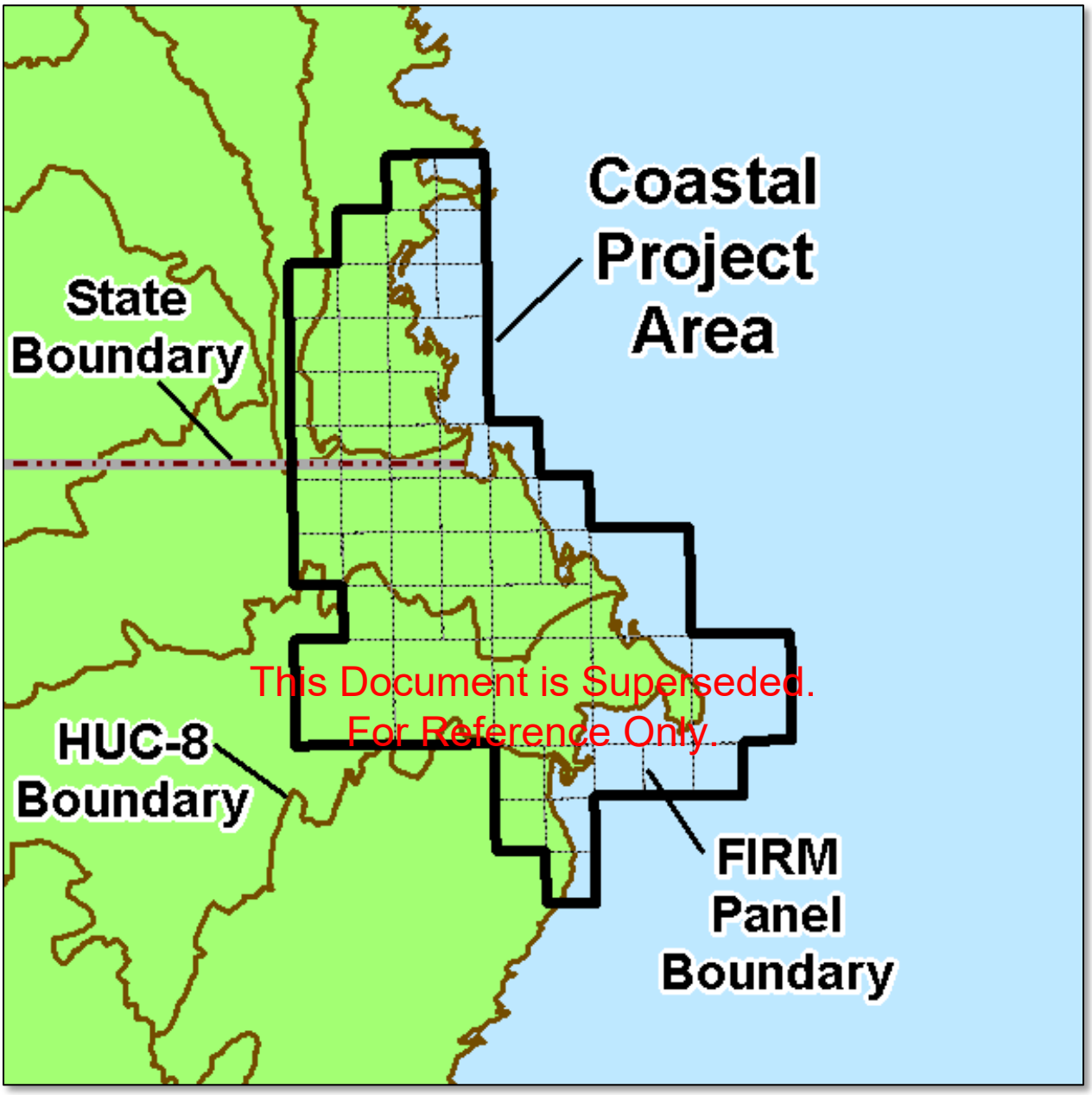

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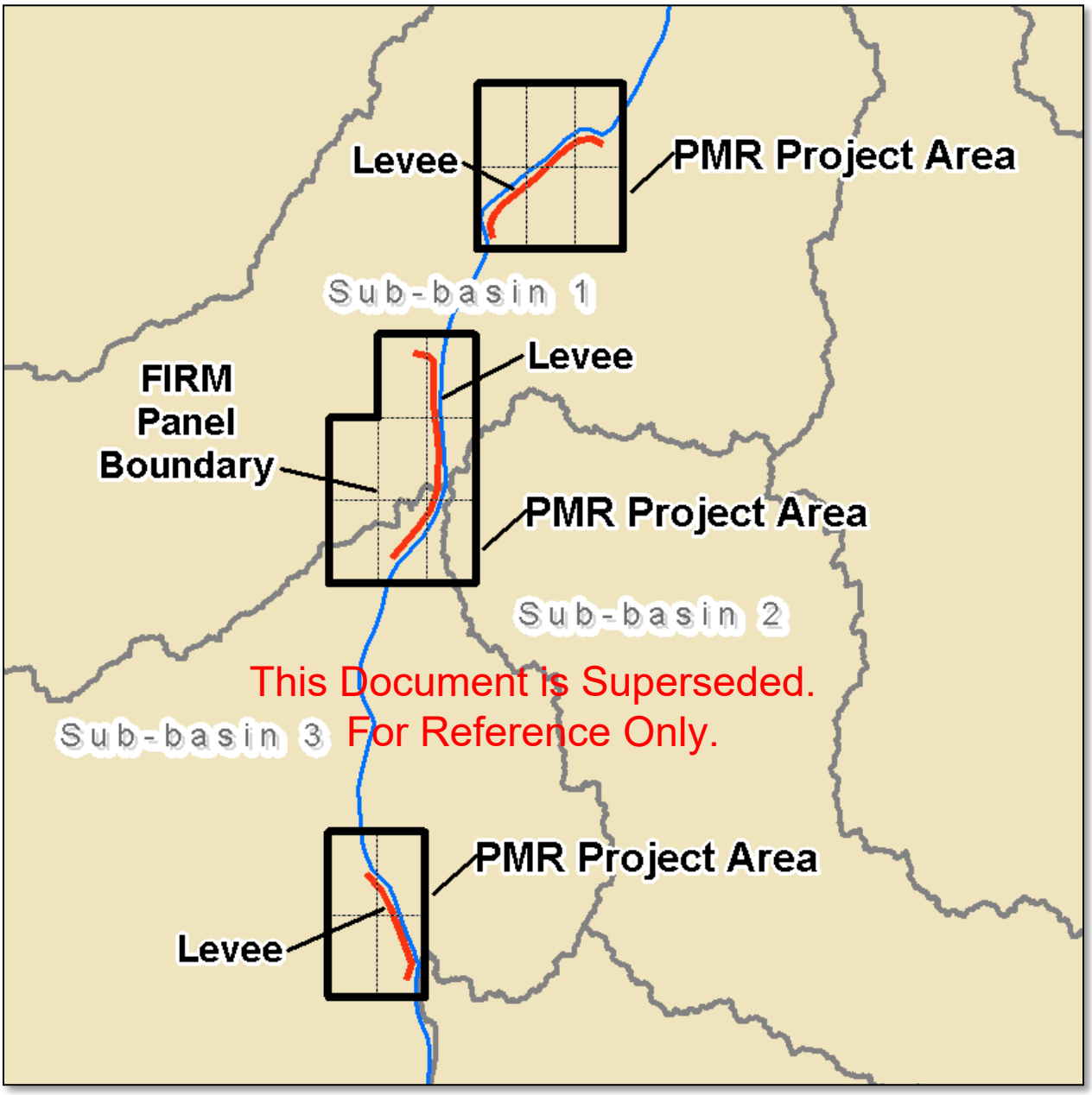
Figure 4: Example Levee FRD Project Areas



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The following contains examples of the types of project footprints that could be produced and general guidance specific to each.

3.1 Watershed Project Areas

Flood Risk Projects defined at the watershed level may have a majority of its streams studied, or may only have certain identified areas within the watershed scoped for study, as shown in Figure 2. Certain datasets, such as CSLF and Depth Grids, are typically only produced where new or updated studies have been performed. Other datasets, such as Flood Risk Assessments and AoMI, are often available for areas beyond those that are studied. As an outcome of the Discovery process, it is important to clarify the extents of each dataset to be produced.

For watershed level Flood Risk Projects, the Watershed Boundary Dataset (WBD), which is a companion dataset to the National Hydrography Dataset (NHD), should be the source for the S_FRD_Proj_Ar layer in the FRD.

Naming convention for the FRD should follow the guidance outlined in the *Data Capture Technical Reference*.

3.2 Coastal Project Areas

Coastal Flood Risk Project extents rarely align with watershed boundaries. Therefore, a few options exist for how the project footprint can be defined. It is important to remember that the extents of the FRR and FRM should align to the same footprint as the FRD. For coastal Flood Risk Projects, the FRD project footprint should generally also not extend inland beyond the coastal-influenced areas, unless riverine flooding sources have also been studied and are part of the project. There are several acceptable options for defining the footprint of coastal Flood Risk Projects.

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Option 1: As shown in Figure 3, define the project footprint to cover the entire coastal study area. In these cases it is recommended that the project area be generated to align with FIRM panel boundaries if possible.

Option 2: Since coastal studies often cover a large geographic area, it may be appropriate to sub-divide the overall project area into smaller project footprints, and to produce a representative FRD, FRR, and FRM for each. This could be done at a county level, multi-county level, or other logical break. To the extent possible, however, the project footprint should still be aligned with FIRM panel boundaries. Overlapping FRD project footprints should be avoided.

Option 3: Within the overall coastal project area, an FRD for each affected HUC-8 watershed can be produced. Since coastal flooding does not terminate at watershed boundaries, this may be easiest to do by generating all of the associated flood risk datasets for the entire study area, and then clipping them to the HUC-8 watershed boundaries prior to finalizing the FRD.

3.3 Other Project Areas

Some types of Flood Risk Projects may not lend themselves well to being generated at the watershed level. Certain Physical Map Revisions (PMRs), such as ones that involve addressing levees, may fall into this category. If not part of a larger watershed project, a Flood Risk Project focused solely on addressing one or more levees may be more appropriate to have its project footprint defined around the levee-impacted area, as shown in Figure 4. The project footprint

should align to the FIRM panel boundaries affected. If there are multiple, disconnected levee systems within the project area, as Figure 4 also shows, it is acceptable to have a multi-part polygon stored in S_FRD_Proj_Ar and used as the project footprint to cover all the affected areas.

3.4 Updates and Maintenance

To the extent possible, once an FRD has been produced for a HUC-8 watershed, all subsequent Flood Risk Projects within that watershed should append, replace, and/or revise the data within that FRD, and ultimately redeliver the FRD at the HUC-8 extent. The flood risk datasets corresponding to the revised areas should be compared against the existing data in the FRD from the surrounding unrevised areas for reasonability and agreement. Since many of the non-regulatory datasets are derived from the regulatory information, it could reasonably be expected, for example, that updated Water Surface Elevation (WSEL) grids for revised flooding sources should tie-in with previously produced WSEL grids on adjacent reaches of stream, following the same tie-in checks that one might employ for the regulatory data. However, depending on the date and type of topographic data used for the revised studies, the depth grids, for example, may not tie-in at the same level of precision as their associated WSEL grids.

4.0 Required vs. Enhanced Datasets, Tables and Fields

The FRD was designed to house various required and enhanced non-regulatory flood risk datasets that could be produced for riverine or coastal studies, as well as those enhanced datasets specific to areas affected by dams or levees. The Standards for Flood Risk Analysis and Mapping enumerate the flood risk datasets that must be produced as part of each Flood Risk Project. Most of the non-regulatory datasets and products consist of multiple feature classes and tables in the FRD. For example, the Areas of Mitigation Interest dataset is made up of the S_AOMI_Pt and L_AOMI_Summary tables. The Flood Risk Assessment dataset involves the population of multiple tables, such as S_CenBlk_Ar, L_RA_AAL, L_RA_Composite, etc. Several summary tables are also used to populate the Flood Risk Report (L_RA_Summary, L_AOMI_Summary, L_CSLF_Summary, etc.) The *Flood Risk Database Technical Reference* specifies when each feature class and raster is required to be created, vs. which ones are enhanced. The Technical Reference also indicates specific data fields designated as enhanced. The FRD Data Model poster provides additional guidance and illustration showing how the various FRD tables are interrelated with one another. Enhanced tables are marked with an [E] in the FRD poster.

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5.0 Table-Specific Guidance

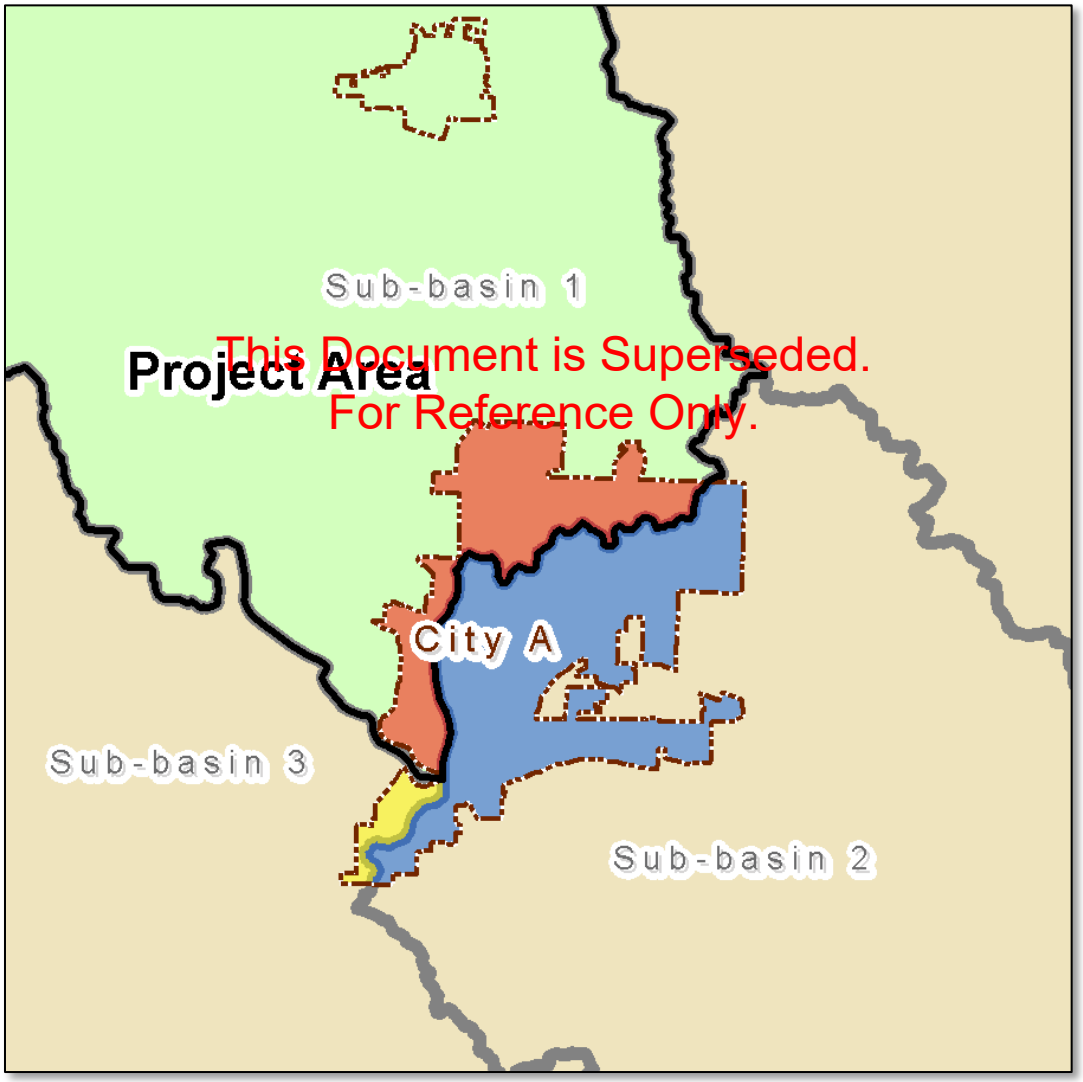
The respective guidance documents for each of the non-regulatory datasets and products (CSLF, AOMI, Flood Risk Assessments, Depth & Analysis Grids, Coastal-Specific Non-Regulatory Datasets, FRM, FRR, etc.) should be referenced for more specific guidance regarding their applicable FRD tables and elements. However, there are other tables in the FRD that are applicable to the overall database. Guidance specific to those are included below.

5.1 S_FRD_Pol_Ar

This feature class should only contain communities that have summary information presented in Section 3 of the FRR. Other political areas from the S_Pol_Ar layer in FIRM databases (e.g., national parks, military bases, etc.) that are not presented in the FRR, but are desired to be shown on the FRM, should be moved to the S_Carto_Ar feature class. This feature class should be clipped by the S_FRD_Proj_Ar polygon so that no features are present in the FRD outside the project footprint.

In areas where the S_FRD_Pol_Ar feature class is clipped to S_FRD_Proj_Ar (e.g. communities whose corporate limits extend beyond the HUC-8 watershed that defines the project footprint), the attributes of the individual features should be adjusted accordingly. For example, as shown in Figure 5, if a community (City A) is split by a HUC-8 boundary between Sub-basins 1, 2, and 3, the community boundary (dashed polygon) should be clipped at the project footprint boundary (thick black polygon) and the appropriate attributes (POPULATION, LND_AR_SM) in the S_FRD_Pol_Ar feature class reduced a pro-rata amount based on the area removed from the original community boundary. Correct calculation of these attributes is critical to ensure correct summary calculations for the related lookup tables in the FRD (e.g. L_RA_Summary, L_CSLF_Summary). For these multi-watershed communities, if it is desired to display the entire community area on the FRM, the portion of the community's area outside the project footprint should be added as a polygon in S_Carto_Ar.

Figure 5: Example Community Spanning Multiple HUC-8 Watersheds



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This feature class may be used for query and visualization of risk assessment data by community. By joining the various lookup tables (e.g., L_RA_Summary, L_Claims, L_Exposure, L_CSLF_Summary, and L_AOMI_Summary) using the relationship classes, the user can symbolize on many of the fields in these tables by community. For example, the user may want

to display the Average Annual Loss Per Capita (L_RA_Summary: AAL_PERCAP) by community on a map symbolized using a color ramp.

5.2 S_FRD_Proj_Ar

Section 3 of this guidance document provides additional information regarding how this feature class should be defined, depending on the type of Flood Risk Project. This feature is used to clip the extent of spatial data submitted in the FRD, excluding S_CSLF_Ar, S_CenBlk_Ar, the raster datasets, and the cartographic feature classes (S_HUC_Ar, S_Carto_Ar, and S_Carto_Ln.)

5.3 S_HUC_Ar

The boundaries delivered in the S_HUC_Ar feature class should be based on the Watershed Boundary Dataset (WBD) obtained from the United States Geological Survey (USGS) or Natural Resources Conservation Service (NRCS). For watershed-based projects, this polygon should match the S_FRD_Proj_Ar project footprint polygon (see Section 3.1 for more details). The HUC boundaries are shown on the FRM and the project locator on the FRM.

5.4 FRD_Study_Info

This table is used as a lookup table from the FRD_Model_Info table to provide additional information about the projects and where the modeling was performed. It is created by aggregating the Study_Info tables from all current and past FIRM databases in the project area.

5.5 FRR_Custom & FRR_Project

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The custom text fields in the FRR_Custom table (OVERVIEW_1, OVERVIEW_2, CSLF_1, etc.) and FRR_Project table (DATA_USED) are stored as "Blob" types. Within ArcGIS, Blob fields cannot be populated directly. Therefore, while there may be multiple approaches and custom tools that could be utilized to populate the content in these fields, one general approach using ArcGIS involves the following steps:

1. Export the table to an XML document from within ArcCatalog.
2. Populate the content of all fields, including the custom text in the Blob fields, as appropriate. There are various third-party XML editors that can be used for this task.
3. Import the XML file back into the FRD from within ArcCatalog.

Other approaches that accomplish the goal of populating this table may be used. The styles of the text in the Blob fields should match those shown in the FRR template.

5.6 FRR_Images

Each image stored in this table is stored as a "Raster" type. Rasters can be loaded directly into the database froms within ArcGIS by loading each image into the IMG_BINARY field.

5.7 L_Claims

This table is used to provide the claims and repetitive loss data listed for each community in Section 3 of the FRR. For example,

- National Flood Insurance Program (NFIP)-recognized repetitive loss properties = 17 (11 residential and 6 commercial)

- NFIP-recognized severe repetitive loss properties = 4 (residential)

There should be one record in the table for each community or partial community in the project area, and one record for the entire project area. For the table record that refers to the entire project area, the CLAIMS_ID field should be populated with the FEMA Case Number in the same format as the CASE_NO field.

As specified in the standards, it is important to remember that this data is privacy-sensitive. If there are less than five (5) claims, five (5) repetitive loss claims, or five (5) severe repetitive loss claims in a community, then those fields (CLAIMS, CLAIMS_VAL, RLP_RES, RLP_COM, RLV_RES, RLV_COM, and SRL_RES) should be null in this table for that community.

5.8 L_Source_Cit

All spatial tables in the FRD have a SOURCE_CIT field tied to values in the L_Source_Cit lookup table. Each distinct data source should have its own source citation type abbreviation (e.g. BASE1, BASE2, BASE3, etc.)

Since many of the non-regulatory datasets are related to, or partially derived from, data in the FIRM databases, many of the records for the L_Source_Cit table can be compiled from the L_Source_Cit tables in the individual FIRM databases. In order to minimize work by having to sequentially renumber all the SOURCE_CIT values from combining the L_Source_Cit tables from multiple FIRM databases, the Mapping Partner may prefix the SOURCE_CIT from the source FIRM database with the DFIRM_ID to provide a unique identifier.

6.0 Raster Guidance

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Additional guidance can be found within the *Flood Depth & Analysis Grids Guidance* document for each of the following raster datasets:

- CstDpthxxxpct (Coastal Flood Depth Grid)
- Depth_xxxxxx (Riverine Flood Depth Grid)
- DVS_xxxxxxx (Depth times Velocity Flood Severity Grid)
- Pct30yrChance (Percent Chance of Flooding over a 30-year Period Grid)
- PctAnnChance (Percent Annual Chance of Flooding Grid)
- Vel_xxxxxxx (Velocity Grid)
- WSE_xxxxxx (Water Surface Elevation Grid)
- WSE_Change (Water Surface Elevation Change Grid)

Guidance can be found within the *Dam-Specific Non-Regulatory Dataset Guidance* document for each of the following raster datasets:

- Arrv_xxxxxxxx (Dam Release Flood Wave Arrival Time Grid)
- FID_xxxxxxx (Dam Release Flood Inundation Duration Grid)

- Peak_xxxxxxx (Dam Release Flood Wave Time to Peak Grid)

Note that for any raster dataset based on the results of a dam release analysis, the extents should be based on the inundation area for the peak flow rate for the scenario being considered. For example, when developing the arrival time raster, the extents of the raster should be based on the inundation area for the peak flow, not the flow at the initial arrival time.

The *Flood Risk Map Guidance* document contains additional guidance for the following raster dataset:

- Hillshade (FRM Topographic Hillshade)

7.0 Non-Standard Tables and Rasters

As part of a Flood Risk Project, it is possible that additional flood risk datasets may have been produced for which no predefined schema exists in the *Flood Risk Database Technical Reference*. The Flood Risk Database is flexible in that it can be used to store these non-standard, flood risk-related feature classes, tables, and rasters. For example, a riverine erosion risk feature class that had been produced or obtained by a FEMA Region or one of its Mapping Partners could be included in the FRD if including that data would enhance risk communication with local stakeholders. Since no defined schema exists for such a dataset, it is left to the discretion of FEMA and the Mapping Partner to identify the appropriate feature class, table, or raster name for inclusion in the FRD and its associated table attributes, where relevant. For feature classes and tables, a SOURCE_CIT attribute should be defined in order to properly link the dataset with additional information in the metadata. The citation type abbreviations from L_Source_Cit should be used to populate this attribute. Additional dataset information will also be captured in the FRD metadata.

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The *Flood Risk Report Guidance* provides additional details regarding how and where the information about such non-standard datasets should be captured within the FRR.

8.0 Metadata

Only one FRD metadata file is necessary for each Flood Risk Project. The *Metadata Profiles Technical Reference* provides information related to populating the metadata for the Flood Risk Database. Additional FRD-specific metadata guidance is provided below:

8.1 Data Quality Information

Because the FRD uses the Geographic Coordinate System as its spatial reference system for final delivery, the original source and production projection information from which area and length attributes in the FRD were calculated should also be stored in the metadata.

In order to adequately explain the data sources used to perform flood risk assessments, the following information should be properly documented:

- Site-specific flood risk assessments
    - Source of building footprints, parcel centroids, or other points/polygons used to store site-specific data
    - Source of building-specific information (replacement values, finished floor elevations, building occupancy, etc.)

- Census block-based flood risk assessments
    - Version of Hazus used
    - Source of updated General Building Stock data that was incorporated into the risk assessment (if applicable)

8.2 Source Information

If any non-standard feature classes or tables were added to the FRD, its source citation abbreviation should be included and explained in this section.

8.3 Entity and Attribute Information

The Overview Description section should include a list of all FRD feature classes and tables included in the submittal. In this list, those tables without data should be identified.

For each non-standard feature class, table, or raster that has been added to the FRD, an "Entity and Attribute Overview" and "Entity and Attribute Detail Citation" entry should be added to the metadata. The "Entity and Attribute Overview" entry should include the general description of the data and what it communicates. The "Entity and Attribute Detail Citation" entry should describe each attribute of the feature class or table, or for a raster should indicate what the value and units of each grid cell represent.

9.0 Delivery Timeline

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The *Data Capture Technical Reference* provides information regarding the format and naming conventions of the Flood Risk Database. The final FRD, FRR, and FRM are delivered to the Map Service Center (MSC) once they are considered final by the FEMA Regional office. For non-regulatory products that are produced as part of a Flood Risk Project that also includes updates to the regulatory products, the FRD, FRR, and FRM should be submitted to the MSC with the final TSDN, no later than 30 days after the Letter of Final Determination (LFD) date.

In addition to this, the FRD, FRR, and FRM should also be provided to affected communities at other times within the Flood Risk Project lifecycle, so that the communities can use them for various risk communication and mitigation activities. Information regarding the timing of delivery of the FRD to communities is provided below.

9.1 Sharing of Draft Data

The goal of sharing draft non-regulatory products with the community is to encourage proactive, actionable discussions about flood risk and mitigation prior to the release of preliminary FIRMs, and where appropriate, to show the community how to use the data to help identify mitigation opportunities on their own. To accomplish this, the draft FRD should be provided to communities as soon as its datasets are at a point in their development where they can be used to support these focused discussions on flood risk. It is not necessary that all elements of the FRD, FRR, and FRM be populated or complete prior to sharing the data at this stage, as long as the conditions of the product(s) are adequately explained to the community. For example, if doing so would provide value and benefit to the community, it would be acceptable to share the draft FRD with the community, even if the FRR and FRM have not been produced yet. However, in this case, the draft FRR and FRM should be provided to the community as closely as possible to when the FRD was shared with them.

Providing a draft of the non-regulatory products is most effective when presented as part of a meeting with community leaders and stakeholders. For example, the draft Flood Depth and Analysis grids, Areas of Mitigation Interest, and Flood Risk Assessment data could be provided to communities just prior to, or immediately following, a Flood Risk Review Meeting during which specific areas of the community, and the non-regulatory data in those areas, were discussed. Or the draft FRD could be delivered prior to a Resilience Meeting, after having provided examples of how the flood risk data can help identify specific areas within the community that may warrant additional discussions at the Resilience Meeting.

If the CSLF dataset has been created, it should be shared with the affected communities prior to preliminary issuance of any updated FIRMs. Because of the timing of the creation of the CSLF dataset, it may be more appropriate to provide two iterations of the draft FRD to the community:

1. Prior to, or associated with, a Flood Risk Review or Resilience Meeting (without CSLF)

2. Just prior to preliminary issuance of the updated regulatory products (with CSLF)

The draft FRD should be provided to the community in either file geodatabase (fGDB) or shapefile (SHP) format, following the schema outlined in the *Flood Risk Database Technical Reference*. However, if providing the data at this stage of the Flood Risk Project in an alternative format (e.g. Google Earth KML file, posting it on a website rather than providing the actual data, etc.) would provide more value or usability to the community, doing so is acceptable.

For Flood Risk Projects that involve regulatory product updates, an updated version of the draft FRD, FRR, and FRM should be provided to communities after issuance of the preliminary FIRMs, preferably near the time of the Consultation Coordination Officer (CCO) Meeting, if any of the non-regulatory products were modified since the last time the community received them.

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9.2 Final Delivery

As mentioned previously, for Flood Risk Projects that include updates to the regulatory products, the final FRD, FRR, and FRM should be submitted to the MSC no later than 30 days after the LFD date. If any changes to the regulatory floodplain boundaries occurred during the post-preliminary process (e.g. as a result of an appeal, revised preliminaries, etc.), the CSLF dataset in the FRD should be updated prior to final submittal. Optionally, the other affected non-regulatory datasets (such as the depth grids and associated risk assessments) can be updated accordingly. The decision to do so should be made in conversation with the FEMA Project Officer.

If the Flood Risk Project did not include regulatory product updates, the final non-regulatory products should be submitted when the final TSDN is submitted.

10.0 Uses in Outreach, Collaboration, and Flood Risk Communication

Preparing the data in digital format has significant advantages. Digital data allow for a more efficient storage, update, search and distribution of information. The most significant advantage is that the FRD is explicitly designed to work within a Geographic Information System (GIS) environment. This means that the FRD can be used to support automated analyses and can be coupled with other readily-available GIS and tabular data in order to increase the understanding and mitigation of flood risk. In addition, the FRD can be used to support outreach efforts and can be widely disseminated over the Internet through Web applications and interfaces.

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