Guidance for Flood Risk Analysis and Mapping

Data Capture – Workflow Details

This Document is Superseded.
For Reference Only.

May 2016

FEMA

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

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

Document History

Affected Section or Subsection	Date	Revision Description
First Publication	November 2015	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.
Throughout	May 2016	Changed all references from First Order Approximation (FOA) to Automated Engineering
Section 4 Terrain Data Submittal Guidance	May 2016	Added reference to new requirement to submit an elevation inventory file to accompany all newly purchased Light Detection and Ranging (LiDAR).
Section 7.6 Spatial_Files	May 2016	Clarified that submitted Hydraulics spatial files in Flood Insurance Rate Map (FIRM) Database format must match modeling and may not match published regulatory products.
Section 8.7 Spatial Files	May 2016	Clarified that Alluvial Fan spatial files in FIRM Database format must match modeling and may not match published regulatory products.
Section 11.0 Post-Preliminary Submittal Guidance	May 2016	Aligned list of Quality Records to submit with the Data Capture Technical Reference.

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1.0 Data Capture Overview

This document provides guidance for submitting the data specified in the Data Capture Technical Reference. For consistency, the information was organized according to the Mapping Information Platform (MIP) submittal folders as specified in the Data Capture Technical Reference.

Note that the guidance principles provided in this document are designed to help the users upload Data Capture data throughout the MIP workflow process such that all study materials are searchable and discoverable via the MIP and/or the Flood Risk Study Engineering Library and that data duplication is minimized. This is an important responsibility for all Mapping Partners and Mapping Partners must certify they have successfully delivered all project documentation.

In the future, most data submitted will automatically be available to the public, so it is important to organize and upload the project documentation carefully. Failure to follow the data capture procedures could result in inadvertent public disclosure of non-public information or could make data that should be public inaccessible.

General information about Data Capture submittals can be found in the Data Capture Guidance – General document. This companion document includes guidance pertaining to MIP Uploads, the MIP folder structure, project narratives, certification, correspondence, and submitting revised data.

For the purposes of this document, the Technical Study Data Notebook (TSDN) is defined as the complete set of the most up-to-date engineering and mapping data associated with a Flood Risk Project accompanied by the applicable Flood Risk Project administration and/or process documentation (e.g., Project Narratives, correspondence, Flood Elevation Determination Docket [FEDD] file, TSDN checklist, certification, etc.). These data form the scientific and technical basis for the flood map and are needed in the future to address challenges or changes to the maps. These data are developed throughout the duration of the project and are submitted to the MIP at the appropriate workflow step using the folder structure and guidance contained in the Data Capture Technical Reference and this guidance document. This definition replaces the previous working definition of the TSDN as a hardcopy notebook that was submitted at the end of each mapping project.

Certain TSDN data may be uploaded at the end of a Flood Risk Project using the Tools and Links/Data Upload/Load Studies Data Artifacts portlet on the MIP (https://hazards.fema.gov). As noted above, this generally will include the FEDD file, the TSDN checklist, and may include other documents describing the Flood Risk Project that include pointers to the actual data folders on the MIP. The bulk of the TSDN (i.e. the engineering and mapping data and narratives describing them) should have been captured throughout the duration of the Flood Risk Project and do not need to be resubmitted.

Related guidance on data capture and deliverables is provided in the following documents:

- Data Capture Guidance – General
- MIP Guidance
- Coastal Data Capture Guidance
- Preliminary Distribution and Revised Preliminary Guidance
- Post-Preliminary Deliverables Guidance

2.0 Discovery Data Submittal Guidance

As noted in the Data Capture Technical Reference, Discovery data must be uploaded to the MIP. Discovery deliverables include all relevant data collected during Discovery (including data collected after the Discovery meeting) and the draft and final Discovery Report and Discovery Map. The Data Capture Technical Reference provides the specifications and descriptions of the required spatial and non-spatial data tables that are to be submitted for Discovery.

Typically, Discovery data will be submitted in the Scoping task folder in the MIP. Review the Data Capture Technical Reference for more details on the MIP folder structure for Discovery data submittals and the file formats of the files that are to be submitted. MIP users can upload any file type (including spatial files) in a zip file during any of the Discovery tasks via the MIP workflow or they can upload data to the Scoping folder via the MIP Tools and Links/File Explorer data upload portlet.

For riverine projects, Discovery data should be submitted to a sub-folder named with the appropriate Hydrologic Unit Code (HUC)-8 code. Coastal projects, for which the scope is identified independently from riverine projects, may encompass more than one HUC-8 code and, therefore, they may be submitted to a subfolder associated with the studied flooding source (such as the Atlantic Ocean).

This section provides guidance on the content of the Discovery submittals.

2.1 Project_Discovery_Initiation

This folder should contain information about the draft Discovery Report and Discovery Map. Additional information related to Discovery initiation can also be included.

- Discovery Report – If applicable, this report should form a complete record of the Project Discovery Initiation activities and deliverables completed prior to the Discovery Meeting. For example, a Table of Contents should be provided and a list of all data collected, followed by a write-up of the data analysis that went into preparing for the Discovery meeting. Review the Discovery Guidance document for additional information about the content and organization of the Discovery Report.
- Discovery Map – The draft Discovery Map should reflect the data gathered prior to the Discovery Meeting. Review the Discovery Guidance document for information about the Discovery Map and an example of a Discovery Map.

2.2 Discovery_Meeting

This folder should contain information about the Discovery meeting(s), to include the invitation letters, agenda, attendance sheets, meeting minutes, and the Project Charter, if applicable. Additional information related to the Discovery meeting(s) can also be included.

- Discovery Meeting Invitation Letters and Other Follow-up Correspondence – In written format, provide the Discovery Meeting invitation letters and/or emails. These letters should identify the time and place for the meeting; provide contact information for the Project Manager or Management Staff; and discuss the intended purpose of the meeting.
- Discovery Meeting Agenda – In written format, provide the Discovery Meeting agenda that identifies date, time, location, Federal Emergency Management Agency (FEMA) participants, topics to be covered, and an estimated time for each. If multiple Discovery meetings are to be held, meeting agendas for each should be included in this file and submitted as one file.
- Discovery Meeting Attendance Record – In written format, provide a Discovery Meeting attendance record containing contact information for all attendees at the Discovery Meeting. If multiple Discovery meetings are to be held, attendance records for each should be included in this file and submitted as one file.
- Discovery Meeting Summary – In written format, provide a Discovery Meeting summary, summarizing pertinent meeting information including key topics and community map update requests. If multiple Discovery meetings are to be held, a meeting summary for each should be included.

- Project Charter – If a project charter is signed between communities and FEMA, it should be submitted either as part of Discovery or as part of the TSDN. The project charter may not always be signed at the end of Discovery. In cases where the Charter is signed during Discovery, the project charter should be submitted to the Discovery_Meeting folder on the MIP. When the Charter is signed after Discovery, the Charter should be submitted to the TSDN folder on the MIP as soon as it is signed by both parties.

2.3 Post Discovery

This folder should contain information that would typically be developed or revised after the Discovery meeting, to include the Discovery Map; the Mapping Activity Statement (MAS), if applicable; the Statement of Work (SOW), if applicable; and the updated Discovery Report. Additional post-Discovery information can also be included.

- Discovery Map – The final Discovery Map should be updated to reflect any additional information obtained during the Discovery Meeting. Review the Discovery Guidance document for information about the Discovery Map and an example of a Discovery Map.
- Mapping Activity Statement (MAS) – If applicable, in written format, provide MAS forms for the flood risk project. FEMA has developed MAS forms covering the tasks and

standards for flood map projects that are being undertaken under a Cooperating Technical Partner (CTP) program Partnership Agreement.

- Statement of Work (SOW) – If applicable, in written format, provide SOW forms for the flood risk project. FEMA has developed SOW forms covering the tasks and standards for FEMA-contracted flood risk projects.
- Discovery Report – The final Discovery Report should be updated to reflect the inventory of collected geospatial data and to document the results of the Discovery Meeting. Review the Discovery Guidance document for additional information about the content and organization of the Discovery Report.

2.4 Spatial_Files

The Data Capture Technical Reference provides the specifications and descriptions of the required spatial and non-spatial data tables that are to be submitted for Discovery in this folder.

2.5 Supplemental_Data

Additional relevant data that are collected during Discovery should be submitted in the format collected in the Supplemental_Data folder. Supplemental Discovery data submitted to the MIP should also be listed in the Discovery Report. Data used for Automated Engineering done in conjunction with Discovery may be submitted to the MIP under a separate Automated Engineering case number, but should also be noted in the Discovery Report.

Discovery data that were obtained from the Discovery_Data_Repository on the MIP do not need to be resubmitted with Discovery deliverables. However, use of data retrieved from the MIP should be cited in the Discovery Report.

It is recommended that if there is a large amount of supplemental Discovery data, it should be organized in sub-folders that describe their general category (e.g., terrain, base data, hydraulic data, etc.) and with filenames that clearly describe their contents so that subsequent users will readily recognize which files may be of use. It is further recommended to include a date in the file name if possible. Any metadata provided by the data originator should accompany the Discovery Supplemental Data submittals and should be named such that it is clear what data are being described.

3.0 Automated Engineering Submittal Guidance

Automated Engineering analyses may be done in conjunction with the Discovery process, as a component of a Coordinated Needs Management Strategy (CNMS) assessment, or as a stand-alone activity. Regardless of when Automated Engineering is performed it is usually best to create a separate MIP Case for the Automated Engineering project with appropriate data development tasks to capture the data and to upload the Automated Engineering data to the Automated Engineering data development tasks using either the MIP Workflow or File Explorer options. If the Automated Engineering data are subsequently refined as part of the MIP workflow (e.g. hydrology or hydraulics), the refined Automated Engineering data should be resubmitted under the appropriate MIP workflow task(s) as the Flood Risk Project data. Only the portions of the Automated Engineering that are updated and/or used for the regulatory maps need to be resubmitted.

3.1 General

Automated Engineering submittals in the General folder should include the following.

- Automated Engineering Report - The Automated Engineering report should discuss the general methodologies and identify exceptions. At a minimum, the report should include a discussion of the parameter selections used to define the models. An editable version of the report should be provided.
- Metadata - Metadata clearly defining the inputs, limitations, and intended use of the analysis and data should be included. The Hydrologic and Hydraulic metadata profiles from the most recent Metadata Profiles Technical Reference can be used as templates.

3.2 Spatial_Files

Spatial data should be provided in a format consistent with the current Technical References available at www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping or the Knowledge Sharing Site (KSS). The following spatial data with the following attributes will be delivered:

- Cross Sections
  - o Water Surface Elevation (WSEL) — all profiles clearly defined
  - o Model name
  - o Station
  - o Flooding source name
- Profile Baseline
  - o Flooding source name
- Floodplain Boundaries
  - o Profile

3.3 Hydrologic Models

All hydrologic calculations and supporting data should be included in the submittal under the Automated Engineering case number's data development task for Hydrology. Such data should be submitted in a fully editable format such as, but not limited to, Microsoft® Excel spreadsheets, Hydrologic Engineering Center Data Storage System (HEC-DSS) files, and HEC Hydrologic Modeling System (HMS) models.

3.4 Hydraulic Models

All hydraulic models should be included in the submittal under the Automated Engineering case number's data development task for Hydraulics. If a proprietary model was used (i.e. only available commercially), then exported freely available models should be included (e.g., XP-Solutions Storm Water Management Model [XPSWMM] exports, Environmental Protection Agency (EPA) SWMM 5.0 models). Additionally, all hydraulic models should be georeferenced.

3.5 Supplemental_Data

Any supplemental data used in generating the Automated Engineering analyses should be submitted in a digital format per the Data Capture Technical Reference and the FIRM Database Technical Reference. Supplemental data should be included under the Automated Engineering case number's applicable data development task. If the data are publicly available, such as from the National Agriculture Imagery Program (NAIP) or U.S. Geological Survey (USGS) Digital Elevation Models (DEMs), and are not modified as part of the analysis, it is sufficient to explicitly identify the location where the data can be obtained. Include the date and where the data were accessed. Any Automated Engineering data that are subsequently modified and used for regulatory product development will need to be uploaded to the applicable regulatory data development task.

4.0 Terrain Data Submittal Guidance

This section provides guidance for preparing and organizing the Terrain data for a Flood Risk Project. For additional information, review the Elevation Data Guidance document about preparing Terrain data for use in a Flood Risk Project.

When FEMA purchases Light Detection and Ranging (LiDAR) data, it will generally make sense to create a separate task for the LiDAR production, and then create a separate task for delivering any processed surfaces for modeling. That way the new LiDAR data can be delivered to the FEMA Library as soon as possible so it can be shared with others. Terrain data gathered for Automated Engineering should be submitted under the Automated Engineering MIP case number's Develop Topographic Data workflow task. Terrain data gathered during Discovery should be submitted under the Discovery MIP case number's Develop Topographic Data workflow task.

Data submittals for newly purchased LiDAR data should include all deliverables (i.e., raw point cloud, classified point cloud, and DEM) and the data should be submitted in its entirety even if the collection footprint extends beyond the current Flood Risk Project area. The data should be submitted under the LiDAR production case number's Develop Topographic Data workflow task and should be organized by data type. As noted in the Data Capture Technical Reference, newly purchased LiDAR data must be accompanied by a spatial elevation inventory file named S_Elev_Inv_Ar. This file will enable FEMA to report the status of its elevation datasets to the U.S Interagency Elevation Inventory (USIEI).

If existing (gathered) Terrain data are used, Mapping Partners only need to upload the bare earth data used for the Flood Risk Project and documentation for the data. The raw point cloud and other LiDAR project components not used for the project do not need to be submitted. If existing (gathered) LiDAR data are used, only the LiDAR data used for that project should be submitted to the MIP. Gathered LiDAR data outside the project area do not need to be submitted.

If Terrain data are processed for use in the Flood Risk Project (e.g. for Hydrologic and Hydraulic [H&H] modeling or for Automated Engineering modeling), the finished elevation model/surface used for the project must be submitted. For instance, if the terrain data were blended from three different sources to create the final terrain data, the original of the three sources and the final terrain file that results from the blending process should be submitted.

Terrain data should be submitted in folders organized by whether the data are the original source data or the final processed data. Within those folders, the data should be organized in sub-folders based on the type of data being submitted (e.g., point cloud, breaklines, DEM, Hydro-Flattened or Enforced, Triangulated Irregular Network [TIN], contours, etc. as applicable). Terrain data can be contained in a single file or in tiled files. When tiled files are submitted, they are to be accompanied by a tiling index file. While all tiled terrain data may reference the same tile index, it is possible that each set of tiled data references a unique tile Index based on different origins and cell sizes. For example, natural DEMs, hydro-corrected DEMs, contours and flow vectors could each be based on a different tile index.

As noted elsewhere, Terrain data submittals will need to be submitted on media (Digital Video Disc [DVD]/portable hard drive) to the Data Depot for upload to the MIP via a backend process. Terrain data submitted on media should be organized in the appropriate folders as specified in the Data Capture Technical Reference in order to facilitate the backend data upload by Customer and Data Services (CDS). Only folders appropriate to the project need to be created.

4.1 General

In addition to the Project Narrative, Certification (if applicable), and the Terrain Metadata file, the Terrain General folder should include the following:

- LiDAR flight plans or flight logs, to include a Pre-flight Operations Plan and Post-flight Aerial Survey and Calibration Report.
- Photogrammetric reports (if applicable) to include:
    - Collection Report detailing mission planning and flight logs, flying heights, camera parameters, forward overlap and sidelap.
    - Survey Report detailing the collection of control and reference points used for calibration and Quality Assurance/Quality Control (QA/QC).
    - Aerial triangulation (AT) report detailing compliance with relevant accuracy statistics.
    - Processing Report detailing photogrammetric processed used to manually compile elevation data or to semi-automatically compile elevation data with automated image correlation or other techniques.
- All Mapping Partner and/or independent QA/QC reports. QA/QC of unclassified point cloud data includes testing for Fundamental Vertical Accuracy (FVA). When LiDAR post-processing is performed, QA/QC includes testing the bare earth product for Supplemental Vertical Accuracy (SVA) and Consolidated Vertical Accuracy (CVA). The vertical accuracy calculations for all LiDAR QA/QC reports should be submitted in a Microsoft® Excel spreadsheet.

5.0 Survey Data Submittal Guidance

Field surveys are performed to collect information that is needed as input into the hydraulic models for Special Flood Hazard Areas (SFHAs) with high flood risk and may be needed for SFHAs with moderate flood risk. The field-surveyed data may include information for the following types of features:

- Cross Sections
- Transects
- Temporary Bench Marks
- High Water Marks
- Structures
  - Bridges
  - Channels
  - Culverts
  - Dams
  - Levees
  - Coastal Structures

This section provides guidance for preparing and organizing the field survey data for MIP submittal, including the recommended survey data naming convention and format. Survey data are not required to be submitted following this guidance. However, survey data that do not follow this guidance should be documented and organized in a comparable way that makes it easy of other users to find the proper measurements and understand the context and relevance to the flood hazard modeling.

Survey notebooks should be included but are not required. All survey data will be collected and delivered in the appropriate coordinate system and vertical datum and should use standard description codes (see the survey codes listed in Table 2) and standard naming and file types.

For riverine projects, Survey data should be submitted to a sub-folder named with the appropriate HUC-8 code. Coastal projects, for which the scope is identified independently from riverine projects, may encompass more than one HUC-8 code and, therefore, they may be submitted to a subfolder associated with the studied flooding source (such as the Atlantic Ocean). Within those folders, the Survey deliverables including points, photographs, and sketches should be organized by stream name.

5.1 Photos

Five digital photographs should be taken for each structure and two digital photographs taken for each cross section. For example, a bridge or culvert would have photos as follows:

- Downstream channel (from the structure looking downstream)
- Downstream face of the structure
- Overtopping cross section looking left to right

- Upstream face of the structure
- Upstream channel

Similarly, relevant photos should be included for other types of structures, such as dams, levees, and coastal structures.

A cross section would have photos as follows:

- Downstream channel (from the structure looking downstream)
- Upstream channel

The surveyor should keep a photo log for each stream surveyed, to facilitate photograph naming and organization. The photo log does not have to be submitted as a deliverable.

Photographs should be compressed to reduce file sizes to the extent possible. They may be submitted in Joint Photographic Expert Group (JPEG), Tagged Image File Format (TIFF), or Bitmap Image File (BMP) format. Photographs are critical and are used to determine the Manning's roughness coefficient and hydraulic model development. Photographs should be taken with the clearest view and reviewed for clarity, especially in low light conditions, before leaving the site. In locations where obstructions may prevent a single picture from being taken to represent the required view, multiple photographs may be taken and stitched together to form the final view.

5.2 Sketches

A survey sketch should be prepared at all hydraulic features, including cross sections (see Figures 3, 5, and 7). The sketch should include notations and measurements representing the structural geometry and the natural ground and show description codes and shot numbers from the field survey so that the sketch can be related to the field survey. Each sketch should include a planimetric and profile view (viewed looking downstream left to right, upstream face of structures) and show the following items: piers/piles, channel banks, channel, direction of flow, rails, deck, footings, abutments, culvert inverts, shape and size of opening, bench mark location, skew to flow, and north arrow.

Sketches should be prepared in digital format or scanned and named based on stream and structure/cross-section number. Any scans should be made at a resolution that captures all content clearly but minimizes file size to the extent possible (200 dots per Inch [dpi] is a reasonable resolution) and may be submitted in TIFF, BMP, Adobe® Portable Document Format (PDF) or JPEG format.

5.3 Survey_Data

Survey data files should be stored in a comma delimited text file, spreadsheet, or database format and include all hydraulic feature data and benchmarks surveyed for that stream. The file should be developed in a format that includes data that correspond to the fields in the L_Survey_Pt table as described in the FIRM Database Technical Reference. An example file is shown in Table 1. All point data associated with structures or features may be listed in one table. As needed, the easting and northing units can be converted into latitude and longitude.

Table 1: Survey Data File Example

Survey Point ID	Structure ID	Survey Code	Structure Description	Northing	Easting	Elev.	Elev. Unit	Horiz. Datum	Vert. Datum	Proj.	Proj. Zone	Proj. Unit
32400	SWI_32400	GR	Cross Section No 2	468854.208	1737859.314	607.66	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32401	SWI_32400	GR	Cross Section No 2	468865.357	1737850.764	602.14	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32402	SWI_32400	GR	Cross Section No 2	468875.480	1737842.719	597.75	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32403	SWI_32400	TOBL	Cross Section No 2	468881.852	1737838.918	593.52	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32404	SWI_32400	TOSL	Cross Section No 2	468887.119	1737835.142	591.86	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32405	SWI_32400	CH	Cross Section No 2	468897.284	1737830.623	581.12	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32406	SWI_32400	CHCL	Cross Section No 2	468900.368	1737828.459	581.48	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32407	SWI_32400	CH	Cross Section No 2	468905.686	1737824.840	581.16	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32408	SWI_32400	TOSR	Cross Section No 2	468912.298	1737821.658	583.91	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32409	SWI_32400	TOBR	Cross Section No 2	468917.314	1737816.902	592.42	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32410	SWI_32400	GR	Cross Section No 2	468926.152	1737809.303	596.96	FT	NAD 83	NAVD 88	WV SP	4702	US FT
3241	SWI_32400	GR	Cross Section No 2	468931.695	1737804.390	598.74	FT	NAD 83	NAVD 88	WV SP	4702	US FT
32412	SWI_32400	GR	Cross Section No 2	468942.672	1737796.103	605.24	FT	NAD 83	NAVD 88	WV SP	4702	US FT

5.4 Supplemental_Data

If additional data are collected during Survey, those data should be submitted in the format collected as supplemental data. Supplemental Survey data submitted to the MIP should also be described in the Project Narrative. Supplemental Survey data may include survey field notebooks.

5.4.1 Survey Field Notebooks

If included in the survey submittal, the following guidance applies to the survey field notebooks.

- Field notebooks should be carefully and legibly prepared, identified, indexed, and preserved.
- All data regarding the establishment and extension of vertical and horizontal control, including descriptions of all established and recovered monuments, should be recorded.

- Each field notebook should contain the name and the field address/location of the Survey Party Chief, and the identity of the survey instruments.
- Each field notebook should be numbered and marked with a brief description of the contents on the cover, carefully indexed, and each page numbered.
- For conventional surveys, each horizontal traverse line and vertical control line should be identified by number and brief description in the field book.
- The first page used on each day of fieldwork should be dated.
- Field notebooks should be free of erasures; any line of horizontal and vertical control may be rejected by the FEMA Project Officer if any erasure is made in recording the data for that line. A single line may be placed through erroneously entered data to indicate its removal.
- If the field notes are electronically recorded, printouts of the electronically recorded field notes should be provided.
- For Global Positioning System (GPS) surveys, the full network adjustment report should be provided.

5.4.2 As-Built

In some cases, a Department of Transportation or other agency may be able to provide as-built drawings for hydraulic structures, which may reduce or eliminate the need for field survey of those structures. If as-built drawings or Computer Aided Design and Drafting (CADD) data are provided for hydraulic structures, these data should be submitted in the As-Built folder. The Project Narrative should include the name of the agency that provided the as-built drawings.

5.5 Spatial_Files

At a minimum, survey data files must be imported into the L_Survey_Pt table of the FIRM Database and submitted in the Spatial_Files folder. Review the FIRM Database Technical Reference for the layout of the L_Survey_Pt table. If spatial point features are created for the survey points, they should also be submitted in the Spatial_Files folder.

5.6 Survey Data Naming Conventions

When gathering survey data for a flood study, it is best to organize data collection activities prior to initiating survey activities in the field. As part of the reconnaissance process, Mapping Partners should review all the stream names to determine the best way to name the files and streams. Before collecting survey data, it is recommended that basic naming and location for each hydraulic feature to be surveyed be predetermined and sketched out on work sheets.

The following guidance is provided for naming of features collected during field surveys:

Figure 1 shows the layout of data collection for an example watershed. The locations to collect survey data are numbered as 100, 200, 300, 400, or 500 in this watershed. To distinguish each location, the watershed and stream descriptors are added to the location. Table 2 shows an example of survey data using the recommended numbering laid out in this section.All structures and cross sections should have a unique alpha three-character ID as a feature name. A feature name (three-character ID) should have the abbreviated stream name followed by the number of the feature on that stream. All numbers should start from the downstream limit and increase upstream. Names should begin with an abbreviation consisting of the first three letters of the stream name. For example, Swift Creek would be **SWI**. In numbering structures and cross sections, it is suggested to use a numbering system that allows for intermediate numbers to be added later in cases where a structure or cross section is skipped or added (e.g., 100, 200, 300, etc.). Some variation may be needed if multiple streams in the same flood risk project area begin with the same three letters. The name and numbers should be separated by an underscore rather than a space or dashes. An optional descriptor can be included at the beginning of the names to accommodate statewide programs (e.g., NC10_SWI_500_1).

For unnamed tributaries, a convention is to use the nearest named stream that the unnamed stream flows into as part of the naming convention. For example, the first structure on an unnamed tributary that flows into Swift Creek would be SWI_100_1 numbered sequentially from downstream to upstream. The second structure on this unnamed tributary will be SWI_200_1.

For example, for the main channel of Swift Creek there are three locations surveyed and numbered as 100, 200, and 300. The descriptor SWI is added to Table 2 to represent SWI Creek. Since this is the main channel of the watershed, 00_0 is entered for the stream information. If this was a named tributary, the first two letters of the named tributary would replace the 00 in the stream designation. The last part of the stream designation is used to designate unnamed tributaries. This value will always be 0 for named tributaries not on the main channel, but will carry a value of one or greater for unnamed tributaries starting with the most downstream unnamed tributary being one and then the next upstream tributary being two and so on.

Point numbers are the series of collected data points surveyed at each section location that starts with the section number. For instance, for the section 100 location, survey points would be numbered 101, 102, 103, 104, etc., for all of the survey points at this location. The next section would start with the point numbers 201, 202, 203, 204, etc. The remaining columns in Table 2 represent the northing, easting, and elevation (X, Y, Z) of the survey points and the code is one of the survey codes listed in Table 3.

For the first unnamed tributary of Swift Creek, the watershed name stays the same because it is still in Swift Creek watershed. The stream name becomes 01_0, as there is no name to use for the first two letters. If there was an unnamed tributary to this tributary, then the stream designation would be 01_1.

At the Mill Branch, the stream designation changes to MI_0. The unnamed tributary to Mill Branch is designated as MI_1. Again, the section numbers are separated by hundreds as 100, 200, 300, 400, and 500. The reasoning behind three digit numbers is they allow sufficient room for all the point data that may be collected at a section (i.e., one hundred data points will be available for surveying between 100 and 200). If after collecting data, there is a need for an additional section between 100 and 200, a number like 150 may be used to add the section and label the points starting with 150 and increasing with 151, 152, 153, etc.

Figure 1: Example Layout of Survey Locations

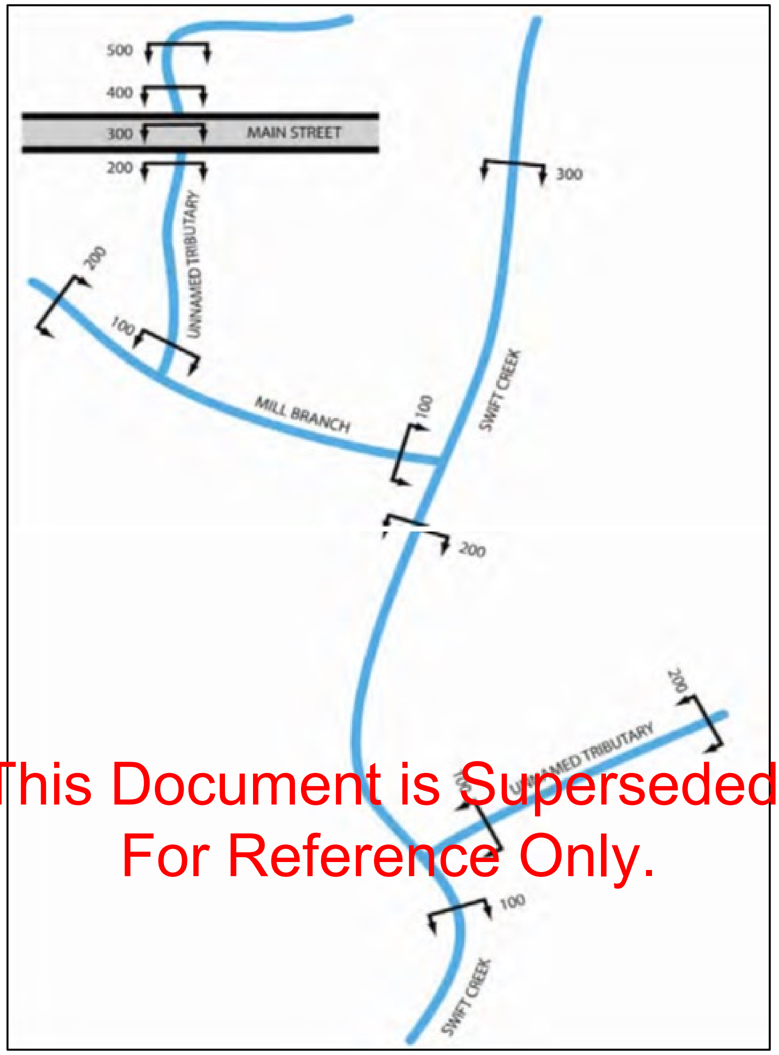


Table 2: Survey Data Naming Example

Watershed	Stream	Section	Point #	Northing	Easting	Elev.	Code
SWI	00_0	100	101	468854.208	1737859.31	607.66	GR
SWI	00_0	100	102	468865.357	1737850.76	602.14	TOBL
SWI	00_0	100	103	468875.480	1737842.71	597.75	TOSL
SWI	00_0	200	201	468881.852	1737838.91	593.52	GR
SWI	00_0	300	301	468887.119	1737835.14	591.86	GR
SWI	01_0	100	101	468897.284	1737830.62	581.12	WW
SWI	01_0	100	102	468900.368	1737828.45	581.48	WEIR
SWI	01_0	100	103	468905.686	1737824.84	581.16	WEIR
SWI	01_0	100	104	468912.298	1737821.65	583.91	WW
SWI	01_0	100	105	46891	1737816.90	592.42	WW
SWI	01_0	200	201	468926.152	1737809.30	596.96	GR
SWI	MI_0	100	101	468931.695	1737804.39	598.74	GR
SWI	MI_0	200	201	468942.672	1737796.10	605.24	GR
SWI	MI_1	100	101	468953.671	1737797.3	603.25	GR
SWI	MI_1	200	201	468954.245	1737825.3	604.65	GR
SWI	MI_1	300	301	468955.324	1737833.6	610.22	RDCL
SWI	MI_1	400	401	468955.665	1738833.2	644.23	CHCL
SWI	MI_1	500	501	468960.321	1737866.2	665.42	TOBR

5.7 Survey Data File Naming Convention and Format

Survey data files should also be organized and named based on the stream name (Swift_Creek_ 3_15_2011.txt). Coastal transects and structures survey data files should be named based on the flooding source, and community (Atlantic_Ocean_City_MD_3_15_2011.txt). The date in the file name is the date the deliverable file was created.

Every hydraulic feature should have a unique identification name that is also be shared by the photographs with additional suffixes to indicate location. For example, a structure on Swift Creek identified as “SWI-100” would have photos named as follows:

- SWI_100_DSCH.jpg – downstream channel (from the structure looking downstream)
- SWI_100_DSFACE.jpg – downstream face of the structure
- SWI_100_OTXS.jpg – overtopping cross section looking left to right
- SWI_100_USFACE.jpg – upstream face of the structure
- SWI_100_USCH.jpg – upstream channel

A cross section on Swift Creek would have photos named as follows:

- SWI_100_DSCH.jpg – downstream channel (from the structure looking downstream)
- SWI_100_USCH.jpg – upstream channel

Sketches should be named based on stream and structure/cross-section number (e.g., SWI_100_SKETCH.jpg).

Table 3: Survey Codes

Code	Description	Field Survey Location
ABT	Abutment	face/foot of abutment of bridge
BOCEDS	Back Of Curb Edge Down Stream	where slope meets top of culvert or top of headwall above culvert centerline on downstream end for determining outlet projection
BOCEUS	Back Of Curb Edge Up Stream	where slope meets top of culvert or top of headwall above culvert centerline on upstream end for determining inlet projection
BRCL	Bridge Centerline	centerline of bridge in overtopping section
CH	Channel	stream bottom between Toe Of Slope (TOS) shots
CHCL	Channel Centerline	center of the main flow area of the stream
CUL	Culvert Shape	multiple CUL codes can be used to define shapes for culverts, especially irregular shapes
CULCL	Culvert Centerline	centerline of culvert in overtopping section
CULDSCR	Culvert Down Stream Crown	the highest point of the downstream end of a culvert
CULDSINV	Culvert Down Stream Invert	the lowest point of the downstream end of a culvert
CULUSCR	Culvert Up Stream Crown	the highest point of the upstream end of a culvert

Code	Description	Field Survey Location
CULUSINV	Culvert Up Stream Invert	the lowest point of the upstream end of a culvert
DAMCL	Dam Centerline	the high point of a dam
DH	Dune Heel	landward toe of primary frontal dune
DP	Dune Peak	peak or rear shoulder of primary frontal dune
DT	Dune Toe	seaward toe of primary frontal dune
EOB	End Of Bridge	end of the bridge deck at the road/rail elevation
ERM	Elevation Reference Mark	Permanent elevation monument. An ERM must be set at every structure and at cross sections if they are more than half a mile to the nearest structure.
FBCL	Foot Bridge Centerline	centerline of non-vehicular bridges in overtopping section
GDR	Guardrail	top of guardrail at ends to define limit and height
GDRBOT	Guardrail at Bottom	base of guardrail at ends to define and height
GR	Ground	on ground to show elevation changes, used outside Top Of Bank (TOB) shots, between TOB and TOS, and to indicate islands or bars within the channel. When used in channel cross-section surveys, a GR point must be placed at least 15 feet past the top of bank or until there is no overhead obstruction from foliage. If overhead foliage is too thick for the entire overbank area, full valley cross sections should be a consideration for modeling.
HWMARK	High Water Mark	historical high water marks-mud/stain lines, drift lines, parole evidence, etc.
INVDS	Invert Down Stream	channel invert at downstream end of structure, used to define paved aprons
INVUS	Invert Up Stream	channel invert at upstream end of structure, used to define aprons
LC	Low Chord	change in bridge deck thickness, usually at center of a pile row or pier. Multiple low chord codes can be used to define irregular shaped bridges such as arched bridges with the explanation of the multiple LC shots shown in the sketch for the structure.
LCDSL	Low Chord Down Stream Left	bottom of deck and beam at the downstream left corner of bridge[1]
LCDSR	Low Chord Down Stream Right	bottom of deck and beam at the downstream right corner of bridge[1]
LCUSL	Low Chord Up Stream Left	bottom of deck and beam at the upstream left corner of bridge[1]

Code	Description	Field Survey Location
LCUSR	Low Chord Up Stream Right	bottom of deck and beam at the upstream right corner of bridge[1]
LV	Levee	the centerline of the top of a levee
PIER	Pier	the up and downstream centerline of a pier
PILE	Pile	the up and downstream centerline of a row of piles
RAIL	Rail	top of rail to define limits and height of railing on structures
RAILBOT	Rail Bottom	bottom of rail to define limits and height of railing on structures
RDCL	Road Centerline	the centerline on a crowned road or the high side of a road with super elevation
SFLOOR	Sea Floor	shots either direct or combination of bathymetric and conventional/Global Positioning System (GPS) survey of coastal area which can be collected during structure or transect survey
TEMP	Temporary Control Point	temporary control point used for data collection of cross sections and structures. TEMPs are established when ERMs are not present.
TOB	Top Of Bank	top of bank in a multiple channel scenario
TOBL	Top Of Bank Left	break point from over bank to channel on the left side when looking downstream
TOBR	Top Of Bank Right	break point from over bank to channel on the right side when looking downstream
TOD	Top Of Deck	to show an irregular arch or dip in a bridge deck between the bridge corner shots
TODDSL	Top Of Deck Down Stream Left	downstream left corner of a bridge on the deck directly above the LCDSL shot to measure deck thickness and width[1]
TODDSR	Top Of Deck Down Stream Right	downstream right corner of a bridge on the deck directly above the LCDSR shot to measure deck thickness and width[1]
TODUSL	Top Of Deck Up Stream Left	upstream left corner of a bridge on the deck directly above the LCUSL shot to measure deck thickness and width[1]
TODUSR	Top Of Deck Up Stream Right	upstream right corner of a bridge on the deck directly above the LCUSR shot to measure deck thickness and width[1]
TOS	Toe Of Slope	the toe in a multiple channel scenario

Code	Description	Field Survey Location
TOSL	Toe Of Slope Left	break point from channel bank to channel bed on the left side when looking downstream
TOSR	Toe Of Slope Right	break point from channel bank to channel bed on the right side when looking downstream
WALL	Wall	top of a retaining wall, also used outside TOBL and TOBR when the stream banks are vertical walls or rock cuts
WALLBOT	Wall Bottom	bottom of a retaining wall, also used outside TOBL and TOBR when the stream banks are vertical walls or rock cuts
WEIR	Weir	top of dam spillways and outlet structures. Multiple weir codes may be used to collect data for gates, flashboards, and other operable structures. The explanation of the multiple shots should be shown in the structure sketch.
WW	Wing Wall	top face of each end of a wing wall or headwall on a structure to define height and length
WWBOT	Wing Wall Bottom	base of each end of a wing wall or head wall on a structure to define height and length

[1] The four bridge corner shots need to be taken outside of any rail to accurately measure hydraulic length.

Figure 2: Typical Cross Section Photograph (Displays Survey Code Locations)

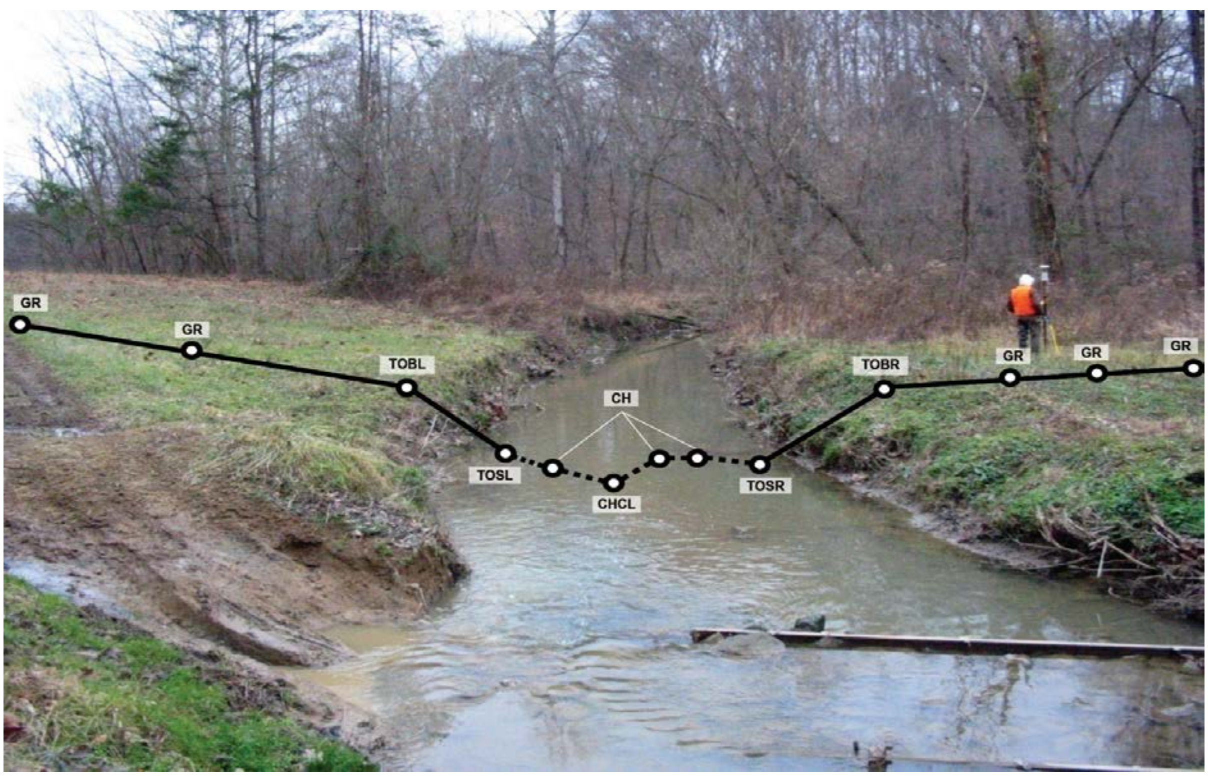


Figure 3: Typical Cross Section Sketch

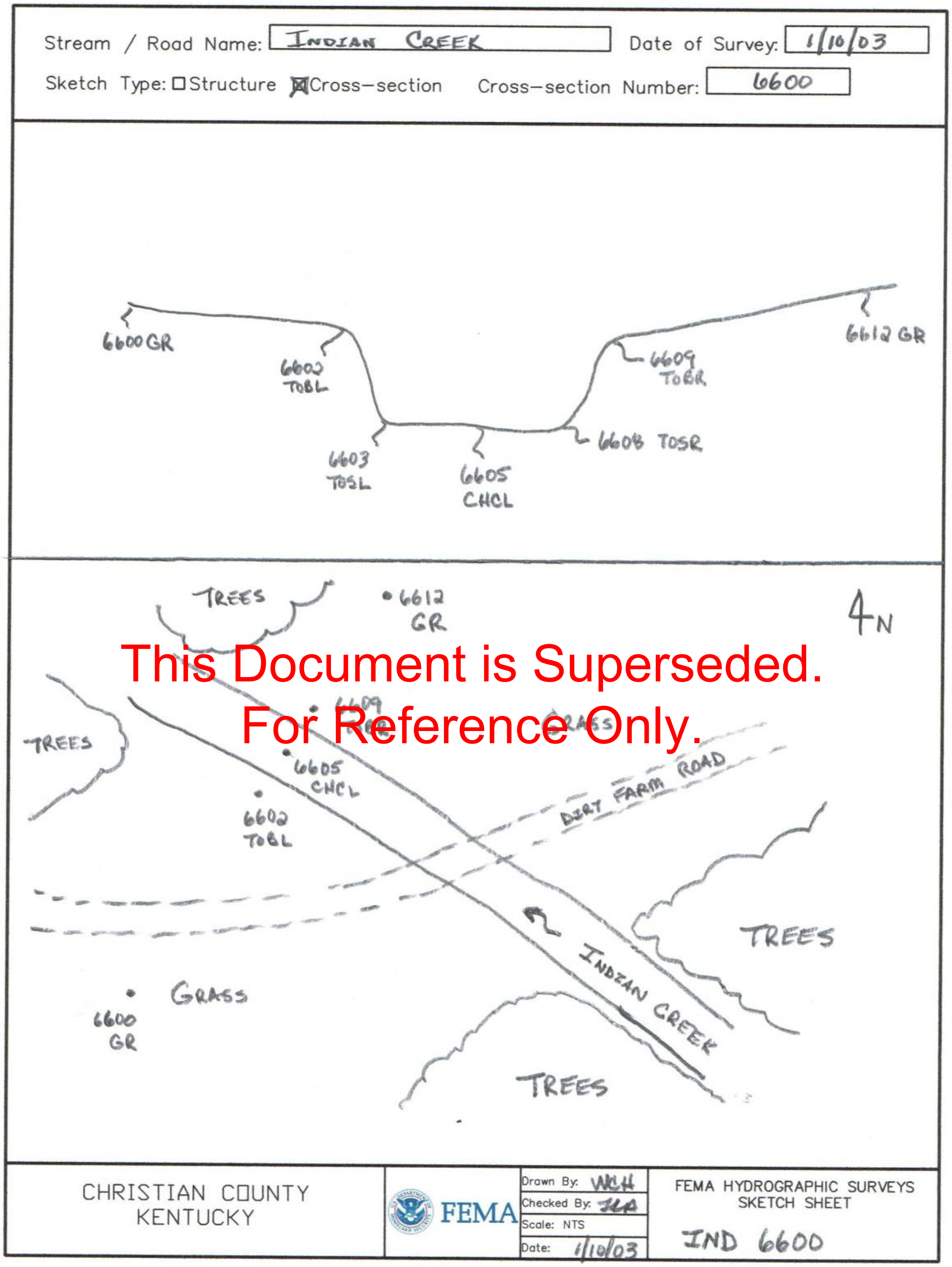


Figure 4: Typical Bridge Photograph (Displays Survey Code Locations)

Figure 5: Typical Bridge Sketch

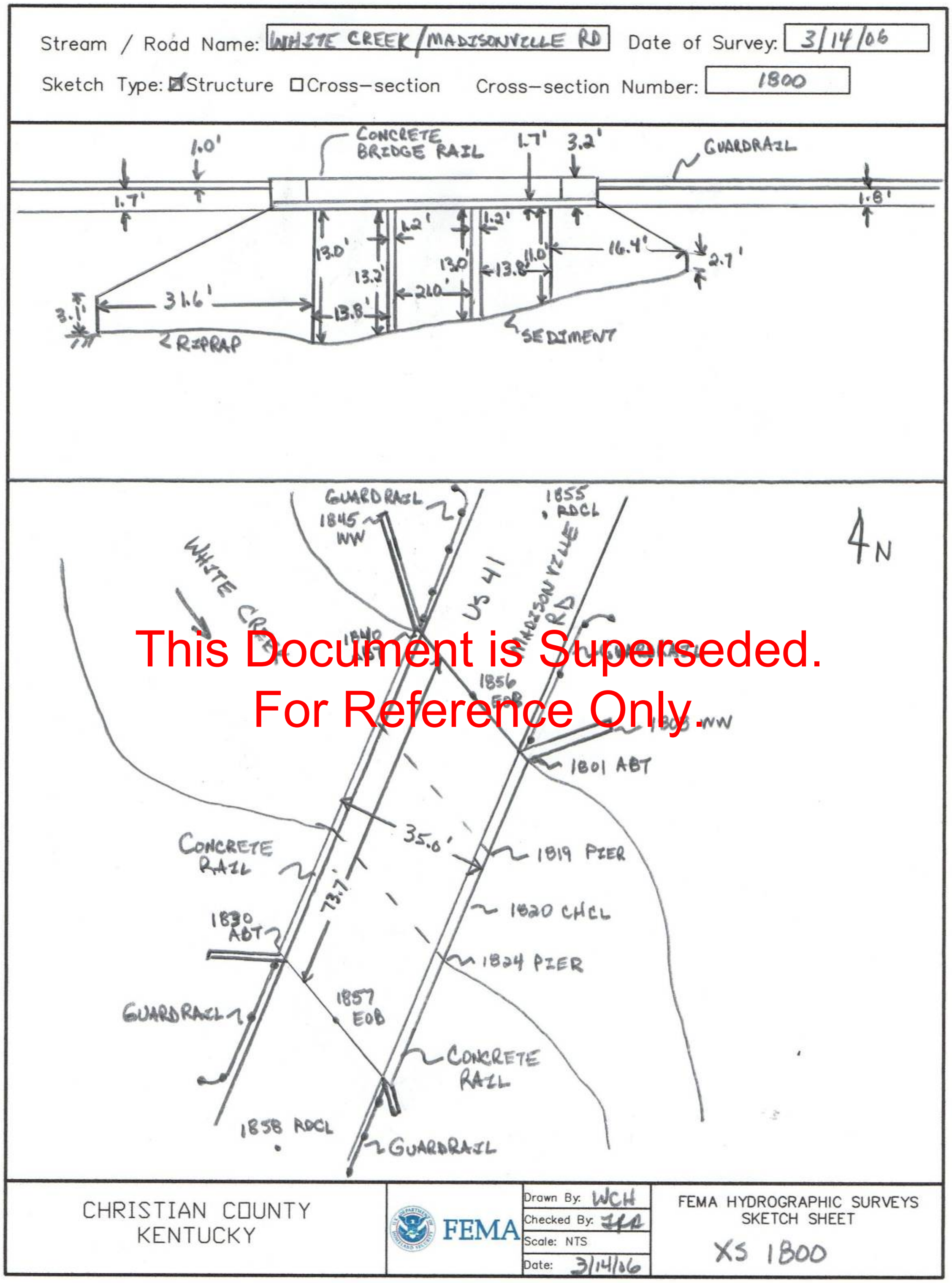


Figure 6: Typical Culvert Photograph (Displays Survey Code Locations)

Figure 7: Typical Culvert Sketch

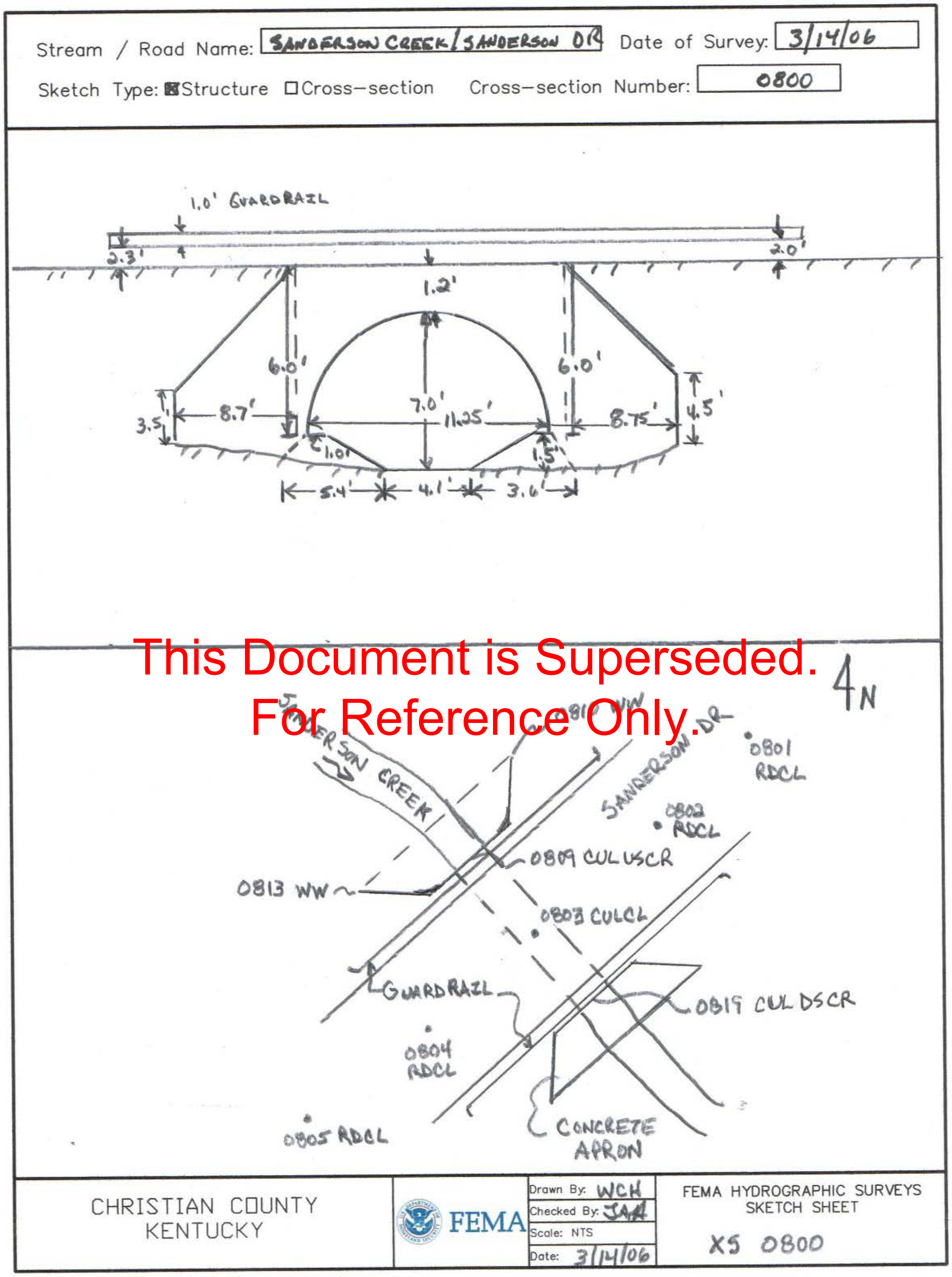


Figure 8: Typical Dam Photograph: Dam Centerline (Displays Survey Code Locations)

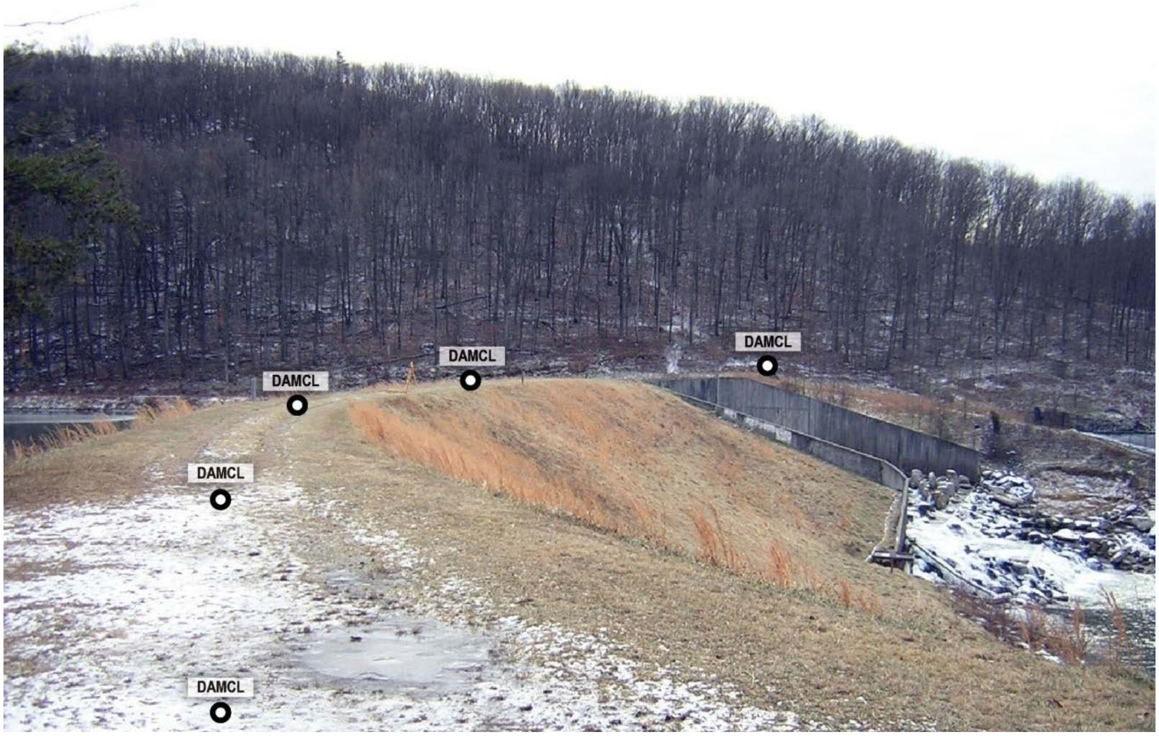


Figure 9: Typical Dam Photograph: Spillway (Displays Survey Code Locations)

Figure 10: Typical Dam Photograph: Outlet Structure (Displays Survey Code Locations)

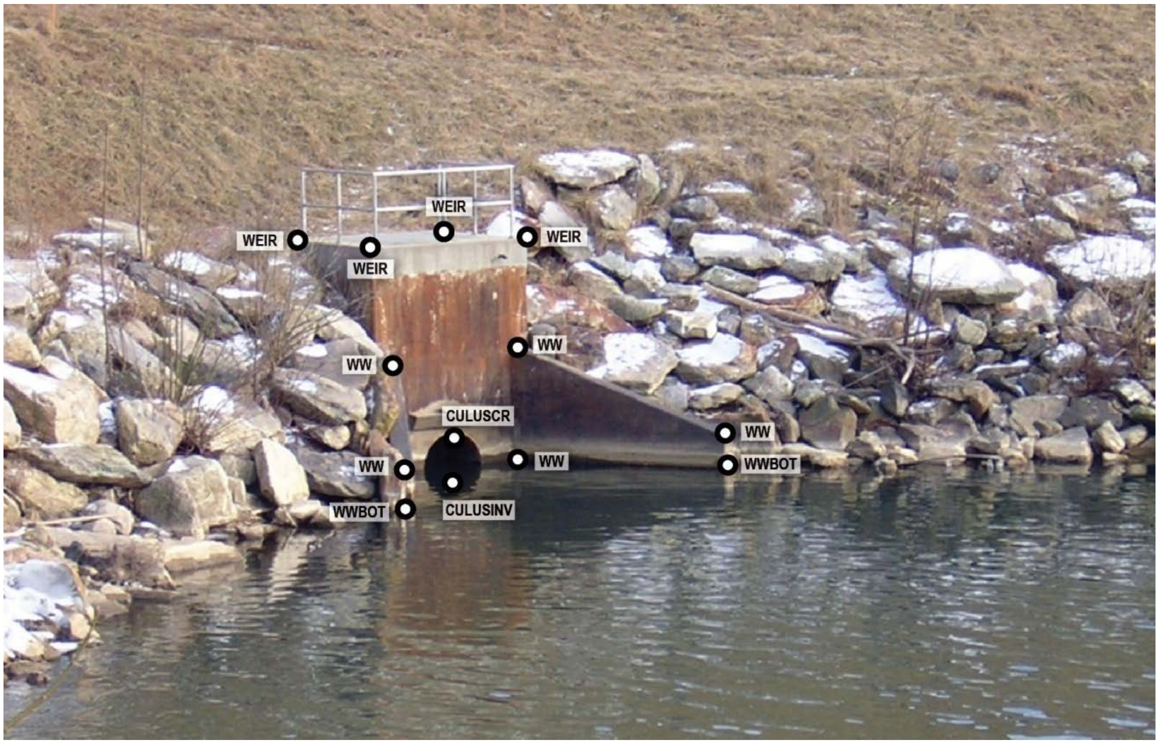


Figure 11: Typical Transect Photograph

Figure 12: Typical Transect in Profile View (Displays Survey Code Locations)

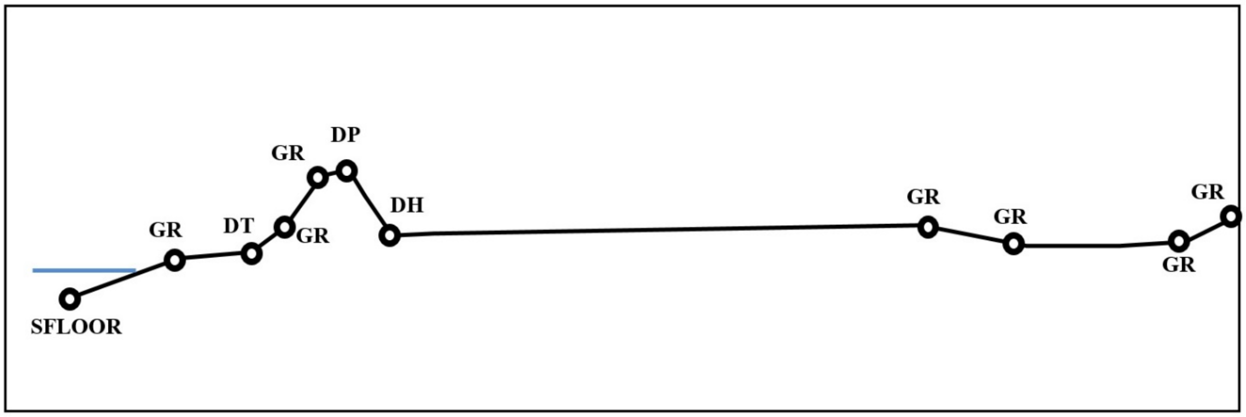
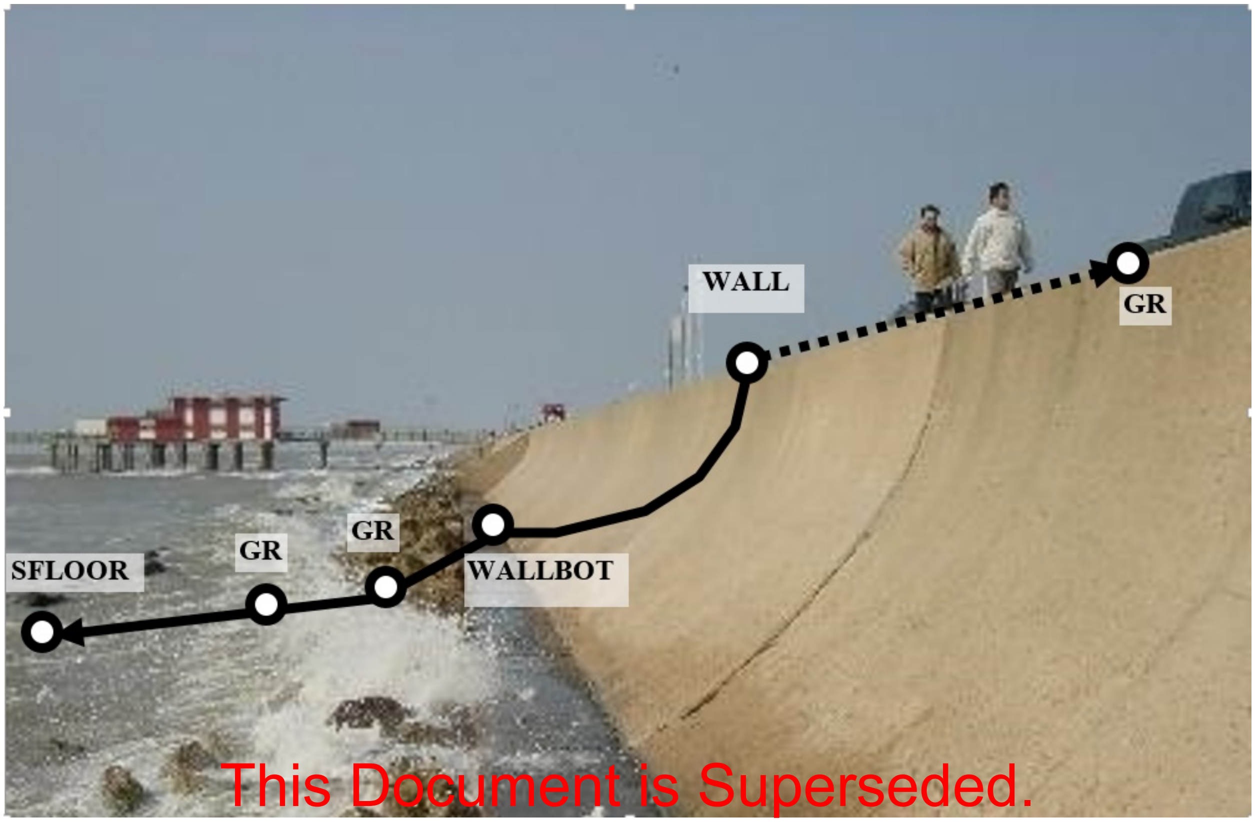


Figure 13: Typical Levee Photograph (Displays Levee-crown Survey Code Locations)

Figure 14: Typical Coastal Structure Photograph (Displays Survey Code Locations)



6.0 Hydrology Data Submittal Guidance

This section provides guidance on the hydrologic data that are submitted to FEMA for the Flood Insurance Study (FIS) with respect to rivers, lakes, closed basins, and ponds. Three broad categories of hydrologic procedures are typically used in the National Flood Insurance Program (NFIP):

- Flood-frequency analyses for gaged streams using Bulletin 17B, Guidelines For Determining Flood Flow Frequency (Interagency Advisory Committee on Water Data, 1982);
- Regional regression equations for ungaged streams, generally those developed by the USGS; and,
- Rainfall runoff models.

Within the category of rainfall runoff models, the HEC-HMS model (or its predecessor, HEC-1) developed by the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC), is used most frequently in the NFIP. In addition to the USACE models, FEMA accepts hydrologic results from over a dozen other rainfall runoff models and it is likely that new models will be announced as acceptable in the future.

For riverine projects, Hydrology data should be submitted to a sub-folder named with the appropriate HUC-8 code. Coastal projects, for which the scope is identified independently from riverine projects, may encompass more than one HUC-8 code and, therefore, they may be submitted to a subfolder associated with the studied flooding source (such as the Atlantic Ocean). Within those folders, the Hydrology deliverables should be organized by stream name, if applicable.

6.1 General

The General folder should include the Hydrology Report, the draft FIS Report Section 5.1, as well as the Project Narrative, Certification (if applicable), and the Hydrology Metadata file.

6.1.1 Hydrology Report

The hydrology report should document the methodology, assumptions, and data used in the hydrologic analyses. The report should have a title page that includes the study name, Mapping Partner name, community and state name, and the date that the report was produced.

The hydrology report must be submitted in Word and PDF format per the Data Capture Technical Reference.

Below is an annotated table of contents for a typical hydrology report. The outline below is not inclusive of every item all studies should incorporate. Each study will have different aspects, so it is very likely that the engineer will have to incorporate and/or delete items from the provided outline. The outline below is for a study that includes SFHAs with high flood risk. For studies without SFHAs with high flood risk, the table of contents may be significantly shorter.

Tabular information that more closely corresponds to applicable FIS Report tables may also be included in the Hydrology Report in lieu of narrative descriptions.

Examples are given for several of the items in the outline. Please note that the examples do not represent 'actual' data. Stream names, locations, county names, etc., were generated only as a reference.

1. Introduction

   a. Study Area

   Describe the location of the study. Include the HUC identifier, state, county, major landmarks, and nearby roads. Define the limits of the study. For example:

   The Water River Basin is located in Maple County, New Jersey. Interstate 99 runs through the central part of the basin. The downstream limit of the study is the confluence of Blue Creek and Red Run.

   b. Purpose and Type of Study

   Describe why the study is being done. In general, revised hydrologic analyses could be initiated for the following reasons:

   - To reflect longer periods of record or revisions in data
   - To reflect changed physical conditions

- To take advantage of improved hydrologic analysis methods
- To correct an error in the hydrologic analysis performed for the effective study.

Document the study type (SFHAs with high flood risk, SFHAs with moderate flood risk, SFHAs with low flood risk). If the study is a combination, list the names of the streams and their corresponding type of study. For example:

The purpose of this study is to investigate the existence and the severity of flood hazards and revise the previous Flood Insurance Study (FIS) for Maple County. Maple County is a rapidly growing urban area partially surrounding the City of Floodport and the current FIS is outdated. This study includes Special Flood Hazard Areas (SFHAs) with high and moderate flood risk. Streams with high flood risk include Red Run, Briar Branch, Wolf Creek, and Green Creek. Streams with moderate flood risk include Blue Creek and Moose Branch.

c. Type of Flooding

State whether the study is located in a tidal or riverine area. If there are tidal influences, discuss the limits of such. Streams with tidal influence will be discussed in a separate Coastal Report. For example:

The entire study is riverine without any tidal influences. It is located approximately 45 miles from the coast.

d. Flooding History

State whether the area has a history of flooding. If so, describe the location and the corresponding events that caused the flooding. Update this information as necessary beyond what is shown in the effective FIS. For example:

There is a history of flooding along the downstream portion of Wolf Creek. During Hurricane Anne, multiple homes along the western portion of the creek by Orchard Road were flooded. Residents reported as much as five feet of water in their homes after this event.

e. Other General Information

Insert any other information for general use that does not fit with any other sub-section. For example, there may have been another study completed recently in the same area that the user should know about.

2. Study Area Characteristics

a. Hydrologic Region

State the name of the hydrologic region of the study and any important information regarding the region. For example:

The Water River Basin is located in the Central Valley, Blue Ridge, and Piedmont Hydrologic Regions. It is bordered by the Blue River Basin, the Yellow River Basin, and the Green River Basin. The Central Valley hydrologic region has characteristics of both the

Blue Ridge and Piedmont Regions. These characteristics include moderate slopes and highly permeable soils.

b. Watershed Size

State the computed size of the watershed and other relevant information about its size. For example:

At its outlet, the Water River Basin's drainage area measures approximately 9,000 square miles, and it is the state's third largest river basin.

c. Soils and Topography

Describe the soils and the general topography of the watershed. If the soil characteristics are used in the hydrologic analysis, include their names, Natural Resources Conservation Service (NRCS) soil type (A, B, C, D), and all other information used in the analysis. For example:

The watershed is composed of B and C type soils. The C type soils are mostly located in the northwest portion of the basin and make up approximately 85% of the basin area. The C type soils are mostly silty loams, while the type B soils are sandy silt. The basin is flat to gently rolling, with steep slopes found in the bluffs along the river. Plateaus can be found in the northwest portion of the basin.

d. Rainfall and Climatic Data

State the typical yearly rainfall of the watershed and the source of the data. Describe any relevant climatic characteristics. For example, if the area experiences frequent and intense rainfall events it should be documented.

e. Land Use

Describe observed land use in the watershed. List each use and the corresponding percentage of the watershed. Land uses types include commercial, industrial, residential, etc.

f. Sub-basins

Describe the method and process for dividing the watershed into sub-basins. If the watershed was not divided into sub-basins explain why. It may also be beneficial for the user to have a list of each sub-basin name or ID and its corresponding size. For example:

Following county requirements, peak discharges were obtained along the study reaches at all sections defining catchments with 100-acre increments in drainage, and at the confluence of tributaries. These sub-basins were delineated using automated Geographic Information System (GIS) routines and a Digital Elevation Model (DEM) obtained from ortho-rectified aerial photography.

3. Approach and Methodology

a. Methodology

Describe the hydrologic methodology and procedures used.

If a rainfall-runoff model is used, the following subsections should be added to the report:

i. Rainfall

Document the source of the depth-duration-frequency data. State whether any spatial distribution of storm data was incorporated into the model calibration. Document the choice of temporal storm distribution, storm duration, and the use of areal reduction factors (or lack thereof). If any of the data are not from an approved source, provide justification. In the latter case, document the data used, including the gages used and methods of fitting gage data to frequency curves and isohyets between gage sites.

ii. Rainfall Losses

Document the factors used in the calculation of rainfall loss. These factors can include soil type, vegetation type, and density, land use, percent of impervious area, and antecedent runoff conditions. Describe the methods used to compute the rainfall losses, the reasoning for using those methods, and the sources of data and methods used to measure parameters. Document the antecedent moisture level modeled for each frequency.

iii. Sub-basin Response

Sub-basin response can be modeled as a series of hydraulic processes or as a response function (the unit hydrograph). The unit hydrograph approach is preferred for developing FISs. If modeling with hydraulic processes is used, provide a full description of the process including the reasoning that it was chosen in lieu of a unit hydrograph approach. If the unit hydrograph is used, document the determination of parameters that set the shape and timing of the hydrograph. If the unit hydrograph is input as a table, document its derivation, including the sources of rainfall and runoff data and the outflow hydrograph.

iv. Routing

Document the routing methods used, including the values of input parameters, the derivation of those parameters, and methods of measurement and sources of data. If channel infiltration is modeled, document the approach used for calculating losses and the sources and methods of measurement of parameters used in the approach. Document the basis for any diversions from the watershed used in the modeling. Document the effect of encroachment on the computation of channel losses and storage and the relation between storage and the extent of the floodplain.

v. Input Hydrograph

Document the source and derivation of any inflow hydrographs that are estimated independent of the modeling process. If synthetic unit hydrographs are used, state the reasoning for selecting the hydrograph and document its derivation, including the sources of the rainfall and runoff data.

vi. Channel Storage

If channel storage routing techniques are used, the parameter documentation should explain the relation between storage and the extent of floodplain. When considering encroachment into the floodplain that can affect the computation of storage, document the effects.

vii. Reservoir Storage

Document the elevation-storage-outflow relation when using reservoir storage, including sources of data, reservoir operations, the outlet structure, etc.

viii. Calibration of Input Parameters

Calibration of runoff, sub-basin response, and routing parameters are performed through modeling major historic storms. Describe the calibration process. If storm calibration is done, document the storm dates, hourly data, and corresponding discharges. Also, document the parameters revised and rationale for revising. Document any and all comparisons and any resulting adjustments.

b. Assumptions

Document any and all assumptions made in the hydrologic analysis. For example:

There are five sub-basins that fall in the area of the "Fall Line" or boundary between the Blue Ridge and Piedmont regions. To avoid underestimating the peak discharges in this transition, a comparison was made using both regression equations. The Blue Ridge regression equation produced a slightly high peak discharge value. Therefore, it was assumed that the subbasins in the "Fall Line" area will be better represented by the Blue Ridge equations.

c. Gages

Document any gages in the study area with their USGS gage number and location description. State whether these gages were used in the discharge calculations. If not, explain the reasoning. For example:

Annual peak flow data are available for two USGS gages in the watershed:

- *Gage No. 01234567 on Mill Creek (31 years of data)*
- *Gage No. 08910111 on Beaverdam Creek (35 years of data)*

Figure 1 presents the flood discharge frequency curves calculated for the entire period of record at Mill Creek and Beaverdam Branch using the Bulletin 17B methodology, as implemented in the USGS PeakFQ computer program (Interagency Advisory Committee on Water Data, Guidelines For Determining Flood Flow Frequency, 1982). Station skew was *used, as these two sites are highly urbanized watersheds for which the Bulletin 17B generalized skew map is not applicable. The program output is presented in the Appendix.*

If gage records contain short, discontinuous, or non-homogeneous periods, and peak flow was enhanced using techniques described in Bulletin 17B, document any such enhancements.

d. Model Input

Describe the input data used in the chosen method. Document the derivation of all parameters, including the methods of measurements and sources. Example input parameters include time of concentration, curve number, drainage area, channel slope, impervious area, mean annual precipitation etc. For rainfall-runoff models, examples include storm distribution, storm duration, antecedent moisture level, rainfall losses, areal reduction factors, storage relationships, hydrograph information, etc.

e. Urbanization

State whether any of the study area is significantly urbanized. If so, document how the urbanization was accounted for in the hydrologic analysis. This should include a description of the method and input parameters. For example:

Maple County has numerous areas that are significantly urban (over 10 percent impervious). The impact of urbanization on peak flows within a catchment was estimated by the use of a Basin Development Factor (BDF), as presented in Flood Characteristics of Urban Watersheds in the United States (USGS Water Supply Paper 2207). The BDF is a rating between one and 12 that accounts for the amount of channelization, channel improvements, curb and gutter streets, and storm drain construction within the upstream, middle, and downstream thirds of the catchment. The urban flow, QU, is estimated from the rural flow, QR, area, A, and BDF as:

$$QU = 7.7 * A^{0.15}(13 - BDF)^{-0.32} QR^{0.82}$$

The BDF was estimated for each sub-basin utilizing aerial photography and GIS data for the location of storm drains.

f. Calibration

State whether any calibration was done. If so, describe the calibration process. For high water mark calibration include dates, measurements, and measurement locations of historic storms. Then document the parameters revised and rationale for revising. For storm calibration include dates, hourly data, and corresponding discharges.

4. Supporting Information

Document any other data used in the analysis that were not already described. For example, if a DEM was used to generate the watershed boundaries, its source and attributes should be documented.

5. Discharge Comparison
   a. Computed Discharges

   Document the results of the analysis. Additionally, show any input values that were calculated as described in the Methodology section.

   b. Effective Discharges

   State the current FEMA effective discharges and the method that was used to determine them. Most effective discharges can be found in the most recent FIS report or in a Letter of Map Revision (LOMR) study that updated the FIS report discharges.

   c. Comparison with Revised Discharges

   Compare the computed discharges with effective discharges, gage discharges, regression discharges, and any other discharges from reliable sources. Use both tables and graphs to illustrate this comparison. Form a conclusion using this comparison that includes discussion on the reasonableness of the model output. Document the similarities and differences between the values. Note any adjustments made to the computed discharges as a result. For example:

   Table 1 compares the 1-percent-annual-chance peak discharges from the effective Flood Insurance Study (FIS) report for Maple County, dated January 1, 1978, at eight locations in the county. Proposed discharges will be used in place of effective discharges to provide consistency in the study in consideration of the additional years of data available for the development of the new regression relations.

6. Summary of Final Discharge Values

   List all of the studied streams, the location where the discharge was estimated, and the corresponding final discharges. This is equivalent to the FIS Report Summary of Discharges table.

7. References

   Document any sources used to complete the report and locations of supplemental information.

8. Tables

   The tables listed below are helpful for studies with numerous streams.

   a. Stream Name, Hydrologic Analysis Method, and Final Discharge
   b. Comparison between Computed and Effective Discharges

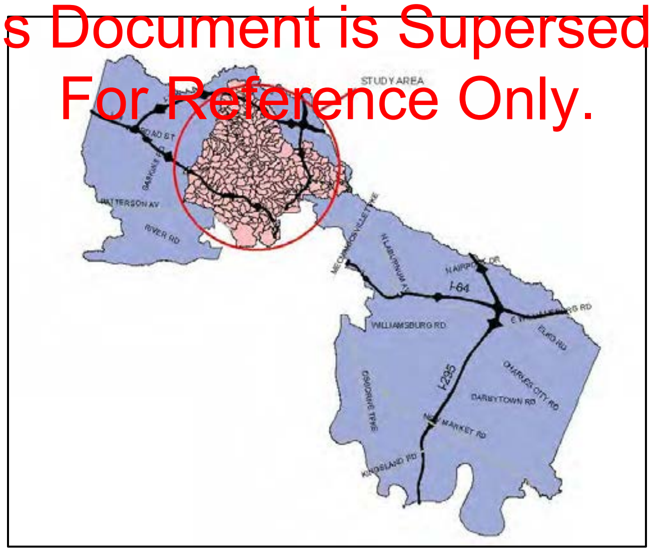
Figure 15: Example Hydrology Report Table: Comparison of Computed and Effective Discharges

Stream	FIS Reference XS	Region	Area (sq mi)	Proposed Discharges	FIS Discharges	Change in Discharge
Blue Creek	Cole Avenue	Blue Ridge	6.3	2,910	3,748	-22.37%
Green Creek	Miles Road	Blue Ridge	3.6	1,683	2,637	-36.17%
Briar Branch	Moon Road	Central Valley	0.6	1,375	1,965	-30.01%
Wolf Creek	Confluence w/ Red Branch	Central Valley	3.5	4,135	3,144	31.55%
Moose Branch	Mountain Road	Piedmont	3	3,065	4,235	-27.64%
Horsepen Branch	Interstate 99	Piedmont	1.2	2,155	2,358	-8.59%
Orchard Branch	Church Road	Piedmont	1.7	1,722	2,171	-20.66%
Beaverdam Creek	Sundburst Road	Piedmont	0.6	1,443	1,383	4.31%

9. Figures
   a. Study Area

Show the study area in reference to the county, state, etc. Circle and label the study area location. Include major landmarks, roads, and municipal boundaries in the graphic.

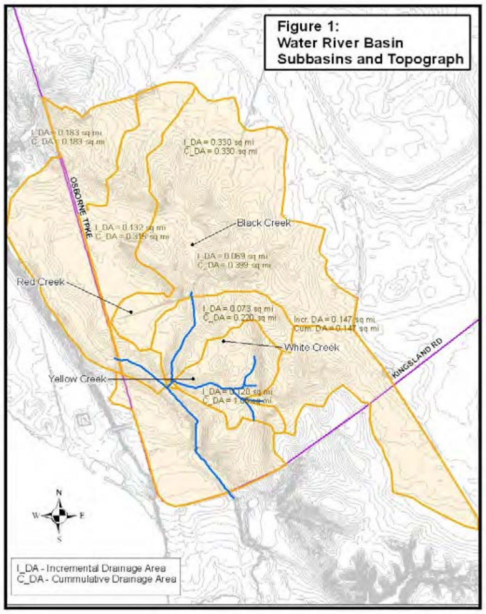
Figure 16: Example Hydrology Report: Map of Study Area



b. Watershed Map

Show the watershed and all of the sub-basins. Include sub-basin names/labels and drainage areas. If the watershed is large, a representative portion of the watershed can be shown to give the user an idea of typical basin size and delineation detail.

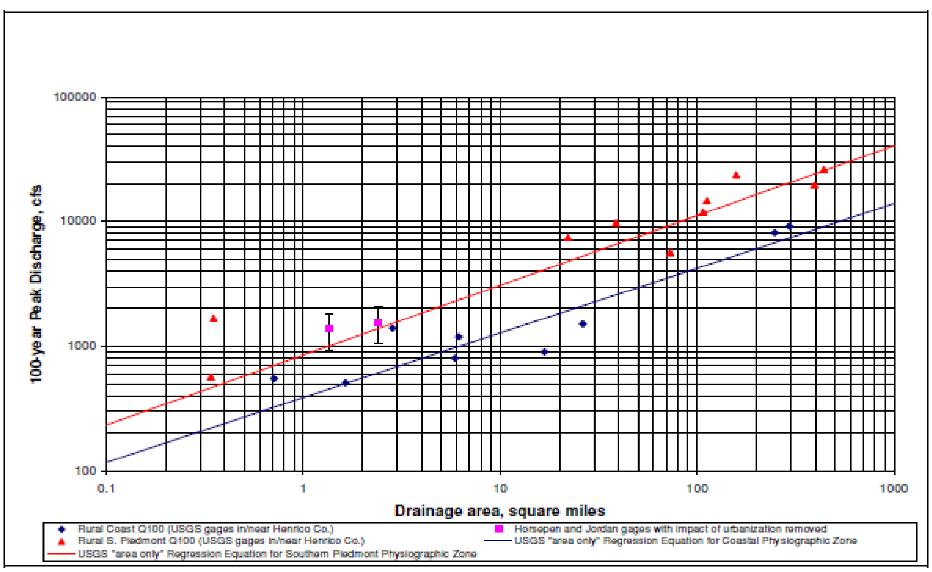
Figure 17: Example Hydrology Report: Watershed Map



c. Comparison Graph

This graph should show the computed discharges with effective discharges, gage discharges, regression discharges, and any other discharges from reliable sources versus drainage area.

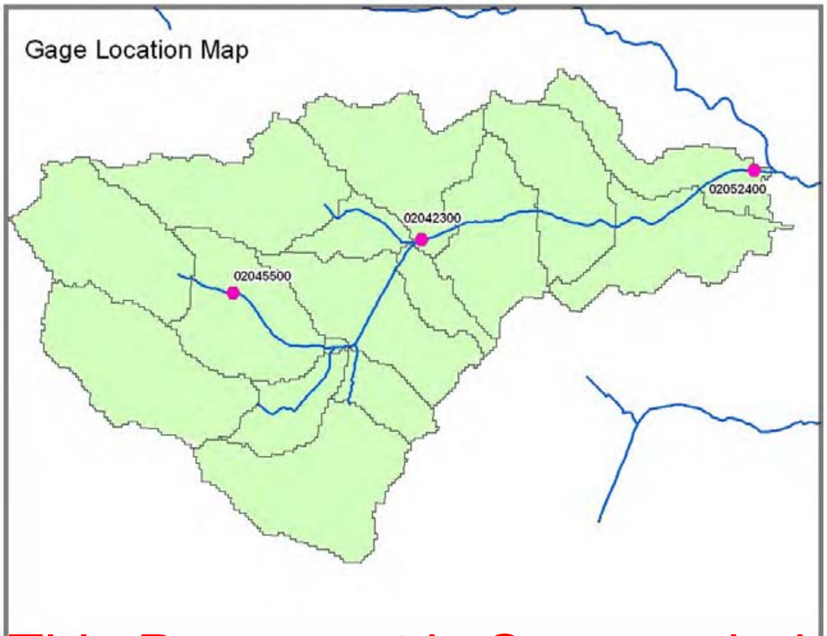
Figure 18: Example Hydrology Report: Discharge Comparison Graph



d. Gage Location Map

Show the gage locations in the study area. If possible, label the gages and streams.

Figure 19: Example Hydrology Report: Gage Location Map



10. Appendix

Input and Output from all hydrologic modeling

List all file names of backup data and analyses. This includes computation of any parameters used in the discharge calculations, discharge calibration, and any geospatial datasets used in the analysis.

6.1.2 FIS Report Section 5.1

FIS Report Section 5.1 discusses the hydrologic analyses and includes the following information:

- A Summary of Hydrologic and Hydraulic Analyses table that lists each studied stream and includes a description of the downstream and upstream study limits, hydrologic model, or method used, date of completion of the analyses, and any special considerations noted.
- A Summary of Discharges table that lists each studied stream and includes a description of the discharge location, drainage area, and lists the peak discharge for the 10-percent-annual-chance (10-year), 4-percent-annual-chance (25-year), 2-percent-annual-chance (50-year), 1-percent-annual-chance (100-year),and 0.2-percent-annual-chance (500-year) floods. If applicable, it should also include the 1-percent-annual-chance future conditions flood discharge.

- Frequency Discharge-Drainage Area Curves used to develop the hydrologic models, if applicable.
- A Summary of Non-Coastal Stillwater Elevations Table that provides a summary of 10-percent-annual-chance (10-year), 4-percent-annual-chance (25-year), 2-percent-annual-chance (50-year), 1-percent-annual-chance (100-year),and 0.2-percent-annual-chance (500-year) flood elevations at all studied lakes and ponds, and along streams in cases where elevations would create a flat profile along the studied reach.
- A table of Stream Gage Information used to Determine Discharges that lists the flooding source, stream gage identifier, gage owner, gage name, drainage area, and period of record for each gage used in the hydrologic analyses.

6.2 Simulations

The Simulations folder should include all of the Hydrology input and output files accompanied by a readme file that describes each of the submitted files. The number and type of required files depend on the model used.

Additional files only need to be submitted if the model used that particular aspect of the model. For example, if the HEC-HMS model was used and the analysis did not include any paired data input, the *.pdata file (file defining paired data) would not need to be submitted.

6.3 Supplemental_Data

Files of backup data and analyses that are not described or included in the hydrology report should be submitted in the Supplemental_Data folder. Some examples of backup data that could be included are as follows.

- Computations for time of concentration, such as the NRCS travel time computations for sheet flow, shallow concentrated flow, and channel flow (could be Excel spreadsheets or PDFs of worksheets in Technical Release-55 [TR-55]).
- Runoff curve number computations that document the percentage of the watershed with various land uses and NRCS hydrologic soil types (soil maps are not required).
- Ancillary data for estimating infiltration parameters for the Green-Ampt equation; derivations of unit hydrographs or S-graphs or estimation of synthetic unit hydrographs like the Snyder’s or NRCS unit hydrographs.
- Hourly (unit) rainfall and discharge data used to calibrate the rainfall-runoff model.
- Input and output files for frequency analyses of rainfall data.
- Input and output files from the USGS National Flood Frequency (NFF) or National Streamflow Statistics (NSS) computer programs for implementing the USGS regression equations.
- Geospatial files and supporting data for the computation of watershed and climatic characteristics for regional regression equations such as drainage area, channel slope, soils data (e.g., percent D soils), impervious area, and mean annual precipitation. These files support and complement the input files for the hydrologic model.

- Any files of backup data and supporting analyses that were not described or included in the hydrology report.

7.0 Hydraulic Data Submittal Guidance

This section provides guidance on the hydraulic data that are submitted to FEMA for the FIS with respect to rivers, lakes, closed basins, and ponds. The technical approach and the related backup data are generally determined based on the level of flood risk along a stream reach. It is assumed that a 1-D or 2-D hydraulic (steady or unsteady) model is used to estimate the Base Flood Elevations (BFEs) regardless of the level of flood risk.

FEMA accepts hydraulic results from over a dozen models and it is likely that new models will be added as acceptable in the future.

For riverine projects, Hydraulics data should be submitted to a sub-folder named with the appropriate HUC-8 code. Coastal projects, for which the scope is identified independently from riverine projects, may encompass more than one HUC-8 code and, therefore, they may be submitted to a subfolder associated with the studied flooding source (such as the Atlantic Ocean). Within those folders the Hydraulics deliverables should be organized by stream name and stream stationing, if applicable.

7.1 General

The General folder should include the Hydraulics Report, the draft FIS Report Section 5.2, as well as the Project Narrative, Certification (if applicable), and the Hydraulics Metadata file.

7.1.1 Hydraulics Report

The hydraulics report should document the methodology, assumptions, and data used in the hydraulic analyses. The report should have a title page that includes the study name, Mapping Partner name, community and state name, and the date that the report was produced. The hydraulics report must be submitted in Word and PDF format per the Data Capture Technical Reference.

Below is an annotated table of contents for a typical hydraulics report. The outline below is not inclusive of every item all studies should incorporate. Each study will have different aspects, so it is very likely that the Mapping Partner will have to incorporate and/or delete items from the provided outline. The outline below is for a study that includes SFHAs with high flood risk. For studies without SFHAs with high flood risk, the table of contents may be significantly shorter.

Tabular information that more closely corresponds to applicable FIS Report tables may also be included in the Hydraulics Report in lieu of narrative descriptions.

Examples are given for several of the items in the outline. Please note that the examples do not represent ‘actual’ data. Stream names, locations, county names, etc., were generated only as a reference.

1. Introduction

   a. Study Area

Describe the location of the study. Include the state, county, major landmarks, and nearby roads. Define the limits of the study.

   b. Purpose and Type of Study

Describe why the study is being done. In general, revised hydraulic analyses could be initiated for the following reasons:

- Hydraulic modeling software that upgrades or supersedes software used to develop the FIRM.
- Topographic information that is more accurate and/or higher resolution than the topographic information reflected in the hydraulic analyses used to develop the FIRM.
- Discharge-frequency relations different than those reflected in the hydraulic model used to develop the FIRM.

Document the type of study (SFHAs with high flood risk, SFHAs with moderate flood risk, SFHAs with low flood risk). If the study is a combination, list the names of the streams and their corresponding type of study. State the miles of study completed for each study type.

   c. Type of Flooding

State whether the study is located in a tidal or riverine area. If there are tidal influences, discuss the limits of such. Streams with tidal influence will be discussed in a separate Coastal Report.

   d. Flooding History

State whether the area has a history of flooding. If so, describe the location and the event that caused the flooding.

   e. Other General Information

Insert any other information for general use that does not fit in any other subsection. For example, there may have been another study completed recently in the same area that the user should know about.

2. Methodology and Modeling

   a. Methodology

Describe the hydraulic methodology and model (including version) used. Methods include:

- Normal depth computations
- One-dimensional steady flow models
- One-dimensional unsteady flow models

- Two-dimensional models

The hydraulic models represent one-dimensional (1-D) or two-dimensional (2-D) flow conditions. The 1-D models utilize cross-sectional data while the 2-D models utilize a grid of ground-elevation points. U. S. Army Corps of Engineers (USACE) Hydraulic Engineering Center River Analysis System, version 3.0.1 (HEC-RAS) HEC-RAS is a commonly used 1-D model.

Generally, a hydraulic model is used to estimate BFEs for SFHAs with moderate to high flood risk and may be used for SFHAs with low flood risk. For example:

The hydraulic model used for this flood study is the USACE Hydraulic Engineering Center River Analysis System, version 3.0.1 (HEC-RAS). The HEC-RAS models were developed for the 1-percent-annual-chance flood event for [list stream names] and the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events for the [list stream names].

b. Assumptions

Document any and all assumptions made in the hydraulic analyses.

c. Topography

Describe what type of terrain data were used in the study. Include the source of the data and attributes in an appropriate Federal Geographic Data Committee (FGDC)-compliant metadata file. For example, if a DEM was used, document the corresponding resolution. If the topography was generated in house, document its derivation. State the vertical datum of the topographic data and of the study. If they are not the same, state the conversion and document how the value was obtained. For two-dimensional models, digital terrain that covers the entire study area is required and the derivation or development of this grid must be clearly documented. For example:

Topographic data for the floodplain models was developed using aerial photography flown in February of 1998 at a scale of 1"=100' and 2-foot contours, with the American Society of Photogrammetry and Remote Sensing (ASPRS) accuracy standards for 1"=100' mapping. This data was then used to create a TIN. Data are referenced in New Jersey State Plane Coordinates, units feet, horizontal datum NAD83, vertical datum NAVD 88, units feet.

d. Survey

Describe the extent of any survey done in the study area and how it was incorporated into the model. Document whether any survey data were used at cross sections and/or structures. For example:

Every crossing was surveyed in detail during the summer of 2004. Surveyed items for bridges include the deck, low chord, parapet, and channel sections at the upstream and downstream faces. Surveyed items for culverts include the culvert soffit, invert, top of road, and channel sections at the upstream and downstream faces. The channel was surveyed every 1000 ft and incorporated into the model by merging the data with overbank points from the TIN. Please see the Appendix for diagrams of each surveyed structure.

e. Boundary Conditions and Tie-ins

Describe how the starting conditions of the models were determined. Document any stream that did not tie-in appropriately. For one-dimensional unsteady modeling, document the sources of data and reasoning used to assign frequencies to the hydrographs for the boundary conditions.

For two-dimensional models, justify the reasonableness of the initial condition. This should include process to develop initial conditions and the reasonableness of them. In addition, document the investigation into using different processes to generate the initial conditions. Include discussion of the sensitivity of the results with respect to storm history and the implication regarding the frequency assigned to the results. For example:

The downstream starting water surface elevation (WSELs) for all profiles in the HEC-RAS models were calculated using normal depth method with the exception of Red Run and Briar Branch. Red Run ties into an existing studied stream at the downstream end; therefore, the model started with a known WSEL from the effective FIS. Briar Branch ties into an existing studied stream at the downstream end; therefore, that model started with a known WSEL from the existing study model.

f. Cross Sections

Describe how the station/elevation data of the cross sections were determined and their source. If data is from multiple sources, explain how the data were merged. For example, the source of the overbank area could be from a DEM, while the channel points could be from a survey. Describe the method for placing the cross sections. Include the method for aligning the cross sections with contours and cross section spacing. Where stream dimensions were approximated, describe the reasoning behind the approximation. If any cross sections are not aligned perpendicular to the flow, document why. For example:

The floodplain cross sections were placed at representative locations, approximately 500 feet apart along the stream centerline. Cross section geometries were obtained from a combination of field survey and cross sections takeoffs based on topographic data provided by the county. Several channel cross sections for each stream were field surveyed. The detailed survey data are presented in Appendix A. Surveyed channel sections were propagated upstream and downstream to non-surveyed cross sections and blended with data from the topographic sources. All cross section overbank ground information was obtained from a TIN developed from the topographic data.

g. Structures

Document the number and type of structures modeled. Describe how each structure was included in the analysis and document the source of the data. Unless surveyed in the field, include an explanation of how the hydraulic structure data were tied to a vertical datum and how the alignment of the structure relative to the stream and floodplain was determined. Describe the process for all data that was approximated. For hydraulic structures that are designated to divert flood flow from its natural path (flood gates, diversion channels, etc.)

state the owners and operators of the structure(s); the date it became operational; operation, inspection, and maintenance plans; and as-built plans describing the dimensions and identifying any moving parts. For each modeled structure, dimensions of the crossing, values of loss coefficients, and the reasoning behind those values should be provided.

Include a clear statement of whether those values and corresponding reasoning are based on observation, measurement, or assumption. Where structures were approximated, describe the reasoning behind the approximation. For two-dimensional modeling, documentation also includes a list of each cell associated with the structure, and a description of the rating table including the derivation, and sources of data. For example:

All structures along the stream were field surveyed. The survey was completed in the summer of 2004 by Smith & Associates. The detailed structure survey data are presented in Appendix A. The study did not include any hydraulic structures designed to divert flow. In general, contraction and expansion coefficients were increased to 0.3 and 0.5 at each structure's upstream and downstream face sections and at the approach section. All other contraction and expansion values were kept at 0.1 and 0.3, respectively.

h. Ineffective and Storage Areas

Document whether any ineffective areas were used. Document their location and the methodology used in incorporating them into the model. The use of roughness coefficients to define ineffective flow areas should be clearly documented. Include a clear explanation of the natural conditions where artificial data have been used.

Document whether any storage areas were used. Document their location and the methodology used in incorporating them into the model. Document the elevation-storage relationship of any storage areas. Include methods, sources, and measurements of data used to define the relations. For example:

Ineffective flow areas (e.g., extremely dense trees and underbrush, dense residential areas, large buildings, fenced areas) were modeled in HEC-RAS by using high Manning's n-values to account for the ineffective areas. No storage areas were used in the model.

i. Channel Roughness Values

Document how channel roughness values were determined. List the range of values used for the channel and overbanks. Describe the types of land cover along the streams and the corresponding n-values.

Document any abnormally high or low values and explain why they were used. Include photographs, if roughness values were based on on-site observations. If roughness values were adjusted based on calibration, a summary of the values before and after the adjustments should be included. For example:

Manning's n-values were estimated based on field inspection of stream channels and floodplain areas for the streams in the county. GIS coverage of floodplain and channel n-values was developed. This GIS coverage consists of "bands" of Manning's n-values. These bands were developed using the field reconnaissance and the orthophotos provided *by the county. The purpose of the n-values "band" coverage is to allow the consistent application of Manning's n-value estimates. Channel n-values ranged from 0.03 to 0.05 and overbank n-values ranged from 0.06 to 0.15. Generally, grassy areas were given an n-value of 0.09 while highly wooded areas were given a value of 0.14. Ineffective flow areas were modeled using high Manning's n-values.*

j. Split and Diverted Flow

Describe how the amount of flow to analyze was determined. Document the location along the main channel of the split or diversion, and the location of the downstream limit of analyses.

k. Other Model Input

Describe any additional model input and how it was determined. Documentation of parameters used in analyses should describe the derivation of those parameters, and methods of measurements and sources from which data supporting those parameters were obtained or measured. Examples include downstream reach lengths, contraction/expansion coefficients, bank locations, etc. In many cases, geometry for urban watersheds is often available from databases managed by public utility agencies. If such data are used, document the name of the database, format, accessibility, and contact information.

l. Floodway

Describe the methodology regarding the floodway analysis. If the hydraulic model was used to generate the floodway, state the method used. If applicable, document the target change in water-surface elevation.

Include meeting minutes of all coordination meetings with community officials regarding the encroachment methods chosen and why. Include the date, time, and location of such meetings and a list of attendees.

m. Floodplain Boundaries

Document the methods used to develop the flood surface and to determine the floodplain boundaries.

n. Calibration

Describe the calibration process. Include historic storm dates, measurements, and locations of high water marks. Document the parameters revised and rationale for revising. Document any and all comparisons and any resulting adjustments. High water marks should be shown on a map. For example:

Eight high water marks were obtained from interviewed residents. However, each of the high water marks taken represented an event that was less than or equal to the 10-year event, making calibration of these marks difficult.

Each of these marks was less than the 10-year event in the hydraulic models. As a reasonability check, the mapped flood boundaries for each of the studied streams were compared with the widths of the existing Zone A boundaries mapped on the effective FIRMs *where applicable. Each of the revised boundaries seemed to roughly have similar shapes and widths with the effective Zone A areas on the effective FIRM maps.*

3. Other Supporting Information

Document any other data that was used in the analysis that was not already described. For example:

Several streams included reaches that were partially conveyed through storm drain systems. In most cases, these systems were short in length and included in the model. The pipe diameters and lengths were obtained from county records. Since typical storm drain systems are designed to convey only the 10-percent-annual-chance flood event, many of the systems were not able to handle the flows and flooding resulted.

4. Results

Discuss the overall results of the analyses. For two-dimensional models, discuss the sensitivity of the results with respect to storm history and the implications regarding the frequency assigned to the results.

Document the effects of supercritical flow velocity on the flood carrying capacity and stability of natural or improved channels. Any findings on the risk of stability or flood carrying capacity of natural or improved channels during a flood should be fully documented.

5. Effective Elevation Comparison

Do the newly studied streams improve the detail of the effective study? Compare the effective elevations in various locations with the ones generated. Form conclusions using this comparison. Explain any significant differences.

6. References

Document any sources used to complete the report and locations of supplemental information.

7. Tables

The tables listed below are helpful for studies with numerous streams.

   a. Stream Name, Study Type, and Hydraulic Model

Figure 20: Example Hydraulics Report Table: Stream Name, Study Type, Hydraulic Model

Stream	Study Type	Hydraulic Model
Blue Creek	Limited Detailed	HEC-RAS
Green Creek	Limited Detailed	HEC-RAS
Briar Branch	Detailed	XP-SWMM
Wolf Creek	Detailed	XP-SWMM
Red Run	Limited Detailed	HEC-RAS
Moose Branch	Limited Detailed	HEC-RAS
Horsepen Branch	Detailed	HEC-RAS
Orchard Branch	Limited Detailed	HEC-RAS
Lizard Creek	Limited Detailed	HEC-RAS
Beaverdam Creek	Limited Detailed	HEC-RAS

b. Stream Name, Upstream Limit, Downstream Limit, Study Length, Study Type

Figure 21: Example Hydraulics Report Table: Stream Name, Study Limits, Length, Study Type

Stream Name	Downstream Limit	Upstream Limit	Miles Studied	Study Type
Blue Creek	Confluence with Wolf Creek	Approx. 0.7 miles downstream of Apple St.	1.3	Updated Detailed
Green Creek	Confluence with Moose Branch	Approx. 1.1 mi upstream of Horse Ave.	14.2	New Detailed
Briar Branch	Confluence with Blue Creek	Approx. 1.2 miles downstream of Ross St.	1.1	Redelineation
Wolf Creek	Approx. 0.1 miles downstream of Holt St.	Approx. 0.1 mi upstream of Denver Ave.	1.7	Redelineation
Red Run	Confluence with Wolf Creek	Approx. 0.2 miles downstream of Hawk Lane	0.9	New Approximate
Moose Branch	Confluence with Wolf Creek	Nine Mile Road	0.8	Updated Detailed
Horsepen Branch	Approx. 0.05 mi upstream of Windsor Ave.	Approx. 0.9 miles upstream of Snow St.	3.2	New Detailed
Orchard Branch	Confluence with Horsepen Branch	Approx. 1.2 miles upstream of the confluence with Horsepen Branch	1.2	New Limited Detailed
Lizard Creek	Confluence with Horsepen Branch	Approx. 0.5 miles upstream of the Turtle Avenue	0.9	New Limited Detailed
Beaverdam Creek	Confluence with Horsepen Branch	Approx. 0.2 miles upstream of the Allen Road	0.7	Updated Limited Detailed

8. Figures

a. Study Area Location Map

Show the study area in reference to the county, state, etc. Circle and label the study area. Include major landmarks, roads, and municipal boundaries

b. Flow Change Locations

This map should indicate the flow change locations used in the hydraulic model using a generalized schematic of the stream network and relevant cross sections, subbasins, or other features that indicate the relationship between the hydrologic and hydraulic analyses.

c. Mapping Data

A listing of the work maps for stream reaches should be included.

The work maps can be submitted in the graphical format of the preliminary maps. If an alternate graphical format is chosen, the work maps should include stream centerline, topography, cross section locations, floodway, and floodplain boundaries. This information should be placed over an aerial photograph or a vector base map.

9. Appendix

Input and Output from all hydraulic modeling

Include tables and profiles from hydraulic model. For example, if HEC-RAS is used the output found in Standard Table 1 should be submitted.

- List of file names of backup data and analyses
- This includes computation of any parameters used in the hydraulic analyses
- Description of photographs taken during field survey to support hydraulic analyses

7.1.2 FIS Report Section 5.2

FIS Report Section 5.2 discusses the hydraulic analyses and should include the following information:

- A Summary of Hydrologic and Hydraulic Analyses table that lists each studied stream and includes a description of the downstream and upstream study limits, hydraulic model or method used, date of completion of the analyses, flood zone, and any special considerations noted.
- A Roughness Coefficients table showing the channel and overbank “n” values for each studied stream.

7.2 Simulations

The Simulations folder should include all of the Hydraulics input and output files accompanied by a readme file that describes each of the submitted files. This includes files for all modeled frequencies required by the Task Order (e.g., the 10-, 4-, 2-, 1-, 0.2-percent-annual-chance floods and 1-percent-plus), if within the scope of the mapping project (if applicable, 1-percent-annual-chance profiles with and without levees) and the floodway analysis.

All input and output files used for levee analyses should be submitted including levee analysis for the 1-percent-annual-chance flood (e.g. de-accredited left levee and hold right levee, de-accredited right levee and hold left levee, both levees in place, and both levees de-accredited), as well as levee analyses for all flood frequencies required by the Task Order (e.g., the 10-, 4-, 2- percent-annual-chance floods with levees in place and the 1- and 0.2-percent-annual-chance floods without levees in place) .

The number and type of required files depends on the model used. Additional files only need to be submitted if the model used that particular aspect of the model. For example, if the HEC-RAS model was used and the analysis did not include any unsteady modeling, no unsteady flow file (*.u01) would need to be submitted. However, the corresponding steady flow file (*.f01) would need to be submitted.

7.3 Profiles

RASPLOT, DXF or DWG files containing profiles for all flood frequencies required by the task order (e.g., 10-percent-annual-chance [10-year], 4-percent-annual-chance [25-year], 2-percent-annual-chance [50-year], 1-percent-annual-chance [100-year], and 0.2-percent-annual-chance [500-year] floods) should be submitted for inclusion in the FIS Report.

7.4 Floodway Data Tables (FWDT)

Floodway Data Tables (FWDT) that list each cross section, stream distance, floodway width, section area, mean velocity, regulatory 1-percent-annual-chance water surface elevation, 1-percent-annual-chance water surface elevation without floodway, 1-percent-annual-chance water surface elevation with floodway, and elevation increase for each studied stream that includes a floodway should be submitted for inclusion in the FIS Report.

7.5 Supplemental_Data

Files of backup data and analyses should be submitted in the Supplemental_Data folder. Some examples of backup data that could be included are as follows:

- Overbank distances used in certain models such as HEC-RAS
- Hydraulic computations used as input to the hydraulic model such as stage-discharge relations at culverts for two-dimensional models
- Calibration information, such as high-water marks
- Maps of historical flooding
- Spatial files of n-value polygons used in model calibration
- Work maps

The structure of these files is at the discretion of the submitting Mapping Partner.

7.6 Spatial_Files

Spatial data must be submitted a format consistent with the FIRM Database Technical Reference. However, for the Hydraulics Data Capture submittal, the submitted data must match the model output with respect to floodplain boundaries, cross sections, and water surface elevations and their precision. Unlike in the regulatory data submittals, floodplain boundaries and cross sections should not be cartographically modified, and the data may not necessarily agree exactly with the regulatory FIRM, FIRM Database, flood profiles, and Floodway Data

Tables. Review the FIRM Graphics Guidance document for information about cartographic modifications to cross section locations.

8.0 Alluvial Fan Data Submittal Guidance

This section describes the type and format of data needed to map the 1-percent-annual-chance flood associated with alluvial fans. A typical approach for the identification and mapping of alluvial fan flooding can be divided into three stages:

Stage 1 – Recognizing and characterizing alluvial fan landforms.

Stage 2 – Defining the nature of the alluvial fan environment and identifying active and inactive areas of the fan; and

Stage 3 – Defining and characterizing the 1-percent-annual-chance flood within the defined areas.

Under Stage 3, there are several acceptable methods for defining the base flood depending on the characteristics of the alluvial fan. These methods are as follows:

- FAN computer program (FEMA, 1990) used for highly active, conical fans – definition of Zone AO areas with depths and velocities.
- Sheetflow Analysis: used for shallow flooding across uniformly sloping surfaces – definition of Zone AO with depths.
- Hydraulic Analytical Methods: used for entrenched channel networks or constructed channels (1-D model) or uncertain flow paths (2-D model) – definition of Zone A, Zone AE, and/or Zone X.

- Geomorphic Data, Post-Flood Hazard Verification, and Historical Information: used for alluvial fans with little or no urbanization – definition of Zone X and/or Zone A areas.
- Composite Methods: used for fans with unique physical features in some locations – some combination of the above methods.

Alluvial Fan data should be submitted to a sub-folder named with the appropriate HUC-8 code. Within those folders, the Alluvial Fan deliverables should be organized by stream name.

8.1 General

The General folder should include the Alluvial Fan Report, the draft FIS Report Section 5.4, as well as the Project Narrative, Certification(if applicable), and the Alluvial Fan Metadata file.

8.1.1 Alluvial Fan Report

The Alluvial Fan Report should discuss various disciplines including geomorphology, soil science, hydrology, and hydraulics. The report should have a title page that includes the study name, Mapping Partner name, community and state name, and the date that the report was produced. The Alluvial Fan Report must be submitted in Word and PDF format per the Data Capture Technical Reference.

Below is an annotated table of contents for a typical Alluvial Fan Report. The outline below is not inclusive of every item all studies should incorporate. Each study will have different aspects, so it is very likely that it will be necessary to incorporate and/or delete items from this outline.

Tabular information that more closely corresponds to applicable FIS Report tables may also be included in the Alluvial Fan Report in lieu of narrative descriptions.

1. Introduction

   Briefly describe the purpose of the study and its location.

2. Sources and References

   Document all sources and references used in the analysis. These items can include geologic maps, soils maps, topographic maps (include vertical datum), field reconnaissance reports, historical records, geomorphic information, photographs, and time-sequence aerial photography. Include the dates that the data were produced and all other applicable attributes.

   a. Stage 1: Recognizing and Characterizing Landforms

      i. Composition

      Discuss the composition of the alluvial fan. Is the landform a sedimentary deposit composed of alluvium or debris-flow deposits? Use soil maps to document the specific types of soil found at the site. For example:

      The NRCS map shows that the alluvial fan is comprised of Carrizo-Riverwash complex with 3 to 8 percent slopes. The Carrizo series consists of very deep, excessively drained soils formed in mixed alluvium. They are commonly found on flood plains and alluvial fans.

      ii. Morphology

      Discuss the shape of the alluvial fan. State whether the fan is partly or fully extended. Discuss the flow patterns of the fan. Use topographic maps and aerial photographs to illustrate this point.

      iii. Location

      Discuss and illustrate the location of the topographic and hydrographic apex of the alluvial fan. Document the characteristics of these locations. For example:

      The upstream limit of the alluvial fan is located approximately 1500 feet upstream of Interstate 40. At this location, the floodplain begins to expand significantly. The downstream limit of the fan is approximately 3,200 feet downstream of Willow Road. At this location, the Carrizo series soils change to silty clay. The limits of the alluvial fan can be seen on Figure A.

iv. Defining Toe and Lateral Boundaries

Discuss and illustrate the location of both the toe and lateral boundaries of the alluvial fan. Document the characteristics of these locations.

b. Stage 2: Defining the Active and Inactive Areas

i. Field Inspection

Document weathering characteristics, such as desert pavement, rock varnish, B-horizon development in the soil profile, calcic-horizon development, and pitting and rilling of clasts. Discuss your findings and how they relate to relative age of the alluvial fan.

Document the types of vegetation found at the site and their density. Discuss all findings and how they relate to composition of the sediment and waterholding capacity of the alluvial fan.

State whether the flow paths of the alluvial fan were evaluated by a field visit to verify the active and inactive portions of the fan. If there was no field visit, explain.

ii. Identification Process

Discuss the overall process of distinguishing between active and inactive areas . Describe the types of data used and any assumptions relating to the classifications.

iii. Identification of Active Areas

Define the active portions of the alluvial fan. These are locations where deposition, erosion, and unstable flow paths are possible. Use historic records, photographs, time-sequence aerial photography, engineering, and geomorphic information to support this conclusion.

iv. Identification of Inactive Areas

Define the inactive portions of the alluvial fan. Inactive alluvial fan flooding is similar to traditional riverine flood hazards and is characterized by relatively stable flow paths.

v. Flooding Types

Describe the types of flooding in the alluvial fan and their locations. The most common flooding types are:

- Flooding along stable channels
- Sheetflow
- Debris flow
- Unstable flow path flooding

c. Stage 3: Defining the 1-Percent-Annual-Chance Flood

i. Methodology

Several methods are approved by FEMA for alluvial fan analysis. Each method has associated assumptions, limitations, and recommended applications. The most applicable method should be chosen based on the alluvial fan's characteristics. State what method was chosen and address why this method was the best fit for the study.

ii. Assumptions

Document any and all assumptions made in the alluvial fan analysis.

iii. Protection Measures

Discuss any flood protection measures. Include the type of protection, age, ownership, size, and location and describe any analyses that demonstrate the measure provides protection from the base flood.

iv. Extent of Flooding

Describe the results of the analysis including the extent and degree of the flooding within the defined area. Provide a map with the entire alluvial fan area and the corresponding flooding.

d. Sediment Transport

i. Sediment Load

Sediment load can be estimated using either of two systems: bed load and suspended load; or wash load and bed-material load. Document the system that was used, the results of the analyses, and all supporting information.

ii. Approach (Shear stress, power, parametric)

Document the approach used in the analysis. Discuss why a certain method was chosen, state any assumptions, and document all data used in the process. Document the applicability of the formula with the site-specific field data.

e. Appendix

i. Input and Output for the 1-percent-annual-chance flood for the hydraulic model used in the analysis
ii. List of file names of backup data and analyses. This includes computation of any parameters used in the hydraulics analyses.

8.1.2 FIS Report Section 5.4

FIS Report Section 5.4 discusses the alluvial fan analyses and should include the following information:

- A Summary of Alluvial Fan Analyses table that lists each studied stream and includes a description of the fan apex and toe locations, drainage area, alluvial fan model(s) used, date of completion of the analyses, and a brief description of the methodology.
- A Results of Alluvial Fan Analyses table that lists each studied stream and includes a description of the fan apex and toe locations, 1-percent-annual-chance peak flow at fan apex, flood zones and depths, and minimum and maximum velocities.

8.2 Simulations

The Simulations folder should include all of the Alluvial Fan input and output files accompanied by a readme file that describes each of the submitted files. The number and type of required files depends on the model used.

8.3 Profiles

Profiles for the 1-percent-annual-chance flood should be submitted. Profiles can be created as DXF or DWG files and should be edited for content for inclusion in the FIS Report.

8.4 Hydraulic_Databases

Input and output files for the 1-percent-annual-chance flood for any hydraulic models, if used in the alluvial fan analysis and not included in the Simulations folder.

8.5 FAN_Program_Files

Input and output files for the FAN program (FEMA, 1990) should be submitted if used for the alluvial fan analysis and not included in the Simulations folder.

8.6 Supplemental_Data

Files of backup data and analyses should be submitted in the Supplemental_Data folder. Some examples of backup data that could be included are as follows:

- Under Stage 1, materials such as geologic maps, field reconnaissance reports, topographic maps, and aerial photographs used to identify the landform as an alluvial fan
- Under Stage 2, historic records of flooding, photographs, time-sequence aerial photography, and geomorphic information that illustrate either active or inactive alluvial fan flooding
- Under Stage 3, any geospatial datasets used for parameter calculation, if applicable, such as a spatial file of n-value polygons should be submitted
- Work maps.

The structure of these files is at the discretion of the submitting Mapping Partner.

8.7 Spatial_Files

Spatial data must be submitted a format consistent with the FIRM Database Technical Reference. However, for the Alluvial Fan Data Capture submittal, the submitted data must match the model output with respect to floodplain boundaries, cross sections, and water surface elevations and their precision. Unlike in the regulatory data submittals, floodplain boundaries and cross sections should not be cartographically modified, backwater may not have been accounted for, minor drawdowns may still exist in the data, and the data may not necessarily agree exactly with the regulatory FIRM, FIRM Database, flood profiles, and Summary of Alluvial Fan Analyses and Results of Alluvial Fan Analyses tables.

9.0 Coastal Data Submittal Guidance

This section provides guidance on the coastal data that are submitted to FEMA for the FIS. Coastal projects, for which the scope is identified independently from riverine projects, may encompass more than one HUC-8 code and, therefore, they may be submitted to a subfolder associated with the studied flooding source (such as the Atlantic Ocean). Within those folders, the Coastal deliverables should be organized by project name, if applicable.

As noted elsewhere, the MIP data upload limitation is currently 2GB. Due to their typically large file size, it is likely that some of the Coastal data submittals will need to be submitted on media (DVD/portable hard drive) to the Data Depot for upload to the MIP via a backend process. The Coastal data submitted on media should be organized in the appropriate folders as specified in the Data Capture Technical Reference in order to facilitate the backend data upload by Customer and Data Services (CDS). Only folders appropriate to the project need to be created.

The Coastal Data Capture Guidance document describes the type and format of data that must be submitted to FEMA for coastal Flood Risk Projects. All data must be submitted in digital format. Coastal data for the entire project (area studied) contracted should be submitted by the Mapping Partner. Ultimately, all of the data needed for a qualified third party to reproduce all aspects of the study results should be submitted.

The Coastal Study Documentation and Intermediate Data Submittals Guidance document describes the Coastal Intermediate Data Submittals (IDSs) for coastal Flood Risk Projects. All relevant coastal IDS documentation completed for the project, including appendices and QA/QC documentation should be submitted. Only the final reports and associated documentation and literature should be contained in these folders; all relevant data and modeling files should be captured within the file structures as required by the Data Capture Technical Reference.

10.0 Regulatory Products Submittal Guidance

Regulatory products (or subsets thereof) are submitted under several MIP workflow tasks to include Floodplain Mapping/Redelineation, Draft, Preliminary, and Final. The FIRM Database Technical Reference provides information about the standards, file format, data dictionary, topology rules, etc. for the FIRM Database files that are submitted.

The Data Capture Technical Reference provides a detailed description of the Preliminary and Final Regulatory Products that must be delivered to the Map Service Center. In addition to the final georeferenced FIRM panel images (RFIRMs) that must be submitted, Mapping Partners may also submit the panel Esri® ArcMap Documents (MXDs) used to create the final FIRM panel images.

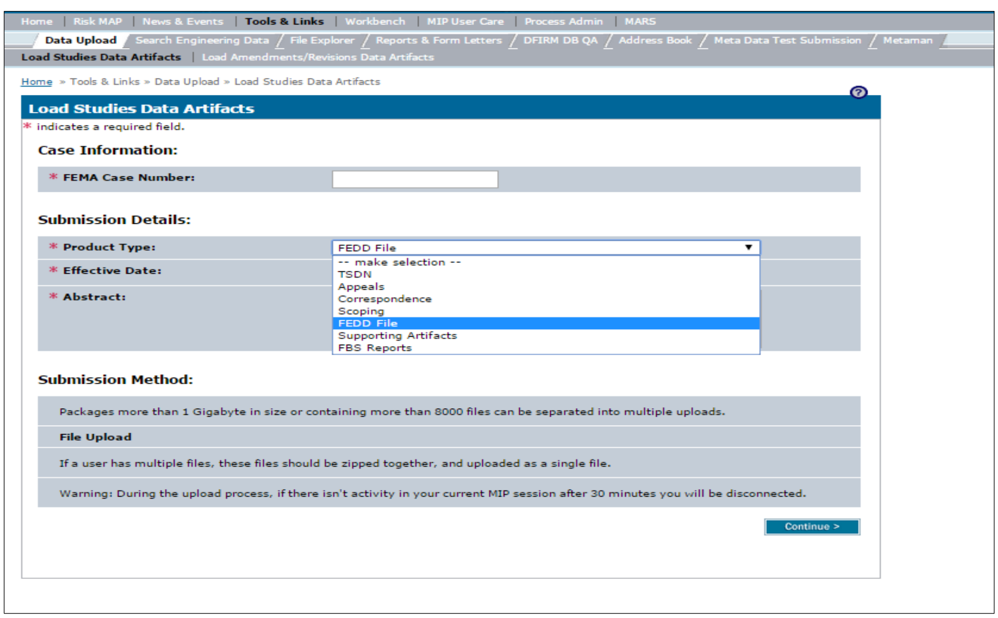
11.0 Post-Preliminary Data Submittal Guidance

There are a number of data artifacts generated for studies throughout the post-preliminary processing, such as the Flood Elevation Determination Docket (FEDD), preliminary and final Summary of Map Actions (SOMAs), and Revalidation letters. These include important information about the studies and retention of much of this information, including the FEDD, is required by regulation. In addition, meeting reports, minutes, and/or other artifacts are generated from several community engagement meetings, such as the Flood Study Review meeting, Community Coordination Officer (CCO) Meeting/Open House, and Resilience meeting, throughout the life cycle of a mapping project that are maintained in the correspondence case file. It is extremely important that FEMA capture these data artifacts as studies are completed, to ensure a complete set of technical and administrative project data is available when questions arise about these studies and/or these studies are updated in the future. Also, review the Post-Preliminary Guidance document for additional information about post-preliminary deliverables.

The Post-Preliminary data deliverables should be uploaded to the MIP using the Tools and Links/Data Upload/Load Studies Data Artifacts portlet and the applicable dropdown option. An example is in Figure 22 below. Include an applicable keyword (e.g., FEDD, TSDN, Floodplain Boundary Standard [FBS], etc.) in the Abstract field of the upload portlet so it can be used as a search keyword and so the files can be placed in the appropriate folder on the MIP.

Review the Data Capture Guidance General document for additional information about submitting revised data, to include revised preliminaries, appeals, and replacing or superseding data in the MIP. Refer to the Post-Preliminary Deliverables Guidance and the Preliminary Distribution and Revised Preliminary Guidance documents for additional information.

Figure 22: MIP Upload: Load Studies Data Artifacts



11.1 Quality_Records

Records that document the successful completion of the Quality Review (QR) process for the Flood Risk Project should be uploaded to the Quality_Records folder. Review the Quality Management Guidance document and the Quality Review Guidance document for details of the QR process and the applicable forms and checklists for each of the reviews.

Per the Quality Review Guidance document and the Data Capture Technical Reference, the following forms should be included in this folder:

- QR1 Passing Report
- QR2 Passing Report
- Pre-QR3 Submission Questionnaire and Self-Certification form
- Post-QR3 Confirmation and Self-Certification form
- QR3 Checklist
- QR5 Checklist
- QR5 Passing Report
- QR5 Shapefile(s)
- QR7 Checklist
- QR7 Passing Report
- QR8 Checklist
- SOMA Checklist

11.2 Floodplain Boundary Standards (FBS) Self-Certification

Per Standard #397, the Floodplain Boundary Standards (FBS) self-certification documentation and data must be submitted within 30 days after a mapping project is issued preliminary and also within 30 days of the issuance of the Letter of Final Determination (LFD) if there were changes to the SFHA boundaries during the post-preliminary phase. The final floodplain (SFHA) boundaries (after tie-ins to structures and smoothing of boundaries, if necessary, are completed) are to be used for FBS compliance checks. Review the FBS Guidance document for details about the FBS self-certification process and its documentation in the FBS Report.

Each FBS Report should be zipped and named as follows:

- County or Community_State_FBS_Preliminary (Example: Bergen_NJ_FBS_Preliminary)
- County or Community_State_FBS_Final (Example: Bergen_NJ_FBS_Final)

The FBS Report(s) should be uploaded to the MIP using the Tools and Links/Data Upload/Load Studies Data Artifacts portlet and the FBS Reports dropdown option. Include the word “FBS” in the Abstract field of the upload portlet so it can be used as a search keyword and so the files can be placed in the FBS folder on the MIP.

11.3 FEDD File

A complete FEDD file includes all correspondence related to due process. Certain items are prepared by the Mapping Partner and others are prepared by FEMA or its designee. Review the Post-Preliminary Deliverables Guidance document for details about the FEDD file responsibilities, its contents, and the FEDD file checklist.

Per the Data Capture Technical Reference, the FEDD file must be submitted as one PDF file per community. Files should be listed in chronological order. For a countywide study, this means multiple FEDD Files will need to be submitted. Each FEDD File should be zipped and named as follows:

- County_State_Community_FEDD_Effective Date (Example: Bergen_NJ_Alpine_FEDD _20141231)

The FEDD File should be uploaded to the MIP using the Tools and Links/Data Upload/Load Studies Data Artifacts portlet and the FEDD File dropdown option. Include the word "FEDD" in the Abstract field of the upload portlet so it can be used as a search keyword and so the files can be placed in the FEDD folder on the MIP.

12.0 Flood Risk Products Submittal Guidance

Risk MAP projects include non-regulatory Flood Risk Products that state and local officials can use to better communicate flood risk to their constituents. Currently, only the cost and schedule for the non-regulatory Flood Risk Products are tracked in the MIP. This is done under a separate MIP project typically named with "RMP" (for Risk Map Product) in its case name. Under this RMP case, the tracking information is done using standard MIP data development tasks that are traditionally used for regulatory products.

Review the MIP Guidance document for a list of the associated data development tasks for RMP projects and for additional details about setting up and using these folders in the MIP to track Risk Map Products.

The Data Capture Technical Reference provides a detailed description of the Final Flood Risk Products that must be delivered to the Map Service Center. The Flood Risk Project data are not uploaded to the MIP at this time. The data should be sent to CDS on media until such time as a MIP upload process has been developed.

In the future, the datasets used to create the Flood Risk Products (i.e. the backup data) listed in the Data Capture Technical Reference will be submitted to the MIP in the folders described there. These data can all be submitted in the native format in which they were prepared.