

Hydrologic and Hydraulic Modeling and Management Standards



December 8, 2009

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SECTION 1 - INTRODUCTION

1.1 Preface

Overview

1.1.1

This document establishes standards for the submittal of hydrologic and hydraulic models to the Harris County Flood Control District (HCFCD) in order to maintain the integrity of the models and supporting data for the engineering community and floodplain administrators in Harris County. With the completion of the Tropical Storm Allison Recovery Project (TSARP) in 2007, the engineering community now has hydraulic models (HEC-RAS), hydrologic models (HEC-HMS), and supporting information that is georeferenced to the same horizontal and vertical data as HCFCD's 2001 LIDAR data.

To maintain the integrity of the models and supporting data, HCFCD has developed the following standards to define the requirements that individuals and companies must follow when submitting models to HCFCD for reviews, approvals, and/or permits. These standards are intended to ensure that models and supporting information checked out for evaluation or modification are revised and/or updated in a consistent manner so others can easily understand the changes. A comprehensive Model and Map Management (M3) system has been developed to assist in the documentation, organization, and management of the models. All CLOMR/LOMR related models must be requested and submitted through the M3 System.

All engineering submittals should follow good engineering and modeling practices, and modeling conclusions must support the design of the associated projects. These modeling standards apply within the jurisdictional limits of Harris County.

Modeling submittals prepared in support of a FEMA Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR) must be approved by the local floodplain administrator(s) that have jurisdiction over the project area. HCFCD is not the floodplain administrator for any of the streams within Harris County, but HCFCD may provide study review services through interlocal agreements with the communities within the County. HCFCD has been delegated the authority by FEMA to manage and maintain the effective model set for the county. The standards defined in this document support these functions.

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1.1 Preface, Continued

When Required 1.1.2

The modeling standards defined in this section are required for the submittal of U.S. Army Corps of Engineers' (USACE) HEC-HMS (hydrologic) and HEC-RAS (hydraulic) models and supporting information that will revise or update the Flood Insurance Models for Harris County in connection with a change in the base flood elevation or in the aerial extent of the floodplain. These include but are not limited to the HEC-HMS and HEC-RAS models that support the following projects:

- Bridge/Culvert crossings on a studied stream
 - Channel modifications on a studied stream
 - Fill in the floodway on a studied stream
 - Fill or other construction in the 1% exceedance probability (100-year) floodplain that will affect the conveyance of a studied stream or floodplain
 - Permanent changes in watershed and/or subbasin boundaries
 - CLOMR and LOMR submittals
-

When Not Required 1.1.3

The modeling standards are not required if any of the following circumstances apply:

- Project is entirely outside of the 1% exceedance probability (100-year floodplain) and does not change any watershed parameters. Such parameters include the following:
 - watershed or subbasin boundaries
 - time of concentration (TC) and storage (R) parameters for a subbasin(s)
 - impervious cover
- Project meets requirements for Method 1, Method 2, or Method 3 detention analysis, unless the analysis meets requirements outlined in Section 1.1.2.
- Hydrologic impacts of mobility/roadway projects (except if they include construction or modification of a bridge/culvert crossing over a studied stream). Hydrologic impact analysis of mobility projects and/or drainage projects that do not meet requirements outlined in Section 1.1.2.
- New HEC-HMS and/or HEC-RAS models for an unstudied stream, except when CLOMR/LOMR submittal is involved. The use of the modeling standards for unstudied streams is encouraged.

However, whenever practical, use the standards presented in Sections 2 and 3 for all HEC-RAS and HEC-HMS modeling. For development projects that result in no adverse impact, most of these requirements may not apply. Developers and their engineers should contact HCFCD on a case-by-case basis to verify the applicability of the standards.

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1.1 Preface, Continued

**Types of
Standards
Overview
1.1.4**

Three types of standards for hydrologic and hydraulic modeling and supporting information are:

1. Model Development and Management Standards
 2. Supporting Spatial Data Standards
 3. Modeling Study Submittal Standards
-

1.1.4 Types of Standards Overview

Model Development and Management Standards

The model development guidelines outlined in this document are intended to standardize the methodologies and assumptions used for hydrologic and hydraulic modeling within Harris County and to preserve the technical and analytical integrity of the effective FEMA models.

1.1.4.1

The Model Development and Management Standards provided in Section 3 relate to the hydrologic (HEC-HMS) and hydraulic models (HEC-RAS) and their supporting methodologies developed for Harris County. These methodologies are described in detail in the following documents:

- HCFCD's Hydrology and Hydraulics Guidance Manual (H&H Guidance Manual), latest version
- HCFCD's Policy, Criteria and Procedure Manual (PCPM), latest version

These standards apply specifically to the modification or update of current effective models and supporting information, and the development of new model sets and supporting information for unstudied streams.

GIS Spatial Data Standards

1.1.4.2

Section 4 presents GIS supporting spatial data standards for the preparation and submittal of the geospatial data that is required in support of new or revised hydrologic or hydraulic modeling. Section 4 also outlines standards associated with the metadata to be included with the required GIS spatial layers.

For hydrologic modeling, the standards include guidelines for the modification or development and submittal of GIS files for the required HEC-HMS features (subbasins, routing reaches, junctions, diversions, reservoirs and sources).

For hydraulic modeling, the standards include guidelines for the modification or development and submittal of cross section and stream line data sets. Coordinate information for stream lines and cross sections shall be included in the HEC-RAS geometry files for all model elements.

Continued on next page

1.1.4 Types of Standards Overview, Continued

**Modeling
Study
Submittal
Standards
1.1.4.3**

Section 5 presents guidelines for the standardization of submittals for hydrologic and hydraulic studies to HCFCD. These standards summarize the following information required for the submittal of new or revised models to HCFCD for review and acceptance into the M3 system:

- Required model files
- Model linkage information
- Design events, study reports
- Applicable FEMA forms
- Sealing Texas Professional Engineer (PE) name and license number
- Engineering firm name and registration number
- GIS data
- Supporting documentation

The standards also provide guidance on the proper organization and submittal methods for modeling studies.

1.1 Preface, Continued

Baseline Model Set
1.1.5 Use the FEMA effective model set as the baseline model set for no adverse impact analyses and studies that will result in a FEMA Letter of Map Change (CLOMR or LOMR). In some instances, a “best available” model may need to be used as the baseline model set if a submitted LOMR on the stream associated with a study is pending approval in the near future. This “best available” model will be defined and distributed by HCFCD and maintained within the M3 system.

SECTION 2 – SUPPORTING DATA FOR MODELING

2.1 Introduction

Overview

2.1.1

A variety of types of supporting maps and datasets are required for the development, update, use, and proper understanding of hydrologic and hydraulic models. This section outlines the available datasets, provides information on how to obtain each relevant dataset, and provides specific guidance on the use of each dataset.

Access to Data

2.1.2

The datasets listed in the following subsections may be checked out from HCFCD either by direct request or during the model checkout process through the M3 system.

2.2 Base Map Datasets

Land Use 2.2.1

Use the land use categories outlined in Section II.3 of the H&H Guidance Manual for any update or correction of land use related modeling parameters. Prior to making any changes to land use based parameters, coordinate with and obtain concurrence from HCFCD. This limitation does not apply to development feasibility studies.

Soils 2.2.2

Green-Ampt parameters are defined for each watershed within Harris County (refer to Section II.2 in the H&H Guidance Manual). As a result, soil data is not directly required for the preparation or update of hydrologic models.

Topography 2.2.3

Use the HCFCD LIDAR dataset (2001) with 2-foot contours as the base topographic data set for modeling purposes. This data is available from the HCFCD Planning department and is organized in tiles by USGS quarter quad. The 2001 LIDAR dataset meets the minimum accuracy requirements for use in FEMA studies. However, the data must be supplemented with survey data for use in hydraulic analysis. (See Section 3.4.2 and Section 3.4.4 of this document for additional information.)

Only use the 2001 LIDAR dataset provided by HCFCD for CLOMR and LOMR submissions. All other LIDAR datasets are not allowed.

Note: *Mapping proposed sites developed since 2001 may not be able to use the 2001 LIDAR dataset because the 2001 LIDAR does not reflect the change. In these cases, for a CLOMR use the conceptual plan or proposed design plans for the project, and for a LOMR use field surveyed topography or as-built survey data.*

2.3 Model Specific Support Data

Watershed and Subbasin Boundaries 2.3.1

Use the watershed and subbasin boundaries from the effective FEMA model set as the basis for all hydrologic modeling. HCFCD must approve any proposed changes in the boundaries or further subdivision of the watershed and subbasin boundaries prior to the submittal of new or revised hydrologic models.

Watershed and subbasin boundaries are provided automatically with all models checked out from the HCFCD M3 system.

Stream Network 2.3.2

Consider two sets of stream information for modeling studies. The set of streams represented in the effective FEMA models shall be the base stream set for all hydraulic modeling of previously studied streams. Use the stream network maintained through the HCFCD Channel Assessment Program (CAP) as a reference to determine whether any significant changes have been made to the stream network. Also use the CAP streams as the basis for any hydraulic modeling of previously unstudied streams.

The CAP stream network provides the standard stream names to be used for modeling. Any desired modifications of the existing FEMA effective or CAP streams due to errors in the existing stream delineations, realignment due to construction, or other factors must be approved by HCFCD prior to the submittal of new or revised hydraulic models.

2.4 Survey Data

Overview 2.4.1	<p>Survey data is a key component of all hydraulic modeling studies and is required for any updates to or modifications of hydraulic models of streams within Harris County. The following subsections outline the survey procedures to be followed in the development of information for hydraulic modeling.</p>
FEMA Data Capture Standards 2.4.2	<p>Use the FEMA Data Capture Standards (Appendix M of the FEMA Guidelines and Specifications for Flood Hazard Mapping Partners) as a guide for the performance, documentation, and data preparation for surveys in support of hydraulic modeling. Appendix M may be accessed through the FEMA website.</p>
Bench Marks 2.4.3	<p>Use the benchmark network maintained by the Permits Group of the Harris County Public Infrastructure Department, Architecture, and Engineering Division as the basis for all surveys associated with hydraulic modeling. The information may be accessed through the Permits Group's website at www.eng.hctx.net/PERMITS/.</p>
Coordinate System and Datum 2.4.4	<p>All survey data shall be submitted in the standard coordinate system used for HCFCD data as stated below.</p> <ul style="list-style-type: none"> • Projection <ul style="list-style-type: none"> – Texas State Plane – Zone – Texas South Central 4204 – Units – U.S. Feet – Use Grid Coordinates as opposed to Surface Coordinates • Horizontal Datum – North American Datum (NAD) 83 • Vertical Datum – North American Vertical Datum (NAVD) 88 with 2001 adjustment

SECTION 3 – MODEL DEVELOPMENT AND MANAGEMENT STANDARDS

3.1 Introduction

Overview
3.1.1 The model development and management standards outlined in this document were designed to standardize the methodologies and assumptions used for hydrologic and hydraulic modeling within Harris County and to preserve the integrity of the effective FEMA models. These standards are based on the policies, procedures, and guidelines established through HCFCD's H&H Guidance Manual and PCPM. The standards presented in these manuals apply specifically to the development of new model sets for unstudied streams; however, they shall also be followed in any modification or update of existing models. These standards apply to hydrologic and hydraulic modeling with the HEC-HMS and HEC-RAS software programs. The versions of these software programs to be used for analysis are discussed in the subsequent sections.

Purpose
3.1.2 The purpose of this section is to outline the requirements for the development of new hydrologic and hydraulic models or the modification of existing models for areas within Harris County. These requirements refer to the modeling software programs, basic methodologies and specifications for modeling.

Application
3.1.3 The standards shall be applied to all new or revised HEC-HMS or HEC-RAS modeling within Harris County.

Continued on next page

3.1 Introduction, Continued

Approach 3.1.4

The model development and management standards are divided into four main sections.

Section	Description
1	This section describes the naming conventions to be used for all hydrologic and hydraulic modeling. The proper application of this system will ensure unique naming for all HEC-HMS and HEC-RAS modeling elements.
2	This section discusses the HEC-HMS model version and methodologies to be used for hydrologic modeling.
3	This section discusses the HEC-RAS model version and methodologies to be used for hydraulic modeling. Subsections related to modeling methodology typically refer the user to HCFCD's PCPM and H&H Guidance Manual.
4	This section describes the requirements for the linkage of HEC-HMS flows to the associated HEC-RAS flow change locations (cross sections).

3.2 Model Element Naming Convention

Overview **3.2.1**

The enforcement of a unique naming convention for all watersheds, streams, and major hydrologic and hydraulic modeling elements is essential for the proper handling of modeling data in a geospatial environment. The traditional system for the naming of first, second, and third order streams; major watersheds; and subbasins has been adopted as the basis for the M3 system. This system has produced the stream unit names as currently reflected in the HCFCD CAP stream layer.

Purpose **3.2.2**

The standards outlined in this section will ensure unique naming of all major geometric elements of HEC-HMS and HEC-RAS models. The standards build from the traditional system with additional requirements for HMS routing reaches, junctions, reservoirs, diversions, sources, sinks, and HEC-RAS reaches. The standards also clarify the approach to be used for the stationing of cross sections within HEC-RAS models.

General **3.2.3**

The basic elements of the naming convention are the unit names of the major watersheds and streams as identified by the HCFCD CAP program. Each element name is based on the root unit name of the associated stream.

3.2.3 General

Watersheds 3.2.3.1

Harris County has been divided into 22 major watershed areas. Each of these major watersheds has been assigned an upper-case single letter unit name. This letter is used in the naming of each stream within a particular watershed. The major watersheds and their identifying letter designations are as follows:

Unit	Watershed
A	Clear Creek
B	Armand Bayou
C	Sims Bayou
D	Brays Bayou
E	White Oak Bayou
F	Galveston Bay
G	San Jacinto River
H	Hunting Bayou
I	Vince Bayou
J	Spring Creek
K	Cypress Creek
L	Little Cypress Creek
M	Willow Creek
N	Carpenters Bayou
O	Goose Creek
P	Greens Bayou
Q	Cedar Bayou
R	Jackson Bayou
S	Luce Bayou
T	Mason Creek
U	Addicks Reservoir
W	Buffalo Bayou

Continued on next page

3.2.3 General, Continued

Streams 3.2.3.2

The streams within the HCFCD watersheds are identified by unique unit numbers based on the upper-case single letter watershed unit ID and a seven digit series of numbers. These unit number identifiers are included as attributes for each stream within the CAP dataset.

Main stem	The first three numbers for the main stem stream within a watershed are always 100 with zeros for the remaining pairs of digits. Example: E100-00-00
1st order tributary	Numbered starting with 101 for the first three numbers with zeros for the other pairs of digits and generally increase sequentially from downstream to upstream along the main stem. Example: E101-00-00
2nd order tributary	Share the same first three digits of the stream to which they are tributary. The second order tributary is identified by the first pair of digits, which generally increases sequentially from downstream to upstream along the 1 st order tributary. The second pair of digits consists of zeroes for 2 nd order tributaries. Example: E101-01-00
3rd order tributary	Third order tributaries share the first five digits of the 2 nd order tributary to which they are tributary. Example: E101-01-01

The final pair of digits identifies these streams and generally increases sequentially from downstream to upstream along the 2nd order tributary.

There are also a small number of 4th and 5th order streams, primarily in the San Jacinto watershed.

4th order tributary	Fourth order stream are identified by a single digit following a decimal point at the end of the base unit number. Example: E101-01-01.1
5th order tributary	Fifth order streams are identified by the addition of a single letter (starting with A for the downstream-most) appended after the 4 th order digit. Example: E101-01-01.1A

In rare cases, a stream may be numbered with a 200 series number. The 200 series typically represents routing reaches for diversions; however, there are occasional exceptions.

3.2 Model Element Naming Convention, Continued

Hydrology 3.2.4

Each hydrologic element that is part of the watershed basin model within HEC-HMS is assigned a unique identifier based on an associated watershed and stream unit number. The specific requirements for each element type (subbasin, routing reach, junction, diversion, reservoir, and source) are described in the following subsections. The naming conventions for reservoirs (detention basins) and source elements follow a slightly different format from the standard unit number base.

3.2.4 Hydrology

Subbasins 3.2.4.1

Subbasin names typically consist of five characters and are comprised of the single-character watershed identifier, the first three digits representing the main stem or 1st order tributary to which the subbasin contributes, and a final letter (Example: E100A). The typical standard approach for assigning this final letter is to begin with the upper-case letter A for the upstream most subbasin along the main stem or tributary and increasing in alphabetical order from upstream to downstream.

If it is necessary to subdivide an existing subbasin, the subdivided basins shall retain the five-character identifier of the original subbasin with the addition of a sequential number (typically upstream to downstream) appended to the end of the base name (Example: E100A1).

Routing Reaches 3.2.4.2

Identification of routing reaches is based on the full unit name for the stream represented by the reach combined with the character “_” and four additional digits describing the stream station (distance from the mouth of the stream in feet divided by 100 and rounded to remove decimals) at the downstream end of the reach, and the characters “_R” to indicate a routing reach.

For example:

E1020100_0057_R	(on 1 st – 3 rd order streams)
E1020101_1_0057_R	(on 4 th order streams)
E1020101_1A_0057_R	(on 5 th order streams)

Where

- E indicates that the reach is in White Oak Bayou Watershed
- 1020100 is the full unit number of the tributary
- _ is a required character as a divider
- 0057 is the station 5700 divided by 100 that represents the station at the downstream end of the reach
- _R indicates that the element is a routing reach

Routing reaches representing diversion channels shall be identified by the 200 series number used for these types of channels rather than the 100 series number for a typical channel.

If it is necessary to subdivide an existing routing reach, the subdivided reaches should retain the original routing reach name with the station number changing to indicate the station at the downstream of the routing reach. The description field for the HEC-HMS reach element must contain the most upstream and downstream bounding HEC-RAS cross sections within the reach.

Continued on next page

3.2.4 Hydrology, Continued

Junctions 3.2.4.3

Identification of junctions is based on the full unit number of the highest order stream at the junction combined with a “_” and four additional digits describing the nearest station (distance from the mouth of the stream in feet divided by 100 and rounded to remove decimals) downstream of the junction, and the characters “_J” to indicate a junction.

For example:

E1170100_0003_J	(on 1 st – 3 rd order streams)
E1170101_1_0003_J	(on 4 th order streams)
E1170101_1A_0003_J	(on 5 th order streams)

Where

E indicates that the reach is in White Oak Bayou Watershed

1170100 is the full unit number of the highest order stream at the junction

_ is a required character as a divider

0003 is the stream station 300 divided by 100, which represents the station of the junction (use the nearest downstream HEC-RAS cross section station where the associated flow change is applied)

_J indicates that the element is a junction

In the case of a tributary stream(s) combining with its main stem, a junction shall be included for each tributary stream (and sometimes the main stem) prior to combination at the primary junction. The primary junction is named as described above. The secondary junction on the main stem, usually upstream of the tributary confluence, includes the station of the most downstream HEC-RAS cross section on the upstream main stem reach (i.e., the station at immediate upstream of the flow-change station). Tributary stream junctions are named according to the tributary stream unit name and station at (nearest) the mouth of the tributary stream (i.e., the downstream-most HEC-RAS cross section of the tributary).

Continued on next page

3.2.4 Hydrology, Continued

Diversions 3.2.4.4

There are two primary naming conventions for diversion elements in HCFCD's HEC-HMS models. Both should be based on the full unit name of the stream contributing the diverted flow combined with four additional digits describing the nearest stream station (stream distance from the mouth in feet divided by 100 and rounded to remove decimals) downstream of the junction. In the case of a regular diversion, the characters "_D" should be appended to the base name. In the case of a side weir overflow, the characters "_SW" should be appended to the base name. In cases where the diversion is from one watershed to another the name should be associated with the source of the diversion.

For example:

Regular diversion:

W1100000_0457_D	(on 1 st – 3 rd order streams)
W1010101_1_0457_D	(on 4 th order streams)
W1010101_1A_0457_D	(on 5 th order streams)

Side weir diversion:

W1100000_0457_SW	(on 1 st – 3 rd order streams)
W1010101_1_0457_SW	(on 4 th order streams)
W1010101_1A_0457_SW	(on 5 th order streams)

Detention Basins 3.2.4.5

Identify detention basins (including all modeled reservoirs) based on the single letter unit name of the watershed combined with the seven-digit identifier assigned to the detention basin by HCFCD. The seven-digit identifier shall be an integer that begins with the number five.

For example:

E500_01_00

Where

E indicates that the reach is in White Oak Bayou Watershed

5 indicates that the element is a reservoir or detention basin

The 2-digits after the 5 indicate the HCFCD Unit # (e.g., E500 shows that reservoir is on Unit E100)

The four digits after the 500 uniquely identify the facility within the watershed

The two underscores "_" are required to divide the seven digits into three pairs

Continued on next page

3.2.4 Hydrology, Continued

Sources 3.2.4.6

Sources used in HEC-HMS models within Harris County typically represent overflows from adjacent watersheds. The names for sources shall consist of the originating subbasin in the contributing watershed combined with a “_” and then the destination subbasin in the receiving watershed. The characters “_SC” shall be appended to the end of a source name.

For example, the source representing the overflow from subarea K100G in Cypress Creek Watershed to subarea U123 in Addicks Reservoir watershed would be named K100G_U123_SC.

Sinks 3.2.4.7

Sinks should not be used in HEC-HMS models within Harris County.

3.2 Model Element Naming Convention, Continued

Hydraulics 3.2.5

There are three element name components required to uniquely identify each element of a HEC-RAS model. These elements are the River Name, Reach Name and Cross Section identifier.

The maximum length for a River or Reach name shall be 16 characters (maximum allowed by HEC-RAS).

3.2.5 Hydraulics

River 3.2.5.1

Identify the river name with the unit name for the modeled stream. This name should be in the form of E100-00-00, where E represents the watershed and the remaining digits identify the stream as described in the preceding sections.

Note: *The River name is limited by HEC-RAS to 16 characters.*

Reach 3.2.5.2

The effective HEC-RAS models only have a single reach. For FEMA submissions, keep the model as a single reach and do not combine reaches to make a network. For impact analyses, a multiple reach model may be submitted. However HCFCD recommends that the tributary be modeled separately with HEC-RAS. Reach names become critical when networked HEC-RAS models are created. In the case of these models, the original single reach main stem model will be split into two reaches at the junction with a tributary stream. Reach names shall include the full unit name combined with four additional digits describing the most downstream station (divided by 100 and rounded to remove decimals) of the reach.

For example:

E100-00-00_0050	(on 1 st – 3 rd order streams)
E1010101-1_0050	(on 4 th order streams)
E1010101-1A_0050	(on 5 th order streams)

Where

E indicates that the reach is in White Oak Bayou Watershed

_ is a required character as a divider

0050 is the station 5000 divided by 100 that represents the station at the downstream end of the reach

Note: *The Reach name is limited by HEC-RAS to 16 characters.*

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3.2.5 Hydraulics, Continued

Station 3.2.5.3

The cross section station is generally based on the cumulative stream length from the mouth of the modeled stream in feet. The established stream stations in the June 2007 effective FEMA models shall not be modified based on any change in alignment of the stream that would result in a lengthening or shortening of the stream unless there is coordination with HCFCD first. As described in previous sections, these cross section identifiers are referenced in the HEC-HMS model and in other external datasets and should remain fixed. However, the channel and overbank lengths for the impacted cross sections shall be modified as appropriate. In the case of the addition of new cross sections or the repositioning of existing cross sections (only allowed if a new structure is added or if channel realignment necessitates a change in the cross section location), new stations should be assigned based on the stream length from the mouth of the modeled stream in feet.

Bridges 3.2.5.4

Identify the bridges within the HEC-RAS model with the station and street name or type of crossing (e.g., 18" pipeline or 10-foot wide pedestrian bridge) if the bridge does not have an associated street name. The name should be entered into the model geometry file using the HEC-RAS geometry editor, under tables, names and node names. By using this option the street name will appear in the output and the RASPLOT output.

3.3 Hydrology

Overview **3.3.1**

This section outlines the standards associated with the various elements of hydrologic modeling with HEC-HMS. These standards apply to all studies that involve the revision of HEC-HMS models as part of their analysis components. These standards do not apply to Method 1 or 2 analyses for detention facilities. However, they will apply to Method 3 analyses. Refer to Section 6 of HCFCD's PCPM for a description of these analysis methods.

Model **Versions** **3.3.2**

Use the HEC-HMS software program version stated on the HCFCD M3 website (www.hcfcd.org/m3) for watershed modeling. Obtain prior permission from HCFCD to use a different version than that stated on the website.

The effective HEC-HMS models will be periodically updated by HCFCD on a watershed-by-watershed basis. The HEC-HMS software program version may be updated to the most current release version of HEC-HMS at these times. HCFCD will issue notices when newer HEC-HMS software program versions are adopted and approved.

Rainfall **3.3.3**

Rainfall data is a key component of hydrologic modeling. Use the design rainfall procedures outlined in Section II.2 of the H&H Guidance Manual for all hydrologic modeling within Harris County. These procedures describe the event totals and rainfall distribution required to fully define the design rainfall used for HEC-HMS modeling. Do not use depth-area reduction of rainfall in HEC-HMS modeling within Harris County.

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3.3 Hydrology, Continued

**Watershed
and Subbasin
Boundary
Modifications
3.3.4**

Use the watershed and subbasin boundaries from the effective FEMA model set as the basis for all hydrologic modeling. Any proposed changes in the boundaries or further subdivision of the watershed and subbasin boundaries must be approved by HCFCD. These boundaries will be provided with all models checked out from the HCFCD M3 system.

Subdivision of subbasins for the purposes of no-rise or mitigation analyses does not require prior approval from HCFCD. Only subbasin boundary changes that will result in a revision of the FEMA effective model require prior approval from HCFCD.

**Loss Rates
3.3.5**

Use the Green and Ampt infiltration methodology to represent infiltration losses for all HEC-HMS modeling. Refer to Section II.2 of the H&H Guidance Manual for details of this methodology.

Develop the impervious cover percentages to be used with the Green and Ampt infiltration method based on the approach described in Section II.3 of the H&H Guidance Manual.

**Unit
Hydrograph
3.3.6**

Use the Clark's Unit Hydrograph method for all HEC-HMS modeling. The procedures used for the development of parameters for the Clark unit hydrograph are described in Section II. 3 of the H&H Guidance Manual.

For all HEC-HMS modeling, use the standardized spreadsheet for the calculation of TC&R parameters provided through the HCFCD M3 system website (www.hcfcd.org/m3).

**Hydrologic
Routing
3.3.7**

Use Modified Puls routing for all routing reaches for which an effective hydraulic model is available.

Modified Puls routing information is to be developed based on the procedure outlined in Section II.4 of the H&H Guidance Manual.

Do not change the number of routing steps used for reaches in existing models without HCFCD's approval. The routing steps may be modified, with approval from HCFCD, if the channel is subdivided to obtain a new junction without changing geometry. The sum of the routing steps should match the original number of steps and the distribution of steps between the reaches should be weighted by the travel time within each of the subdivided routing reaches.

Obtain HCFCD's approval to use any other type of routing.

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3.3 Hydrology, Continued

**Detention
Facilities
3.3.8**

Refer to Section 6 of HCFCD's PCPM and Section II.7 of the H&H Guidance Manual.

**Off-Line
Detention
3.3.9**

Analyze the impact of Off-Line detention in HEC-HMS modeling based on the procedure outlined in the H&H Guidance Manual. Consult with HCFCD staff to request the Side Weir Diversion Tool Guidance Manual to aid in the modeling of side weirs along studied streams.

**Baseflow
3.3.10**

Do not use baseflow in HEC-HMS modeling of Harris County Watersheds

3.4 Hydraulics

Overview 3.4.1

This section outlines the standards associated with the various elements of hydraulic modeling with the HEC-RAS model as applied to the modeling of streams within Harris County.

Model Management Standards Application 3.4.2

When submitting new or revised HEC-RAS models for all studied and unstudied streams to HCFCD for their review, the following requirements will apply:

- Fully georeference all new HEC-RAS models and all new elements in revised models.
- Use survey data to define the channel portion of a new or modified cross section. Exceptions may be made for stream reaches with a consistent channel shape. However, any such exceptions must be approved by HCFCD prior to submittal of the model. Base all surveys on the coordinate system and datum established in Section 2.
- Base all overbank cross section data on new field survey or LIDAR-generated DEM data from the approved LIDAR dataset for Harris County.
- Do not interpolate cross sections within the channel ROW unless previous approval from HCFCD has been obtained by the engineer. LIDAR or field survey must be used for all overbank cross section data.
- Add new cross section line x-y coordinates or revise coordinates for realigned cross section in the HEC-RAS model through the Geometric Data window (Edit Menu, XS Schematic Lines option).
- Submit all survey field notes to HCFCD.
- Label all new cross sections in the Description box within the HEC-RAS Cross Section Data window to describe the source of the new cross sectional data. This information shall include the engineers name and the date that the new section was added or the existing section revised.

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3.4 Hydraulics, Continued

Model Versions **3.4.3**

Use the HEC-RAS software program version for watershed model as stated on the HCFCD website (www.hcfcd.org/m3). Obtain prior permission from HCFCD to use a different version than the one on the website.

The effective HEC-RAS models will be periodically updated by HCFCD on a stream-by-stream basis. The HEC-RAS software program version may be updated to the most current release version of HEC-RAS at these times. HCFCD will issue notices when newer HEC-RAS software program versions are adopted and approved.

The HEC-RAS software program version for the June 2007 effective models from the countywide study for Harris County is version 3.0.1. HCFCD has received special dispensation from FEMA to continue the use of this version pending resolution of issues with the floodway calculation routines in HEC-RAS or the submission of a stream-wide LOMR with the a newer version.

Cross Sections **3.4.4**

Cross sections are the key component of a HEC-RAS hydraulic model. The following sections provide guidance for the various elements and options used to represent cross section characteristics in a HEC-RAS model.

3.4.4 Cross Sections

Topographic Data
3.4.4.1

Develop cross sections based on survey data or a combination of survey and 2001 LIDAR data. Follow the requirements outlined in Section 3.4.2. The reference benchmark and datum must be identified in the study report.

Spacing
3.4.4.2

A minimum of five cross sections per stream mile (maximum spacing of approximately 1,000 feet) is required for hydraulic modeling. A structure may count as one of the required cross sections. However, in the case of multiple structures in close proximity or multiple cross sections at or near a structure, a maximum spacing of approximately 1,000 feet shall be maintained for the remainder of the reach, even if this results in more than five cross sections per mile.

Locate cross sections required for new bridges/ based on the approach outlined in the HEC-RAS Hydraulic Reference Manual (most current version).

Overbank Lengths
3.4.4.3

Refer to Section III.2 of the H&H Guidance Manual for details of the methodology to be used in the definition of overbank reach lengths.

Roughness Coefficients
3.4.4.4

Use the generally accepted ranges for Manning's roughness coefficients that conform to HCFCD's PCPM and are consistent with Section III.2 of the H&H Guidance Manual for modeling. Refer to guidance in the HEC-RAS Hydraulic Reference Manual (most current version), TxDOT Hydraulic Design Manual or similar publications for guidance.

Refer to Section III.2 of the H&H Guidance Manual for guidance in the case of subdivisions with privacy fences in channel overbanks.

Expansion and Contraction Coefficients
3.4.4.5

Use the expansion and contraction coefficients that are outlined in Section III.2 of the H&H Guidance Manual.

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3.4.4 Cross Sections, Continued

**Blocked
Obstructions
3.4.4.6**

Refer to HEC-RAS Hydraulic Reference Manual (most current version) for guidance in the use of blocked obstructions.

Refer to Section III.2 of the H&H Guidance Manual for guidance in the use of blocked obstructions to represent structures in channel overbanks

**Ineffective
Flow Areas
3.4.4.7**

The ineffective flow option within a HEC-RAS model can be applied in two ways:

1. In the case of ineffective areas at hydraulic structures, refer to Section III.3 of the H&H Guidance Manual and to the HEC-RAS Hydraulic Reference Manual.
 2. In the case of isolated inundation areas due to perched channels, disconnected low areas, and similar features, Use the permanent ineffective areas settings.
-

**Levee Points
3.4.4.8**

Refer to Section III.3 in the H&H Guidance Manual.

3.4 Hydraulics, Continued

Bridge and Culvert Modeling 3.4.5

Refer to Section III.3 of the H&H Guidance Manual for guidelines for the modeling of bridge and culvert structures.

Transition Control Structures 3.4.6

Model slope transition control structures in HEC-RAS following the procedure documented in Section III.4 of the H&H Guidance Manual.

3.5 Hydrologic and Hydraulic Model Considerations

Overview

3.5.1

There are several modeling standards that relate to both hydrologic and hydraulic modeling. These standards include the design events to be analyzed, the relationship between HEC-HMS combination points, and the flow in associated HEC-RAS models and quality control procedures. The following subsections discuss these standards.

Design Events

3.5.2

For impact analysis studies, follow the criteria outlined in HCFCD's PCPM. For studies that require the preparation of a CLOMR or LOMR, also evaluate the required FEMA events (10%, 2%, 1%, and 0.2% annual exceedance chance events).

Station- Discharge Relationships

3.5.3

The procedure to be used to correlate flows generated in HEC-HMS to cross section stations in associated HEC-RAS models is documented in Section II.4 of the H&H Guidance Manual.

HCFCD will provide the associated corresponding flow distribution spreadsheet (if available) with each FEMA effective model requested at checkout.

Flows in Headwater Subbasins

3.5.4

The procedure to be used to develop flows for portions of HEC-RAS reaches that extend into HEC-HMS headwater basins is documented in Section II.6 of the H&H Guidance Manual.

SECTION 4 – GIS STANDARDS FOR MODELING SUBMITTALS

4.1 Introduction

Overview
4.1.1

The GIS standards section defines the standards for the geospatial data that are required to support new or revised hydrologic or hydraulic modeling. Such data will include GIS files that contain all of the required features for hydrologic modeling, revised stream lines (where applicable), and coordinate information contained within HEC-RAS models. This section also outlines the metadata standards associated with this information.

Purpose
4.1.2

This section describes the required geospatial data that must be submitted in support of modeling studies. It also defines the coordinate system and horizontal and vertical datums to be used for this data.

Application
4.1.3

Update all relevant GIS data layers, including revisions to the 1% and 0.2% FEMA effective floodplains and FEMA floodway limits, for all submittals when proposed activities modify any or all of the following:

- Watershed drainage area boundaries
 - Subbasin drainage area boundaries
 - FEMA Effective Floodplain limits
 - FEMA Effective Floodway limits
 - Cross section location map
-

4.2 HEC-HMS Geospatial Data Requirements

Overview 4.2.1

Geospatial data has become essential for the proper understanding, management, and maintenance of hydrologic models. This geospatial information allows for visualization of the modeling data, verification of changes in the geometry of the models, and spatially-oriented storage and retrieval of modeling information. The models that HCFCD provides for use by the engineering community include geospatial data representing the FEMA effective condition of the models along with appropriate metadata. Modify this spatial information and associated metadata as needed, and resubmit the data if any changes are required in the hydrologic modeling.

Purpose 4.2.2

The purpose of this subsection is to describe the requirements for geospatial data that must be submitted in support of new or revised HEC-HMS models.

Application 4.2.3

When submitting a hydrologic model, submit all geospatial information in GIS format, and include appropriate metadata.

Follow these guidelines for submitting geospatial information:

1. Submittals must include geospatial information representing the elements of a HEC-HMS model. GIS data submittals shall be in either shapefile or geodatabase format with each layer or feature class clearly named.
 2. GIS data must be in the proper projection with the correct horizontal and vertical datums (refer to Section 2.4.4).
 3. The subbasin polygon layer and the stream network and schematic connections must meet the topology requirements stated in Section 4.2.5.
 4. All submitted shapefiles or geodatabases must include metadata that meets the minimum Federal Geographic Data Committee (FGDC) requirements. Refer to Section 4.4.1 for a sample of the required metadata.
-

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4.2 HEC-HMS Geospatial Data Requirements, Continued

Required GIS Layers 4.2.4

Fully define the geospatial characteristics of a hydrologic model. The connectivity elements of the model (reaches, basin to junction or reach connections, etc.) may be schematic. However, there should be a geospatial element to represent each component of the submitted HEC-HMS basin model.

The following GIS shapefiles or geodatabase layers are required for submittal of new or revised hydrologic modeling:

- HMSSubbasin (Polygon)
- HMSReach (Line)
- HMSJunction (Point)
- HMSDiversion (Point)
- HMSSource (Point)
- HMSSink (Point)
- HMSReservoir (Point)

Some files (sources, diversions and reservoirs) are not required if these elements are not used in the HEC-HMS model. Among these shapefiles, HMSSink should be blank in accordance to Section 3.2.4.7, which indicates that “Sinks should not be used in HEC-HMS models within Harris County.” In each layer, include an attribute titled “HMSCode” that is populated with the corresponding element names used in the HEC-HMS models (refer to standard naming convention in Section 3.2). The attributes for each of these layers will ultimately be extracted directly from the HEC-HMS model or TC&R spreadsheet associated with the model. The HMSCode will allow the M3 system to extract this information and is the only required attribute for these shapefiles.

In addition to the basic HEC-HMS elements, Submit additional shapefiles used to define parameters for subbasin TC&R calculations if these parameters have been modified.

The required shapefiles for the length of the longest water course and subbasin centroid are listed below:

- LongestStream (Line)
- SBCentroid (Point)

When available, each of the shapefiles listed in this subsection will be provided with the model check-out.

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4.2 HEC-HMS Geospatial Data Requirements, Continued

Topological Correctness 4.2.5

All submitted geospatial data must be topologically correct both internally to the study watershed and externally with adjacent watersheds. Any discrepancy with adjacent watersheds must be reviewed and approved by HCFCD prior to submittal.

Follow these guidelines for submitting geospatial data:

- Watershed boundaries must not overlap or leave shortfalls between adjacent watershed boundaries.
- Subbasin boundaries must not overlap or leave shortfalls between each other. Any “sliver” polygons due to subbasin boundary inconsistencies must be eliminated prior to submittal.
- Reaches and schematic connection end points must be snapped to connecting junctions, sources, sinks, diversions, reservoirs or other reaches.
- Schematic connections linking subbasins with other elements must be snapped to the centroid of the subbasin (the centroid of a subbasin must be adjusted to be within the subbasin if it would otherwise fall outside of the basin).

Metadata 4.2.6

Include metadata with all geospatial information submitted in support of hydrologic modeling. The metadata must meet the minimum Federal Geographic Data Committee (FGDC) requirements. Refer to Section 4.5.4 for an example of the minimum requirements. Geospatial data included with models checked out from HCFCD will include metadata that meets minimum standards. If the model is revised, edit this existing metadata and resubmit with the revised model. For additional information regarding the FGDC metadata standards, see the FGDC website at www.fgdc.gov.

4.3. HEC-RAS Geospatial Data Requirements

Overview 4.3.1

Geospatial data is essential for the proper understanding, management, and maintenance of hydraulic models. This geospatial information allows for the visualization of the modeling data, verification of changes in the geometry of the models and spatially-oriented storage, and retrieval of modeling information. The HEC-RAS models provided by HCFCD will include geospatial data representing the FEMA effective condition of the models. If any changes are required in the hydraulic modeling, modify and resubmit this spatial information as needed.

Purpose 4.3.2

The purpose of this subsection is to describe the requirements for geospatial information that must be submitted in support of new or revised HEC-RAS models.

Application 4.3.3

Certain geospatial information is required when submitting a hydraulic model. Incorporate this data directly into the Geometry file for the HEC-RAS model and submit it in shapefile or geodatabase format.

Follow these guidelines when incorporating geospatial data:

1. Include the X and Y coordinates for all XS Schematic Lines in the Geometry file.
2. Include the X and Y coordinates for all Reach Schematic Lines in the Geometry file.
 - a. Match the reach lines with the most current version of the CAP stream lines that is maintained by HCFCD and distributed with models.
 - b. Snap the ends of reaches to a vertex of an upstream or downstream connecting reach.
3. Submit cross section and stream line data as GIS data layers in addition to their direct incorporation into the HEC-RAS model.
4. Put the GIS data in the required projection with the correct horizontal and vertical datums.
5. Do not truncate HEC-RAS reaches in models checked out from HCFCD.

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4.3. HEC-RAS Geospatial Data Requirements, Continued

Metadata 4.3.4

Incorporate the metadata associated with HEC-RAS models directly into the Geometry file of the model project, and include the following:

- For each cross section description, include adequate information to identify the data (LIDAR and Survey) used to create the cross section.
- For each description, include the modification date for altered cross sections and the creation date for any new cross sections.
- For the project and plan descriptions, include information related to any realignment of the original stream line (Reach Schematic Line).

Include metadata with all geospatial information submitted in support of hydrologic modeling. The metadata must meet the minimum Federal Geographic Data Committee (FGDC) requirements. Refer to Section 4.5.4 for an example of the minimum requirements. Geospatial data included with models checked out from HCFCD will include metadata that meets minimum standards. If the model is revised, edit this existing metadata and resubmit with the revised model. For additional information regarding the FGDC metadata standards, see the FGDC website at www.fgdc.gov.

4.4 FEMA Submittal Geospatial Data Requirements

Overview
4.4.1 Modifications to hydrologic or hydraulic models that necessitate the submission of a CLOMR or LOMR must be supported with appropriate geospatial information.

Purpose
4.4.2 The purpose of this subsection is to describe the requirements for geospatial information that must be submitted in support of studies that require preparation of a CLOMR or LOMR (revision of the effective floodplain limits), in addition to that required in direct support of hydrologic and hydraulic modeling.

Application
4.4.3 Update all relevant GIS data layers as outlined in Section 4.1.3, and modify the geospatial files distributed with the models checked-out for the study. In addition to the geospatial data requirements described in the previous sections, submit geospatial data associated with the update of the floodplain mapping for a study.

The required layers include the following:

- 1% annual chance (100-year) floodplain
 - 0.2% annual chance (500-year) floodplain
 - Floodway
 - Revised base flood elevations (if applicable)
-

Metadata
4.4.4 Include metadata with all geospatial information submitted in support of a CLOMR or LOMR application. The metadata must meet the minimum Federal Geographic Data Committee (FGDC) requirements. Refer to Section 4.5.4 for an example of the minimum requirements. Geospatial data included with models checked out from HCFCD will include metadata that meets minimum standards. Additional information regarding FGDC's metadata standards can be found at www.fgdc.gov.

4.5 Metadata Requirements

**Overview
4.5.1** Metadata consists of information that characterizes a particular dataset and the history of that dataset. Metadata will be used to provide documentation for data products associated with hydrologic and hydraulic analysis in Harris County.

**Purpose
4.5.2** The purpose of this subsection is to describe the minimum requirements for metadata that must be submitted in support of studies that require the (1) update of existing or (2) creation of new hydrologic and hydraulic models within Harris County.

**Application
4.5.3** Metadata associated with the geospatial files distributed with the models that are checked out for the study should be revised to reflect the changes made to these files as a result of the study and resubmitted with the study models. All submitted metadata must meet minimum FGDC standards. The following section outlines the minimum requirements.

**FGDC Basic
Required
Metadata
4.5.4**

1. Identification
 - a. General
 - i. Abstract - Narrative summary of the data set.
 - ii. Purpose - Summary of the intentions with which the data set was developed.
 - iii. Access Constraints - Restrictions and legal prerequisites for accessing the data set. Standard notes from HCFCD.
 - iv. Use Constraints - Restrictions and legal prerequisites for using the data set after access is granted. Standard verbiage from HCFCD.
 - b. Contact
 - c. Citation
 - i. Details
 1. General
 - a. Title (auto filled – file name)
 - b. Originator - The name of an organization or individual that developed the data set.
 - c. Publication Date - The date when the data set is finished or when uploaded to HCFCD's Model and Map Management (M3) system.

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4.5 Metadata Requirements, Continued

**FGDC Basic
Required
Metadata
4.5.4, Continued**

- d. Time Period
 - i. Currentness Reference - The basis on which the time period of content information is determined.
 - ii. This is a standard pull down in ArcCatalog with two choices: ground condition, publication date. HCFCD should standardize the use of publication date with the understanding that it is the date of the final model or when it is uploaded.
 - iii. Calendar Date
 - 1. FEMA Case
 - a. Should be the date matching report.
 - 2. Non FEMA Case
 - a. Should be the date uploaded to M3.
- e. Status
 - i. Progress – ArcCatalog has three choices:
 - 1. Complete
 - 2. In work
 - 3. Planned
 - ii. Update Frequency
 - 1. Should us 'as needed' from the pull down
- f. Spatial Domain
 - i. Bounding Coordinates and G-Polygon
 - 1. Bounding Coordinates
 - a. North (auto filled if defined)
 - b. South (auto filled if defined)
 - c. East (auto filled if defined)
 - d. West (auto filled if defined)
- g. Keywords
 - i. Theme Keyword - Common-use word or phrase used to describe the subject of the data set.
 - 1. HMS
 - a. Basin Name
 - b. Study Name
 - 2. RAS
 - a. Reach Names
 - b. Study Names
 - ii. Theme Thesaurus - Reference to a formally registered thesaurus or a similar authoritative source of theme keywords.
 - 1. Should be either Study or FEMA Study
- h. Browse Graphic
- i. Security
- j. Cross Reference

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4.5 Metadata Requirements, Continued

**FGDC Basic
Required
Metadata
4.5.4, Continued**

2. Data Quality
 - a. General
 - b. Attribute Accuracy
 - c. Positional Accuracy
 - d. Source Information
 - e. Process Step
 3. Data Organization
 4. Spatial Reference
 5. Entity Attribute
 - a. Detailed Description
 - i. Label (auto filled)
 - ii. Type (auto filled)
 6. Distribution
 7. Metadata Reference
 - a. General
 - i. Metadata Date (auto filled)
 - ii. Metadata Standard Name (auto filled)
 - iii. Metadata Standard (auto filled)
 - iv. Contact
 1. Details
 - a. Person
 - b. Organization
 - c. General
 - i. Contact Voice Telephone
 - ii. Address
 - iii. Address Type
 - iv. City
 - v. State or Province
 - vi. Postal Code
 - vii. Extensions
-

SECTION 5 – MODELING STUDY SUBMITTAL STANDARDS

5.1 Introduction

Data Submittal Standards Overview 5.1.1 The data submittal standards defined in this section are intended to standardize hydrologic and hydraulic modeling submittals within Harris County. These standards outline the requirements for both the checkout and submittal of models and associated study information.

The requirements include

- the procedures for requesting model information from HCFCD,
- identification of the relevant model and supporting files that must be submitted for a study, and
- the procedures for submitting this information.

These submittal standards are a key component of the overall management of models through the HCFCD M3 system.

Purpose 5.1.2 This section outlines the requirements for the submittal of modeling data that is to be managed by HCFCD. These requirements are intended to standardize the contents of model submittals, facilitate the review of models, facilitate coordination between potentially overlapping or conflicting studies, and provide the framework for efficient management of modeling data into the future.

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5.1 Introduction, Continued

Application 5.1.3

Provide all relevant models and supporting data associated with a submitted study. This includes (at a minimum) the following elements:

- New or revised HEC-HMS model (if required for study)
- Revised TC&R spreadsheet (if the HEC-HMS model has been modified)
- HEC-HMS to HEC-RAS flow linkage table (flow distribution table)
- Supporting GIS hydrologic layers as defined in Section 4.2
- New or revised HEC-RAS model
- Supporting GIS hydraulic layers as defined in Section 4.3
- Digital version (PDF format) of the drainage report for the study (The report must be signed and sealed by a professional engineer.)
- Survey data developed for the study

Additional submittal requirements for studies that update the FEMA floodplain limits include the following:

- FEMA MT-2 forms, either included with the drainage report or bundled as a separate CLOMR or LOMR submittal package
- Duplicate effective and revised effective hydraulic models
- Revised FEMA FIS profiles plots
- Revised 1% and 0.2% floodplains
- Updated/Revised floodway limits

For additional information regarding the electronic submittal of a modeling study for review, see the HCFCD Electronic Review Submittal Guidelines. This document includes a description of how to organize the submittal and details of the required structure and contents of a submittal.

Use the M3 Checker tool (available for download from the M3 website (www.hcfcd.org/m3) for preparing a submittal for HCFCD review. This tool will assist the user in the preparation of a study submittal that meets the acceptability requirements outlined in this document and in the Electronic Review Submittal Guidelines and in the submittal of this information through the M3 website. However, the successful processing of a submittal through the M3 Checker or M3 Portal does not guarantee approval of the M3 submittal.

5.2 Model Checkout

Overview
5.2.1 This section outlines the requirements for the checkout of modeling data that is managed and maintained by HCFCD.

Purpose
5.2.2 The model checkout standards are intended to allow for the efficient distribution of models and supporting information, facilitate coordination between potentially overlapping or conflicting studies, and provide the framework for efficient management of modeling data into the future.

Application
5.2.3 The checkout request is available online through the HCFCD website (www.hcfcd.org/m3).

The model checkout workflow consists of the following major elements:

- The user will access the HCFCD website for model checkout.
- The user will provide the required information to identify the requestor, purpose and type of study, study area and requested models.
- The user will submit the request to HCFCD for processing.
- The system will assign a tracking number that will be used for all subsequent submittals and correspondence.
- The system will determine if notifications of potentially conflicting studies are required and send any relevant notifications.
- HCFCD staff will process the request and provide the requested data via FTP or DVD depending on the size of the data request. This expiration date can be adjusted during the course of the study at the request of the requestor.

Model requests that will not ultimately result in the resubmittal of models for review and incorporation into a CLOMR or LOMR will not be tracked by the M3 system. Such cases could include impact analyses that do not require preparation of a CLOMR or LOMR, the request of models for academic purposes or for private developer feasibility studies that will not be reviewed by HCFCD. Models for these purposes may be obtained in a batch download from the HCFCD website. The details of the checkout process are provided in the following subsections.

Continued on next page

5.2 Model Checkout, Continued

Project Area Identification 5.2.4

The engineer or other entity requesting models through the HCFCD checkout procedure will be required to identify the study area for which the requested models will be used. Accurate identification of the project area associated with a model checkout request will facilitate both the HCFCD's notification and review procedures.

The project area identification will consist of the three primary components:

- The watershed
- The subject stream or streams
- The key map page(s) encompassing the project area

These elements are discussed in the following subsections.

5.2.4 Project Area Identification

Watershed 5.2.4.1

The watershed element is the key component for the identification and checkout of hydrologic data. Refer to Section 3.2.3.1 for a full list of the modeled watersheds in the Harris County area. The requester will be able to select the appropriate watershed through a drop down list available on the HCFCD's checkout web page. Based on this identification, HCFCD will provide the effective FEMA HEC-HMS model for the selected watershed and any other hydrologic models that may be relevant to the study.

Streams 5.2.4.2

Once the watershed is selected, a list of studied streams will be shown to allow the user to identify the HEC-RAS models to be checked-out. If the study for which the request is being made will result in a development of a hydraulic model on a previously unstudied stream, the requestor will be required to identify this stream(s) in addition to any previously studied streams also include in the request. Based on this information, HCFCD will provide the effective FEMA HEC-RAS model(s) for the selected studied streams.

Key Map® 5.2.4.3

The requestor shall identify the Key Map® page(s) and Key Map® square or set of Key Map® squares that will be impacted by the project. This information will allow HCFCD to better track and manage studies and will be the primary identification used to determine the possibility of conflicts with other new or ongoing studies.

5.2 Model Checkout, Continued

Study Initiation 5.2.5

Once the requestor has identified the study area and the desired models for checkout, additional information must be submitted to more fully define the study.

This information will be used to

- track the status of the study,
- allow HCFCD staff to prepare for receipt of the study, and
- facilitate the review process and to facilitate coordination between potentially conflicting studies.

The requirements for study identification are described in the following subsections.

Once the required study information has been entered, the checkout system will assign a tracking number and expiration date for the request. The tracking number will consist of the single character watershed unit identifier and a unique five-digit integer. The five digit integer will be assigned sequentially as new studies are initiated for each watershed. This number will be used for all subsequent notification, submittal, and review activities associated with the study. The expiration date sets a deadline for resubmittal of models based on the checked out versions. This date is intended to ensure that the most current models are used for studies and may be extended by request to HCFCD. The expiration date is described in detail in Section 5.2.6.

All information provided by the requestors through the M3 website (www.hcfcd.org/m3) will become public records.

5.2.5 Study Initiation

Study Engineer **5.2.5.1**

When a requesting engineer logs-on to the system the information associated with the corporate login will automatically be populated in the study initiation form. The user will be required to enter the name and contact information (phone, e-mail and address if different from the corporate login address) of the project manager or lead engineer of the study for which the modeling data is being requested. The corporate login information will include a set of default contact information to be used in the event that the project manager or lead engineer leaves the company or if the primary contact changes prior to completion of the study. To receive a corporate login, contact HCFCD and a corporate login will be established.

Submittal Requirements **5.2.5.2**

As discussed in Section 5.2.3, the requester will need to indicate whether the checked-out models will ultimately be submitted in a modified form. If the models will not be resubmitted, the checkout system will direct the user to the download location for a pre-bundled set of models for their study location. The effective model sets will periodically be bundled and placed in this download location. These models may not represent the latest version of the effective model set if a LOMR is approved after the bundle is created. Types of model requests that may not result in the eventual resubmittal of the models could include requests for models for educational or research use, requests for models for preliminary private developer feasibility studies or public feasibility assessments and requests for projects that will not directly impact the drainage system in Harris County.

If the requester determines at a later date that they will be resubmitting models in association with a CLOMR or LOMR, they will need to go through the model checkout process again and initiate a new request and associated study definition. This process will generate a tracking number for the study and will facilitate the review process. This will also ensure that the requester is using the most current versions of the models available for the subject watersheds and streams. Submittal without a tracking number will not be accepted.

Study Description **5.2.5.3**

Provide a brief description of the study (255 characters or less) that includes the purpose of the study and any anticipated changes to the requested models or the effective floodplain.

5.2.5.3 Study Description

**Project Owner
or Sponsor**
5.2.5.3.1

Provide the contact information for the owner or sponsor of the project. This information is required for public projects but optional for private projects.

**Project
Duration**
5.2.5.3.2

Enter the anticipated duration (in months) of the project. The duration is considered to be the time from the request for modeling data to the resubmittal of that modeling data for review by HCFCD. This information will be used for internal workload management to better facilitate reviews.

**Additional
Items**
5.2.5.3.3

Indicate whether HEC-RAS unsteady flow modeling or any other non-standard modeling approaches are anticipated as part of the study. This information will assist HCFCD in the facilitation of the review process.

5.2.5 Study Initiation, Continued

**Regulatory
Entity
5.2.5.4**

Identify the primary regulatory entity that will be responsible for the final review and approval of the project. Indicate all that apply. The options include Harris County, the City of Houston, and other cities within Harris County.

Modeling submittals prepared in support of a FEMA CLOMR or LOMR must be approved by the local floodplain administrator(s) with jurisdiction over the project area. HCFCD is not the floodplain administrator for any of the streams within Harris County but may provide study review services through interlocal agreements with the municipalities in the County. HCFCD has been delegated the authority by FEMA to manage and maintain the effective model set for the county.

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5.2 Model Checkout, Continued

Checkout Expiration 5.2.6

Once the requestor has completed the online checkout form, the M3 system generates a tracking number for the study and determines an expiration date for the requested model checkout. The requestor will either need to resubmit their revised models by this date or coordinate with HCFCD to extend the expiration date. The purpose of this expiration data is to ensure that the requestor is using the most current versions of the hydrologic and hydraulic models and associated data for their study area. This expiration date in concert with the conflict notifications discussed in Section 5.2.8 will help HCFCD to manage or avoid potential conflicts between studies that impact the same stream or watershed.

Model Delivery 5.2.7

HCFCD will provide the requested models on a CD/DVD or through an FTP client, depending on the size of the data set requested. In either case, HCFCD will use the contact information entered through the online checkout form to notify the requestor of the location of the requested data.

Requests for additional supporting information (such as land use data, topographic data, or aerial photography) must be made separately from the model checkout request. HCFCD's contact information for such requests is provided on the M3 website (www.hcfcd.org/m3).

Coordination Notifications 5.2.8

As mentioned in previous sections, the model checkout information provided through the M3 system will allow for more efficient management of potential overlaps between CLOMR/LOMR studies that impact the same stream or watershed. The study area definition information will be evaluated by the system whenever models are requested or submitted in order to determine potential overlaps.

Potential overlaps identified by the system will generate e-mail notifications to HCFCD staff and the staff of any other indicated regulatory entity. These notifications will provide the primary contact information for all overlapping studies, contact information for the appropriate HCFCD staff or other regulatory staff, the type of overlap, and the date that models were requested for the newly overlapping study. It is the responsibility of the notified study initiators to coordinate and determine whether their various activities do overlap and to determine what steps should be taken to account for other ongoing projects in their modeling efforts.

5.3 Model Submittal

Overview
5.3.1 This section outlines the requirements for the submittal of new or revised models and supporting data for the models that are managed and maintained by HCFCD. All models submitted must follow the modeling standards outlined in Sections 1 through 4.

Purpose
5.3.2 The model submittal standards are intended to facilitate the review, approval, archival, and management of new and revised models and supporting information. They are also intended to facilitate coordination between potentially overlapping or conflicting studies as well as provide the framework for efficient management of modeling data into the future.

Application
5.3.3 The model submittal procedure requires completing an online submittal form through HCFCD's website (www.hcfcd.org/m3). Submitters are strongly encouraged to use the M3 Checker tool (available for download from the M3 website) to organize their study information for submittal. This tool will collect the information required for study submittal and organize the submittal data to meet the requirements of the HCFCD Electronic Review Submittal Guidelines.

The details of the submittal process are provided in the following subsections.

Study Submittal
5.3.4 Fill out the M3 online form on HCFCD's website in order to initiate the submittal process for a study. This form can either be populated directly or via the upload of the submittal data file prepared by the M3 Checker. Models, reports, plans, permit applications, and other supporting information will be submitted either on a CD/DVD or through an FTP client to Harris County Permits Commercial Receiving as required by HCFCD's PCPM. The detailed requirements for model submittals are described in the following subsections.

Submitters are strongly encouraged to use the M3 Checker tool (available for download from the M3 website) to organize their study information for submittal. This tool will collect the information required for study submittal and organize the submittal data to meet the requirements of the HCFCD Electronic Review Submittal Guidelines. The tool will prepare a data file that can be uploaded directly to the M3 website. This will allow the user to bypass a majority of the online submittal steps. The tools will also perform basic acceptability checks to ensure that the submittal is complete.

5.3.4 Study Submittal

**Study Reports
5.3.4.1** Engineering reports signed and sealed by a professional engineer licensed in Texas must be submitted in support of all modeling studies as required by HCFCD's PCPM.

**HEC-HMS
Submittal
5.3.4.2** This section describes the information that must be provided for a HEC-HMS model at the time of submittal. The focus of this section is on the actual files that need to be submitted and the required information to adequately identify those files. The standards for the actual development of the HEC-HMS model and supporting information are described in Sections 2, 3, and 4.

5.3.4.2 HEC-HMS Submittal

Basic Elements
5.3.4.2.1

Submit the complete HEC-HMS project for the study with all relevant files for the execution of the required model runs. In some cases, it may not be necessary to update the existing HEC-HMS model for a new study. In these cases, the HEC-HMS model does not need to be resubmitted. In some cases, there may be multiple HEC-HMS projects or multiple scenarios within a single project associated with a study. The submittal form requires the user to provide full details of the contents of the primary HEC-HMS project and short descriptions of any other HEC-HMS projects or alternate scenarios within a single project. In addition to the HEC-HMS project, the system requires complete identification of the geospatial files associated with the model submittal.

Recurrence Intervals
5.3.4.2.2

The online submittal form/M3 Checker requires the user to identify all recurrence interval events included with the primary HEC-HMS model. This includes the identification of HEC-HMS basin models associated with watersheds that have recurrence interval dependent TC&R parameters.

GIS Data
5.3.4.2.3

The online submittal form/M3 Checker requires the user to identify the geospatial files associated with the HEC-HMS model. The standards for the development of these files are discussed in detail in Section 4.

The files include the following:

- Subbasins (polygon)
- Routing Reaches (line)
- Schematic Links (line)
- Junctions (point)
- Diversions (point)
- Sources (point)
- Reservoirs (point)

Some files (sources, diversions, and reservoirs) are not required if these elements are not used in the HEC-HMS model.

5.3.4 Study Submittal, Continued

Model Support Information 5.3.4.3

Submit the standard TC&R and flow distribution spreadsheets required in support of a HEC-HMS model. The online submittal form/M3 Checker requires that these files are identified.

HEC-RAS Submittal 5.3.4.4

This section describes the information that must be provided for a HEC-RAS model at the time of submittal. The focus of this section is on the actual files that must be submitted and the required information to adequately identify those files. The standards for the actual development of the HEC-RAS model and supporting information are described in Sections 2, 3, and 4.

5.3.4.4 HEC-RAS Submittal

Basic Elements
5.3.4.4.1 Submit the complete HEC-RAS project(s) for the study with all relevant files for the execution of the required model runs. In some cases, there may be multiple HEC-RAS plans or multiple scenarios within a single project associated with a study. The submittal form requires that the full details of the contents of the primary HEC-RAS project(s) and short descriptions of any other HEC-Projects or alternate scenarios within a single project be provided with the study.

Plans
5.3.4.4.2 The online submittal form/M3 Checker requires that the relevant HEC-RAS project plans be provided. Indicate all plans required for the review and approval of the submitted study.

Relevant plans may include the following:

- Duplicate effective plan
 - Corrected effective plan
 - Pre-Project plan
 - Post-Project plan
 - Floodway plan
-

Profiles
5.3.4.4.3 The online submittal form/M3 Checker will verify that the correct profiles in the HEC-RAS flow files associated with the key plans have been included. These profiles must include, at a minimum, the profiles required by HCFCD's PCPM. These minimum requirements are also discussed in Section 3 of this document.

Required profile names are as follows (case sensitive):

- 50PCT_2yr
 - 20PCT_5yr
 - 10PCT_10yr
 - 4PCT_25yr
 - 2PCT_50yr
 - 1PCT_100yr
 - 0.2PCT_500yr
 - 1PCTFloodway_100yrFW
-

Unsteady Models
5.3.4.4.4 Unsteady flow HEC-RAS models may be applicable for the evaluation of certain projects. However, the submittal of unsteady flow HEC-RAS models will not require the full online description of model contents required for steady-state models at this time. The online submittal form/M3 Checker calls for the identification of relevant plans within the HEC-RAS project. HCFCD's M3 system will be used to store and potentially distribute these unsteady models.

5.3.4 Study Submittal, Continued

Supporting Information 5.3.4.5

Supporting information such as survey data, plans, aerial photographs, and other information (refer to Sections 2, 3, and 4 for discussions of supporting data types and standards) must be submitted in digital form with the models. Include hardcopies as appropriate and as required by HCFCD's PCPM.

5.3 Model Submittal, Continued

FEMA Requirements 5.3.5

Any study that impacts the FEMA regulatory water surface elevation or floodplain extent or adds a hydraulic structure to a studied stream will require a CLOMR and/or LOMR. CLOMRs and LOMRs must be prepared in accordance with FEMA Guidelines and Specifications. The CLOMR or LOMR application must be submitted in digital form along with the study models. Refer to Section 5.4 for additional details regarding FEMA submittals.

5.4 FEMA Submittal

**Overview
5.4.1** This section outlines the requirements for the submittal of modeling data that is associated with updates to the FEMA floodplains and/or floodways (CLOMR, LOMR, or FEMA restudy). All models submitted must follow the modeling standards outlined in Sections 1 through 4.

**Purpose
5.4.2** The FEMA submittal standards are intended to ensure that all floodplain regulatory requirements are met and to provide the framework for efficient management of modeling and floodplain mapping data into the future.

**Application
5.4.3** Any study that impacts the FEMA regulatory water surface elevation or floodplain/floodway extent or adds a hydraulic structure to a studied stream requires a CLOMR and/or LOMR. The CLOMR or LOMR application must be submitted in digital form along with the study models.

Update all GIS data layers, FEMA FIS tables and profiles, 1% and 0.2% FEMA effective floodplains, and FEMA floodway limits for all submittals when proposed activities modify any or all of the following:

- Watershed drainage area boundaries
 - Subbasin drainage area boundaries
 - Flow rates in any studied channels
 - FEMA Effective Floodplain limits
 - Floodway limits
 - Channel water surface elevation profiles
 - Cross section location map
-

**CLOMR or
LOMR
5.4.4** Prepare CLOMRs and LOMRs in accordance with FEMA Guidelines and Specifications. Refer to the FEMA website for details about the required documentation and fees. The forms and associated information for preparation of CLOMRs and LOMRs may be accessed at http://www.fema.gov/plan/prevent/fhm/frm_form.shtm.

5.4.4 CLOMR or LOMR

Profile/Table
5.4.4.1

In addition to the FEMA requirements for CLOMR and LOMR submittals, provide updates to any impacted profile plots from the effective set of profiles included in the FIS study for Harris County.

- Prepare profile plots using the FEMA RASPLOT application. Refer to http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm#1 to download the RASPLOT software.
 - Use the same horizontal and vertical scales for the revised profile plots that were used for the original profiles if at all possible.
 - Submit both the database and DXF files generated by the RASPLOT application and modify as necessary in CAD.
 - Submit water surface elevation tables showing the comparison between the effective, corrective effective, and proposed project models.
-

SECTION 6 - REFERENCES

6.1 References

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