MASTER DRAINAGE PLAN UPATE

FORT BEND COUNTY, TEXAS

Standard Methodology

November 4, 2022

Prepared for:

Fort Bend County Drainage District

Prepared by:

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1.0 INTRODUCTION

The Fort Bend County Drainage District (FBCDD) commissioned the development, or update, of master drainage plans (MDP) for major streams within Fort Bend County. The locations of the streams are shown in Exhibit 1 and are listed in the table below.

Table 1 – Master Drainage Plan Studied Streams

Watershed	Stream Name
Oyster Creek	Upper Oyster
	Middle Oyster
	Lower Oyster
	Flat Bank Creek
	Red Gully
	Ditch H
	Stafford Run
	Mustang Bayou
	Mustang Bayou Diversion
	Long Point Creek
Bessie's Creek	Bullhead Bayou
	Bessie's Creek
	Brookshire Creek
Big Creek	Big Creek
	Big Creek Diversion Channel
	Dutch John
	Dry Creek
	Cottonwood Creek
	Gapps Slough
	Coon Creek
	Seabourne Creek
	Deer Creek
	Lateral II-B-7
	Lateral II-B-9
	Fairchilds Creek
Willow Fork	Willow Fork
	Cane Island
	V-A-3
San Bernard River	San Bernard River
	Cedar Creek
	Buffalo Creek
	Snake Creek
	Turkey Creek
	Dry Branch
	Mound Creek
	Guy Creek

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Table 1 - Master Drainage Plan Studied Streams

Watershed	Stream Name
Cow Creek	Cow Creek
	Bee Creek
	Turkey Creek
Jones Creek	Jones Creek
	Andrus Creek
	Flewellen Creek
	Rabbs Bayou
	Robinowitz Ditch
	Pleasant Gulley
	Briscoe Ditch
	Sims Bayou
	Brays Bayou
	Keegans Bayou
	Clear Creek

The MDP updates were completed by four (4) consulting firms' area are as follows:

1. Freese and Nichols, Inc.
2. Halff Associates, Inc.
3. Pape-Dawson Engineers, Inc.
4. Walter P. Moore and Associates, Inc.

The purpose of the MDP updates is to produce updated hydrologic and hydraulic models, along with updated floodplain maps, identify typical channel sections to convey the existing 100-year flow, ROW needed for channel widening, alternatives for regional detention, and potential for diversion channels. The models produced will reflect updated rainfall depth, duration, and frequency data as defined in the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 update. The following sections document the data, methodology, and software used for the MDP development and updates. Additional guidance is documented in the updated Drainage Criteria Manual (DCM).

2.0 HYDROLOGIC METHODOLOGY

2.1 RAINFALL DATA AND DISTRIBUTION

In September of 2018, the National Oceanic and Atmospheric Administration (NOAA) released updated rainfall values for Texas in the form of "NOAA Atlas 14, Volume 11 Precipitation-Frequency Atlas of the United States, Texas" with updated, detailed, localized rainfall values for the State of Texas. In the southeastern part of the state particularly, this new research yielded increased rainfall intensities from

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those previously determined using TP-40 and Technical Memorandum NWS Hydro-35. Depth versus duration data for a variety of storm frequencies, from the 2-year to the 500-year storm are summarized in the table below. These rainfall distribution was used for the Drainage Master Plan developments or updates.

Table 2 – NOAA Atlas 14, Volume 11 Rainfall Distribution

Duration	Rainfall Depth (in)						
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	500 yr
5 min	0.59	0.73	0.84	1.00	1.13	1.26	1.57
15 min	1.19	1.46	1.69	2.00	2.25	2.50	3.11
1 hr	2.26	2.78	3.22	3.83	4.30	4.80	6.20
2 hr	2.83	3.53	4.19	5.16	5.99	6.91	9.45
3 hr	3.17	4.00	4.82	6.08	7.19	8.47	12.00
6 hr	3.77	4.86	5.97	7.72	9.33	11.20	16.30
12 hr	4.40	5.79	7.20	9.41	11.40	13.80	20.50
1 day	5.09	6.82	8.55	11.20	13.70	16.50	24.50

2.2 BASIN DELINEATIONS

Hydrologic subbasins were delineated to create 0.5 to 3 square mile drainage areas. These sizes generally depended on level of development. In areas where less detail was warranted, such as the San Bernard and Brazos River studies and regions outside of Fort Bend County, significantly larger subbasins were utilized. Subbasin outlets were defined based on the following points of interest:

- Changes in land use
- Changes in topographic characteristics
- Hydraulic restrictions such as bridges and culverts
- Stream confluences

Watershed-specific details regarding approach to subbasin delineation are provided in section 2.0 of individual MDP reports.

2.3 INFILTRATION LOSSES

The Green-Ampt loss method was used to determine runoff abstractions in development of the FBCDD MDP hydrologic models. The application of this methodology is described in detail in section 2.4.2 of the

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updated DCM. Note that Green-Ampt parameters are in the process of being updated in the portion of Fort Bend County that is south of the Brazos River.

2.4 IMPERVIOUS COVER

Impervious cover values were determined by classifying land use types. These land use types and associated impervious cover values are shown in Table 2-1 of the updated DCM.

2.5 TRANSFORM METHODS

The Basin Development Factor (BDF) method was utilized to calculate Clark time of concentration (TC) and storage (R) coefficients. This process is described in detail in section 2.4.3 of the updated DCM.

2.6 CHANNEL ROUTING DATA

Unsteady-flow HEC-RAS hydraulic models were relied upon for routing flows through watersheds in this study. For cases where subbasin outlets were not defined along channels modeled in HEC-RAS, the Lag routing method was used in HMS. Other cases specific to particular watersheds are documented in section 2.0 of individual MDP reports.

2.7 FLOW ROUTING

Unsteady-flow HEC-RAS hydraulic models were relied upon for routing flows through watersheds in this study. Sections 3.2.3 to 3.2.6 in the updated DCM describe the principles and assumptions of unsteady modeling that were used in this study. Discharges reported in the HEC-HMS model should not be used for any purpose, and users should rely on results produced by the HEC-RAS hydraulic models.

2.8 MODELING SOFTWARE

HEC-HMS 4.3 was used to develop flow hydrograph boundary conditions for this study.

3.0 HYDRAULIC METHODOLOGY

3.1 ELEVATION DATUM

All elevations used in the FBCDD MDP hydraulic analyses are referenced to the 1988 North American Vertical Datum, 2001 Adjustment (NAVD 88, 2001 Adj.). Supporting data for hydraulic models that references this datum includes the following:

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- 2014 Fort Bend County LiDAR
- Bridge and culvert survey points
- Record drawings

3.2 MODELING SOFTWARE

HEC-RAS 5.0.7 was used for unsteady hydraulic analyses. Flow hydrograph boundary conditions within the HEC-RAS models are linked directly to results of the hydrologic analysis through DSS files, which are created during execution of hydrologic models.

3.3 CROSS SECTION DEVELOPMENT

Hydraulic models were developed at varying levels of detail throughout Fort Bend County in urban and rural environments. Therefore, spacing and width of 1D cross sections vary significantly throughout the study area. Watershed-specific details regarding 1D cross section development are provided in section 3.0 of individual MDP reports.

3.4 2D AREAS

2D flow areas were utilized on an as-needed basis to model channel overbank flooding, overflows between studied channels, and backwater inundation. Where these flooding effects are minimal, models do not utilize 2D flow areas. Watershed-specific details regarding 2D flow areas are provided in section 3.0 of individual MDP reports.

3.5 1D MANNING ROUGHNESS COEFFICIENTS

1D manning roughness coefficients (n-values) were defined using 2019 aerial photographs and field visit notes as primary data sources. Table 3-1 of the updated DCM and documents listed in section 3.5 of the updated DCM were used as a basis for determining channel n-values. Watershed-specific details regarding 1D n-values are provided in section 3.0 of individual MDP reports.

3.6 2D MANNING ROUGHNESS COEFFICIENTS

2D manning roughness coefficients were assigned using 2018 HGAC Land Cover values and are listed in Table 3-2 of the DCM. Manning's override regions were used to modify standard HGAC derived values where necessary, such as changes in land use and high conveyance areas in need of a finer level of detail. Watershed-specific details regarding 2D n-values are provided in section 3.0 of individual MDP reports.

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3.7 BOUNDARY CONDITIONS

In general, normal depth boundary conditions, flow hydrographs, lateral inflow hydrographs, and uniform lateral inflow hydrographs are used in unsteady flow hydraulic analyses. Flow hydrograph boundary conditions within the HEC-RAS models are linked directly to results of the hydrologic analysis through DSS files, which are created during execution of hydrologic models. Additional boundary condition types were used on a case-by-case basis. Watershed-specific details regarding boundary conditions are provided in section 3.0 of individual MDP reports.

4.0 FLOODPLAIN MAPPING

4.1 100-YR AND 500-YR FLOODPLAINS

100-yr and 500-yr floodplain inundation mapping was processed from hydraulic modeling results. In order to produce simplified floodplain inundation mapping, the following general steps were followed:

- Export depth results at 9'x9' resolution, filtered to depths exceeding threshold (0.1 to 0.5 feet)
- Eliminate isolated floodplain polygons or islands under area threshold (0.1 to 2 acres)
- Smooth polygons (20 to 250-foot PAEK algorithm)

The threshold ranges mentioned above are commonly accepted values. Engineering judgment was used to determine thresholds that best suited conditions in differing watersheds.

4.2 CONVEYANCE ZONES

A similar process was used to produce conveyance zone mapping in lieu of regulatory floodway mapping. Conveyance zones were defined as areas where Depth times Velocity values equaled or exceeded 1.5. Below are the steps followed to produce conveyance zone mapping:

- Export Depth*Velocity rasters at 9'x9' resolution, filtered to values equaling or exceeding 1.5
- Eliminate isolated floodplain polygons or islands under area threshold (0.1 to 2 acres)
- Smooth polygons (20 to 250-foot PAEK algorithm)

The threshold ranges mentioned above in parentheses are commonly accepted values. Engineering judgment was used to determine thresholds that best suited conditions in differing watersheds. Generally, higher smoothing tolerances were used when processing conveyance zone mapping.

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4.3 BFE LINES

To provide supplemental data to floodplain inundation mapping, BFE lines were delineated to show 100-yr water surface elevations in 1-foot increments. In order to process these polylines, the following general steps were followed:

- Export 9'x9' WSE raster
- Compute 1' and 0.1' contours
- Smooth contours (~40-foot PAEK algorithm)
- Manually edit to simplify 1' contours as necessary using 0.1' contours as reference

The smoothing tolerance listed above is a commonly accepted value. Engineering judgment was used to determine a tolerance that best suited conditions in differing watersheds. The goal of this tolerance and subsequent edits is to produce BFE lines that are simple to interpret by various users.

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Drainage Master Plans Streams

Fort Bend County

FN PROJECT NO.	OFF18050
DATE CREATED	5/3/2019
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas South Central
FILE NAME	Drainage Master Plan Streams
PREPARED BY	DML

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EXHIBIT 1

Legend

- Steams
- Fort Bend

0 4 8 Miles

Date Saved: 5/3/2019 7:12:58 AM

Path: H:\STORMWATER\Final Exhibits\Drainage Master Plan Streams.mxd