
Comprehensive Analysis of Coastal Floodplain Resiliency Data: An Investigation of Nine Counties in the Upper Texas Coast

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EXECUTIVE SUMMARY

The state of Texas is vulnerable to various extreme weather events. In the Gulf Coast region, these weather events are predominately linked to rainfall and flooding, most recently exemplified with record rainfall events in 2015 and 2016, and catastrophic flooding caused by Hurricane Harvey in 2017.

Mitigation and rebuilding from these events and corresponding damages is dependent on a multitude of factors including defining and measuring the event itself. Recognizing the state's long and well-documented history of flooding, hurricanes, wildfires, and droughts, as well as its ongoing efforts to mitigate future disaster effects in its most vulnerable areas, the Texas General Land Office (GLO) is leading Texas' efforts of rebuilding while prioritizing resiliency in the Harvey aftermath.

The goal of this project is to assist the GLO with the CDBG-DR (Community Development Block Grant – Disaster Recovery) Program for Texas by gathering flood-related data for nine counties, as well as offering recommendations to the GLO and local officials to aid in mitigation and recovery from future flood events. The project is divided into five tasks to gather comprehensive information from various sources. Task 1 collects flood-related GIS data (FEMA flood zones, high water marks, critical infrastructures, etc.), studies and plans. Task 2 reviews drainage strategies on three scales of analysis: federal (EPA, FEMA, etc.), regional (TWDB, TCEQ, etc.), and local (counties, cities, etc.). Task 3 engages, collects input, and determines the needs, concerns, and recommendations of local government regulators, drainage engineers, planners and other stakeholders in their respective areas and specializations. Task 4 delivers an online map viewing tool with 7 viewing apps, each one serving a specific purpose (Vulnerability of Life and Infrastructure, Emergency Response Infrastructure, etc.). This report is the outcome of Task 5, in which the research team compiles the work and findings of previous tasks into a report format.

The research team was able to identify common flood-related issues encountered by the counties from information collected during Tasks 1 through 3. One of the most repeatedly mentioned needs is updated FEMA 100-year floodplain maps. Many counties stated that the maps do not match current conditions anymore, because locations of the floodplain do not match observations when flooding occurs. In addition, counties still lacked reference floodplain in correspondence with the new ATLAS-14 standard, which is a new regulation for the amount of rainfall of 100-year and 500-year storms. It is expected that the size of the new 100-year and 500-years floodplains should be bigger than their older counterparts.

Updated floodplain maps could provide counties with critical and accurate information about flood prevention and mitigation.

In terms of interagency cooperation and coordination, many of the counties commented they have good communications with each other, but not so good with state and federal agencies. Issues with delayed permitting and funding processes are repeatedly reported by counties. Permitting sometimes took years, which made projects more costly than they should be with expedited permitting. In terms of cooperation between counties and cities, many counties and cities are looking for more cooperation with others on regional flood control plans, measures and projects.

Flooding is never an isolated issue. Natural, social, and economical factors all played important roles in flooding problems across the area of interest of this study. Natural factors such as elevation, terrain and distance to the coast inevitably contribute to whether a region is flood-prone or not. Low socioeconomic status in some cities and neighborhoods are also positively related to repetitive flooding according to the interviews.

One of the most important products of this research is the online map viewing tool. There are seven individual apps each serving a specific purpose. Take the Vulnerability of Life and Infrastructure app as an example. The purpose of this app is to see where people would be in the most danger in the event of a flood. Floodplains, Hurricane Harvey high water marks and low water crossings are presented on the same map with schools, hospitals, and nursing homes, for viewers to place where people are the most vulnerable to flooding.

To use the tool, the user will access a portal through a link provided on the GLO website, and log in with username and password. The user will then choose one app out of seven that meets their need. After entering the app, the user can check the desired layer of information (For example, "FEMA 100 yr Flood") to view. If the user is only interested in certain counties, he/she can enter the name of the counties under the "Select County(s)" box. Legends are on the lower-left corner as a reference. If the user is interested in looking at more detailed information of a specific data point, clicking on a point on the map with a marker will reveal more details.

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TABLE OF CONTENTS

Executive Summary	ii
Acknowledgements	iv
Table of Contents	v
List of Figures	ix
List of Tables	x
Acronyms	xii
1. Introduction	15
1.1. Project Objectives	16
1.2. Work Plan Overview.....	16
2. Data collection and analysis (TASK #1)	18
2.1. Collection and Processing of GIS Data	18
2.2. Naming Structure and Organization of GIS Data	19
2.3. Collection and Organization of Documents	22
2.4. Quality Assurance and Control	23
3. Review and Analyze Existing Regional Drainage Oversight Strategies and Coordination (TASK #2) ..	24
3.1. Local Entities	26
3.1.1. Orange County	28
3.1.2. Jefferson County	32
3.1.3. Chambers County.....	36
3.1.4. Liberty County.....	39
3.1.5. Newton County	41
3.1.6. Polk County	43
3.1.7. Hardin County	44

3.1.8. Tyler County	45
3.1.9. Jasper County	45
3.2. Regional Entities.....	46
3.2.1. Texas Water Development Board (TWDB)	46
3.2.2. Texas Department of Transportation (TxDOT)	48
3.2.3. Texas Commission on Environmental Quality	51
3.2.4. River Authorities	55
3.2.5. Southeast Texas Regional Alerting and Information Network Portal.....	57
3.2.6. Non-Governmental Entities	57
3.3. Federal Entities	63
4. Stakeholder interviews (TASK #3)	72
4.1. Task Description and Objectives	72
4.2. Approach.....	72
4.2.1. Developing Contact Database.....	72
4.2.2. Questionnaire Development.....	73
4.2.3. Online Survey	73
4.2.4. Face to Face Interviews and Small Focus Groups	76
4.2.5. Final Stakeholder Workshop.....	78
4.3. Results and Discussion	79
4.3.1. Online survey	79
4.3.2. Workshop.....	83
4.4. Survey Recommendations	84

5. Consolidating and Building an Organized Data Library (TASK #4)	87
5.1. Data Library Overview.....	87
5.2. Documents.....	87
5.3. Geographic Information System (GIS) Data.....	88
5.3.1. Geospatial Data File Types and Their Modification and Use in Viewing Apps.....	89
5.3.2. Storage of Vector Data in Data Library’s Primary PostgreSQL Databases.....	93
5.3.3. Publication of Vector Data as WMS and WFS Endpoints.....	93
6. Recommendations	95
6.1. Mitigation of Compound Flood Risks for Coastal Counties	95
6.2. Improved Regional Planning	95
6.3. Adopted Updates to New 100-year Rainfall Estimates.....	96
6.4. Consideration of Future Land Use and Infrastructure Conditions.....	96
6.5. Development of Updated Floodplain Maps.....	96
7. Conclusions	98
8. References	100
9. List of Exhibits	104
10. List of Appendices	112

LIST OF FIGURES

Figure 2-1: Study Area (nine counties east of greater Houston) 19

Figure 3-1 Counties with Drainage Master Plans..... 26

Figure 3-2 Major waterways and watershed that impact flooding in Orange County, TX 29

Figure 3-3 - Flood Risk Map for Jefferson County (Source: FEMA Flood Service Center)..... 34

Figure 3-4 – Chambers County watersheds, drainage areas and major water bodies (Source: Chambers County Master Drainage Plan 2014)..... 37

Figure 3-5 – TxDOT Roads in the Study Area 50

Figure 3-6 - Studies area and river authorities' boundaries 55

Figure 4-1 Distribution of online survey responses by county 75

Figure 4-2 Distribution of online survey responses by area of responsibility 75

Figure 4-3 Distribution of interviewees by county 77

Figure 4-4 Distribution of interviewees by area of responsibility 77

Figure 4-5 Images of workshop attendees 79

Figure 10-1 IUP Process 142

Figure 10-2 Application Process..... 142

Figure 10-3 – Loan Process Flowchart 146

Figure 10-4 - IUP and Loan Process *Zoom In*..... 149

Figure 10-5 - Application Process..... 150

LIST OF TABLES

Table 2-1 : Summary of Acquired GIS Data.....	20
Table 2-2: Summary of Acquired Documents.....	22
Table 3-1 – Summary of drainage oversight documents in Orange County, TX.....	31
Table 3-2 – Summary of drainage oversight documents for Jefferson County, Texas	35
Table 3-3 - Drainage oversight agencies in Chambers County, TX	36
Table 3-4 – Summary of Drainage Oversight Documents in Chambers County, TX	38
Table 3-5 - Drainage Districts and Oversight Jurisdiction in Liberty County, TX.....	39
Table 3-6 - Summary of Drainage Oversight Documents in Liberty County, TX	40
Table 3-7 - Available Drainage Oversight Documents for Newton County, TX.....	42
Table 3-8 - Summary of Drainage Oversight Documents in Polk County, TX	43
Table 3-9 - Summary of Drainage Oversight Documents in Hardin County, TX	44
Table 3-10 - Summary of TWDBI Flood Related Documents for Counties within the Domain of the Study	47
Table 3-11 Phase II MS4 Implementation Program – activities summary.....	53
Table 3-12 – Deep East Texas Council of Governments (DETCOG).....	57
Table 3-13 - Southeast Texas Regional Planning Commission (SETRPC)	58
Table 3-14 - Houston-Galveston Area Council (H-GAC).....	59
Table 3-15 - Trust for Public Lands.....	60
Table 3-16 - The Conservation Fund	60
Table 3-17 - The Association of State Wetland Managers.....	61

Table 3-18 - The National Association of Conservation Districts..... 62

Table 3-19 - Natural Hazards Mitigation Association 62

Table 3-20 Federal Document Summary 65

ACRONYMS

ANRA	Angelina & Neches River Authority
CBDG	Community Development Block Grant
CBDG-DR	Community Development Block Grant Disaster Recovery
CIP	Capital improvements program
CWA	Clean Water Act
DD6,7	Drainage District 6, Drainage District 7
DEM	Digital Elevation Map/Model
DETCOG	Deep East Texas Council of Governments
DMP	Drainage Master Plan
DOI	Bureau of Land Management of the Department of Interior
DRG	Digital Raster Graphics
EFH	Essential Fish Habitats
EFHA	Essential Fish Habitat Assessment
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FWS	Fish and Wildlife Service
GIS	Geographic Information Systems
GLO	Texas General Land Office
HAPC	Habitat Areas of Particular Concern
H-GAC	Houston-Galveston Area Council
HGL	Hydrocarbon Gas Liquids
HMP	Hazard Mitigation Plan
HUD	U.S. Department of Housing and Urban Development
KML	Keyhole Markup Language

KMZ	Keyhole Markup Language Zipped
LIDAR	Light Detection and Ranging
LNVA	Lower Neches Valley Authority
LWRCRPS	Land and Water Resources Conservation and Recreation Plan statewide inventory
MCM	Minimum Control Measures
MS4	small municipal separate storm sewer system
NAD	North American Datum
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NWS	National Weather Service
OCDD	Orange County Drainage District
POTW	Publicly owned treatment works
QA/QC	Quality Assurance and Quality Control
SE Texas R.A.I.N	Southeast Texas Regional Alerting and Information Network
SETRPC	South East Texas Regional Planning Commission
SFHA	Special Flood Hazard Area
SRA	Sabine River Authority of Texas
SSURGO	Soil Survey Geographic
STATSGO	State Soil Geographic
SWMP	Stormwater management program
SQL	Structured Query Language
TCEQ	Texas Commission on Environmental Quality
TDEM	State of Texas Division of Emergency Management
TIFP	Texas Instream Flow Program
TNRIS	Texas Natural Resource Information System

TRA	Trinity River Authority
TRRC	Texas Railroad Commission
TTC	Texas Target Communities
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
UA	urbanized area
USACE	United States Army Corps of Engineers
USDA NRCS	U.S. Department of Agriculture National Resource Conservation Service
USFWS	U.S. Fish and Wildlife Service
UTA	University of Texas at Arlington
UTSA	University of Texas at San Antonio

1. INTRODUCTION

As the first step of leading Texas' efforts of rebuilding while prioritizing resiliency after Harvey, GLO has begun assessing projects and considering state-run programs that replaced or repaired Harvey devastation and is investing resources in efforts that promise to mitigate damage from a wide range of future natural disasters. A research team was compiled to assist the GLO in fulfilling its duty to administer the CDBG-DR program for Texas in compliance with all CDBG-DR rules and regulations. The research team was primarily made up of researchers from the University of Texas at San Antonio (UTSA) and the University of Texas at Arlington (UTA) with additional support from Rice University and industry expert consultants from Torres & Associates, LLC, RJN Group, Inc., and Floodace, LLC. The team gathered and organized, and analyzed data related to repetitive flooding events experienced in the counties of Hardin, Jasper, Jefferson, Newton, Orange, Tyler, Polk, Liberty, and Chambers. After analyzing the data, the team was responsible for making recommendations to the GLO and local officials for regional oversight and coordination of drainage infrastructure to aid in the recovery from future flooding events. The pertinent information from these efforts was gathered in an organized data library in collaboration with a GLO-designated database manager, and provided for use by the GLO, other governmental entities, and the public.

UTSA assembled a strong research team with an established record of accomplishment in providing comprehensive oversight planning services for drainage/stormwater infrastructure systems and working knowledge of regulatory and statutory framework relating to grant processes funded by U.S. Department of Housing and Urban Development. The researchers involved provided data collection and analysis services related to the effects of regional flooding and, in coordination with local communities and community leaders, developed long-term plans and strategies to protect communities from floods and other natural disasters.

1.1. Project Objectives

The main objective of this project was to gather, organize, and analyze data related to repetitive flooding events experienced in the counties of Hardin, Jasper, Jefferson, Newton, Orange, Tyler, Polk, Liberty, and Chambers, and make recommendations to the GLO and to local officials for regional oversight and coordination of drainage infrastructure to aid in the counties' recovery from future flooding events. The research team additionally conducted community outreach activities, and informed local communities and community leaders, on behalf of the GLO, of recommended flood mitigation actions to take based on the data analysis.

This report serves as a comprehensive deliverable summarizing the data collection and documentation process as well as key findings of the data collection efforts put forth by the research team. In addition, an organized, accessible data library, which consolidates the collected data in a user-friendly application, was created to be published at the discretion of the GLO for both public and private use.

1.2. Work Plan Overview

To develop a set of best practices and sound recommendations, the researchers first undertook a thorough review of literature including available past research and relevant reports from Texas and across the nation. A major focus of the researchers was to identify drainage issues and difficulties commonly faced by Texas coastal communities. This research was conducted through two primary courses of action. First, an informal advisory group was formed to recommend topics and issues to address in research efforts. This group, consisting of experienced hydrologic/hydraulic engineers with a vested interest in matters related to drainage design, mitigation, litigations, and regulations, represented hydrology/hydraulics personnel from higher education institution and private companies in Texas. Second, the research team conducted interviews with local officials to collect additional pertinent topics and issues of concern for the study area. Description of the communication methodology and a summary of results is included in the tasks. From these communications, frequently encountered problems were identified and emphasized.

The work was performed by a group of full-time experienced engineers and researchers with significant research and applied experience in hydrologic measurements, gathering and organizing hydrologic data pertinent to regional oversight and the coordination of the drainage infrastructure, hydro-informatics, decision support systems, web services, spatial and temporal data imputation and interpolation,

statistical analysis, and geo-information systems development. Partners of this research team have experience and responsibilities on evaluating and implementing sustainable water resource programs, using and applying new methods that exploit distributed web service, remote data storage and access, with integrated decision support tools. The team's broad experience on both the research and the applied sides of flood management and associated international and U.S. demonstration sites helped the achievement of the research objectives and ensured that the resulting tools and methods are applicable, useful, and easily implemented in working environments.

2. DATA COLLECTION AND ANALYSIS (TASK #1)

Task 1 involved conducting a comprehensive search to locate information related to repetitive flooding events experienced in the counties of Hardin, Jasper, Jefferson, Newton, Orange, Tyler, Polk, Liberty, and Chambers. This included identifying and documenting similar data collection efforts pertaining to flooding in the nine counties conducted by other agencies and governmental entities in Texas. Specific efforts of Task 1 included: collecting topographic and GIS data and documentation pertinent to regional drainage in the counties, data and documentation collected from entities whose actions affect regional drainage infrastructure (e.g., U.S. Army Corps of Engineers) and data and documentation collected by the Federal Emergency Management Agency (FEMA) and respective drainage districts or other organizations with pertinent data. The collected documentation included: flood studies, local and regional flood mitigation plans, engineering/infrastructure studies, environmental studies, resiliency plans, emergency response plans, regulation and policy studies, and specific disaster information.

2.1. Collection and Processing of GIS Data

The research team identified and documented relevant types of GIS data and the respective sources, as summarized Table 2-1. The GIS data were then obtained from the corresponding source from each of the nine counties as shown in Figure 2-1. The raw GIS data was post-processed to ensure that (1) the data represented information respective to only a specific county, instead of a larger or smaller extent of surrounding area and (2) the data were consistently projected to one geographic coordinate system. As such, the post-processing was conducted with respect to two general scenarios: (A) for GIS data covering an excessively large area, there were either clipped (for point shapefiles, line shapefiles and rasters) or selected (for polygon shapefiles) based on the county boundary; (B) for data in small tiles, such as digital elevation model (DEM) raster data, mosaics were created to cover the whole county. A series of GIS data (either in feature or raster format) were generated for each of the nine counties as a final product. Exhibits in the attached to this report (see: List of Exhibits) show the maps of each type of GIS for Chambers County, respectively. Chambers County is included as an example data set because it is reflective of GIS data layers that were available for download from the majority of the counties investigated.

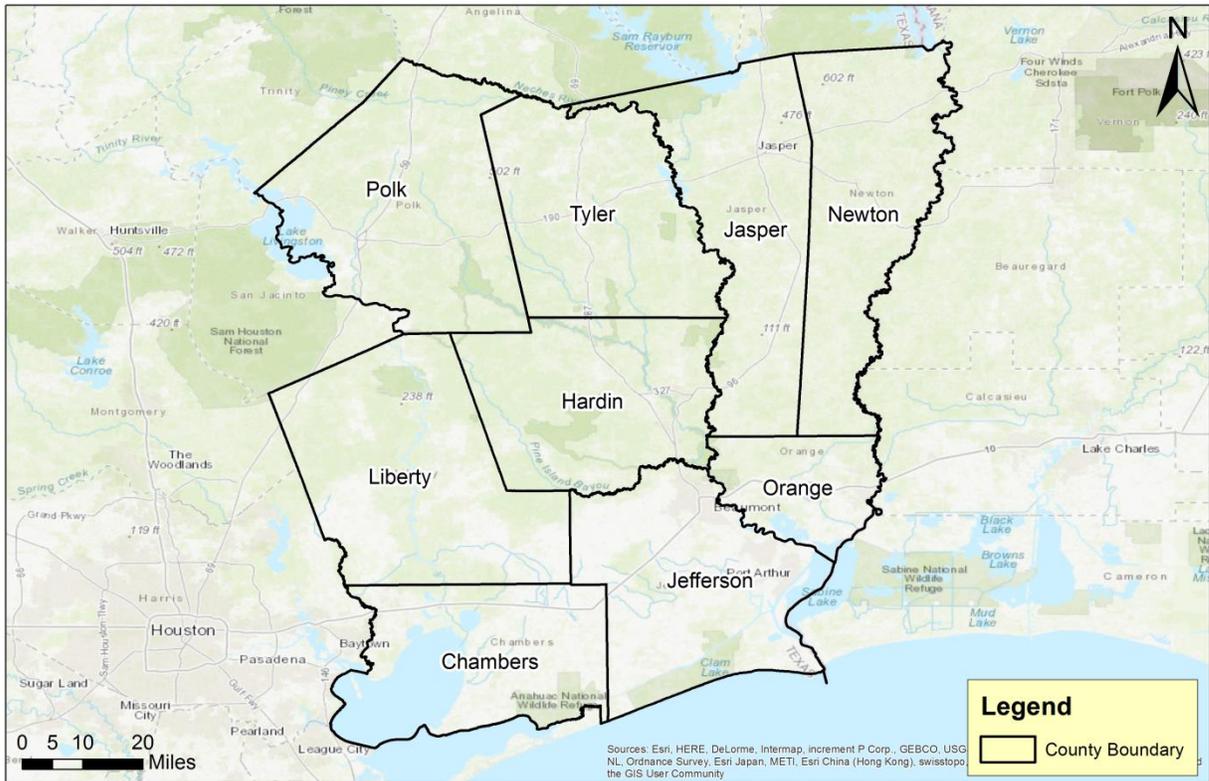


Figure 2-1: Study Area (nine counties east of greater Houston)

2.2. Naming Structure and Organization of GIS Data

The GIS data were categorized by county and sub-categorized by data type. The research team created a naming convention for unique each data type, illustrated in Table 2-1, to then consolidate the data within a database. Each filename includes area, data source, and time of creation.

In addition, an inventory list was generated to record key information of the GIS data. This serves as the metadata for each GIS file. The inventory list consists of a descriptive name, a file name, description of source, a time of download, and a time of creation for each GIS file.

Table 2-1 : Summary of Acquired GIS Data

Data Type		Naming Example		
Administrative Boundaries	Groundwater Conservation Districts		TL_GCD_TWDB_19.shp	
	Groundwater Management Areas		TL_GMA.shp	
	Priority Groundwater Management Areas		TL_PGMA_TWDB_17.shp	
	Regional Water Planning Areas		TL_RWPA.shp	
	River Authorities and Special Law Districts		TL_RWPA.shp	
	TCEQ ¹ Regions		TL_TCEQReg.shp	
	TxDOT ² Districts		TL_TxDOTDist.shp	
	Water Districts		TL_WaterDist.shp	
Critical Infrastructure	Cellular Towers		TL_CellularTowers.shp	
	Colleges and Universities		TL_CollegeUniv.shp	
	Emergency Operations Centers	Local	TL_LocalEOC_HIFLD_2018.shp	
		State	TL_StateEOC_HIFLD_2019.shp	
	Emergency Response Risk Management Plan Facilities		TL_ERRMPF.shp	
	Hospitals		TL_Hospitals.shp	
	Local Law Enforcements locations		TL_LLEL.shp	
	Major State Government Buildings		TL_MSGB.shp	
	Nursing Homes		TL_NursingHomes.shp	
	Private Schools		TL_PrivateSchool.shp	
	Public Schools		TL_PublicSchool.shp	
	Treatment and Disposal	Landfills		TL_Landfills_HIFLD_2018.shp
		Wastewater Treatment Plants		TL_WWTP_EPA_2016.shp
	Energy Infrastructure	Biodiesel Plants		TL_BiodieselPlants_EIA_2018.shp
		Crude Oil Pipelines		TL_CrudeOilPipe_EIA_2018.shp
		Electric Power Transmission Lines		TL_EPTL.shp
		Electric Substations		TL_ElectricSub_HIFLD_2018.shp
		Ethanol Plants		TL_EthanolPlants_EIA_2018.shp
		HGL ³ Pipelines		TL_HGLPipe_EIA_2018.shp
		Natural Gas Pipelines		TL_NaturalGasPipe_EIA_2019.shp
		Natural Gas Plants		TL_NaturalGasPlant_EIA_2019.shp
		Petroleum Pipelines		TL_PetroPipe_EIA_2018.shp
		Petroleum Refineries		TL_PetroRefineries_EIA_2019.shp
		Power Plants		TL_PowerPlants_EIA_2019.shp
	Wind Turbines		TL_WindTurbines_2019.shp	
	Environmentally Sensitive Areas	American Indian Lands		TL_AmerIndianLands.shp
		Archeological Projects		TL_ArchProj_Line.shp
		Artificial Reefs		TL_ArtificialReefs.shp
		Boat Ramps		TL_BoatRamps_TPWD_2018.shp
		Critical Habitats		TL_CriticalHabitats.shp
Fisheries		EFH ⁴	TL_FishEFH_2018.shp	

Data Type			Naming Example	
		EFHA ⁵	TL_FishEFHA_2018.shp	
		HAPC ⁶	TL_FishHAPC_2018.shp	
		Historic Sites		TL_HistoricSites.shp
		LWRCRPS ⁷		TL_LWRCRPS.shp
		National Parks		TL_NationalParks.shp
		National Register of Historic Places	Districts	TL_NRHP_Dist.shp
			Properties	TL_NRHP_Prop.shp
		Public Water System Surface Water Intakes		TL_SWIntakes_TCEQ_2016.shp
		State Parks		TL_StateParks.shp
		US FWS ⁸ Properties		TL_USFWSProp_APVD.shp
		Wetlands		TL_Wetlands.shp
		Wildlife Management Areas		TL_WLMA.shp
		Transportation Infrastructure	Airports	
	Bridges		TL_Bridges.shp	
	Railroads		TL_Railroads.shp	
	Roads		TL_Roads.shp	
	Roadways		TL_Roadways_TxDOT.shp	
	Seaports		TL_Seaports.shp	
	Low Water Crossings		TL_LWX_TNRIS_14.shp	
	Dams		TL_Dams.shp	
Flood Control Structures	Dams		TL_Dams_Flood.shp	
Levees			TL_LeveeSystem_Line.shp	
Demographics			TL_Demographics_CT_18.shp	
Disaster-Related Data	Evacuation Routes		TL_EvacRoutes_2019.shp	
	Floodplain Maps		TL_S_FLD_HAZ_AR_18.shp	
	Highwater Marks		TL_HWM_TNRIS_14.shp	
DRG ⁹			TL_DRG_2002_USDA.sid	
			TL_Woodville_DRG_1954_250000_USGS.tif	
Elevation Data	National Elevation Dataset		TL_DEM_USGS.tif	
Gages			TL_Gage_USGS.shp	
General Data	Address Data Points		TL_AddressPoints.shp	
	Cities		TL_Cities.shp	
	City Boundaries		TL_CityBoundaries.shp	
	Land Parcels		TL_LandParcels_TNRIS_19.shp	
Hydrography	Aquifers	Major	TL_MajorAquifers.shp	
		Minor	TL_MinorAquifers.shp	
	Drainage Areas		TL_HUC10_Drainage.shp	
	Flowlines		TL_Flowlines.shp	
	Major River Basins		TL_MRB.shp	
Major Rivers		TL_MajorRivers.shp		

Data Type		Naming Example
	Reservoirs	TL_Reservoirs.shp
	Rivers, Streams, and Waterbodies	TL_RiversStreams_TNRIS.shp
	Shorelines	TL_Shorelines.shp
	Waterbodies	TL_Waterbodies.shp
Land Cover Data	Land Cover Land Use Data	TL_LULC.tif
	Urban Imperviousness Data	TL_impper2016.tif
	Canopy Data	TL_Canopy_2011.tif
Soil Data	STATSGO ¹¹	TL_Soil_STATSGO.shp
	SSURGO ¹²	TL_Soil_SSURGO.shp

2.3. Collection and Organization of Documents

The research team identified potential sources for flood-related plans and studies according to the document categories and sources summarized in Table 2-1. The documents covered federal, state, regional, county and city levels which ensured all pertinent information was thoroughly gathered. The collection effort primarily focused on publicly available information which could be obtained online. In cases of lacking documentation, which mostly occurred on the city and county levels, the research team contacted emergency management personals of the cities and counties for additional flood-related plans and studies.

Table 2-2: Summary of Acquired Documents

Data Types	Source	Data Types	Source
Flood Studies	GLO	Emergency Response/Management Plans	TXDEM
	FEMA		Office of the Texas Governor
	Cities		Cities
	Counties		Counties
Hazard Mitigation Plans	FEMA	Regulation and Policy Studies	FEMA
	TXDEM		Cities
	TWDB		Counties
	Cities		Academic Sources
	Counties		
Engineering/Infrastructure Studies	TxDOT	Disaster Information [Declarations]	FEMA
	USACE		Cities
	Cities		Counties
	Counties		Office of the Texas Governor
			NOAA

Data Types	Source	Data Types	Source
Environmental Studies	EPA	Other Local Plans	Academic Sources
	TCEQ		Cities
	US Dept. of the Interior		Counties
	US Fish & Wildlife	Other Regional Plans	Drainage Districts
	Texas A&M Forest Service		Groundwater Conservation Districts
	TX Parks and Wildlife		Groundwater Management Areas
	Cities		Regional Councils
	Counties		Regional Water Planning Groups
	Academic Sources		River Authorities
Resiliency Plans	TX GLO		Soil and Water Conservation Districts
	Cities		TWDB
	Counties		TxDOT
			Water Districts

2.4. Quality Assurance and Control

The GIS data and collected flood-related documents underwent thorough cross-checking by multiple entities within the research team to ensure consistent data and documentation deliverables. Specifically, each file was checked with regards to (1) processing of GIS data, (2) functionality of hyperlinks, (3) consistency with naming convention, and (4) consistency with the inventory list. In analyzing the GIS processing, each GIS dataset was examined to verify that the data was correctly georeferenced, clipped, selected, and/or mosaicked. The data manager, who is the leader of Task 4 which will be discussed later in this report, also performed an assessment of the data and document for redundancy, metadata completeness, and accuracy. Any issues identified during the quality control were corrected and the revised data has been reviewed again before putting in final format. After all the data was uploaded into the database, a final QA/QC effort was undertaken. During this process, gaps were identified and bridged by obtaining additional data.

3. REVIEW AND ANALYZE EXISTING REGIONAL DRAINAGE OVERSIGHT STRATEGIES AND COORDINATION (TASK #2)

The goal of Task 2 is to gather and review all relevant information related to the planning of drainage and stormwater. This task aims to enhance the GLO's understanding of the planning process that pertains the implementation of drainage and stormwater infrastructure, and the execution of short- and long-term recovery of affected areas by natural disasters, such as hurricanes, tropical storms and other extreme storm events. In the end of this chapter, we expect to identify the main planning processes, and identify the main gaps on the stormwater planning on the region.

This analysis is divided in three main scales of analysis: **Local**, **Regional**, and **Federal**. For each scale, the research team have collected material available in the world wide web (internet) and have conducted interviews with representatives from multiple stakeholders and agencies by phone, email or in person. For this study, local entities included the cities and counties. We have identified the counties that have developed drainage master plans and conducted a comprehensive review based on 18 criteria. Regional entities include state agencies, such as the Texas Commission on Environmental Quality (TCEQ), the Texas Water Development Board (TWDB), the Texas Department of Transportation (TxDOT), River Authorities, and the South East Texas Regional Planning (SETRPC). The Federal agencies which interface with drainage and stormwater systems included the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), the U.S. Department of Agriculture National Resource Conservation Service (USDA NRCS), the Bureau of Land Management of the Department of Interior (DOI), and the U.S. Fish and Wildlife Service (USFWS).

Available drainage documentation differs among the nine counties. Jefferson County, Chambers County, and to some extent Orange County have more detail drainage information and completed studies compared to the other six counties. This is in part due to presence of drainage district(s) in those three counties as well as relative more robust economy and population.

In general, none of the counties in the study area have an updated drainage master plan that is based NOAA Atlas 14 rainfall, hence, there is a critical need to develop updated master plans. Furthermore, given that watershed limit does not always follow political boundaries, it is imperative to develop a regional drainage master plan to encompass the nine counties. Large scale hydrologic analysis should be performed that incorporate the effect of pluvial, fluvial, and storm surge on flooding. Following the

regional master plan, individual counties, drainage districts, and cities could extract and improve on information from the regional master plan to develop their own drainage master plans.

The regional river authorities with jurisdiction (Sabine, Trinity, Lower Neches, and Angelina & Neches) in the study counties plays significant role in drainage oversight and flood mitigation and planning. The release of water from Toledo Bend dam for example, impact Newton and Orange Counties flood planning and mitigations in different ways. While the impact of the release is often immediate in the northern reaches of Newton County, it results in bimodal flooding peaks in the southern reaches of Newton and Orange Counties.

Several of the flood prone areas in the counties are under the jurisdiction of the Texas Department of Transportation (TxDOT). Several of the county leaderships and flood plain administrators indicated that there are inadequate drainages across many of the state roads. This is more pronounce along Interstate 10 which transects four counties. This issue accentuates the importance of consultations with TxDOT on any regional or local drainage master plan development and hydrologic infrastructure improvements.

3.1. Local Entities

Local drainage oversight is provided at the local level through the individual Counties, Drainage Districts, and various City Public Work Departments. Texas Water Code (Chapters 51, 53 and 54) allows for the creation of drainage districts among several kinds of independent water districts. Drainage districts are created by county commissioners' court, city ordinances, the Texas State Legislature or the Texas Water Commission. The districts are funded by general obligation and revenue bonds.

The initial analysis in this chapter included the review of local drainage master plans and hydraulic manuals. Out of the nine counties encompassing the domain of this project, which include Liberty, Chambers, Jefferson, Orange, Hardin, Polk, Tyler, Jasper and Newtown, four have developed drainage master plans (see Figure 3-1) and two counties have published drainage hydraulic manuals. Additionally, other documents that influence drainage oversight that were reviewed include Strategic Plans, Criteria Manuals, regulations and ordinances, and planning studies that influence drainage decision making.

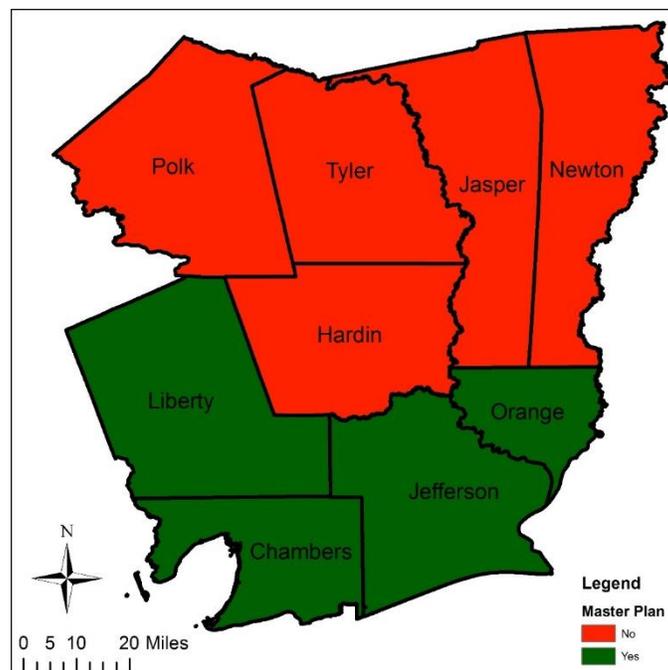


Figure 3-1 Counties with Drainage Master Plans

Given that the drainage master plans are comprehensive planning documents that provide basic information and guidance necessary for the sound stewardship of the drainage system, the project team surmised that, at the minimum, the drainage master plan should satisfy the following requirements:

- Compiles basic information relevant to the storm drainage system.

- Describes the basic functional parameters of the drainage network.
- Highlights known system deficiencies.
- Describes and graphically illustrates recommended improvements.
- Presents basic cost information for general budgeting and the development of an adoptable capital improvements program (CIP).
- Provides tools for informing individual citizens and other interested parties of the existing system and proposed improvements.
- Serves as a resource for gaining public support for needed improvements.
- Facilitates logical planning decisions relative to other regional and local programs.

In the light of these requirements, the project team formulated evaluation criteria for the existing drainage master plans based on 18 criteria or questions. The list of questions follows with seven highlighted (bold) as very significant:

1. Is the objective of the Master Plan clearly defined?
2. Are existing conditions well characterized?
- 3. Is future growth projected and addressed?**
4. Are main drainage problems identified?
5. Are past flooding events described?
- 6. Are past flooding damages estimated?**
7. Are general physiographic (watersheds, water bodies, topography, soil types, wetlands, etc.) characteristics well characterized?
8. Are significant anthropogenic features identified? (Political boundaries, communities, transportation, land use, industries, etc.)
- 9. Are sources of drainage and flooding problems identified?**
10. Has hydrologic/hydraulic modeling been performed?
11. Are models adequately built to identify problems on a proper scale?
- 12. Are remedies and projects proposed to solve/alleviate flooding problems?**
- 13. Are the costs of the remedies and projects proposed adequately estimated?**

14. Are sources of funding identified to fund improvements?
- 15. Was the community involved in the development of the drainage master plan? How?**
- 16. How much of the drainage master plan has been implemented?**
17. How much does the master plan cost?
18. Has sustainability been considered?

In addition to the analysis conducted above, phone interviews were conducted with officials responsible for development or implementation of the master drainage plans, which brought clarification to the research team's analysis. Nine central questions were asked in the interviews with local representatives and three are highlighted (bold) as very important for successful drainage oversight:

1. When was the drainage master plan developed?
2. How long did it take from beginning to completion?
- 3. Has the master plan been ever updated?**
4. Does it need to be updated?
5. How much did it cost?
6. What was the funding source?
- 7. How much of the master plan was implemented?**
- 8. What aspects of the plan are strong?**
9. What aspects of the plan are weak?

Following below, is a summary of the research team's findings pertaining to each of the nine counties. Additional details from the analyses of the drainage master plans, phone and personal interviews with stakeholders can be found in Appendix A.

3.1.1. Orange County

The Orange County Drainage District (OCDD) provides oversight for managing the short-term and long-term drainage needs within Orange County. OCDD is responsible for providing and maintaining drainage from the developed areas of the County to the rivers, bayous, creeks, gullies and man-made ditches that span large portions of Orange County. This occurs through the district's drainage infrastructure that

consists almost exclusively of earthen drainage ditches. On a day-to-day basis, the district is engaged in the maintenance of these earthen ditches, which usually consists of mowing and/or removal of silt.

As illustrated in Figure 3-2, the primary water bodies that pose a significant risk of flooding in the District includes the Neches River and the Sabine River (which forms the western and eastern boundaries of the County respectively), and two tidal influenced bayous: Cow Bayou (that generally flows though the center of the county), and Adams Bayou (which flows through the City of Orange in the eastern part of the County). Of these, only the Cow Bayou and Adam Bayou are under the jurisdiction of the OCDD. Hence, most of the drainage and planning studies in the county have focused on these two water bodies.

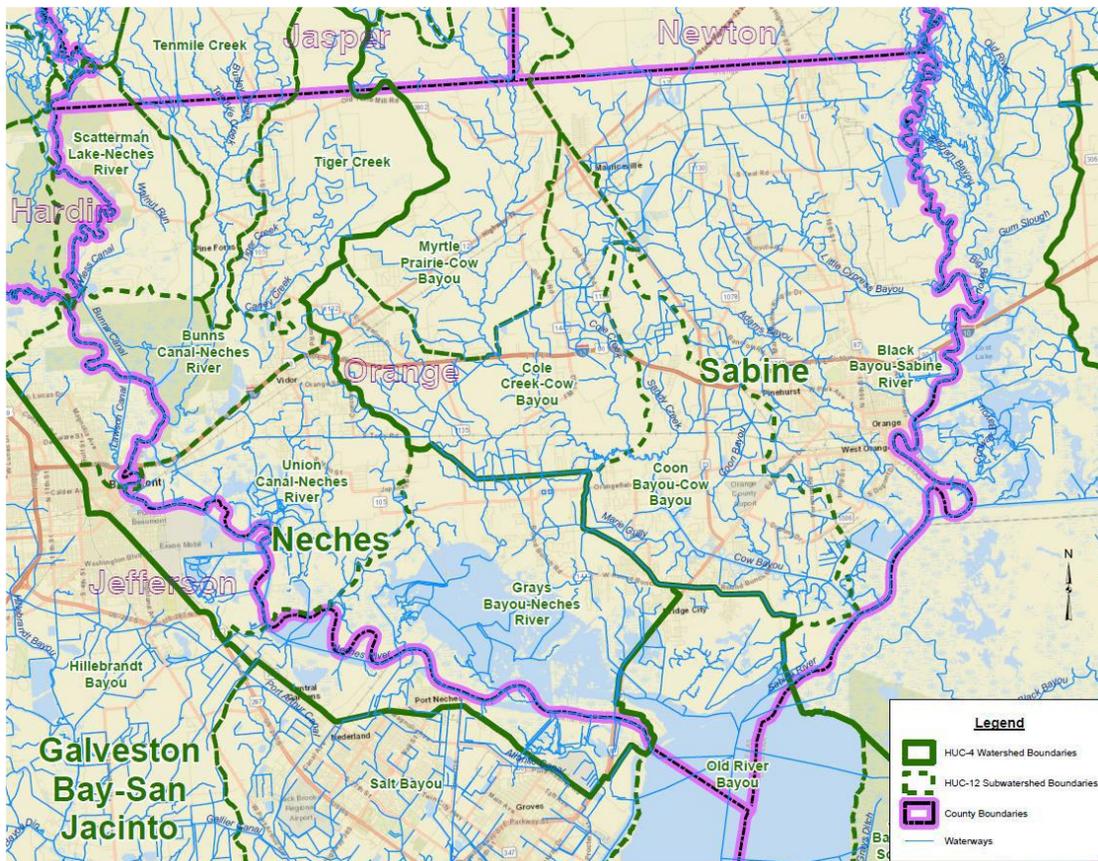


Figure 3-2 Major waterways and watershed that impact flooding in Orange County, TX

Some of the flood protection and planning studies that address drainage in Orange County are summarized in Table 3-1. The published documents outline the structural and nonstructural

infrastructure needed to reduce the flooding in the County. Additionally, the Hazard Mitigation Plan (HMP) which was developed by a consortium of cities and other authorities within the County outlined roles and process for disaster response including flooding. Following the HMP, the District is in the process of developing a Drainage Master Plan (DMP) using the NOAA Atlas 14 rainfall data. This DMP is still in the draft version as of the time of this report. Nevertheless, the GLO team reviewed the draft DMP for completeness and provided in Appendix A.

Table 3-1 – Summary of drainage oversight documents in Orange County, TX

Document Title	Document Type	Author	Publication Date	Summary
Flood Protection Planning Study: Hurricane Flood Protection System, Orange County TX	Planning Study	Carrol & Blackman, Inc., Costello, Inc. LJA Engineers, Inc	Dec 2012	Details the complex interaction and combination of hurricane flood events, levels of protection, structural features and costs, environmental effects and impacts, assessment of benefits, and strategies for development of actual projects to reduce the risk of harm to residents, damage to property and infrastructure, and economic loss from hurricane generated floods in the County
Cow Bayou Watershed Protection Study	Planning Study	Dodson & Associates, Inc.		Develop hydrologic and hydraulic computer models for the Cow Bayou watershed in order to analyze existing conditions, develop existing conditions floodplain, establishment of drainage criteria and methodology review guidelines, and to develop a plan of improvements addressing flooding problems within the watershed over the extended future.
Flood Protection Planning Study for Cow Bayou and Adam Bayou	Planning Study	Carrol & Blackman, Inc.	30 Nov. 2015	Develop structural and non-structural alternatives to mitigate the flooding impacts from a 100-year rainfall event. Perform the hydrologic and hydraulic analysis of the Cow and Adams Bayous watersheds and provides proposed flood protection alternatives. Provides information on budgetary cost estimates, calculation of project benefits, and environmental considerations for the proposed alternative recommendations.
Orange County Drainage District Hazard Mitigation Plan Update	Hazard Mitigation Plan		13 Feb. 2018	Identify and analyze District vulnerabilities to natural hazards and outline mitigation actions that help to reduce or avoid the impacts of such hazards. The Plan Update enables the District to maintain eligibility for the federal mitigation grant program funds administered by the State of Texas Division of Emergency Management (TDEM) and the Texas Water Development Board (TWDB).

Document Title	Document Type	Author	Publication Date	Summary
Drainage District Master Plan (DRAFT)			08 Oct. 2019	

3.1.2. Jefferson County

Major water bodies that can generate flooding in Jefferson County include the Neches River and Pine Island Bayou, which form the border with Hardin and Orange Counties; Sabine Lake, which forms the eastern border with Cameron Parish, Louisiana; and the Gulf of Mexico to the south. As shown in the Flood Risk Map (Figure 3-3), the presence of these large water bodies indicate that Federal and regional drainage regulations will have significant influence on drainage projects within the County.

Within Jefferson County, three drainage districts, DD3, DD6, and DD7, provide county-wide drainage oversight. In addition to the drainage districts, each city within Jefferson County has a local floodplain administrator for the community's participation in the National Flood Insurance Program. Each city may develop its own criteria for design of its drainage systems – primarily the design of storm sewers and street drainage, as well as stormwater detention storage for these systems. For example, the City of Port Arthur's Public Works Stormwater Drainage division manages the stormwater drainage within the City. This includes the provision of regular maintenance to ditches, culverts, manholes, street cleaning of streets with curbs and gutters and herbicide treatment. The Street and Drainage Division under the Public Work Department of the City of Beaumont provides oversight for a drainage ditch system of more than 840 miles in length, an underground drainage system of more than 400 miles, and approximately 20,000 catch basins. The division also oversees a street sweeping program which addresses all curb and gutter streets throughout the City.

Jefferson County Drainage District No. 6 (DD6) serves Beaumont, Bevil Oaks, China, Nome and the communities of Fannett, Northwest Forest, Hillebrandt Acres, Cheek and LaBelle as well as farm and timber land in between. DD6 controls storm and flood waters from rivers, streams and ditches, and drains and reclaims overflowed lands. DD6 services about 40% of northern Jefferson County with oversight of over 1091 linear miles of streams, ditches and outfalls. Jefferson County DD6, oversees all flood control and drainage activities to all properties located within the District boundaries in Jefferson County. The District published a Drainage Master Plan in 2006 and Drainage Criteria Manual in 2007. The

enforcement of the drainage criteria manual is overseen by the District Drainage Engineer. A review of the master plan and criteria manual are provided in Appendix A.

Jefferson County Drainage District No. 7 (DD7) has drainage oversight for South Jefferson County. DD7 covers an area of 107.42 square miles and encompasses the cities of Port Arthur, Groves, Nederland and Port Neches and unincorporated areas of Jefferson County. Two thirds of the District are below five (5) feet above sea level. Sixty (60) to Seventy (70) percent of the District drains to Taylor's Bayou. The district drainage network consists of 281 miles of concrete and earthen outfall ditches, 36 miles of levee and seawalls, and 20 pump stations with a combined pumping capacity of 8.2 million gallons per minute.

A summary of the published drainage master plan and other available drainage planning and oversight documents for Jefferson County is provided in Table 3-2.

Table 3-2 – Summary of drainage oversight documents for Jefferson County, Texas

Document Title	Document Type	Author	Publication Date	Summary
A Plan Related to Drainage and Flood Damage Reduction	Drainage Master Plan			
Drainage Regulation: Jefferson County Drainage District 6	Regulation	Drainage District No. 6	19 Nov. 2007	Drainage regulations designed to protect, maintain and enhance public health, safety and general welfare, and to minimize the impacts of increases in stormwater runoff and flooding, by providing for the review and approval of the drainage plans and proposals for management of stormwater and flooding associated with certain development proposals, and to establish minimum requirements and efficient procedures by which these regulations are to be administered and enforced.
Drainage Criteria Manual for Drainage District No. 6	Drainage Criteria Manual	Drainage District No. 6	Dec. 2007	Use to support the implementation of the Drainage Master Plan and Drainage Regulation that were adopted by the Jefferson County DD6.
Flood Protection Planning Study, City of Beaumont, Texas, Jefferson County, Texas	Planning Study	LP Engineering, LLC	Mar 2011	Conducted study of the Hillebrandt Bayou watershed to develop a Master Drainage Plan and assess structural and nonstructural flood protection alternatives in sufficient detail to serve preliminary engineering design.
Jefferson County Hazard Mitigation Plan	Hazard Mitigation Plan	Metro Planning, Inc.	Jan 2011	

3.1.3. Chambers County

Drainage oversight in Chambers County is provided by multiple agencies as described in Table 3-3. Oversight for Drainage and Storm Water Management within the county, east of the Trinity River extending from the Liberty County line on the north to the Galveston County Line on the south, is provided by the Trinity Bay Conservation District. Drainage and storm water management within the county west of the Trinity River, within the Extra Territorial Jurisdiction of Bay town, Beach City, Mont Belvieu, and within these cities where connections are proposed to facilities owned and maintained by Chambers County, falls under the jurisdiction of the County Engineer. Moreover, regional and Federal agencies, such as the Galveston District of the U.S. Army Corps of Engineers and Texas Department of Transportation have jurisdiction on wetlands and access to state highways.

Table 3-3 - Drainage oversight agencies in Chambers County, TX

Authority	Jurisdiction
Chambers County Engineer	Subdivisions, Master Plans, Engineering design and documents for streets, and for drainage in the western part of the county.
Trinity Bay Conversation	Water, sanitary sewer, and drainage in the eastern part of the county.
Trinity River Authority	Development, construction and operation of the Trinity River from its source to the mouth in Trinity Bay.
U.S. Army Corps of Engineers, Galveston District	Wetlands, filling of wetlands, and modification to waters of the United States
Texas Department of Transportation (TxDOT)	Access to state highways for driveway permits and drainage approval for discharges into TxDOT roadside ditches.

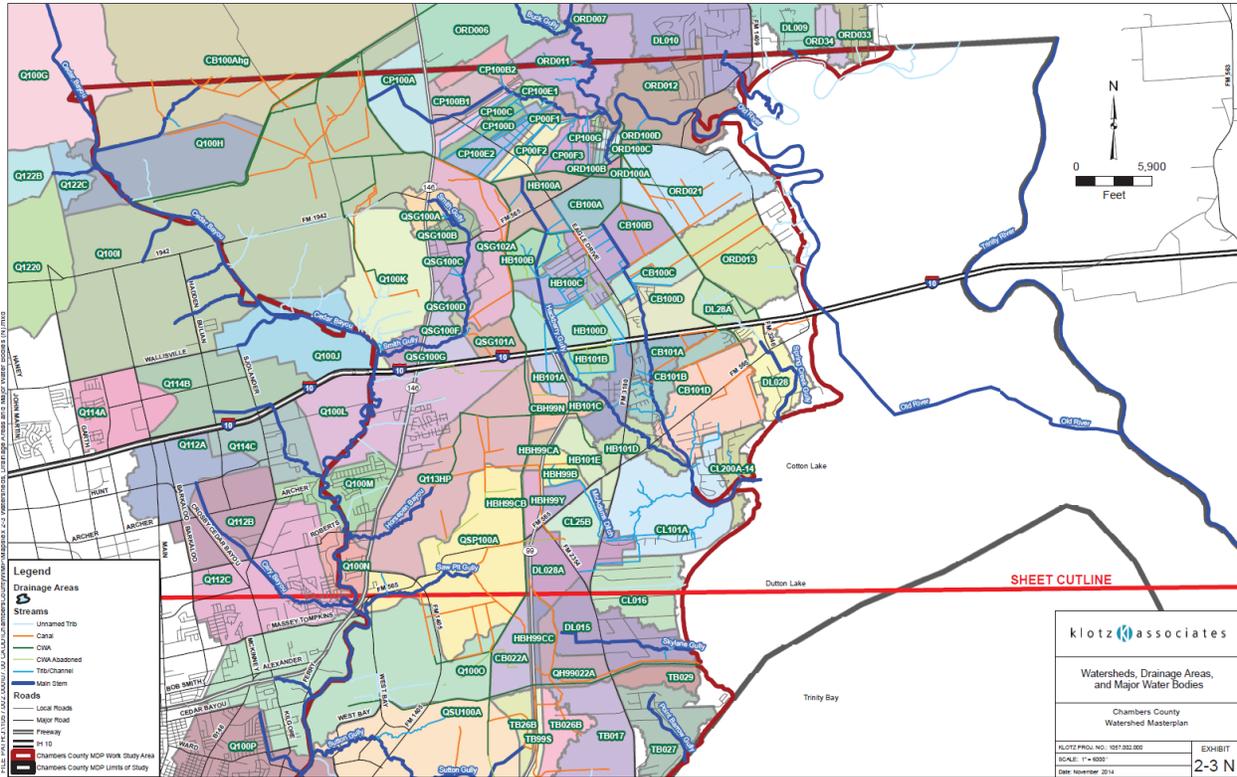


Figure 3-4 – Chambers County watersheds, drainage areas and major water bodies (Source: Chambers County Master Drainage Plan 2014).

The drainage master plan developed for Chambers County in 2014 by Klotz Associates is the benchmark that is used in this study for the evaluation of drainage master plans. The master plan is very comprehensive and provides detailed structural and nonstructural infrastructure improvements that are needed to reduce flooding impacts in the county. The full review of the drainage master plan is provided in Appendix A. However, the hydraulic and hydrologic analyses performed in the master plan are not based on the newly released NOAA Atlas 14 data and requires updating. Additionally, the county has developed a comprehensive drainage master plan and criteria manual for establishing the principles and practices for the analysis, design, and construction of drainage infrastructure. A summary of drainage oversight documents in Chambers County is listed in Table 3-4.

Table 3-4 – Summary of Drainage Oversight Documents in Chambers County, TX

Document Title	Document Type	Author	Publication Date	Summary
Chambers County Master Drainage Plan	Master Plan	Klotz Associates	November 2014	Master plan addresses existing drainage and flooding problems and expected drainage need drainage needs.
Drainage Criteria Manual for Chambers County, Texas	Drainage Criteria Manual	DODSON & Associates, Inc.	August 09, 2005	Established standard principles and practices for the analysis, design, and construction of primary drainage system in Chambers County
Amended Culvert Policy with Mailbox Policy	Commissioners Court Order	Chambers County	March 28, 2017	Set limits for Chamber County culvert installation and pricing. Set specifications of ditches and driveways in new subdivisions
Chambers County Subdivision Regulations	Regulation	Chambers County	Updated 23 Jan 2018	Set the minimum standards for subdivision and development based on the Chambers County Development Design Standards and the regulations of the Trinity Bay Conservation District, private and public utility agencies, the Texas Department of Transportation, the National Flood Insurance Program, and state and federal regulations.

3.1.4. Liberty County

Drainage oversight in Liberty County is managed at the County level under the Subdivision and Development Regulation. Section 50 of the regulation governs the design, construction and public dedication and use of all drainage, flood control and storm water management facilities and features for Subdivisions and Manufactured Home Rental Communities within the County but outside the incorporated limits of any municipality in the County. Other drainage oversight and area of jurisdictions in Liberty County are highlighted in Table 3-5.

A review of the Liberty County 2016-2036 strategic plan calls for the development of a regional (county wide) drainage district. Additionally, the plan alluded to the creation of a drainage plan between December 2015 and May 2016. However, the only drainage master plan that is available for Liberty County (at the time of this report) is one created as part of a school project by students from Texas A&M University under the umbrella of the Texas Target Communities (TTC) program. The TTC program was established in 1993 by the Department of Landscape Architecture and Urban Planning at Texas A&M University. This program selects small communities from the state of Texas and provides residents with valuable assistance in planning while serving as a “real world” learning laboratory for graduate students. As demonstrated in review of the drainage master plan, this master plan needs to be updated with revised hydraulic and hydrologic analysis based on the new NOAA Atlas 14 rainfall data to better understand the extent of flooding and needed mitigation measures in Liberty County. In addition to the drainage master plan, a review of other drainage oversight related documents in Liberty County was conducted. The results are summarized in Table 3-6.

Table 3-5 - Drainage Districts and Oversight Jurisdiction in Liberty County, TX

Agency	Jurisdiction
Drainage District	
Drainage District #1	Old River
Drainage District #2	Raywood
Drainage District #4	Dever
Water Districts	
Water Control Improvement District #1	Eastgate
Water Control Improvement District #5	Liberty

Agency	Jurisdiction
Water Control Improvement District #6	Governor's Road

Table 3-6 - Summary of Drainage Oversight Documents in Liberty County, TX

Document Title	Document Type	Author	Publication Date	Summary
Liberty County Drainage Master Plan	Master Plan	Texas A&M University	23 May 2016	Modeled the hydrological response of the county, assess and select mitigation alternatives, developed cost estimates, and maintenance plan with specific roles within the various county governments for its ongoing upkeep
Liberty County Strategic Plan 2016-2036	Strategic Plan	Liberty County & TTC	Aug 2016	Strategic plan for fully developed county by 2036 to aid in communicating the overarching vision, guiding development approvals by representatives, serving as a basis for regulations such as subdivision regulations, building codes, etc., and inform and support capital improvement plans.
Liberty County Subdivision and Development Regulations	Regulations	Liberty County	Jan 2019	Section 50 of the regulation establishes the powers and duties of the County authorized under the Texas Water Code, Texas Local Government Code, and other laws to regulate construction of new projects, drainage facilities, and public projects.
Road and Drainage Standards for Subdivisions and Development	Regulations	Liberty County	27 Jul 2004	Established specifications for paving and drainage improvements
Drainage Criteria Manual: Liberty County	Drainage Criteria Manual	RPS Klotz Associates	Aug 2016	Establishes standard principles and practices for the analysis, design, and

Document Title	Document Type	Author	Publication Date	Summary
Water Control Improvement District #1				construction of primary drainage systems in Liberty County WCID #1.

3.1.5. Newton County

Drainage oversight in Newton County falls under the purview of the Floodplain Administrator. Although the county does not have a published drainage master plan or criteria manual, the County has a Flood Damage Prevention Order, originally enacted in 1998 and renewed on 22 August 2018 that requires Floodplain Development Application be completed for all new development prior to start of construction.

The FEMA Flood Insurance Study for the County was reviewed and summarized in

Table 3-7. Toledo Bend Reservoir and Dam controls the flow along the Sabine River throughout the watershed. The dam's primary purpose is to supply water and generate electricity and the Reservoir was not intended for flood control. The dam frequently releases excess flow downstream causing flooding all along the River.

The Sabine River dominates the watershed and causes frequent flooding and severe erosion all along its course from Toledo Bend to Sabine Lake. To mitigate both erosion and frequent flooding, Newton County has begun a series of ambitious buyout programs all along the Sabine River. These programs

target buildings located inside the floodplain, especially those properties that have been flooded multiple times.

Table 3-7 - Available Drainage Oversight Documents for Newton County, TX

Document Title	Document Type	Author	Publication Date	Summary
Newton County Flood Damage Prevention Order	Regulation	Newton County	22 Aug 2018	County ordinance established to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas of the county
Flood Insurance Study Report, Newton County, Texas	Report	Newton County	16 Nov 2018	Developed flood hazard data that is used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management

3.1.6. Polk County

Drainage oversight in Polk County falls under the auspice of the Floodplain Administrator. The County does not have a drainage master plan. Drainage oversight in the County is enforced using the Polk County Department of Public Works Road Standard (Section XIII) and the Flood Damage Prevention Order, which are summarized in Table 3-8.

Table 3-8 - Summary of Drainage Oversight Documents in Polk County, TX

Document Title	Document Type	Author	Publication Date	Summary
Polk County Flood Damage Prevention Order	Regulation	Polk County	3 Sep 2010	County ordinance established to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas of the county
Polk County Department of Public Works Road Standard	Regulation	Polk County DPW	22 Jul 1998	Established standards for all drainage facilities in existing and proposed county road rights-of-way, public rights-of-way, or public drainage easements.

3.1.7. Hardin County

Drainage oversight in Hardin County falls under the jurisdiction of the County’s Floodplain Administration Department. The County does not have a drainage master plan. Drainage oversight in the County is enforced using the Hardin County Rules, Regulations and Requirements Relating to the Approval and Acceptance of Improvements in Subdivisions or Revised Subdivisions (Section F) and the Flood Plain Order, which are summarized in Table 3-9. In addition to the local oversight, the influence of State and Federal regulatory bodies on drainage infrastructure that will impact the Big Thicket National Preserve and the Village Creek State Park will be significant.

Table 3-9 - Summary of Drainage Oversight Documents in Hardin County, TX

Document Title	Document Type	Author	Publication Date	Summary
Hardin County Flood Plain Order	Regulation	Hardin County	27 Sep 2010	County ordinance established to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas of the county
Rules, Regulations and Requirements Relating to the Approval and Acceptance of Improvements in Subdivisions or Revised Subdivisions	Regulation	Hardin County	12 Sep 2016	Established minimum standard for drainage facilities within subdivisions to be designed in accordance with TxDOT Hydraulic Manual (Section F).
Hardin County WCID No. 1 Flood Control Study	Planning	KSA Engineers, Inc.	May 1990	Evaluate flooding and local drainage problems which currently exist within Hardin County WCID No. 1 and to determine improvements required to alleviate such problems

3.1.8. Tyler County

Drainage oversight in Tyler County is under the purview of the Floodplain Management Office of the Emergency Management Department. The County participates in the NFIP; hence it adopted a Floodplain Management Ordinance to manage drainage activities within the unincorporated portions of the county that are designated by the FEMA as a “Special Flood Hazard Area” (SFHA). All Tyler County cities (Woodville, Ivanhoe, Colmesneil, and Chester) have adopted similar ordinances regulating development within the FEMA SFHA within the borders of their cities.

3.1.9. Jasper County

Drainage oversight in Jasper County is under the purview of the Floodplain Administrator who also acts as the Emergency Management Program Manager. Jasper County participates in the FEMA NFIP program through of the Lower Sabine Watershed. The County does not have a drainage master plan but enforces drainage activities through the Subdivision Rules and Regulations as Amended December 10, 2007.

3.2. Regional Entities

The regional entities that were explored for drainage oversight programs and documents in this effort include the following:

- The Texas Department of Transportation (TxDOT), the Texas Water Development Board (TWDB), the Texas Commission of Environmental Quality (TCEQ).
- River authorities, including the Sabine River Authority of Texas (SRA), the Trinity River Authority (TRA), Lower Neches Valley Authority (LNVA), and the Angelina & Neches River Authority (ANRA).

3.2.1. Texas Water Development Board (TWDB)

The Texas Water Development Board (TWDB) provides Texas communities with water planning, data collection and dissemination, financial assistance, and technical assistance services. According to information provided on the TWDB website, the Texas Legislature and Governor expanded the TWDB's role in flood planning and financing in 2019. The agency is charged with administering a new state and regional flood planning process with flood planning regions based on river basins. The regional flood planning process will be developed, and initial regional flood planning groups formed by mid-2020; the first regional flood plans will be due in 2023, and the first state flood plan will be due September 1, 2024.

The legislature also made a one-time transfer of \$793 million from the state's Economic Stabilization or "Rainy Day" Fund to create a new flood funding program to be administered by the TWDB. The program will be designed to make the implementation of drainage and flood projects more affordable for Texas communities and to meet immediate needs for funding. The funding is scheduled to be available in 2020. Additionally, the state legislature provided the TWDB with funds to collect more flood-related data, advance its river and coastal modeling capabilities, and distribute critical flood information through an online dashboard. Key TWDB flood related programs are discussed in the following sections. Table 3-10 provides a summary of key TWDB documents that are reviewed as part of this study, and Appendix B provides a detailed review of the TWDB assistance programs.

Two main programs are highlighted here. The *Flood Protection Planning Grant Program*, through the State's Research and Planning Fund, provides financial assistance to political subdivisions to conduct watershed-based feasibility studies in order to evaluate both structural and nonstructural solutions to flood hazards within the watershed. The *Flood Mitigation Assistance Grant Program*, under the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance Grant Program, assists states and communities by providing federal funds for cost-effective measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP).

The Texas Water Development Board also oversees the amount of discharge to streams through the *Texas Instream Flow Program* (TIFP). The TIFP was created by the Texas Legislature in 2001 to study Texas rivers and streams and assess the amount of water required to maintain a healthy river system. The program is administered by the Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, and Texas Water Development Board. The program objective is to answer these two main questions: what makes a healthy environment for each river or stream? and how much water should flow in each river or stream to ensure a healthy environment? The results of the studies are intended to be used as best available science for water management to guide state agencies in managing rivers and streams. Therefore, it is important to consider the design criteria established as part of the TIFP program in any stream diversion projects.

Table 3-10 - Summary of TWDBI Flood Related Documents for Counties within the Domain of the Study

Document Title	Document Type	Author	Publication Date	Summary
Geomorphic Processes, Controls, And Transition Zones	Planning Study	Jonathan D. Phillips	Oct 2008	Study to delineate major geomorphic process zones, with an emphasis on stream energetics as indicated by stream power; to identify major geomorphic controls (including sea level and climate change and antecedent topography); and determine the location and primary

Document Title	Document Type	Author	Publication Date	Summary
in the Middle and Lower Trinity River				controls over key “hinge points” or transition zones
Instream Flow Study of the Lower Sabine River (DRAFT)	Planning Study	Texas Instream Flow Program and Sabine River Authority	Mar 2010	Conduct scientific studies to determine flow conditions necessary to support a sound ecological environment in the Lower Sabine River

3.2.2. Texas Department of Transportation (TxDOT)

The role of Texas Department of Transportation (TxDOT) in drainage oversight in the studied counties cannot be overstated as demonstrated in Figure 3-5. The counties are transacted by several state roads including Interstate 10 which transect four of the nine counties. The primary drainage regulatory document for TxDOT is the Hydraulic Design Manual (Revised September 2019). The manual stipulates the standards and criteria necessary to comply with state laws related to drainage activities. A non-exhaustive list of State of Texas drainage related laws includes:

1. Texas Water Code Chapter 11
2. Texas Water Code Chapter 16 Subchapter I
3. Title 30 Texas Administrative Code Chapter 299
4. Title 43 Texas Administrative Code Rule 15.54(e)
5. Memoranda of Understanding, State
6. Texas Executive Order D.B. No. 34

Chapters 4 to 15 of the manual outlined the criteria for design of channels, culverts, bridges, storm drains, pump stations, reservoir, and NFIP design of floodplain encroachment and cross drainage structures among many others.



0 5 10 20 30 40 Miles

- Interstate 10
- Major Road
- Study Area Boundary

Figure 3-5 – TxDOT Roads in the Study Area

3.2.3. Texas Commission on Environmental Quality

Texas Commission on Environmental Quality is the state agency that administers the Municipal Separate Storm Sewer System (MS4) permit program under the National Pollution Discharge Elimination System (NPDES). The NPDES permit program, created in 1972 by the Clean Water Act (CWA), helps address water pollution by regulating point sources that discharge pollutants to waters of the United States. The permit provides two levels of control: technology-based limits and water quality-based limits (if technology-based limits are insufficient to provide protection of the water body).

An MS4 is a conveyance or system of conveyances that is 1) owned by a state, city, town, village, or other public entity that discharges to waters of the U.S., 2) designed or used to collect or convey stormwater (e.g., storm drains, pipes, ditches), 3) not a combined sewer, and 4) not part of a sewage treatment plant, or publicly owned treatment works (POTW). To prevent harmful pollutants from being washed or dumped into MS4s, certain operators are required to obtain NPDES permits and develop stormwater management programs (SWMPs). The SWMP describes the stormwater control practices that could be implemented (consistent with permit requirements) to minimize the discharge of pollutants from the sewer system.

EPA's NPDES (National Pollutant Discharge Elimination System) stormwater permitting program labels MS4s as small, medium or large for the purposes of regulation.

- The Phase I stormwater program covers medium and large MS4s. Phase I MS4s were automatically designated nationwide as medium MS4s if they were located in an incorporated place or county with a population between 100,000 – 249,999 or a large MS4s if located in an incorporated place or county with a population of 250,000 or greater, based on the 1990 U.S Census UAs. Operators of regulated Phase I MS4s must apply for an individual permit.
- A small MS4 is any MS4 that is not already covered by the Phase I stormwater program. Small MS4s include federally owned systems, such as military bases. Operators of regulated small MS4s (located in urbanized area (UA) as defined by the Bureau of the Census or located outside of a UA and are brought into the program on a case-by-case basis by the TCEQ) must obtain authorization and apply for a waiver.

A regulated small municipal separate storm sewer system (MS4) must develop and submit to the TCEQ, a stormwater management program (SWMP) that includes at least these six minimum control measures (MCMs), as follows:

- MCM 1: Public Education, Outreach, and Involvement
- MCM 2: Illicit Discharge Detection and Elimination
- MCM 3: Construction Site Stormwater Runoff Control
- MCM 4: Post-construction Stormwater Management in New Development and Redevelopment
- MCM 5: Pollution Prevention and Good Housekeeping for Municipal Operations
- MCM 6: Industrial Stormwater Sources (- only if a MS4 serves a population more than 100,000)

In the project study area, only four counties have implemented MS4 permits issued under the NPDES program. The counties Jasper, Newton, Tyler, Polk and Liberty does not have permits cataloged in the NPDES website. A description of the MS4 permits for Jefferson, Orange, Chambers and Hardin follows below.

MS4 Implementation in Jefferson County:

The City of Beaumont was issued an NPDES Storm Water Discharge Permit for its municipal separate storm sewer system (MS4) in August of 1998 and continues to implement the program through subsequent permits. In response to the issuance of the permit, the City has implemented numerous Best Management Practices (BMP's) in City Departments to help minimize stormwater pollution. These BMPs include responsible ways for dealing with chemicals and other materials, which may have a negative impact on water quality as well as training of city employees in how they can perform their daily tasks in a way that will minimize the potential for polluting our local waterways. In addition, the City of Beaumont created and enacted the *Watershed Protection Ordinance* to address and enforce a policy that will reduce stormwater pollution in Beaumont, and the City has produced numerous public education materials to educate the general public on stormwater pollution.

County of Jefferson issued a work authorization to Carroll & Blackman, Inc. in July 2015 to perform key Phase II MS4 Implementation Tasks for the Jefferson County Stormwater Quality Coalition, which consists of Nederland, Port Neches, Groves, Port Arthur, Jefferson County and Jefferson County DD7. Currently, a Texas engineering firm, LJA Engineers, Inc. is managing Jefferson County's Stormwater

Management Programs (SWMPs) per this company’s website. The list below summarizes the activities performed within the scope of Phase II MS4 Implementation Program by the private company Carroll & Blackman which also reflects a conventional Phase II MS4 Program Implementation steps.

Table 3-11 Phase II MS4 Implementation Program – activities summary

Phase II MS4 - Key Implementation Tasks		
Public Outreach, Education and Involvement		Post-Construction Stormwater Management
Development of Public Education Materials		Ordinance Enforcement Assistance
Media Campaign		Inspection of Post-Construction Controls
Contractor Training and Outreach Program		Training Programs for Plan Review Personnel
Reproduction of Flyers, Brochures and Other Materials		Plan Review Assistance
Conduct Public Meetings		Record Maintenance/Data Entry
SWMP Committee Meetings		Good Housekeeping for Municipal Operations
Record Maintenance/Data Entry		Employee Training Programs
Illicit Discharge Detection and Elimination		Municipal Facility Inspections
Ordinance Enforcement Assistance		Parking Lot Inspections
Outfall Screening		Record Maintenance/Data Entry
Maintain/Update Outfall Inventory Map		Miscellaneous
Record Maintenance/Data Entry		Stakeholder Representation
Construction Site Stormwater Runoff Control		Development /Submittal of Annual Reports

Ordinance Enforcement Assistance		
Construction SWPPP Review		
Training Programs for Permitting Personnel		
Monitor Permittee Owned Construction Projects		
Construction Site Inspections and Enforcement		
Record Maintenance/Data Entry		

MS4 Implementation in Orange County:

The Engineering firm LJA Engineers, Inc. manages Orange County’s MS4 Program. As a part of LJA’s role, environmental scientists and technicians provide full implementation services including the development of SWMPs, public education programs, outfall mapping/inspections, municipal facility inspections, construction site inspections, TCEQ stakeholder representation, TMDL compliance, annual report development, and audit representation for Orange County.

MS4 Implementation in Hardin County:

Hardin County’s MS4 Program is also being managed by LJA. As part of LJA’s role, environmental scientists and technicians provide full implementation services including the development of SWMPs, public education programs, outfall mapping/inspections, municipal facility inspections, construction site inspections, TCEQ stakeholder representation, TMDL compliance, annual report development, and audit representation for Hardin County.

MS4 Implementation in Chambers County:

The County Engineer’s Office directs MS4 related inquiries to an outside website platform called MS4Web. The county is managing the stormwater management plan through a software where all inspections, BMPs and minimum control practices can be tracked. Other than this link, the research team could not find additional information on MS4 for Chamber’s County.

3.2.4. River Authorities

The nine counties within the study area overlap with four river authorities: Angelina & Neches River Authority (ANRA), Lower Neches Valley Authority (LNVA), Sabine River Authority (SRA) and Trinity River Authority (TRA) (Figure 3-6).

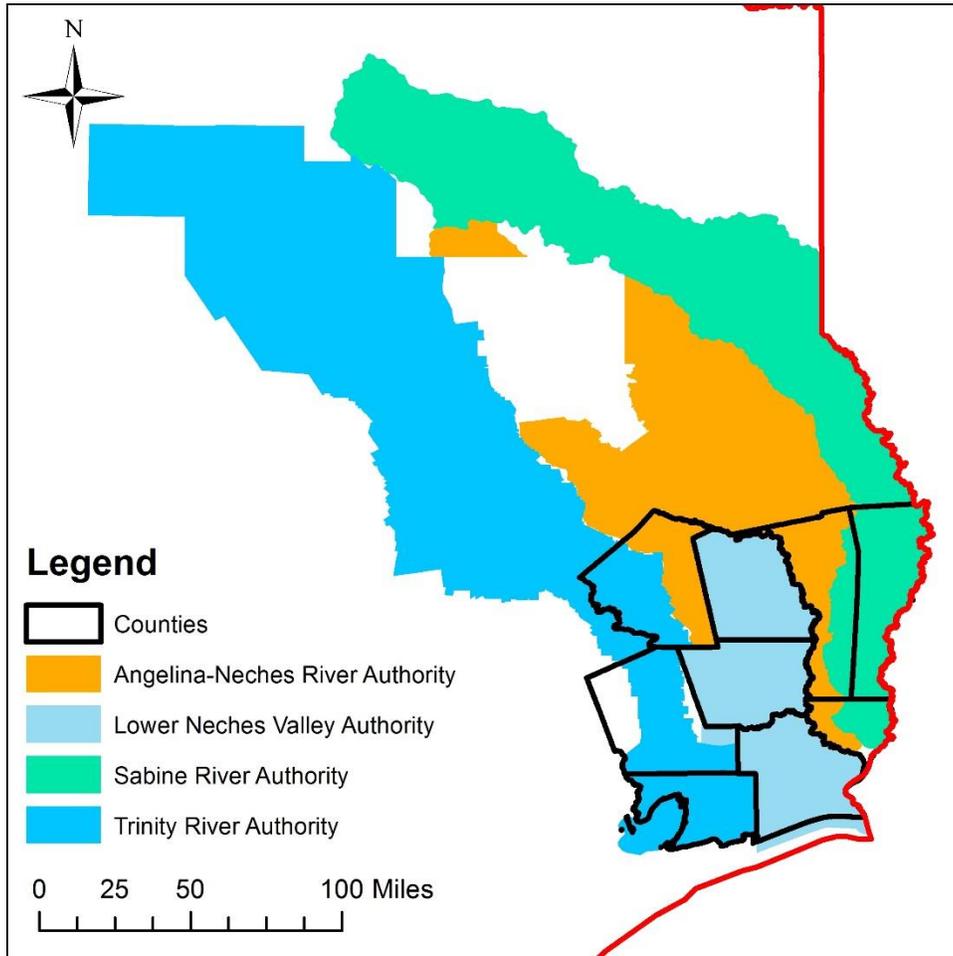


Figure 3-6 - Studies area and river authorities' boundaries

Trinity River Authority

The Trinity River basin is the largest river basin in Texas that begins and ends completely within the state boundary. Trinity River Authority (TRA) maintains a master plan for basin-wide development and serves as a conduit for tax-exempt financing for municipal projects and as a local sponsor for federal water projects in the jurisdictional counties which include Liberty, Polk, and Chambers. TRA has developed fourteen (14) Master Plans since 1958 with the last published in May 2016. The Master Plan does not address flooding in detail but references multiple USACE flood control projects.

Lower Neches Valley Authority

The Neches River originates in Van Zandt County and flows through the Piney Woods of East Texas before entering a highly industrialized area in Orange and Jefferson counties. The tidal portion of the river has been dredged to accommodate seagoing vessels. The northeastern one-third of the basin is drained by the Angelina River, while the remaining two-thirds of the 10,011 square-mile area are drained by the Neches River, Pine Island Bayou, and Village Creek. The river empties into the Sabine Lake estuary.

Sabine River Authority

The Sabine River basin covers 21 counties in Texas, including Newton, Jasper, and Orange Counties. The Sabine River Authority of Texas (SRA-Texas) provides oversight for the conservation, storage, control, preservation, quality, and utilization of water in the Sabine River and its Texas tributaries. As a matter of policy, however, the authority has limited its activities to major projects beyond the financial means of local interests. It has no taxing power and, for financing, relies primarily upon revenue bonds and income from its projects. The SRA-Texas jurisdiction includes oversight for the Texas side of the Toledo Bend Dam and Reservoir, Lake Fork Dam and Reservoir, and the Iron Bridge Dam and Reservoir Projects. The SRA-Texas has water rights authorizing impoundment of 4,477,000 acre-feet and diversion and use of 750,000 acre-feet for municipal, industrial, and agricultural purposes.

Angelina & Neches River Authority

The Angelina & Neches River Authority (ANRA) has jurisdiction over the rivers and streams of the state in the Neches River Basin. The ANRA must maintain a master plan for the entire basin, serve as the local sponsor for federal water projects in the basin, and provide public services authorized by the legislature. The ANRA, acting under the broad authority of the Texas State Constitution and Chapter 8501, Special District and Local Laws Code as a conservation and reclamation district, has the same power of control and regulation over the waters of the Neches River and its tributaries that the state has including, flood control and protection, use of water (commercial, domestic, industrial, and irrigation), and drainage. Specifically, for drainage, ANRA provide for the better encouragement and development of drainage systems for, and provide for the drainage of, lands in the valleys of the Neches River and its tributaries as needed for profitable agricultural production. ANRA additionally provide for drainage for other land in the watershed area of the authority as required for the most advantageous use of the land.

3.2.5. Southeast Texas Regional Alerting and Information Network Portal

The Southeast Texas Regional Alerting and Information Network (SE Texas R.A.I.N) Portal is a public portal developed to provide important information to decision makers during threatening weather conditions. The portal provides data from a coalition of five counties including Hardin, Jasper, Jefferson, Newton, and Orange Counties and is headed by the respective County Judges. The system displays rainfall, streamflow, and stream and reservoir levels in major streams, bayous, and reservoirs compiled from many data sources including the United States Geological Survey (USGS) and the National Weather Service (NWS). The system relies on a network of river and reservoir gaging stations throughout the five-county area of Hardin, Jasper, Jefferson, Newton, and Orange Counties, as well as the Sabine and Neches River Basins in the Southeast Texas Region.

The purpose of the SE TEXAS RAIN website is to provide the information collected by the gages in a user-friendly format directly to the public to assist the community in making self-informed decisions during threatening weather conditions. This information is also used by Emergency Management Offices, county governments and local and regional governments to advise the public of rising water conditions in reservoirs, rivers and bayous.

3.2.6. Non-Governmental Entities

The research team consulted and reviewed the roles of the Deep East Texas Council of Governments (DETCOG), Southeast Texas Regional Planning Commission (SETRPC), Houston – Galveston Area Council (H-GAC) and other non-governmental organizations (NGOs) to review their roles in drainage planning, funding, and flooding responses. The information gathered from this effort are summarized in the following sections.

Table 3-12 – Deep East Texas Council of Governments (DETCOG)

Category	Detail
Website	https://www.detcog.gov/
Mailing Address	210 Premier Drive, Jasper, Texas 75951
Contact	Van Bush,

	<p>Regional 9-11 Director</p> <p>Ph: (409) 384-5704 ext. 5263</p> <p>Wendy Anderson,</p> <p>GIS Data Quality Coordinator</p> <p>Ph: (409) 384-5704 ext. 5253</p>
Purpose / Key Points	<ul style="list-style-type: none"> • DETCOG is both a political subdivision of the State of Texas and a federally chartered Economic Development District. They are one of 24 regional councils of governments in Texas. They were founded to facilitate planning, eliminate duplication, and promote economy and efficiency in the coordinated development of our region. While they are a governmental agency, they have no taxing or ordinance making authority. • The 12 counties who are members of DETCOG include Newton, Polk, Tyler, and Jasper counties of the nine counties in the report.

Table 3-13 - Southeast Texas Regional Planning Commission (SETRPC)

Category	Detail
Website	http://www.setrpc.org/
Mailing Address	2210 Eastex Freeway, Beaumont, Texas 77703
Contact	<p>Pete de la Cruz,</p> <p>Director of Emergency Communications</p> <p>Ph: (409) 384-5704 ext. 5263</p>

	<p>James Moore,</p> <p>GIS Data Quality Coordinator</p> <p>Ph: (409) 724-1911 ext. 7501</p>
Purpose / Key Points	<ul style="list-style-type: none"> • The Planning Commission was established in June 1970 for the purpose of solving area wide problems by promoting intergovernmental cooperation and coordination, conducting comprehensive regional planning, and providing a forum for the discussion and study of area issues. • Included in the counties who are members of SETRPC are Hardin, Orange, and Jefferson.

Table 3-14 - Houston-Galveston Area Council (H-GAC)

Category	Detail
Website	http://www.h-gac.com/home/residents.aspx
Mailing Address	3555 Timmons, Suite 100, Houston, Texas 77027
Contact	<p>Joshua Owens,</p> <p>Regional Flood Management Committee</p> <p>Ph: (713) 627-3200</p> <p>joshua.owens@h-gac.com</p>
Purpose / Key Points	<ul style="list-style-type: none"> • H-GAC's serves as the instrument of local government cooperation, promoting orderly development and the safety of its citizens. H-GAC's program of regional planning is the foundation of responsible public service in a rapidly changing region. H-GAC provides planning programs in most areas of shared governmental concern.

	<ul style="list-style-type: none"> Included in the counties who are members of H-GAC are Chambers and Liberty.
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Table 3-15 - Trust for Public Lands

Category	Detail
Website	https://www.tpl.org/
Mailing Address	3555 Timmons, Suite 100, Houston, Texas 77027
Contact	Robert Kent – State Director, Texas (469) 615-5448 Email Inquiry: texas@tpl.org
Purpose / Key Points	<ul style="list-style-type: none"> The Trust for Public Land works to protect the places people care about and to create close-to-home parks—particularly in and near cities, where 80 percent of Americans live. Their goal is to ensure that every child has easy access to a safe place to play in nature. They also conserve working farms, ranches, and forests; lands of historical and cultural importance; rivers, streams, coasts, and watersheds; and other special places where people can experience nature close at hand.

Table 3-16 - The Conservation Fund

Category	Detail
Website	https://www.conservationfund.org/
Mailing Address	807 Brazos Street Suite 1002, Austin, Texas 78701
Contact	Andy Jones - Texas State Director

	(512) 477-1712 ajones@conservationfund.org
Purpose / Key Points	<ul style="list-style-type: none"> • They practice conservation to achieve environmental and economic outcomes. All Fund programs place conservation at its center, and their entrepreneurial staff creates and implements innovative, practical ways to benefit the natural world and the well-being of Americans from every walk of life • Mr. Jones said that the Conservation fund had done “dozens” of projects in southeast Texas counties in the past several decades. The Conservation Fund provided a map which showed the Texas counties in which they had worked. The list and the map are included in the report.

Table 3-17 - The Association of State Wetland Managers

Category	Detail
Website	https://www.aswm.org/
Mailing Address	32 Tandberg Trail, Suite 2A, Windham, ME 04062
Contact	Marla Stelk – Executive Director (207) 892-3399 dawn@aswn.org
Purpose / Key Points	<ul style="list-style-type: none"> • The Association of State Wetland Managers promotes and enhances protection and management of wetland resources, to promote application of sound science to wetland management efforts and to provide training and education for its members and the public. ASWM's members and partners include states and tribes, federal agencies, nonprofit partners, wetland professionals, educators, wetland enthusiasts and many others. The main

	<p>common goal between these groups is a better understanding of wetlands and how to protect that resource throughout the Nation.</p>
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Table 3-18 - The National Association of Conservation Districts

Category	Detail
Website	https://www.nacdnet.org/
Mailing Address	NACD Headquarters 509 Capitol Court, NE, Washington, DC 20002-4937
Contact	Keith Owen, South Central Region Representative (405) 360-3503
Purpose / Key Points	<ul style="list-style-type: none"> NACD promotes the wise and responsible use of natural resources for all lands by representing locally-led conservation districts and their associations through grassroots advocacy, education and partnerships.

Table 3-19 - Natural Hazards Mitigation Association

Category	Detail
Website	http://nhma.info/
Mailing Address	P.O. Box 170984, Boston, MA 02117
Contact	Only generic contact information available nathazma@gmail.com

Purpose / Key Points	<ul style="list-style-type: none"> • The NHMA promotes natural hazard risk reduction and climate adaptation through planning, adaptation, and mitigation. They create a “Whole Community” forum to: <ul style="list-style-type: none"> ○ Share ideas and experiences ○ Develop a thoughtful and unified voice ○ Promote greater awareness of the social, economic and environmental components of safe and resilient development ○ Creation of more equitable, safe and sustainable hazard mitigation programs so that that foreseeable natural events do not become disasters. • The NHMA promotes steps to reduce the risk and consequences of natural events with a special emphasis on protecting the most vulnerable populations in our communities.
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3.3. Federal Entities

The research team’s review of federal documents included documents from the U.S. Federal Department of Emergency Management (FEMA), the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE) and the U.S. Department of Agriculture (USDA). The federal documents reviewed generally fell into two categories: reports and guidelines. For the purpose of this project, reports were generally found to be more helpful and contain more study-area-specific information. After-Action Reports were found to be particularly insightful.

The federal documents were evaluated based on several base criteria or questions the research team identified as important, as well as document-specific questions if necessary. The full review (questions, answers, document reference numbers and links) for each document listed in Table 3-20 can be found in Appendix D. A list of the general questions for federal documents is shown below:

1. What is the document about?
2. What location does the document cover?

3. What is/are the purpose(s)/goal(s)/objective(s) of the document?
4. What is/are the main idea(s)/finding(s) in the document?
5. Who oversees the document and its implementation?
6. Are policies or guidelines in the documents uniformly implemented, or is there a high degree of variation in the implementation?
7. What is/are the most influential factor(s) affecting quality or effectiveness of the documents?
8. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.
9. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.
10. Was “drainage” mentioned? If so, provide a summary including page numbers.
11. Was “Texas” mentioned? If so, provide a summary including page numbers.
12. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.
13. What region-specific information can be obtained from the document?
14. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?
15. How can the document be improved?

While some document-specific questions will not make sense without context, a list of the document-specific questions for federal documents is shown below:

1. What would be the implementation of the document to help promote the goals?
2. What were the core capabilities defined in National Preparedness Goal?
3. Are there any examples of volume-based stormwater retention standards in this document?
4. What national priorities will be taken into consideration for ranking project proposals?
5. What were the five mission areas in the National Preparedness Goal?
6. How are the Federal Interagency Operational Plans (FIOPs) maintained?
7. What is the scope of this Federal Interagency Operational Plan (FIOP)?
8. What does the Focal Watershed Review: East and West Galveston Bay, Texas tell us?
9. What stressors to coastal wetlands in the Gulf of Mexico region were identified?
10. What tools and strategies for the Gulf of Mexico region stressors were identified?
11. What gaps and needs for the Gulf of Mexico region stressors were identified?
12. What are the causes and potential risks associated with the identified regional problems?
13. What tentative solutions to the identified regional problems were proposed?

14. What are the needs and recommendations provided by stakeholders?
15. What are the future needs for improving watershed condition and mitigating potential for watershed impairment?
16. What were the benefits to local communities?
17. What are the activities that CRS could grant credits for?
18. What is the expiration date of this document?

The summary below provides key findings from the documents relating to project-specific questions (Texas, counties, regional information, flooding, mitigation, drainage, etc.).

Table 3-20 Federal Document Summary

Agencies	Document Title	Publication Date	Author	Summary
Federal Emergency Management Agency (FEMA)	2018 National Preparedness Report	Nov 2018	U.S. Department of Homeland Security	provides an overview of key developments in national preparedness—incorporating findings and lessons learned from incidents in 2017 in combination with data and inputs from federal interagency and whole community partners
	Plan Integration: Linking Local Planning Efforts	Jul 2015	FEMA (Region III/3)	a step-by-step guide developed to help communities not only analyze their local plans for existing integration, but also further improve those efforts including interagency coordination
	National Flood Insurance Program Community Rating System: A Local Official’s Guide to Saving Lives, Preventing Property Damage, and Reducing the Cost of Flood Insurance	Jun 2018	FEMA	provides guidelines for local officials on the Community Rating System, which allows for reduced flood insurance premiums

Agencies	Document Title	Publication Date	Author	Summary
	National Flood Insurance Program Community Rating System: Coordinator's Manual	May 2017; Expires March 2020	FEMA	The Coordinator's Manual is the guidebook for the CRS. It explains how the program operates, what is credited, and how credits are calculated. Although it is primarily a reference for CRS activities and credits, it can also help guide communities that want to design or improve their floodplain management programs.
	Using HAZUS for Mitigation Planning	Aug 2018	FEMA Natural Hazards Risk Assessment Program, National Mitigation Planning Program, and the Hazus Program	This job aid helps users identify and understand the multiple types of reports, tables, maps, and data produced by Hazus, and how this information can be incorporated into a Hazard Mitigation Plan.
	Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR) Guide: Comprehensive Preparedness Guide (CPG) 201	May 2018	FEMA	provides guidance for conducting a Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR), formerly State Preparedness Report.
	Disaster Assistance Essentials	Jan 2017	FEMA (Region VI/6)	A guide to the different types of federal disaster assistance for major disaster declarations, the disaster declaration process, how FEMA Region 6 works with state, tribal and local officials to assist survivors, emergency management preparedness and disaster mitigation.

Agencies	Document Title	Publication Date	Author	Summary
	Overview of the Federal Interagency Operational Plans	Aug 2016	U.S. Department of Homeland Security	The FIOPs are designed to provide state, local, tribal, territorial, and insular area planners an understanding of how the Federal Government functions in its response, so that they may develop or modify plans to bolster an integrated and whole community effort to make the collective response stronger and more effective. This document is comprised primarily of excerpts from the FIOPs and presents a high-level introduction to each.
	Response Federal Interagency Operational Plan	Aug 2016	U.S. Department of Homeland Security	This FIOP describes how the Federal Government delivers core capabilities for the Response mission area. Specifically, the Response FIOP is an all-hazards plan that describes how the Federal Government coordinates its efforts to save lives, protect property and the environment, and meet basic human needs following an emergency or disaster.
	Mitigation Federal Interagency Operational Plan	Aug 2016	U.S. Department of Homeland Security	The Mitigation FIOP describes how the Federal Government delivers core capabilities for the Mitigation mission area. The purpose of this FIOP is to establish a joint system for supporting local, state, tribal, territorial, and insular area partners and delivering public resources in a coordinated, effective, and proficient manner.
	Recovery Federal Interagency Operational Plan	Aug 2016	U.S. Department of Homeland Security	The Recovery FIOP describes how the Federal Government delivers eight core capabilities for the Recovery mission area. It is a plan that provides guidance for implementing the NDRF. The Recovery FIOP provides guidance for effective delivery of recovery support to disaster-impacted local, state, tribal, territorial, and insular area jurisdictions.
	Protection Federal Interagency Operational Plan	Aug 2016	U.S. Department of Homeland Security	This FIOP describes how the Federal departments and agencies work together to deliver Protection core capabilities through eight coordinating activities. Protection coordinating activities enable the Federal Government to: (1) Deliver the core capabilities for the mission area and (2) Execute the critical tasks associated with each core capability. These activities support and integrate Protection efforts during steady state (day-to-day activities) and escalated activities that flow from emergent threats and elevated risks.

Agencies	Document Title	Publication Date	Author	Summary
	2017 Hurricane Season FEMA After-Action Report	Jul 2018	FEMA	This After-Action Report focuses on three of the storms that made landfall as major hurricanes in the United States in quick succession. Specifically, this report focuses on the response and initial recovery from August 25 to November 30, 2017.
	FEMA Guidance for Flood Risk Analysis and Mapping	Apr 2019	FEMA	The purpose of this policy is to enable consistent performance by identifying the standards that must be followed in the delivery of the Risk MAP program.
U.S. Environmental Protection Agency (EPA)	Coastal Wetlands Initiative: Gulf of Mexico Review	Unknown	EPA	part of Coastal Wetlands Initiative; helps to identify and understand stressors impacting coastal wetlands and strategies to protect and restore coastal wetlands
	National Coastal Condition Report IV 2012	Sep 2012	EPA (Office of Water; Office of Research and Development (ORD))	Summarizes conditions of the nation's estuaries and coastal embayment's, including the coastal waters of the conterminous United States, Southeastern Alaska, Hawaii, American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands
	National Coastal Condition Assessment 2010	Jan 2016	EPA (Office of Water; Office of Research and Development (ORD))	an assessment of the condition of the coastal waters of the United States, including a vast array of beautiful and productive estuarine, Great Lakes, and coastal embayment waters
	National Lakes Assessment 2012	Dec 2016	EPA (Office of Water)	an evaluation of the biological, chemical, physical, and recreational condition of lakes in the United States
	National Rivers and Stream Assessment 2008-2009	Mar 2016	EPA (Office of Water)	an assessment of the nation's rivers and streams
	National Wetlands Condition Assessment 2011	May 2016	EPA (Office of Water)	the first national evaluation of the ecological condition of the nation's wetlands

Agencies	Document Title	Publication Date	Author	Summary
	Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act	Dec 2009	EPA (Office of Water)	technical guidance and background information to assist federal agencies in implementing EISA Section 438; contains guidance on how compliance with Section 438 can be achieved, measured and evaluated; contains information detailing the rationale for the stormwater management approach
	Improving the EPA Multi-Sector General Permit for Industrial Stormwater Discharges	2019	National Academies of Sciences, Engineering and Medicine	guidance to assist state NPDES permittees and assess compliance with Phase I and MS4 programs, develop SWMP, assess pollutants of concern, and provide federal assistance
	Municipal Separate Storm Sewer System MS4 Program Evaluation Guidance	Jan 2007	EPA (Office of Wastewater Management)	guidance primarily for phase I and II NPDES communities for developing an integrated stormwater management system; including proper management of existing wet ponds, wetlands etc.
	National Water Quality Inventory: Report to Congress	Aug 2017	EPA	summarizes findings from four National Aquatic Resources Surveys and site-specific assessment results reported by sites to EPA
	Stormwater Wet Pond and Wetland Management Guidebook	Feb 2009	EPA	Overview of stormwater management procedures according to CWA. Clarification on specifics regarding stormwater discharge pollutant mechanisms and effects, assessment of SW pollution plans and in-stream water quality, assesses the design of stormwater permitting program etc.
	Urban Stormwater Management in the United States	Oct 2008	National Research Council	committee review and recommendations in regard to current industrial stormwater discharge regulations
U.S. Army Corps of Engineers	Coastal Texas Protection and Restoration	Oct 2018	USACE	In November 2015, the U.S. Army Corps of Engineers (USACE) in partnership with the non-Federal Sponsor(NFS), the Texas General Land Office (GLO), began the Coastal Texas

Agencies	Document Title	Publication Date	Author	Summary
	Feasibility Study			Protection and Restoration Feasibility Study (Coastal Texas Study) to determine the feasibility of alternatives to enhance, restore, and sustain the environment, economy, and culture along the Texas coast. This Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS) documents the examination and selection of the Tentatively Selected Plan (TSP).
U.S. Department of Agriculture (USDA)	Report to Congress USDA-NRCS Watershed Protection and Flood Prevention Program Multi-Year Plan	Dec 2015	USDA-NRCS	This multi-year plan describes near-term needs including the existing approved project backlog, remediation of existing structures, and emerging needs, along with a process for guiding future investments to improve watershed condition. The Watershed Program can provide a valuable tool for agriculture and rural communities across the Nation to address serious water management threats from extreme drought to unprecedented flooding.

Federal documents generally fall into two categories, guidelines and reports. While guidelines may be helpful for guiding regional or local entities as they attempt to make updates to regional or local plans, they often only provide generic information. Thus, the focus of the summary of federal documents is on reports, specifically those that provided information specific to the project location or flooding, mitigation or drainage.

The U.S. EPA provided many relevant documents pertaining this study. As example, a specific document that was insightful into stakeholder thoughts and recommendations was the *EPA’s Coastal Wetlands Initiative: Gulf of Mexico Review*. In this report, within the Focal Watershed Review section over East and West Galveston Bay, Texas, the EPA identified stressors, tools and strategies, and gaps and needs for coastal wetlands by using literature as well as stakeholder input. Other EPA reports included potentially helpful information on the environmental quality of lakes, streams, rivers, wetlands, and coasts, such as the reports included in the National Aquatic Research Surveys (NARS), including the overview entitled *National Water Quality Inventory: Report to Congress*. Reviewed EPA guidelines included those related to stormwater and wetlands but were found to provide no project-specific information.

The U.S. Federal Emergency Management Agency (FEMA) also provided a multitude of pertinent documents. One document the research team found relevant was the *2018 National Preparedness*

Report. The report mentioned the primary keywords identified by the research team, and in doing so, highlighted region-specific preparedness issues such as power outages, fuel supply and distribution issues, and local building codes leading to uneven resiliency. The *2017 Hurricane Season FEMA After-Action Report* provides insight into Hurricanes Harvey, Irma, and Maria. This report identifies a lack of flood insurance for those affected by Hurricane Harvey. A general guidance document titled *Plan Integration: Linking Local Planning Efforts* provides potentially valuable information on how communities can enhance local plans and improve coordination with other agencies. Other guidance documents that could be potentially useful for local agencies are the guides to the National Flood Insurance Program Community Rating System, which allows communities who have earned credits to reduce flood insurance premiums. Another guidance mentions the use of FEMA's HAZUS program, which is used for estimating potential losses, for mitigation use. The *Threat and Hazard Identification and Risk Assessment (THIRA)* and *Stakeholder Preparedness Review (SPR) Guide: Comprehensive Preparedness Guide (CPG) 201* may also be helpful to local communities, with some information on coastal preparedness. *FEMA Region 6's Disaster Assistance Essentials* presents the disaster assistance available for major disasters. FEMA's Federal Interagency Operational Plans (FIOPs), including the overview, prevention, protection, mitigation, response, and recovery plans, provide guidance for achieving the National Preparedness Goal. Coastal areas are of interest in these plans. The *FEMA Guidance for Flood Risk Analysis and Mapping* document provides insight into how flood risk is analyzed and mapped. More accurate mapping for coastal regions, better communication of these documents, and implementation of climate change were identified by the research team as three areas of potential improvement for the document.

The final federal documents the research team identified as important to this project were from the U.S. Army Corps of Engineers (USACE) and a report from the United States Department of Agriculture (USDA). The *Coastal Texas Protection and Restoration Feasibility Study* presented alternatives for improvement at the coast, which potentially impacts Chambers County and Jefferson County. Stressors are identified for the areas as well as tentative solutions. The *USDA-NRCS Watershed Protection and Flood Prevention Program Multi-Year Plan* describes needs for improving watershed condition. The document includes watershed purposes, needs and recommendations provided by stakeholders, and future needs.

4. STAKEHOLDER INTERVIEWS (TASK #3)

4.1. Task Description and Objectives

The activities of Task 3 aimed to engage, collect input, and determine the needs, concerns, and recommendations of local government regulators, drainage engineers, planners and other stakeholders in their respective areas and specializations. The input of the stakeholders is meant to complement the other types of information collected in the other tasks of the project. The objectives of the task were as follows:

- Target stakeholders in all counties within the project scope.
- Target staff at different levels of local government (city, county, etc.) and from municipalities with different sizes.
- Target a variety of stakeholder groups and expertise including: 1) policy makers and regulators, 2) drainage engineers and technical staff, 3) emergency management and recovery staff, and 4) staff in related organization.
- Utilize different method of collecting input to provide stakeholders with maximum flexibility in contributing the information being collected.
- Analyze all information collected and use to develop appropriate recommendations reflecting the opinions of the stakeholders.

4.2. Approach

To achieve the objective of reaching the largest number of stakeholders and providing them with a variety of opportunities to contribute their input, a number of data collection methods were used within the activities of task 3. The approach used to collect stakeholder input can be divided into the following:

4.2.1. Developing Contact Database

This process started with a stakeholder meeting, which was held in Beaumont on June 5, 2019. The meeting introduced the project, and specifically the activities of Task 3, to representatives from a variety of local organizations in the area. Contact information for all attendees were collected and used as a starting point for building a contacts database for the task. This preliminary list was then supplemented through online searches and referrals targeting the following areas of responsibilities and expertise in the nine counties:

- Policy Makers and Regulators,
- Drainage Engineers and other technical staff,
- Emergency management and recovery staff
- Planners,
- Staff in related organizations.

In total, a list of 134 names was developed and used for the different data collection activities within the task. These include 48 policy makers and regulators, 67 county and city staff, and 19 staff from related organizations at the regional and state levels.

4.2.2. Questionnaire Development

A list of questions was developed to serve as a bases for collecting stakeholder input. The list was based on the task proposal and previous studies. The list was reviewed and refined by different team members and outside experts. A copy of the questions is included in the Appendix G. The questionnaire included a wide range of questions targeting the different areas of expertise within the list of contacts and was used as a basis for the different data collection method used within the task. The questions focused on the following areas:

- Drainage references currently used
- Drainage district issues
- Documentation and regulatory procedures
- Frequently encountered drainage-related questions or problems
- Procedures used to address common drainage issues
- Procedures used to address drainage issues related to major storms such as Harvey
- Assessment of possible flood mitigation/prevention approaches.

4.2.3. Online Survey

The first method used to collect information from the stakeholders was an online survey The intent of the online survey was to perform the following:

1. Providing stakeholders with a flexible method of responding the questions at their own pace.
2. Soliciting additional contacts from the survey respondents to add to the contacts database.

3. Screening the initial list of contacts and identify the most relevant targets for face-to-face interviews.

The survey included a shorter version of the questionnaire. A copy of the survey questions is included in the Appendix F. The questions focused on the following areas:

- Demographic questions.
- Experiences regarding drainage and flooding problems and projects:
 - References and regulatory processes.
 - Frequently encountered problems.
 - Processes to respond to major storms, and how to improve them.
- Assessment of possible flood mitigation/prevention approaches.
- Additional contacts.

The survey was initially deployed in the period from July 11th through August 22 and yielded 42 responses. Following the stakeholder workshop (see section 2.5), the survey was redeployed in the period between September 30th and October 18th and yielded an additional 15 responses, resulting in a total of 57 responses. Figure 4-1 provides a description of the distribution of the responses by county, while Figure 4-2 provides their distribution based on the areas of responsibility and expertise of the responders. As seen in the figures, the responses covered all targeted counties with the larger counties being more represented as expected. The distribution of the responses by area of responsibility was more evenly distributed and covered the range of expertise targeted by the task activities.

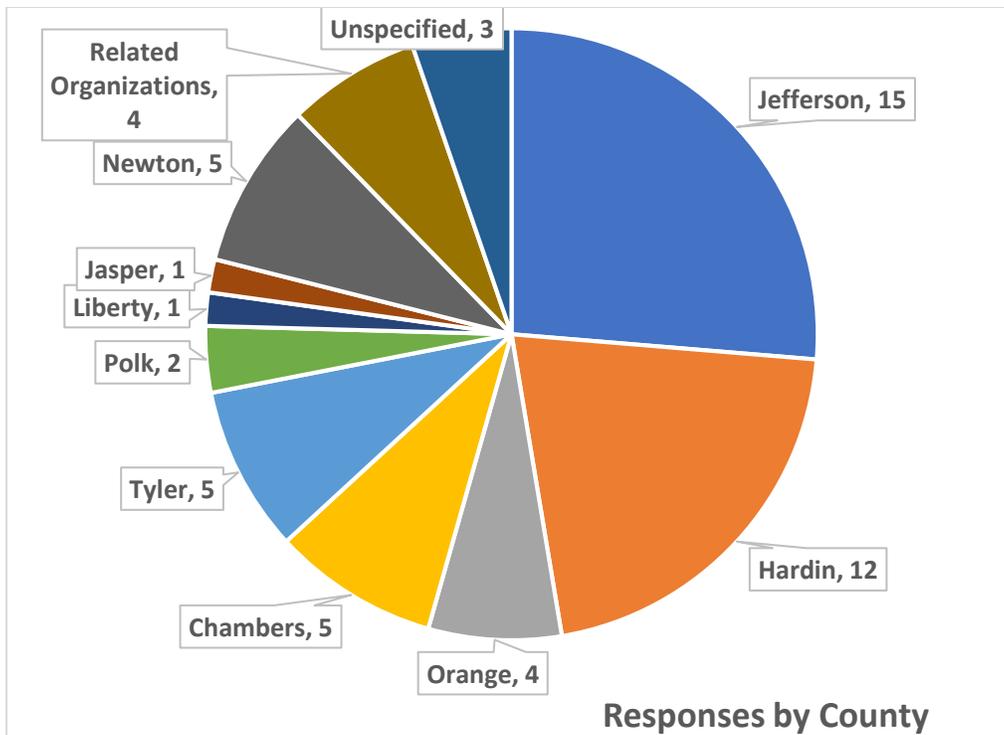


Figure 4-1 Distribution of online survey responses by county

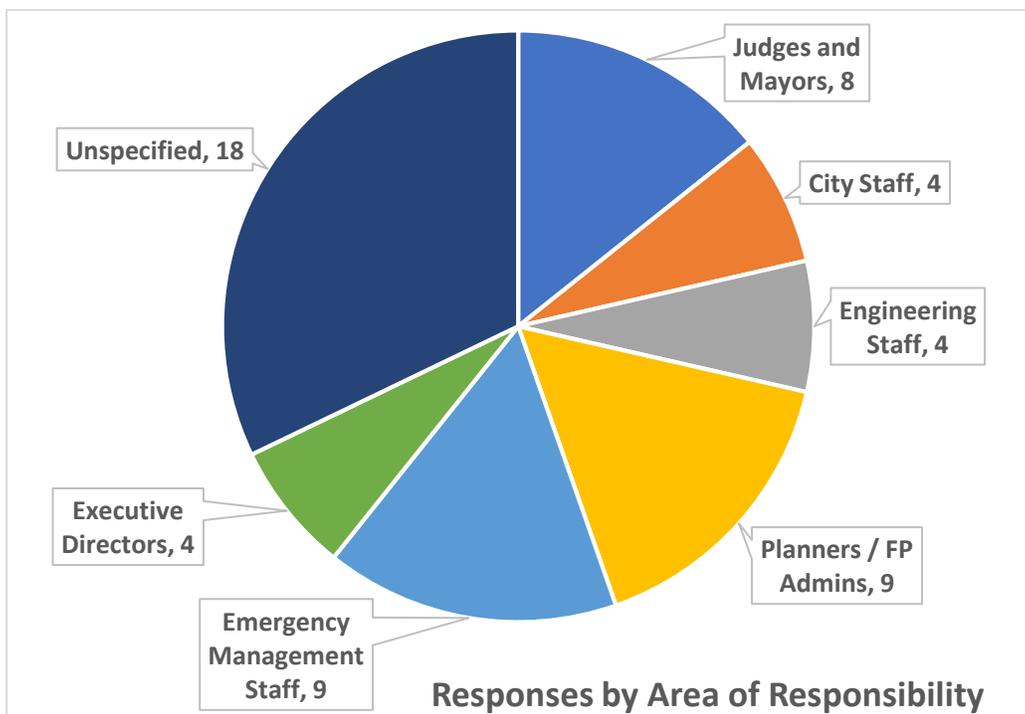


Figure 4-2 Distribution of online survey responses by area of responsibility

4.2.4. Face to Face Interviews and Small Focus Groups

For the second phase of the input collection process, the research team conducted several site visits to the area and performed a number of face-to-face interviews and small focus groups with a select group of stakeholders from across the project area. Interviewees were selected based on the initial contacts list as well as the responses to the online survey. The selection aimed to provide a balanced geographic distribution as well as cover all areas of expertise targeted by the task activities. In total, 19 interviews were conducted including 14 individual interviews and 5 small focus groups with a total of 28 interviewees. Figure 4-3 provides a description of the distribution of the responses by county, while Figure 4-4 provides their distribution based on the areas of responsibility and expertise of the responders. As seen in the figures, the responses covered the majority of the targeted counties and were well distributed across the range of expertise targeted by the task activities.

Interview questions were based on the initial list of questions described in section 2.2. However, each interview adapted to the specific areas of expertise and interests of the interviewees. Areas covered within the interviews included:

- Experiences regarding drainage and flooding problems and projects within your area of experience.
- References and regulatory processes.
- Frequently encountered problems.
- Processes to respond to major storms, and how to improve them.
- Communication, collaboration and coordination issues
- Community engagement issues
- Assessment of possible flood mitigation/prevention approaches

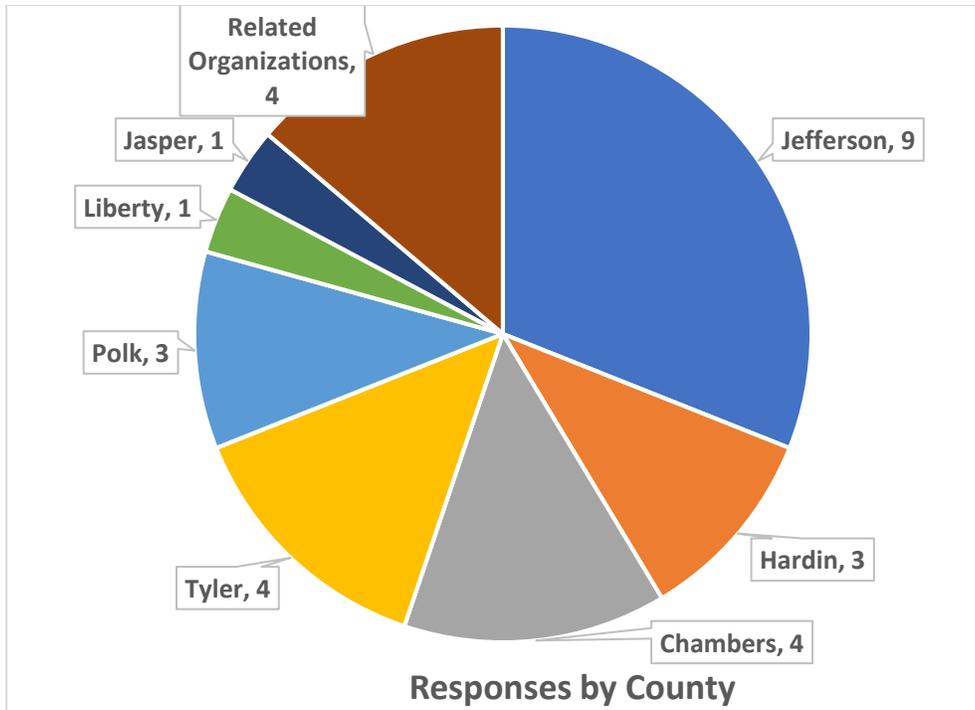


Figure 4-3 Distribution of interviewees by county

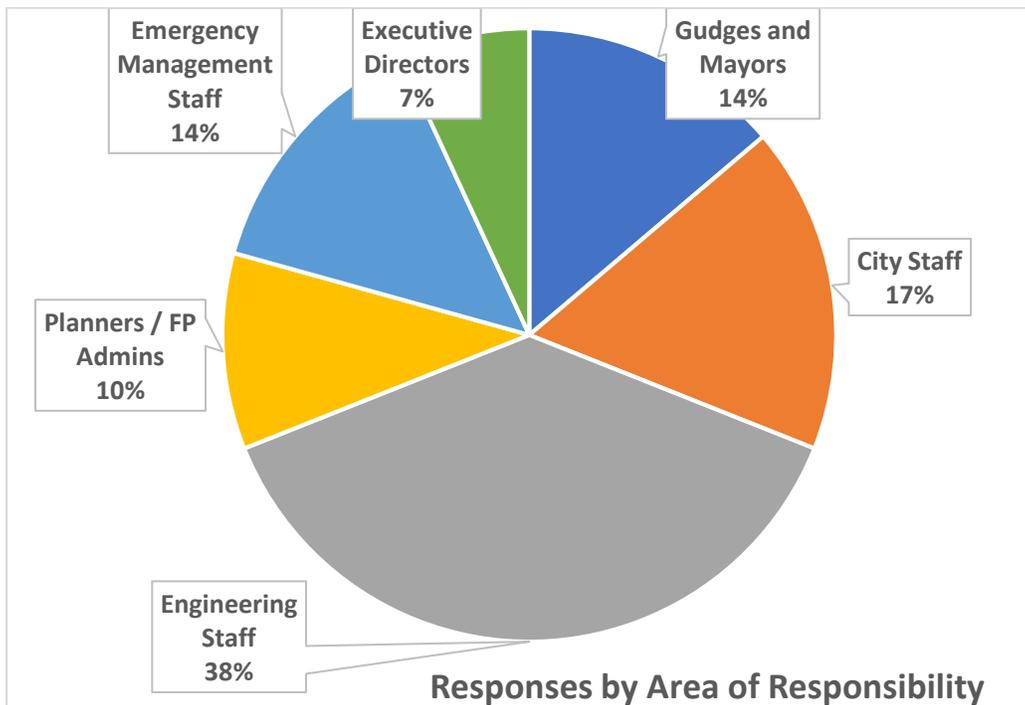


Figure 4-4 Distribution of interviewees by area of responsibility

4.2.5. Final Stakeholder Workshop

To conclude the input collection process, a final stakeholder workshop was held on September 27th at the Beaumont University Campus. Invitations to the workshop were sent to all names included in the contacts database and invitees were encouraged to forward the invitation to any other stakeholder they thought may be interested in attending. The objective of the workshop was to present the preliminary findings of the online surveys and interviews to the stakeholders and solicit their feedback on any gaps that may exist in the information collected. A total of 21 stakeholders attended the workshop, with an additional seven who registered but did not show. The workshop included several presentations by the project team. Subsequently, the attendees were divided by area of expertise into three groups: policy makers, emergency management staff, and engineering staff. A facilitated discussion was then conducted by each group in which the attendees were asked to provide input on any gaps they see in the outcomes presented as well as to prioritize the recommendations. Figure 4-5 shows images of workshop attendees. As mentioned in previously, the online survey was redeployed after the workshop, which resulted in 15 additional responses.



Figure 4-5 Images of workshop attendees

4.3. Results and Discussion

4.3.1. Online survey

The following provides a summary of the responses received for the online survey.

- *Drainage references and guidelines currently used:*

Respondents mentioned a wide range of references and documents including drainage districts 6 and 7 drainage plans, FEMA maps, USACE studies, NOAA/NWS studies, Lower Neches Valley Authority reference documents, NFIP, state guidelines, city and county ordinances, and subdivision regulations. 25% of respondents indicated that their jurisdiction does not use any references or guidelines or that they are unaware of any.

- *Frequently encountered drainage problems in area of responsibility.*

Out of 24 respondents who answered this question, 20 (83.3%) indicated that they frequently encountered drainage problems within their area of responsibility. The following summarizes the problems mentioned by the respondents:

- Existing debris and silt in waterways which keeps the water level high. Need for cleaning up of bayous.
- Lack of funding and financing for needed projects
- Flooding of primary ingress/egress streets even with small amounts of rain (2 to 3 inches).
- Erosion of ditches next to dirt streets, with the resulting sediment washed downhill, plugging culverts and resulting in streets being eroded to the point of being impassable.
- Inadequate or nonexistent drainage canals.
- Not having adequate outfall capacity to accommodate development or even current conditions. Existing drainage does not have the capacity to carry the load.
- Significant amount of Big Thicket and Parks and Wildlife areas that make it impossible to do cleanouts in very important areas.
- Not having a drainage district in some counties (e.g. Hardin County).
- I-10 not allowing for drainage all along the corridor
- Low water crossings and street ponding areas.
- Projects designed for one area are not considered in the problems it will cause for other areas.
- *Procedures needed to address common drainage issues:*
 - Lack of needed funding was identified as major issue by a large number of respondents. There is a clear need for additional funding of needed projects. This includes funding to clear bayous and tributaries for better drainage, as well as funding to improve outfalls and provide detention facilities.
 - More studies of channelization projects, retention ponds, etc. This includes drainage master plans, engineering studies, hydrologic and hydraulic studies, city and county wide studies as well as regional studies.
 - Developing a regional master drainage plan.
 - Clearing bayous and tributaries from existing debris and silt to allow for better drainage,
 - Raising some of the streets and expanding the capacity of the culverts for the amount of water that needs to be handled in a short "burst" period of time.

- Modifications to I-10 to allow for better drainage
- Strictly enforced development guidelines.
- Written standards for maintenance projects.
- Replacement of failed and damaged earthen dams.
- Faster permitting and environmental clearances
- Additional manpower (for small cities) to handle processes of applying for funding and managing projects.
- Additional equipment especially for smaller jurisdictions.

- *Handling of major storms especially Harvey*

Approximately 70% of the respondents indicated that their procedures for handling major storms do not differ from those used in handling other types of storms and rain events. Respondents who indicated a difference in procedures mentioned inter-local agreements as well as a lack of capacity to handle these major storms as the main differences.

Respondents, however, listed a number of problems that either were caused or made worse by Harvey. These include:

- Increased debris and silt in major waterways bayous, and tributaries.
- Silt buildup in roadside drainage ditches and culverts. Silt loading of upper portions of lakes.
- Damage to street surface and subsurface (both paved and unpaved) from the extended submergence.
- Damage to homes and businesses

When asked if all problems resulting from Harvey have been addressed, 81% of the respondents indicated that this is not true and that several Harvey-caused problems remain unresolved. Lack of funding and needed studies were identified as the main reason for this situation by most respondents

- *Assessment of possible flood mitigation measures and approaches.*

The following represents the assessment of the respondents of possible flood mitigation measures and approaches proposed by the researchers:

- Updating flood maps:

The general consensus was that the existing flood maps are too old and don't reflect existing conditions. A strong need therefore exists to produce updated maps and for these maps to be updated on a regular basis in the future.

- Elevating critical systems, facilities, and roadways above base flood elevation:

Most respondents agreed that this measure is needed especially with regard to key roadways and some critical infrastructure and facilities. Some respondents indicated that the cost to elevate all of these roadways and facilities may be too high making them unfeasible financially.

- Storm water management including installing retention basins, larger culverts and debris removal

The majority of the responses indicated strong support of and for these measures. A couple of respondents indicated that their jurisdiction cannot implement retention basin unless they purchase properties from private owners. Similar support was expressed for erosion control solutions.

- Installing backup power generators for critical systems

There was less consensus in the responses to this measure. Several respondents, mostly coming from larger counties and jurisdictions, indicated that while this issue is important, it has already been addressed and the necessary backup capacity now exists in their area of responsibility. Another group, mostly representing smaller jurisdictions (e.g. small towns) indicated that they still do not have sufficient backup [power generation capacity and that this is a high priority for them.

- Back-up communication systems

Responses to this issue were mixed similar to those regarding backup power. A group of respondents indicated that this need has been met, while others indicated it has not and that it remains a high priority for them. The main difference between the two groups was, for the most part, also the size of the jurisdiction.

- Encouraging the use of building practices that allow for more pervious coverage

There were some positive responses to this issue, but several respondents also indicated a lack of information about the topic. Some indicated that implementing these practices will be hard in their jurisdiction.

- Using Native vegetation to preserve the natural environment
Most responses received indicated a lack of information about the benefits of using native vegetation.
- Improving building codes and regulations
Responses to this issue were mixed. Several respondents indicated strong support for strengthening building codes and regulations, while others indicated that their jurisdiction does not have that capability and/or that it would be difficult to implement.

4.3.2. Workshop

The following describes the outcomes of the three facilitated group discussion conducted within the workshop:

- *Emergency Management Coordinators:*
 - Regional focus is beneficial as a way for agencies at different scales to share information
 - Need one centralized point where people needing to be rescued could call
 - Hydrology and Hydraulics study
 - Need updated floodplain maps
 - Could also include geospatial mapping that identify floodplain levels that could be accessed and shared through a regional dashboard
 - Communication is effective regionally; focus on communication between local + regional agencies with the state and federal agencies
 - Need to coordinate with other agencies before events
 - Texas Division of Emergency Management is very responsive
 - Effective, accurate forecasting must be the priority
 - Verify there is communication equipment that will work during and after an event
 - Flood warning systems
 - GIS Regional dashboard
 - Dredging as needed
 - FEMA funds are for repairing, but in some cases, what is needed is improvement / mitigation (for resiliency). However, FEMA funds can only be used for replacement
 - GLO mitigation funding could help with this
- *Policy Makers:*

- Funding for pre-, during and post-disaster is priority
- More flexibility for allocation of funding at local / regional level
- Issues with LMI
- Focus on cleaning out waterways
- Focus on regional planning / regional approach
- Instrumentation and gaging needs to be accurate
- River levels should be tracked and communicated with all entities downstream
- Need information from streams and tributaries to be shared with everyone downstream
- Permitting processes take much too long. These are hindering progress
 - Corp of Engineer projects are taking too long to permit
- Need more flexibility with state and federal funds
 - Funds allocated for buyouts may be better utilized for infrastructure
- Smaller counties don't have the funding for planning
- There should be a consolidated application for funding (similar to the Common App for college applications)

➤ *Engineers:*

- Permitting issues for some agencies (such as railroads) impede progress in addressing flooding
- Coordination of system maintenance between the state agencies needs improvement
- Pre-approved contracts should be in place for disaster response and clean-up
- All entities should have a way to share best practices
- Issues arise when a city can't solve drainage issues because an adjacent drainage district doesn't have funds to address drainage issues
- More focus on the drainage component of transportation / highway projects (TxDOT)

➤ *Overall:*

- There needs to be a more comprehensive workshop to address regional issues around drainage and emergency management. This should include representatives from all regional, state and federal agencies.

4.4. Survey Recommendations

The following recommendations reflect the opinions of the stakeholders suggested from the surveys and workshops.

Building code:

- Update the current FEMA maps with new BFE level to account for the record flood events in East Texas counties.
- Integrate new modification to residential building codes to Adopt new construction elevation of one foot above 500 year flood plain as compared to the current 100 year flood plain.
- Expand the use of detention facility (ponds) and incorporate their use in conjunctions with new development zones.
- Maintain and clean existing tributaries, levees and detention ponds from debris and sediments.

Communications and coordinated management systems:

- Establishing a unified emergency operation or command unit to respond to emergency calls from all counties through multijurisdictional coordinated effort and guidance.
- Improve communication structure to gather and collect constructive information between agencies before feeding them to people during major events through social media or other platforms.
- Building a backup Emergency resilient communication platform such as project 25 communication a national effort to get Police, fire, EMS, and municipalities to talk to each other on one unified system.

Recovery Funding:

Streamline applications for funding from federal and state agencies through a single channel to facilitate emergency and recovery effort for local jurisdictions.

New development zoning

- Integrate best practices of issuing new development permits with supported studies to evaluate the impact of expanding pervious cover on floods and enforce drainage alternatives like detention ponds or drainage canals capable of retaining higher rainfall records.
- Develop zoning requirements for developments considering existing and new flood zones developed during Harvey.

- Identifying critical infrastructure like power plants, water and sewer plants and evaluate the potential to raise their elevations furnish them with backup power sources prevent shut down during major events.

5. CONSOLIDATING AND BUILDING AN ORGANIZED DATA LIBRARY

(TASK #4)

5.1. Data Library Overview

The data library consists of documents relating to flooding and other extreme weather events relevant to nine southeast Texas counties – Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk, and Tyler. The link to the portion of the library where these documents are described and can be read or downloaded is provided in Appendix E.

The data library also includes geospatial data files, i.e., data files that tie geographic coordinates (such as 30.128° North, 93.561° West) to descriptions of natural or human-made structures at those coordinates. A link to the portion of the library where these data files are described and can be downloaded is in Appendix E. Such data files are best viewed in relation to one another, on a base map of the area of interest. For this reason, several viewing apps have been developed. A link to the portal for these viewing apps is provided in Appendix E.

The file naming system, data storage and archiving software, documented computer coding, and other mechanisms are in place to readily update the library and the viewing apps, as discussed below.

5.2. Documents

Documents in the library are named based on the names given them by the source from which they were obtained, but with additional identifying information. File names for files pertaining only to one particular county begin with the two letter county abbreviation established by the Texas Historical Commission (<https://www.thc.texas.gov/public/upload/preserve/survey/survey/Texas%20County%20Abbreviations%20TARL.pdf>). Documents are thus readily identified for the county of concern, and no inconsistencies in naming will arise as the library expands to include additional counties. Document names may also end with the year of publication, to readily identify the document's age, and to distinguish it from more current documents of the same type as they are added to the library in upcoming years.

The documents can be read on-line or downloaded at <http://glofloodmitg.coe.utsa.edu>, where they are arranged by county.

5.3. Geographic Information System (GIS) Data

Geographic information system (GIS) data is data that ties geographic coordinates (such as 30.128° North, 93.561° West) to descriptions of features of interest. In the rightmost column of Table 2-1, the file names ending in .shp are for a type of GIS data known as vector data, while file names ending in .tif are for raster data. A basic understanding of the types of GIS data is essential to understanding how the data library is structured, how it functions, and how it is to be updated.

Vector data uses geographic coordinates to identify points, lines, and polygons to represent the locations and shapes of various feature. A vector data set might, for example, consist of a dozen or so points, with each point identifying the geographic coordinates of a dam, so that the locations of the dams can be displayed on a map. When vector data contains points that are not connected with lines, the vector data is said to contain point data. When multiple points are tied together to form a line, such as a line that traces out an evacuation route, then the vector data set contains line data, or polyline data. Finally, when points are tied together to form a loop defining the boundary of a feature such as a county or a lake, the vector data set contains polygon data.

Vector data files not only display the geometry (i.e., where points appear on a map, or the paths traced out by lines or polygons) through geographic coordinates for the feature of interest but can store a lengthy list of attributes (i.e., various qualitative and quantitative descriptions) of that feature. So, for example, vector data representing a set of dams as points may also have associated with each point the name of the dam, the year the dam was constructed, and so on. A vector data file that outlines basins with polygons, may also store for each polygon the area of the basin, the number of people living in that basin, names and phone numbers of agencies developing flood mitigation plans for that basin, and so on. Therefore, vector data files can be used to clearly show the geometry (locations and shapes) of features and abundant information about those features.

GIS vector data files are often in an ESRI shapefile format, with the file having an .shp extension being supported by several other files (with extensions .shx, .dbf, and others). This shapefile format requires specialized software and knowledge of how to use it if one is to open or edit the vector data it contains. However, vector data can actually be stored in several other formats, including the .csv format, where it can be opened and edited by Excel or other commonly available spreadsheet software, though one must be careful not to alter the geographic coordinates in the “geometry” column. As can be seen in the videos for authorized users of the viewing apps (which has links in Appendix E), the combined use of

both .csv format and the .shp format for storing vector data enables local stakeholders to update layers of information to be displayed in the maps without specialized software or training.

While vector data is very effective in conveying much information, it is not always adequate for conveying how particular properties, such as ground elevation, might vary throughout a basin or other area. For such a purpose, raster data is often preferred.

Raster data is in the form of a grid. A photographic image taken from high above the Earth looking downward is an example of raster data. In such an image, each pixel, or grid cell, has at its center a pair of geographic coordinates, and may have three numbers for representing the amount of red, green and blue color for that cell. Collectively, the cells form the photographic image. The satellite image we see of the ground, with streets, buildings, lakes, and other features on Google Earth or in a smart phone direction app (with satellite option selected) is raster data. But the use of raster data is not limited to such images. The raster data set may instead be simply a quantitative representation of a single variable. For example, each cell may have a gray scale value representing the ground elevation, with the lower the elevation, the darker the gray. Collectively, the cells would then display an image showing where the ground elevation is higher (light gray or nearly white at hill tops or in the higher portions of slopes) and lower (dark gray or nearly black valleys). So, raster data can be used not only to provide a photographic image of an area, but also, alternatively, as an image showing the spatial distribution of the values of variables of interest.

Raster data offers the advantages of providing representations that appear realistic, and of being capable of storing spatially distributed quantities. Hydrologic and hydraulic computer models that predict stream flood elevations may rely heavily on raster data. Yet, unlike vector data files, raster data files do not lend themselves to storing various descriptions of features of interest – only the color scale values, and geographic coordinates are provided for each cell. Also, raster data files typically take up much more computer space and thus take longer to upload and download than do vector data files.

5.3.1. Geospatial Data File Types and Their Modification and Use in Viewing Apps

The vector data contained in the GIS data files is easily viewed through the library's viewing apps. Links to the viewing apps and instructional videos are in Appendix E. If the reader is unfamiliar with such apps, watching the introductory video is recommended before reading any further.

The viewing apps allow the user to select ESRI World Imagery raster data as the base map. This base map provides a photographic image of the area of concern, with major streets and other major features labeled.

When the viewing app is opened, only the default base map layer appears in the map window. One may then select counties of interest and add the desired layers of information by checking the corresponding boxes. All of these layers of information that can be added to the base map layer are of vector data, to allow for rapid display of information that complements the visual information provided by the raster base map.

All vector data displayed in the viewing apps is in GeoJSON format. This is the standard format that allows for easy display and data querying over the Internet.

GeoJSON formatted data published on the Internet by various governmental and non-governmental entities through Representational State Transfer (REST) endpoints (i.e., web addresses from which data can be obtained) may be read by the app and directly appear as layers of information in the app. This operation of adding GeoJSON layers of information from various external endpoints can be executed by authorized users who select the “Add REST Endpoint” link on the app home page. One advantage to being linked to such an endpoint is that as data is updated by the hosting entity, the update will almost instantly appear in the corresponding layer of information in the viewing app. The latest rainfall estimates and latest forecasts can thus appear as a layer of information in the app.

The viewing apps are capable of reading from the two basic types of geospatial REST endpoints – web feature service (wfs) and web mapping service (wms). The wfs endpoints allow for greater flexibility when incorporating the data into the viewing app. They allow for selection of styling (whether squares, circles or some other symbol should be used for points, the thickness and what color of lines, etc.) and for selecting subsets from the data. The wms endpoints merely provide an image of the layer of information.

None of the vector data obtained through the contract to build the library was originally in GeoJSON format. Yet, many of the layers of information in the viewing apps will likely come from data stored in the library, not from external endpoints. Converting this locally stored data to GeoJSON format is essential to full utilization of the viewing apps. The process of converting this data into the GeoJSON

format and having it appear as a layer of information on top of the base map in a viewing app is as follows:

1. The vector data (which will be in either shapefile or csv format, as discussed below) is uploaded into the app by an authorized user via the “Add/Update Layer” link on the app’s home page (as demonstrated in the video with link in Appendix E). As the vector data is uploaded, the app stores it in a PostgreSQL database in the GeoJSON format. (PostgreSQL is discussed in 5.3.2.)
2. The app then links the PostgreSQL database to Geoserver software, which maps out the data for display over the base map.

Each viewing app has its own PostgreSQL database. Layers of vector data can be added to, removed from, or modified in each of these databases, and the appearances of layers of information in the app will change accordingly. The data library’s primary PostgreSQL database is separate from these app databases, and requires separate authorization for entry. In this way flexible and frequent modification is possible at the local level, without exposing the primary database to unnecessary risks.

Nearly all the vector data obtained under this contract and needed to be converted into GeoJSON was originally in the form of ESRI shapefiles. The viewing apps allow for authorized users who select the “Add/Update Layer” option on the viewing app home page to upload vector data of the shapefile format into the app, and the app automatically converts the shapefile format into a GeoJSON format. A link to the instructional video to “Add/Update Layer” is in Appendix E.

One of the disadvantages of the shapefile format is that the column headings in its data tables cannot be more than 10 characters long and cannot have any spaces. This limitation can make understanding the meaning of the name more difficult. For example, the high-water mark vector data obtained in the shapefile format has as one of its column headings “Flooding S” instead of the more readily understood “Flooding Stream”. Other variable names in shapefile datasets obtained are even more obscure – “HW_Elev_88”, “MTCC”, “CONTDTE”, to name a few. Unless such obscure names can somehow be changed before the data is uploaded into the viewing app, they will appear in the app popup tables that describe features of interest as the user clicks on them. An alternative vector data format developed by ESRI, the geodatabase format (as indicated by the .gdb extension), eliminates this 10-character limit. However, most of the data obtained for the library was simply unavailable in that format.

A second disadvantage of the shapefile format – and a disadvantage of the geodatabase format as well – is that it requires the user to be familiar with geographic information system (GIS) software (such as ArcGIS) in order to view or edit. So, for example, an authorized person such as an emergency response

planner, who would like to update names and contact information in the viewing app, would need to be familiar with GIS software, or at least find someone who is.

Because of the two above disadvantages posed by the shapefile format, Python script has been written that creates .csv files for a given shapefile. This Python script includes various options for renaming attributes, adding columns for additional information, excluding columns that are not of interest, and so on, and is deliberately documented so that those unfamiliar with Python may adjust the script as needed, and then use it to generate a final version of the csv file. Alternatively, the Python script can be simplified to simply convert to csv with no modifications, and then the resulting csv file can be opened and edited manually with Microsoft Excel or any other widely used spreadsheet software. The .csv file can then be uploaded into the viewing app using the “Add/Update Layer” link on the app home page (as described in more detail in the video linked to in Appendix E), just as can be done with shapefiles. The viewing app will automatically convert it to GeoJSON format for display over the Internet. One word of caution is in order here: When .csv files are created from the shapefiles, they .csv files do not store the projection metadata. All shapefiles introduced into the library are in the North American 1983 geographic coordinate system and datum. The viewing apps can adjust when shapefiles having different metadata are uploaded, but they cannot adjust for .csv files because the .csv file stores no such information, and the NAD 83 system is therefore assumed by default. So, if a shapefile is used to create a csv file for uploading into a viewing app, one should first ensure the shapefile is in NAD83.

5.3.2. Storage of Vector Data in Data Library's Primary PostgreSQL Databases

PostgreSQL is widely used open source software for building relational databases, i.e., a database in which tables of data are systematically related so as to facilitate information querying. It also facilitates data transfer for interactive websites. Structured Query Language (SQL) is used to query information and generate reports from PostgreSQL databases, and is the standard programming language used to do the same for other databases as well. The PostgreSQL Global Development Group has maintained the software, periodically releasing new versions, since 1997. PostgreSQL is often referred to simply as "Postgres".

Each of the viewing apps contains its own database developed through PostgreSQL, with the PostGIS extension to accommodate the geometric data of the features. These databases may be modified as the viewing interests change, or as layers of information are updated. In general, various formats of vector data are entered into the PostgreSQL database for the app, from which in turn Geoserver software renders as a layer of information in the viewing app. Authorized users may add, modify, or delete layers of information from the app. Such flexibility is important for meeting local needs.

The PostgreSQL databases for the viewing apps will almost surely be altered such that they are not optimal for all purposes of interest to the Texas General Land Office. Therefore, a separate PostgreSQL database (for which PostGIS was enabled) containing all vector data originally obtained for this project, and named PrimaryVectorDB, was developed. Links to this database and the script used to create it from vector data files are in Appendix E. The PrimaryVectorDB was also inspected for completeness with the PostgreSQL interface pgAdminIV. In some cases, it was important to add attributes to vector datasets before uploading. For example, Federal Emergency Management Agency (FEMA) maps related to flooding were obtained as shapefiles by county, but the shapefiles themselves do not explicitly provide as an attribute the county or the year of the study. Links to scripts showing the addition of these attributes are in Appendix E.

5.3.3. Publication of Vector Data as WMS and WFS Endpoints

The data library allows for users to download vector data as shapefiles, as discussed in 5.1. If one wishes to then view the downloaded vector data, one would need to open it with GIS software, or pass it through a process, perhaps a manual and tedious process, for it to appear in a viewing app other than the seven that are included in this library. Yet some entities have viewing apps that would utilize a more

convenient transfer of the data directly through the Internet via web mapping service (wms) and web feature service (wfs) endpoints, just as the viewing apps for this project can import from endpoints published by other entities. For this reason, the PrimaryVectorDB was built with the PostGIS extension enabled. As discussed previously, each of the seven viewing apps also has its own database, and each of these databases is also able to have its data published through a wfs or wms REST endpoint, as discussed in the on-line documentation for Geoserver.

6. RECOMMENDATIONS

A comprehensive understanding of the study area was developed for Tasks 1 through 3.

Recommendations are tentatively proposed to cover five general areas. These include:

- Mitigation of compound flood risks for coastal counties (combined rainfall-runoff and storm surge);
- Improved regional planning;
- Adopted updates to new 100-year rainfall;
- Consideration of future land use and infrastructure conditions;
- Development of updated flood plain maps

6.1. Mitigation of Compound Flood Risks for Coastal Counties

Flooding in Texas can generally be categorized into three types: pluvial (local flooding from rain), fluvial (river flooding), and storm surge. It is important to prepare not only each single one of the three, but also combinations. Some counties experienced storm surge and fluvial flooding during Ike, and some experienced pluvial and fluvial flooding during Harvey. While all three types of flooding occur simultaneously in a storm event, current technology allows the modeling of one of the three types at a time. For example, HEC-RAS 1D, one of the mostly used hydraulic analysis tools in Texas, is only capable of modeling fluvial flooding. Most of the other available analysis tools also only account for a single type of flooding, too. Therefore, when conducting planning and future studies, the scenario where more than one type of flooding can occur simultaneously needs to be considered.

6.2. Improved Regional Planning

Urges for regional planning have been heard from stakeholders during the Task 3 interviews. From information obtained through this study, the research team recognizes the importance for planning that balances considerations for political and watersheds. Planning based on hydrologic boundaries has three benefits. First, counties/cities can address upstream/downstream effects of flood mitigation infrastructures more easily in a regional project. Second, this allows one study to benefit all cities and counties inside the entire hydrologic boundary. Finally, a regional project combines the resources and voices of all participating agencies, potentially expediting the permitting and funding processes. More open and spontaneous conversations between administrative bodies are recommended by the research team for better cooperation.

6.3. Adopted Updates to New 100-year Rainfall Estimates

The frequency of heavy storm events in the last five years have raised public concerns in the upper Texas coast over the validity of formerly adopted 100-year rainfall estimates and other storm return periods (i.e. 500 year, 50-year, 10-year, etc.). The NOAA Atlas 14 rainfall updates come at a critical moment for the region, as the statistical updates to annual exceedance rainfall depths were long overdue. An approximate 3 to 5-inch increase to the 100-year rainfall is a pivotal shift towards long-term flood risk mitigation. The increased 100-year rainfall will soon become officially adopted into current land development criteria and design standards. Needs for updated floodplain studies and maps have come along with the advent of NOAA Atlas 14. Higher probabilities of storm events indicate that floodplains associated with frequency rainfall are expected to expand largely. When designing for flood mitigation and resiliency, administrators and planners need to keep in mind the increasingly extreme weather and provide extra for the future.

6.4. Consideration of Future Land Use and Infrastructure Conditions

It was learned in this study that many of the studied areas are experiencing rapid urbanization. Urban areas, with high density of concrete and asphalt covered lands, are associated with higher runoff coefficients. This increasingly high coefficient can lead to higher peak flow during a future flood event. Therefore, taking future land use into the analyses is getting better prepared for flooding. The FEMA floodplain studies mainly look at current conditions only, but it is important for administrators, planners and researchers to consider future land use conditions while designing.

Future conditions of flood mitigation infrastructure should also be an important consideration while planning. When installing a flood mitigation infrastructure, it is recommended that administrators plan for the lifetime, maintenance, and emergency back-up plan (e.g. backup generator for pump storage) for the infrastructure. Lifetime cost and sustainability analyses for newly proposed flood mitigation infrastructure projects are also recommended.

6.5. Development of Updated Floodplain Maps

Accurate floodplain maps are critical to planning, flood mitigation, emergency responses and recovery. To achieve better accuracy, more advanced hydrologic analysis tools need to be applied. The 2D HEC-RAS (2-Dimensional Hydrologic Engineering Center's River Analysis System) is an example, where engineers can model flooding not only by one-directional downstream flows of a river, but also multi-

directional overland flows within a much larger area of interest. Such models are especially useful for areas with compound (pluvial and fluvial) flooding.

The research team recognizes the development in hydrologic modeling technology, which allows engineers to predict flood zones and depths with a much higher accuracy and reliability. Observing that floodplain maps from 1980s and 1990s are still the only available floodplain maps for many stakeholders of this study, the research team highly recommends future studies with advanced hydrologic and hydraulic modeling tools.

7. CONCLUSIONS

The project was completed based on five tasks to gather comprehensive information from various sources. Task 1 was collection of flood-related GIS data (FEMA flood zones, high water marks, critical infrastructures, etc.), studies and plans. Task 2 was reviewing drainage strategies on three scales of analysis: federal (EPA, FEMA, etc.), regional (TWDB, TCEQ, etc.), and local (counties, cities, etc.). Task 3 was reaching out to local government regulators, drainage engineers, planners and other stakeholders in their respective areas and specializations in order to determine the needs, hear the concerns, and providing recommendations for all stakeholders. Task 4 was the creation of an online map viewing tool with 7 viewing apps, each one with a specific purpose (Vulnerability of Life and Infrastructure, Emergency Response Infrastructure, etc.). This report was the outcome of Task 5, in which the research team compiled the work and findings of previous tasks into a report format.

The research team identified common flood-related issues by the counties from information collected during Tasks 1 through 3. Many needs were identified during this process. One of the most repeatedly mentioned is updated FEMA 100-year floodplain maps. The currently available floodplain maps are outdated for many counties. Additionally, no updates to the floodplain maps have been made for the recently published NOAA Atlas 14 study, which is a new regulation standard for the amount of rainfall of 100-year and 500-year storms. It is expected that the size of the new 100-year and 500-years floodplains should be bigger than their older counterparts, given higher rainfall. Updated floodplain maps could provide counties with critical and accurate information about flood prevention and mitigation.

Many counties commented they have good communications with each other, but not so good with state and federal agencies in terms of interagency cooperation and coordination. Issues with delayed permitting and funding processes were repeatedly heard during the Task 3 interviews with the stakeholders. Permitting sometimes took years, which made projects more costly than they should be with expedited permitting. On the other hand, many counties and cities are looking for more cooperation with others on regional flood control plans, measures and projects.

Flooding is not just caused by storms, and there are usually compound reasons behind flooding. Natural, social, and economical factors all played important roles in flooding problems across the area of interest of this study. Natural factors such as elevation, terrain and distance to the coast inevitably contribute to whether a region is flood-prone or not. Low socioeconomic status in some cities and neighborhoods are also positively related to repetitive flooding according to the interviews.

One of the most important products of this research is the online map viewing tool. There are seven individual apps inside the viewing tool, each serving a specific purpose. Take the Vulnerability of Life and Infrastructure app as an example. The app relates repeatedly flooded areas to people who are the most vulnerable to flooding. Floodplains, Hurricane Harvey high water marks and low water crossings are presented on the same map with schools, hospitals, and nursing homes, for viewers to places where people are the most vulnerable to flooding. This could help the administrative understand where people like children, patients and elderly need flood mitigation strategies the most. Also, before the arrival of a severe storm, emergency responders will have access to locations of large groups of vulnerable people.

To use the tool, the user will access a portal through a link provided on the GLO website and log in with username and password. The user will then choose one app out of seven that meets the need. After entering the app, the user can check the desired layer of information (For example, "FEMA 100-year Flood") to view. If the user is only interested in certain counties, he/she can enter the name of the counties under the "Select County(s)" box. Legends are on the lower-left corner as a reference. If the user is interested in looking at more detailed information of a specific data point, clicking on a point on the map with a marker will reveal more details.

8. REFERENCES

- Environmental Protection Agency. (2009, February). Stormwater Wet Pond and Wetland Management Guidebook. Retrieved November 5, 2019, from <https://www3.epa.gov/npdes/pubs/pondmgmtguide.pdf>.
- Environmental Protection Agency. (2017, August). National Water Quality Inventory Report to Congress. Retrieved November 5, 2019, from <https://www.epa.gov/waterdata/national-water-quality-inventory-report-congress>.
- EPA (Office of Wastewater Management). (2007, January). Municipal Separate Storm Sewer System MS4 Program Evaluation Guidance. Retrieved November 5, 2019, from <https://www3.epa.gov/region9/water/npdes/ms4audits.html#evaluation>.
- EPA (Office of Water). (2016, December). National Lakes Assessment 2012. Retrieved November 5, 2019, from <https://www.epa.gov/national-aquatic-resource-surveys/nla>.
- EPA (Office of Water). (2016, March). National Rivers and Streams Assessment. Retrieved November 5, 2019, from <https://www.epa.gov/national-aquatic-resource-surveys/nrsa>.
- EPA (Office of Water). (2016, May). National Wetland Condition Assessment 2011. Retrieved November 5, 2019, from <https://www.epa.gov/national-aquatic-resource-surveys/nwca>.
- EPA (Office of Water). (2016, September 13). Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects. Retrieved November 5, 2019, from <https://www.epa.gov/greeningepa/technical-guidance-implementing-stormwater-runoff-requirements-federal-projects>.
- EPA (Office of Water; Office of Research and Development (ORD)). (2016, January). National Coastal Condition Assessment 2010. Retrieved November 5, 2019, from https://www.epa.gov/sites/production/files/2016-01/documents/ncca_2010_report.pdf.
- Federal Emergency Management Agency. (2012, September). National Coastal Condition Report IV 2012. Retrieved November 5, 2019, from <https://www.epa.gov/national-aquatic-resource-surveys/national-coastal-condition-reports>.

Federal Emergency Management Agency. (2015, July). Plan Integration: Linking Local Planning Efforts. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/108893>.

Federal Emergency Management Agency. (2017, May). National Flood Insurance Program (NFIP) Community Rating System (CRS) Coordinator's Manual. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/8768>.

Federal Emergency Management Agency. (2018, November). 2018 National Preparedness Report. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/170861>.

Federal Emergency Management Agency. (2018, June). National Flood Insurance Program (NFIP) Community Rating System (CRS): A Local Official's Guide to Saving Lives, Preventing Property Damage, Reducing the Cost of Flood Insurance. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/16104>.

Federal Emergency Management Agency. (2018, May). Comprehensive Preparedness Guide (CPG) 201: Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR) Guide. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/165308>.

Federal Emergency Management Agency. (2018, July). 2017 Hurricane Season FEMA After-Action Report | FEMA.gov. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/167249>.

Federal Emergency Management Agency. (2019, April). Guidelines and Standards for Flood Risk Analysis and Mapping. Retrieved November 5, 2019, from <https://www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping>.

Federal Emergency Management Agency. (2019, March 1). Coastal Wetlands Initiative: Gulf of Mexico Review. Retrieved November 5, 2019, from <https://www.epa.gov/wetlands/coastal-wetlands#reviews>.

FEMA (Region VI/6). (2017, January). FEMA Region 6 - Disaster Assistance Essentials. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/128354>.

FEMA Natural Hazards Risk Assessment Program, National Mitigation Planning Program, and the Hazus Program. (2018, August). Using HAZUS for Mitigation Planning. Retrieved November 5, 2019,

Mullen, L. (n.d.). Working with Spatial Data. Retrieved November 30, 2019, from <https://lincolnmullen.com/projects/spatial-workshop/spatial-data.html>.from <https://www.fema.gov/media-library/assets/documents/105722>.

National Academies of Sciences, Engineering and Medicine. (2019, February 20). Improving the EPA Multi-Sector General Permit for Industrial Stormwater Discharges. Retrieved November 5, 2019, from <https://www.nap.edu/catalog/25355/improving-the-epa-multi-sector-general-permit-for-industrial-stormwater-discharges>.

National Research Council, Earth and Life Studies, Water Science and Technology Board, & Committee on Reducing Stormwater Discharge Contributions. (2008, October 15). Urban Stormwater Management in the United States. Retrieved from <https://www.nap.edu/catalog/12465/urban-stormwater-management-in-the-united-states>.

Natural Resources Conservation Service. (2015, December). Report to Congress USDA-NRCS Watershed Protection and Flood Prevention Program Multi-Year Plan. Retrieved November 5, 2019, from <http://www.watershedcoalition.org/wp-content/uploads/2016/02/Watershed-Protection-and-Flood-Prevention-Program-Multi-Year-Plan-2-22-16.compressed.pdf>.

U.S. Department of Homeland Security. (2016, August). 2016 Federal Interagency Operational Plans (FIOPs). Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/120091>.

U.S. Department of Homeland Security. (2016, August). 2016 Federal Interagency Operational Plans (FIOPs). Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/120091>.

U.S. Department of Homeland Security. (2016, August). Mitigation Federal Interagency Operational Plan. Retrieved November 5, 2019, from <https://www.fema.gov/media-library/assets/documents/120092>.

U.S. Department of Homeland Security. (2016, August). Recovery Federal Interagency Operational Plan. Retrieved November 5, 2019, from https://www.fema.gov/media-library-data/1471451918443-dbbb91fec8ffd1c59fd79f02be5afddd/Recovery_FIOP_2nd.pdf.

U.S. Department of Homeland Security. (2016, August). Federal Interagency Operational Plans. Retrieved November 5, 2019, from <https://www.fema.gov/federal-interagency-operational-plans>.

United States Army Corps of Engineers. (2018, October). Coastal Texas Protection and Restoration Feasibility Study. Retrieved November 5, 2019, from [https://www.swg.usace.army.mil/Portals/26/docs/Planning/Public Notices-Civil Works/Coastal-TX DIFR-EIS/Coastal Texas DIFR-EIS_Oct2018.pdf?ver=2018-10-24-162409-300](https://www.swg.usace.army.mil/Portals/26/docs/Planning/Public%20Notices-Civil%20Works/Coastal-TX%20DIFR-EIS/Coastal%20Texas%20DIFR-EIS_Oct2018.pdf?ver=2018-10-24-162409-300).

9. LIST OF EXHIBITS

Exhibit 1: USGS DEM of Chambers County

Exhibit 2: Soil Data of Chambers County

Exhibit 3: Hydrography Data of Chambers County

Exhibit 4: Transportation Data of Chambers County

Exhibit 5: Land Use Data of Chambers County

Exhibit 6: Water Resource Infrastructure of Chambers County

Exhibit 7: Gauges of Chambers County

Exhibit 8: Wetlands of Chambers County

Exhibit 9: High Water Marks of Chambers County

Exhibit 10: Flood Zones of Chambers County

Exhibit 11: River Authorities of Chambers County

Exhibit 12: Critical Infrastructure of Chambers County

Exhibit 13: Critical Infrastructure of Chambers County

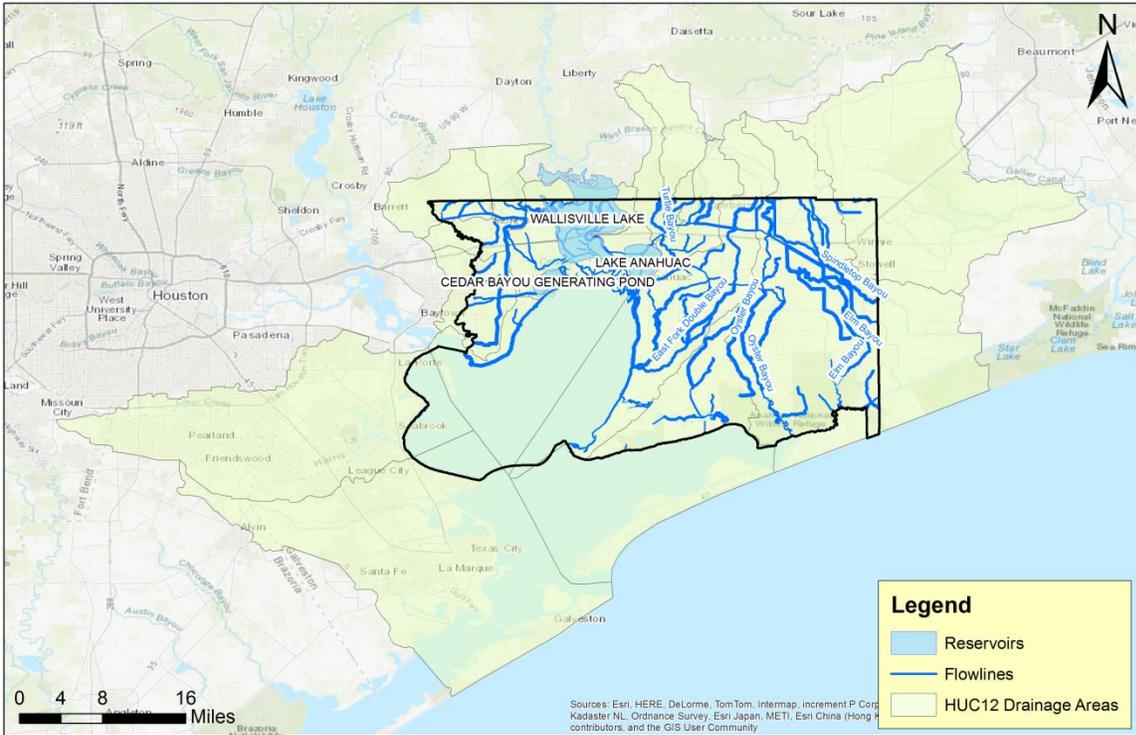


Exhibit 3: Hydrography Data of Chambers County

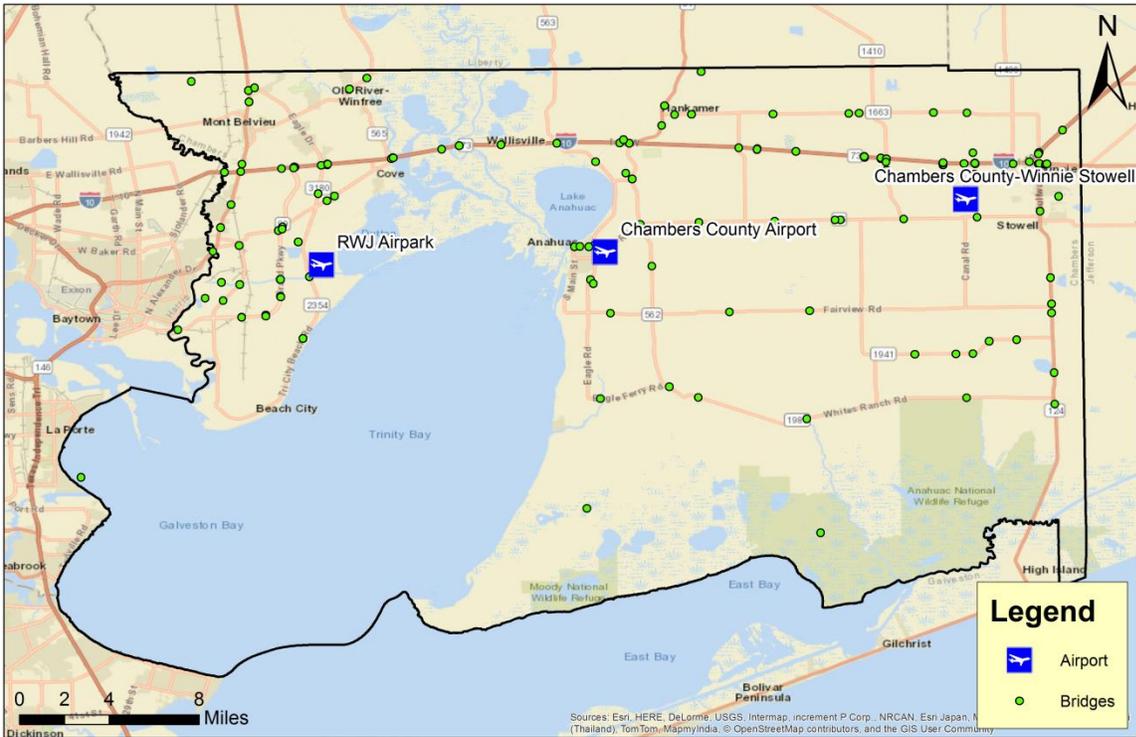


Exhibit 4: Transportation Data of Chambers County

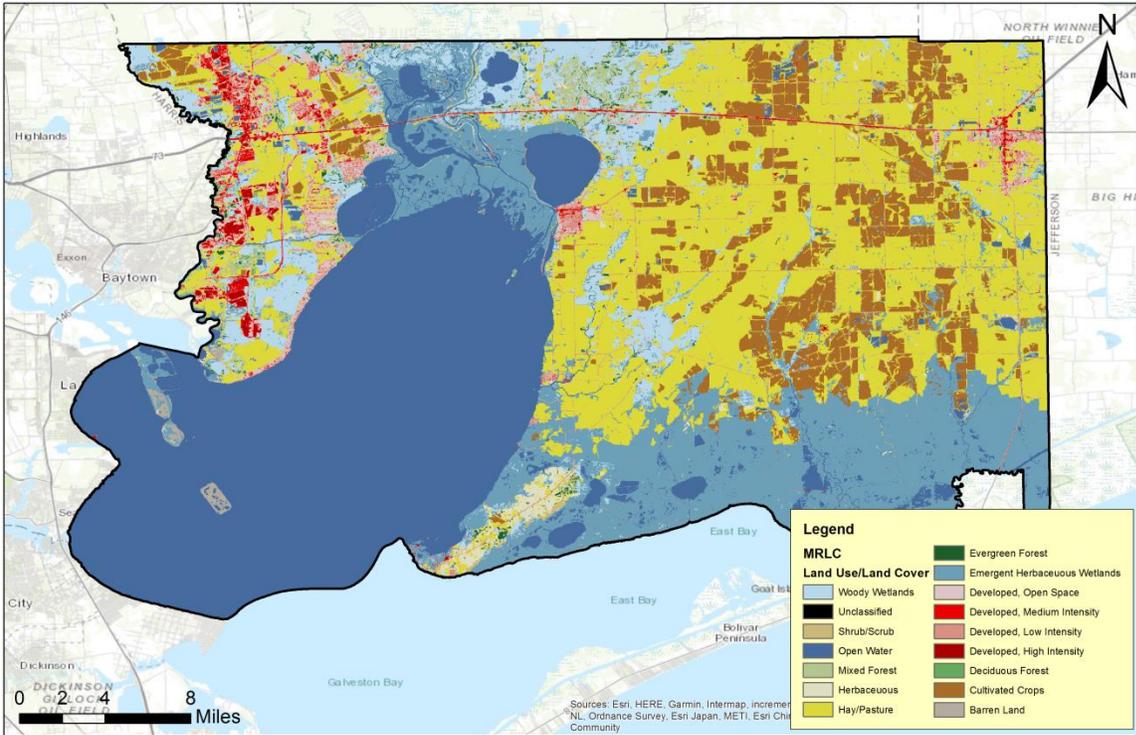


Exhibit 5: Land Use Data of Chambers County

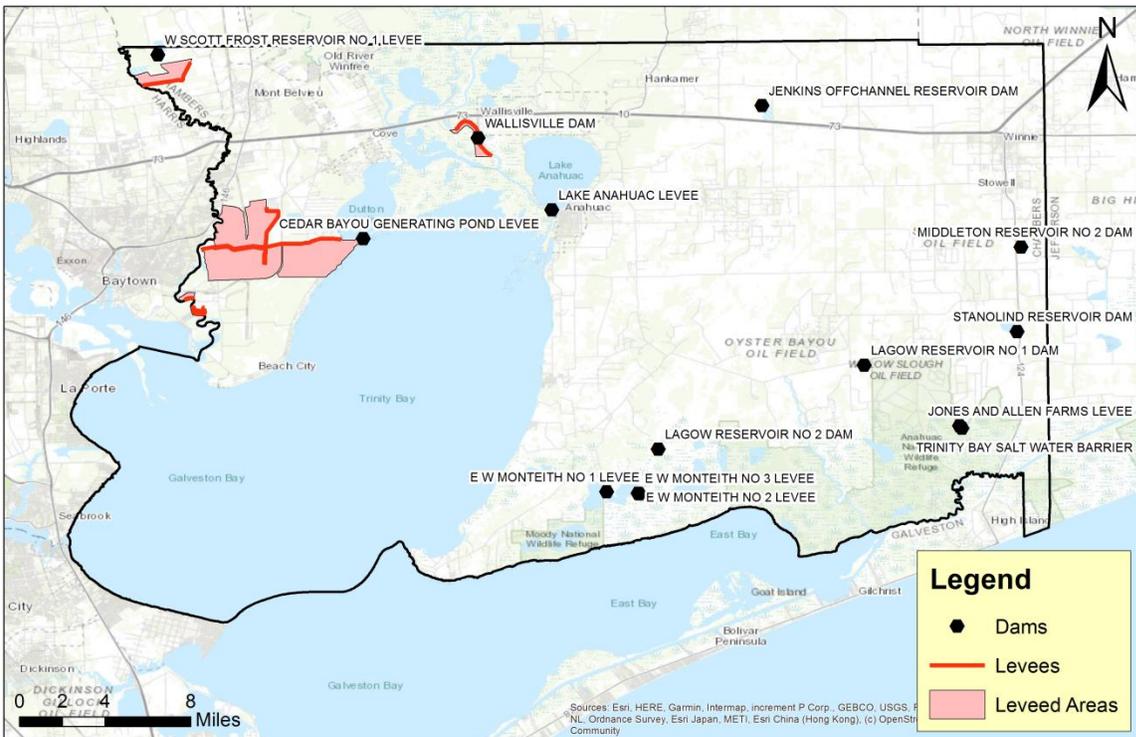


Exhibit 6: Water Resource Infrastructure of Chambers County

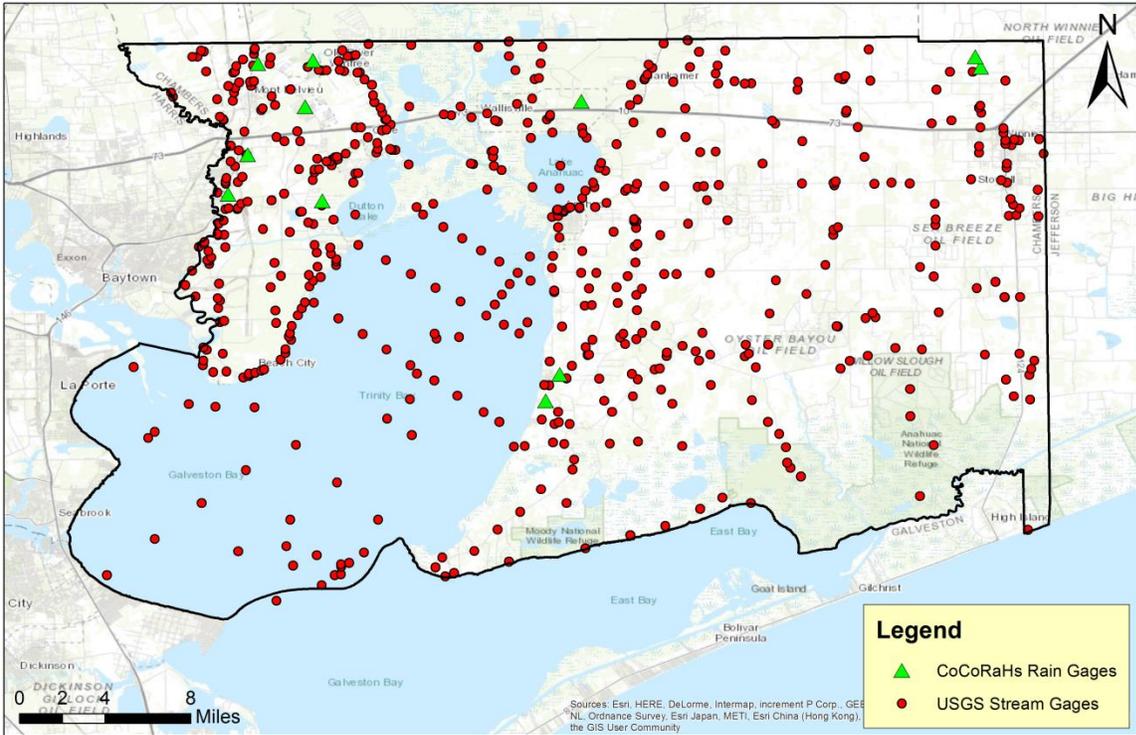


Exhibit 7: Gauges of Chambers County

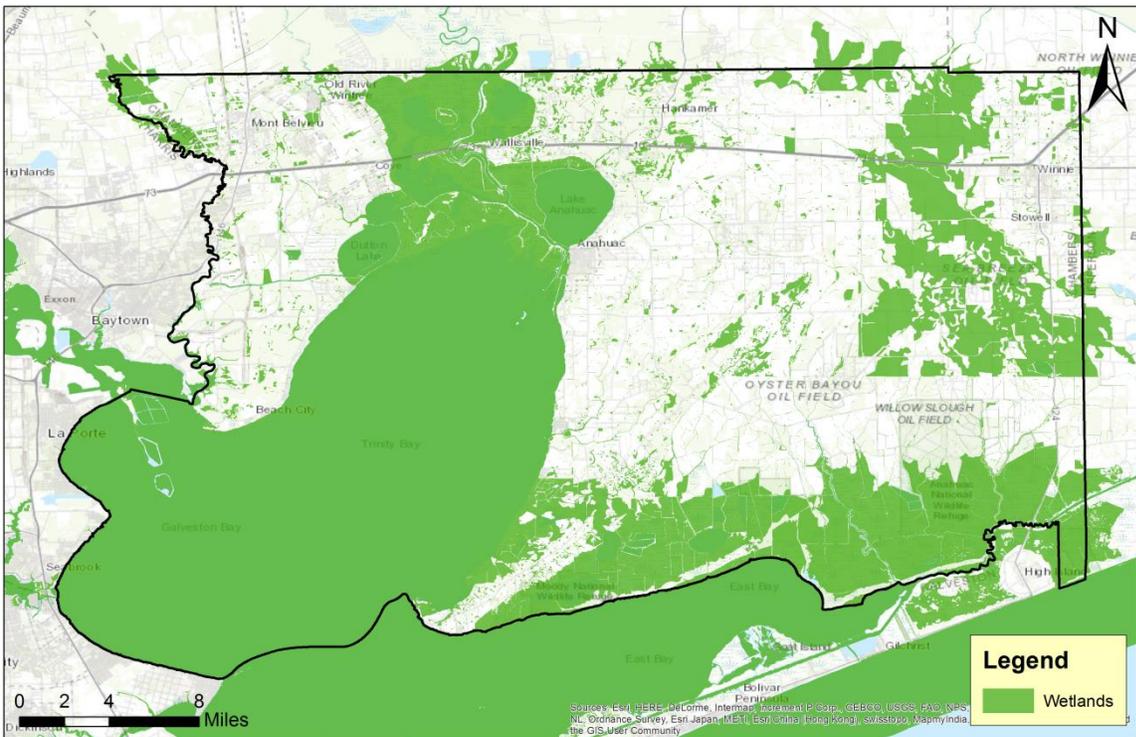


Exhibit 8: Wetlands of Chambers County

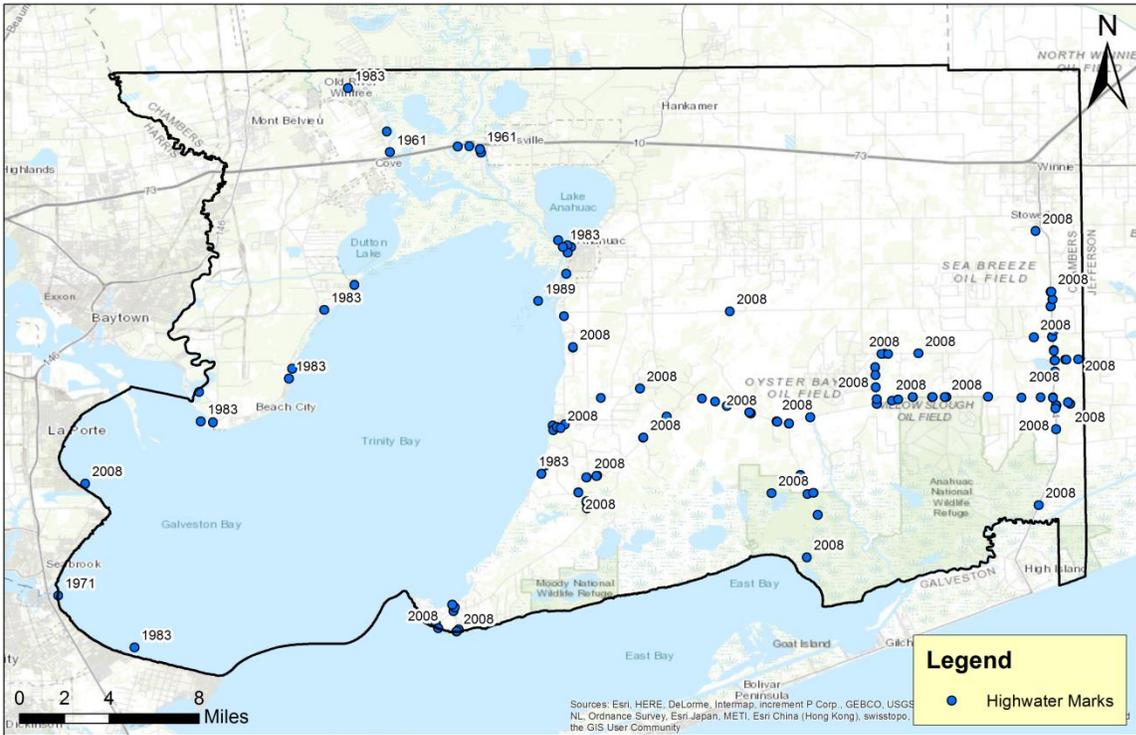


Exhibit 9: High Water Marks of Chambers County

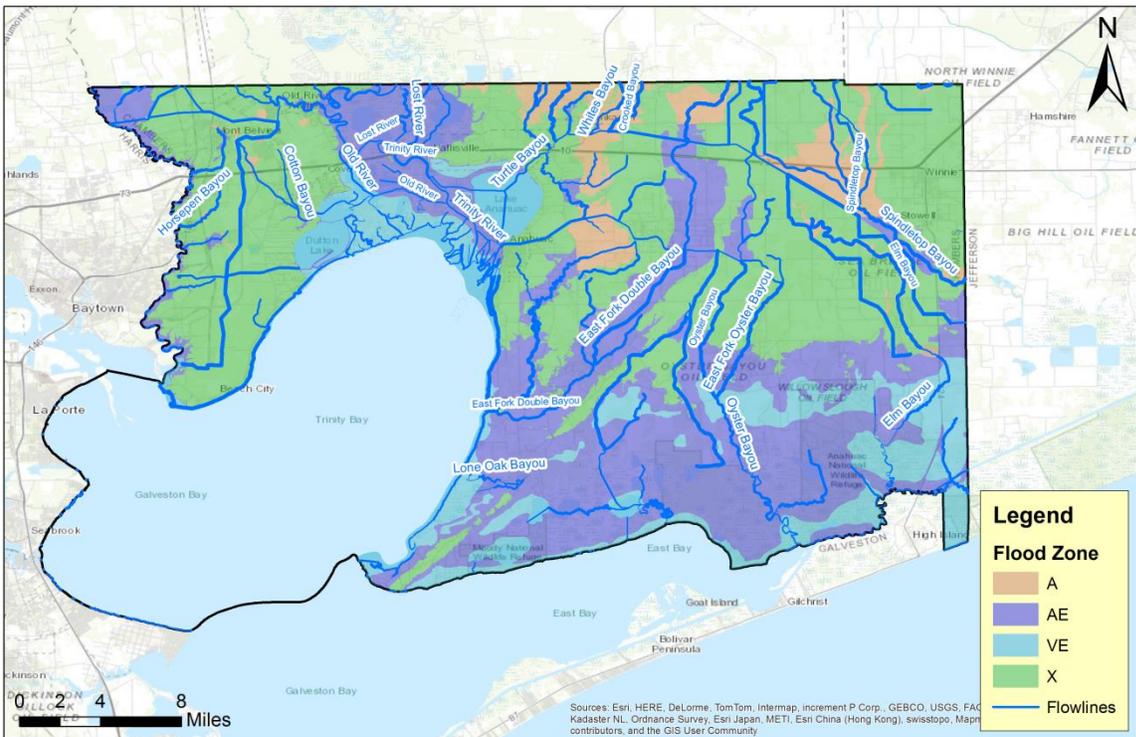


Exhibit 10: Flood Zones of Chambers County

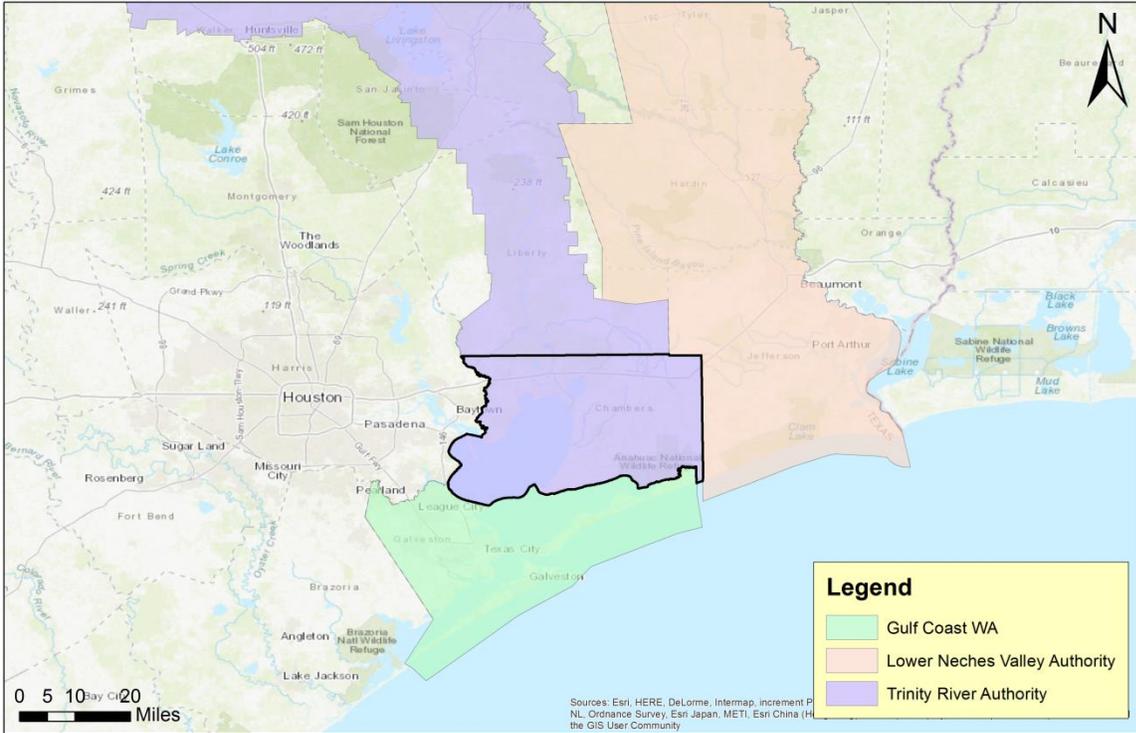


Exhibit 11: River Authorities of Chambers County

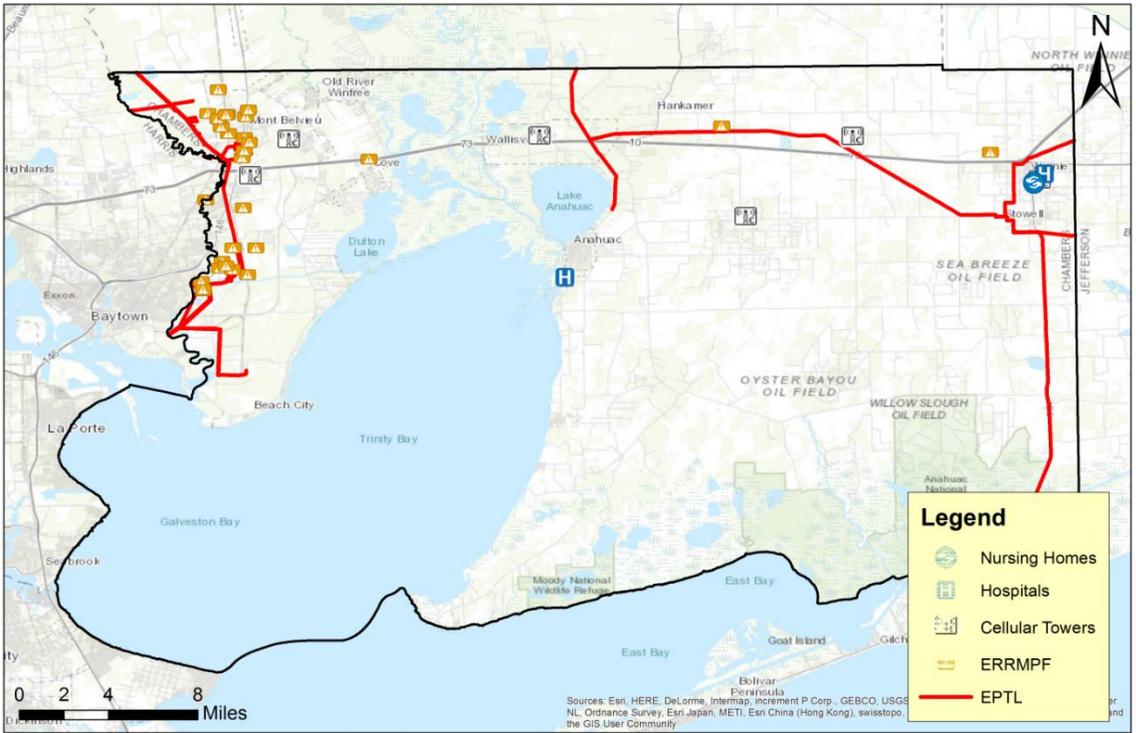


Exhibit 12: Critical Infrastructure of Chambers County

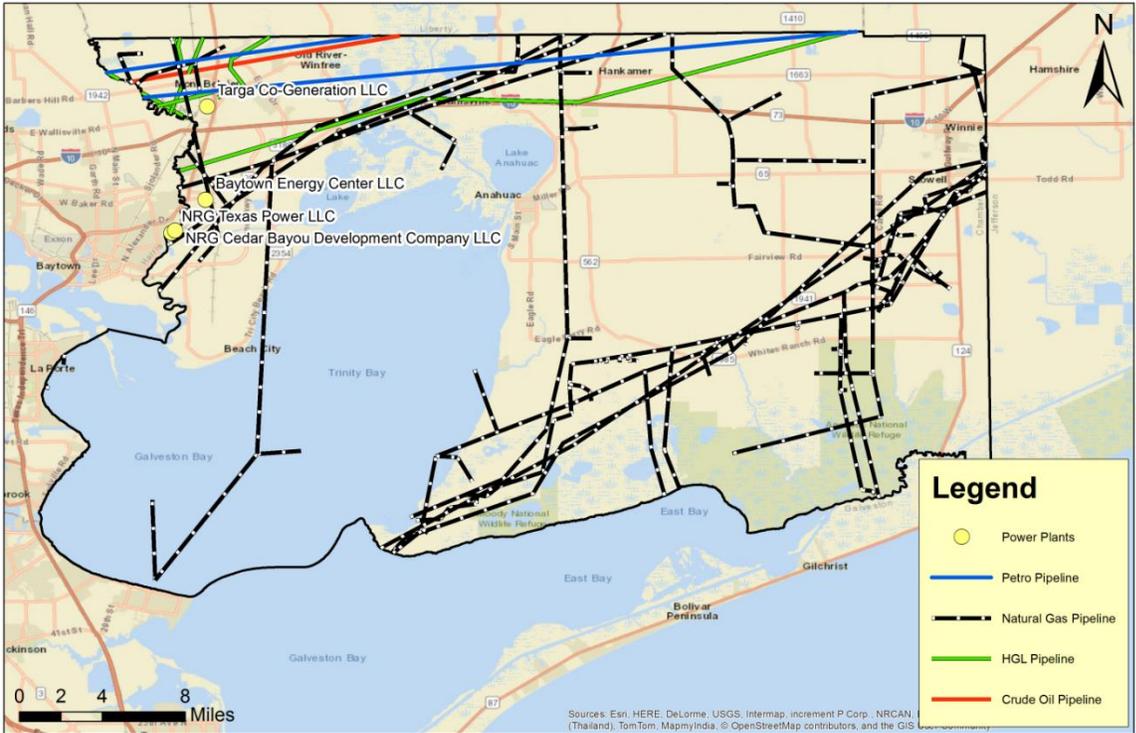


Exhibit 13: Critical Infrastructure of Chambers County

10. LIST OF APPENDICES

APPENDIX A – Drainage Master Plan Reviews

APPENDIX B – Texas Water Development Board Programs

APPENDIX C – Summary of Conversations with River Authorities

APPENDIX D – Summary of Federal Documents

APPENDIX E – Links to Library Documents, Data, Apps, Instructional Videos, and Computer Code

APPENDIX F – Stakeholder Input Online Survey

APPENDIX G – Stakeholder Questionnaire

APPENDIX A – DRAINAGE MASTER PLAN REVIEWS

Jefferson County

Title: A Plan Related to Drainage and Flood Damage Reduction

Year: 2006

Authors: Unidentified

URL: <http://www.dd6.org/resources/drainage-regulations-and-criteria-information/send/5-drainage-regulations-and-criteria-information/8-master-drainage-plan>

1. Is the objective of the Master Plan clearly defined?

Yes. The objective of the master plan is to “to examine how development is reviewed and to lay the groundwork required by statute so that the District can develop, adopt, implement, and enforce regulations relating to its review and approval of development proposals.” The plan also “calls for the District to identify priorities for future watershed studies, to coordinate local involvement in the revision of flood maps by the Federal Emergency Management Agency, to formalize how flood conditions are documented, to develop in-house capabilities for using geographic information system technology, and to develop a drainage design criteria manual.”

2. Are existing conditions well characterized?

The soil and topography of the district is described in general terms.

3. Is future growth projected?

Yes. It is stated that the last five years of development has been at a pace of less than 2% and some (not defined how much) population shifting from Beaumont into Jefferson County. Existing procedures for approving the drainage features of new developments are outlined in detail.

4. Are main drainage problems identified?

The problems are described (localized ponding, ditch/creek flooding), however detailed maps are not provided. It is mentioned that some flooding areas are not shown on FIRMs, and most of these are

concentrated in the city of Beaumont. The document mentions some neighborhood drainage networks are not adequate, but does not identify which neighborhoods. An estimate of the number of buildings prone to flooding is provided, but a map was not created due to 'limited GIS capabilities'.

5. Are past flooding events described?

Not in specifics.

6. Are past flooding damaged estimated?

The total NFIP payments in the drainage district are tabulated.

7. Are general physiographic (watersheds, water bodies, topography, soil types, wetlands, etc.) characteristics well characterized?

They are described in broad detail, however the maps included cover too large of an area with no smaller scale detailed maps. The maps included are FIRMs and maps of past flood insurance claims for the whole county.

8. Are significant anthropogenic features identified? (Political boundaries, communities, transportation, land use, industries, etc.)

Major industries and employers in the area are identified in the narrative, as well as city boundaries and floodplain boundaries shown on a map. There are no maps showing land use.

9. Are sources of drainage and flooding problems identified?

They are identified in very general terms only, but not specific locations or sources. It is claimed there are more detailed studies in smaller areas, however details from these studies aren't included in the master plan.

10. Is hydrologic/hydraulic modeling performed?

No.

11. Are models adequately built to identify problems on a proper scale?

Models weren't built.

12. Are remedies and projects proposed to solve/alleviate flooding problems?

Only in broad terms. Specific remedies and projects are not detailed in this master plan.

13. Are the costs of the remedies and projects proposed adequately estimated?

No.

14. Are sources of funding identified to pay for improvements?

No.

15. Was the community involved in the development of the Drainage Master Plan? How?

Yes. Two public meetings were held, in addition to the Advisory Committee meetings, which were open to the public as well but not advertised.

16. How much of the Drainage Master Plan has been implemented?

The plan identifies the following actions:

- Develop and Implement Drainage Regulations – Yes, subdivision guidebook (written in 2010) contains detailed rules for drainage;
- Identify Watershed Study Needs - Yes, detailed watershed study for the Middle Hillebrandt watershed in the City of Beaumont was completed in 2011;
- Coordinate Flood Map Revisions – No. Latest FIRMs are from 2002;
- Document Flood Conditions – Yes. Detailed rain gauge data is available throughout the drainage district;
- Develop GIS Capabilities – Yes, website includes interactive maps now;
- Develop Drainage Design Criteria Manual – completed in 2007;
- Drainage & Flood Mitigation Projects – Yes, projects have been completed in the years immediately following the master plan.

17. How much does the Master Plan cost?

No estimate provided.

18. Has sustainability been considered?

No.

Jefferson County

Title: Flood Protection Plan

Year: 2011

Authors: Unidentified

URL:

1. Is the objective of the Master Plan clearly defined?

The objective of conducting a study of the Hillebrandt Bayou watershed is clearly defined. It is unclear how the purpose of the study was to develop a Master Drainage Plan if the Master Drainage Plan was written six years prior. The Master Drainage Plan had to have been written without this study's findings.

2. Are existing conditions well characterized?

Yes, existing conditions are modeled hydraulically and hydrologically and extensive data was collected, such as high water marks from recent floods, underground storm networks and LiDAR data.

3. Is future growth projected?

Yes. Fully developed conditions are projected.

4. Are main drainage problems identified?

Yes, specific drainage problems are identified and photos of flooding are provided as well as location maps. The specific ditches and storm sewers that flood are identified.

5. Are past flooding events described?

Yes. Specific impacts, such as hospital workers at the Christus St. Elizabeth being stranded and cars being stranded/flooded are described as recurring flooding hazards. Newspaper clippings describing the flood of 2003 are included.

6. Are past flooding damaged estimated?

The cost of insurance claims from each of the 11 significant flooding events in the past 23 years (as of 2011) are included. Also, because the official FIRM floodplain is not accurate, the value of homes prone to flood damage with the study's updated map are included as well.

7. Are general physiographic (watersheds, water bodies, topography, soil types, wetlands, etc.) characteristics well characterized?

Yes. There is an overview description of the whole county, as well as more detailed descriptions of smaller watersheds and study areas.

8. Are significant anthropogenic features identified? (Political boundaries, communities, transportation, land use, industries, etc.)

Yes. Flooded highways, hospitals, houses, apartment complexes and retirement homes are identified.

9. Are sources of drainage and flooding problems identified?

Yes. Sources of drainage and flooding problems are identified in detail. Culverts that are undersized are clearly identified and a photo is included. Inadequately sized ditches are identified and photographed. A distinction is made between local storm sewers being inadequate and tailwater being too high for storm sewers to function properly.

10. Is hydrologic/hydraulic modeling performed?

Yes. HEC-HMS and HEC-1 was used to model the hydrology. HEC-RAS was used to model the hydraulics. GIS was used to delineate floodplains. Underground storm sewer networks were modelled with GEOPAK which uses WinStorm as its hydraulic engine.

11. Are models adequately built to identify problems on a proper scale?

Yes. The HEC-RAS models were developed from DEMs and the underground storm sewer network was modelled where needed.

12. Are remedies and projects proposed to solve/alleviate flooding problems?

Yes. Remedies are proposed for each specific drainage problem, along with a discussion of alternatives and reasoning of why the proposed remedy is best.

13. Are the costs of the remedies and projects proposed adequately estimated?

Yes. Many of the projects were already constructed or in the process of being constructed by the time this document was complete. One project, the Calder Improvement Project, has the cost estimate included in its descriptive narrative. The other projects only have their estimate further down in the document in the recommendations section. The completed projects have both their estimated cost as well as the actual cost.

14. Are sources of funding identified to pay for improvements?

Yes. Specific grants were either awarded or in the process of being applied for. Some of the funding was available from the DD6 General Reserve Fund, which is acquired through property taxes. The City of Beaumont, LNVA and TXDOT were also identified as possible sources of funding.

15. Was the community involved in the development of the Drainage Master Plan? How?

Yes. There were public meetings held, as well as a Constituent Committee which included interested members of the public.

16. How much of the Drainage Master Plan has been implemented?

The actions the plan identifies are:

Non-structural:

- Continued floodplain management by DD6 - Yes
- Continual Update/enhancement of hydrologic and hydraulic models developed in the study – Yes, detailed maps of ditches and streams continue to be updated
- Updating and maintaining Arc-View data base – Yes, interactive maps available on DD6 website
- Implementation and use of the Drainage Criteria Manual – Yes, DCM rules in effect

Structural:

- Calder - Completed

- Ridgewood - Completed
- 100D - Completed
- 104B - Completed
- 104 - Completed
- 107 - Completed
- Flood Gates - Completed

17. How much does the Master Plan cost?

The estimated cost is \$49,733,084. The estimated net damage avoided: \$126,553,755.

18. Has sustainability been considered?

An environmental assessment was completed for the project and included in Appendix J.

Orange County

Title: Orange County Drainage District Hazard Mitigation Plan Update

Year: 2018

Authors: AECOM

URL: https://www.orangecountydrainage.com/documents/Hazard_Mitigation_Plan_Update_2017_2018_0328a.pdf

1. Is the objective of the Master Plan clearly defined?

Yes. The objective statement: "The Plan Update was written to identify and analyze District vulnerabilities to natural hazards and outline mitigation actions that help to reduce or avoid the impacts of such hazards."

The objective statement makes it very clear that plan is not considered a Drainage Master Plan and includes analysis of other natural hazards.

2. Are existing conditions well characterized?

No. The only characterization of existing conditions is a Flood Insurance Rate Map.

3. Is future growth projected?

It is projected that future growth and development will be very minimal.

4. Are main drainage problems identified?

No.

5. Are past flooding events described?

Yes, several flooding events are described with a brief paragraph summarizing damages and specific location of the flooding.

6. Are past flooding damaged estimated?

They have an estimate of past weather event damages (\$1.2 billion) but these are lumped together with tornados and other non-flood related events.

They have a table of property damage from past hurricane events from 1996-2017 which totals hurricane damage from each event – which will naturally include damage other than flooding. The estimate for Harvey was not yet available.

They also have a table of all flood events in which flooding damage greater than \$50,000 was reported. They provide an estimate from the Orange County Hazard Mitigation Plan, that flooding costs the county \$980,480 a year.

7. Are general physiographic (watersheds, water bodies, topography, soil types, wetlands, etc.) characteristics well characterized?

No. That is beyond the scope of this document.

8. Are significant anthropogenic features identified? (political boundaries, communities,

No.

9. Are sources of drainage and flooding problems identified?

No.

10. Is hydrologic/hydraulic modeling performed?

No.

11. Are models adequately built to identify problems on a proper scale?

No models are built.

12. Are remedies and projects proposed to solve/alleviate flooding problems?

No. General plans such as ‘build detention ponds where needed’ are proposed but specifics are not. Repairing drainage structures damaged by Hurricane Harvey is proposed.

13. Are the costs of the remedies and projects proposed adequately estimated?

The projects are not specific enough yet to estimate.

14. Are sources of funding identified to pay for improvements?

Most of the mitigation actions identify 'grant funding/ operating funds' as the source, but does not go into further specifics.

15. Was the community involved in the development of the drainage master plan? How?

Yes, there was a public meeting on September 12, 2017 which was announced in the local newspaper, on the government website and on the on the outside of the District Administration Building beginning in mid-August. It is unclear how many members of the public attended this meeting and they did not have comments.

In addition, there was an online survey in which 22 people responded. The most common suggestion was that they needed to dig more ditches, and clean and maintain the existing ditches. Every survey was included in Appendix B, but no summary of the responses was included.

16. How much of the drainage master plan has been implemented?

There is not yet a drainage master plan.

17. How much does the master plan cost?

There is not yet a drainage master plan.

18. Has sustainability been considered?

Very minimally. Each mitigation action was graded on a matrix and 'environmentally sound' was one of the seven criteria.

Liberty County

Title: Liberty County Master Drainage Plan Stormwater Solutions

Year: 2016

Authors: TAMU (Rabi Mohtar and Fouad Jaber)

URL: <https://oaktrust.library.tamu.edu/handle/1969.1/158350>

1. Is the objective of the Master Plan clearly defined?

Yes, but the report doesn't deliver. The objective statement: "developing a sustainable, effective, and budget-friendly storm water mitigation plan for Liberty County, Texas, acting on behalf of Texas Target Communities and AgriLife Extension." This report was developed as a Texas A&M school project and the writing has a distinct educational tone. An emphasis was placed on green infrastructure.

This is a school project and doesn't appear to be in use by Liberty County. They seemed unaware of it when called. While the objective states that it is a Master Drainage Plan, the reality is a school research project on low impact development and some sizing estimates for LID options.

2. Are existing conditions well characterized?

No. The only characterization of existing conditions is a Flood Insurance Rate Map.

3. Is future growth projected?

Locations of future growth are projected.

4. Are main drainage problems identified?

No.

5. Are past flooding events described?

No.

6. Are past flooding damaged estimated?

No.

7. Are general physiographic (watersheds, water bodies, topography, soil types, wetlands, etc.) characteristics well characterized?

The streams and watersheds were delineated using SWAT and land use and soil types characterized in order to create curve numbers for within Liberty City and Dayton, however the county-wide characteristics aren't characterized.

8. Are significant anthropogenic features identified? (political boundaries, communities, transportation, land use, industries, etc.)

No.

9. Are sources of drainage and flooding problems identified?

No.

10. Is hydrologic/hydraulic modeling performed?

Hydrologic modeling was performed, but only for within two towns. Hydraulic modeling was not performed.

11. Are models adequately built to identify problems on a proper scale?

No.

12. Are remedies and projects proposed to solve/alleviate flooding problems?

The project proposes LID options for new developments, but doesn't address existing flooding problems at all.

13. Are the costs of the remedies and projects proposed adequately estimated?

While estimates of the cost to build new LIDs is provided, it isn't a way to solve existing drainage problems.

14. Are sources of funding identified to pay for improvements?

No.

15. Was the community involved in the development of the drainage master plan? How?

No.

16. How much of the drainage master plan has been implemented?

This isn't a real drainage master plan and doesn't have anything to implement.

17. How much does the master plan cost?

There is not yet a drainage master plan.

18. Has sustainability been considered?

Yes. Low impact development is one of the main focuses of the project.

Chambers County

Title: Chambers County Master Drainage Plan

Year: 2014

Authors: Klotz Associates

URL: https://www.co.chambers.tx.us/page/road_and_bridge

1. Is the objective of the Master Plan clearly defined?

Yes. "This Chambers County Master Drainage Plan was developed to address existing drainage and flooding problems and to provide for drainage needs expected to occur in the coming years, particularly the coming decade, as development continues."

2. Are existing conditions well characterized?

Yes they are described thoroughly and include current floodplains, land use and infrastructure.

3. Is future growth projected?

Yes, it is estimated that the Working Study Area will be at ultimate development conditions in 20-25 years, and the area is experiencing 2 percent annual increased cover projected to continue over the next 5-10 years. Land use projections were used in hydrologic models and mapped.

4. Are main drainage problems identified?

Yes. Detailed models identify the exact locations and source of drainage problems.

5. Are past flooding events described?

While locations of past flooding are described, specific floods (ie, hurricane Ike) are not. Repetitive loss regions are mapped.

6. Are past flooding damaged estimated?

No.

7. Are general physiographic (watersheds, water bodies, topography, soil types, wetlands, etc.) characteristics well characterized?

Yes. The major watersheds, soil types and topography of the county are thoroughly described.

8. Are significant anthropogenic features identified? (political boundaries, communities, transportation, land use, industries, etc.)

Yes, the county is divided into improvement districts and watershed districts. Critical infrastructures are identified on maps in sufficient detail.

9. Are sources of drainage and flooding problems identified?

Yes, in extensive detail.

10. Is hydrologic/hydraulic modeling performed?

Yes. Detailed models were built in HEC-HMS for the hydrology and HEC-RAS for hydraulics. Floodplains were mapped in GIS. Where available, existing models were used and updated as needed.

11. Are models adequately built to identify problems on a proper scale?

Yes. Drainage areas were delineated, HMS models built to account for changes in flow with increased impervious cover and HEC-RAS models were built where needed. In some cases models from previous, recent studies were used.

12. Are remedies and projects proposed to solve/alleviate flooding problems?

Yes, several projects are proposed to comprehensively address the drainage problems in Chambers County. For each watershed, detention and excavation are compared as alternatives.

13. Are the costs of the remedies and projects proposed adequately estimated?

Yes, each project has an estimated cost as well as the estimated cost of the alternative. Where detention is preferred, it is suggested that land be bought now while it is less expensive and detention built later when needed to save costs.

14. Are sources of funding identified to pay for improvements?

Yes, sources of both internal and external funding are listed and described in detail, for example specific, relevant FEMA grants are listed.

15. Was the community involved in the development of the drainage master plan? How?

While “public involvement” is listed in the scope of the study, the only specific mention of community involvement is that there were discussion with Chambers County staff and officials. The report says that coordination with the public was ‘done under the direction of the County’, so it is unclear if the public was involved at all.

16. How much of the drainage master plan has been implemented?

From phone calls with the County, very little of the drainage plan has been implemented. Some ditches have been cleaned out, but that is all that was mentioned. A drainage manual was already in effect when the master plan was written.

17. How much does the master plan cost?

The master plan doesn’t add up the total, and for each project there is a cost for both detention and channel excavation (to compare both options). There are also numerous ‘small’ projects, defined as less than \$5 million. The total of the large projects is \$40 million if the channel is chosen.

There are two diversion projects whose costs are in ‘table 7-1a and table 7-1b’, however the document is nearly 400 pages long and is divided into two volumes and the table of contents doesn’t indicate in which volume or appendix a table might appear. After considerable searching, those tables could not be located. Information within the drainage plan should have been easier to find.

18. Has sustainability been considered?

Yes, the document summarizes environmental issues that may need to be addressed, such as wetland delineation and endangered species habitats.

APPENDIX B – TEXAS WATER DEVELOPMENT BOARD PROGRAMS

In looking at the TWBD website: <http://www.twdb.texas.gov/index.asp> it appeared based upon the Team designation as if the correct person to discuss the potential programs would be Ms. Nancy Richards. Below is the East Texas team, telephone numbers and an email address hyperlinked to the team member's name.

Team 4 - East (H/I)

- Manager: Nancy Richards, (512) 463-0250
- Financial Analyst: Charles Nichols, (512) 463-5158
- Engineer: Lucia Loera, P.E., (281) 895-0722
- Senior Engineer: James Bronikowski, (512) 475-0145
- Engineer: Mike Cook, (512) 463-5722
- Engineer: Matthew Young, (281) 895-0722
- Project Reviewer: Laurie Shelton, (281) 895-0722
- Project Reviewer: Jessica Taylor, (512) 463-7191
- Environmental Reviewer: Sara Sopczynski, (512) 936-0852
- Regional Water Planner: Lann Bookout, (512) 936-9439
- Attorney: Annette Mass, (512) 463-9683
- Administrative Assistant: April Alcorn, (512) 936-0803

We discussed with Ms. Richards the potential for the TWDB Board to have programs for the eight counties included in the study (Hardin, Jefferson, Newton, Orange, Tyler, Polk, Liberty, and Chambers). Ms. Richards said that all Texas counties were able to apply through several programs to the TWDB for assistance with water related projects. By water related she meant water utility projects and flooding related projects. She said we could go to the TWDB website to learn about the programs that the TWDB has to assist Texas counties.

Ms. Richards said that \$793 million in potential funding was approved by the recent Texas legislative

session. The last hurdle was a vote for the funds to be taken from the State “rainy day” fund. So, the funds are not yet available. However, when approved, these funds will be available to help Texans with water related projects.

Ms. Richards also stated that Mr. Ivan Ortiz, Flood Grants Team Lead, (512) 463-8184, is also a source of information about applying for Flood Grants. He is the person at TWDB to whom many of the applications are submitted. He will know the details about project submittals.

From the website:

<http://www.twdb.texas.gov/financial/programs/>

“The TWDB offers a variety of cost-effective loan and grant programs that provide for the planning, acquisition, design, and construction of water related infrastructure and other water quality improvements totaling approximately \$28 billion” (since 1957).

The following is information about several flooding related assistance programs directly from the TWDB website.

- One program is a request for **Flood Protection Grant** applications. There appear to be no funds available at this time for Fiscal Year 2020 but it is still useful to include this information so that the counties can see the potential format of future requests for application particularly after the almost \$800 million is approved for funding water projects. The Flood Protection Grant applications are for award of grants for flood protection planning, flood early warning systems, or the implementation of local strategies for alerting and responding to floods. Details of this program can be found on the TWDB website at:
<http://www.twdb.texas.gov/flood/grant/FPP.asp>
- Another program is the **Flood Mitigation Assistance (FMA)** grant program which provides federal funding to assist states and communities to fund cost effective measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP). Details of this program can be found on the TWDB website at: <http://www.twdb.texas.gov/flood/grant/FMA.asp>
- Another program is the **Clean Water State Revolving Fund (CWSRF) Loan Program** which allows for financial assistance for stormwater mitigation, estuary management projects, disaster

recovery and other types of projects. Details of this program can be found on the TWDB website at: <http://www.twdb.texas.gov/financial/programs/CWSRF/index.asp>

- Another program is the **Texas Water Development Fund** which includes financial assistance for flood control may include structural and nonstructural flood protection improvements such as construction of storm water retention basins, enlargement of stream channels, modification or reconstruction of bridges, acquisition of floodplain land for use in public open space, relocation of residents of buildings removed from a floodplain, public beach re-nourishment, flood warning systems, control of coastal erosion, and development of flood management plans. Details of this program can be found on the TWDB website at:
<http://www.twdb.texas.gov/financial/programs/TWDF/index.asp>
- Another program is **Drinking Water State Revolving Fund** which includes financial assistance for flood resiliency projects or project components as well as many other types of projects. Details of this program can be found on the TWDB website at:
<http://www.twdb.texas.gov/financial/programs/DWSRF/index.asp>

As listed above, the TWDB has many programs designed to help Texas counties with water related and in particular flood related projects. Ms. Richards was very helpful in providing the information about TWDB programs. If a county has flood control requirements for which they need assistance, a call to Ms. Richards or Mr. Ortiz will allow them to begin the process of obtaining funding for the project(s). The TWDB website contains detailed information about how to apply for project funding. If the rainy day funds are allowed, the TWDB is likely to be able to grant some of these funds to the counties who apply for them.

The following are details of applicable flood related programs from TWDB in detail:

Program 1: Request for Applications for FY 2018-2019 Flood Protection Grants

The Texas Water Development Board (TWDB) requests applications for the possible award of grants for flood protection planning, flood early warning systems, or the implementation of local strategies for alerting and responding to floods. The TWDB will accept applications that include political subdivisions in Texas that have the authority to plan for and implement projects related to flood protection.

Summary of the Request for Applications

Solicitation Date (Opening):

Thursday, May 10, 2018

Due Date (Closing):

2:00 p.m., Wednesday, July 11, 2018

Anticipated Award Date:

September 2018

Project Completion Date:

Project must be completed no later than August 31, 2021

Estimated Total Funding:

Up to \$1,800,000

Eligible applicants:

Political subdivisions in Texas that have the authority to plan for and implement projects related to flood protection.

Contract Person for Additional Information

Application information and instructions are available upon request from Mr. Ivan Ortiz, Flood Grants Team Lead, (512) 463-8184, or see instructions for Request for Application.

Purpose and Objectives

The purpose of this request for applications is to provide assistance to political subdivisions to implement prevention and/or corrective measures for reducing loss of life and property due to flood. These measures take a variety of forms and may include the development of flood protection plans; the planning for, installation of, or enhancement of flood early warning systems; or the development of strategies to prepare for and respond to flood events. The TWDB expects that these measures will complement and enhance existing efforts related to providing floodplain management resources to local entities, providing weather and streamflow data, or developing near real-time and online flood information. In consideration of the significant and deadly flooding events in 2015 and 2016, as well as Hurricane Harvey in 2017, the TWDB is placing a high priority on projects with the merit and ability to protect the health, public safety, and economic prosperity of Texans residing in declared disaster areas

dating from May 2015 to September 2017 to include all declared areas from the seven federally declared disasters as well state declared disasters.

Flood Protection Grant Categories

The TWDB may award project proposals that consist of a singular flood protection category or a combination of two or more categories.

1. Flood Protection Planning (before a flood event)

The intent of flood protection planning is to conduct detailed studies of known or potential floodplains to better inform the development of flood protection strategies for watersheds through structural and nonstructural measures before a flood event, such as

- determining and describing problems from or related to flooding,
- identifying and planning solutions to flooding problems, and
- estimating the benefits and costs of these solutions.

2. Flood Early Warning Systems (before or during a flood event)

The intent of flood early warning systems is to provide a tool for communities to warn its constituents in the event of a flood. Examples include but are not limited to developing a plan for implementing or the installation of

- sirens,
- reverse 911 call systems,
- automatic reporting for river and/or rainfall gauges, and
- information technology to monitor, detect, and assimilate data for flood prediction.

3. Flood Response (during or after a flood event)

The intent of implementing local flood response strategies is to help communities better respond to a flood event on a local level to minimize long-term hardships associated with the event.

Strategies can include but are not limited to

- hazard analysis and remediation,
- evacuation plans, and
- outreach to constituents to relay information on mitigation and evacuation.

Eligibility Criteria and Evaluation Criteria

Prior to technical review, each application will be screened for completeness and compliance with the provisions of this notice. Incomplete applications and those that do not meet the provisions of this notice may be eliminated from consideration.

Applications must meet the following criteria to be considered eligible:

- Is the applicant a political subdivision in Texas with authority to plan for and implement projects related to flood protection?
- Does the project propose a flood protection planning study, a flood early warning system, and/or a flood response strategy?
- Is the application complete?

Applications will be evaluated for merit based on the following criteria:

- What is the purpose of the project?
- What is the technical merit of the proposed scope of work and method for monitoring progress?
- What is the severity of existing or potential flood hazard?
- Once implemented, how will the project reduce loss of life? What is the size of the population protected by the project? How is public safety enhanced?
- Once implemented, how will the project reduce the loss of property? What is the economic benefit of the project in terms of the structures or services protected?
- Project Schedule - Is the timeframe for project completion reasonable?
- Project Budget - Are the tasks and expense budgets reasonable?
- Qualifications and direct experience of the project team.
- Does the project encompass the basin or watershed?
- Does the project address an existing or previously declared disaster area (as declared between May 2015 to September 2017)?

- Does the project benefit a participant or an applicant requesting participation in the National Flood Insurance Program (NFIP)?

Description of Funding Consideration

Up to \$1,800,000 has been authorized for assistance for flood protection grants during fiscal years 2018 and 2019. Fifty percent of the total cost of the project may be provided to applicants. In-kind services may be substituted for any part of local share, if such services are directly in support of the project or planning effort and are properly documented and approved by the TWDB. It is the intent of this program to award at least 50% of the available funding to communities with less than 50,000 in population. We reserve the right to award more or less than 50% based on the quantity and quality of the applications.

Projects must be completed before August 31, 2021.

In the event that acceptable applications are not submitted, the TWDB retains the right to not re-award grant funds. The TWDB also reserves the right to limit the amount of funding to any one project and to partially fund proposals by funding discrete activities, portions, or phases of a proposed project. The TWDB reserves the right to reject parts of, any, or all applications if staff determines that the application(s) does not adequately meet the required criteria or if the funding available is less than the requested funding.

Negotiations with Selected Applicants

The applicable scope of work, deliverables, tasks, timeline, and contract amount will be negotiated after the TWDB selects the most qualified applicants. Failure to arrive at mutually agreeable terms of a contract with the most qualified applicant shall constitute a rejection of the TWDB's offer and may result in subsequent negotiations with the next most qualified applicant.

Submission Requirements

Applicants should submit six double-sided paper copies and one digital copy (portable drive or CD) of a complete application, including the required attachments, to the TWDB on or before 2:00 p.m., on Wednesday, July 11, 2018.

Applications can be directed in person to Mr. David Carter, Texas Water Development Board, Stephen F. Austin Building, 6th Floor, 1700 North Congress Avenue, Austin, Texas 78701, or by mail to Mr. David

Carter, Texas Water Development Board, P.O. Box 13231-Capitol Station, Austin, Texas 78711-3231.

Program 2: FEMA Flood Mitigation Assistance Grant Program

The Flood Mitigation Assistance (FMA) grant program under the Federal Emergency Management Agency (FEMA), provides federal funding to assist states and communities to fund cost effective measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP).

FMA was created as part of the National Flood Insurance Reform Act of 1994 (42 U.S.C.4101) with the goal of reducing or eliminating claims under the NFIP. The Texas Water Development Board administers the FMA grant program for the State of Texas on behalf of FEMA.

Eligible Activities

There are two types of work that can be funded:

- **FMA Planning Grants:** To develop or update the Flood Hazard component of the Multi-Hazard Mitigation Plan.
- **FMA Project Grants:** To implement measures to reduce flood losses. Projects that reduce the risk of flood damage to structures insurable under the NFIP are eligible. Such activities include:
 - Acquisition of insured structures and real property;
 - Relocation or demolition of insured structures;
 - Dry flood proofing of insured structures;
 - Elevation of insured structures; and
 - Minor localized flood reduction projects.

Applicant Eligibility

Any political subdivision (including any Indian or authorized tribal or native organization) that has zoning and building code jurisdiction over a particular area having special flood hazards and is participating in the NFIP, is eligible to apply for an FMA grant. Communities that are suspended or on probation from the NFIP are not eligible to apply for an FMA grant. A community applying for an FMA Project Grant must have an approved Multi-Hazard Mitigation plan in accordance with 44 CFR Part 201.

Eligibility Criteria

A project must, at a minimum, be:

- Cost effective and beneficial to the National Flood Insurance Fund. The Benefit Cost Ratio must yield 1.0 or greater;
- Technically feasible; and
- Physically located in a participating NFIP community or it must reduce future flood damages in an NFIP community.

A project must also conform with:

- The minimum standards of the NFIP Floodplain Management Regulations;
- The applicant's Multi-Hazard Mitigation Plan; and
- All applicable laws and regulations, such as Federal and State environmental standards or local building codes.

Cost Sharing and Funding Limitations

FEMA may contribute up to 75 percent of the total eligible costs. At least 25 percent of the total eligible costs must be provided by a nonfederal source; of this 25 percent, no more than half (12.5 percent) can be provided as in-kind contributions from third parties.

- Funding limits for **planning grants** are: no more than \$300,000 per year to any State and the total to all communities within the State; no more than \$50,000 per grant to any one community; and no more than one grant to any one community per five-year period.
- Funding limits for **project grants** are: no more than \$20,000,000 State-wide during any five-year period; and no more than \$3,300,000 to any one community during any five-year period.

Multi-Hazard Mitigation Plan

An approved Multi-Hazard Mitigation Plan (Mitigation Plan), whether single or multi-jurisdictional, is an eligibility requirement of a community in order to apply for an FMA project grant.

The Mitigation Plan is submitted to FEMA for approval through the Texas Division of Emergency Management (TDEM). The Mitigation Plan must assess flood risk and identify technically feasible and

cost-effective options to reduce that risk. The Mitigation Plan must describe the planning process and public involvement during the planning process in developing the Mitigation Plan, and must provide proper documentation of its formal adoption by the jurisdiction.

Application Period

The Texas Water Development Board will accept applications during the "Request for Application" time frame. It is required that applications be submitted electronically through FEMA's web-based Electronic Grants Management System (e-Grants) and a completed Texas Water Development Board Application form for either the FMA Planning Grant or FMA Project Grant must also be provided. Applicants must request access into the e-Grants system. Access requests and questions regarding the application process should be directed to:

Mr. Ivan Ortiz

Texas Water Development Board

Flood Mitigation Planning

1700 North Congress, P.O. Box 13231

Austin, Texas 78711-3231

Telephone: (512) 463-8184 | Email: livan.ortiz@twdb.texas.gov

Program 3: Clean Water State Revolving Fund

CWSRF Program Information Sheet

1. What can the program do for you?

The Clean Water State Revolving Fund, authorized by the Clean Water Act, provides low-cost financial assistance for planning, acquisition, design, and construction of wastewater, reuse, and stormwater infrastructure.

2. Who can borrow?

Eligible applicants for the CWSRF include cities, counties, districts, river authorities, designated management agencies, authorized Indian tribal organizations, and public and private entities proposing nonpoint source or estuary management projects.

3. What types of projects can I use the loan funding for?

Financial assistance from the CWSRF can be utilized for:

- wastewater treatment facilities
- collection systems
- wastewater recycling and reuse improvements
- stormwater mitigation
- nonpoint source pollution control
- estuary management project
- eligible green project reserve components
- disaster recovery

4. Are loans or grants offered?

Both below market interest rate loans and loan forgiveness (similar to grants) is offered. For loans, the interest rate subsidy is 130 basis points off the entity's underlying credit rating. For example, if an applicant has an underlying rating of "AA" then the interest rate is reduced 130 basis points off the market's "AA" scale. For equivalency projects the interest rate subsidy is increased to a 165-basis point reduction. Loan terms are available up to 30 years.

Principal forgiveness is available on a limited basis to eligible disadvantaged communities and green projects. The amount of principal forgiveness for a disadvantaged project (up to 70%) is dependent upon the annual median household income and household cost factor for the project area. Entities may receive subsidized green funding (up to 15% forgiveness from green component costs) if their project has eligible components that total 30% of the project's total cost.

5. What phases of the project are eligible for funding?

The CWSRF provides financial assistance for planning, acquisition, design and construction of your wastewater, reuse, and/or stormwater project.

6. How much funding is available?

Whether you are seeking financial assistance for smaller projects or large scale capital improvement projects, the CWSRF is an excellent fit for your system's needs. The CWSRF program has approximately \$525 million available on an annual basis but can be increased based on demand.

For current detailed information regarding funds available, please see the CWSRF Intended Use Plan located on the upper right side of this webpage.

7. What if an entity requires funding over a period of time for a project?

For entities that have funding needs for a project that may span over several years, the CWSRF has the ability to provide multi-year commitments. This option allows borrowers to receive a funding commitment for the full amount of their project, but close on portions of it over a multiyear schedule.

8. When can I apply for SRF financial assistance?

CWSRF financing is available year round. In order to be invited to apply for funding, entities must submit a completed Project Information Form.

Special Requirements

Financial assistance through the CWSRF program requires compliance with applicable rules, policies, and statutes including:

- Submittal of a Project Information Form to be listed in the current Intended Use Plan
- 1.75% loan origination fee
- National Environmental Policy Act-type environmental review
- Adoption of a Water Conservation and Drought Contingency Plan for all financial assistance greater than \$500,000
- Application of Davis-Bacon wage rate requirements
- Compliance with EPA's American Iron and Steel Provisions
- For equivalency projects:
 - EPA's Disadvantaged Business Enterprise program, which requires applicants and prime contractors to follow six affirmative steps in procurement (Guidance and additional information is available).
 - Additional steps when procuring architecture and engineering services.
 - Additional steps when procuring architecture and engineering services.

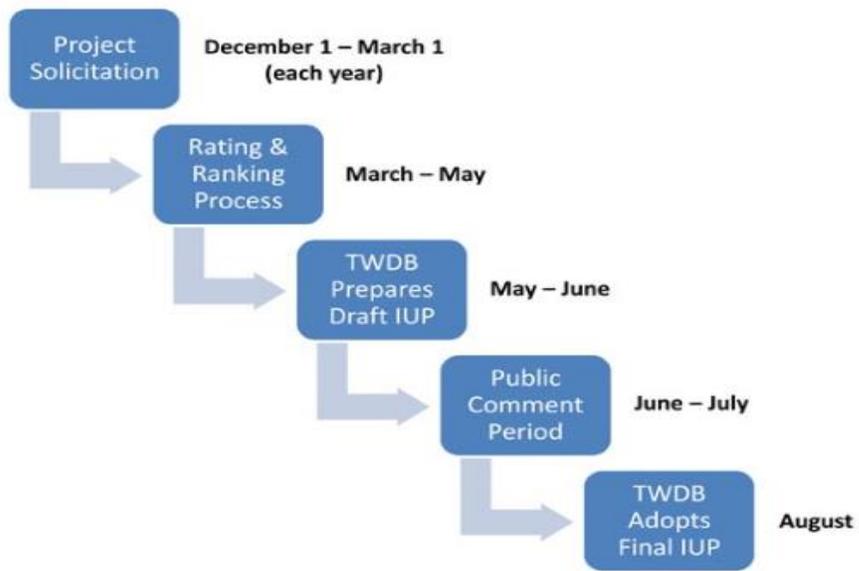


Figure 10-1 IUP Process

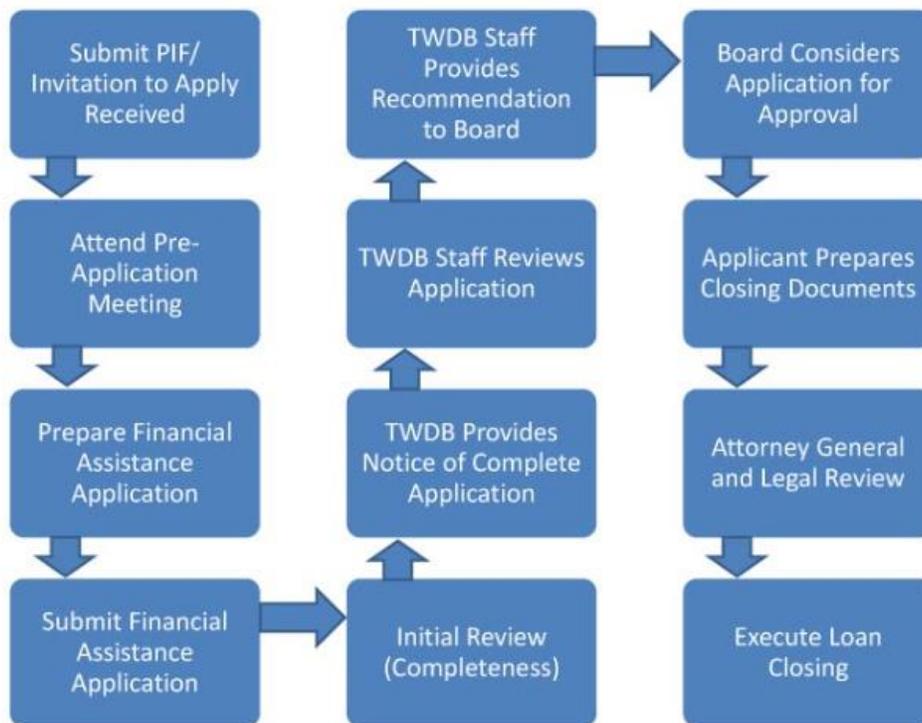


Figure 10-2 Application Process

Where Can I Get More Information?

In order to provide you with a single point of contact at the TWDB, our project implementation staff is organized into six regional project implementation teams. Each team is led by a manager that serves as the primary point of contact for both our existing and future customers. For assistance with the application or any questions related to your project, please look up contact information for your Regional Team.

Program 4: Texas Water Development Fund

TWDF Program Information Sheet

1. What can the program do for you?

The Water Development Fund (DFund) is a state funded loan program that does not receive federal subsidies and is not subject to federal crosscutters. The DFund enables the Board to fund multiple eligible components in one loan to our borrowers, e.g. an application for funding of water and wastewater components can be processed in a single loan.

2. Who can borrow?

Eligible applicants for the DFund include all political subdivisions of the state (at tax exempt rates) and nonprofit water supply corporations (at taxable rates). Political subdivisions include cities, counties, districts, and river authorities. (See additional eligibility Special Requirements below).

3. What types of projects can I use the loan funding for?

Financial assistance for **water supply** projects may include planning, design, and construction for:

- wells
- retail distribution and wholesale transmission lines
- system acquisitions
- pumping facilities
- storage reservoirs and tanks
- water treatment plants
- purchase of water rights

Financial assistance for **wastewater** projects may include planning, design, and construction for:

- sewer treatment plants
- collection systems
- system acquisitions
- nonpoint source pollution abatement
- development of new municipal solid waste disposal facilities

Financial assistance for **flood control** may include structural and nonstructural flood protection improvements such as:

- construction of storm water retention basins
- enlargement of stream channels
- modification or reconstruction of bridges
- acquisition of floodplain land for use in public open space
- relocation of residents of buildings removed from a floodplain
- public beach re-nourishment
- flood warning systems
- control of coastal erosion
- development of flood management plans

4. **Are loans and grants offered?**

Due to statutory limitations, only loans are offered through the DFund. The interest rate on a DFund loan varies depending on market conditions. The lending rate scales are set at approximately the TWDB's borrowing cost. The lending rates are intended to provide reasonable rates for TWDB customers while covering the TWDB's cost of funds and risk exposure.

5. **What project components can I receive funding to complete?**

The pre-design funding option is available for most water supply, treatment, and wastewater projects and allows an eligible applicant to receive a loan commitment on the basis of preliminary engineering, environmental, economic, and social information. Funds for completing detailed planning, including environmental studies, are provided at closing, whereas funds for design, preparation of final plans and specifications, and construction are placed in escrow until needed.

If the pre-design funding option is not used, applicants seeking only construction phase funding must develop plans and specifications and have them approved by TWDB staff, obtain all necessary permits, and open bids prior to closing the loan.

6. How much funding is available?

The TWDB will sell bonds as needed to obtain proceeds for DFund which will be used to fund loans for our applicants.

7. When can I apply?

The first step in the application process is to schedule a pre-application conference with your to discuss the project's eligibility. The purpose of the conference is to discuss the proposed project and receive any needed guidance and assistance. For tax-exempt borrowers, the applicant, the applicant's financial advisor, and the applicant's consulting engineer should attend this conference. Requesting a pre-application conference does not in any way obligate an applicant to continue the process.

8. What are the Conditions of Financial Assistance?

Special Requirements

- Water supply projects must be consistent with the current TWDB State Water Plan
- Entities receiving assistance greater than \$500,000 must adopt a water conservation and drought contingency plan
- U.S. Iron and Steel Manufactured Goods requirements
- Review of legislative requirements regarding water loss threshold limits

Loan Process

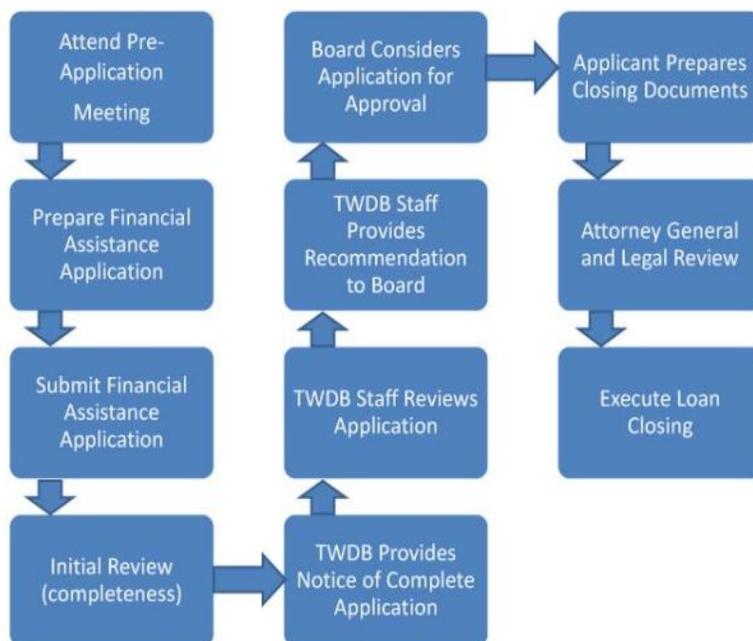


Figure 10-3 – Loan Process Flowchart

Where Can I Get More Information?

In order to provide you with a single point of contact at the Texas Water Development Board (TWDB), our project implementation staff is organized into six regional project implementation teams. Each team is led by a manager that serves as the primary point of contact for both our existing and future customers. For assistance with the application or any questions related to your project, please contact your Regional Project Implementation Team.

Program 5: Drinking Water State Revolving Fund (DWSRF) Loan Program

DWSRF Program Information Sheet

1. What can the program do for you?

The Drinking Water State Revolving Fund, authorized by the Safe Drinking Water Act, provides low-cost financial assistance for planning, acquisition, design, and construction of water infrastructure.

2. Who can borrow?

Eligible applicants for the DWSRF include publicly and privately owned community water systems, including nonprofit water supply corporations and nonprofit, non-community public water systems.

3. What types of projects can I use the loan funding for?

Financial assistance from the DWSRF can be utilized for:

- water treatment facilities
- distribution systems
- upgrade or replace water infrastructure
- address standards from the Safe Drinking Water Act
- consolidation of systems
- purchasing additional capacity
- source water protection projects
- eligible green project reserve components
- flood resiliency projects or project components
- disaster recovery

4. Are loans or grants offered?

Both below market interest rate loans and loan forgiveness (similar to grants) is offered.

For loans the interest rate subsidy is 135 basis points off the entity's underlying credit rating. For example, if an applicant has an underlying rating of "AA" then the interest rate is reduced 135 basis points off the market's "AA" scale. Loan terms range from 20-30 years.

Principal forgiveness is available on a limited basis to eligible disadvantaged communities, very small systems, green projects, and urgent need projects.

The amount of principal forgiveness for a disadvantaged project (up to 70%) is dependent on the annual median household income and household cost factor for the project area. Projects that serve a population of 1,000 or fewer are eligible for up to 100% principal forgiveness (\$300,000 maximum). If a project is determined to be of urgent need, the applicant may qualify for 100% loan forgiveness (\$500,000 maximum unless a disadvantaged community, which has up to a \$800,000 maximum depending on the percentage category). Entities may receive subsidized green funding (up to 15% forgiveness) if their project has eligible components that total 30% of the project's total cost.

5. What project components can I receive funding to complete?

The DWSRF provides financial assistance for planning, acquisition, design and construction.

6. How much funding is available?

Whether you are seeking financial assistance for smaller projects to large scale capital improvement projects, the DWSRF can assist with your financing needs. The DWSRF program has the capacity to lend approximately \$250 million annually.

For current detailed information regarding funds available, please see the DWSRF Intended Use Plan located on the upper right side of this webpage.

7. What if an entity requires funding over a period of time for a project?

For entities that have funding needs for a project that may span over several years, the DWSRF has the ability to provide multi-year commitments. This option allows borrowers to receive a funding commitment for the full amount of their project, but close on portions of it over a multiyear schedule.

8. When can I apply for SRF financial assistance?

DWSRF financing is available year-round. In order to be invited to apply for funding, entities must submit a completed Project Information Form.

Special Requirements

Financial assistance through the DWSRF program requires compliance with applicable rules, policies, and statutes including:

- Submittal of a Project Information Form (PIF) to the current Intended Use Plan
- 2.15% loan origination fee
- National Environmental Policy Act-type environmental review.
- Projects must be consistent with the current TWDB State Water Plan
- Adoption of a Water Conservation and Drought Contingency Plan for all financial assistance greater than \$500,000
- Application of Davis-Bacon wage rate requirements

- Compliance with the EPA's Disadvantaged Business Enterprise program, which requires applicants and prime contractors to follow six affirmative steps in procurement (Guidance and additional information is available)
- Compliance with EPA's American Iron and Steel Provisions
- Review of legislative requirements regarding water loss threshold limits

IUP and Loan Process

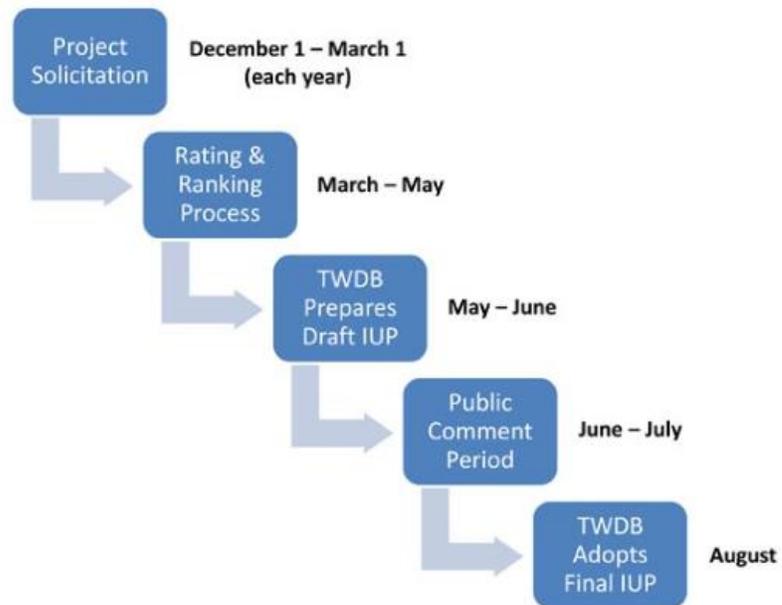


Figure 10-4 - IUP and Loan Process

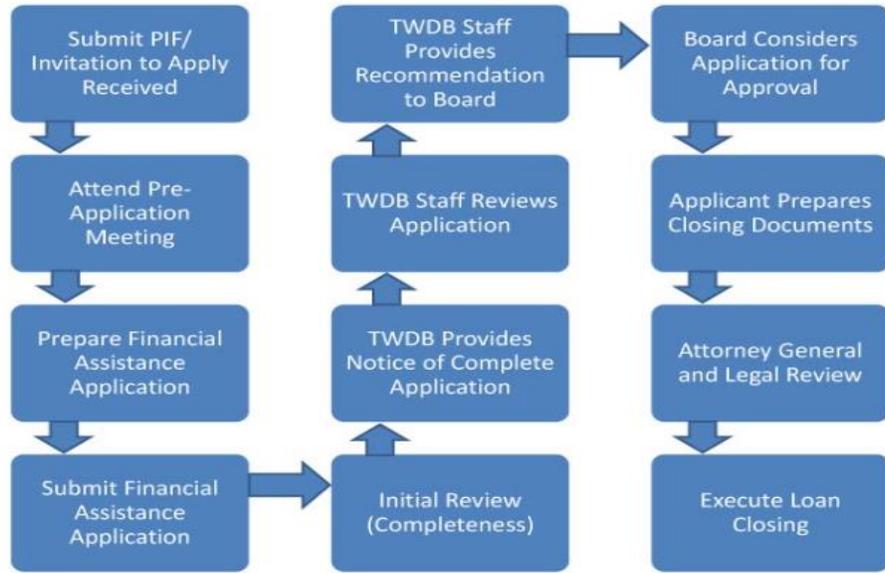


Figure 10-5 - Application Process

APPENDIX C – SUMMARY OF CONVERSTATIONS WITH RIVER AUTHORITIES

River Authority	Contact & Phone Number	Comment
Lower Neches Valley Authority	409.892.4011	<ul style="list-style-type: none"> • The only thing the LNVA has provided related to funding flood control is the Sam River and Dam B (Lake BA Steinhagen) – US Army Corps of Engineers project that they sponsored locally. Dam provided flooding control in addition to creating the reservoir. • Provided a percentage of the funding. Generally, these projects are ~25% locally sponsored (by Lower Neches River Authority). • May have more opportunity to work on drainage in the future based on recent legislation.
Sabine River Authority	409 746 2192	<ul style="list-style-type: none"> • There is no information on the agency’s website about drainage or flooding. • Contact indicated that the River Authority does not regulations/jurisdiction along Sabine River except for reservoirs. They operate gate operations but only for control of reservoir level. • Agency may become more involved in drainage improvements in coming years, based on state legislations.
Trinity River Authority	817-467-4343	<ul style="list-style-type: none"> • There is no information on the agency’s website about drainage or flooding. • Agency does not have any drainage regulation that affect the subject Counties. • They monitor the flowage easement to ensure certain aspects of the sewer system is above the flowline so sewage cannot get into their water. • They control Lake Livingston (reservoir). Walker, Trinity and Polk.
Angelina-Neches	936 632 7795	<ul style="list-style-type: none"> • Call answered by the receptionist • Indicated that agency does not handle drainage or flood control infrastructure • Falls under the jurisdiction of the Army Corps of Engineers

APPENDIX D – SUMMARY OF FEDERAL DOCUMENTS

FEMA Documents

Title: 2017 HURRICANE SEASON FEMA AFTER-ACTION REPORT

Year: 2017

Authors: FEMA

URL: <https://www.fema.gov/media-library-data/1533643262195-6d1398339449ca85942538a1249d2ae9/2017FEMAHurricaneAARv20180730.pdf>

1. What is the document about?

The report focuses on the response and initial recovery from August 25 to November 30, 2017 of three storms (Harvey, Irma and Maria) which made landfall as major hurricanes in the United States.

2. What location does the document cover?

Places where affected by the hurricanes. Texas, Florida, Puerto Rico and U.S. Virgin Islands.

3. What is/are the purpose(s)/goal(s)/objective(s) of the document?

Building a culture of preparedness, increasing state capacity, enhancing intergovernmental coordination through the FEMA Integration Teams, improving the readiness of our incident workforce by organizing a scalable and capable workforce, and posturing FEMA and the whole community to provide life-saving and life-sustaining commodities, equipment, and personnel from all available sources.

4. What is/are the main idea(s)/finding(s) in the document?

There were five focus areas: (1) Scaling a response (2) Staffing (3) Sustained whole community logistics operations (4) Responding during long-term infrastructure outages (5) Mass Care to initial housing operations

5. What region-specific information can be obtained from the document?

Based on the findings of the report, of households impacted by Hurricane Harvey, 80 percent didn't have flood insurance. This would be a major issue which needs to be taken care of for the nine counties.

6. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

FEMA has updated hurricane plans, annexes, procedures for the states and territories and improved its logistics operations ahead of the 2018 hurricane season. Besides, FEMA added 300 new emergency generators to the inventory and updated high priority national level contracts.

FEMA summarized six points for recommendations from the lessons learned:

- (1) Revise the National Response Framework and the Response Federal Interagency Operation Plan
- (2) Build capability and empower the implementation of sheltering and housing solutions
- (3) Improve the delivery and effectiveness of housing options
- (4) Clarify federal roles and responsibilities for housing
- (5) Evaluate and implement appropriate housing solutions
- (6) Promote all-hazard insurance

The plan or direction for FEMA includes: Building a culture of preparedness, increasing state capacity, enhancing intergovernmental coordination through FEMA Integration Teams, improving the readiness of FEMA'S incident workforce by organizing a scalable and capable workforce, and posturing FEMA and the whole community to provide life-saving and life-sustaining commodities, equipment, and personnel from all available sources.

Title: 2018 National Preparedness Report

Year: 2018

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/170861>

1. What is the document about?

The 2018 National Preparedness Report provides an overview of key developments in national preparedness—incorporating findings and lessons learned from incidents in 2017 in combination with data and inputs from federal interagency and whole community partners. The report evaluates and measures progress in building, sustaining, and delivering five selected core capabilities that have faced emerging and persistent challenges. Refining the scope of the 2018 edition of the report to focus on these challenging elements concentrates the discussion on what the whole community—including individuals, businesses, nonprofit organizations, and all levels of government—needs to address to increase the Nation’s preparedness. The in-depth assessment of the targeted areas provided in this report will be particularly important in the years to come, as the Nation looks to address long-term trends that will influence national preparedness—including rising disaster costs, new technology, an older and more diverse population, and evolving threats such as cybersecurity.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose of the study is to evaluate the performance of the 32 core capabilities that have been identified in the National Preparedness Goal and provide areas of potential improvement. The report focuses on these five core capabilities: operational coordination, infrastructure systems, housing, economic recovery, and cybersecurity.

3. What is/are the main idea(s)/finding(s) in the document?

Operational Coordination

The Nation is advancing the implementation of a National Incident Management System (NIMS), but significant challenges remain in implementing the system during large-scale events in incident command, resource management, staffing, and communications.

Infrastructure Systems

Interdependencies between energy and other infrastructure systems present challenges in response and recovery; efforts to mitigate disruptions and to help communities learn from and plan for these challenges are growing.

The whole community has taken steps to increase the resilience of infrastructure, but challenges remain.

Housing

The Nation continues to face challenges with delivering disaster housing and is exploring innovative programs to address capability gaps.

Challenges remain with efforts to coordinate timely and efficient housing damage assessments for survivors after large-scale disasters.

While research shows that incorporating mitigation strategies in rebuilding can yield positive benefits, limited incentives exist to encourage resilient home reconstruction after a disaster.

Economic Recovery

Partners across the whole community have engaged in recent efforts to build business planning capabilities, though many small businesses lack business continuity plans.

While federal agencies have made efforts to streamline disaster recovery assistance, businesses continue to face challenges navigating post-disaster economic recovery programs.

Post-disaster, communities often struggle to effectively communicate and coordinate with the private sector, and efforts to address these challenges are ongoing.

Financial disruptions from disasters can disproportionately affect less-resourced communities, prolonging their return to economic viability.

Cybersecurity

Evolving cyber threats continue to outpace the development of protective practices; at the same time, technology users often fail to implement precautionary measures to safeguard their cyber systems.

Insufficient information sharing between the public and private sectors has hindered the Nation's effectiveness in defending against cyber threats.

The Federal Government faces persistent challenges in the recruitment and retention of cybersecurity personnel, though it has taken steps to improve cybersecurity training for the Nation.

4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

Yes. Both terms were mentioned. For flood, the document introduced some past severe events, ongoing recovery efforts and lessons learned from those events.

5. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

For mitigation, it first said mitigation in the deferral disaster assistance part and introduced FEMA has a hazard mitigation assistance grant program. And mitigation was also one of the five missions which were organized from the core capabilities.

6. Was “Texas” mentioned? If so, provide a summary including page numbers.

Yes, this report did mention Texas several times.

7. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

Yes, this report did mention the counties several times.

8. What region-specific information can be obtained from the document?

The issues which are specific to the region are:

- (1) Power outage during the events
- (2) Fuel supply and distribution got impacted because of significant infrastructure damage happened in the Texas Gulf Coast Areas
- (3) Texas does not have a statewide building code and allows local jurisdictions to set their own regulations, which might lead to uneven implementation of housing resiliency across the Nation.

9. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

The 2018 National Preparedness Report serves as an inflection point, providing an overview of the challenges and progress in preparedness over the past six years before employing a revised approach for assessing preparedness in future reports.

Going forward, the National Preparedness Report will update its approach and include an assessment of progress against objectives that state, tribal, and local partners set through the revised Threat and Hazard Identification and Risk Assessment (THIRA)/Stakeholder Preparedness Review (SPR) methodology.¹⁰ The revised THIRA/SPR methodology addresses community feedback and will provide more specific and quantitative data for preparedness analysis through standardized targets to set goals and measure progress over a three-year period. Data from the revised methodology will allow FEMA to conduct a rigorous analysis of how states, territories, urban areas, and tribal governments are performing, in the aggregate, to meet their targets.

Title: *Plan Integration: Linking Local Planning Efforts*

Year: 2015

Authors: FEMA

URL: <https://www.fema.gov/media-library/assets/documents/108893>

1. What is the document about?

This document, *Plan Integration: Linking Local Planning Efforts*, is a step-by-step guide developed to help communities not only analyze their local plans for existing integration, but also further improve those efforts including interagency coordination. Any level of government can perform plan integration and while this document was developed for local planning efforts, principles and lessons from this guide are applicable for many different users.

This guide closely relates to the goal of our study and should be used as a reference.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose of the document is to provide guidelines for plan integration at the local level. It can effectively integrate plans and policies across disciplines and agencies in the community by considering the potential of hazards as one of the key factors in future development.

3. What were the benefits to local communities?

There were 4 benefits:

(1) Improving coordination;

(2) Developing specific recommendations for integration into community-wide plans;

(3) Compiling existing planning measures to include in your hazard mitigation plan in order to catalog efforts and illustrate that integration is being performed

(4) Meeting the Local Mitigation Plan Review Tool requirement to integrate hazard mitigation

4. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The objectives of plan integration are to:

- (1) Integrate hazard mitigation into areas such as land use, transportation, climate change, sustainability, natural and cultural resource protection, watershed management, and economic development;
- (2) Solicit more participation and provide an opportunity for various departments within local government to work together on a regular basis;
- (3) Better define the roles of, and improve intergovernmental coordination between, planners, emergency managers, engineers, other local government staff, and regional partners in improving disaster resiliency

5. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.
6. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes, both terms were mentioned several times. However those were all mentioned in the plan names. Since the goal of this document is to integrate different plans and policies in local ones, detailed information of how to mitigate flooding damage wasn't mentioned at all.

7. Was “Texas” mentioned? If so, provide a summary including page numbers?

No.

8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No.

Title: *National Flood Insurance Program Community Rating System: A Local Official's Guide to Saving Lives, Preventing Property Damage, and Reducing the Cost of Flood Insurance*

Year: 2018

Authors: FEMA

URL: <https://www.fema.gov/media-library/assets/documents/16104>

1. What is the document about?

The document provides guidelines for local officials on the Community Rating System, which allows for reduced flood insurance premiums.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose is to educate local officials on eligible credits and how to apply for them.

3. What are the activities that CRS could grant credits for?

There are 19 different activities and they fall into four series, which are: Public Information; Mapping and Regulations; Flood Damage Reduction and Flood Preparedness.

In Public Information, the activities are Elevation Certificates, Map Information Service, Outreach Projects, Hazard Disclosure, Flood Protection Information, Flood Protection Assistance and Flood Insurance Promotion. In Mapping and Regulations, the activities are Floodplain Mapping, Open Space Preservation, Higher Regulatory Standards, Flood Data Maintenance and Stormwater Management. In Flood Damage Reduction, the activities are Floodplain Management Planning, Acquisition and Relocation, Flood Protection and Drainage System Maintenance. In Flood Preparedness,

4. Were "mitigation" or "mitigate" or "mitigating" mentioned? If so, provide a summary including page numbers.

Yes. However it mentioned flood and mitigation only as activities which could be used for getting credits from National Flood Insurance Program (NFIP).

Title: *National Flood Insurance Program Community Rating System: Coordinator’s Manual*

Year: 2017

Authors: FEMA

URL: <https://www.fema.gov/media-library/assets/documents/8768>

1. What is the document about?

The Coordinator’s Manual is the guidebook for the CRS. It explains how the program operates, what is credited, and how credits are calculated.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose of the CRS is to support the NFIP. The CRS recognizes, encourages, and rewards—by the use of flood insurance premium adjustments—community and state activities that go beyond the minimum required by the NFIP to reduce and avoid flood damage to insurable property, strengthen and support the insurance aspects of the NFIP, and foster comprehensive floodplain management. Although the manual is primarily a reference for CRS activities and credits, it can also help guide communities that want to design or improve their floodplain management programs.

3. What is the expiration date of this document?

March 31, 2020.

4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.
5. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes. Both terms were mentioned about 150 times in this document. However they only appeared in elements or criteria in the programs. None of them served as the methods of flood mitigation.

6. Was “Texas” mentioned? If so, provide a summary including page numbers.
7. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

They weren't mentioned. Coastal areas were mentioned a couple of times, but only in elements, criteria or glossary part.

Title: *Using HAZUS for Mitigation Planning*

Year: 2018

Authors: FEMA

URL: <https://www.fema.gov/media-library/assets/documents/105722>

1. What is the document about?

This job aid demonstrates how HAZUS results can be incorporated into hazard mitigation plans and assists with the development of hazard mitigation actions.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

While the purpose of this job aid is to help users identify and understand the types of reports, tables, maps and data produced in Hazus that can be incorporated into a Hazard Mitigation Plan, it can also be used by those who are interested in using the software to support the results of the risk assessment in mitigation plans.

Users of this document can include, but are not limited to:

- Plan authors;
- Mitigation planners;
- State and local in-house geographic information system (GIS) staff;
- Regional planning commissions;
- Universities;
- Planning researchers and students;
- Consultants;
- Plan reviewers; and
- State, tribal and local officials, including contract officers

3. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

4. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes. However it was mentioned only at how Hazus could help improving mitigation plans. How to conduct or improve flood mitigation weren't mentioned.

5. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

Hazus can be a helpful tool to assist the mitigation plan author in displaying result from the risk assessment and developing mitigation actions.

Title: *Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR) Guide: Comprehensive Preparedness Guide (CPG) 201*

Year: 2018

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/165308>

1. What is the document about?

It provides guidance for conducting a Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR), formerly State Preparedness Report. The 1st Edition of CPG 201 (April 2012) presented the basic steps of the THIRA process. Specifically, the 1st Edition described a standard process for identifying community-specific threats and hazards and setting targets for each core capability identified in the National Preparedness Goal. The 2nd Edition (August 2013) expanded the THIRA process to include resource estimation, streamlined the number of steps in the process, and provided additional examples of how to develop a THIRA.

CPG 201, 3rd Edition, includes both the THIRA and SPR because they are interconnected processes that, together, communities use to evaluate their preparedness. The 3rd Edition also introduces updates to both methodologies. The THIRA includes standardized language to describe threat and hazard impacts and capability targets. This allows communities to collect more specific, quantitative information while also providing important context. Through the updated SPR process, communities collect more detailed and actionable data on their current capabilities and identified capability gaps. Communities then indicate their intended approaches for addressing those gaps, and assess the impact of relevant funding sources on building and sustaining capabilities.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose or goal of this document is to provide a common and consistent approach for communities to support the first two components of the National Preparedness System: 1) Identifying and Assessing Risk; and 2) Estimating Capability Requirements, as implemented through the THIRA/SPR.

3. What were the five mission areas in the National Preparedness Goal?
The five mission areas were prevention, protection, mitigation, response and recovery.
4. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.
Yes. It mentioned flood 5 times and mitigation 10 times. Flood appeared in the example threats and hazards by category as example. Mitigation appeared in one of the five mission areas.
5. Was “Texas” mentioned? If so, provide a summary including page numbers.
6. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.
No. But it did mention coastal zones once. An example question was raised asking how the location would affect the community’s ability to manage it.
7. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?
This document provides a foundation for all levels of government to complete the National Preparedness System by generating actionable data to drive investment strategies through identified planning efforts, organizational and equipment investments, and training and exercise initiatives.

The THIRA/SPR provides a national risk and capability picture from the perspective of the states, territories, urban areas, and tribes. This contributes to achieving the National Preparedness Goal of “a secure and resilient Nation with the capabilities required to prevent, protect against mitigate, respond to, and recover from the threats and hazards that pose the greatest risk.”
Achieving the Goal requires participation at all levels of the community. Through the THIRA/SPR process, communities are better able to educate individuals, families, businesses, organizations, community leaders, and senior officials about the risks they face and their roles in and contributions to prevention, protection, mitigation, response and recovery efforts.

Title: *Disaster Assistance Essentials*

Year: 2017

Authors: FEMA Region 6

URL: <https://www.fema.gov/media-library/assets/documents/128354>

1. What is the document about?

This guide provides information about the different types of federal disaster assistance that may be available when the president declares a major disaster. It also provides an explanation of the disaster declaration process and how FEMA region 6 work with state and local officials to assist disaster survivors. In addition, information about the importance of planning ahead and mitigating against damage from future disasters could also be found.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The document aims to provide available federal assistance during a disaster declaration to state, tribal, and local officials.

3. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

4. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes. But it only introduced some basic concepts related to mitigation, like National Flood Insurance Program (NFIP), Community Rating System (CRS), Floodplain Management, Hazard Mitigation Planning and Hazard Mitigation Grant Program.

5. Was “Texas” mentioned? If so, provide a summary including page numbers.

6. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

It did mention Texas once, but it was in the name of the FEMA Region 6 webpage link. None of the nine counties were mentioned.

However it did mention coastal zone area in page 28. Projects which locate in a coastal area often prompt EHP (Environmental and Historic Preservation) review.

Title: *Overview of the Federal Interagency Operational Plans*

Year: 2016

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/120091>

1. What is the document about?

The National Preparedness System outlines an organized process for the whole community to achieve the National Preparedness Goal. The National Preparedness System integrates efforts across the five preparedness mission areas – Prevention, Protection, Mitigation, Response, and Recovery – in order to achieve the goal of a secure and resilient Nation. One component of the National Preparedness System is a Federal Interagency Operational Plan (FIOP) for each mission area that provides a detailed description of roles and responsibilities, specifies the critical tasks, and identifies Federal resourcing requirements for delivering national preparedness core capabilities. This study was comprised primarily of excerpts from the FIOPs and presented introductions to each.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The FIOPs are designed to provide state, local, tribal, territorial, and insular area planners an understanding of how the Federal Government functions in its response, so that they may develop or modify plans to bolster an integrated and whole community effort to make the collective response stronger and more effective.

The FIOPs describe how Federal departments and agencies will partner with local, state, tribal, territorial, insular area, nongovernmental, and private sector partners to deliver the individual mission area core capabilities within the range of their authorities, skills, and resources.

The FIOPs address the critical tasks, responsibilities, and resourcing, personnel, and sourcing requirements for the core capabilities.

While the National Planning Frameworks are intended to be used by a full range of stakeholders—individuals, families, communities, the private and nonprofit sectors, faith-based organizations, and local, state, tribal, territorial, insular area, and Federal governments—and the Nation as a whole, the FIOPs are directed toward Federal department and agency operations.

3. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.
4. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes. There were Mitigation FIOPs. The purpose of Mitigation FIOP is to establish a joint system for supporting local, state, tribal, territorial, and insular area partners and delivering public resources in a coordinated, effective, and proficient manner.
5. How are the FIOPS maintained?

The FIOPs are regularly reviewed to evaluate consistency with existing and new policies, evolving threats and hazards, and experience gained from use. Interagency partners would be engaged in the review and maintenance process for the FIOPs.
6. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

The FIOPs described how Federal departments and agencies would partner with local, state, tribal, territorial, insular area, nongovernmental, and private sector partners to deliver the individual mission area core capabilities within the range of their authorities, skills, and resources and also addressed the critical tasks, responsibilities, and resourcing, personnel, and sourcing requirements for the core capabilities.

Title: *Response Federal Interagency Operational Plan*

Year: 2016

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/120091>

1. What is the document about?

This Response FIOF builds upon the National Response Framework (NRF), which sets the strategy and doctrine for how the whole community² builds, sustains, and delivers the Response core capabilities identified in the National Preparedness Goal. This FIOF describes the concept of operations for integrating and synchronizing existing national-level Federal capabilities to support local, state, tribal, territorial, insular area, and Federal plans and is supported by Federal department-level operational plans, where appropriate. The concept of operations and supporting tasks contained in the Response FIOF are scalable, flexible, resilient, and adaptable, allowing the FIOF to be used regardless of cause, size, location, or complexity. Concepts of operations and/or tasks may be modified, added, or deleted depending upon the incident.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

This FIOF describes how the Federal Government delivers core capabilities for the Response mission area. Specifically, the Response FIOF is an all-hazards plan that describes how the Federal Government coordinates its efforts to save lives, protect property and the environment, and meet basic human needs following an emergency or disaster. The Response FIOF is built on the National Incident Management System (NIMS) concepts and principles and reflects the whole community concept, which incorporates a full range of stakeholders—individuals, families, communities, the private and nonprofit sectors, faith-based organizations, and local, state, tribal, territorial, insular area, and Federal governments—in national preparedness activities and as full partners in incident response operations.

3. What is the scope of this Federal Interagency Operational Plan (FIOF)?

The Response FIOF describes how the Federal Government coordinates its efforts to save lives, protect property, and preserve the environment in response to or anticipation of an incident.

Federal departments and agencies initiate this mission by engaging with whole community partners to identify and prioritize needed Federal response support capabilities and actions within 24 to 72 hours following an incident. Specifically, this FIOP addresses the CTs, responsibilities, resourcing, Response Federal Interagency Operational Plan personnel, and sourcing requirements to accomplish Federal response objectives across Federal departments and agencies.

The Response FIOP is designed to address a notice or no-notice incident. The Response FIOP base plan and core capability-specific functional annexes primarily address a no-notice incident where the need for Federal support is obvious and immediate, where anticipatory planning and resource prepositioning were precluded, and where the exact nature of resources and the exact nature of the incident is not known. When there is time to plan for the response to a potentially catastrophic incident, proactive disaster response operations can occur.

4. What is/are the main idea(s)/finding(s) in the document?

There were a list of key Federal decisions including a broad range of major decision items during Response FIOP implementation.

(1) Heads of Federal departments and agencies with statutory authority for Response FIOP operations activate and deploy Federal resources or teams to the impacted area in anticipation of or in response to an incident and in coordination with local, state, tribal, territorial, and insular area governments and private entities.

(2) Pursuant to a Governor's or (Tribal) Chief Executive's request, the President of the United States determines the need to declare an emergency or major disaster under the Stafford Act.

(3) If a Stafford Act declaration is made, the President will appoint an FCO for each affected state, tribe, or territory to lead Federal support efforts. The FCO serves in the JFO and works with the State Coordinating Officer to meet local, state, tribal, territorial, and insular area assistance requirements and priorities.

(4) When an incident is anticipated to exceed local, state, tribal, territorial, or insular area resources, the Governor of a state or Chief Executive of a federally-recognized Indian tribe may request Federal support through the Stafford Act or other authorities.

(5) For a declaration other than under the Stafford Act or for a request for Federal-to-Federal support, the President, in coordination with the appropriate heads of Federal departments and

agencies, will determine the lead Federal agency and funding mechanism for disaster or emergency operations, as necessary.

(6) When activated, the NRCC and appropriate RRCCs, including FEMA personnel and all ESFs, will coordinate with the FEMA Region(s) to determine and provide needed resources and policy guidance to support the response.

(7) If a JFO is established, decisions on location, staffing, program priorities, and demobilization will be required.

(8) Decision to invoke expanded authorities, such as the Defense Production Act, policy changes, waivers, and regulatory relief.

5. Were "flood" or "flooding" mentioned? If so, provide a summary including page numbers.
6. Were "mitigation" or "mitigate" or "mitigating" mentioned? If so, provide a summary including page numbers.

Yes. Both terms were mentioned several times. Flood appeared in the example threats and hazards by category as example. Mitigation was one of the five mission areas and appeared as activities which communities need to build pre- and post-disaster.

7. Was "Texas" mentioned? If so, provide a summary including page numbers.
8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.
No. But it did mention coastal areas for 14 times in coastal management zone and also land search and rescue operations near coastal areas.

9. How can the document be improved?
This document could be improved or updated though incidents.

Title: *Mitigation Federal Interagency Operational Plan*

Year: 2016

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/120091>

1. What is the document about?

This FIOF builds upon the NMF, which sets the strategy for how the whole community¹ builds, sustains, and delivers the Mitigation core capabilities identified in the National Preparedness Goal. This FIOF describes the concept of operations for integrating, synchronizing, and ensuring the continuity of existing national-level Federal capabilities to support local, state, tribal, territorial, insular area, and Federal plans, and it is supported by Federal department-level operational plans where appropriate.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The Mitigation FIOF describes how the Federal Government delivers core capabilities for the Mitigation mission area. The purpose of this FIOF is to establish a joint system for supporting local, state, tribal, territorial, and insular area partners and delivering public resources in a coordinated, effective, and proficient manner. Building and sustaining a mitigation-minded culture within Federal department and agency programs can contribute to making the Nation more socially, ecologically, and economically resilient before, during, and after an incident.

3. What would be the implementation of the document to help promote the goals?

(1) Establish opportunities for Federal partners to jointly discuss interagency mitigation priorities within their existing authorities and resources;

(2) Identify gaps and support improvements to address current and future risks in current mitigation efforts, where needed;

(3) Identify programmatic opportunities where appropriate to better align program funds, products, and services in support of the core capabilities through partnerships with each other and the whole community;

(4) Promote the integration of continuity planning and operations to ensure Mitigation core capabilities and the coordinating structures can be provided during and after an incident; and

(5) Describe how programs deliver core capabilities, outputs, and outcomes in the form of incentives, projects, products, guidance, technical assistance, and other services.

4. What were the core capabilities defined in National Preparedness Goal?
The Mitigation core capabilities goals are Planning, Public Information and Warning, Operational Coordination, Community Resilience, Long-Term Vulnerability Reduction, Risk and Disaster Resilience Assessment and Threats and Hazards Identification.

5. What is the scope of this Federal Interagency Operational Plan (FIOP)?

The scope of this FIOP is not limited to disaster-focused authorities and capabilities, but encompasses a larger scope of authorities as described within the Authorities and References section. Within this broader scope, Federal departments and agencies deliver a capability or capabilities during steady state as well as before, during, and after an incident.

6. Was "Texas" mentioned? If so, provide a summary including page numbers.
7. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No. But it did mention coastal for 10 times, in an example in Adaptive Risk Management. The term was only mentioned as coastal management as part of the risk management.

8. What is/are the main idea(s)/finding(s) in the document?

Issues including globalization, technological innovation, demographic shifts, increasing population in vulnerable areas, escalating resource demands, climate changes, and security concerns, such as proliferation of weapons of mass destruction and the movement of people across borders, contribute to the complexity of future disasters. These trends indicate a future environment that presents a wide range of problems that occur unpredictably and perhaps simultaneously.

9. How can the document be improved?

This FIOP will be regularly reviewed to evaluate consistency with existing and new policies; evolving threats and hazards; and experience gained from use. Interagency partners will be engaged in the review and maintenance process for this FIOP. Reviews of this FIOP will be conducted on a quadrennial basis. The review and maintenance process may include developing incident-specific and classified annexes, which include the delivery schedule for Federally coordinated assets and resources, as appropriate. The FIOP will be updated periodically, as required, to incorporate new Executive guidance and statutory and procedural changes, as well as lessons learned from exercises and actual incidents.

Significant updates to the Mitigation FIOP will be vetted through a Federal senior-level interagency review process. The review process provides an opportunity to reassess the FIOP's direction and to address current conditions and realities by engaging stakeholders, revising the document, and publishing an amended version for the whole community. Information reported through the monitoring process will be integrated into the FIOP, as appropriate. Where conditions, realities, and stakeholder perspectives have changed little or not at all, the FIOP may remain unchanged. The FIOP review will accomplish the following:

- (1) Provide an assessment of, and updated information on, the delivery of core capabilities;
- (2) Ensure that the FIOP is consistent with other mission areas;
- (3) Incorporate lessons learned and effective practices; and

Title: *Recovery Federal Interagency Operational Plan*

Year: 2016

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/120091>

1. What is the document about?

This Recovery FIOP provides guidance to implement the National Disaster Recovery Framework (NDRF), which sets the doctrinal guidance for how the whole community builds, sustains, and delivers the Recovery core capabilities identified in the National Preparedness Goal. It describes the concept of operations for integrating and synchronizing existing national-level Federal capabilities to support local, state, tribal, territorial, insular area, and Federal plans and is supported by Federal department-level operational plans, where appropriate.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The Recovery FIOP describes how the Federal Government delivers eight core capabilities for the Recovery mission area. It is a plan that provides guidance for implementing the NDRF. The Recovery FIOP provides guidance for effective delivery of recovery support to disaster-impacted local, state, tribal, territorial, and insular area jurisdictions. It provides a flexible structure that enables disaster recovery managers to operate in a unified and collaborative manner while preserving the civil rights and civil liberties of all community members. The Recovery FIOP describes how Federal recovery field leadership—the Federal Coordinating Officer (FCO) and Federal Disaster Recovery Officer (FDRC)—and Recovery Support Function (RSF) agencies and related entities work in coordination with nongovernmental and private sector organizations to support local, state, tribal, territorial, and insular area recovery efforts. The Recovery FIOP consists of a base plan and eight core capability annexes. The Recovery FIOP is built on the National Incident Management System concepts and principles and promotes the whole community as full partners in recovery operations and national preparedness activities.

3. What is the scope of this Federal Interagency Operational Plan (FIOP)?

The scope of this FIOP is not limited to disaster-focused authorities and capabilities, but encompasses a larger scope of authorities as described within Appendix III: Authorities and

References. Within this broader scope, Federal departments and agencies apply a capability or capabilities using steady state authorities before, during, and after an incident.

4. What were the core capabilities defined in National Preparedness Goal?

(1) The eight Recovery core capabilities as an organizing principle for Federal disaster recovery support;

(2) How the Recovery FIOF will integrate with the Prevention, Protection, Mitigation, and Response FIOFs and their corresponding coordinating structures;

(3) The organizational concept of the interagency recovery coordination structure in the field and how it relates to other field-level organizations;

(4) The post-disaster FDRC and RSF activation, deployment, and evaluation process;

(5) How the Federal interagency recovery coordination structure will adapt and interface with local, state, tribal, territorial, and insular area recovery organizational structures;

(6) The role of the Mitigation Advisor, Unified Federal Review (UFR) Advisor, and other advisors and program liaisons;

(7) The purpose and objectives of post-disaster recovery impact assessment and mission scoping processes;

(8) The process for coordinating RSF activities and facilitating the application of Federal Recovery core capabilities in support of impacted local, state, tribal, territorial, and insular area communities;

(9) The parameters for developing and implementing the Recovery Support Strategy (RSS);

(10) Considerations in determining the timeline for demobilization and transition to steady state operations; and

(11) The process by which RSF agencies use existing programs to enhance and leverage pre-disaster recovery preparedness and post-disaster recovery, mitigation, and resilience.

5. Were "flood" or "flooding" mentioned? If so, provide a summary including page numbers.

6. Were "mitigation" or "mitigate" or "mitigating" mentioned? If so, provide a summary including page numbers.

Yes. Both of them were mentioned several times in the NFIP and the core capabilities. There were some core capability integration factors which related to Mitigation.

7. Was "Texas" mentioned? If so, provide a summary including page numbers.
8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No. However coast was mentioned 7 times. Most of them appeared in the mitigation part in the recovery core capabilities.

9. What region-specific information can be obtained from the document?

Since Chamber County and Jefferson County are coastal areas, the principles of sustainable and disaster resistant communities through the protection of coastal barriers and zones should be promoted.

10. How can the document be improved?

This FIOP will be regularly reviewed to evaluate consistency with existing and new policies, evolving threats and hazards, and experience gained from use. Interagency partners will be engaged in the review and maintenance process for this FIOP. The review and maintenance process may include developing incident-specific and classified annexes, which include the delivery schedule for Federally coordinated assets and resources, as appropriate. The FIOP will be updated periodically, as required, to incorporate new executive guidance and statutory and procedural changes, as well as lessons learned from exercises and actual incidents. Significant updates to the Recovery FIOP will be vetted through a Federal senior-level interagency review process.

Title: *Protection Federal Interagency Operational Plan*

Year: 2016

Authors: U.S. Department of Homeland Security

URL: <https://www.fema.gov/media-library/assets/documents/120091>

1. What is the document about?

The Protection FIOF builds upon the National Protection Framework, which sets the strategy and doctrine for how the whole community builds, sustains, and delivers the Protection core capabilities. Federal departments and agencies maximize the effectiveness of Protection core capabilities through a range of coordinating activities. Coordinating activities are the primary, but not exclusive, Federal coordinating mechanisms for building, sustaining, and delivering the Protection core capabilities. Because the coordinating activities are autonomous as well as interdependent, this FIOF focuses on how existing Federal capabilities support local, state, tribal, and territorial partners and how those capabilities support each other. The concepts of operations contained in the Protection FIOF are scalable, flexible, and adaptable, allowing the FIOF to be used across the range of Protection coordinating activities. Critical tasks are defined actions that are executed by organizations to deliver the Protection core capabilities. Concepts of operations and/or tasks may be modified, added, or deleted depending upon the risk, mission activity, or threat.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

This FIOF describes how the Federal departments and agencies work together to deliver Protection core capabilities through eight coordinating activities. Protection coordinating activities enable the Federal Government to:

- (1) Deliver the core capabilities for the mission area and
- (2) Execute the critical tasks associated with each core capability.

These activities support and integrate Protection efforts during steady state (day-to-day activities) and escalated activities that flow from emergent threats and elevated risks.⁴ The Protection mission, as defined in the National Preparedness Goal, requires Federal departments and agencies to coordinate activity organized under an array of existing authorities, policy directives, operational plans, and relationships. The Protection FIOF does not supersede or

direct planning conducted under applicable legal authorities, but serves as the National Preparedness System plan for aligning and synchronizing the coordinating activities. Each appendix in Annex C of this FIOP describes key authorities, policies, plans, and coordinating structures as well as how individual coordinating activities support other coordinating activities.

3. What is the scope of this Federal Interagency Operational Plan (FIOP)?

This document is written for and is applicable across all Federal departments and agencies involved in protecting people, property, critical assets, systems, and networks against the greatest risks to the Nation. Additionally, it serves as a guide to how the Federal Government builds Protection core capabilities with local, state, tribal, and territorial governments; the private sector; nongovernmental organizations (NGO); and individuals.

4. What were the core capabilities defined in National Preparedness Goal?

It was to distinct critical elements necessary to achieve the National Preparedness Goal.

5. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

6. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Both of them were mentioned several times in the NFIP and the core capabilities. There were some core capability integration factors which related to Mitigation.

7. Was “Texas” mentioned? If so, provide a summary including page numbers.

8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No. But it mentioned coast 25 times. Most of them were in the coast guard security part and the rest of them were in the List of Acronyms.

9. How can this document be improved in the future?

This FIOP will be regularly reviewed to evaluate consistency with existing and new policies, evolving threats and hazards, and experience gained from use. Interagency partners will be engaged in the review and maintenance process for this FIOP. The review and maintenance process may include developing incident-specific and classified annexes, which include the

delivery schedule for federally coordinated assets and resources, as appropriate. The FIOP will be updated periodically, as required, to incorporate new executive guidance and statutory and procedural changes, as well as lessons learned from exercises and actual incidents. Significant updates to the Recovery FIOP will be vetted through a Federal senior-level interagency review process.

Title: FEMA Guidance for Flood Risk Analysis and Mapping

Year: 2019

Authors: FEMA

URL: <https://www.fema.gov/media-library/assets/documents/34953>

1. What is the document about?

The documents are guidelines that vetted recommended approaches for FEMA's Risk Mapping, Assessment and Planning (Risk MAP) Program. These guidance documents support current FEMA standards and facilitate effective, efficient implementation of the program. All guidance documents were written to support FEMA standards and align with current regulations.

2. Who oversees the document and its implementation?

FEMA's Risk Analysis Division.

3. What is/are the main idea(s)/finding(s) in the document?

The guidelines ensure the production of accurate flood plain maps portraying the following information. First, flood hazard areas are subject to various chance of flooding, ranging from 0.2 to 1 percent, in any given year. These areas are sub-divided into flood insurance zones depending on the type of flooding. Second, base flood elevation (BFE) is the computed elevation of a flood having a 1 percent chance of being equaled or exceeded in a given year. BFE accounts for the cumulative effects of topography, soils, vegetation, surface imperviousness and flow dynamics. Third, future conditions floodplains sometimes are presented based on projections of future land use alongside the current condition floodplains.

4. Are policies or guidelines in the documents uniformly implemented, or is there a high degree of variation in the implementation?

The guidelines have a minimal requirement on how floodplain maps should be produced. In general, all floodplain maps should clearly depict various flood hazard areas and flood insurance zones. Flood insurance premium is however determined based on relationship between the BFE and the elevation of a structure. In addition, producing an accurate floodplain map with a BFE enables building restrictions to be set commensurate with a more realistic profile of the horizontal and vertical extent of flooding. Nonetheless, only the more expensive of FEMA's flood study methods—detailed studies and most limited detailed studies—yield a base flood elevation.

5. What is/are the most influential factor(s) affecting quality or effectiveness of the documents?

Topographic data are the most important factor in determining water surface elevations, base flood elevation, and the extent of flooding and, thus, the accuracy of flood maps in riverine areas. The USGS National Elevation Dataset (NED), developed from airborne and land surveys, is commonly used in flood map production, even though the elevation uncertainties of the NED are about 10 times greater than those defined by FEMA as acceptable for floodplain mapping. Data collected using high-resolution remote sensing methods such as LiDAR (light detection and ranging) can have absolute errors on the order of centimeters, consistent with FEMA requirements, but they are not available nationwide.

6. What region-specific information can be obtained from the document?

As the two coastal counties in the whole nine counties, Chambers and Jefferson face coastal flooding issues. FEMA's one dimensional model has been proved insufficient by published results in terms of yielding accurate base flood elevations. As a remedy, coastal flood maps can be improved significantly through use of coupled two-dimensional storm surge and wave models. Granted that this change may take a decade to come, FEMA can consider a comparison study of available models, conducted by independent external advisory groups, in order to quantify uncertainties and indicate which models should be incorporated into mapping practice.

7. How can the document be improved?

The documents could potentially include more specific guidelines about metadata – information about how flood data are generated. Documenting how each mile was studied—including what input data, mapping, and modeling methods were used, the date of mapping, the contractor, and the starting and ending points of each study segment—would help users better understand the reliability and accuracy of the data. Many of these metadata are not currently included in Flood Insurance Study reports, particularly to this level of detail.

Through the guidelines, FEMA could seek to better communicate uncertainty surrounding flood hazard and its consequences. Based on the past experience, the public often perceive areas outside of flood hazard areas as “risk free”, which is partly due to how flood hazard is portrayed in the FEMA maps. Showing only the floodplain boundaries has the disadvantage of implying that every building in a designated flood zone may flood and that every building outside the zone is safe. These misunderstandings could be gradually reduced by transitioning from “in/out” to structure-specific flood frequency determination and associated flood elevations.

FEMA is already allowing future conditions floodplains based on projections of future land use. This is very necessary under climate change and rapid urbanization yet requires the improved ability to predict future climate and land use. FEMA should work closely with the multidisciplinary communities of science and engineering in this regard.

EPA Documents

Title: Coastal Wetlands Initiative: Gulf of Mexico Review

Year: Unknown

Authors: EPA

URL: <https://www.epa.gov/wetlands/coastal-wetlands#reviews>

1. What is the document about?

This document is a review as part of the EPA's Coastal Wetlands Initiative. The regional reviews aim to help the EPA and NOAA identify and understand stressors impacting coastal wetlands as well as strategies to protect and restore coastal wetlands. The study includes results from the Galveston Bay CWR and the Mississippi Sound Coastal CWR. (For applicability to the current study, the Galveston Bay CWR is the focus.)

2. What location does the document cover?

The document covers the Gulf of Mexico.

3. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose is to engage stakeholders in the protection of coastal wetlands in the Gulf Coast region. The report was produced through discussion with stakeholders.

4. Were "flood" or "flooding" mentioned? If so, provide a summary including page numbers.

Yes, 54 times.

Page 4: "Property buyouts to remove buildings from flood-prone areas and restore the floodplain to its natural state."

Page 5: "The unique combination of regional and global climate factors in the Gulf region increases the importance of coastal wetlands. Hurricanes and tropical storms, which are prevalent in this region, erode shorelines and cause flooding and wind damage to properties and infrastructure."

Page 6: "Often, artificial hydrologic modifications impede the ability of wetlands to migrate inland and abate flooding. Levees, dams, and dikes change the source, quality, or quantity of water and sediment that is available to coastal ecosystems, which

restricts the ability of coastal wetlands to survive (Day et al., 2000, 2007; Martin et al., 2000; EPA, 1987).”“Storms and hurricanes are another stressor causing coastal wetland acreage loss in the Gulf region. Hurricanes Katrina and Rita affected coastal Louisiana and surrounding areas in August 2005, and Hurricane Ike struck the coast of Galveston, Texas, in September 2008. These storms caused heavy damage and flooding along the coast, including damage to coastal wetlands.”

Pages 6-7:“In both of the Gulf region focal watersheds, hydrologic alterations were noted as another major stressor causing wetland losses. One of the limiting variables associated with wetland growth is consistent inflow of sediment and nutrients; however, natural riverine input to most of the Gulf of Mexico has been impacted by artificial flood controls, resulting in a decrease in the sediment and nutrients needed for wetlands to survive (Ko and Day, 2004). The movement and deposition of sediment can be impeded by a variety of flood control mechanisms (Louisiana Sea Grant, 2010). These structures can also restrict freshwater flow, which in turn can allow toxic metals and organics to accumulate. In addition, the creation of channels and canals, often the result of activity by the gas and oil industry, can lead to saltwater intrusion, which can destroy freshwater marshes (Ko and Day, 2004).”

Page 8 as part of the tools and strategies: “Property buyouts of repeatedly flooded land” and “flood districts”.

Page 12 as part of a Focal Watershed Review of the East and West Galveston Bay, Texas: “Increasing impervious surfaces and traditional stormwater drainage infrastructure result in increased runoff during rainstorms (contributing to flooding) and (to a lesser extent, given low permeability of soils) decreased groundwater recharge.” And Flood management practices (page 16) and others (page 17). “Flood” is also mentioned extensively in the Focal Watershed Review of the Mississippi Coastal Watershed.

Page 45 (Conclusions): “Although not a common strategy, **property buyouts** have been used to remove properties from flood-prone areas in both watersheds.”

In the References, page 49

In Appendix E: Federal Agency Programs That Support Coastal Wetland Protection, Restoration, and Management (pages 64-73).

5. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes, these are mentioned throughout the document (153 mentions), especially in the two Focal Watershed Reviews.

6. Was “drainage” mentioned? If so, provide a summary including page numbers.

Yes, drainage is mentioned in both Focal Watershed Reviews.

7. Was “Texas” mentioned? If so, provide a summary including page numbers.

Yes, Texas is mentioned throughout the document (172 mentions), especially in the Gulf of Mexico section and the Focal Watershed Review for East and West Galveston Bay.

8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

Chambers, Jefferson, and Liberty Counties are mentioned on page 10 in the Focal Watershed Review for East and West Galveston Bay: “Counties within the smaller West Galveston Bay watershed include Brazoria, Chambers, Fort Bend, Galveston, and Harris. Counties located within East Galveston Bay watershed are Chambers, Galveston, Jefferson, and Liberty. Although these two watersheds were the focus of the review, participants provided information and comments regarding the larger Galveston Bay region, which includes the metroplex of Houston and surrounding cities and municipalities.” The other counties are not mentioned.

9. What region-specific information can be obtained from the document?

Information for the Gulf of Mexico region as well as the Focal Watershed Review: East and West Galveston Bay, Texas can be obtained. (see subsequent questions for more detail)

10. What stressors to coastal wetlands in the Gulf of Mexico region were identified?

Stressors identified from the Galveston Bay CWR include coastal development (causing nonpoint source pollution and shoreline hardening), limitations of regulations, hydrologic alterations

(including channelization, dredging, and water withdrawal), and climate change and sea level rise.

11. What tools and strategies for the Gulf of Mexico region stressors were identified?

The following tools and strategies were identified from the Galveston Bay CWR. For coastal development, tools and strategies include: compensatory mitigation, watershed plans, conservation easements, property buyouts of repeatedly flooded land, and total maximum daily loads (TMDLs). For limitation of regulations, tools and strategies include: land management and conservation programs, research on hydrologic nexus, and rolling easements. For hydrologic alterations, tools and strategies include beneficial use of dredged material, flood districts, subsidence districts, and regional sediment management plans. For climate change and sea level rise, tools and strategies include living shorelines, conservation (preservation and restoration) funding, and modeling.

12. What gaps and needs for the Gulf of Mexico region stressors were identified?

The gaps and needs for coastal development include widespread land use planning, widespread use of watershed plans, outreach and education (for the public and local decision-makers), detailed wetland mapping, collaboration, incentives for conservation, and mitigation monitoring. The gaps and needs for the limitation of regulations include clarifying CWA jurisdiction (particularly by conducting scientific studies on geographically isolated wetlands); integrated mapping, monitoring, and data collection system (including accessible database of authorized wetland impacts/mitigation, and other CWA Section 404 permit data); location compensatory mitigation in the same watershed and as close to the coast as the impacts that are authorized; state and/or local regulatory and incentive programs; sustained funding for studies to better understand wetland functions, values, and loss; outreach and education; and stronger enforcement (including high-resolution aerial photography to track losses and assist in enforcement). The gaps and needs for hydrologic alterations include increased collaboration and reduction of regulatory barriers to beneficial use of dredged material. For climate change and sea level rise, gaps and needs include land use planning, mapping and modeling, and outreach and education.

13. What does the Focal Watershed Review: East and West Galveston Bay, Texas (pages 10-44) tell us?

This section includes an **Introduction, Stressors** (including coastal development, shoreline hardening, nonpoint source pollution, limitations of regulations, changes affecting federal jurisdiction, state regulatory role, incremental losses, mitigation, unauthorized wetland loss, rolling easement litigation, hydrologic modifications, alterations in freshwater flows, alterations in sediment, flood management practices, dredging, sand and gravel excavation, groundwater pumping, oil and gas extraction, seismic exploration, climate change and sea level rise, sea level rise, limited estuarine marsh mitigation opportunities, impacts to black mangrove, hurricanes and storms, oil spills, invasive species, and funding at cross-purposes), **Tools and Strategies** (including tools to address coastal development: compensatory mitigation for wetland impacts, watershed plans, comprehensive conservation and management plans, the Armand Bayou and Dickinson Bayou watershed plans; total maximum daily loads (TMDLs), property buyouts; tools to address the limitation of regulations: research associated with federal jurisdiction, land management and conservation programs, wetlands reserve program, land use planning, ecological habitat map, conservation organizations, conservation grants, rolling easements; tools to address impacts of hydrologic modifications: beneficial use of dredged materials, regional sediment management plans, flow standards, use of wetlands for stormwater management and flood damage prevention, subsidence districts; tools to address climate change and sea level rise: living shorelines, modeling and habitat studies; other tools to address coastal wetland stressors: ecosystem services valuation, revised shoreline classifications), and **What's Needed? What's missing?** (including improve planning to control impacts of coastal development: land use planning, local and county involvement in wetland protection, green infrastructure, nonpoint source pollution control program; strengthen wetland regulatory programs: enforcement, clarifying CWA jurisdiction, increasing compliance, increasing transparency of CWA Section 404 permitting, permit coordination, compensatory mitigation, state programs, cumulative impacts; provide additional funding and collaboration for wetland programs (regulatory and non-regulatory): lack of funding, conservation funding, flood control coordination, NGO and government cooperation; develop tools for climate change and sea level rise: sea level rise tools; other gaps and needs to address multiple wetland stressors: wetland

mapping, beneficial use of sediment, monitoring, ecosystem valuation information, education and incentives, and habitat assessment gaps).

The section also includes Highlights for “Clean Water Act Jurisdiction and Evidence of Surface Connectivity for Texas Gulf Coastal Depressional Wetlands” and “Accomplishments of the Galveston Bay Estuary Program, 1995–2012”.

The section was written after an extensive literature review as well as discussion with participants.

Title: National Coastal Condition Report IV 2012

Year: September 2012

Authors: EPA (Office of Water and Office of Research and Development (ORD))

URL: <https://www.epa.gov/national-aquatic-resource-surveys/national-coastal-condition-reports>

1. What is the document about?

“This fourth NCCR (NCCR IV) assesses the condition of the nation’s estuaries and coastal embayments, including the coastal waters of the conterminous United States, Southeastern Alaska, Hawaii, American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands. This assessment is based primarily on the EPA’s NCA data collected between 2003 and 2006. The NCA, the NOAA’s NMFS and NOS, and the FWS’s NWI contributed most of the information presented in this current report.”

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

“To better address questions about national coastal condition, the EPA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Fish and Wildlife Service (FWS) agreed to participate in a multi-agency effort to assess the condition of the nation’s coastal resources. The agencies chose to assess condition using nationally consistent monitoring surveys to minimize the problems created by compiling data collected using multiple approaches. The results of these assessments are compiled periodically into a National Coastal Condition Report (NCCR).”

3. What is/are the main idea(s)/finding(s) in the document?

“The NCCR IV shows an overall condition score of 3.0 for the nation’s coastal waters; although this score has improved substantially since 1990, the overall condition of the nation’s coastal resources continues to be rated fair. If the national score were recalculated without Alaska, Hawaii, and the island territories, however, the overall condition score would be 2.5 (rated fair; only a slight improvement from the overall condition score of 2.3 in NCCR III). This report also presents analysis of temporal changes in coastal condition from 1990 to 2006, with regional chapters focusing on changes mainly from 2000 to 2006.”

4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.
No.
5. Were “mitigate” or “mitigation” mentioned? If so, provide a summary including page numbers.
Yes, only on page 123. It is pertaining to loss of estuarine habitats.
6. Was “drainage” mentioned? If so, provide a summary including page numbers.
It was only mentioned once in the References.
7. Was “Texas” mentioned? If so, provide a summary including page numbers.
Yes, nineteen times throughout Chapter 5 (pages 129-154) on the condition of the Gulf Coast, which includes our study area. Texas is mentioned on pages: 133, 134, 144, 145, 146, 150, 151, 152, and in two entries in the References.
8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.
No.
9. What region-specific information can be obtained from the document?

The summary for Chapter 5 (Gulf Coast Coastal Condition):

“Based on the indices used in this report, the overall condition of Gulf Coast coastal waters is rated fair. The coastal wetland and sediment quality indices are rated poor in Gulf Coast coastal waters for 2003–2006, while water quality and benthic condition were also of concern (rated fair and fair to poor, respectively). The fish tissue contaminants index is rated good for this region. Benthic index values were lower than expected in 20% of the Gulf Coast estuaries. Although elevated sediment contaminant concentrations were found in only 3% of the coastal area, sediments were toxic in 15% of the coastal area. Poor water clarity was observed in 21% of the coastal area, elevated levels of DIP were observed in 14% of the area, and dissolved oxygen concentrations were rated poor in less than 5% (4.8%) of the area. DIN concentrations rarely exceeded cutpoints. The overall condition rating of 2.4 in this report represents no significant change from the ratings of

2.4 and 2.2 observed in the previous reports (NCCR II and III), but still represents an improvement in overall condition since the early 1990s.

NOAA's NMFS manages several fisheries in the Gulf of Mexico LME, including reef fishes, mackerel, and shrimp. The top commercial species are invertebrate species of white, brown, and pink shrimp; oysters; and blue crabs. The menhaden stock in this LME is healthy, but in 2005, Hurricanes Katrina and Rita did considerable damage to the four Gulf menhaden reduction factories. Continued coastal sinking and sea-level rise in the northwestern Gulf of Mexico LME may lead to shrimp habitat deterioration, and current high fishery yields may not be indefinitely sustainable. Contamination in Gulf Coast coastal waters has affected human uses of these waters. In 2006, 100% of the coastal miles of the Gulf Coast and 76% of the estuarine square miles were under fish consumption advisories, primarily due to mercury contamination. In addition, approximately 48% of the region's monitored beaches were closed or under advisory for some period of time during 2006. Increasing population pressures in the Gulf Coast region warrant additional monitoring programs and increased environmental awareness to correct existing problems and to ensure that indicators that appear to be in fair condition do not worsen."

Title: National Coastal Condition Assessment 2010

Year: January 2016

Authors: EPA

URL: <https://www.epa.gov/national-aquatic-resource-surveys/national-coastal-condition-assessment-2010-results>

1. What is the document about?

“This *National Coastal Condition Assessment 2010* (NCCA 2010) is the fifth in a series of reports assessing the condition of the coastal waters of the United States, including a vast array of beautiful and productive estuarine, Great Lakes, and coastal embayment waters. It is part of the National Aquatic Resource Surveys (NARS), a series of statistically based surveys designed to provide the public and decision makers with nationally consistent and representative information on the condition of all the nation’s waters. The NCCA 2010 answers questions such as: What is the condition of the nation’s coastal waters, and is that condition getting better or worse? What is the extent of the stressors affecting them?”

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

“The NCCA 2010 presents information on the ecological condition of U.S. coastal and Great Lakes nearshore waters and key environmental stressors affecting these waters. Importantly, it provides data that coastal managers can use to determine the future direction of coastal monitoring efforts.”

3. What is/are the main idea(s)/finding(s) in the document?

“Key Findings

Biological Quality

A majority of coastal and Great Lakes nearshore waters support healthy communities of benthic macroinvertebrates (bottom-dwelling creatures such as worms and clams) which are indicators of biological quality. Data show that 56% of the nation’s coastal and Great Lakes nearshore waters are rated good for biological quality, 10% are rated fair, and 18% are rated poor based on the benthic index. Data are incomplete or missing for 15% of waters. The Northeast Coast has the highest percentage of waters rated poor for biological quality (27%).

Water Quality

Water quality is rated good in 36% of coastal and Great Lakes nearshore waters, fair in 48%, and poor in 14% based on the water quality index. Components of the water quality index include phosphorus, nitrogen, water clarity, chlorophyll a, and dissolved oxygen. The most widespread of these stressors is phosphorus (rated poor in 21% of waters). Too much phosphorus can enter coastal waters from sources such as sewage and fertilizer runoff and result in large algal blooms, increased levels of chlorophyll a, and reduced water clarity and dissolved oxygen levels. Of the five regions, the Gulf Coast has the highest percentage of waters rated poor for water quality (24%).

Sediment Quality

A majority (55%) of coastal and Great Lakes nearshore waters have good sediment quality, 21% have fair quality, and 13% have poor quality. This finding is based on an index of sediment quality that has two component indicators: sediment contaminants and sediment toxicity. Overall, 79% of coastal waters are rated good based on low levels of sediment contaminants and 57% of waters are rated good based on the toxicity effects of contaminants. The Gulf Coast and the West Coast have the highest percentage of waters rated poor for sediment quality—about 25%. Nationally, sediment quality data are incomplete or missing for 11% of waters.

Ecological Fish Tissue Quality

This report, which primarily addresses ecological rather than human health conditions in coastal waters, assesses the potential harm that fish tissue contaminants pose to predator fish, birds, and wildlife. Based on this index, less than 1% of coastal and Great Lakes nearshore waters are rated good, 26% are rated fair, and 49% are rated poor. Data are incomplete or missing for the remaining 24% of waters. Selenium is the most widespread contaminant exceeding the fish tissue contaminant thresholds for predators. While selenium occurs naturally and is nutritionally valuable, too much selenium can be toxic. These findings indicate that contaminants in fish may have long-term adverse effects on fish-eating wildlife. With the exception of a supplemental study in the Great Lakes, analysts did not evaluate human health risks.

In 2010, NCCA researchers used a new, highly protective analytical approach for determining ecological fish tissue contaminant ratings that is more conservative than the approach used in the past. Screening values are based on impacts to the most sensitive freshwater or saltwater fish, birds, and wildlife species.

Change in Coastal Condition

The NCCA 2010 uses a consistent set of data from three periods (1999–2001, 2005–2006, and 2010) to evaluate change in coastal condition over time. This analysis includes national and regional findings for the water quality index, sediment quality index, and benthic index for the Northeast, Southeast, Gulf, and West Coast regions over the three periods. Data from past fish tissue collection efforts are not comparable across the three time periods, and therefore are not included in the change analysis. In addition, the change analysis does not include the Great Lakes because they were not part of this survey until 2010.”

4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

Yes, on page 3: “Coastal wetlands that provide critical habitat, mitigate floods, and protect shorelines from erosion continue to be lost to residential and commercial development.”

5. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes, on page 3: “Coastal wetlands that provide critical habitat, mitigate floods, and protect shorelines from erosion continue to be lost to residential and commercial development.”; page 102: “The NCCA 2010 findings, along with the change analysis, support the need for continued management attention to coastal stressors at the national, regional, state, and watershed scales to mitigate problems where they exist and protect those areas that are still in good condition.”; and page xiii: “The NCCA 2010 findings support the need for continued attention to coastal stressors at the national, regional, state and watershed scales. In addition, the findings support the need to identify and mitigate challenges where they exist and protect areas that are still in good condition.”; page 95: “Information gathered from this survey will be useful in supporting the protection and restoration of coastal marine environments, mitigating damage to the marine ecosystem, and implementing discharge-monitoring requirements of industry.”.

6. Was “drainage” mentioned? If so, provide a summary including page numbers.

Yes. Drainage is mentioned twice as part of a section titled “Highlight: Watershed Influence on Open Nearshore Waters and Embayments of the U.S. Great Lakes Coastal Zone” on page 20. Since this section does not apply to our study area, a summary is not provided.

7. Was “Texas” mentioned? If so, provide a summary including page numbers.

Yes, twice in the Acknowledgements for the Texas Parks and Wildlife Department and Texas A & M University (page ii) and once in the section on the Gulf Coast (page 76).

8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.
No.
9. What region-specific information can be obtained from the document?

Results of the study for the Gulf Coast:

“Biological Quality

Biological quality is rated good in 61% of Gulf Coast waters, based on the benthic index. Fair biological quality occurs in 20% of these waters, and poor biological quality occurs in 15%.

Water Quality

Based on the water quality index, 16% of Gulf Coast waters are in good condition, 58% are rated fair, and 24% are rated poor. Phosphorus and chlorophyll a contribute most to the fair and poor water quality index scores in this region. The ratings of the component indicators are included below:

Phosphorus is found at low levels (rated good) in 19%, at medium levels (rated fair) in 35%, and at high levels (rated poor) in 44% of Gulf Coast waters.

Nitrogen is found at low levels (rated good) for 81%, moderate levels (rated fair) in 8%, and at high levels (rated poor) in 10%.

DO is found at high levels (rated good) in 65%, moderate levels (rated fair) in 24%, and low levels (rated poor) in 7%.

Water clarity is good in 61% of Gulf Coast waters, fair in 16%, and poor in 16%. Data are missing for 8%.

Chlorophyll a is found at low levels (rated good) in 23% of coastal area, at moderate levels (rated fair) in 56%, and at high levels (rated poor) in 17%.

Sediment Quality

Based on the sediment quality index, 54% of Gulf Coast waters are in good condition, 17% are in fair condition, and 25% are in poor condition. For the Gulf Coast region, sediment contaminant analyses indicate that 93% of coastal waters are in good condition, 3% are in fair condition, and

none are in poor condition. Sediment toxicity tests indicate that 46% of Gulf Coast waters are in good condition, 15% are in fair condition, and 25% are in poor condition. Sediment toxicity data are missing for 14% of Gulf Coast waters.

Ecological Fish Tissue Quality

Based on the ecological fish tissue contaminant index, 69% of the Gulf Coast area is in poor condition, 26% is in fair condition, and 0% is in good condition. Of the total area, 6% has not been assessed for fish tissue contaminants. The contaminants that most often exceed the LOAEL (poor) thresholds in the Gulf Coast are selenium, mercury, and arsenic.

Change in Gulf Coastal Condition

Change in Water Quality

The Gulf Coast shows statistically significant decreases in the percent area rated good for the water quality index across all three periods, from 1999–2001 to 2005–2006 (16%) and from 2005–2006 to 2010 (10%). Phosphorus, chlorophyll a, and (to a lesser extent) dissolved oxygen contribute most to this change. Other components of the water quality index show mixed change from one period to the next or change that is not statistically significant (Figure 4-12 and Table 4-5).

Change in Sediment and Biological Quality

The percent area rated good for the Gulf Coast sediment quality index decreases consistently over the three periods, with the 15% change from 2005–2006 to 2010 being statistically significant. This change is primarily due to sediment toxicity, which shows a 25% decline in area rated good during from 2005-2006 to 2010. For sediment contaminants, results show a different pattern of change (a consistent increase in the area rated good), although this change is statistically significant only between 1999–2001 and 2005–2006. Changes in the benthic index over time are variable, primarily due to the change in the percent area with missing data (Figure 4-13 and Table 4-6).”

In addition to being the name of the regional study area, the Gulf of Mexico is also mentioned in two highlights.

One highlight about the Gulf of Mexico is “NOAA Gulf of Mexico Offshore Surveys” on pages 51-56, with the following summary: “These NOAA Gulf survey results suggest that the majority of these offshore shelf waters (an estimated 84% overall) are in good condition based on present sampling, with the notable exception of impacts coinciding with the well-documented hypoxic

“dead zone” in the Mississippi River delta area. In an effort to be consistent with the underlying concepts and protocols of earlier programs, the indicators used in these offshore assessments include measures of stressors (e.g., chemical contaminants and symptoms of eutrophication), which are often associated with adverse biological impacts in shallower estuarine and inland ecosystems. However, there may be other sources of human-induced stress in these coastal-ocean systems, particularly those causing physical disruption of the seafloor (e.g., commercial bottom trawling, oil pipeline and platform placements, and minerals extraction) that may pose risks to living resources and that have not been captured adequately here.”

Another highlight about the Gulf of Mexico is “The Gulf of Mexico Oil Spill: Sediment Findings from the NCCA 2010” on pages 83-85, with the following conclusion: “Data show a significant increase in sediment toxicity in the DWH oil spill impact area from 2005-06 to 2010. This same pattern is seen nationally. Sediment contaminant data from the same area reveal no significant change. Because the NCCA sediment toxicity index reflects the cumulative, synergistic, and additive effects of all contaminants in sediment, it is not possible to establish a cause-effect relationship between the DWH oil spill and the increase in percent area rated poor for sediment toxicity. The suite of contaminants analyzed in each sediment sample does not include all of the constituents needed to confirm the presence or absence of oil released by the DWH spill or of dispersants used in subsequent remediation efforts.”

Title: National Lakes Assessment 2012

Year: December 2016

Authors: EPA

URL: <https://www.epa.gov/national-aquatic-resource-surveys/nla>

1. What is the document about?

The National Lakes Assessment 2012: A Collaborative Survey of the Lakes in the United States presents the results of a second evaluation of the biological, chemical, physical, and recreational condition of lakes in the United States, the first having been conducted in 2007.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

“The NLA offers a unique opportunity to frame discussions and plan strategies for the protection and restoration of lakes across the United States. Results of the NLA provide a broad range of information that can help us better understand the condition of lakes in the United States, some of the stressors affecting them, and how stressors relate to local conditions. While we explore associations between these indicators, the NLA analysis presented in this report does not seek to explain or identify the causes of degraded conditions or sources of stressors.”

3. What is/are the main idea(s)/finding(s) in the document?

“NLA 2012 Condition

The NLA indicates that nutrient pollution is common in U.S. lakes; 40% of lakes have excessive levels of total phosphorus and 35% have excessive levels of total nitrogen. Nutrient pollution is the most widespread stressor among those measured in the NLA and can contribute to algae blooms and affect public health and recreational opportunities in lakes.

An algal toxin, microcystin, is detected in 39% of lakes, but concentrations rarely reach moderate or high levels of concerns established by the World Health Organization (<1% of lakes).

The herbicide atrazine is detected in 30% of lakes, but concentrations rarely reach the EPA level of concern for plants in freshwater (<1% of lakes).

We find that 31% of lakes have degraded benthic macroinvertebrate communities, while 21% of lakes have degraded zooplankton communities. NLA exploratory analyses indicate an

association between nutrients and biological condition, with lakes with phosphorus pollution likely also to have a degraded biological condition.

NLA Change:

A comparison of the 2007 and 2012 National Lakes Assessments indicates little change between surveys. In most cases, the percentage of lakes in degraded biological, chemical and physical condition did not change at the national scale over this five-year period.

One notable exception to this pattern was observed with algal toxin measures. An analysis of cyanobacteria cell density, a measure of the density of cells that could produce cyanotoxins, shows a statistically significant increase (+8.3%) in the percentage of lakes in the most disturbed category between 2007 and 2012. The NLA identified a significant increase in the detection of microcystin among lakes in 2012 (+9.5%). However, concentrations of this algal toxin remained low and rarely exceeded WHO recreational levels of concern (<1% of the population) in both assessments.

Another difference emerged through additional in-depth analyses of nutrient data. While we did not observe changes in the condition categories, analysts found a dramatic 18.2% decline in the percentage of oligotrophic lakes (<10 µg/L of total phosphorus) and an overall increase in the median concentration of phosphorus across all lakes.”

4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

No.

5. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes, on page 14, which mentions that “the presence of natural organic compounds in the form of dissolved organic carbon, or DOC, can mitigate the effects of pH fluctuations.” in a section on Acidification.

6. Was “drainage” mentioned? If so, provide a summary including page numbers.

No.

7. Was “Texas” mentioned? If so, provide a summary including page numbers.

Yes, once in the Acknowledgements on page i (Texas Commission on Environmental Quality) and once in the Report Photographs [last page, no number] (Texas Parks and Wildlife Department).

8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No.

Title: National Rivers and Stream Assessment 2008-2009

Year: 2008-2009

Authors: EPA

URL: <https://www.epa.gov/national-aquatic-resource-surveys/nrsa>

1. What is the document about?

“The National Rivers and Streams Assessment 2008–2009: A Collaborative Survey (NRSA) presents the results of an unprecedented assessment of the nation’s rivers and streams. It encompasses a stunning range of waters -- from huge workhorse rivers that roll past our largest urban areas, to tiny undisturbed creeks tucked away in national parks, and everything in between. It provides information on the biological condition of the nation’s rivers and streams, the key stressors that affect them, and how the condition of small streams has changed since 2004.”

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

“The goals of the NRSA are to determine the extent of rivers and streams that support healthy biological condition and the extent of waters affected by a selected set of important stressors. This report does not track the origins of stressors in rivers and streams. It does provide background on the types of sources that are often associated with these stressors. In addition, the survey supports a longer-term goal: to determine whether our rivers and streams are getting cleaner and how we might best invest in protecting and restoring them.”

3. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

Yes, ten times.

In the Executive Summary (page xiv): “Of these, poor riparian vegetative cover and high levels of riparian disturbance are the most widespread stressors, reported in 24% and 20% of the nation’s river and stream length, respectively. These habitat conditions make rivers and streams more vulnerable to flooding, contribute to erosion and allow more pollutants to enter waterways.” In the Chapter 1. Introduction in “The nation’s rivers and streams” (page 1): “Over the centuries, we have radically changed most U.S. rivers and streams by interrupting their

flows with dams and levees; straightening and modifying their channels for irrigation, navigation or flood control; building our cities and developing our farmland in their watersheds and floodplains; withdrawing their water for our use; and discharging our waste materials into their flow. Our rivers and streams are also subject to influences such as seasonal, annual and climate-change induced variations in precipitation and temperature, as well as changing cycles of erosion and deposition (e.g., during flooding or dam releases).”

In the Chapter 1. Introduction in “Some facts about large rivers” (page 2): “The Missouri has been extensively dammed for irrigation, hydroelectricity and flood control, and its river basin is home to ten million people from 28 tribes, ten states and a small part of Canada.” In Chapter 3. Condition of the Nation’s Rivers and Streams in the section on Physical habitat stressors (page 35): “Human uses of the landscape, such as agriculture, forestry, construction, and urbanization, can increase the amount of fine sediments entering streams and rivers. The same types of land uses can also change the amount and timing of water runoff into channels, especially when they increase the amount of impervious land surfaces. Typically, these hydrologic alterations increase the frequency of high-magnitude floods, and channels can respond by down-cutting (incising), eroding their banks, and washing away important aquatic habitat.” And “For the NRSA, scientists measured the ratio between the particle size of observed sediments and the size of sediments each river or stream can move or scour during its flood stage; these measurements were taken based on measures of the size, slope and other physical characteristics of the stream channel.”

In Chapter 6. Ecoregional Results in the Introduction section (page 59) and in the Xeric section (page 88), which both discuss the Xeric ecoregion’s propensity for flash floods.

In Chapter 6. Ecoregional Results in the Coastal Plains section (page 72): “Historically, this ecoregion had extensive bottomlands that flooded for several months; these areas are now widely channelized and confined by levees.” This ecoregion includes our study area.

4. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes, in Chapter 3. Condition of the Nation’s Rivers and Streams (page 35): “The NRSA focuses on four indicators of physical habitat conditions in rivers and streams: streambed excess fine sediments, in-stream fish habitat, riparian (streamside) vegetation and riparian disturbance.

These indicators help document the impact of our human footprint across the landscape as well as the progress made through widespread protection and mitigation efforts.”

5. Was “drainage” mentioned? If so, provide a summary including page numbers.

Yes, it is mentioned twelve times.

In the Chapter 1. Introduction in the section “Some facts about large rivers” (page 2), which discusses the Mississippi river’s large drainage area.

In the Chapter 3. Condition of the Nation’s Rivers and Streams in the section on Acidification (pages 33-34) discusses acid mine drainage (7 occurrences).

In the Chapter 6. Ecoregional Results in the section for Coastal Plains (our study area) (page 73): “Acid mine drainage, urban runoff, air pollution, sedimentation and the introduction of invasive (i.e., non-native) species have affected riparian habitats and native aquatic fauna.” And another mention of the Mississippi’s drainage area.

In the Chapter 6. Ecoregional Results in the section for Xeric (page 88): “In southern areas of the ecoregion, internal drainages often end in saline lakes or desert basins without reaching the ocean (e.g., Utah’s Great Salt Lake).”

It is mentioned once in the Sources and References (page 116).

6. Was “Texas” mentioned? If so, provide a summary including page numbers.

Yes, it is mentioned seven times.

In the Chapter 2. Design of the National Rivers and Streams Assessment section on “What area does the NRSA cover?” (page 7), it mentions that annual precipitation exhibits a sharp change in Texas.

In the Chapter 2. Design of the National Rivers and Streams Assessment section on “What regions are used to report NRSA results?” (page 11), Texas is mentioned as part of the Southern Plains and Coastal Plains ecoregions, depending on the location within Texas.

In the Chapter 6. Ecoregional Results section on Coastal Plains Setting, eastern Texas is mentioned (page 72).

In the Chapter 6. Ecoregional Results section on Southern Plains Setting, central and Northern Texas are mentioned (page 80), as well as: “This ecoregion also contains a sizable portion of U.S. petroleum and natural gas production in Oklahoma, Kansas and Texas.”.

Texas is also mentioned twice in the Acknowledgements (page iv) (Texas Commission on Environmental Quality and Texas Parks and Wildlife Department).

7. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No.

8. What region-specific information can be obtained from the document?

The regional results for the Coastal Plains ecoregion (our study area):

“Biological condition

The macroinvertebrate MMI shows that 69% of river and stream length in the Coastal Plains ecoregion is in poor condition compared to least-disturbed conditions, 16% is in fair condition, and 14% is in good condition. The macroinvertebrate O/E taxa loss results show that 18% of river and stream length has lost more than 50% of the taxa expected to occur, and 34% of river and stream length has lost between 20% and 50% of expected taxa.

The fish MMI shows that 39% of river and stream length is in poor condition.

Thirteen percent of river and stream length is not assessed or, for various reasons, has insufficient data to calculate the fish MMI.

Indicators of stress of the indicators of stress measured for the NRSA, the most widespread in the Coastal Plains ecoregion are phosphorus, nitrogen, in-stream fish habitat, riparian vegetative cover and riparian disturbance. Compared to least-disturbed conditions for this ecoregion:

Phosphorus is at high levels (rated poor) in 39% of river and stream length, medium levels (rated fair) in 28%, and low levels (rated good) in

33%. Nitrogen is at high levels (rated poor) in 32% of river and stream length, medium levels (rated fair) in 27%, and low levels (rated good) in 41%. In-stream fish habitat is in poor condition in 24% of river and stream length, fair in 30%, and good in 45%.

Riparian vegetative cover is in poor condition in 18% of river and stream length, fair in 13%, and good in 69%. Riparian disturbance is rated poor in 13% of river and stream length, fair in 40%, and good in 47%.”

9. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

“A picture of the condition of the nation’s rivers and streams is emerging from this survey and its predecessor streams assessment. Nearly half of our rivers and streams exhibit poor biological condition based on macroinvertebrate communities. Phosphorus, nitrogen, and streambed sediments are associated with widespread impacts on biological integrity. Analyses indicate that reducing levels of these constituents may result in measurable improvement to the biological health of rivers and streams. This survey suggests the need to address the many sources of these stressors—including runoff from urban areas, agricultural practices and wastewater—in order to ensure healthier waters for future generations.”

Title: National Wetlands Condition Assessment 2011

Year: May 2016

Authors: EPA

URL: <https://www.epa.gov/national-aquatic-resource-surveys/nwca>

1. What is the document about?

“The National Wetland Condition Assessment (NWCA) 2011: A Collaborative Survey of the Nation’s Wetlands presents the results of the first national evaluation of the ecological condition of the nation’s wetlands. The NWCA is part of a broader effort by EPA and state, tribal, and federal partners to conduct national scale assessments characterizing the ecological condition of the nation’s waters. Under the National Aquatic Resource Survey (NARS) program, studies have been completed for wadeable streams (2004), lakes (2007), rivers and streams (2008-2009), and coastal waters (2010). The issuance of the NWCA 2011 report marks the completion of the first full-cycle of assessments by EPA and its partners under the NARS program.”

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

“Similar to the other NARS studies, the NWCA identified the following key goals for the project: Produce a national report describing the ecological condition of the nation’s wetlands and stressors commonly associated with poor condition; Collaborate with states and tribes in developing complementary monitoring tools, analytical approaches, and data management technology to aid wetland protection and restoration programs; and Advance the science of wetland monitoring and assessment to support wetland management needs.”

3. What is/are the main idea(s)/finding(s) in the document?

“The NWCA 2011 is the first national assessment of wetland ecological condition. This accomplishment required an extraordinary amount of effort and cooperation between state, tribal, and federal partners throughout its design and implementation. During the 2011 field season, more than 50 field crews sampled 1,179 wetland sites across the country, using standardized protocols to collect information to characterize wetland condition. Previous

wetland monitoring and assessment studies have been conducted at local and regional scales, or have focused on specific wetland types or ecological properties, but none have evaluated wetland condition for a full range of wetland types across the entire country. Thanks to the efforts of the field crews and many other partners, the NWCA collected the most comprehensive set of biological, physical, and chemical data on wetlands across the U.S. This national data set will provide valuable and previously unavailable information on the ecological condition of a broad range of wetlands to policy makers, land managers, and scientists. This includes important insight on wide-spread stressors impacting wetland biological condition, and the potential improvement that could be seen nationally by reducing these stressors.

The NWCA 2011 found 48% of wetland area is in good condition, based on the national Vegetation Multimetric Index (VMMI) developed for NWCA, while 32% of wetland area is in poor condition. Of the four major ecoregions reported on by NWCA, the West had the lowest percentage of wetland area in good condition at 21%. The Coastal Plains (50%), Eastern Mountains and Upper Midwest (52%), and Interior Plains (44%) have similar percentages of area in good condition as the national estimates.

Nationally, vegetation removal, surface hardening (e.g., pavement, soil compaction), and ditching are the most widespread of the indicators of stress evaluated in NWCA. Vegetation removal and surface hardening stressor indicators are high for 27% of wetland area, while the ditching stressor is high for 23% of wetland area. NWCA 2011 further found that wetlands with high stressor levels from vegetation removal and surface hardening are about twice as likely to have poor biological condition as those with low or moderate levels. Additional analysis that looks at how condition might improve if these two stressors are reduced, called attributable risk, suggests a possible 20% reduction in wetland area with poor biological condition if the stressor level was reduced from high to moderate or low.

Stressor levels for both of the soil indicators of chemical stress are low for the majority of wetland area nationally. However, moderate stressor levels for heavy metals are found in 47% of wetland area in the West and 31% of wetland area in the Eastern Mountains and Upper Midwest. Soil phosphorous stressor levels are also moderate or high for 22% and 13% of wetland area, respectively, in the Eastern Mountains and Upper Midwest.

NWCA conducted the first national study of algal toxins in wetlands. Microcystin, a toxin that can harm people, pets, and wildlife, was detected in 12% of wetland area nationally. However,

based on recreational exposure risk levels established by the World Health Organization, very little wetland area is found at either moderate or high risk levels.

Nationally, 61% of wetland area has low stressor levels from the nonnative plant indicator, but stressor levels varied by ecoregion. In the West, the majority of wetland area, 71%, has high or very high stressor levels from the nonnative plant indicator. In the Interior Plains, nearly half of the wetland area (46%) has high or very high stressor levels.”

4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

Yes, twelve times.

In the Executive Summary (page viii): “Wetlands help improve water quality by filtering pollutants, protecting downstream or coastal areas from floods and erosion, serving as homes or sources of food for a diverse and abundant range of species including humans, and offering places for recreation and scientific and cultural exploration.”

In the Chapter 1 Introduction section on “Why are wetlands important?” (page 4): “We now know that wetlands are a vital component of the nation’s waters and provide many crucial benefits including water quality improvement, flood abatement and carbon storage, biodiversity support, plus aesthetic, recreational, educational, and scientific opportunities.” And “Wetlands can act as natural sponges, capturing and slowly releasing surface water resulting from heavy rains, snow melt, and other floodwaters. Trees, grasses, and other wetland plants help slow the speed of floodwaters and disperse the excess water across floodplains. These processes lower flood heights, reduce erosion, and decrease the otherwise destructive effects of swiftly moving floodwaters. In addition, wetlands at the edges of lakes, rivers, bays, and the ocean buffer shorelines from the damaging effects of storm surges caused by hurricanes, tropical storms, and other powerful weather events.”

In a Highlight on the California coast (page 20): “wetlands along the coast face flooding from potential sea level rise.”

In Chapter 2 on Design of the NWCA in the “What data were collected and why?” section (page 23): “Algae: Algae respond quickly to ecological change in wetlands and have been widely used as indicators of recent changes in wetland condition because of their rapid reproduction rates, short life cycles, broad distribution, and sensitivity to changes in nutrient levels (McCormick and Cairns Jr. 1994). In addition, diatom species can provide insights into past hydrology such as recent flooding, standing water, or droughts (McCormick and Cairns Jr. 1994, USEPA 2002, Lane

and Brown 2007).” And on buffer: “In contrast, human-mediated disturbances to the buffer can be indicators of stress to wetland condition, or may directly cause stress. An example of this would be surface hardening (e.g., pavement, soil compaction) in the buffer which could alter the hydrology of a wetland by limiting the natural ability of soils in the buffer (and potentially the wetland) to soak up stormwater, thus increasing the potential for flooding or erosion to the wetland.”

In a Highlight on Nebraska (page 41) where historic flooding is mentioned.

In a Highlight on North Carolina, South Carolina, Alabama, and Georgia (page 65) where wetland condition information is said to “aid state and regional management decisions about wetland services such as flood control, water quality filtering, or the identification of restoration needs and opportunities.”

5. Were “mitigation” or “mitigate” or “mitigating” mentioned? If so, provide a summary including page numbers.

Yes, in Chapter 2 Design of the NWCA in the section “What data were collected and why?” (page 23): “The buffer can also reduce wetland disturbance from activities in adjacent areas and mitigate stressors that may affect wetland condition.”

6. Was “drainage” mentioned? If so, provide a summary including page numbers.

Yes, drainage is mentioned four times.

In Chapter 2 Design of the NWCA in the section “What data were collected and why?” (page 23) mentions drainage ditches as an alteration to water flow and retention in the Hydrology section.

In the Highlight of Minnesota (page 73), where drainage history is mentioned twice.

In the Highlight of the Gulf of Mexico (page 9), where drainage areas are shown in a map. This is our study area.

7. Was “Texas” mentioned? If so, provide a summary including page numbers.

Yes, Texas is mentioned six times.

Texas is mentioned in the Acknowledgements (Texas Commission on Environmental Quality) (page i).

The other occurrences are in the Chapter 4: Ecoregion and Wetland Type Results for the Coastal Plains region (page 60-63), for the Interior Plains region (pages 76-79), and for the West Ecoregion (pages 80-83).

8. Were Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, Orange, Polk or Tyler Counties (of Texas) mentioned? If so, provide a summary including page numbers.

No.

9. What region-specific information can be obtained from the document?

Coastal Plains Ecoregion Results (part of our study area):

“Summary of findings

A total of 513 randomly selected sites were sampled in the Coastal Plains ecoregion during the 2011 field season, representing 30,893,305 acres. Of the total number of Coastal Plains sites sampled, 62 are inland herbaceous wetlands, representing 3,750,551 acres, and 163 are inland woody wetlands, representing 21,859,265 acres. Estuarine wetlands in the Coastal Plains include 288 sites, representing 5,283,489 acres. Detailed results for estuarine wetland types are reported in the Estuarine Wetlands section of this chapter.

Biological Condition

For all wetland types assessed in the Coastal Plains (Figure 4-2), 50% of the estimated wetland area is in good condition; 21% is in fair condition and 29% is in poor condition based on the Vegetation Multimetric Index (VMMI) (see Chapter 2 for details on the VMMI). The proportion of wetland area in good (50%), fair (26%), and poor (25%) is similar for inland woody wetlands in this ecoregion. The NWCA found that the proportion of inland herbaceous wetlands in poor condition, however, is much larger, 59%, than the proportion of inland woody wetlands in poor condition (Figures 4-3 and Figure 4-4).

Indicators of Stress

For all wetland types assessed in the Coastal Plains, vegetation removal, ditching, and surface hardening are the indicators with the greatest proportion of wetland area at high stressor levels (Figure 4-2). However, the majority of wetland area throughout the ecoregion has low levels for each of the stressors. Key findings include:

Vegetation removal is high for 25% of the wetland area compared to moderate for 21% and low for 54% of wetland area.

Hardening levels are high in 23% of wetland area, while 9% and 69% of wetland area have moderate or low stressor levels, respectively.

Ditching is high in 21% of the wetland area, moderate in 5%, and low in 74%.

For inland wetland types assessed within the Coastal Plains ecoregion (Figures 4-3 and 4-4), data show:

More than half of the area assessed for inland herbaceous wetlands has high stressor levels associated with vegetation removal (61%), hardening (57%), and ditching (52%).

The most prevalent stressors at high levels for inland woody wetlands are also vegetation removal (24% of wetland area), hardening (20%), and ditching (16%), but these high stressor levels are a smaller proportion of wetland area compared to the herbaceous wetlands.

The extent of high levels of vegetation removal, damming, ditching, hardening, and filling/erosion stressors are greater in inland herbaceous wetlands than in inland woody wetlands. Very high and high levels for the nonnative plant stressor indicator are also greater in herbaceous wetlands.”

Summary of the Estuarine Wetlands (part of our study area):

“Summary of findings

The 327 randomly selected estuarine wetland sites that were sampled in the NWCA represent an estimated 5,485,646 acres. Estuarine wetlands are reported separately for herbaceous and woody types. Estuarine herbaceous wetlands (salt marshes) are evaluated based on 258 randomly selected sites, which represented an estimated 4,987,824 acres. Estuarine woody wetlands (deciduous or evergreen woody dominated wetlands, mangrove swamps) represent a smaller proportion of the wetland area, 497,821 acres, based on evaluation of 69 sites.

Biological Condition

Estuarine herbaceous wetlands have an estimated 58% of wetland area in good condition, 17% in fair condition, and 26% in poor condition (Figure 4-14) based on the VMMI (see Chapter 2 for details). Estuarine woody wetlands have an estimated 59% of wetland area in good condition, 20% in fair condition, and 22% in poor condition (Figure 4-15).

Indicators of Stress

Stressor level is generally low for all indicators of stress for both estuarine herbaceous and estuarine woody wetlands. For the estuarine herbaceous wetlands the indicators of stress with the greatest estimated wetland area at high stressor levels are ditching (18%), surface hardening (11%), and damming (10%). In addition, high or very high levels for the nonnative plant stressor total 24% of estuarine herbaceous wetland area. Soil phosphorus stressor levels are low for 37% of herbaceous wetland area, moderate for 28%, and high for 2%. Soil phosphorus and soil heavy metal stressors are not assessed for 33% of the wetland area, due to difficulties collecting soil samples at some sites.

In the estuarine woody wetlands, the indicators of stress with the greatest estimated wetland area at high stressor levels are ditching (18% of wetland area) and hardening (13%). The heavy metals stressor is at low levels for 44% of wetland area, but at moderate levels for 55%. Less than 1% of estuarine woody wetland area is at high stressor levels for heavy metals.”

There is a Highlight called “Gulf of Mexico Coastal Wetlands Pilot Project: Setting the Stage for the NWCA” on pages 9-10.

The objectives of the pilot project are: “The EPA, in collaboration with the United States Geological Service (USGS), implemented a pilot project along the northern coast of the Gulf of Mexico (GOM) in order to evaluate the effectiveness of a three-tier survey framework for regional wetland assessment. The results of the pilot study provided insight into the usefulness of the chosen indicators in determining condition and provided several “lessons learned” that were beneficial to the development of the NWCA 2011.”

“Overall, the GOM coastal wetlands pilot project highlighted the great cooperation and effort necessary to conduct a regional condition assessment, and it provided critical information and lessons learned that informed planning efforts and development of the NWCA 2011.”

10. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

“For resource managers and other decision-makers, the NWCA provides important information about the condition of wetlands and several wide-spread stressors influencing their biological condition. Additionally, the results point to potential improvement in condition that might be seen nationally by reducing these stressors. The NWCA found that wetlands with high levels of vegetation removal and surface hardening stress are about twice as likely to have poor biological condition as those with low or moderate levels of these stressors. Further analysis

that looks at how condition might improve if these two stressors are reduced, called attributable risk, suggests a possible 20% reduction in wetland area with poor biological condition if the stressor level changed from high to moderate or low.

The NWCA developed a robust VMMI that was successfully used to evaluate the condition of wetlands across major ecoregions and wetland types. In addition, NWCA developed several indicators of stress based on readily collected field data and used these to evaluate the relationship between common stressors and biological condition. NWCA scientists also conducted research into other potential indicators of wetland condition, and while not highlighted in this public report, findings from this research will help inform future scientific studies.

The NWCA marks a beginning in our endeavors to assess wetland condition nationally. Work conducted under the NWCA has advanced the state of science into indicators of wetland condition and improved our ability to evaluate wetland condition at national and regional scales. Subsequent studies and research by EPA, states, and other partners will continue to build upon the knowledge gained through the NWCA and allow us to further explore and evaluate the condition of wetlands at multiple scales. We will be better able to answer important policy and management questions about the overall health of this critical resource, and design effective strategies to fulfill the objectives of the federal Clean Water Act—to restore and maintain the chemical, physical, and biological integrity of the nation’s waters.”

Title: Improving the EPA Multi-Sector General Permit for Industrial Stormwater Discharges

Year: 2019

Authors: National Academies of Sciences, Engineering and Medicine

EPA Number: N/A, ISBN 978-0-309-48846-4 | DOI 10.17226/25355

URL: https://www.freshlawblog.com/wp-content/uploads/sites/15/2019/08/NASEM_Improving-the-EPA-Multi-Sector-General-Permit-for-Industrial-Stormwater-Discharges.pdf

1. What is the document about?

This document reports on a study by the National Academies of Sciences, Engineering and Medicine on certain aspects of the industrial stormwater program, with an emphasis on monitoring requirements and retention standards. The document also includes committee review and recommendations regarding current industrial stormwater discharge regulations.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

Taken directly from the document: “The purpose of this report is to address several concerns related to the stormwater monitoring in the MSGP (Multi-Sector General Permit).”

3. What are the needs and recommendations provided by stakeholders?

Taken directly from the document: “In this report, the committee recommends updating MSGP benchmark monitoring requirements and thresholds using a periodic review process to incorporate the latest science and monitoring information into each permit revision. Additionally, the committee recommends allowing more sophisticated monitoring methods, training, and support for enhanced data analysis tools within the MSGP. The committee recommends risk-based tiered monitoring requirements to improve the quality of data from the largest, high-risk facilities, while moderating the burden on the lowest-risk facilities.”

4. What is/are the main idea(s)/finding(s) in the document?

Three major sections:

- (1) Pollutant Monitoring Requirements and Benchmark Thresholds;
- (2) Stormwater Sampling and Data Collection;
- (3) Consideration of Retention Standards in the MSGP

5. Was “Texas” mentioned? If so, provide a summary including page numbers.

No.

6. Are there any examples of volume-based stormwater retention standards in this document?

There are multiple standards for retention criteria for different jurisdictions listed on page 87 in the document, though Texas is not on the list.

Title: Municipal Separate Storm Sewer System MS4 Program Evaluation Guidance

Year: 2019

Authors: U.S. EPA Water Permits Division

EPA Number: EPA-833-R-07-003

URL: https://www3.epa.gov/npdes/pubs/ms4guide_withappendixa.pdf

1. What is the document about?

This document is a guidance to assist state NPDES (National Pollutant Discharge Elimination System) permittees assess compliance with Phase I and MS4 programs, develop SWMP, assess pollutants of concern, and provide federal assistance.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

Taken directly from the document: “The purpose of this Guidance is to provide NPDES permitting authority staff the information and questions necessary to conduct a comprehensive MS4 program evaluation and determine if the permittee is implementing the program in order to reduce pollutants discharged to the MEP. This Guidance is not intended to be used as a checklist, but rather as a reference to prepare for and conduct an MS4 evaluation. The evaluator must ultimately rely on personal experience and best professional judgment (BPJ) to conduct a comprehensive MS4 program evaluation.”

3. What is/are the main idea(s)/finding(s) in the document?

Taken directly from the document:

“The National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Program Evaluation Guidance (Guidance) is intended to assist State and NPDES permitting authority staff to:

- Assess the compliance and effectiveness of Phase I and Phase II MS4 programs;
- Develop Phase II MS4 stormwater management programs (SWMPs);

- Assess pollutants of concern;
 - Provide technical assistance”
4. Were “flood” or “flooding” mentioned? If so, provide a summary including page numbers.

Yes. This document asks permittees to make sure that the impacts on water quality in flood management projects are assessed, and that on existing flood control devices have been evaluated. It also listed several Flood management program records that the permittees are asked to review on page 46. Criteria on flood management are also mentioned on page 49 and 119.

5. Was “Texas” mentioned? If so, provide a summary including page numbers.

No.

Title: Technical Guidance on Implementing The Stormwater Runoff Requirements For Federal Projects Under Section 438 Of The Energy Independence And Security Act

Authors: U.S. EPA Office of water

EPA Number: EPA 841-B-09-001

URL: https://www.wbdg.org/FFC/EPA/EPACRIT/epa_841b09001.pdf

1. What is the document about?

This document is a guidance for requirements for federal agencies to reduce stormwater runoff from federal development projects to pre-development conditions to protect water resources.

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

Taken directly from the document: “The purpose of this document is to provide technical guidance and background information to assist federal agencies in implementing EISA Section 438. Each agency or department is responsible for ensuring compliance with EISA Section 438. The document contains guidance on how compliance with Section 438 can be achieved, measured and evaluated. In addition, information detailing the rationale for the stormwater management approach contained herein has been included.”

“This document is intended solely as a guidance. This document is not a regulation nor does it substitute for statutory provisions or regulations. This guidance does not impose any legally binding requirements on federal agencies and does not confer any legal rights or impose legal obligations upon any member of the public. This document does not create a cause of action against the EPA, other federal agencies, or the United States.”

3. What is/are the main idea(s)/finding(s) in the document?

The report contains two parts: 1. Implementation Framework and 2. Case Studies on Capturing the 95th Percentile Storm Using Onsite Management Practices.

In this study, 9 scenarios were listed to show the feasibility to for stormwater management to retain 95% of the runoff on site. “Scenarios 1-8 are examples of sites where it was technically

feasible to design the stormwater management system to retain the 95th percentile storm onsite. Scenario 9, however, was provided as an example of an METF analysis where site constraints allowed the designers to retain only 75% of the 95th percentile storm.”

“The second section of this document contains nine case studies that are intended to be representative of the range of projects that are subject to the requirements legislated in Section 438 of the Energy Independence and Security Act. The facility examples in the case studies were selected to illustrate project scenarios for differing geographic locations, site conditions, and project sizes and types.”

4. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

Through demonstration and calculation for 9 scenarios, this study concludes that GI/LID systems could be implemented to various climate and soil conditions. The recommendation of this study is that although the GI/LID system is capable to manage stormwater in a variety of scenarios, there are many other stormwater management options available outside the analyses from this document, and that site managers will have additional flexibility by looking at these options.

9. Was “Texas” mentioned? If so, provide a summary including page numbers.

No.

Title: Urban Stormwater Management in the United States

Year: 2008

Authors: National Research Council (The National Academies)

URL: https://www3.epa.gov/npdes/pubs/nrc_stormwaterreport.pdf

1. What are the documents?

The document is a summarizing report for a research study conducted at the request of EPA to review its current (previously current) permitting program for stormwater management and discharge under the Clean Water Act and provide suggestions for improvement. Specifically:

1a. Clarify mechanisms by which pollutants in stormwater discharge affect ambient water quality.

1b. Consider how useful monitoring is for determining the potential of discharge to contribute to water quality standards violations and for determining adequacy of stormwater pollution prevention plans

1c. what specific pollutant should be monitored? Where?

1d assess the relationship between levels of stormwater pollution plan implementation and in-stream water quality concerning Best Management Practices (BMP's)

1e. Asses the design of the stormwater permitting program under CWA

2. Who are in charge of the documents and their implementation?

- This specific document is not for implementation but an overarching study and review of current stormwater management practices. However, the stormwater management practices addressed in the document are generally implemented by the federal government under the Clean Water Act or U.S. EPA stormwater program.

3. When were the documents developed/updated?

2008

4. What are the most essential products from the documents?

- Recommendations from the academies based on extensive research and review study of the current stormwater permitting and monitoring under the CWA
- A review of hydrologic, geomorphic and biological effects of urbanization on watershed with recommendations
- Specific policy recommendations regarding MS4's and industry monitoring
- An argument for a more comprehensive best management practices (BMP's), also referred to as stormwater control measures (SCM's) in the document, implementation and review
- The appendices provides valuable information on specifics on modeling software such as (Appendix D) SWAT, WinSLAMM (the Source Loading and Management Model) and SWMM (version 5).
 - o Appendix C – summaries of responses from a questionnaire sent to a group of state stormwater managers; many questions are similar to the ones asked in Task 3 of this GLO project.
 - o Appendix B - provides a comprehensive list of terms often associated with SCM's/hydrology/general stormwater management.

5. Are policies or guidelines in the documents uniformly implemented, or is there a high degree of variation in the implementation?

The stormwater program is uniformly implemented; however there are specific Act's within the program that allow states to adopt their own state implementation plans. Page 40 provides a timeline of legal and regulatory milestones of the stormwater program which briefly highlights implementation.

6. What is (are) the most influential factor(s) affecting quality or effectiveness of the documents?

This is a very high quality document complete with case studies and specific examples easily interpreted by the public. It provides key information in tables, highlighted boxes and

7. What region-specific issues can be identified from the federal document(s)?

Chapter 2 provides some historical insight is provided about Texas and the EPA stormwater program and MS4s, permit coverage specifics in comparison to other states, a case study from Austin, Texas on citizen involvement in stormwater regulation (CWA Section 505).

Chapter 3, again highlights Austin, Texas in another case study on urbanization decline of biological assemblages.

Chapter 5 discusses stormwater management approaches and includes a portion about groundwater/subsidence in Texas.

Overall, this document could be useful on a regional/ statewide scale because it summarizes the practices of other states and draws out key comparisons, highlighting successes and failures in stormwater management and monitoring.

8. How can the documents be improved in terms of communications with the users of the products?

There are no recommendations for improving communication.

9. What are the future directions of improving the documents?

Future direction in improving the documents would namely be updating the document with a review of how practices have changed or improved nationwide since the original publication in 2008.

Title: Stormwater Wet Pond and Wetland Management Guidebook

Year: 2009

Authors: EPA

EPA Number: EPA 833-B-09-001

URL: <https://www3.epa.gov/npdes/pubs/pondmgmtguide.pdf>

1. What are the documents?

Primarily guidance for **phase I and II National Pollutant Discharge Elimination System (NPDES) communities** for developing integrated stormwater management systems; including proper management of existing wet ponds, wetlands etc.. These practices in this guidebook are not required by federal law but are meant to help in maintain Best Management Practices (BMP's).

2. Who are in charge of the documents and their implementation?

This material is based on an original publication for the Center for Watershed Protection, but republished by EPA - **these are not required/implemented, only guidance.**

3. When were the documents developed/updated?

Revised and re-published in February of 2009

4. What are the most essential products from the documents?

- BMP's for Wet Pond and Wetland maintenance and establishment
- Maintenance activity profile sheets
- Unit costs for pond and wetland maintenance (example/case study)
- Pond and wetland checklists
- Technical data and information to help improve existing design standards

5. Are policies or guidelines in the documents uniformly implemented, or is there a high degree of variation in the implementation?

6. What is (are) the most influential factor(s) affecting quality or effectiveness of the documents?

The documents provide a lot of the basics required for BMPs such as tables and checklists to walk through typical inspection/maintenance for ponds, maintenance activities and a corresponding typical schedule for existing ponds and wetlands, and how to address specific failures (step –by step) for detention features.

The document is extremely visual and straight forward, providing schematics and photos and examples when applicable.

7. What region-specific issues can be identified from the federal document(s)?

The document is applicable to any phase I and II National Pollutant Discharge Elimination System (NPDES) communities, but has no specifics for Texas or the Gulf Coast.

8. How can the documents be improved in terms of communications with the users of the products?

The document is well-organized and extremely detailed making it easy for readers to follow. There are no suggestions to make toward improvement at this time, other than updating the document with new information and BMPs since original publication in 2009.

9. What are the future directions of improving the documents?

The document could be improved with large scale case studies or adding a chapter with region specific challenges (ie relating to climate, topography, ecology etc.). It would also be beneficial that the user understand the advantages of installing and maintaining a natural system like a wet pond or wetland versus an engineered structure.

Title: National Water Quality Inventory: Report to Congress

Year: 2017

Authors: EPA

EPA Number: EPA 841-R-16-011

URL: <https://www.epa.gov/waterdata/national-water-quality-inventory-report-congress>

1. What are the documents?

This is a report summarizing findings from two complimentary sources: 1. National Aquatic Resource Surveys (NARS) and 2. Site-specific assessment results reported by EPA sites and loaded into the Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS). The report and surveys were developed in response to critiques about water quality monitoring and subsequent reporting process; they cover the following bodies of water:

- Rivers and streams
- Lakes, ponds and reservoirs
- Coastal waters
- Wetlands

Within each category of water body the following categories are covered:

- Key findings from the national surveys including: biological quality, sediment quality, ecological fish tissue contaminants
- Key findings from the state or site specific assessments including (change per water body category)

2. What is the purpose of the documents:

- The National Water Quality Inventory is required and prepared under Section 305(b) of the Clean Water Act; it draws from two types of information on water quality. 1. The EPA national aquatic surveys and 2. Local, site-specific assessment results reported from state agencies.

3. Who are in charge of the documents and their implementation?

N/A - There is no implementation for this report; it is a summary of current conditions written by EPA to congress

4. When were the documents developed/updated?

The report was published in 2017 but draws from the aquatic surveys conducted or 2008, 2010, 2011 and 2012.

5. What are the most essential products from the documents?

6. Are policies or guidelines in the documents uniformly implemented, or is there a high degree of variation in the implementation?

N/A - There is no implementation for this report; it is a summary of current conditions written by EPA to congress

7. What is (are) the most influential factor(s) affecting quality or effectiveness of the documents?

Numerical values and statistics; how these statistics have changed over time in regard to water quality are the most effective at conveying the current state of national surface water quality

8. What region-specific issues can be identified from the federal document(s)?

- Minimal; the intent of this document is to summarize the state of *national* water quality. However, there are some sections broken into West, East and Plains.
- The assessment on coastal waters is based on an analysis of indicators of ecological conditions in the coastal waters (including the Gulf Coast).
- The assessment on wetland health provides an isolated assessment on wetlands in the coastal plains

9. How can the documents be improved in terms of communications with the users of the products?

N/A - This document is neither particularly relevant to the Gulf Coast or to the goal of this project (GLO) nor is it intended as guidance for a user of a product or policy.

10. What are the future directions of improving the documents?

The documents seem to convey the intended information in an organized, concise format. There are no improvement suggestions to provide.

USDA Documents

Title: Report to Congress USDA-NRCS Watershed Protection and Flood Prevention Program Multi-Year Plan

Year: 2015

Authors: USDA-NRCS

URL: <http://www.watershedcoalition.org/wp-content/uploads/2016/02/Watershed-Protection-and-Flood-Prevention-Program-Multi-Year-Plan-2-22-16.compressed.pdf>

1. What is the document about?

This multi-year plan describes near-term needs including the existing approved project backlog, remediation of existing structures, and emerging needs, along with a process for guiding future investments to improve watershed condition. The Watershed Program can provide a valuable tool for agriculture and rural communities across the Nation to address serious water management threats from extreme drought to unprecedented flooding.

2. What is/are the main idea(s)/finding(s) in the document?

NRCS will use the prioritization process outlined in this plan to focus funding on the highest priority projects for improving watershed condition and building landscape resilience and preserving, protecting, and improving the Nation's land and water resources and quality of the environment.

The watershed projects which in this program all have five authorized purposes, which are flood prevention, watershed protection, agricultural water management, municipal and industrial water supply and fish and wildlife habitat and public recreation development.

3. What are the needs and recommendations provided by stakeholders?

- 1) Focus investments on agricultural water supply and resilience to climate change;
- 2) Include forest restoration on private lands to protect water supplies as a priority;
- 3) Align investments with other agencies where possible to maximize impact;
- 4) Establish a continuing review and ranking of watershed projects;
- 5) Advocate for legislative changes to streamline implementation.

4. What are the future needs for improving watershed condition and mitigating potential for watershed impairment?

A process based on State and National priorities is needed. NRCS is working on establishing it. The process will include an annual announcement program funding (APF) that will outline the specific state and national priorities to be emphasized in the funding year. This allows the agency to focus funding effectively, while providing flexibility over time to accommodate emerging watershed protection priorities.

5. What national priorities will be taken into consideration for ranking project proposals?
 - 1) Partner leverage and contributions;
 - 2) Positive return on investment and higher benefit–cost ratio;
 - 3) Contributions to a regional water management need or concern;
 - 4) Benefits in high-poverty or historically underserved communities;
 - 5) Durability of water management solutions for the benefitted area (e.g., economic benefits exceed estimated operation and maintenance (O&M) costs for the long term; local O&M assured; success of the project is not dependent on environmental or economic factors outside the project area).

Documents created by Disaster Medical Assistance Team

Title: Hurricane Katrina (OR-2 DMAT) After Action Report: New Orleans Airport, August 31-September 10, 2005

Year: 2005

Authors: Dr. Helen Miller, Joel McNamara, Dr. Jon Jui

URL: <https://www.hsdl.org/?abstract&did=766144>

1. What is the document about?

The report focuses on the response and recommendations of the Disaster Medical Assistance Team from August 31 to September 10, 2005 of Hurricane Katrina which made landfall in the United States.

2. What location does the document cover?

The document covers the assistance to New Orleans, Louisiana.

3. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The purpose of this AAR is to identify issues and areas of improvement and to present a roadmap for any additional assessment and improvements that may need to be made for the assistance team.

4. What is/are the main idea(s)/finding(s) in the document?

There were twelve focus areas: (1) Command (2) Planning (3) Public Information (4) Operations (5) Logistics and Supply (6) Pharmacy (7) Transportation (8) Communications (9) Security (10) Evacuees (11) Personnel (12) Health. The major issues are lack of resources and ineffective communications and operations.

5. What is/are the conclusion(s)/recommendation(s)/implication(s) of the document?

Besides several recommendations based on the focus area, there were also some suggestion and recommendation for the cooperating agencies like FEMA/NDMS. During the disaster, the communication of different agencies and assistance team wasn't very effective, which leads to some disorganized operations. The report recommends that FEMA/NDMS should provide better and more structured orders.

USACE Documents

Title: Coastal Texas Protection and Restoration Feasibility Study

Year: 2018

Authors: USACE

URL: https://www.swg.usace.army.mil/Portals/26/docs/Planning/Public%20Notices-Civil%20Works/Coastal-TX%20DIFR-EIS/Coastal%20Texas%20DIFR-EIS_Oct2018.pdf?ver=2018-10-24-162409-300

1. What is the document about?

In November 2015, USACE began the Coastal Texas Protection and Restoration Feasibility Study (Coastal Texas Study) to determine the feasibility of alternatives to enhance, restore, and sustain the environment, economy, and culture along the Texas coast. The document is Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS).

2. What is/are the purpose(s)/goal(s)/objective(s) of the document?

The study determined the feasibility and impacts of constructing large-scale coastal storm risk management (CSRMM) and ecosystem restoration (ER) alternative plans to restore and enhance the State's ecologic coastal features and reduce the risk of coastal storm damage. The CSRMM alternative plans consist of structural features that include levees, floodwalls, surge barrier gates (both navigable and environmental flow control gates), and breakwaters. The ER alternative plans consist of nonstructural features that include habitat restoration and shoreline erosion control through marsh, beach/dune, and island restoration.

3. What is/are the main idea(s)/finding(s) in the document?

The document details the examination and selection of the Tentatively Selected Plan (TSP).

4. What region-specific information can be obtained from the document?

As the two coastal counties in the whole nine counties, Chambers and Jefferson face problems related to the following five aspects:

- 6) Coastal communities including residential populations and the petrochemical industry becoming increasingly vulnerable to life safety and economic risks due to coastal storm events;
 - 7) Critical infrastructure throughout the region including hurricane evacuation routes, nationally significant medical centers, government facilities, universities, and schools becoming more at risk of damage from coastal storm events;
 - 8) Existing Hurricane Flood Protection Systems, including systems at Port Arthur, which do not meet current design standards for resiliency and redundancy and will be increasingly at risk from storm damages due to RSLR and climate change;
 - 9) Degradation of nationally significant migratory waterfowl and fisheries habitats, oyster reefs, and bird rookery islands within the study area occurring due to storm surge erosion; and
 - 10) Water supply shortages due to increasing conflicts between municipal and industrial water supply and the ecological needs of coastal estuaries and ecosystems.
5. What are the causes and potential risks associated with identified regional problems?

Stressors like catastrophic weather, coupled with a rise in relative sea level, have taken a toll on coastal areas. Relative sea levels could rise by 1 to 6 feet over the next 50 years. Also, major coastal storms could increase in intensity, and the intensity of precipitation events is likely to increase. For instance, the Galveston area experiences a major hurricane on average every 18 years. Storm surge from Hurricane Ike reached 20 feet and pushed water almost 30 miles inland in places. A 4-foot increase in sea level could affect a quarter of interstates and arterials and nearly 75 percent of port facilities on the Gulf coast. As a result, all of the biological and economic resources along the Texas Gulf coast face challenges.

In addition, Substantial Gulf shoreline and barrier beach erosion, greater than 30 feet per year in some areas, compromises risk reduction of communities, industry, critical infrastructure, and coastal habitats making them more vulnerable to storm surge and flood damage.

6. What tentative solutions to the identified regional problems were proposed?

In Chambers County, a major tentative plan was the “Coastal Barrier with complementary system of nonstructural measures”, or the Alternative A in the document. This alternative was developed to address storm surge flooding at the Gulf interface and to also include the highest number of structures and critical facilities within the alignment. The alignment would provide risk reduction to the critical GIWW by maintaining the existing geomorphic features along Bolivar Peninsula and Galveston Island. The planning strategy included preventing storm surge from entering Galveston Bay with a barrier

system across Bolivar Peninsula, a closure at the pass at Bolivar Roads, improvements to the Galveston seawall, and a barrier along the west end of Galveston Island. To address wind-driven surges in the bay, which could impact both the back side of Galveston Island and the upper reaches of the bay, nonstructural measures, such as ring levees and closures on key waterways, have been included in the system. This particular solution will reduce economic damage from coastal storm surge flooding to businesses, residents, and infrastructure in the areas of the Galveston Bay system, with the worth of \$970 million to \$1.288 billion in total equivalent annual hurricane/tropical storm surge damages during a period of analysis from 2035-2085.

APPENDIX E – Links to Library Documents, Data, Apps, Instructional Videos, and Computer Code

[Library Documents](#) briefly summarizes relevant documents, and provides further links to allow them to be read on-line or downloaded.

[Vector Data](#) presents descriptions of shapefiles and images of their coverage, and links for downloading.

[Raster Data](#) presents descriptions of digital elevation models, lidar data, and other raster data, and images of their coverage. It also provides links for downloading, or instructions on how to obtain the data.

The library includes several instructional videos for viewing apps:

[Introductory Video for the General User](#) demonstrates the capabilities of the apps and how to use them to the beginner.

[Video for the Authorized User](#) shows how authorized users may delete, edit or add layers of information appearing in the app.

The [viewing app portal](#) provides access to the seven viewing apps.

[Primary Vector Database](#) describes PrimaryVectorDB, the main vector database resulting from this contract, in a PostgreSQL geojson format, with the PostGIS extension enabled, and links to that database.

[Computer code](#) provides python script that processes vector datasets before they are uploaded into the PrimaryVectorDB and into each of the apps. The script also documents that process. Script that was used to upload vector data into PrimaryVectorDB is also shown.

APPENDIX E – Links to Library Documents, Data, Apps, Instructional Videos, and Computer Code

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The library includes several instructional videos for viewing apps:

[Introductory Video for the General User](#) demonstrates the capabilities of the apps and how to use them to the beginner.

[Video for the Authorized User, Part I](#) shows how authorized users may delete or add layers of information appearing in the app.

[Video for Authorized User, Part II](#) shows how authorized users may edit data in columns of information that appear in the popup when clicking on the associated feature on the map, or to add entirely new columns.

[Video for Authorized User, Part III](#) shows how authorized users may convert a .shp file into a .csv file using a Python Jupyter notebook. [How to Install Jupyter Notebook](#) and [How to Create a Jupyter Notebook](#) demonstrate how to be set up to apply the code, so that converting from .shp to .csv is possible.

[Video for Authorized User, Part IV](#) shows how authorized users may create .kmz files in Google Earth, and then convert to .csv and add attributes for the features created in Google Earth, so that the .csv can then be brought into one or more of the viewing apps.

The [viewing app portal](#) provides access to the seven viewing apps.

[Primary Vector Database](#) describes PrimaryVectorDB, the main vector database resulting from this contract, in a PostgreSQL GeoJSON format, with the PostGIS extension enabled, and links to that database.

[Computer code](#) provides python script that processes vector datasets before they are uploaded into the PrimaryVectorDB and into each of the apps. The script also documents that process. Script that was used to upload vector data into PrimaryVectorDB is also shown.

APPENDIX F – Stakeholder Input Online Survey

GLO - Stakeholder Input Survey

SURVEY OF FACTORS LEADING TO REPETITIVE FLOODING EVENTS IN SOUTH EAST TEXAS



The purpose of this survey is to collect preliminary information on factors leading to repetitive flooding events in south East Texas. Your responses herein will assist the researchers to build guidance and aid in the recovery from future flooding events. Please answer as many questions as you can based on your area of responsibility and experience.

Demographic and Contact Information:

1. County:

Chambers

Hardin

Jasper

Jefferson

Liberty

Newton

Orange

Polk

Tyler

2. Name:

3. Organization:

4. Position:

5. Years of Experience in Current Position:

6. Phone Number:

7. Email:

FACTORS LEADING TO REPETITIVE FLOODING EVENTS:

The following questions aim to capture your experiences regarding drainage and flooding problems and projects within your area of experience. Please answer as many questions as you can.

8. What are the drainage references (documents/plans/standards/guidelines) currently being used in your area of responsibility?

9. Describe, briefly, the regulatory process needed to design and implement a drainage project in your area of responsibility?

10. Are there any frequently encountered drainage problems in your area of responsibility?

Yes

No

11. Explain the frequently encountered drainage problems:

12. What procedures are needed to address common drainage issues in your area of responsibility?

13. Are the procedures different for major storms?

Yes

No

14. What are the main differences?

15. Do you see any problems or limitations associated with these procedures?

Yes

No

16. Describe these problems or limitations:

17. What are the major drainage-related problems that occurred due to hurricane Harvey and its aftermath?

18. What drainage projects were implemented to address these problems (if any)?

19. Where you able to address all problems resulting from Harvey?

Yes

No

20. What problems were you unable to address?

PERSONAL ASSESSMENT

Based on your experience, what are your thoughts about the following flood mitigation/prevention approaches:

21. Updating flood maps to be utilized to determine the Base Flood Elevation:

22. Elevating critical systems, facilities, and roadways above base flood elevation:

23. Installing backup power generators for critical systems (water, sewer, etc.):

24. Avoiding an increase in impervious cover by keeping projects in their original footprint:

25. Encouraging the use of building practices that allow for more pervious coverage:

26. Replanting with only native vegetation to preserve the natural environment.

27. Storm water management including installing retention basins, larger culverts and debris

28. Guards, erosion control solutions

29. Back-up communication systems

30. Supporting local community efforts to enhance building codes and regulations

ADDITIONAL CONTACTS

Are there any additional contacts you can propose that could provide input on these issues?

31. Please provide the name and contact information (phone & email) for each contact you propose:

Thank you very much for your input.

APPENDIX G – Stakeholder Questionnaire

GLO PROJECT QUESTIONS

DEMOGRAPHIC QUESTIONS

Name:

County:

Organization:

Position:

Years of experience in current position:

Overall years of experience:

Phone:

Email:

CONTENT QUESTIONS

- ***Drainage References*** (documents/plans/standards/guidelines)
 - What are the drainage references (documents/plans/standards/guidelines) currently being used in your area of responsibility?
 - How effective is the information in these references?
 - Likert scale of 1-7 (very ineffective to very effective)
 - Do you see any problems and/or limitations associated with the use of these references?
Yes – No
 - If yes, please describe these problems and/or limitations
 - Do you see a need to adopt alternative references?
Yes - No
 - What alternative references would you like to adopt?
 - Any specific suggestions for improvement?

- ***Documentation and Regulatory:***
 - Describe, briefly, the regulatory process needed to design and implement a drainage project in your county?
 - Do you see any problems or limitations associated with these procedures?
What changes would you propose to the current documentation requirements and processes?
 - Any specific suggestions for improvement?

- ***Frequently Encountered Drainage Problems***

- Are there any frequently encountered drainage problems in your area of responsibility? If so, please describe them.
How are these problems typically addressed?
- Any specific suggestions for improvement?
-
- ***Procedures used to address common drainage issues***
 - What procedures are needed to address common drainage issues in your area of responsibility?
 - Do you see any problems or limitations associated with these procedures?
 - What changes would you propose to the current procedures?
- ***Procedures used to address drainage issues associated with major storms***
 - Are the procedures different for major storms?
 - Do you see any problems or limitations associated with these procedures in regards to major storms?
 - What changes would you propose to the current procedures?
- ***Procedures used to address drainage issues associated with storm surge***
- ***Response to Major Storms***
 - What are the major drainage-related problems that occurred due to hurricane Harvey and its aftermath?
 - What drainage projects were implemented to address these problems (if any)?
 - What was the cost of these projects?
 - Were there any problems or limitations associated with any of these projects (e.g. availability of funds, approval process, technical problems, etc.)
 - Where you able to address all problems resulting form Harvey?
Yes – No
 - If not, what issues remain unresolved and could reoccur if another hurricane hits?
- ***Opinions about specific drainage issues (e.g., natural drainage)***
- ***Drainage district issues***
- ***Collaboration/coordination among agencies***
- ***Community engagement***

- **Emergency Management and Infrastructure Rehabilitation Processes:**
 - In your county (area of responsibility) are infrastructure rehabilitation projects managed at the local or regional levels?
 - What are the advantages and disadvantages of local control from your point of view?
 - What are the advantages and disadvantages of regional control from your point of view?
 - How would you evaluate current disaster response and recovery processes in your area of responsibility?
 - Likert scale of 1-7 (very ineffective to very effective)
 - What changes (if any) are needed in these disaster response and recovery processes?
 - At the local level?
 - At the regional level?
 - At the state level?
 - At the federal level?
 - Please describe the cumulative impact of previous major storms on the infrastructure in your county (area of responsibility).
 - Did Harvey impact any sites within your area of responsibility that are considered to be at risk by the Texas Coastal Resilience Study? If so, please identify the sites and describe the impacts?
 - Were any of the improvements identified in the Texas Coastal Resilience Study implemented in your area of responsibility? If so, please describe.
 - Do you have any opinion regarding the FEMA Public Assistance Program?
 - How do you achieve the balance between rebuilding and prioritizing resiliency?
 - Describe the level of cooperation and coordination during the assessment, planning, construction, and post-construction monitoring stages of a typical infrastructure project?
 - What would suggest increasing that level of cooperation and coordination
 - Who typically conducted the needed planning studies for your infrastructure projects:
 - Vendors
 - Research institutions
 - Describe the advantages and disadvantages of each?
 - Do you conduct a cost-benefit analysis for infrastructure projects in your area of responsibility?
 - Yes – No
 - If yes, who conducts the analysis?
 - If no, why? What is needed for this analysis to be conducted?
 - Do you leverage the experience of the local Council of Government?
 - Yes – No
 - If no, why? What is needed for you to be able to do so?
 - How familiar are you with existing certification programs such as Enterprise Green Communities, LEED, and ICC-700 National Green Building Standard?
 - Likert scale for each program & other
 - Has your community pursued certification under any of these programs in the past?
 - If yes, describe the project and the program.
 - If no, why?

- How would you evaluate the role of community engagement in implementing infrastructure projects?
- Describe the community engagement activities and processes that you typically perform within infrastructure projects?
- Based on your experience, please comment on the following funding-related processes:
 - o Granting communities access o funding for costs deemed allowable for each specific program.
 - o Using purchasing as a flood control measure.
- Based on your experience, what are your thoughts about the following flood mitigation/prevention approaches:
 - o Updating flood maps to be utilized to determine the Base Flood Elevation
 - o Elevating critical systems, facilities, and roadways above base flood elevation.
 - o Installing backup power generators for critical systems (water, sewer, etc.).
 - o Avoiding an increase in impervious cover by keeping projects in their original footprint
 - o Encouraging the use of building practices that allow for more pervious coverage.
 - o Replanting with only native vegetation to preserve the natural environment.
 - o Storm water management including installing retention basins, larger culverts and debris
 - o Guards, erosion control solutions.
 - o Back-up communication systems.
 - o Supporting local community efforts to enhance building codes and regulations.