CITY OF CONROE MASTER DRAINAGE PLAN

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REASONS FOR A DRAINAGE MASTER PLAN

A drainage master plan will act as a roadmap for the City to effectively address flood issues
 It will also help the City be prepared to apply for flood mitigation grants when they become available



TYPICAL GRANT APPLICATION REQUIREMENTS

- Project Description & Type
- Project Cost

Project Benefits

- Project Impacts
- Drainage master planning
- Benefitted population and Census Data





STUDY GOALS



Not CoveredPartially CoveredCovered in Presentation

PROJECT SCOPE OF WORK



FLOOD RISK EVALUATION

WITH RAPID ASSESSMENT MODELING





RAPID ASSESSMENT DRAINAGE MODELING

- 2D drainage models were developed to model both riverine and urban flooding (covers <u>entire watershed</u>)
- High-level modeling with higher detail added in critical areas
- Helped identify flood patterns and areas with high flood risk





RAPID ASSESSMENT | HEC-RAS 6



FEATURES OF HEC-RAS 6

2D Mesh – fast and easy development of high-level hydrologic and hydraulic modeling Precipitation and Infiltration easier and more spatially accurate, hydrologic modeling **2D** Connections (bridges and culverts) - localized detailed modeling **Terrain Modifications** - more efficient alternative analysis **Raster Calculator** – more <u>efficient</u> benefit / impact analysis



RAPID ASSESSMENT | 2D MESH



model the flow of water in two dimensions. ■ Each cell develops a stage-volume curve based on the underlying terrain (think storage area) ■ Each cell face develops a stagedischarge curve based on the underlying terrain (think cross section)

 \square A 2D mesh = 2D cells that can



RAPID ASSESSMENT | RAIN ON MESH

- Precipitation applied directly to the model
- Infiltration and runoff determined at each cell (no basin runoff parameter weighting)
- Covers entire watershed
- Removes need for complex hydrologic analysis (routing, etc.)

Rain on mesh hydrology simplifies the hydrologic analysis





RAPID ASSESSMENT | LAND USE LAYER



LAND USE LAYER

■ Used to develop: Manning's n layer (hydraulics) ■ Infiltration layer (hydrology) National Land Cover Database used as a base ■ Base Layer Cleanup Recent changes based on latest aerial imagery ■ Added detail missing from database

RAPID ASSESSMENT | TERRAIN LAYER





TERRAIN LAYER

 LiDAR is typically used as base and modified in RAS Mapper
 LiDAR is available for the entire state of Texas
 TNRIS.org



RAPID ASSESSMENT | TERRAIN CONDITIONING





TERRAIN CONDITIONING

- New terrain tools allow for rapid modification / conditioning
 Bridges and culverts are not included in the terrain dataset
 Removed structures from the terrain to keep positive drainage throughout the model
 "Purping" or "Conditioning"
- "Burning" or "Conditioning"



RAPID ASSESSMENT | RESULTS

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RAPID ASSESSMENT | RESULTS









RAPID ASSESSMENT | PROBLEM AREA IDENTIFICATION



PROBLEM AREA IDENTIFICATION Modeling allows evaluation of common areas of flooding Other metrics also used: ■ Areas identified by City Staff ■ Areas with repetitive loss structures Correlated to historical flooding Assists in targeting improvements ■ Identified 22 problem areas (+10) backup) to develop projects for the City

18

RAPID ASSESSMENT | PROBLEM AREA IDENTIFICATION

Watersh ed	ldentified Area Number	Identified Area Name	Modeling Re	sults	Repetiti ve Loss	City Identifi ed	Tier	Potent ial Project ID
White Oak Creek North	1	Teas Lakes	4	:	L	NO	3	
	2	Teaswood	8	1	2	YES	2	22
	3	White Oak and O'Grady	4	٤	3	YES	3	
	4	Longmire & SH- 105	18	3	3	NO	1	1
Live Oak	5	Forest Estates	13	5	5	NO	1	2
Branch	6	Loop 336	4	:	L	NO	3	
	7	Magnolia & Owen	5	2	1	NO	3	
Artesian Creek	8	Artesian Forest 1	20	٤	3	YES	1	
	9	Artesian Forest 2	31	-	L	YES	1	3
	10	Artesian Forest 3	14	ļ	5	YES	1	
	11	Magnolia	4	1	5	NO	3	
	12	Maple	8	1	5	NO	3	
	13	N. Roberson	13	2	2	NO	1	4
	14	East Fork North	41	4	1	NO	1	5
	15	Woody Creek	4	2	2	NO	2	23
	16	Lilly	8	4	1	NO	1	6
	17	West Branch	33	9	Ð	NO	1	7
Alligator	18	East Fork South	32	3	3	NO	1	8
Creek	19	Oakdale	7	:	L	YES	3	
	20	Oak Hollow	32	ļ	5	NO	1	9
	21	Cable	16	3	3	NO	1	10
	22	N. Downtown	26	:	L	NO	2	24
	23	Madeley	6	:	L	NO	2	25
	24	Silverstone	25	()	NO	2	26

Watersh ed	ldentified Area Number	ldentified Area Name	Modeling Results	Repetitiv e Loss	City Identifie d	Tier	Potenti al Project ID
	25	S. Frazier	12	5	NO	1	11
Grand	26	The Reston	9	2	NO	2	27
Lake Creek	27	Rivershire East	42	7	YES	1	12
	28	Rivershire West	174	5	YES	1	13
Sliverdal	29	Sliverdale	4	1	NO	3	
e Creek	30	Baretta	13	5	NO	1	14
	31	Hillcrest	3	1	NO	3	
	32	Valley	5	3	NO	1	15
	33	Hunnington	35	11	YES	1	16
	34	Woodside Manor	7	1	NO	3	
Stewarts	35	Woodland	17	1	NO	3	
Creek	36	Possum Branch	95	2	NO	2	28
	37	East Davis	13	3	NO	1	17
	38	Stewarts Trib	50	1	NO	2	29
	39	Avenue M	54	4	YES	1	18
	40	South 3rd	9	3	NO	1	19
	41	Trinity Park	49	0	YES	2	30
Little	42	Toby	16	3	YES	1	20
Creek	43	Bretton Woods	2	2	NO	2	31
	44	Southern Oaks	21	16	YES	1	21
	45	McDade Estates			YES	3	
West	46	Magnolia & Maple			YES	3	
Fork	47	Sports Park			NO	3	
	48	Sherbrook			YES	3	
Lake	49	Commanche	20	2	No	3	
Conroe Estates	50	Rush Creek Lake	21	4	Yes	1	32

RAPID ASSESSMENT | DETAILED MODELING



DETAILED MODELING

 Additional modeling detail is added to the model at problem areas
 "Zoom-in" approach
 Added definition

 More detail to Land Use layer
 Add Culverts
 Add Bridges

 Urban Modeling (ICM)

RAPID ASSESSMENT | DETAILED MODELING



URBAN FLOODING

HEC-RAS

- Can model surface water in urban settings
- Cannot easily and accurately model flow through storm sewer
- Subtract storm sewer level of service flow from Rain on Mesh Analysis
- Infoworks ICM
 - Detailed analysis of identified urban problem areas
 - Needed for interconnected storm sewer network to model flow
 - 2D surface / 1D subsurface

21

RECOMMENDATIONS

DRAINAGE IMPROVEMENTS





DRAINAGE IMPROVEMENTS | PROJECTS



PROJECTS

 Analyze the problem areas to identify the best solution for flood risk reduction
 Establish a target and a metric for

success

- Reduce 100-YR flooding depths
- Reduce structural flooding
- Provide no negative impacts

23

DRAINAGE IMPROVEMENTS | TYPES OF IMPROVEMENTS

	Project ID	Identified Area Name	Mitigation Solution					
Watershed			Improve Channel / Ditch	Diversion Channel	Improve Bridge / Culverts	Benching	Upsized Storm Sewer	Pond
Live Oak	1	Longmire & SH-105	\checkmark		\checkmark			
Branch	2	Forest Estates	\checkmark		\checkmark			
Artesian	3	Artesian W.						\checkmark
Creek	4	Artesian E.	\checkmark		\checkmark			
	6	Lilly					\checkmark	
	7	East Fork N.			\checkmark	\checkmark		
Alligator	8	East Fork S.			\checkmark	\checkmark		
Creek	9	W. Branch			\checkmark	\checkmark		
	10	Oak Hollow	\checkmark		\checkmark			
	11	Cable					\checkmark	
	12	S. Frazier					\checkmark	
Grand Lake	13	Rivershire E.	\checkmark		\checkmark			
Сгеек	14	Rivershire W.	\checkmark	\checkmark	\checkmark	\checkmark		
Silverdale Creek	15	Baretta	\checkmark				\checkmark	
	16	Valley	\checkmark		\checkmark			
Stewarts	17	Hunnington			\checkmark	\checkmark		
Creek	18	Avenue M			\checkmark	\checkmark		
	19	S. 3rd	\checkmark		\checkmark			
Little Caney	20	Toby				\checkmark		
Creek	21	Southern Oaks		\checkmark	\checkmark	\checkmark		
Lake Conroe Estates	22	Rush Creek Lake						

TYPES OF IMPROVEMENTS

- Detention Ponds
- Channelization
- Creek Benching
- Crossing Improvements
- Storm Sewer Improvements



DETENTION PONDS

 Can be modeled using RAS Terrain editing tools
 Ponds built using the RAS terrain editing tools
 Pulls flows out of creek near crest of design storm
 Reduces flow downstream and, in turn, mitigates flood risk

DRAINAGE IMPROVEMENTS | CHANNELS



CHANNELIZATION

- Can be modeled using RAS Terrain editing tools
- Channels widened and deepened to increase conveyance capacity
 Only used for widening existing concrete channels

26

DRAINAGE IMPROVEMENTS | BENCHING



BENCHING

- Can be modeled using RAS Terrain editing tools
- Used for increasing conveyance capacity for natural creeks
 Reduces environmental impacts when compared to channelization
 Maintains floodplain overbank storage thus reducing downstream impacts
 Con: larger footprint = large land

acquisition

27

DRAINAGE IMPROVEMENTS | CROSSINGS



CONTROLLING RESTRICTION

 HGL slopes were used to determine controlling restriction
 Crossings were considered controlling where the HGL was shallower than normal depth (i.e.

backwater)

 An iterative approach was sometimes necessary to achieve the target WSEs while ensuring an efficient recommendation
 Switching between structure adjustments and creek

adjustments

DRAINAGE IMPROVEMENTS | CROSSINGS





DRAINAGE IMPROVEMENTS | STORM SEWER



STORM SEWER

Focused on trunk line location and sizing
 Inlets assumed full conveyance
 Added detail during design



DRAINAGE IMPROVEMENTS | RESULTS



RESULTS ANALYSIS

 Depth-difference rasters were used to analyze benefits
 Can add or subtract water surface elevation grids to show changes
 Can color code and add contours for better visualization of benefits and impacts

Note: ROG models create lensing distortions that need to be edited for any final mapping products

DRAINAGE IMPROVEMENTS | RESULTS



OTHER RECOMMENDATIONS

- Mapping updates
- Full update to Drainage Criteria Manual
- Add rain, stage, and flow gages
- Implement a flood warning system
- Additional Drainage Studies
 - Downtown
 - April Sound
 - Lake Conroe Estates





Figure 3-1 Flood Map Quality Rating

IMPLEMENTATION STRATEGY

RANKING, FUNDING, AND STATE FLOOD PLAN





IMPLEMENTATION PLAN | OVERVIEW



IMPLEMENTATION

- A detailed implementation plan helps guide the next steps
- Short term and long-term strategies to improve flood resiliency

IMPLEMENTATION PLAN | PRIORITIZATION

Historical Damages	 Number of FEMA repetitive losses in watershed 		
Cost	 Construction, right of way acquisition, environmental mitigation, engineering design and survey, and flood mitigation 		
Repetitive Losses Removed	Number of repetitive losses removed from 1% ACE floodplain	7 COMPARISON	
Other Structures Removed	Number of other structures removed from 1% ACE floodplain	METRICS	
Roadway	Reduction in water overtopping roads		
Social Vulnerability Index	Measure of community resilience		
Low & Moderate Income	 Measure of family incomes compared to regional averages 		



IMPLEMENTATION PLAN | PRELIMINARY RANKING

Project Project ID Rank		t Identified Project	Ctructural Mitigatian Mathad	Structures F from 1%	Cost	
		Name	Structural mitigation method	Historically Flooded	Other	(\$M)
4	4	Artesian East	Channel Widening / Larger Crossings	5	14	1.3
6	6	Lilly	Storm Sewer Improvements	4	5	1.9
16	12	Valley	Channel Widening / Larger Crossings	3	5	0.5
12	15	South Frazier	Storm Sewer Improvements	3	-	0.3
19	20	South 3rd	Channel Widening / Larger Crossings	2	1	0.4
17	1	Hunnington	Benching / Larger Crossings	9	18	24.2
3	2	Artesian West	Detention Pond	5	13	6.8
9	3	West Branch	Benching / Larger Crossings	5	11	5.2
15	5	Baretta	Storm Sewer Improvements	5	13	3.7
21	7	Southern Oaks	Benching / Larger Crossings	9	6	17.2
18	8	Avenue M	Benching / Larger Crossings	2	42	17.8
13	9	Rivershire East	Channel Widening / Larger Crossings	6	20	11.7
7	10	East Fork North	Benching / Larger Crossings	4	12	4.5
10	11	Oak Hollow	Channel Widening / Larger Crossings	3	16	24.8
14	13	Rivershire West	Benching / Larger Crossings	5	140	30
2	14	Forest Estates	Channel Widening / Larger Crossings	4	9	7.5
11	16	Cable	Channel Widening / Larger Crossings	3	7	8.2
20	17	Toby	Benching	2	11	4.1
8	18	East Fork South	Benching / Larger Crossings	2	11	6
1	19	Longmire & SH-105	Channel Widening / Larger Crossings	2	13	9.6

*ranking is preliminary and subject to change



Short

Term

Long

Term

37

LONG TERM (OVER 5-YEARS)

- Long-term projects with large funding needs or significant constraints
- Can continue to study with available funds to further identify constraints and identify potential paths forward
- Waiting for disaster or relief funding from federal or state agencies

SHORT TERM (5-YEARS)

- Identifying and securing project teams
- Policy improvements to reduce future flood risk
- Property buyouts
- Remapping initiatives
- Flood warning (gages & alerts)
- Short term projects that have access to funding and limited constraints



IMPLEMENTATION PLAN | FUNDING

- Various funding sources are available at both the state and federal level
- Each funding vehicle has its own specific criteria and stipulations
- Stay involved with your local Council of Governments (HGAC) and the State Flood Plan to ensure the City's flood mitigation needs are being noted and staff is aware of up-coming funding opportunities

Federal

- **CDBG-DR:** Community Development Block Grant Disaster Recovery
- CDBG-M
 - Community Development Block Grant Mitigation
- FMA
 - Flood Mitigation Assistance
- CWSRF
 - Clean Water Act State Revolving Fund

State		
 FP Flood FIF Flood 	Protection Grant Infrastructure Fund	



IMPLEMENTATION PLAN | STATE FLOOD PLAN



- Texas' first State Flood Plan will be completed in 2024
- Conroe is located within Region 6 San Jacinto Regional Flood Planning Group
- It is vital for the City's flood mitigation and management needs to be included in the plan in order to receive future grant funding
- The projects developed as part of this study have been included in the draft plan



QUESTIONS?

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