APPENDIX A
PROJECT MANAGEMENT MEETINGS
Appendix A.1

Kickoff Meeting
### STUDY PARTNERS KICKOFF MEETING AGENDA

**Study Partners: HCFCD, City of Houston, Montgomery County, SJRA**

April 8, 2019  
San Jacinto River Regional Flood Mitigation Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Kickoff Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>2:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>4:00 PM</td>
</tr>
</tbody>
</table>

#### Agenda

1. **Introductions (HCFCD Leadership/Matt)**

2. **Project Goals and Objectives (Halff)**
   *Conduct a comprehensive Flood Mitigation Plan of the San Jacinto River Basin*
   - Primary Mitigation Planning
   - Secondary Mitigation Planning
   - Other Mitigation Actions
   - Community Outreach and Education

3. **Project Scope Overview (Halff)**
   - Project Management and Coordination
   - Data Collection and Review
   - Existing Conditions Flood Hazard Assessment (Approximately 535 stream miles)
   - Analysis of Historical Storms
   - Future Flood Risk Planning Assessment
   - Primary Flood Mitigation Planning
   - Secondary Flood Mitigation Planning
   - Other Flood Hazard Mitigation Action
   - Community Outreach and Education
   - Final Deliverables

4. **Project Schedule Overview (Halff)**
   - Existing Conditions H&H and Calibration Memo – October 2019
   - Future Conditions Memo – December 2019
   - Sedimentation and Vegetation Control Memo – January 2020
   - Alternative Funding Memo – March 2020
   - Primary Flood Mitigation Memo and Implementation Memo – June 2020
   - Secondary Flood Mitigation Planning Memo – November 2019
   - Other Mitigation Actions Memorandum – February 2020
   - Draft Report – July 2020
   - Final Report – August 2020
5. **Project Deliverables (Halff)**  
   - Overview of what specific items and recommendations will be delivered at the end of the study

6. **Work Flow (Halff)**  
   - All deliverables and communication sent through HCFCD; Progress will continue  
   - Four weeks total review time for Existing Conditions and Primary Alternatives: two-week initial review for all partners, one week consultant response, one week final comment to reach preliminary resolution on questions and items  
   - Four weeks agency review time for Draft Report, four weeks for Halff to address comments

7. **Vegetation and Sediment Control (FNI)**  
   - Overview of Process and Goals

8. **Methodology Discussion (Halff)**  
   - *Terrain* data based on HGAC 2018 LiDAR and other pre-2018 sources  
   - Atlas 14 Rainfall using HC regions and calculated 24-hour depths for Montgomery and surrounding counties  
   - Initial and Constant for loss parameters and BDF methodology for transform parameters  
   - New models using LiDAR dataset; Existing HC models adjusted as needed to facilitate the study goals  
   - Future conditions (50-year horizon, Ultimate development)  
   - FEMA BCA using county appraisal district data; LiDAR elevations + additional for FFE  
   - Model calibration using 3-storms (Harvey + 2 Others)

9. **Data Collection Requests (Halff/FNI)**  
   - HCFCD will provide the majority of the data (Terrain, Models for Spring, Cypress, etc.)  
   - Reports and data from SJRA, MCO, COH  
   - Dredging and bathymetry from USACE, TWDB, CWA

10. **Public Education and Outreach (HCFCD Communications/Crouch)**  
    - Discuss current scope  
      - Informational material and graphics for web-copy and social media  
      - 2-3 standardized presentations study partners can use for meetings  
      - Talking points  
      - Does not include public meetings  
    - Addressing questions  
      - Study specific  
      - Other projects conducted by study partners  
      - Media inquiries  
    - Web-Presence  
      - Public comment form currently available on project webpage  
      - Individual project webpages vs one study website  
    - HCFCD’s obligation to conduct public outreach within Harris County as part of the 2018 Bond Program (to be pursued through a separate contract and funding)
### 11. Project/Partner Accounting, Coordination and Communication Protocol (HCFCD PM/Jing)
- Accounting protocols
- Joint invoice review timeframe for partners (5 working days)
- One working contact person from each study partner
- Project questions, inquiries, requests come through HCFCD PM

### 12. Questions
SAN JACINTO
Regional Watershed Master Drainage Plan

Study Partners Kickoff Meeting
April 8, 2019
Plan Goals

• The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  – Conduct a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Develop approaches to enhance public information and flood level assessment
  – Evaluate flood mitigation strategies to improve long-term resilience
Plan Objectives

- The plans specific objectives are:
  - Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  - Secondary Mitigation Planning (Flood Assessment/Warning)
  - Other Mitigation Actions (Communications Protocols, Flood Response)
  - Community Outreach & Education (Drainage, Maintenance, Projects)
# San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Project Scope

• Project Management and Coordination
  – HCFCD Executive Briefings (2)
  – Briefings with SJRA, Montgomery County, City of Houston (2)
  – Coordination Meetings with Supporting Partners (5)

• Data Collection and Review
  – Terrain, Gage Data, Historical Events, Models, Flood Data, Reports, etc.
  – Field Reconnaissance Visits
  – Model and Data Evaluation
  – Field Survey Data
Project Scope

• Existing Conditions Flood Risk Assessment
  – Runoff Risk (Hydrology) – Update baseline and verify calculated flows
    • Comprehensive hydrologic model of the basin
    • Update loss and transform parameters
    • Develop to work with Unsteady HEC-RAS modeling
  – Flood Hazard Assessment (Hydraulics) – Develop unsteady RAS models
    • Convert existing models from Steady to Unsteady
    • Update parameters and flow data from hydrologic models
    • Develop inundation mapping

• Analysis of Historical Storms
  – Evaluate several historical storms using updated hydrologic model
  – Calibrate models to match historical stage and flow data within tolerance
  – Finalize existing conditions models
Project Scope

• Future Flood Risk Planning Assessment
  – Estimate future conditions in the watershed without mitigation measures
  – Update hydrologic and hydraulic models to reflect future conditions

• Primary Flood Mitigation Planning (Flood Mitigation)
  – Primary Alternatives – Identify and evaluate top 4 pre-proposed projects*
  – Secondary Alternatives – Identify and evaluate up to 5 additional projects*
  – Identify ROW, environmental, utility and other issues
  – Evaluate alternative funding opportunities
  – Develop and implementation plan
  – Vegetation and sediment control plan

* May include policy changes such as land use or detention
Project Scope

• Secondary Flood Mitigation Planning (Flood Warning)
  – Coordinate with partners* to discuss potential expansion to the Flood Warning System
  – Evaluate current system and make recommendations for additional ALERT 2 Rain and Stage gages

• Other Mitigation Actions (Flood Response)
  – Meet with partners* discuss existing protocols and develop strategies to improve flood mitigation actions
  – Develop a communications plan/protocol for partners to facilitate information sharing in a timely fashion
  – Locate critical infrastructure
  – Identify evacuation routes and access during flood events

* HCFCD, SJRA, MCO, COH, TXDOT, HCOEM, MCOEM
Project Schedule

- Major Project Milestones
  - Existing H&H and Calibration Memorandum – 10/14/19
  - Primary Alternatives Analysis Memorandum – 6/9/2020
  - Vegetation and Sedimentation Control Memorandum – 1/6/20
  - Draft Report – 7/6/20
  - Final Report – 8/31/20
Project Deliverables

- Existing H&H and Calibration Memo
- Primary Alternatives Analysis Memo
- Draft and Final Report
  - Process, Methodology, Recommendations
  - Implementation Plan – Specific projects with budget and priority
  - Vegetation and Sedimentation Plan
- Supporting Data (Digital)
  - PDF version of the report, exhibits, appendices
  - Spreadsheets used for parameter calculations
  - Final HMS/RAS models
  - GIS Data (Geodatabase)
  - Photos

*Digital copies will be provided to study partners through HCFCD*
Project Work Flow

- All deliverables and communications sent through HCFCD
- Four week review time for Existing Conditions and Primary Alternatives
  - Two week initial review (study partners)
  - One week consultant response
  - One week resolution of questions
  - *Does not mean all modeling is updated, just comments and questions are considered and any issues resolved*
- Four weeks agency review time for Draft Report
- Four weeks for Halff to update and submit Final Report
Vegetation and Sediment Control

• **Goal of Sediment Management Strategy is to:**
  – Provide benefit to Flood Risk Reduction
  – Reduce Maintenance Requirements

• **Tasks to be performed:**
  – Review existing studies, data, and recommendations
    • Sedimentation Rates
    • Historic changes in stream alignments
    • Ongoing maintenance requirements
  – Identify possible sources of sediment contribution
  – Determine possible impacts of sedimentation on flooding
  – Develop mitigation measures to minimize future sedimentation
    • Upper watershed Management Strategies
    • Riverine Management Strategies
    • Regulatory Management Strategies
Project Methodology

- Terrain based on 2018 HGAC LiDAR and other pre-2018 data
- Atlas 14 Rainfall (Weighted average 24-hr depths by watershed)
- Initial and Constant loss parameters
- Basin Development Factors (BDF) method for Clark UH
- New hydraulic models use 2018 LiDAR or best available data
- Existing hydraulic models adjusted as needed
- Model calibration using 3 storms
  - Hurricane Harvey (2017)
  - Tax Day Flood (2016)
  - October 1994 Storm
- Future conditions (50-year horizon)
- FEMA BCA using county appraisal data, LiDAR for FFE est.
Atlas 14 Rainfall Values

West Fork San Jacinto River-Conroe Lake: 13.98 in

East Fork San Jacinto River: 14.56 in

Tarkington Bayou-Lucy Bayou: 16.97 in

Canyon Creek-Lake Creek: 14.66 in

Crystal Creek-West Fork San Jacinto River: 16.46 in

Sicastreek-Cato Creek: 16.17 in

East Fork San Jacinto Marsh Forkat Lake Houston: 17.03 in

Little Cypress Creek-Cypress Creek: 16.18 in

Frontal Lake Houston: 17.37 in

Sources: HESS, WERES, Watershed Assessment Corp., OCBOG, USGS, FAO, NRCS, CADAS, TRCA, KADASAR, NC. Geographic Data, Environmental Survey, NJ. ICES, Sheng Shu (Hong Kong), operators. © OpenStreetMap contributors, and the GIS User Community.
Data Collection Requests

• HCFCD is providing majority of the data
  – Combined terrain dataset (HGAC 2018, others)
  – M3 models of Spring, Cypress, Little Cypress, Willow Creeks
  – HCFWS gage data

• Additional reports and data from SJRA, MCO, COH appreciated

• Dredging and Bathymetry from USACE, TWBD, CWA
Public Education and Outreach

• Current Scope
  – Material and graphics for web-copy and social media
  – Standardized presentations study partners can use for presentations
  – Talking points
  – Public meetings NOT included

• Addressing Questions
  – Questions specific to the San Jacinto FMP
  – Other projects conducted by study partners
  – Media Inquiries

• Web Presence
  – Public comment form is available on the HCFCD website
  – Individual project webpages vs. one study website

• HCFCD is obligated to conduct public outreach within Harris County per the 2018 Bond Program (Separate Contract)
Accounting, Coordination, Communication

- Accounting Protocols
- Joint Invoice Review – Five (5) working days for partners
- One (1) working contact person per study partner
- All project questions, inquiries, requests will be directed to the HCFCD Project Manager (J. Chen)
Questions?

Study Partners Kickoff Meeting
April 8, 2019
## MEETING MINUTES

### To:
Jing Chen, P.E., CFM

### From:
Terry Barr, P.E., CFM

### Subject:
Upper San Jacinto River Regional Flood Mitigation Plan – Study Partners Kickoff Meeting

### Attendees:
- Marcus Stuckett, HCFCD
- Gary Bezemek, HCFCD
- Jing Chen, HCFCD
- Ataul Hannan, HCFCD
- Craig Maske, HCFCD
- Rob Lazarro, HCFCD
- Susan Wheeler, HCFCD
- Jeremy Ratcliff, HCFCD
- Matt Barrett, SJRA
- Chuck Gilman, SJRA
- Diane Cooper, Montgomery County
- Darren Hess, Montgomery County
- Gary Hill, City Houston PW
- Cliff Edwards, HCP4
- Jeremy Phillips, HCP2 (Phone)
- Terry Barr, Halff
- Sam Hinojosa, Halff
- Andrew Moore, Halff
- Hector Olmos, Freese & Nichols
- Cory Stull, Freese & Nichols
- Conner Strokes, Crouch
- Leslie Halloway, Crouch

### Meeting Date:
04/8/2019 – 2:30 pm

### Location:
HCFCD, Brookhollow Office

### Minutes Date:
4/16/2019

### AVO No.:
033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Meeting Introduction</td>
<td>Mr. Stuckett introduced the project meeting followed by introductions from each study partner. The meeting agenda was provided to the group (See attached agenda for reference). Mr. Barr discussed the intent of the meeting, which was to discuss the project scope and coordination</td>
</tr>
<tr>
<td>2.</td>
<td>Project Goals and Objectives</td>
<td>Mr. Barr reviewed the overall study goals and objectives. Ms. Cooper asked what type of historical rainfall will be used. Mr. Stull stated that gridded rainfall adjusted by gauge data would be used. Ms. Cooper asked how the model will incorporate new development and gap development. Mr. Stull stated that the plan will follow the water projection approach which looks at potential development over 50 years. Drainage criteria changes may be considered as mitigation options.</td>
</tr>
<tr>
<td>3.</td>
<td>Project Scope Overview</td>
<td>Mr. Barr presented the major items in the scope of the study which included: Project Management, Data Collection, Existing Conditions, Analysis of Historical Storms, Future Flood Risk Planning, Primary and Secondary Flood Mitigation Planning, and Other Mitigation Actions.</td>
</tr>
<tr>
<td>4.</td>
<td>Project Schedule Overview</td>
<td>Mr. Barr presented the overall schedule and submittal dates. He stated that the funding requirement with FEMA requires the study be submitted within 18 months. Mr. Edwards asked what happens if deadlines are not met. Ms. Chen responded that the study is FEMA funded and the...</td>
</tr>
</tbody>
</table>
schedule must be maintained. Ms. Green stated that overall project deadline needs to be met.

5. **Project Deliverables**
   Mr. Barr reviewed the project deliverables as well as the interim deliverables. He stated that all deliverables will be digital. Mr. Edwards requested that the digital documents be searchable. Mr. Barr stated that 2 weeks will be available for HCFCD and the stakeholders to review the documents. SJRA, Montgomery County, and City of Houston representatives agreed the 2 weeks was sufficient time to review. Ms. Cooper requested enough notification to prepare to review the submittals. Mr. Edwards asked if public meetings will be held with the project. Mr. Barr stated that they are not currently in the scope.

6. **Work Flow**
   Ms. Cooper asked how comments will be coordinated through each stakeholder. Mr. Barr stated that a comment matrix would be developed and sent along with any submittal. HCFCD will manage the comments and provide the comments template.

7. **Vegetation and Sediment Control**
   Mr. Stull reviewed the vegetation and sediment control scope. Ms. Cooper stated that Montgomery County does not currently have the authority to manage sediment in the streams. She asked if the recommendation would include the current county jurisdictional authority? Mr. Stull confirmed that the recommendations would include the potential sediment management plans for stakeholder consideration. Mr. Edwards asked if the study would include the USACE data collected for Lake Houston. Mr. Stull stated that the study will be solely based on data from other entities. Sediment modeling will not be included in this study. Ms. Chen stated that HCFCD was currently collected the USACE dredging data.

8. **Methodology Discussion**
   Mr. Barr presented the hydrologic methodologies to be used for the analysis. Ms. Cooper asked what projection will be used for modeling and base files. Mr. Barr stated that since the LiDAR will be based on the Texas South Central coordinate system, that all models will be created in South Central. He stated that any mapping in Montgomery County could be moved to the appropriate coordinate system. Mr. Stull presented the rainfall depths to be used per watershed based on the Atlas 14 rainfall data. Ms. Cooper asked if the Memorial Day 2016 event be used for calibration. Mr. Hinojosa stated that the Tax Day 2016 event would be extended to include the Memorial Day event.

9. **Data Collection Requests**
   Mr. Barr reviewed the data currently requested from each entity including reports, terrain, and existing studies.
10. **Public Education and Outreach**

Mr. Barr stated that public meetings were not part of the current scope. Ms. Chen stated that HCFCD was working on a separate contract for public meetings. Ms. Green stated that public meetings may be held at various locations in the watershed. Ms. Holloway stated that the current scope is to provide handouts, maps, and a website so all stakeholders are consistent on data presented to the public. She mentioned that having a project specific website would assist in handling questions and communication with the public. Summaries of ongoing parallel projects could be provided to the public through the central site. Study partner website could direct the public to the central site. Ms. Cooper discussed having an internal collaboration website to handle data transfer. Mr. Hinojosa stated that Halff could host a website for stakeholder use if needed.

Stakeholders to consider internal coordination website. Also consider a central website for dissemination of material to the public.

11. **Project/Partner Accounting, Coordination and Communication Protocol**

Ms. Green stated that there will be monthly meetings for the project stakeholders.

HCFCD to coordinate monthly progress meetings.

12. **General Discussion**

Ms. Wheeler stated that HCFCD is ready to receive the funding from the study partners HCFCD will allow the study partners to review the invoices from Halff. Partners will have 5 days to respond.

Study partner contacts will be Matt Barrett (SJRA), Diane Cooper (Montgomery County) and Gary Hill (City of Houston).

Ms. Cooper asked if the models would be FEMA ready? Mr. Edwards asked what it would take to get to FEMA ready.

Ms. Cooper asked how can the models be managed for use by developers and how do expectations can be managed for the planning level study.

Mr. Edwards stated that for the project to be a success, it needs to survive the first recommended project. Mr. Hinojosa stated that the projects will be large and very expensive.

Mr. Edwards mentioned that it may be helpful to include other funding source requirements and add the information needed to satisfy their requirements such as the GLO, FEMA, HUD, etc.

Ms. Cooper asked how the study can be used to guide policy. Mr. Barr mentioned that policy recommendations will be included in the study and may be the only feasible option.

Mr. Hill asked if we can use the study to determine the existing level of service of the streams. Mr. Barr stated that it could be determined from the modeling. Mr. Bezemek stated that the level of service can be challenging with channels as the bank elevation can change drastically in varying cross sections.

13. Ms. Chen concluded the meeting.
This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Phone Number</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terry Barr</td>
<td>Halff Associates, Inc.</td>
<td>(713) 588-2451</td>
<td><a href="mailto:tbarr@halff.com">tbarr@halff.com</a></td>
</tr>
<tr>
<td>Leslie Holladay</td>
<td>Crouch</td>
<td>713 868 1043</td>
<td><a href="mailto:leslie@crouchenvironmental.com">leslie@crouchenvironmental.com</a></td>
</tr>
<tr>
<td>Jing Chen</td>
<td>HCFCO</td>
<td>713 684 4264</td>
<td><a href="mailto:jing.chen@hcfd.org">jing.chen@hcfd.org</a></td>
</tr>
<tr>
<td>Connor Stokes</td>
<td>Crouch</td>
<td>713 868 1043</td>
<td><a href="mailto:connor@crouchenvironmental.com">connor@crouchenvironmental.com</a></td>
</tr>
<tr>
<td>Andrew Moore</td>
<td>Halff</td>
<td>936 777 6377</td>
<td><a href="mailto:gmoore@halff.com">gmoore@halff.com</a></td>
</tr>
<tr>
<td>Sam Hinojosa</td>
<td>Halff</td>
<td>936 777 6372</td>
<td><a href="mailto:shinijose@halff.com">shinijose@halff.com</a></td>
</tr>
<tr>
<td>Craig Masters</td>
<td>HCFCO</td>
<td>713 684 4041</td>
<td><a href="mailto:craig.masters@hcfd.org">craig.masters@hcfd.org</a></td>
</tr>
<tr>
<td>Rob Lazaro</td>
<td>HCFCO</td>
<td>713 684 4027</td>
<td><a href="mailto:rob.lazaro@hcfd.org">rob.lazaro@hcfd.org</a></td>
</tr>
<tr>
<td>Gary Bezemer</td>
<td>HCFCO</td>
<td>713 684 4000</td>
<td></td>
</tr>
<tr>
<td>Donna Groon</td>
<td>HAFCO</td>
<td>713 588 7144</td>
<td><a href="mailto:diana.groon@hcfd.org">diana.groon@hcfd.org</a></td>
</tr>
<tr>
<td>Matt Barrett</td>
<td>SJRA</td>
<td>936 588 7144</td>
<td><a href="mailto:mbarnett@sjra.net">mbarnett@sjra.net</a></td>
</tr>
<tr>
<td>Diane Cooper</td>
<td>Montgomery Co</td>
<td>936 588 8111</td>
<td><a href="mailto:diane.cooper@mont.coop.org">diane.cooper@mont.coop.org</a></td>
</tr>
<tr>
<td>Darren Hess</td>
<td>MCDIEMEN</td>
<td>936 523 9300</td>
<td><a href="mailto:darren.hess@mcdiem.com">darren.hess@mcdiem.com</a></td>
</tr>
<tr>
<td>Ataul Hannan</td>
<td>HCFCO</td>
<td>713 684 4117</td>
<td><a href="mailto:ataual.hannan@hcfd.org">ataual.hannan@hcfd.org</a></td>
</tr>
<tr>
<td>Cory Smith</td>
<td>FM</td>
<td>713 680 6804</td>
<td><a href="mailto:cory.smith@fm.com">cory.smith@fm.com</a></td>
</tr>
<tr>
<td>Susan Wheeler</td>
<td>HCFCO</td>
<td>713 588 3300</td>
<td><a href="mailto:susan.wheeler@hcfd.org">susan.wheeler@hcfd.org</a></td>
</tr>
<tr>
<td>Gary Hill</td>
<td>CoH/HPW</td>
<td>832 375 3232</td>
<td><a href="mailto:gary.hill@houston.tx.gov">gary.hill@houston.tx.gov</a></td>
</tr>
<tr>
<td>Name</td>
<td>Organization</td>
<td>Phone Number</td>
<td>Email</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>--------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Cliff Eddins</td>
<td>HC P4</td>
<td>713-787-8822</td>
<td><a href="mailto:cgeddins@halff.com">cgeddins@halff.com</a></td>
</tr>
<tr>
<td>Chuck Gilman</td>
<td>SJRA</td>
<td>936-588-7158</td>
<td><a href="mailto:cgilman@sjra.net">cgilman@sjra.net</a></td>
</tr>
<tr>
<td>Jeremy Ketchum</td>
<td>HCFCD</td>
<td>713-684-4100</td>
<td><a href="mailto:jketchum@hcfcd.com">jketchum@hcfcd.com</a></td>
</tr>
</tbody>
</table>
Appendix A.2

Executive Briefings
## EXECUTIVE BRIEFING AGENDA

**Study Partners: HCFCD, City of Houston, Montgomery County, SJRA**

February 14, 2020  
San Jacinto River Watershed Master Drainage Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Executive Briefing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>2:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:30 PM</td>
</tr>
</tbody>
</table>

### Agenda

<table>
<thead>
<tr>
<th>1.</th>
<th>Introductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td><strong>San Jacinto MDP Presentation</strong></td>
</tr>
<tr>
<td></td>
<td>• Community Outreach</td>
</tr>
<tr>
<td></td>
<td>• Data Collection</td>
</tr>
<tr>
<td></td>
<td>• Existing Conditions H&amp;H</td>
</tr>
<tr>
<td></td>
<td>• Calibration</td>
</tr>
<tr>
<td></td>
<td>• Future Conditions</td>
</tr>
<tr>
<td></td>
<td>• Primary Mitigation</td>
</tr>
<tr>
<td></td>
<td>• Secondary Mitigation</td>
</tr>
<tr>
<td></td>
<td>• Other Mitigation Actions</td>
</tr>
<tr>
<td></td>
<td>• Schedule</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Technical Discussion</strong></td>
</tr>
<tr>
<td></td>
<td>• Future Conditions and BDF Methodology</td>
</tr>
<tr>
<td></td>
<td>• Primary Mitigation Planning</td>
</tr>
<tr>
<td>4.</td>
<td><strong>Additional Questions/Discussion</strong></td>
</tr>
</tbody>
</table>
SAN JACINTO
Regional Watershed Master Drainage Plan
Agenda

- Communication and Outreach
- Data Collection
- Existing H&H Modeling
- Historical Storm Analysis and Calibration
- Future Conditions
- Primary Mitigation Planning
- Secondary Mitigation Planning
- Other Mitigation Actions
- Project Schedule and Status
Goals and Objectives

• The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  – Conduct a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Develop approaches to enhance public information and flood level assessment
  – Evaluate flood mitigation strategies to improve long-term resilience

• The plans specific objectives are:
  – Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  – Secondary Mitigation Planning (Flood Assessment/Warning)
  – Other Mitigation Actions (Communications Protocols, Flood Response)
  – Community Outreach & Education (Drainage, Maintenance, Projects)
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td>Total</td>
<td>535.6</td>
</tr>
</tbody>
</table>
Communication and Outreach

• Communication
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (7)

• Outreach
  – 1st round of public meetings complete – December 2019
  – Woodlands Drainage Task Force Meeting – January 28th
  – Study Website
    www.sanjacstudy.org
Data Collection

• Field Reconnaissance
  – Extensive Site Work
  – Observe, photograph, document

• Field Survey
  – Focus on bridges and culverts
  – More than 20 crossings

• Modeling Data
  – Terrain (2018) LiDAR
  – M3, BLE, Other Models
  – Observed HWM and Gage Data

• Previous Reports
  – 9 Relevant Major Previous Efforts
  – Reviewed and Documented
Existing Conditions H&H

- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Soils and Percent Impervious
  - BDF Values and Slopes (TC+R)
  - HEC-HMS Model Development
  - Limited adjustment to M3 Models
Existing Conditions H&H

• Hydraulics
  – Updated cross section geometry
  – New/updated bridges and culverts
  – Reviewed and adjusted n-values
  – Developed unsteady RAS models
  – Updated M3 as needed
  – Combined into comprehensive model
  – Normal lake operations
    • No Additional Gates
    • No Seasonal Lowering
Analysis of Historical Storms

• Historical Storms
  – Memorial Day (2016)
  – Hurricane Harvey (2017)
  – October 1994

• Leveraged GARR Data
  – Met with USGS
  – Peach Creek Adjustment
  – Gage Summary in Report

<table>
<thead>
<tr>
<th>Basin</th>
<th>Maximum Rainfall Accumulation (in.)</th>
<th>Total (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15-min</td>
<td>1-hr</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>0.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>0.4</td>
<td>1.2</td>
</tr>
<tr>
<td>East Fork San Jacinto River (North)</td>
<td>0.5</td>
<td>1.6</td>
</tr>
<tr>
<td>East Fork San Jacinto River (South)</td>
<td>0.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>1.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>0.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>0.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>0.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>2.2</td>
<td>2.8</td>
</tr>
<tr>
<td>West Fork San Jacinto River (to Lake Conroe)</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>West Fork San Jacinto River (to Lake Houston)</td>
<td>0.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>0.6</td>
<td>1.8</td>
</tr>
</tbody>
</table>
Calibration

- Calibration Process
  - Stage (Manning’s ‘n’)
  - Flow (Initial/Constant Losses)
  - Timing (BDF for TC+R)
  - Volume (BDF, Manning’s ‘n’)

- Coordination with HDR

- Calibration Complete
Calibration Results

• Calibration Challenges
  – USGS Peach Creek Gage
  – Initial/Constant Loss Rates
  – Lake Conroe Inflow/Outflow

• Calibration Results*

<table>
<thead>
<tr>
<th>Stream</th>
<th>Location</th>
<th>1% Annual Exceedance Discharge Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>USGS Peak FQ</td>
</tr>
<tr>
<td>West Fork</td>
<td>I-45</td>
<td>111,000</td>
</tr>
<tr>
<td>West Fork</td>
<td>Grand Pkwy</td>
<td>120,000</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>I-45</td>
<td>20,700</td>
</tr>
<tr>
<td>East Fork</td>
<td>FM 1485 East River</td>
<td>83,100</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>FM 2090</td>
<td>34,300</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>FM 2090</td>
<td>36,100</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>I-45</td>
<td>-</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Sendera Ranch Dr</td>
<td>-</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>Kuykendahl Rd, M112</td>
<td>-</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>County Limit</td>
<td>-</td>
</tr>
</tbody>
</table>
Future Conditions

- Future Conditions Data
  - Detailed population projection (Harris, Montgomery, Etc.)
    - Harris-Galveston Subsidence District’s Regional Groundwater Update Project
  - TWDB population projections
    - 2021 Regional Water Planning (Grimes, Liberty, San Jacinto, Walker, Waller)

- Hydrologic Parameter Adjustments
  - Basin Development Factors (BDF)
  - TC+R
  - % Impervious

- Assumptions
  - No changes in Lake Operations
  - Detention Requirement
  - No floodplain development
Future Conditions

- Future Conditions Results
  - Increases in total volume and peak flows along channels (Variable)
  - Minimal changes to existing lake levels
  - Quicker rising limb than existing but similar receding limb
  - Detention vs. No Detention assumptions require discussion
Primary Mitigation Planning

- Reviewed previous reports and master plans
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
Primary Mitigation Planning

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers
Primary Mitigation Planning

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks
Primary Mitigation Planning

• Estimate a range of target volumes

<table>
<thead>
<tr>
<th>Difference in Volumes (ac-ft)</th>
<th>500yr</th>
<th>100yr</th>
<th>50yr</th>
<th>25yr</th>
<th>10yr</th>
<th>5yr</th>
<th>2yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500yr</td>
<td>289,914</td>
<td>257,190</td>
<td>219,495</td>
<td>168,485</td>
<td>123,390</td>
<td>78,745</td>
<td></td>
</tr>
<tr>
<td>100yr</td>
<td>163,114</td>
<td>127,434</td>
<td>96,786</td>
<td>52,374</td>
<td>20,639</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50yr</td>
<td>113,143</td>
<td>83,538</td>
<td>54,781</td>
<td>17,821</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25yr</td>
<td>74,866</td>
<td>47,875</td>
<td>22,771</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10yr</td>
<td>36,503</td>
<td>13,448</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5yr</td>
<td>14,164</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2yr</td>
<td>10,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Primary Mitigation Planning

- Evaluate potential volume needs vs. flood reduction benefits
  - High Potential: East Fork SJR, Spring, Peach, Caney Creeks
  - Moderate Potential: Lake Creek

- Consider potential improvements (In Progress)
  - Primary: Previously recommended projects
  - Secondary: New structural and policy ideas

- Primary Alternatives Analysis (Storage)
  - East Fork SJR
  - Caney Creek
  - Peach Creek
  - Lake Creek
  - Spring Creek
Sedimentation and Vegetation

- Strategies to reduce flow of sediments into Lake Houston
- Developed annual sediment rating curves for 7 watersheds
  - Predictive tool that relates sediment transport with stream flow
  - Cypress Creek is the highest contributor
- First step toward Regional Sediment Management Plan (RSM)
- Inventory of sediment sources
- Common sediment management strategies
- Recommended strategies for West Fork and Spring Creek
- Full report included as an appendix to Final Report
Secondary Mitigation Planning

• Received input from HCFCD, MCO, USGS, Others
• Considered variety of gage types (Rain, Flow, Stage)
• Flood warning and data for future calibration efforts
Other Mitigation Actions

• Evaluate communications plan/protocol during emergencies
• Identify critical infrastructure and compare to inundation
• Determine expected flood frequency evacuation routes
• Meeting with all Emergency Management Coordinators
  – Completed (Montgomery, Waller, Walker, Grimes, Conroe)
  – Scheduled (Liberty, San Jacinto, Harris, Houston)
  – Workshop (March 12th) to discuss preliminary findings
Project Schedule

- Major Project Milestones
  - Existing H&H and Calibration Memorandum – 10/14/2019
  - Primary Alternatives Analysis Memorandum – 6/9/2020
  - Vegetation and Sedimentation Control Memorandum – 2/7/2020
Questions?
particular, the 1943, 1957, and 1985 plans were used and the recommendations catalogues and approximately mapped. Many of the proposed projects are not feasible due to current development levels; however, several are being considered as part of the primary mitigation alternatives. Mr. Barr discussed the use of the structural inventory tool to determine the location and frequency of expected structural flooding. Using the damages, graphs were developed that show the number and frequency of flooded structures for each river mile along each of the major streams (Peach, Caney, Spring, etc.) Using this information, the study team was able to identify “damage centers” that will be monitored during the mitigation alternatives analysis. Mr. Poppe suggested providing some exhibits that show graduated visuals for expected damages by flood frequency (i.e. a Heat Map).

Mr. Olmos further explained the process for determination of target storage volumes for each damage center. Instead of trying to determine a specific level of service (LOS) reduction (i.e. reduce current 100-year flows to current 10-year flows), a range of flow reductions were considered to consider the potential reduction of flooding instances associated with each target volume. A series of LOS reductions were modeled, and the data plotted to estimate the volume that would provide the maximum benefit for the least volume (i.e. the point of diminishing returns). Mr. Barr indicated that, by using this method, a series of target volumes were determined and will be used as a starting point for detention modeling along the various streams. Based on the analysis, the streams with the highest potential benefit vs. volume are East Fork SJR, Spring Creek, Peach Creek, and Caney Creek. Storage on Lake Creek may also provide some benefit to the West Fork SJR.

In addition to structural flood reduction solutions, the study teams may consider the flood reduction benefits of potential policy changes, such as detention of floodplain preservation. Buy-outs are also an option that could be considered. Specific discussion related to policy evaluation is included in Item 4 (Policy Discussion).

Ms. Chen asked if this information would be beneficial to the State Flood Plan. TWBD is currently in the process of selecting the regional planning groups. Mr. Barr indicated that the information could be beneficial to the plan when the San Jac study is complete.

- Mr. Barr briefly discussed the Sedimentation and Vegetation analysis prepared by FNI as part of the Primary Mitigation Planning effort. The plan lays out several strategies to help reduce sediment loads into the West Fork San Jacinto River, and into Lake Houston. A complete report has been provided to HCFCD in draft format. Mr. Hannan asked about the potential flood reduction benefits as related to sediment removal. Mr. Olmos indicated that the investigation focused more on the sediment sources and potential management measures rather than specific flood implications. Previous discussions with HCFCD have yielded a consensus that, while sedimentation may have localized impacts on flooding, the majority of flood volumes are located in the channel and

| Halff/FNI – Provide exhibits that include expected damage heat maps |
| Halff/FNI – Consider relationship between sedimentation and flooding |
overbanks, above the lower part of the channel where sediment accumulates. Mr. Hannan suggested that the connection at least be mentioned in the report.

- Mr. Barr briefly discussed the Secondary Mitigation Planning, which focuses on the existing FWS gage network and the potential for additional gages to augment the gage coverage. The team met with HCFCD, SJRA, MCO, and USGS to discuss gage needs and have provided a draft memo with recommendations for gage location and type. Ms. Chen indicated that HCFCD is already in the process of adding several more gages. The specific locations will be added to the memo. Mr. Poppe mentioned that, given the long-term nature of the proposed flood mitigation projects, the ability to provide better flood warning information was very important. Mr. Hannan and Mr. Poppe also discussed the upcoming flood forecasting capabilities that will become available through HCFCD. Mr. Barr indicated that the potential flood forecasting capability had been discussed with Jeff Lindner (HCFCD) and that the modeling prepared as part of this effort could be leveraged to expand the coverage up into the San Jacinto basin. It was also discussed how surrounding counties use the FWS, and the addition of a flood forecasting capability will be of great benefit to them. Mr. Barr indicated that an implementation strategy will be prepared that includes estimated costs of the gage installation.

- Mr. Barr discussed the Other Mitigation Actions task, which focuses on emergency management and the communication internally and externally during a disaster. Ms. Chen indicated that the study team had held several meetings with the surrounding counties, as well as with Harris County and City of Houston. She also stated that a larger workshop would be held on March 11th. Mr. Barr mentioned that the team was looking at critical infrastructure and major roadway flooding that could impact evacuation routes during a major flood event. Mr. Poppe noted that one of the things that could be mentioned in the meetings with the EMC’s is the potential for better resources for the public to call during a disaster. He noted that during Harvey, HCFCD phone lines were maxed out and people started calling 911. Ms. Green suggested a potential centralized call center to distribute information about current flood conditions, forecasts, recommended actions, etc. In addition, the public may be unclear or uneducated about the best places to receive information from those agencies tasked with emergency management. That element should be considered.

- Finally, Mr. Barr provided a brief overview of the schedule. The Mitigation Planning should conclude in early June with the Draft Report to be submitted on July 6th.

3. Technical Discussion
   - With respect to the Future Conditions analysis, Mr. Hannan indicated that the issue with the BDF detention factor default for less developed areas needed to be discussed with the MAAPnext management team. It
is not unexpected that a new method would have some issues to be worked through. Mr. Barr indicated that the volume difference between the existing and future conditions was relatively small (1-2%) so the storage alternatives aren’t significantly impacted. However, the discrepancy should be evaluated before the detention policy alternative can be properly considered.

- Another item of discussion was how to best show the **benefits of potential projects for comparison and recommendation**. Mr. Poppe suggested that the team look at other metrics beyond the traditional BCA, because those metrics may skew projects to certain areas or may show that projects are not economically feasible. The group conversation included other potential metrics such as the number of structures no longer flooded (removed from structure value), acreage reclaimed, roadway miles no longer inundated, critical facilities protected, reduction of per capita flood-related deaths, and others. While there was no knowledge in the group about specific FEMA accounting of fatalities as it related to monetary benefits, they should be considered in our project evaluations and prioritization. These benefits will need to be weighed against the potential costs of these projects. Mr. Barr and Mr. Olmos indicated that the projects could run into the $ Billions, which will likely result in the need to phase projects. Given the expense, identifying a potential funding source will be an important task.

4. **Policy Discussion**

- With respect to **Detention Policy**, there was some back and forth discussion about the potential for evaluating detention scenarios to gain a general understanding of how detention, or a lack thereof, could impact flooding as the basin develops. The current future conditions (year 2070) analysis leverages data from HGSD and TWDB to predict development patterns. However, changes to these projections could have a significant impact how detention changes flow characteristics in the basin.

  Additional development scenarios should be considered if detention policy is to be effectively evaluated. In addition, different detention rates may need to be considered. The scale of the current study may also be an issue. The modeling completed as part of this study looks at wholesale implementation of detention and it’s impacts on the major streams. It does not consider the impacts of detention vs. no detention at the tributary or individual development level. The general consensus of the group was that development will generally have a noticeable impact on the surrounding properties if increases in the flow are not mitigated. Due to timing and other factors, these impacts may not show up at a regional scale. Mr. Poppe suggested looking at some test cases at the tributary level to gain perspective.

  Mr. Poppe also inquired as to the specifics of Montgomery County’s current detention policy. Mr. Barr indicated that the study team can provide specific information. Ultimately, the goal of this study would be to provide some analysis and inform them about the potential negative
impacts of allowing undetained development. Montgomery and the surrounding counties will need to determine their own detention policy.

Mr. Poppe stated that policy matters, and that Harris County has been gaining knowledge of its own for decades with respect to development and drainage criteria. Our discussion of policy should seek to share that knowledge in the hopes that other counties avoid unintended consequences from under mitigated new or redevelopment before they are developed and costs to address the problems increase significantly.

5. Additional Questions and Discussion

- The final discussion points were related to the scale of solutions and the potential for phasing. There was concern that the scale of the proposed solutions would be too large to move forward in a timely fashion. Mr. Barr indicated that given the size of the problem, the solutions will be very expensive. However, the availability of land will likely result in the splitting of detention storage into multiple parts. The overall solution will be a combination of multiple projects in different watersheds, not just one single project.

The analysis will determine which project should move forward first and can provide the most incremental benefit. At each project phase, incremental benefit will need to be shown. In addition to the localized improvements of each project or project phase, the team will evaluate the improvements downstream. For example, a regional detention basin on Spring Creek would certainly be intended to help flooding along Spring Creek, but the downstream benefits along the West Fork and in lake Houston would also be evaluated to ensure that benefits are not just isolated to one area. The damage center analysis and strategic location of these improvements are intended to solve the larger regional issues.

6. Ms. Chen concluded the meeting.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
# EXECUTIVE BRIEFING AGENDA

*Harris County Flood Control District*

**July 21, 2020**  
San Jacinto River Watershed Master Drainage Plan  
Teams Conference Call

<table>
<thead>
<tr>
<th>Meeting called by</th>
<th>Type of Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jing Chen, P.E., CFM</td>
<td>Executive Briefing</td>
</tr>
<tr>
<td>Facilitator</td>
<td></td>
</tr>
<tr>
<td>Terry M. Barr, P.E., CFM</td>
<td></td>
</tr>
<tr>
<td>Meeting Start Time</td>
<td>1:00 PM</td>
</tr>
<tr>
<td>Meeting Stop Time</td>
<td>2:00 PM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions**
2. **Goals and Objectives**
3. **H&H and Calibration Recap**
4. **Primary Mitigation Planning**
   - San Jacinto Regional WMDP
   - Lake Houston Influence
5. **Secondary Mitigation Planning**
6. **Other Flood Hazard Mitigation Actions**
7. **Implementation Planning**
   - Short-term Strategies
   - Long-term Strategies
   - Metrics
   - Scoring
   - Ranking
   - Implementation
   - Funding
   - Challenges
8. **Next Steps**
9. **Coordination and Communication**
10. **Project Schedule and Status**
11. **Questions**
Agenda

• Goals and Objectives
• H&H and Calibration Recap
• Primary Mitigation Planning
• Secondary Mitigation Planning
• Other Mitigation Actions
• Implementation Planning
• Project Schedule and Status
Goals and Objectives

• The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  – Prepare a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Evaluate flood mitigation strategies to improve long-term resilience
  – Consider approaches to enhance public information and flood level assessment

• The plans specific objectives are:
  – Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  – Secondary Mitigation Planning (Flood Assessment/Warning)
  – Other Mitigation Actions (Communications Protocols, Flood Response)
  – Community Outreach & Education (Drainage, Maintenance, Projects)
H&H and Calibration

- Developed Comprehensive Model
- Updated H&H Modeling
  - Atlas 14 Rainfall (varies by watershed)
  - Updated LiDAR Terrain
  - Developed combined unsteady RAS model
- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994
- BFE increases of approximately 2’
- Leverage as best available information and updated to meet FEMA standards.
Sedimentation and Vegetation

- Sediment Report Findings
  - USACE has removed ~3% of sediment deposited since Lake Houston Dam's construction (1954)
  - Cypress Creek, Spring Creek, West Fork are highest contributors
Sedimentation and Vegetation

• Identified 49 potential sediment management strategies, including:
  – Sediment traps
  – Stream restoration projects
  – Protection of sand mines
  – Public-private partnerships
  – Sediment bypass tunnel

• Next Steps
  – Complete a regional sediment mitigation (RSM) plan with more detailed sediment transport and volumetric analyses
  – Identify new stream gage locations to pinpoint sediment sources
  – Conduct a feasibility study to implement pilot projects
  – Additional analyses: dam hydraulics, sediment tunnel, stream stabilization
Flood Mitigation Strategies

• **Primary Flood Mitigation Planning (Flood Reduction)**
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Developed cost estimates
  – Evaluated potential benefits
  – Identified implementation path and challenges

• **Secondary Flood Mitigation Planning (Flood Warning)**
  – Coordinated with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommended locations for additional FWS gages

• **Other Mitigation Actions (Flood Response)**
  – Coordinated with agencies responsible for Emergency Management
  – Provided recommendations for updated communications protocols
  – Identified potential flooding of roadways and critical infrastructure
A total of 16 flood reduction projects are recommended:

10 regional detention facilities (229,000 ac-ft)

6 channelization Projects (38.5 miles)
Lake Houston Influence

- Influence of Lake Houston extends from the dam to Lake Houston Parkway.
- Upstream of Lake Houston Parkway, the West Fork controls...
Lake Houston Influence
San Jacinto Regional WMDP

- Plan Cost: $2.9B - $3.3B
- Overall Plan Benefits: $756 M
- BCR: 0.23 – 0.26

<table>
<thead>
<tr>
<th>Stream</th>
<th>Existing Structural Damages ($M)</th>
<th>Combined Alternatives Structural Damages ($M)</th>
<th>Structural Benefit ($M)</th>
<th>Cost Range ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>339.4</td>
<td>117.3</td>
<td>222</td>
<td>313.6 – 388.5</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>119</td>
<td>101.4</td>
<td>17.5</td>
<td>–</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>374.1</td>
<td>370.4</td>
<td>3.7</td>
<td>–</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>196.7</td>
<td>196.2</td>
<td>0.5</td>
<td>–</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>128.3</td>
<td>78.3</td>
<td>50.1</td>
<td>134.3 – 166.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>396.2</td>
<td>198.2</td>
<td>198</td>
<td>966</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>16.7</td>
<td>4.5</td>
<td>12.1</td>
<td>303 - 422</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>163.9</td>
<td>32.9</td>
<td>131.1</td>
<td>718.0 – 812.0</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>190.8</td>
<td>70.5</td>
<td>120.2</td>
<td>478.0 – 533.0</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>20</td>
<td>19.2</td>
<td>0.8</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,030.3</strong></td>
<td><strong>1,274.1</strong></td>
<td><strong>756.2</strong></td>
<td><strong>2,912.9 – 3,288.1</strong></td>
</tr>
</tbody>
</table>
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, SJRA
- 26 Gages recommended (HCFCD Currently installing 5)
- Approximate installation cost range $240k - $330k (plus maint.)
- Potential for inundation mapping along modeled streams
Other Mitigation Actions

- Other Mitigation Action Goals
  - Evaluate communications plan/protocol during emergencies
  - Identify critical infrastructure and compare to inundation
  - Determine expected flood frequency evacuation routes

- Conducted Emergency Management Workshop (March 11th)
  - Communication during a disaster was effective, no significant changes
  - Some adjustments or efficiencies could be made
  - Variety of flood monitoring approaches from remote to in-person
  - Information gaps in documentation, floodplain mapping, gage coverage
Other Mitigation Actions

• Recommendation Summary
  – Documentation and Staffing
    • Develop and follow written Emergency Response Plan; Keep up to date
    • Perform regular review and conduct practice exercises
  – Communication
    • Link various social media accounts to improve coverage and consistency
    • Improve internal alerts for infrastructure flooding or failure
  – Flood Monitoring and Protection
    • Identify areas that require monitoring and install gages at those locations
    • Work with other agencies to integrate gages into a larger, regional system
    • Leverage flood monitoring to provide timely alerts to the public
  – Public Education
    • Develop a public education strategy that includes social media, radio, TV, and face-to-face discussion
    • Leverage pre-developed resources from agencies like TWDB
Other Mitigation Actions

• Critical Infrastructure
  – Includes city/county facilities, police, fire/EMS, W/WWTP, hospitals, etc.
  – Approximately 1460 “critical” facilities in the San Jacinto basin
  – Approximately 239 potentially impacted by the 500-year event

• Roadway Flood Frequency
  – Evaluated potential flooding for all roadway classifications
  – Four evacuation route crossings inundated by less than 1% ACE
    • Cypress Creek at IH-45
    • West Fork San Jacinto at IH-69
    • Peach Creek at IH-69
    • East Fork San Jacinto at IH-69
Implementation Planning

- Implementation includes short-term and long-term strategies
  - Short-term strategies can be fully/partially implemented within 5 years
  - Long-term strategies will take longer than 5 years, perhaps decades
Short-term Strategies

- Develop a **San Jacinto River Vision Group** to foster collaboration of stakeholders in the basin with the goals of:
  - Establishing common drainage and detention criteria
  - Updating H&H and floodplain analysis standards
  - Implementing recommended MDP projects
- Implement additional gages to augment the flood warning system
- Implement Other Mitigation Action recommendations
- Buyout frequently flooded structures (2-, 5-YR)
- Remap the main streams and tributaries to improve flood risk data
- Develop watershed plans for tributaries in the major watersheds.
Long-Term Strategies

- Channelization and Detention projects may require significant time and funding
- Implementation Plan includes:
  - Metrics
  - Scoring
  - Ranking
  - Project Stages
  - Project Team
  - Funding Options
  - Potential Lead Agencies
  - Challenges
Implementation - Metrics

- **Historical Damages** – Number of historically flooded structures
- **Predicted Damages** – Number of instances of flooding based on a 50-year project life
- **Flooding Instance Reduction** – Number of instances of flooding removed by the project
- **Structures Removed** – Number of structures removed from the 1% ACE floodplain
- **BCR** – Benefit Cost Ratio of the project
- **Roadway** – Total depth of reduction of WSELs along modeled roadways for all frequency storm events
- **SVI** – Average SVI of structures benefitted by project
- **LMI** – Average LMI of structures benefitted by project
- **Cost** – Total cost of project
Implementation – Scoring

- Metrics are weighted based on priority
- Projects are assigned a score of 0 – 4 based on quartile compare to other projects
- Example: Walnut Creek Detention removes 1,296 structures from the 1% ACE. This project removes the most of all projects so receives a 4.0 as a score.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Assigned Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical Damages</td>
<td>10%</td>
</tr>
<tr>
<td>Predicted Damages</td>
<td>10%</td>
</tr>
<tr>
<td>Instance Reduction</td>
<td>20%</td>
</tr>
<tr>
<td>Structures Removed</td>
<td>20%</td>
</tr>
<tr>
<td>BCR</td>
<td>10%</td>
</tr>
<tr>
<td>Roadway</td>
<td>5%</td>
</tr>
<tr>
<td>SVI</td>
<td>10%</td>
</tr>
<tr>
<td>LMI</td>
<td>10%</td>
</tr>
<tr>
<td>Cost</td>
<td>5%</td>
</tr>
</tbody>
</table>
## Implementation – Scoring

<table>
<thead>
<tr>
<th>Cost ($M)</th>
<th>Watershed Historical Damages</th>
<th>Watershed Predicted Damages</th>
<th>Instance Reduction</th>
<th>Structures Removed from 1% ACE</th>
<th>BCR</th>
<th>Roadway</th>
<th>SVI</th>
<th>LMI</th>
<th>Cost</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
<td>5%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Spring
- **Walnut Creek**: Cost = 97.2–132.1, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 3.0, Instance Reduction = 4.0, Structures Removed from 1% ACE = 4.0, BCR = 1.0, Roadway = 1.0, SVI = 0.0, LMI = 3.0, Cost = 3.0, Total Score = 2.60
- **Birch Creek**: Cost = 81.6–121.6, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 3.0, Instance Reduction = 3.0, Structures Removed from 1% ACE = 3.0, BCR = 1.0, Roadway = 0.0, SVI = 1.0, LMI = 3.0, Cost = 3.0, Total Score = 2.10
- **DC2-200 Channel**: Cost = 53.6–203.6, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 3.0, Instance Reduction = 0.0, Structures Removed from 1% ACE = 0.0, BCR = 3.0, Roadway = 0.0, SVI = 1.0, LMI = 3.0, Cost = 3.0, Total Score = 1.05
- **I-45 Channel**: Cost = 81.2–231.2, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 3.0, Instance Reduction = 3.0, Structures Removed from 1% ACE = 4.0, BCR = 4.0, Roadway = 2.0, SVI = 0.0, LMI = 2.0, Cost = 2.0, Total Score = 2.60

### Lake
- **Caney Creek Detention**: Cost = 98.0–163.0, Watershed Historical Damages = 0.0, Watershed Predicted Damages = 0.0, Instance Reduction = 1.0, Structures Removed from 1% ACE = 3.0, BCR = 1.0, Roadway = 1.0, SVI = 1.0, LMI = 2.0, Cost = 2.0, Total Score = 1.25
- **Little Caney Creek**: Cost = 98.0–128.0, Watershed Historical Damages = 0.0, Watershed Predicted Damages = 0.0, Instance Reduction = 1.0, Structures Removed from 1% ACE = 2.0, BCR = 2.0, Roadway = 2.0, SVI = 2.0, LMI = 3.0, Cost = 3.0, Total Score = 0.95
- **Garrett's Creek Detention**: Cost = 107.0–131.0, Watershed Historical Damages = 0.0, Watershed Predicted Damages = 0.0, Instance Reduction = 2.0, Structures Removed from 1% ACE = 2.0, BCR = 2.0, Roadway = 3.0, SVI = 1.0, LMI = 2.0, Cost = 2.0, Total Score = 1.55

### Peach
- **Walker Creek Detention**: Cost = 201.0–218.0, Watershed Historical Damages = 1.0, Watershed Predicted Damages = 1.0, Instance Reduction = 1.0, Structures Removed from 1% ACE = 0.0, BCR = 3.0, Roadway = 3.0, SVI = 3.0, LMI = 3.0, Cost = 1.0, Total Score = 1.30
- **SH 105 Detention**: Cost = 356.0–433.0, Watershed Historical Damages = 1.0, Watershed Predicted Damages = 1.0, Instance Reduction = 1.0, Structures Removed from 1% ACE = 0.0, BCR = 3.0, Roadway = 3.0, SVI = 3.0, LMI = 3.0, Cost = 0.0, Total Score = 1.75
- **I-69 Channel**: Cost = 161.0–311.0, Watershed Historical Damages = 1.0, Watershed Predicted Damages = 1.0, Instance Reduction = 4.0, Structures Removed from 1% ACE = 2.0, BCR = 4.0, Roadway = 4.0, SVI = 3.0, LMI = 3.0, Cost = 1.0, Total Score = 2.55

### Caney
- **Detention at FM 1097**: Cost = 105.0–131.0, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 2.0, Instance Reduction = 2.0, Structures Removed from 1% ACE = 1.0, BCR = 4.0, Roadway = 4.0, SVI = 4.0, LMI = 4.0, Cost = 3.0, Total Score = 2.25
- **Detention at SH 105**: Cost = 179.0–208.0, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 2.0, Instance Reduction = 4.0, Structures Removed from 1% ACE = 3.0, BCR = 4.0, Roadway = 4.0, SVI = 4.0, LMI = 4.0, Cost = 3.0, Total Score = 3.00
- **US 69 Channelization**: Cost = 194.0–209.0, Watershed Historical Damages = 2.0, Watershed Predicted Damages = 2.0, Instance Reduction = 3.0, Structures Removed from 1% ACE = 1.0, BCR = 2.0, Roadway = 2.0, SVI = 2.0, LMI = 2.0, Cost = 1.0, Total Score = 2.05

### East Fork
- **Winter's Bayou Dam**: Cost = 134.0–166.6, Watershed Historical Damages = 3.0, Watershed Predicted Damages = 1.0, Instance Reduction = 2.0, Structures Removed from 1% ACE = 2.0, BCR = 3.0, Roadway = 3.0, SVI = 3.0, LMI = 2.0, Cost = 2.0, Total Score = 2.40

### West Fork
- **River Plantation Channel**: Cost = 148.0–538.0, Watershed Historical Damages = 4.0, Watershed Predicted Damages = 4.0, Instance Reduction = 1.0, Structures Removed from 1% ACE = 1.0, BCR = 2.0, Roadway = 2.0, SVI = 2.0, LMI = 2.0, Cost = 1.0, Total Score = 1.75
- **Kingwood Benching**: Cost = 818.0–848.0, Watershed Historical Damages = 4.0, Watershed Predicted Damages = 4.0, Instance Reduction = 3.0, Structures Removed from 1% ACE = 2.0, BCR = 2.0, Roadway = 2.0, SVI = 2.0, LMI = 2.0, Cost = 0.0, Total Score = 2.05
## Implementation - Ranking

- **Project Ranking - Adjusted**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project</th>
<th>Score</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Caney - Detention at SH 105</td>
<td>3.00</td>
<td>179.0–208.0</td>
</tr>
<tr>
<td>2</td>
<td>Spring - Walnut Creek</td>
<td>2.60</td>
<td>97.2–132.1</td>
</tr>
<tr>
<td>3</td>
<td>Spring - I-45 Channel*</td>
<td>2.60</td>
<td>81.2</td>
</tr>
<tr>
<td>4</td>
<td>East Fork - Winter's Bayou Dam</td>
<td>2.40</td>
<td>134.0–166.6</td>
</tr>
<tr>
<td>5</td>
<td>Caney - Detention at FM 1097</td>
<td>2.25</td>
<td>105.0–131.0</td>
</tr>
<tr>
<td>6</td>
<td>Peach - SH 105 Detention</td>
<td>1.75</td>
<td>356.0–433.0</td>
</tr>
<tr>
<td>7</td>
<td>Peach - I-69 Channel*</td>
<td>2.55</td>
<td>161.0</td>
</tr>
<tr>
<td>8</td>
<td>Spring - Birch Creek</td>
<td>2.10</td>
<td>81.6–121.6</td>
</tr>
<tr>
<td>9</td>
<td>Caney - US 69 Channelization*</td>
<td>2.05</td>
<td>194.0</td>
</tr>
<tr>
<td>10</td>
<td>West Fork - Kingwood Benching</td>
<td>2.05</td>
<td>818.0 - 848.0</td>
</tr>
<tr>
<td>11</td>
<td>West Fork - River Plantation Channel*</td>
<td>1.75</td>
<td>148.0</td>
</tr>
<tr>
<td>12</td>
<td>Lake - Garret's Creek Detention</td>
<td>1.55</td>
<td>107.0–131.0</td>
</tr>
<tr>
<td>13</td>
<td>Peach - Walker Creek Detention</td>
<td>1.30</td>
<td>201.0–218.0</td>
</tr>
<tr>
<td>14</td>
<td>Lake - Caney Creek Detention</td>
<td>1.25</td>
<td>98.0–163.0</td>
</tr>
<tr>
<td>15</td>
<td>Spring - DC2-200 Channel*</td>
<td>1.05</td>
<td>53.6</td>
</tr>
<tr>
<td>16</td>
<td>Lake - Little Caney Creek</td>
<td>0.95</td>
<td>98.0–128.0</td>
</tr>
</tbody>
</table>

*Adjustment to facilitate no adverse impact by ensuring detention prior to channel projects*
Long-term Project Implementation

- **Project Definition**
  - Develop a Project Team
  - Identify Funding Sources
  - Project Development (Feasibility, PER)

- **Project Construction**
  - Acquire Necessary ROW
  - Complete Design and Permitting
  - Project Construction

---

**San Jacinto Regional Watershed Master Drainage Plan**

**Phase I - Project Definition**

Definition Phase includes identifying the agency and consultant team to develop the projects, identifying and securing funding for the program, and additional feasibility and preliminary engineering for project specifications.

**Phase II - Project Construction**

Construction Phase includes acquiring the land and easements needed for the project, developing construction drawings, identifying and securing any environmental permitting, and project construction.
Implementation - Project Team

- **Regional Facilitator**
  - Coordinate projects among lead agencies
  - Resource for projects and policy
  - Technical Resource
  - Agency such as TWDB, Drainage District, Task Force

- **Lead Agency**
  - Coordinate with Regional Facilitator
  - Champion projects from Concept to Construction
  - Identify and Secure Funding
  - Conduct Engineering Analysis and Design
  - Identify and Acquire ROW
  - Construction and Maintenance
Implementation - Funding

- **Recommended Funding Options**
  - **FEMA PDM and HMGP** – Explore grants for buyouts and flood warning systems; Potential funding for western side projects with BCR > 1.0.
  - **CDBG-DR and CDBG-MIT** – LMI threshold requirements better suited to projects in the eastern part of the basin
  - **NRCS WFPO** – Investigate if projects qualify; Requires an NRCS approved plan
  - **TWDB FP and FIF** – Several abridged applications were submitted in June 2020 for projects by various agencies; Partially fund WPS.
  - **Local Bonds, Taxes or Impact Fees** – Local matches may be required by several of the grant sources. Communities and agencies should consider bond elections or budgeting for drainage studies and projects
  - **Private Investment** – Major industry or development interests may be looking for opportunities to reduce flooding in these watersheds
Low to Moderate Income (LMI) Areas
## Implementation - Lead Agencies

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project</th>
<th>County Location</th>
<th>Location</th>
<th>Potential Lead Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Caney - Detention at SH 105</td>
<td>Montgomery</td>
<td>Montgomery</td>
<td>Montgomery County</td>
</tr>
<tr>
<td>2</td>
<td>Spring - Walnut Creek</td>
<td>Waller</td>
<td>USACE</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Spring - I-45 Channel</td>
<td>Harris/Montgomery</td>
<td>USACE</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Peach - I-69 Channel</td>
<td>Montgomery</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>East Fork - Winter's Bayou Dam</td>
<td>San Jacinto</td>
<td>San Jacinto County, Liberty County</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Caney - Detention at FM 1097</td>
<td>Montgomery</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Spring - Birch Creek</td>
<td>Waller</td>
<td>Montgomery County, HCFCD</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Caney - US 69 Channelization</td>
<td>Harris/Montgomery</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>West Fork - Kingwood Benching</td>
<td>Harris County</td>
<td>HCFCD</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Peach - SH 105 Detention</td>
<td>Montgomery</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>West Fork - River Plantation Channel</td>
<td>Montgomery</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Lake - Garret's Creek Detention</td>
<td>Grimes County</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Peach - Walker Creek Detention</td>
<td>Montgomery/San Jacinto</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Lake - Caney Creek Detention</td>
<td>Grimes</td>
<td>Montgomery County</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Spring - DC2-200 Channel</td>
<td>Harris/Montgomery</td>
<td>HCFCD</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Lake - Little Caney Creek</td>
<td>Montgomery</td>
<td>Montgomery County</td>
<td></td>
</tr>
</tbody>
</table>
Implementation - Challenges

• Short Term
  • Keeping the momentum of the study
  • Consistent floodplain and drainage policy in jurisdictions with different political climates and economic needs
  • Securing funding for a major remapping effort
  • Resistance to buyout of frequently flooded structures
  • Funding for short-term efforts (gages, studies, etc.)

• Long Term
  • Securing funding for major projects
  • Acquiring ROW
  • Environmental permitting and mitigation
  • Utility relocation for major O&G or electrical lines
  • Relocation of transportation infrastructure
  • Rapid change in construction costs
  • Changes in development patterns
Next Steps

• Establish a San Jacinto River Vision Group
• Submit San Jacinto study to TWDB RFPG for inclusion in the State Flood Plan
• Identify Regional Facilitator
• Install recommended gages as funding permits
• Implement Emergency Management recommendations
• Initiate Floodplain Mapping Effort based on SJRWMDP models
• Prioritize tributary watersheds for planning studies
• Progress top 2 projects through development phase
  – Caney - Detention at SH 105
  – Spring - Walnut Creek
Coordination and Communication

• Coordination
  – ROW Discussion – 06/05/20
  – SJRA Board Meeting – 07/23/20
  – HC Precinct 3 Briefing – 06/30/20
  – HC Precinct 4 Briefing – 07/16/20

• Communications
  – Community Meeting – 08/13/20
  – July/August Briefings
    • Council Member Dave Martin
    • Congressman Crenshaw
    • State Representative Huberty
    • Montgomery County Drainage Council
    • Kingwood Association Management
    • Lake Houston Area Chamber
    • Community Activists (Bob Rehak, Barbara Hillburn)
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Under Review) – 95%
- Secondary Mitigation Planning (Finalized) – 100%
- Other Mitigation Actions (Under Review) – 95%
Questions?
# STUDY PARTNERS BRIEFING AGENDA

**City of Houston**

July 9, 2020
San Jacinto Regional Watershed Master Drainage Plan
Teams Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Executive Briefing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>4:00 pm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>5:00 pm</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions**

2. **Goals and Objectives**
   - Conduct a comprehensive Flood Mitigation Plan
   - Identify vulnerability to flood hazards causing loss of life and property
   - Develop approaches to enhance public information and flood level assessment
   - Evaluate flood mitigation strategies to improve long-term resilience

3. **Existing Conditions**
   - Existing Conditions H&H Modeling Update
   - Analysis of Historical Storms
   - Sedimentation and Vegetation

4. **Primary Mitigation Planning**
   - Flood Mitigation Strategies
   - Primary Mitigation Tasks
   - Damage Center Identification
   - Flood Mitigation Projects
   - Additional Mitigation Measures
   - Implementation Planning

5. **Secondary Mitigation Planning**
   - Gage Recommendations

6. **Other Mitigation Actions Planning**
   - Coordination with Emergency Managers
   - Updated communication plans/protocols
   - Critical infrastructure and roadway flood frequency

7. **Community Outreach**
   - Partners and Stakeholder Communication
   - Community Outreach

8. **Study Schedule**

9. **Questions**
SAN JACINTO
Regional Watershed Master Drainage Plan
Agenda

- Goals and Objectives
- Existing Conditions
- Primary Mitigation Planning
- Secondary Mitigation Planning
- Other Mitigation Actions Planning
- Community Outreach
- Project Schedule and Status
- CWA Lake Houston Gate Study
- Questions
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
City of Houston

- West Fork San Jacinto
- East Fork San Jacinto
- Lake Houston
Flood Claim Density
Goals and Objectives

- The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  - Conduct a comprehensive Flood Mitigation Plan
  - Identify vulnerability to flood hazards causing loss of life and property
  - Develop approaches to enhance public information and flood level assessment
  - Evaluate flood mitigation strategies to improve long-term resilience

- The plans specific objectives are:
  - Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  - Secondary Mitigation Planning (Flood Assessment/Warning)
  - Other Mitigation Actions (Communications Protocols, Flood Response)
  - Community Outreach & Education (Drainage, Maintenance, Projects)
Existing Conditions H&H Analysis

• Developed Comprehensive Model
• Limited Updates to M3 Models
• Hydrology
  – Atlas 14 Rainfall (varies by watershed)
  – Updated Watershed Delineation
  – Updated Infiltration/Transform Parameters
  – HEC-HMS Model Development

• Hydraulics
  – Updated cross section geometry
  – New/updated bridges and culverts
  – Reviewed and adjusted n-values
  – Developed unsteady RAS models
Analysis of Historical Storms

- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994

- Leveraged Gage Adjusted Radar Rainfall (GARR) Data

- USGS Gages (Used 22/25)
  - Met with USGS
  - Gage Summary in Report

- Calibration Report Submitted
Sedimentation and Vegetation

- Strategies to reduce flow of sediments into Lake Houston
- Developed annual sediment rating curves for 7 watersheds
  - Predictive tool that relates sediment transport with stream flow
  - Cypress Creek is the highest contributor
- First step toward Regional Sediment Management Plan (RSM)
- Inventory of sediment sources
- Common sediment management strategies
- Recommended strategies for West Fork and Spring Creek
- Did NOT evaluate relationship between sediment and flooding
Flood Mitigation Strategies

• **Primary Flood Mitigation Planning (Flood Reduction)**
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Develop cost estimates
  – Evaluate potential benefits
  – Identify implementation path and challenges

• **Secondary Flood Mitigation Planning (Flood Warning)**
  – Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommend locations for additional FWS gages

• **Other Mitigation Actions (Flood Response)**
  – Coordinate with agencies responsible for Emergency Management
  – Provide recommendations for updated communications protocols
  – Identify potential flooding of roadways and critical infrastructure
Primary Mitigation Tasks

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Damage Center Identification

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers

Significant number of structures at risk during higher frequency storms (2-yr - 25-yr)
Damage Center Identification

• East Fork SJR, West Fork SJR
• Peach, Caney, Spring Creeks

Instances from higher frequency storms (2-yr, 5-yr) were removed to avoid skewing the data
Watershed Mitigation Potential

• Higher Potential
  – Spring Creek (Benefits in watershed; Potential reduction downstream)
  – East Fork (Major Lake Houston contributor; Available open space)
  – Peach/Caney Creek (Available open space; Benefits in watershed)

• Moderate Potential
  – Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

• Lower Potential
  – Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  – Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  – Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  – Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  – West Fork (Limited open space; High volume; Benefits in watershed)
Previously Recommended Projects

- Reviewed previous reports and master plans
  - 1943 – San Jacinto River Master Plan
  - 1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
  - 1989 – South Montgomery County Flood Protection Plan
  - 1997 – Lake Creek Reservoir Study
  - 2000 – Lake Houston Regional Flood Protection Study
  - 2015 – Cypress Creek Overflow Management Plan
  - 2019 – Estimate Land Cover Effects on Selected Watersheds
  - 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

- Considered 34 Previously Recommended Projects
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
San Jacinto Regional WMDP

- Combined projects show increased local and regional benefits
- Current project combinations (by Watershed)
  - Spring Creek: Walnut Detention, Birch Detention, I-45 to Riley Fuzzell
  - Lake Creek: Caney Detention, Little Caney Detention, Garrett’s Detention
  - East Fork: Winters Detention, Lower East Fork Channel Improvements
  - Caney Creek: SH105 and FM1097 Detention, Channel D/S of I-69
  - Peach Creek: SH 105 and Walker Detention, Channel D/S of I-69
  - Full Combined Model: Ultimate Flood Reduction Improvements
- Projects in Spring Creek have the highest BCR (0.55 – 1.22)
San Jacinto Regional WMDP

- Plan Cost: $2.9B - $3.3B
- Overall Plan Benefits: $756 M
- BCR: 0.23 – 0.26

<table>
<thead>
<tr>
<th>Stream</th>
<th>Existing Structural Damages ($M)</th>
<th>Combined Alternatives Structural Damages ($M)</th>
<th>Structural Benefit ($M)</th>
<th>Cost Range ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>339.4</td>
<td>117.3</td>
<td>222</td>
<td>313.6 – 388.5</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>119</td>
<td>101.4</td>
<td>17.5</td>
<td>–</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>374.1</td>
<td>370.4</td>
<td>3.7</td>
<td>–</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>196.7</td>
<td>196.2</td>
<td>0.5</td>
<td>–</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>128.3</td>
<td>78.3</td>
<td>50.1</td>
<td>134.3 – 166.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>396.2</td>
<td>198.2</td>
<td>198</td>
<td>966</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>16.7</td>
<td>4.5</td>
<td>12.1</td>
<td>303 - 422</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>163.9</td>
<td>32.9</td>
<td>131.1</td>
<td>718.0 – 812.0</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>190.8</td>
<td>70.5</td>
<td>120.2</td>
<td>478.0 – 533.0</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>20.8</td>
<td>19.2</td>
<td>0.8</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,030.3</strong></td>
<td><strong>1,274.1</strong></td>
<td><strong>756.2</strong></td>
<td><strong>2,912.9 – 3,288.1</strong></td>
</tr>
</tbody>
</table>
Low to Moderate Income (LMI) Areas
Additional Regional Measures

• Detention Policy
  – Local detention provides critical mitigation for development and CIP
  – Regional benefits are dependent on location and timing of development
  – Future conditions modeling indicated limited detention impact, BUT
    • 2070 development was centered on lower basin (1-2% volume increase)
    • Ultimate development along the basin outer boundaries shows a higher increase in runoff volume (>5%)
  – Detention **DOES** have an impact on local flooding issues
  – Comprehensive impact analysis should be performed

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $3B
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
## Buyouts

- Summary of structures and expected damages in each watershed that flood in the 5-year event

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Structure Count</th>
<th>Existing Damages (NPV, 50-yr Period) ($M)</th>
<th>2019 Market Value ($M)</th>
<th>Estimated Buyout Cost (2.5× Mkt. Value) ($M)</th>
<th>Benefit-Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>34</td>
<td>46.65</td>
<td>4.38</td>
<td>10.96</td>
<td>4.3</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>39</td>
<td>29.92</td>
<td>9.61</td>
<td>24.02</td>
<td>1.2</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>40</td>
<td>69.92</td>
<td>16.80</td>
<td>42.01</td>
<td>1.7</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>30</td>
<td>31.02</td>
<td>6.05</td>
<td>15.13</td>
<td>2.0</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>31</td>
<td>36.53</td>
<td>5.53</td>
<td>13.83</td>
<td>2.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>38</td>
<td>40.29</td>
<td>6.41</td>
<td>16.02</td>
<td>2.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>5</td>
<td>4.72</td>
<td>1.02</td>
<td>2.55</td>
<td>1.9</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>71</td>
<td>59.46</td>
<td>8.67</td>
<td>21.67</td>
<td>2.7</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>85</td>
<td>74.05</td>
<td>7.80</td>
<td>19.49</td>
<td>3.8</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>9</td>
<td>4.76</td>
<td>1.08</td>
<td>2.70</td>
<td>1.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>58</td>
<td>57.07</td>
<td>7.34</td>
<td>18.34</td>
<td>3.1</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>1</td>
<td>1.51</td>
<td>0.21</td>
<td>0.52</td>
<td>2.9</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>2</td>
<td>1.57</td>
<td>0.97</td>
<td>2.43</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>443</strong></td>
<td><strong>457.46</strong></td>
<td><strong>75.87</strong></td>
<td><strong>189.67</strong></td>
<td><strong>2.4</strong></td>
</tr>
</tbody>
</table>
Implementation Planning

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Perform project prioritization
  - Update project costs and benefits
  - Select and weight metrics based on study partner input
  - Perform project prioritization
- Develop project phasing plan
  - Model projects cumulatively to ensure no negative impacts
  - Update environmental and cultural data, update utility information, ROW
  - Identify potential funding sources depending on criteria (BCR, LMI, etc.)
- Move forward with Feasibility, Preliminary Engineering, Design
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k (Plus Maintenance)
Other Mitigation Actions

- Other Mitigation Action Goals
  - Evaluate communications plan/protocol during emergencies
  - Identify critical infrastructure and compare to inundation
  - Determine expected flood frequency evacuation routes

- Conducted Emergency Management Workshop (March 11th)

- Working on draft memorandum
Communication and Outreach

• Communication
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (8)
  – Emergency Managers Workshop
  – H-GAC Coordination

• Outreach
  – 1st round of community meetings complete – December 2019
  – 2nd Community Meeting (Virtual) in planning – August 2020
  – Stakeholder Meetings (Jul/Aug)
  – Woodlands Drainage Task Force Meeting – January 28th
  – Study Website
    www.sanjacstudy.org
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Workshops Completed) – 95%
- Secondary Mitigation Planning (Adjusted Schedule) – 100%
- Other Mitigation Actions (Adjusted Schedule) – 95%

### SAN JACINTO REGIONAL WMDP - PROJECT SCHEDULE

<table>
<thead>
<tr>
<th>Task 1: Project Management, Coordination, and Document Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>457</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 2: Review and Assess Existing Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 3: Existing Conditions Hydrologic and Hydraulic Model Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 4: Analyze Historical Storm Events and Calibrate Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>144</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 5: Future Conditions Hydrologic and Hydraulic Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>387</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 6: Primary Flood Mitigation Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>189</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 7: Secondary Flood Mitigation Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>155</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 8: Other Flood Hazard Mitigation Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>457</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 9: Community Outreach and Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task 10: Final Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
</tr>
</tbody>
</table>
Study Submittals

• Submitted
  – Existing Conditions Memorandum (08/12/19)
  – Historical Storms Memorandum (04/07/20)
  – Future Conditions Memorandum (04/07/20)
  – Secondary Mitigation Memorandum (05/13/20)
  – Primary Mitigation Memo (06/08/20)
  – Updated Sedimentation/Vegetation Memo (06/26/20)
  – Other Mitigation Actions Memo (06/30/20)

• Upcoming
  – Draft Report (07/13/20)
    • Alternative Funding
    • Implementation Plan
  – Final Report (08/31/20)
Questions?
**STUDY PARTNERS MEETING NOTES**  
*City of Houston*

July 9, 2020  
San Jacinto Regional Watershed Master Drainage Plan  
Microsoft Teams Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>4:00 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>5:00 PM</td>
</tr>
</tbody>
</table>

## Agenda

### 1. Attendees
- Jing Chen, HCFCDF
- Dena Green, HCFCDF
- Steve Costello, COH
- Laura Patino, COH
- Adam Eaton, COH
- Terry Barr, Halff
- Sam Hinojosa, Halff
- Andrew Moore, Halff
- Cory Stull, Freese & Nichols
- Garrett Johnston, Freese & Nichols

### 2. Goals and Objections
- Jing introduced the meeting.
- Terry introduced the San Jacinto study. He showed the watershed included in the study and the funding partners. He presented the location of the watershed in reference to City of Houston.
- Terry showed the density of flood claims within the basin.
- Terry introduced the goals and objectives of the San Jacinto Regional Watershed Master Drainage Plan.

### 3. Existing Conditions
- Terry presented the update of the Existing Conditions analysis. He stated that all major streams in the basin have been included in a combined existing conditions model. The model utilized existing models from HCFCDF as well as new models for the upper regions. The model utilizes the latest Atlas 14 rainfall and has been calibrated to historical storm events including Hurricane Harvey and Memorial Day 2016. The model has also been validated with the October 1994 and Tropical Storm Imelda events. The calibration and validation including comparing the model to 22 USGS gages in the watershed.

### 4. Primary Mitigation Planning
- Terry summarized the primary mitigation process which included identifying mitigation strategies to reduce flooding for region.
- The team identified damage centers to determine which locations should be targeted with the mitigation projects using the structural inventory tool and the updated existing
conditions modeling. Of the damage centers, the highest damage concentrations were in those centers closer to the confluence.

- Using the damage center information, the team identified tiers for mitigation planning to rank the potential mitigation projects based on number of damages, regional benefit, and potential mitigation volumes.
- The team reviewed and cataloged projects recommended in several previous reports to determine if any of these should be included in the analysis. Many of the projects are no longer feasible or were originally intended for water supply purposes; however, the information was used as a starting point for many of the projects that were evaluated as part of this study. In addition, the team also proposed new mitigation strategies.
- The team evaluated a total of 25 projects, choosing those deemed most effective to develop a regional master plan, which includes detention and channelization project spread throughout the watershed. The “most effective” projects are those that performed the best for each watershed as well as provided regional benefit. Terry stated that the projects improve the areas near the damage center within their respective watershed, but also provide flood reduction benefits further downstream, including beyond their confluences with receiving streams. He stated that Lake Houston limits the effectiveness of these projects downstream (ex. confluence with East Fork) and that reductions to the Lake Houston level would be needed to see further improvements. However, this study does not evaluate or recommend changes to the lake. A separate Lake Houston study is reviewing improvements for the Lake Houston area.
- The benefit-cost ratios (BCR) for Spring Creek were the highest (0.55-1.22) because of more development in the Spring Creek Watershed. However, overall cost benefits are not positive for many of the projects (0.75 – 1 range). Terry stated that the BCR is not the only metric for funding the projects. FEMA will also consider social benefits for this BCR range of 0.75 to 1 and some funding may still be available for these projects.
- In addition, Terry showed the low-to-moderate income (LMI) areas as they relate to potential projects. Funding will vary based on LMI. Lower income areas could potentially be good candidates for CDBG or other funding sources that account for socio-economically disadvantaged areas.
- Terry discussed additional mitigation measures, including detention, floodplain preservation, and buyouts, as potential options. Detention associated with local development is needed to offset negative impacts for the local streets, sewers, and streams. Future projections show that the impact of local detention on the regional scale is minor, but much of the analysis depends on assumptions made about the development location and timing. Terry reiterated that detention is an important tool to mitigate drainage impacts of development especially when considering cumulative effects or hydrograph timing.
- Terry stated that floodplain preservation is recommended because losses in floodplain storage can have negative impacts downstream. The study did not evaluate specific areas or scenarios related to floodplain preservation. Future conditions do not include floodplain fill. Harris County has “no adverse impact” and floodplain fill mitigation policies in place and Terry agreed that those policies were beneficial.
- Terry indicated that while the proposed projects (detention, channel) will provide significant benefits, some structures, specifically those that flood during frequent storms (2- & 5-year), will likely continue to flood. For these structures, buyouts may be the recommended strategy. Buyout is more effective than the mitigation projects from a purely economic perspective.
• The next step is to finalize and prioritize the list of projects to be included in the overall master drainage plan and develop a project phasing plan and then finally move forward with feasibility, preliminary engineering, design, construction, etc.

5. Secondary Mitigation Planning
• Terry presented the additional gages that are recommended in the area including stage, flow, and rainfall. The gages provide first responders early information to flooding in the region. The team recommended 26 gages throughout the San Jacinto Basin, 5 of which are already being installed by HCFC. Many of the gages are proposed in the upper basin areas where there are currently minimal gages. This is a benefit to Harris County because the gages will identify, early in the storm event, the amount of runoff that is expected to be routed through Harris County from the upper basin.

6. Other Mitigation Actions
• Terry discussed coordinating with local agencies to determine how the agencies react to storm events and their communication protocols.
• The team also identified roadway levels of service and critical infrastructure within the potential floodplains.
• Most counties have a plan for responding to flooding events and are already coordinating with the region. Identified some areas of improvements for each agency.

7. Communication and Outreach
• Terry explained that there is a defined coordination effort, which includes meetings with both the study partners, and other supporting partners, such as the surrounding counties and H-GAC.
• As part of the Other Mitigation Actions task, the team met with emergency managers for each of the regional entities to understand protocol, and also conducted an emergency management workshop.
• The team also has an outreach plan, with the first round of community meetings in December 2019 and a second round planned for August 2020 (virtual). In addition, there is a study website that provides an overview of the study goals and progress. (www.sanjacstudy.org).

8. Study Schedule
• Terry presented the study schedule with the final report being submitted in August 2020.

9. Questions/Comments
• Jing stated that the team will be presenting this information to the public as part of a community meeting. Terry followed up by stating that additional implementation information will be developed prior to the public meeting. The public meeting will be less technical and will focus on the sources of flooding in the watershed and the recommended path forward.
• Jing asked about the factor used for buyouts in the slides. The current calculation includes a factor of 2.5 x Market Value, which was based on the acquisition factor recommended by James Wade with HCFC. Jing indicated that the recommended factor for voluntary buyouts is 1.6 x Market Value. Terry indicated that the calculation was done to provide an order of magnitude estimate of what it would take to buyout all the property in the floodplain. It should also be noted that it is unlikely that all property owners in the floodplain would voluntarily sell their property, which would increase costs above the 1.6.
| • Steve Costello mentioned that he is investigating a public private partnership for extracting sand within the watershed. He requested a copy of the sedimentation memo to review before meeting with particular agencies. Cory Stull stated that the SJRA is investigating a pilot project on sedimentation collection within the basin. Steve indicated that a long-term plan for sediment removal is needed and that he would like to sit down and discuss this plan with representatives of the Texas Aggregates and Concrete Association (TACA).

• Steve Costello asked how the projects would be funded and if they were broken into short term and long-term projects. Terry stated that the implementation is being drafted and will be included in the report along with funding opportunities. Sam stated that some projects are short-term but most are long-term projects that will take decades to implement. |
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
San Jacinto Flood Mitigation Strategies

• Primary Flood Mitigation Planning (Flood Reduction)
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Develop cost estimates
  – Evaluate potential benefits
  – Identify implementation path and challenges

• Secondary Flood Mitigation Planning (Flood Warning)
  – Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommend locations for additional FWS gages

• Other Mitigation Actions (Flood Response)
  – Coordinate with agencies responsible for Emergency Management
  – Provide recommendations for updated communications protocols
  – Identify potential flooding of roadways and critical infrastructure
Existing Conditions Modeling

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Soils, % Impervious, BDF (TC+R)
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

• Historical Storms
  – Memorial Day (2016)
  – Hurricane Harvey (2017)
  – October 1994

• Leveraged Gage Adjusted Radar Rainfall (GARR) Data

• USGS Gages (Used 22/25)
  – Met with USGS
  – Peach Creek Adjustment
  – Gage Summary in Report

• Calibration Report Submitted
Damage Center Identification

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks
Watershed Mitigation Potential

- **Higher Potential**
  - Spring Creek (Benefits in watershed; Potential reduction downstream)
  - East Fork (Major Lake Houston contributor; Available open space)
  - Peach/Caney Creek (Available open space; Benefits in watershed)

- **Moderate Potential**
  - Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

- **Lower Potential**
  - Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  - Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  - Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  - Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  - West Fork (Limited open space; High volume; Benefits in watershed)
Flood Reduction Projects Summary
# Flood Reduction Projects Summary

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Walnut Creek 10 miles U/S of Spring Creek</td>
<td>91 - 120</td>
<td>123</td>
<td>1.02 - 1.35</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Mill Creek 10 miles U/S of Spring Creek</td>
<td>96 - 126</td>
<td>81.6</td>
<td>0.65 - 0.85</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Birch Creek 10 miles U/S of Spring Creek</td>
<td>77 - 117</td>
<td>82.6</td>
<td>0.70 - 1.07</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>I-45 to 3 miles D/S of Riley Fuzzell</td>
<td>81</td>
<td>145.3</td>
<td>1.79</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>Between Gosling Road and I-45</td>
<td>123</td>
<td>82.6</td>
<td>0.66</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-200 U/S of I-45</td>
<td>59</td>
<td>53</td>
<td>0.89</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-500 U/S Kuykendahl Rd. to Willow Creek</td>
<td>142</td>
<td>70.3</td>
<td>0.49</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Caney Creek 0.3 miles North of SH 105</td>
<td>98 - 163</td>
<td>34</td>
<td>0.21 - 0.35</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Little Caney Creek 1.1 miles U/S of Lake Creek</td>
<td>98 - 128</td>
<td>27.6</td>
<td>0.22 - 0.28</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Garrett's Creek 0.74 miles U/S of Lake Creek</td>
<td>107 - 131</td>
<td>35.4</td>
<td>0.27 - 0.33</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Lake Creek Mainstem 0.6 miles U/S of SH 105</td>
<td>187 - 264</td>
<td>61.8</td>
<td>0.15 - 0.33</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach 12 miles U/S of New Caney @ SH105</td>
<td>299 - 428</td>
<td>57</td>
<td>0.13 - 0.19</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach/Walker 19 miles U/S of New Caney</td>
<td>203 - 222</td>
<td>68</td>
<td>0.30 - 0.33</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Channel</td>
<td>Peach Creek D/S of I-59</td>
<td>180</td>
<td>75.9</td>
<td>0.42</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.0 miles U/S of FM 1097</td>
<td>104 - 131</td>
<td>19.8</td>
<td>0.15 - 0.19</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.9 miles U/S of SH 105</td>
<td>177 - 207</td>
<td>26.3</td>
<td>0.13 - 0.15</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Channel</td>
<td>Caney Creek D/S of US-69 to the East Fork</td>
<td>140</td>
<td>75.9</td>
<td>0.54</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou Nebbetts 2 miles U/S Cleveland</td>
<td>128 - 176</td>
<td>39.8</td>
<td>0.15 - 0.20</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou 5 miles U/S of Cleveland</td>
<td>132 - 163</td>
<td>44.2</td>
<td>0.26 - 0.33</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>East Fork 10 miles U/S of Cleveland near FM945</td>
<td>138 - 141</td>
<td>34.3</td>
<td>0.15 - 0.16</td>
</tr>
<tr>
<td>East Fork</td>
<td>Bench</td>
<td>East Fork FM 1485 to Luce Bayou</td>
<td>326</td>
<td>24.9</td>
<td>0.08</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to SH 242</td>
<td>148</td>
<td>33.8</td>
<td>0.22</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to 3.2 miles D/S of SH 242</td>
<td>179</td>
<td>30.3</td>
<td>0.15</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork D/S of I-59</td>
<td>722</td>
<td>67</td>
<td>0.09</td>
</tr>
<tr>
<td>West Fork</td>
<td>Bench</td>
<td>West Fork D/S of I-59</td>
<td>818</td>
<td>55.6</td>
<td>0.07</td>
</tr>
</tbody>
</table>
### Spring Creek

#### Project Details

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Detention</td>
<td>Walnut Creek 10 miles U/S of Spring Creek</td>
<td>91 - 120</td>
<td>123</td>
<td>1.02 - 1.35</td>
</tr>
<tr>
<td>2</td>
<td>Detention</td>
<td>Mill Creek 10 miles U/S of Spring Creek</td>
<td>96 - 126</td>
<td>81.6</td>
<td>0.65 - 0.85</td>
</tr>
<tr>
<td>3</td>
<td>Detention</td>
<td>Birch Creek 10 miles U/S of Spring Creek</td>
<td>77 - 117</td>
<td>82.6</td>
<td>0.70 - 1.07</td>
</tr>
<tr>
<td>4</td>
<td>Bench</td>
<td>I-45 to 3 miles D/S of Riley Fuzzell</td>
<td>81</td>
<td>145.3</td>
<td>1.79</td>
</tr>
<tr>
<td>5</td>
<td>Bench</td>
<td>Between Gosling Road and I-45</td>
<td>123</td>
<td>82.6</td>
<td>0.66</td>
</tr>
<tr>
<td>6</td>
<td>Bench</td>
<td>DC2-200 U/S of I-45</td>
<td>59</td>
<td>53</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>Bench</td>
<td>DC2-500 U/S Kuykendahl Rd. to Willow Creek</td>
<td>142</td>
<td>70.3</td>
<td>0.49</td>
</tr>
</tbody>
</table>

---

**Legend:**
- **Project Included in Plan**
- **Project Considered**
# Spring Creek

- **Most Effective Projects**
  - Birch Creek Detention
  - Walnut Creek Detention
  - Channel Improvements from I-45 to Riley Fuzzell
- **Total Cost:** $249M - $318M
- **Spring Creek WSEL Reduction (Watershed & Basin-wide)**

## Regional Project Reductions

<table>
<thead>
<tr>
<th>Spring Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with West Fork</td>
<td>-0.16</td>
<td>-0.1</td>
<td>0.12</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.16</td>
<td>-0.16</td>
<td>-0.16</td>
</tr>
<tr>
<td>I-69</td>
<td>-0.11</td>
<td>-0.11</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

## Spring Creek Reductions

<table>
<thead>
<tr>
<th>Spring Creek Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SH249</td>
<td>-2.53</td>
<td></td>
</tr>
<tr>
<td>Kuykendahl</td>
<td>-1.96</td>
<td></td>
</tr>
<tr>
<td>Gosling</td>
<td>-1.45</td>
<td></td>
</tr>
<tr>
<td>I-45</td>
<td>-6.65</td>
<td></td>
</tr>
<tr>
<td>Riley Fuzzell</td>
<td>-6.61</td>
<td></td>
</tr>
</tbody>
</table>
Lake Creek

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Detention</td>
<td>Caney Creek 0.3 miles North of SH 105</td>
<td>98 - 163</td>
<td>34</td>
<td>0.21 - 0.35</td>
</tr>
<tr>
<td>9</td>
<td>Detention</td>
<td>Little Caney Creek 1.1 miles U/S of Lake Creek</td>
<td>98 - 128</td>
<td>27.6</td>
<td>0.22 - 0.28</td>
</tr>
<tr>
<td>10</td>
<td>Detention</td>
<td>Garrett's Creek 0.74 miles U/S of Lake Creek</td>
<td>107 - 131</td>
<td>35.4</td>
<td>0.27 - 0.33</td>
</tr>
<tr>
<td>11</td>
<td>Detention</td>
<td>Lake Creek Mainstem 0.6 miles U/S of SH105</td>
<td>187 - 264</td>
<td>61.8</td>
<td>0.15 - 0.22</td>
</tr>
</tbody>
</table>

- Project Included in Plan
- Project Considered
Lake Creek

- Most Effective Projects
  - Garrett’s Creek Detention
  - Little Caney Creek Detention
  - Caney Creek Detention
- Total Cost: $303M - $422M
- Lake Creek WSEL Reduction

Regional Project Reductions

<table>
<thead>
<tr>
<th>Lake Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Garrett’s Det.</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.63</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-0.48</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-0.56</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-0.15</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.14</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.09</td>
</tr>
</tbody>
</table>

Lake Creek Reductions

<table>
<thead>
<tr>
<th>Lake Creek Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 105</td>
<td>-4.5</td>
</tr>
<tr>
<td>FM 149</td>
<td>-3.63</td>
</tr>
<tr>
<td>Superior Road</td>
<td>-3.32</td>
</tr>
<tr>
<td>Splendora Ranch (Fish Crk)</td>
<td>-4.7</td>
</tr>
</tbody>
</table>
Caney Creek

- Most Effective Projects
  - Mainstem detention upstream of SH105
  - Mainstream detention upstream of FM1097
  - Channel Improvements from US59 to East Fork Confluence
- Total Cost: $421M - $478M
- Caney Creek WSEL Reduction (Watershed & Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>Caney Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SH 105 Det.</td>
</tr>
<tr>
<td>Confluence with Peach</td>
<td>-0.79</td>
</tr>
<tr>
<td>Confluence with East Fork</td>
<td>-0.55</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.08</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-0.05</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.04</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Caney Creek Combined Improvements

<table>
<thead>
<tr>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 105</td>
</tr>
<tr>
<td>FM 2090</td>
</tr>
<tr>
<td>HWY 242</td>
</tr>
<tr>
<td>I-69</td>
</tr>
<tr>
<td>FM 1485</td>
</tr>
</tbody>
</table>
Peach Creek

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Detention</td>
<td>Peach 12 miles U/S of New Caney @ SH105</td>
<td>299 - 428</td>
<td>57</td>
<td>0.13 - 0.19</td>
</tr>
<tr>
<td>13</td>
<td>Detention</td>
<td>Peach/Walker 19 miles U/S of New Caney</td>
<td>203 - 222</td>
<td>68</td>
<td>0.30 - 0.33</td>
</tr>
<tr>
<td>14</td>
<td>Channel</td>
<td>Peach Creek D/S of I-69</td>
<td>180</td>
<td>75.9</td>
<td>0.42</td>
</tr>
</tbody>
</table>
Peach Creek

- Most Effective Projects
  - Mainstem detention upstream of SH105
  - Mainstream detention upstream of FM1097
  - Channel Improvements from US59 to East Fork Confluence
- Total Cost: $682M - $830M
- Peach Creek WSEL Reduction (Watershed & Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>Peach Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Caney</td>
<td>-1.02</td>
</tr>
<tr>
<td>Confluence with East Fork</td>
<td>0.23</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>0.13</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>0.08</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>0.05</td>
</tr>
<tr>
<td>I-69</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Peach Creek Combined Improvements

- SH 105: -3.76 ft
- FM 2090: -5.39 ft
- I69: -13.88 ft
- Roman Forest: -10.75 ft
- FM 1485: -1.38 ft
East Fork SJR

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Detention</td>
<td>Winters Bayou Nebletts 2 miles U/S Cleveland</td>
<td>128 - 176</td>
<td>39.8</td>
<td>0.15 - 0.20</td>
</tr>
<tr>
<td>19</td>
<td>Detention</td>
<td>Winters Bayou 5 miles U/S of Cleveland</td>
<td>132 - 163</td>
<td>44.2</td>
<td>0.26 - 0.33</td>
</tr>
<tr>
<td>20</td>
<td>Detention</td>
<td>East Fork 10 miles U/S of Cleveland near FM945</td>
<td>138 - 141</td>
<td>34.3</td>
<td>0.15 - 0.16</td>
</tr>
<tr>
<td>21</td>
<td>Bench</td>
<td>East Fork FM 1485 to Luce Bayou</td>
<td>326</td>
<td>24.9</td>
<td>0.08</td>
</tr>
</tbody>
</table>
East Fork SJR

- Most Effective Projects
  - Mainstem detention upstream of SH105
  - Mainstream detention upstream of FM1097
  - Channel Improvements from US59 to East Fork Confluence
- Total Cost: $458M - $489M
- East Fork SJR WSEL Reduction (Watershed & Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>East Fork Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winters Det.</td>
</tr>
<tr>
<td>Confluence with Caney</td>
<td>0.08</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.50</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.37</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.30</td>
</tr>
<tr>
<td>I-69</td>
<td>0.00</td>
</tr>
</tbody>
</table>

East Fork Reductions

<table>
<thead>
<tr>
<th>East Fork Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM 945</td>
<td>-0.02</td>
</tr>
<tr>
<td>SH 105</td>
<td>-2.16</td>
</tr>
<tr>
<td>I-69</td>
<td>-1.96</td>
</tr>
<tr>
<td>FM 2090</td>
<td>-2.39</td>
</tr>
<tr>
<td>FM 1485</td>
<td>-9.74</td>
</tr>
</tbody>
</table>
West Fork SJR

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Channel</td>
<td>West Fork from I-45 to SH 242</td>
<td>148</td>
<td>33.8</td>
<td>0.22</td>
</tr>
<tr>
<td>23</td>
<td>Channel</td>
<td>West Fork from I-45 to 3.2 miles D/S of SH 242</td>
<td>179</td>
<td>30.3</td>
<td>0.15</td>
</tr>
<tr>
<td>24</td>
<td>Channel</td>
<td>West Fork D/S of I-59 (3000' Wide)</td>
<td>722</td>
<td>67</td>
<td>0.09</td>
</tr>
<tr>
<td>25</td>
<td>Bench</td>
<td>West Fork D/S of I-59 (3500' Wide)</td>
<td>818</td>
<td>55.6</td>
<td>0.07</td>
</tr>
</tbody>
</table>
West Fork San Jacinto

- Most Effective Projects
  - West Fork Channelization from I-45 to SH242
  - West Fork Channelization downstream of US59
- Total Cost: $966M
- West Fork SJR WSEL Reduction (Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>West Fork Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper WF 750</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.17</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-3.07</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>0.13</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>0.05 - 2.34</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>0.05 0.06</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>0.02 0.04</td>
</tr>
</tbody>
</table>
San Jacinto Regional WMDP

San Jacinto River Master Drainage Plan

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway *</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Caney Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Caney Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
Low to Moderate Income (LMI) Areas
San Jacinto Regional WMDP

- Plan Cost: $3.1B - $3.5B
- Overall Plan Benefits: $677 M
- BCR: 0.19 – 0.22

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Damages, Existing ($M)</th>
<th>Damages, Combined Alts ($M)</th>
<th>Benefit ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>466.6</td>
<td>163.8</td>
<td>302.8</td>
</tr>
<tr>
<td>Willow</td>
<td>112.2</td>
<td>86.6</td>
<td>25.6</td>
</tr>
<tr>
<td>Cypress</td>
<td>213.2</td>
<td>211.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>30.9</td>
<td>30.8</td>
<td>0.1</td>
</tr>
<tr>
<td>East Fork</td>
<td>101.4</td>
<td>56</td>
<td>45.5</td>
</tr>
<tr>
<td>West Fork</td>
<td>269.7</td>
<td>132.7</td>
<td>137</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>10.1</td>
<td>3.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Peach</td>
<td>113.1</td>
<td>27.9</td>
<td>85.3</td>
</tr>
<tr>
<td>Caney</td>
<td>135.6</td>
<td>63.8</td>
<td>71.9</td>
</tr>
<tr>
<td>Luce</td>
<td>14.6</td>
<td>14</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>1467.4</td>
<td>790.4</td>
<td>677.2</td>
</tr>
</tbody>
</table>
Additional Regional Measures

• Detention Policy
  – Detention associated with local development provides critical mitigation, but the regional benefits associated with local detention are highly dependent on the location and timing of development
  – 2070 modeling indicated limited detention impact, but development was centered on the urban core lower in the basin (1-2% volume increase)
  – Ultimate development along the basin outer boundaries shows a higher increase in runoff volume (>5%); detention impact may increase
  – Detention **DOES** have an impact on local flooding issues

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $3B
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
Buyouts

- Summary of structures and expected damages in each watershed that flood in the 5-year event

<table>
<thead>
<tr>
<th>Buyouts - Structures Flooding in 5-yr Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watershed</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>Spring</td>
</tr>
<tr>
<td>Willow</td>
</tr>
<tr>
<td>Cypress</td>
</tr>
<tr>
<td>Little Cypress</td>
</tr>
<tr>
<td>East Fork</td>
</tr>
<tr>
<td>West Fork</td>
</tr>
<tr>
<td>Lake Creek</td>
</tr>
<tr>
<td>Peach</td>
</tr>
<tr>
<td>Caney</td>
</tr>
<tr>
<td>Luce</td>
</tr>
<tr>
<td>Tarkington</td>
</tr>
<tr>
<td>Jackson Bayou</td>
</tr>
<tr>
<td>Gum Gully</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Implementation Planning

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Prioritize projects (Watershed or Regional Approach)
  - Select and weight metrics based on study partner input
  - Update project costs and benefits
  - Gather information on the selected metrics
  - Perform project prioritization
- Develop project phasing plan based on priority
  - Model projects cumulatively (i.e. Project 1, Project 1 & 2,...All projects) to ensure no negative impacts
  - Update environmental and cultural data, update utility information, ROW
  - Identify potential funding sources depending on criteria (BCR, LMI, etc.)
- Move forward with Feasibility, Preliminary Engineering, Design
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, NWS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k
  - Additional costs for annual maintenance
Other Mitigation Actions

- Other Mitigation Action Goals
  - Evaluate communications plan/protocol during emergencies
  - Identify critical infrastructure and compare to inundation
  - Determine expected flood frequency evacuation routes

- Conducted Emergency Management Workshop (March 11th)

- Working on draft memorandum
Tasks to be Completed

- Finalize Implementation Plan
- Project Ranking
- Identify Funding Sources
- Detention Policy Recommendations
Study Deliverables Schedule

- Preliminary Mitigation Planning Memo (June 8th)
- Draft Report (July 13th)
- Final Report (August 31st)
Agenda

• Goals and Objectives
• Existing Conditions
• Primary Mitigation Planning
• Secondary Mitigation Planning
• Other Mitigation Actions Planning
• Community Outreach
• Project Schedule and Status
• Questions
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
San Jacinto River Authority

SJRA Jurisdiction
- West Fork San Jacinto
- East Fork San Jacinto
- Lake Creek
- Spring Creek
- Caney Creek
- Peach Creek
- Luce Bayou
Historical Flooding

Legend
- Watershed
- Water Features
- Major Stream

Historical Flooded Structures
Value
- High: 1500
- Low: 0
Goals and Objectives

• The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  – Conduct a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Develop approaches to enhance public information and flood level assessment
  – Evaluate flood mitigation strategies to improve long-term resilience

• The plans specific objectives are:
  – Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  – Secondary Mitigation Planning (Flood Assessment/Warning)
  – Other Mitigation Actions (Communications Protocols, Flood Response)
  – Community Outreach & Education (Drainage, Maintenance, Projects)
Existing Conditions H&H Analysis

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Updated Infiltration/Transform Parameters
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

• Historical Storms
  – Memorial Day (2016)
  – Hurricane Harvey (2017)
  – October 1994

• Leveraged Gage Adjusted Radar Rainfall (GARR) Data

• USGS Gages (Used 22/25)
  – Met with USGS
  – Gage Summary in Report

• Calibration Report Submitted
Sedimentation and Vegetation

- Strategies to reduce flow of sediments into Lake Houston
- Developed annual sediment rating curves for 7 watersheds
  - Predictive tool that relates sediment transport with stream flow
  - Cypress Creek is the highest contributor
- First step toward Regional Sediment Management Plan (RSM)
- Inventory of sediment sources
- Common sediment management strategies
- Recommended strategies for West Fork and Spring Creek
- Did NOT evaluate relationship between sediment and flooding
Flood Mitigation Strategies

• **Primary Flood Mitigation Planning (Flood Reduction)**
  - Primary Alternatives – Based on previously identified solutions
  - Secondary Alternatives – Developed additional flood reduction projects
  - Develop cost estimates
  - Evaluate potential benefits
  - Identify implementation path and challenges

• **Secondary Flood Mitigation Planning (Flood Warning)**
  - Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  - Recommend locations for additional FWS gages

• **Other Mitigation Actions (Flood Response)**
  - Coordinate with agencies responsible for Emergency Management
  - Provide recommendations for updated communications protocols
  - Identify potential flooding of roadways and critical infrastructure
Primary Mitigation Tasks

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Watershed Mitigation Potential

- Higher Potential
  - Spring Creek
  - East Fork San Jacinto
  - Peach/Caney Creek
- Moderate Potential
  - Lake Creek
- Lower Potential
  - Cypress Creek
  - Willow Creek
  - Little Cypress Creek
  - Luce/Tarkington Bayou
  - Jackson Bayou
  - West Fork San Jacinto

<table>
<thead>
<tr>
<th></th>
<th>Watershed Benefits</th>
<th>Open Space</th>
<th>Regional Reductions</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luce Bayou</td>
<td></td>
<td>☑</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>East Fork</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>High</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>High</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>High</td>
</tr>
<tr>
<td>West Fork</td>
<td>☑</td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Lake Creek</td>
<td></td>
<td>☑</td>
<td>☑</td>
<td>Moderate</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>High</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>☑</td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Little Cypress</td>
<td></td>
<td>☑</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>☑</td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
</tbody>
</table>
Previously Recommended Projects

• Reviewed previous reports and master plans
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

- Considered 34 Previously Recommended Projects
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
San Jacinto Regional WMDP

- Cost: $2.9B - $3.3B
- Overall Plan Benefits: $756 M

A total of 16 flood reduction projects are recommended

- 10 regional detention facilities (229,000 ac-ft)
- 6 channelization Projects (38.5 miles)
Low to Moderate Income (LMI) Areas
Additional Regional Measures

• Detention Policy
  – Local detention provides critical mitigation for development and CIP
  – Regional benefits are dependent on location and timing of development
  – Future conditions info shows development around existing urban centers
  – Comprehensive impact analysis should be performed

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $2-3B
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will likely continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
- Buyout cost is approximately $190M
Path to Implementation

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Perform project prioritization
- Develop project phasing plan
- Move forward with Feasibility, Preliminary Engineering, Design
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k (Plus Maintenance)
Other Mitigation Actions

• Other Mitigation Action Goals
  – Evaluate communications plan/protocol during emergencies
  – Identify critical infrastructure and compare to inundation
  – Determine expected flood frequency evacuation routes

• Conducted Emergency Management Workshop (March 11th)
Communication and Outreach

• Communication
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (8)
  – Emergency Managers Workshop
  – H-GAC Coordination

• Outreach
  – 1st round of community meetings complete – December 2019
  – 2nd Community Meeting (Virtual) in planning – August 2020
  – Stakeholder Meetings (Jul/Aug)
  – Study Website
    www.sanjacstudy.org
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Under Review) – 95%
- Secondary Mitigation Planning (Finalized) – 100%
- Other Mitigation Actions (Under Review) – 95%

Current Progress: 472
Days Remaining: 39
Completion Date: 8/31/2020
Study Submittals

• Submitted
  – Existing Conditions Memorandum (08/12/19)
  – Historical Storms Memorandum (04/07/20)
  – Future Conditions Memorandum (04/07/20)
  – Secondary Mitigation Memorandum (05/13/20)
  – Primary Mitigation Memo (06/08/20)
  – Updated Sedimentation/Vegetation Memo (06/26/20)
  – Other Mitigation Actions Memo (06/30/20)
  – Draft Report (7/14/2020)

• Upcoming
  – Final Report (08/31/20)
Questions?
# MEETING MINUTES

**To:** Jing Chen, P.E., CFM  
**Attendees:** Amber Batson, SJRA  
Bret Raley, SJRA  
Chuck Gilman, SJRA  
Cheryl Turney, SJRA  
Chris Meeks, SJRA  
Cynthia Bowman, SJRA  
Daniel Hildebrand, SJRA  
Heather Ramsey-Cook, SJRA  
Jace Houston, SJRA  
James Alexander, SJRA  
Jason Williams, SJRA  
Kaaren Cambio, SJRA  
Lloyd Tisdale, SJRA  
Pam Steiger, SJRA  
Raymond Johnson, SJRA  
Rick Moore, SJRA  
Ron Kelling, SJRA  
Ronnie Anderson, SJRA  
Tom Michael, SJRA  
Jing Chen, HCFCD  
Beth Walters, HCFCD  
Terry Barr, Halff Associates, Inc.

**From:** Terry Barr, P.E., CFM  
**Subject:** San Jacinto River Watershed Master Drainage Plan Progress Meeting  
**Meeting Date:** 07/23/2020 – 8:00 pm  
**Location:** Go To Meeting Webinar  
**Minutes Date:** 07/23/2020  
**AVO No.:** 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | **Study Presentation**  
• Mr. Barr started the presentation with a general overview of the project | |
| 2.   | **Goals and Objections**  
• Terry introduced the San Jacinto study. He showed the watershed included in the study and the funding partners. He presented the location of the watershed in reference to the SJRA coverage area  
• Terry showed the density of flood claims within the basin.  
• Terry introduced the goals and objectives of the San Jacinto Regional Watershed Master Drainage Plan. | |
| 3.   | **Existing Conditions**  
• Terry presented the update of the Existing Conditions analysis. He stated that all major streams in the basin have been included in a combined existing conditions model. The model utilized existing models from HCFCD as well as new models for the upper regions. The model utilizes the latest Atlas 14 rainfall and has been calibrated to historical storm events including Hurricane Harvey and Memorial Day 2016. The model has also been validated with the October 1994 and Tropical Storm Imelda events. The calibration and validation including comparing the model to 22 USGS gages in the watershed. | |
4. **Primary Mitigation Planning**

- Terry summarized the primary mitigation process which included identifying mitigation strategies to reduce flooding for the region.
- The team identified damage centers to determine which locations should be targeted with the mitigation projects using the structural inventory tool and the updated existing conditions modeling. Of the damage centers, the highest damage concentrations were in those centers closer to the confluence.
- Using the damage center information, the team identified tiers for mitigation planning to rank the potential mitigation projects based on number of damages, regional benefit, and potential mitigation volumes.
- The team reviewed and cataloged projects recommended in several previous reports to determine if any of these should be included in the analysis. Many of the projects are no longer feasible or were originally intended for water supply purposes; however, the information was used as a starting point for many of the projects that were evaluated as part of this study. In addition, the team also proposed new mitigation strategies.
- The team evaluated a total of 25 projects, choosing those deemed most effective to develop a regional master plan, which includes detention and channelization project spread throughout the watershed. The “most effective” projects are those that performed the best for each watershed as well as provided regional benefit. Terry stated that the projects improve the areas near the damage center within their respective watershed, but also provide flood reduction benefits further downstream, including beyond their confluences with receiving streams. He stated that Lake Houston limits the effectiveness of these projects downstream (e.g., confluence with East Fork) and that reductions to the Lake Houston level would be needed to see further improvements. However, this study does not evaluate or recommend changes to the lake. A separate Lake Houston study is reviewing improvements for the Lake Houston area.
- The benefit-cost ratios (BCR) for Spring Creek were the highest because more development in the Spring Creek Watershed. However, overall cost benefits are not positive for many of the projects (0.75 – 1 range). Terry stated that the BCR is not the only metric for funding the projects. FEMA will also consider social benefits for this BCR range of 0.75 to 1 and some funding may still be available for these projects.
- In addition, Terry showed the low-to-moderate income (LMI) areas as they relate to potential projects. Funding will vary based on LMI. Lower income areas could potentially be good candidates for CDBG or other funding sources that account for socio-economically disadvantaged areas.
- Terry discussed additional mitigation measures, including detention, floodplain preservation, and buyouts, as potential options. Detention associated with local development is needed to offset negative impacts for the local streets, sewers, and streams. Future projections show that the impact of local detention on the regional scale is minor, but much of the analysis depends on assumptions made about the development location and timing. Terry reiterated that detention is an important tool to mitigate
drainage impacts of development especially when considering cumulative effects or hydrograph timing.

- Terry stated that floodplain preservation is recommended because losses in floodplain storage can have negative impacts downstream. The study did not evaluate specific areas or scenarios related to floodplain preservation. Future conditions do not include floodplain fill. Harris County has “no adverse impact” and floodplain fill mitigation policies in place and Terry agreed that those policies were beneficial.
- Terry indicated that while the proposed projects (detention, channel) will provide significant benefits, some structures, specifically those that flood during frequent storms (2- & 5-year), will likely continue to flood. For these structures, buyouts may be the recommended strategy. Buyout is more effective than the mitigation projects from a purely economic perspective.
- The next step is to finalize and prioritize the list of projects to be included in the overall master drainage plan and develop a project phasing plan and then finally move forward with feasibility, preliminary engineering, design, construction, etc.

5. **Secondary Mitigation Planning**

- Terry presented the additional gages that are recommended in the area including stage, flow, and rainfall. The gages provide first responders early information to flooding in the region. The team recommended 26 gages throughout the San Jacinto Basin, 5 of which are already being installed by HCFCD. Many of the gages are proposed in the upper basin areas where there are currently minimal gages. This is a benefit to Harris County because the gages will identify, early in the storm event, the amount of runoff that is expected to be routed through Harris County from the upper basin.

**Other Mitigation Actions**

- Terry discussed coordinating with local agencies to determine how the agencies react to storm events and their communication protocols.
- The team also identified roadway levels of service and critical infrastructure within the potential floodplains.
- Most counties have a plan for responding to flooding events and are already coordinating with the region. Identified some areas of improvements for each agency.

**Communication and Outreach**

- Terry explained that there is a defined coordination effort, which includes meetings with both the study partners, and other supporting partners, such as the surrounding counties and H-GAC.
- As part of the Other Mitigation Actions task, the team met with emergency managers for each of the regional entities to understand protocol, and also conducted an emergency management workshop.
- The team also has an outreach plan, with the first round of community meetings in December 2019 and a second round planned for August 2020.
In addition, there is a study website that provides an overview of the study goals and progress. ([www.sanjacstudy.org](http://www.sanjacstudy.org))

### Study Schedule

- Terry presented the study schedule with the final report being submitted in August 2020.

### SJRA Board Comments and Questions

- Kaaren stated that none of the projects in the study presented included projects on Cypress Creek. She asked why it was not included. Terry mentioned that there were already studies and efforts on Cypress Creek.
- Kaaren asked if the study included any of the other projects on Cypress Creek. Terry stated that most of the large detention available would address the overflow and not issues downstream. He also stated that detention on Cypress Creek did not have much impact on elevations in Lake Houston.
- Kaaren recommended using FEMA as a partner since most of the money came from FEMA and that it may help in seeking future funding. Terry stated that the draft report mentions the potential funding sources. She mentioned that BRICK funding would be a good opportunity for future funding. Caren applauded the project fact sheets to simplify the information.
- Lloyd stated that he may have more questions once the study is completed as to how to continue funding these projects.
- Mark asked if there was any Harris County bond funding for any of these projects. Terry stated that HCFCF would be better suited to answer the question but there may be some funding available for upstream projects.
- Mark asked if the Lake Houston gates project was included. Terry stated that the
- Mark asked if the sediment from sand mines are addressed in the report. Terry stated that overall sediment measures are mentioned but that further study may be required for specific sediment measures.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
## Agenda

1. **Introductions**

2. **Goals and Objectives**
   - Conduct a comprehensive Flood Mitigation Plan
   - Identify vulnerability to flood hazards causing loss of life and property
   - Develop approaches to enhance public information and flood level assessment
   - Evaluate flood mitigation strategies to improve long-term resilience

3. **Existing Conditions**
   - Existing Conditions H&H Modeling Update
   - Analysis of Historical Storms

4. **Primary Mitigation Planning**
   - Flood Mitigation Strategies
   - Primary Mitigation Tasks
   - Damage Center Identification
   - Flood Mitigation Projects
   - Implementation Planning
   - Sedimentation and Vegetation

5. **Secondary Mitigation Planning**
   - Gage Recommendations

6. **Other Mitigation Actions Planning**
   - Coordination with Emergency Managers
   - Updated communication plans/protocols
   - Critical infrastructure and roadway flood frequency

7. **Community Outreach**
   - Partners and Stakeholder Communication
   - Community Outreach

8. **Study Schedule**

9. **CWA Lake Houston Gate Study Update**

10. **Questions**
SAN JACINTO
Regional Watershed Master Drainage Plan
Agenda

- Goals and Objectives
- Existing Conditions
- Primary Mitigation Planning
- Secondary Mitigation Planning
- Other Mitigation Actions Planning
- Community Outreach
- Project Schedule and Status
- CWA Lake Houston Gate Study
- Questions
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Harris County Precinct 1

- San Jacinto River
- Lake Houston
- Cypress Creek
Flood Claim Density
Goals and Objectives

• The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  – Conduct a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Develop approaches to enhance public information and flood level assessment
  – Evaluate flood mitigation strategies to improve long-term resilience

• The plans specific objectives are:
  – Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  – Secondary Mitigation Planning (Flood Assessment/Warning)
  – Other Mitigation Actions (Communications Protocols, Flood Response)
  – Community Outreach & Education (Drainage, Maintenance, Projects)
Existing Conditions H&H Analysis

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Soils, % Impervious, BDF (TC+R)
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994

- Leveraged Gage Adjusted Radar Rainfall (GARR) Data

- USGS Gages (Used 22/25)
  - Met with USGS
  - Peach Creek Adjustment
  - Gage Summary in Report

- Calibration Report Submitted
Flood Mitigation Strategies

• Primary Flood Mitigation Planning (Flood Reduction)
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Develop cost estimates
  – Evaluate potential benefits
  – Identify implementation path and challenges

• Secondary Flood Mitigation Planning (Flood Warning)
  – Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommend locations for additional FWS gages

• Other Mitigation Actions (Flood Response)
  – Coordinate with agencies responsible for Emergency Management
  – Provide recommendations for updated communications protocols
  – Identify potential flooding of roadways and critical infrastructure
Primary Mitigation Tasks

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Damage Center Identification

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers

Significant number of structures at risk during higher frequency storms (2-yr - 25-yr)
Damage Center Identification

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks

Instances from higher frequency storms (2-yr, 5-yr) were removed to avoid skewing the data
Watershed Mitigation Potential

• Higher Potential
  – Spring Creek (Benefits in watershed; Potential reduction downstream)
  – East Fork (Major Lake Houston contributor; Available open space)
  – Peach/Caney Creek (Available open space; Benefits in watershed)

• Moderate Potential
  – Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

• Lower Potential
  – Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  – Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  – Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  – Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  – West Fork (Limited open space; High volume; Benefits in watershed)
Previously Recommended Projects

• Reviewed previous reports and master plans
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

- Considered 34 Previously Recommended Projects
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
## Flood Reduction Projects Summary

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Walnut Creek 10 miles U/S of Spring Creek</td>
<td>91 - 120</td>
<td>123</td>
<td>1.02 - 1.35</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Mill Creek 10 miles U/S of Spring Creek</td>
<td>96 - 126</td>
<td>81.6</td>
<td>0.65 - 0.85</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Birch Creek 10 miles U/S of Spring Creek</td>
<td>77 - 117</td>
<td>82.6</td>
<td>0.70 - 1.07</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>I-45 to 3 miles D/S of Riley Fuzzell</td>
<td>81</td>
<td>145.3</td>
<td>1.79</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>Between Gosling Road and I-45</td>
<td>123</td>
<td>82.6</td>
<td>0.66</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-200 U/S of I-45</td>
<td>59</td>
<td>53</td>
<td>0.89</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-500 U/S Kuykendahl Rd. to Willow Creek</td>
<td>142</td>
<td>70.3</td>
<td>0.49</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Caney Creek 0.3 miles North of SH 105</td>
<td>98 - 163</td>
<td>34</td>
<td>0.21 - 0.35</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Little Caney Creek 1.1 miles U/S of Lake Creek</td>
<td>98 - 128</td>
<td>27.6</td>
<td>0.22 - 0.28</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Garrett's Creek 0.74 miles U/S of Lake Creek</td>
<td>107 - 131</td>
<td>35.4</td>
<td>0.27 - 0.33</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Lake Creek Mainstem 0.6 miles U/S of SH105</td>
<td>187 - 264</td>
<td>61.8</td>
<td>0.15 - 0.22</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach 12 miles U/S of New Caney @ SH105</td>
<td>299 - 428</td>
<td>57</td>
<td>0.13 - 0.19</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach/Walker 19 miles U/S of New Caney</td>
<td>203 - 222</td>
<td>68</td>
<td>0.30 - 0.33</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Channel</td>
<td>Peach Creek D/S of I-69</td>
<td>180</td>
<td>75.9</td>
<td>0.42</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.0 miles U/S of FM 1097</td>
<td>104 - 131</td>
<td>19.8</td>
<td>0.15 - 0.19</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.9 miles U/S of SH 105</td>
<td>177 - 207</td>
<td>26.3</td>
<td>0.13 - 0.15</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Channel</td>
<td>Caney Creek D/S of I-69 to the East Fork</td>
<td>140</td>
<td>47</td>
<td>0.34</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou Nebletts 2 miles U/S Cleveland</td>
<td>128 - 176</td>
<td>39.8</td>
<td>0.15 - 0.20</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou 5 miles U/S of Cleveland</td>
<td>132 - 163</td>
<td>44.2</td>
<td>0.26 - 0.33</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>East Fork 10 miles U/S of Cleveland near FM945</td>
<td>138 - 141</td>
<td>34.3</td>
<td>0.15 - 0.16</td>
</tr>
<tr>
<td>East Fork</td>
<td>Bench</td>
<td>East Fork FM 1485 to Luce Bayou</td>
<td>326</td>
<td>24.9</td>
<td>0.08</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to SH 242</td>
<td>148</td>
<td>33.8</td>
<td>0.22</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to 3.2 miles D/S of SH 242</td>
<td>179</td>
<td>30.3</td>
<td>0.15</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork D/S of I-69 (3000' Wide)</td>
<td>722</td>
<td>67</td>
<td>0.09</td>
</tr>
<tr>
<td>West Fork</td>
<td>Bench</td>
<td>West Fork D/S of I-69 (3500' Wide)</td>
<td>818</td>
<td>55.6</td>
<td>0.07</td>
</tr>
</tbody>
</table>
San Jacinto Regional WMDP

- Combined projects show increased local and regional benefits
- Current project combinations (by Watershed)
  - Spring Creek: Walnut Detention, Birch Detention, I-45 to Riley Fuzzell
  - Lake Creek: Caney Detention, Little Caney Detention, Garrett’s Detention
  - East Fork: Winters Detention, Lower East Fork Channel Improvements
  - Caney Creek: SH105 and FM1097 Detention, Channel D/S of I-69
  - Peach Creek: SH 105 and Walker Detention, Channel D/S of I-69
  - Full Combined Model: Ultimate Flood Reduction Improvements
- Projects in Spring Creek have the highest BCR (0.70 – 1.79)
## San Jacinto Regional WMDP

- Plan Cost: $3.1B - $3.5B
- Overall Plan Benefits: $677 M
- BCR: 0.19 – 0.22

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Damages, Existing ($M)</th>
<th>Damages, Combined Alts ($M)</th>
<th>Benefit ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>466.6</td>
<td>163.8</td>
<td>302.8</td>
</tr>
<tr>
<td>Willow</td>
<td>112.2</td>
<td>86.6</td>
<td>25.6</td>
</tr>
<tr>
<td>Cypress</td>
<td>213.2</td>
<td>211.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>30.9</td>
<td>30.8</td>
<td>0.1</td>
</tr>
<tr>
<td>East Fork</td>
<td>101.4</td>
<td>56</td>
<td>45.5</td>
</tr>
<tr>
<td>West Fork</td>
<td>269.7</td>
<td>132.7</td>
<td>137</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>10.1</td>
<td>3.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Peach</td>
<td>113.1</td>
<td>27.9</td>
<td>85.3</td>
</tr>
<tr>
<td>Caney</td>
<td>135.6</td>
<td>63.8</td>
<td>71.9</td>
</tr>
<tr>
<td>Luce</td>
<td>14.6</td>
<td>14</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1467.4</strong></td>
<td><strong>790.4</strong></td>
<td><strong>677.2</strong></td>
</tr>
</tbody>
</table>
Low to Moderate Income (LMI) Areas
Additional Regional Measures

• Detention Policy
  – Detention associated with local development provides critical mitigation, but the regional benefits associated with local detention are highly dependent on the location and timing of development
  – 2070 modeling indicated limited detention impact, but development was centered on the urban core lower in the basin (1-2% volume increase)
  – Ultimate development along the basin outer boundaries shows a higher increase in runoff volume (>5%); detention impact may increase
  – Detention **DOES** have an impact on local flooding issues

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $3B
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
Buyouts

• Summary of structures and expected damages in each watershed that flood in the 5-year event

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Count</th>
<th>Market Value</th>
<th>Mkt Value * 1.25</th>
<th>Existing NPV 50-yr damage</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>87</td>
<td>12,184,636</td>
<td>15,230,795</td>
<td>80,537,873</td>
<td>5.3</td>
</tr>
<tr>
<td>Willow</td>
<td>43</td>
<td>13,197,517</td>
<td>16,496,896</td>
<td>30,707,624</td>
<td>1.9</td>
</tr>
<tr>
<td>Cypress</td>
<td>31</td>
<td>12,790,373</td>
<td>15,987,966</td>
<td>55,385,994</td>
<td>3.5</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>13</td>
<td>2,468,448</td>
<td>3,085,560</td>
<td>11,513,834</td>
<td>3.7</td>
</tr>
<tr>
<td>East Fork</td>
<td>34</td>
<td>4,083,750</td>
<td>5,104,688</td>
<td>21,596,467</td>
<td>4.2</td>
</tr>
<tr>
<td>West Fork</td>
<td>10</td>
<td>1,412,655</td>
<td>1,765,819</td>
<td>6,244,840</td>
<td>3.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>3</td>
<td>519,100</td>
<td>648,875</td>
<td>2,390,871</td>
<td>3.7</td>
</tr>
<tr>
<td>Peach</td>
<td>71</td>
<td>7,536,240</td>
<td>9,420,300</td>
<td>44,668,723</td>
<td>4.7</td>
</tr>
<tr>
<td>Caney</td>
<td>82</td>
<td>7,288,986</td>
<td>9,111,233</td>
<td>56,872,257</td>
<td>6.2</td>
</tr>
<tr>
<td>Luce</td>
<td>5</td>
<td>583,203</td>
<td>729,004</td>
<td>2,845,449</td>
<td>3.9</td>
</tr>
<tr>
<td>Tarkington</td>
<td>60</td>
<td>6,657,070</td>
<td>8,321,338</td>
<td>45,279,121</td>
<td>5.4</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>2</td>
<td>518,533</td>
<td>648,166</td>
<td>1,529,131</td>
<td>2.4</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>1</td>
<td>211,015</td>
<td>263,769</td>
<td>1,514,652</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>442</strong></td>
<td><strong>69,451,526</strong></td>
<td><strong>86,814,408</strong></td>
<td><strong>361,086,836</strong></td>
<td><strong>4.2</strong></td>
</tr>
</tbody>
</table>
Implementation Planning

• Identify projects to be included in MDP
• Finalize modeling of individual selected projects
• Develop Project Tiers (Regional Approach)
  – Select and weight metrics based on study partner input
  – Update project costs and benefits
  – Gather information on the selected metrics
  – Perform project prioritization
• Develop project phasing plan
  – Model projects cumulatively (i.e. Project 1, Project 1 & 2,...All projects) to ensure no negative impacts
  – Update environmental and cultural data, update utility information, ROW
  – Identify potential funding sources depending on criteria (BCR, LMI, etc.)
• Move forward with Feasibility, Preliminary Engineering, Design
Sedimentation and Vegetation

- Strategies to reduce flow of sediments into Lake Houston
- Developed annual sediment rating curves for 7 watersheds
  - Predictive tool that relates sediment transport with stream flow
  - Cypress Creek is the highest contributor
- First step toward Regional Sediment Management Plan (RSM)
- Inventory of sediment sources
- Common sediment management strategies
- Recommended strategies for West Fork and Spring Creek
- Did NOT evaluate relationship between sediment and flooding
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k (Plus Maintenance)
Other Mitigation Actions

• Other Mitigation Action Goals
  – Evaluate communications plan/protocol during emergencies
  – Identify critical infrastructure and compare to inundation
  – Determine expected flood frequency evacuation routes

• Conducted Emergency Management Workshop (March 11th)
• Working on draft memorandum
Communication and Outreach

• Communication
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (8)
  – Emergency Managers Workshop
  – H-GAC Coordination

• Outreach
  – 1st round of community meetings complete – December 2019
  – 2nd round of community meetings in planning – July 2020
  – Woodlands Drainage Task Force Meeting – January 28th
  – Study Website
    www.sanjacstudy.org
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Workshops Completed) – 85%
- Secondary Mitigation Planning (Adjusted Schedule) – 100%
- Other Mitigation Actions (Adjusted Schedule) – 80%
Study Submittals

• Submitted
  – Existing Conditions Memorandum
  – Secondary Mitigation Memorandum
  – Historical Storms Memorandum

• Upcoming
  – Other Mitigation Actions Memo (Early June)
  – Alternative Funding Memo (Early June)
  – Updated Sedimentation/Vegetation Memo (06/12/20)
  – Primary Mitigation Memo (06/08/20)
  – Draft Report (07/13/20)
Questions?
## Agenda

### 1. Attendees
- Terry Barr, Halff
- Sam Hinojosa, Halff
- Andrew Moore, Halff
- Jing Chen, HCFCD
- Gary Bezemek, HCFCD
- Lance Gilliam, Harris County Precinct 1
- Myron Jones, HCFCD
- Amar Mohite, Harris County Precinct 1
- Garrett Johnson, FNI

### 2. Goals and Objections
- Jing introduced the meeting.
- Terry introduced the goals and objectives of the San Jacinto Regional Watershed Master Drainage Plan.
  - Amar asked if the study would look at policy rules and regulations to determine how future development could affect flooding. Terry stated that the study did review future conditions to determine how 50-year projected development could affect the major channels. He stated that it is difficult to identify localized flooding issues in a large regional study. While the inclusion of onsite detention for development in the modeling does not show a significant impact, Terry stated that the team believes detention policy is important to avoid local flooding impacts resulting from development.
  - Amar stated that if you look at the past 20 years, the region has grown rapidly. He stated the study should recommend a coalition for the region that promotes the idea that local jurisdictions should coordinate on policies. Terry agreed and stated that some of the future conditions analysis does relay this information. Amar stressed that even general discussion of future coalitions and coordination should occur.

### 3. Existing Conditions
- Terry presented the update of the Existing Conditions analysis. He stated that all major streams in the basin have been included in a combined existing conditions model. The model utilizes the latest Atlas 14 rainfall and has been calibrated to historical storm events including Hurricane Harvey and Memorial Day 2016. The model has also been validated.
with the October 1994 and Tropical Storm Imelda events. The calibration and validation including comparing the model to 22 USGS gages in the watershed.

<table>
<thead>
<tr>
<th>4. Primary Mitigation Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Terry summarized the primary mitigation process which included identifying mitigation strategies to reduce flooding for region.</td>
</tr>
<tr>
<td>• The team identified damage centers to determine which locations should be targeted with the mitigation projects using the structural inventory tool and the updated existing conditions modeling. Of the damage centers, the highest damage concentrations were in those centers closer to the confluence.</td>
</tr>
<tr>
<td>• Using the damage center information, the team identified tiers for mitigation planning to rank the potential mitigation projects based on number of damages, regional benefit, and potential mitigation volumes.</td>
</tr>
<tr>
<td>• The team reviewed and cataloged projects recommended in several previous reports to determine if any of these should be included in the analysis. Many of the projects were no longer feasible or were originally intended for water supply purposes; however, the information was used as a starting point for many of the projects that were evaluated as part of this study. In addition, the team also proposed new mitigation strategies.</td>
</tr>
<tr>
<td>• The team evaluated a total of 25 projects, choosing those deemed most effective to develop a regional master plan, which includes detention and channelization project spread throughout the watershed. The “most effective” projects are those that performed the best for each watershed as well as provided regional benefit. Terry stated that the projects improve the areas near the damage center within their respective watershed, but also provide flood reduction benefits further downstream, including beyond their confluences with receiving streams. He stated that Lake Houston limits the effectiveness of these projects downstream and that reductions to the Lake Houston level would be needed to see further improvements. However, this study does not evaluate or recommend changes to the lake. A separate Lake Houston study is reviewing improvements for the Lake Houston area.</td>
</tr>
<tr>
<td>• The benefit-cost ratios (BCR) for Spring Creek were the highest, but overall cost benefits are not positive for many of the projects. Terry stated that the BCR is not the only metric for funding the projects. Acreage recovered, roadway miles removed, and raw structure counts should also be considered. In addition, Terry showed the low-to-moderate income (LMI) areas as they relate to potential projects. Lower income areas could potentially be good candidates for CDBG or other funding sources that account for socio-economically disadvantaged areas.</td>
</tr>
<tr>
<td>• Terry discussed additional mitigation measures, including detention, floodplain preservation, and buyouts, as potential options. Detention associated with local development is needed to offset negative impacts for the local streets, sewers, and streams. Future projections show that the impact of local detention on the regional scale is minor, but much of the analysis depends on assumptions made about the development location and timing. Development locations can change and alter the results. Terry reiterated that detention is an important tool to mitigate drainage impacts of development and agreed with Amar that the study should be careful to clarify the team’s position on detention.</td>
</tr>
<tr>
<td>• Amar stated that the study could also bring up regional detention and mention it if this would be more effective than local detention. Amar stated that detention for development and detention for flood reduction should be clarified early in the reports.</td>
</tr>
</tbody>
</table>
- Terry stated that floodplain preservation is recommended because losses in floodplain storage can have negative impacts downstream. The study did not evaluate specific areas or scenarios related to floodplain preservation. Harris County has “no adverse impact” and floodplain fill mitigation policies in place and Terry agreed that those policies were beneficial.
- Terry indicated that while the proposed projects (detention, channel) will provide significant benefits, some structures, specifically those that flood during frequent storms (2- & 5-year), will likely continue to flood. For these structures, buyouts may be the recommended strategy.
- The next step is to finalize the list of projects to be included in the overall master drainage plan and develop a project phasing plan.
- Terry briefly discussed the Sedimentation and Vegetation report, which identifies strategies to reduce flow of sediments into Lake Houston. The report is the first step toward a regional sediment management plan. Terry specified that the sediment and vegetation effort did not evaluate the impact of sedimentation on flooding.

5. **Secondary Mitigation Planning**
   - Terry presented the additional gages that are recommended in the area including stage, flow, and rainfall. The gages provide first responders early information to flooding in the region. The team recommended 26 gages throughout the San Jacinto Basin, 5 of which are already being installed by HCFCD.

6. **Other Mitigation Actions**
   - Terry discussed coordinating with local agencies to determine how the agencies react to storm events and their communication protocols
   - The team also identified roadway levels of service and critical infrastructure within the potential floodplains.
   - Most counties have a plan for responding to flooding events and are already coordinating with the region. Identified some areas of improvements for each agency.

7. **Communication and Outreach**
   - Terry explained that there is a defined coordination effort, which includes meetings with both the study partners, and other supporting partners, such as the surrounding counties and H-GAC.
   - As part of the Other Mitigation Actions task, the team met with emergency managers for each of the regional entities to understand protocol, and also conducted an emergency management workshop.
   - The team also has an outreach plan, with the first round of community meetings in December 2019 and a second round planned for July. In addition, there is a study website that provides an overview of the study goals and progress. ([www.sanjacstudy.org](http://www.sanjacstudy.org))

8. **Study Schedule**
   - Terry presented the study schedule with the final report being submitted in August 2020.

9. **CWA Lake Houston Gate Study Update**
   - Jing stated that the HCFCD is participating in the Lake Houston Gate project as a stakeholder. She stated that the project is FEMA funded and the team will be looking at benefit costs of the project, including minimizing downstream impacts to the additional gates.
- She stated the team is identifying successes and constraints of the project. She also mentioned that the project kicked off in mid-April and the H&H analysis is ongoing and will extend through October.

<table>
<thead>
<tr>
<th>10.</th>
<th>Questions/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amar recommended the study include the discussion on detention policy and floodplain preservation as a potential policy to reduce future flooding. Terry agreed and stated the project report would include information.</td>
</tr>
<tr>
<td></td>
<td>Jing recommended adjusting language for the detention to recognize that while local detention did not result in significant changes at the regional level given the teams modeling assumptions, detention is still a reliable strategy to mitigate development impacts.</td>
</tr>
<tr>
<td></td>
<td>Amar stated that these regional studies are needed but we need to be thoughtful in how we present the information and to include some of the policy discussion. He stated that pieces of reports can be taken out of context. Terry stated that the recommendations for this region are long term and need to be presented as such.</td>
</tr>
<tr>
<td></td>
<td>Amar and Lance requested the memos and reports to review and provide high level input on the project.</td>
</tr>
</tbody>
</table>
## Agenda

1. **Introductions**

2. **Goals and Objectives**
   - Conduct a comprehensive Flood Mitigation Plan
   - Identify vulnerability to flood hazards causing loss of life and property
   - Develop approaches to enhance public information and flood level assessment
   - Evaluate flood mitigation strategies to improve long-term resilience

3. **Existing Conditions**
   - Existing Conditions H&H Modeling Update
   - Analysis of Historical Storms

4. **Primary Mitigation Planning**
   - Flood Mitigation Strategies
   - Primary Mitigation Tasks
   - Damage Center Identification
   - Flood Mitigation Projects
   - Implementation Planning
   - Sedimentation and Vegetation

5. **Secondary Mitigation Planning**
   - Gage Recommendations

6. **Other Mitigation Actions Planning**
   - Coordination with Emergency Managers
   - Updated communication plans/protocols
   - Critical infrastructure and roadway flood frequency

7. **Community Outreach**
   - Partners and Stakeholder Communication
   - Community Outreach

8. **Study Schedule**

9. **CWA Lake Houston Gate Study Update**

10. **Questions**
Agenda

- Goals and Objectives
- Existing Conditions
- Primary Mitigation Planning
- Secondary Mitigation Planning
- Other Mitigation Actions Planning
- Community Outreach
- Project Schedule and Status
- CWA Lake Houston Gate Study
- Questions
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Harris County Precinct 2

- San Jacinto River/Lake Houston
- Luce Bayou
- Jackson Bayou
Flood Claim Density
Goals and Objectives

- The goal of the *San Jacinto Regional Watershed Master Drainage Plan* is to
  - Conduct a comprehensive Flood Mitigation Plan
  - Identify vulnerability to flood hazards causing loss of life and property
  - Develop approaches to enhance public information and flood level assessment
  - Evaluate flood mitigation strategies to improve long-term resilience

- The plans specific objectives are:
  - Primary *Flood Mitigation* Planning (Detention, Conveyance, Buy-Outs)
  - Secondary Mitigation Planning (*Flood Assessment/Warning*)
  - Other Mitigation Actions (Communications Protocols, *Flood Response*)
  - Community Outreach & Education (Drainage, Maintenance, Projects)
Existing Conditions H&H Analysis

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Updated Infiltration/Transform Parameters
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994

- Leveraged Gage Adjusted Radar Rainfall (GARR) Data

- USGS Gages (Used 22/25)
  - Met with USGS
  - Peach Creek Adjustment
  - Gage Summary in Report

- Calibration Report Submitted
Flood Mitigation Strategies

• **Primary Flood Mitigation Planning (Flood Reduction)**
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Develop cost estimates
  – Evaluate potential benefits
  – Identify implementation path and challenges

• **Secondary Flood Mitigation Planning (Flood Warning)**
  – Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommend locations for additional FWS gages

• **Other Mitigation Actions (Flood Response)**
  – Coordinate with agencies responsible for Emergency Management
  – Provide recommendations for updated communications protocols
  – Identify potential flooding of roadways and critical infrastructure
Primary Mitigation Tasks

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Damage Center Identification

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers

Significant number of structures at risk during higher frequency storms (2-yr - 25-yr)
Damage Center Identification

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks

Instances from higher frequency storms (2-yr, 5-yr) were removed to avoid skewing the data.
Watershed Mitigation Potential

- **Higher Potential**
  - Spring Creek (Benefits in watershed; Potential reduction downstream)
  - East Fork (Major Lake Houston contributor; Available open space)
  - Peach/Caney Creek (Available open space; Benefits in watershed)

- **Moderate Potential**
  - Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

- **Lower Potential**
  - Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  - Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  - Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  - Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  - West Fork (Limited open space; High volume; Benefits in watershed)
Previously Recommended Projects

- Reviewed previous reports and master plans
  - 1943 – San Jacinto River Master Plan
  - 1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
  - 1989 – South Montgomery County Flood Protection Plan
  - 1997 – Lake Creek Reservoir Study
  - 2000 – Lake Houston Regional Flood Protection Study
  - 2015 – Cypress Creek Overflow Management Plan
  - 2019 – Estimate Land Cover Effects on Selected Watersheds
  - 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

- Considered 34 Previously Recommended Projects
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study

<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>East Fork</td>
<td>East Fork Reservoir (EF-G1)</td>
<td>1985</td>
<td>Reservoir assumes only using 3 of 5' of storage</td>
</tr>
</tbody>
</table>
San Jacinto Regional WMDP

San Jacinto River Master Drainage Plan

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway *</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
<table>
<thead>
<tr>
<th>Watershed</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Walnut Creek 10 miles U/S of Spring Creek</td>
<td>91 - 120</td>
<td>123</td>
<td>1.02 - 1.35</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Mill Creek 10 miles U/S of Spring Creek</td>
<td>96 - 126</td>
<td>81.6</td>
<td>0.65 - 0.85</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Birch Creek 10 miles U/S of Spring Creek</td>
<td>77 - 117</td>
<td>82.6</td>
<td>0.70 - 1.07</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>I-45 to 3 miles D/S of Riley Fuzzell</td>
<td>81</td>
<td>145.3</td>
<td>1.79</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>Between Gosling Road and I-45</td>
<td>123</td>
<td>82.6</td>
<td>0.66</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-200 U/S of I-45</td>
<td>59</td>
<td>53</td>
<td>0.89</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-500 U/S Kuykendahl Rd. to Willow Creek</td>
<td>142</td>
<td>70.3</td>
<td>0.49</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Caney Creek 0.3 miles North of SH 105</td>
<td>98 - 163</td>
<td>34</td>
<td>0.21 - 0.35</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Little Caney Creek 1.1 miles U/S of Lake Creek</td>
<td>98 - 128</td>
<td>27.6</td>
<td>0.22 - 0.28</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Garrett's Creek 0.74 miles U/S of Lake Creek</td>
<td>107 - 131</td>
<td>35.4</td>
<td>0.27 - 0.33</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Lake Creek Mainstem 0.6 miles U/S of SH105</td>
<td>187 - 264</td>
<td>61.8</td>
<td>0.15 - 0.22</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach 12 miles U/S of New Caney @ SH105</td>
<td>299 - 428</td>
<td>57</td>
<td>0.13 - 0.19</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach/Walker 19 miles U/S of New Caney</td>
<td>203 - 222</td>
<td>68</td>
<td>0.30 - 0.33</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Channel</td>
<td>Caney Creek D/S of I-69</td>
<td>180</td>
<td>75.9</td>
<td>0.42</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.0 miles U/S of FM 1097</td>
<td>104 - 131</td>
<td>19.8</td>
<td>0.15 - 0.19</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.9 miles U/S of SH 105</td>
<td>177 - 207</td>
<td>26.3</td>
<td>0.13 - 0.15</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Channel</td>
<td>Caney Creek D/S of I-69 to the East Fork</td>
<td>140</td>
<td>47</td>
<td>0.34</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou Nebletts 2 miles U/S Cleveland</td>
<td>128 - 176</td>
<td>39.8</td>
<td>0.15 - 0.20</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou 5 miles U/S of Cleveland</td>
<td>132 - 163</td>
<td>44.2</td>
<td>0.26 - 0.33</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>East Fork 10 miles U/S of Cleveland near FM945</td>
<td>138 - 141</td>
<td>34.3</td>
<td>0.15 - 0.16</td>
</tr>
<tr>
<td>East Fork</td>
<td>Bench</td>
<td>East Fork FM 1485 to Luce Bayou</td>
<td>326</td>
<td>24.9</td>
<td>0.08</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to SH 242</td>
<td>148</td>
<td>33.8</td>
<td>0.22</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to 3.2 miles D/S of SH 242</td>
<td>179</td>
<td>30.3</td>
<td>0.15</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork D/S of I-69 (3000' Wide)</td>
<td>722</td>
<td>67</td>
<td>0.09</td>
</tr>
<tr>
<td>West Fork</td>
<td>Bench</td>
<td>West Fork D/S of I-69 (3500' Wide)</td>
<td>818</td>
<td>55.6</td>
<td>0.07</td>
</tr>
</tbody>
</table>
San Jacinto Regional WMDP

- Combined projects show increased local and regional benefits
- Current project combinations (by Watershed)
  - Spring Creek: Walnut Detention, Birch Detention, I-45 to Riley Fuzzell
  - Lake Creek: Caney Detention, Little Caney Detention, Garrett’s Detention
  - East Fork: Winters Detention, Lower East Fork Channel Improvements
  - Caney Creek: SH105 and FM1097 Detention, Channel D/S of I-69
  - Peach Creek: SH 105 and Walker Detention, Channel D/S of I-69
  - Full Combined Model: Ultimate Flood Reduction Improvements
- Projects in Spring Creek have the highest BCR (0.70 – 1.79)
San Jacinto Regional WMDP

- Plan Cost: $3.1B - $3.5B
- Overall Plan Benefits: $677 M
- BCR: 0.19 – 0.22

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Damages, Existing ($M)</th>
<th>Damages, Combined Alts ($M)</th>
<th>Benefit ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>466.6</td>
<td>163.8</td>
<td>302.8</td>
</tr>
<tr>
<td>Willow</td>
<td>112.2</td>
<td>86.6</td>
<td>25.6</td>
</tr>
<tr>
<td>Cypress</td>
<td>213.2</td>
<td>211.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>30.9</td>
<td>30.8</td>
<td>0.1</td>
</tr>
<tr>
<td>East Fork</td>
<td>101.4</td>
<td>56</td>
<td>45.5</td>
</tr>
<tr>
<td>West Fork</td>
<td>269.7</td>
<td>132.7</td>
<td>137</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>10.1</td>
<td>3.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Peach</td>
<td>113.1</td>
<td>27.9</td>
<td>85.3</td>
</tr>
<tr>
<td>Caney</td>
<td>135.6</td>
<td>63.8</td>
<td>71.9</td>
</tr>
<tr>
<td>Luce</td>
<td>14.6</td>
<td>14</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1467.4</strong></td>
<td><strong>790.4</strong></td>
<td><strong>677.2</strong></td>
</tr>
</tbody>
</table>
Low to Moderate Income (LMI) Areas
Additional Regional Measures

• Detention Policy
  – Detention associated with local development provides critical mitigation, but the regional benefits associated with local detention are highly dependent on the location and timing of development.
  – 2070 modeling indicated limited detention impact, but development was centered on the urban core lower in the basin (1-2% volume increase).
  – Ultimate development along the basin outer boundaries shows a higher increase in runoff volume (>5%); detention impact may increase.
  – Detention **DOES** have an impact on local flooding issues.

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas.
  – Future Conditions modeling does not include floodplain fill.
  – Approx. market value of all flooded structures in the 100-year ~ $3B.
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
## Buyouts

- Summary of structures and expected damages in each watershed that flood in the 5-year event

### Buyouts - Structures Flooding in 5-yr Event

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Count</th>
<th>Market Value</th>
<th>Mkt Value * 1.25</th>
<th>Existing NPV 50-yr damage</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>87</td>
<td>12,184,636</td>
<td>15,230,795</td>
<td>80,537,873</td>
<td>5.3</td>
</tr>
<tr>
<td>Willow</td>
<td>43</td>
<td>13,197,517</td>
<td>16,496,896</td>
<td>30,707,624</td>
<td>1.9</td>
</tr>
<tr>
<td>Cypress</td>
<td>31</td>
<td>12,790,373</td>
<td>15,987,966</td>
<td>55,385,994</td>
<td>3.5</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>13</td>
<td>2,468,448</td>
<td>3,085,560</td>
<td>11,513,834</td>
<td>3.7</td>
</tr>
<tr>
<td>East Fork</td>
<td>34</td>
<td>4,083,750</td>
<td>5,104,688</td>
<td>21,596,467</td>
<td>4.2</td>
</tr>
<tr>
<td>West Fork</td>
<td>10</td>
<td>1,412,655</td>
<td>1,765,819</td>
<td>6,244,840</td>
<td>3.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>3</td>
<td>519,100</td>
<td>648,875</td>
<td>2,390,871</td>
<td>3.7</td>
</tr>
<tr>
<td>Peach</td>
<td>71</td>
<td>7,536,240</td>
<td>9,420,300</td>
<td>44,668,723</td>
<td>4.7</td>
</tr>
<tr>
<td>Caney</td>
<td>82</td>
<td>7,288,986</td>
<td>9,111,233</td>
<td>56,872,257</td>
<td>6.2</td>
</tr>
<tr>
<td>Luce</td>
<td>5</td>
<td>583,203</td>
<td>729,004</td>
<td>2,845,449</td>
<td>3.9</td>
</tr>
<tr>
<td>Tarkington</td>
<td>60</td>
<td>6,657,070</td>
<td>8,321,338</td>
<td>45,279,121</td>
<td>5.4</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>2</td>
<td>518,533</td>
<td>648,166</td>
<td>1,529,131</td>
<td>2.4</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>1</td>
<td>211,015</td>
<td>263,769</td>
<td>1,514,652</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>442</strong></td>
<td><strong>69,451,526</strong></td>
<td><strong>86,814,408</strong></td>
<td><strong>361,086,836</strong></td>
<td><strong>4.2</strong></td>
</tr>
</tbody>
</table>
Implementation Planning

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Develop Project Tiers (Regional Approach)
  - Select and weight metrics based on study partner input
  - Update project costs and benefits
  - Gather information on the selected metrics
  - Perform project prioritization
- Develop project phasing plan
  - Model projects cumulatively (i.e. Project 1, Project 1 & 2,...All projects) to ensure no negative impacts
  - Update environmental and cultural data, update utility information, ROW
  - Identify potential funding sources depending on criteria (BCR, LMI, etc.)
- Move forward with Feasibility, Preliminary Engineering, Design
Sedimentation and Vegetation

- Strategies to reduce flow of sediments into Lake Houston
- Developed annual sediment rating curves for 7 watersheds
  - Predictive tool that relates sediment transport with stream flow
  - Cypress Creek is the highest contributor
- First step toward Regional Sediment Management Plan (RSM)
- Inventory of sediment sources
- Common sediment management strategies
- Recommended strategies for West Fork and Spring Creek
- Did NOT evaluate relationship between sediment and flooding
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k (Plus Maintenance)
Other Mitigation Actions

- Other Mitigation Action Goals
  - Evaluate communications plan/protocol during emergencies
  - Identify critical infrastructure and compare to inundation
  - Determine expected flood frequency evacuation routes
- Conducted Emergency Management Workshop (March 11th)
- Working on draft memorandum
Communication and Outreach

- **Communication**
  - Study Partners Meetings (6)
  - Supporting Partners Meeting (8)
  - Emergency Managers Workshop
  - H-GAC Coordination

- **Outreach**
  - 1st round of community meetings complete – December 2019
  - 2nd round of community meetings in planning – July 2020
  - Woodlands Drainage Task Force Meeting – January 28th
  - Study Website
    - [www.sanjacstudy.org](http://www.sanjacstudy.org)
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Workshops Completed) – 85%
- Secondary Mitigation Planning (Adjusted Schedule) – 100%
- Other Mitigation Actions (Adjusted Schedule) – 80%
Study Submittals

• Submitted
  – Existing Conditions Memorandum
  – Secondary Mitigation Memorandum
  – Historical Storms Memorandum

• Upcoming
  – Other Mitigation Actions Memo (Early June)
  – Alternative Funding Memo (Early June)
  – Updated Sedimentation/Vegetation Memo (06/12/20)
  – Primary Mitigation Memo (06/08/20)
  – Draft Report (07/13/20)
Questions?
STUDY PARTNERS MEETING NOTES

Harris County Precinct 2

May 22, 2020
San Jacinto Regional Watershed Master Drainage Plan
Skype Conference Call

Meeting called by: Jing Chen, P.E., CFM    Type of Meeting: Study Partners Meeting
Facilitator: Terry M. Barr, P.E., CFM    Meeting Start Time: 2:00 PM
Meeting Stop Time: 3:00 PM

Agenda

1. **Attendees**
   - Terry Barr, Halff
   - Sam Hinojosa, Halff
   - Andrew Moore, Halff
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - Byron Acevedo, Harris County Precinct 2
   - Milton Rahman, Harris County Precinct 2
   - Jeremy Ratcliff, HCFCD
   - Cory Stull, FNI

2. **Goals and Objections**
   - Jing introduced the meeting.
   - Terry introduced the San Jacinto study. He showed the watershed included in the study and the funding partners. He presented the location of the watershed in reference to Precinct 2.
   - Terry showed the density of flood claims within the basin.
   - Terry introduced the goals and objectives of the San Jacinto Regional Watershed Master Drainage Plan.

3. **Existing Conditions**
   - Terry presented the update of the Existing Conditions analysis. He stated that all major streams in the basin have been included in a combined existing conditions model. The model utilized existing models from HCFCD as well as new models for the upper regions. The model utilizes the latest Atlas 14 rainfall and has been calibrated to historical storm events including Hurricane Harvey and Memorial Day 2016. The model has also been validated with the October 1994 and Tropical Storm Imelda events. The calibration and validation including comparing the model to 22 USGS gages in the watershed.

4. **Primary Mitigation Planning**
   - Terry summarized the primary mitigation process which included identifying mitigation strategies to reduce flooding for region.
   - The team identified damage centers to determine which locations should be targeted with the mitigation projects using the structural inventory tool and the updated existing
conditions modeling. Of the damage centers, the highest damage concentrations were in those centers closer to the confluence.

- Using the damage center information, the team identified tiers for mitigation planning to rank the potential mitigation projects based on number of damages, regional benefit, and potential mitigation volumes.
- The team reviewed and cataloged projects recommended in several previous reports to determine if any of these should be included in the analysis. Many of the projects were no longer feasible or were originally intended for water supply purposes; however, the information was used as a starting point for many of the projects that were evaluated as part of this study. In addition, the team also proposed new mitigation strategies.
- The team evaluated a total of 25 projects, choosing those deemed most effective to develop a regional master plan, which includes detention and channelization project spread throughout the watershed. The “most effective” projects are those that performed the best for each watershed as well as provided regional benefit. Terry stated that the projects improve the areas near the damage center within their respective watershed, but also provide flood reduction benefits further downstream, including beyond their confluences with receiving streams. He stated that Lake Houston limits the effectiveness of these projects downstream and that reductions to the Lake Houston level would be needed to see further improvements. However, this study does not evaluate or recommend changes to the lake. A separate Lake Houston study is reviewing improvements for the Lake Houston area.
- Milton asked if there were any projects proposed in the Precinct 2 area. Terry stated that most projects were outside Harris County, with the goal of reducing projects within Harris County.
- The benefit-cost ratios (BCR) for Spring Creek were the highest, but overall cost benefits are not positive for many of the projects. Terry stated that the BCR is not the only metric for funding the projects. Acreage recovered, roadway miles removed, and raw structure counts should also be considered. Milton asked if the costs were broken down by County. Terry stated that most of the projects are outside the County and costs are broken down by project.
- In addition, Terry showed the low-to-moderate income (LMI) areas as they relate to potential projects. Lower income areas could potentially be good candidates for CDBG or other funding sources that account for socio-economically disadvantaged areas.
- Terry discussed additional mitigation measures, including detention, floodplain preservation, and buyouts, as potential options. Detention associated with local development is needed to offset negative impacts for the local streets, sewers, and streams. Future projections show that the impact of local detention on the regional scale is minor, but much of the analysis depends on assumptions made about the development location and timing. Development locations can change and alter the results. Terry reiterated that detention is an important tool to mitigate drainage impacts of development and specified that the study should be careful to clarify the team’s position on detention.
- Terry stated that floodplain preservation is recommended because losses in floodplain storage can have negative impacts downstream. The study did not evaluate specific areas or scenarios related to floodplain preservation. Harris County has “no adverse impact” and floodplain fill mitigation policies in place and Terry agreed that those policies were beneficial.
- Terry indicated that while the proposed projects (detention, channel) will provide significant benefits, some structures, specifically those that flood during frequent storms (2-
& 5-year), will likely continue to flood. For these structures, buyouts may be the recommended strategy.

- The next step is to finalize the list of projects to be included in the overall master drainage plan and develop a project phasing plan.
- Terry briefly discussed the Sedimentation and Vegetation report, which identifies strategies to reduce flow of sediments into Lake Houston. The report is the first step toward a regional sediment management plan. Terry specified that the sediment and vegetation effort did not evaluate the impact of sedimentation on flooding.

## 5. Secondary Mitigation Planning

- Terry presented the additional gages that are recommended in the area including stage, flow, and rainfall. The gages provide first responders early information to flooding in the region. The team recommended 26 gages throughout the San Jacinto Basin, 5 of which are already being installed by HCFCD.

## 6. Other Mitigation Actions

- Terry discussed coordinating with local agencies to determine how the agencies react to storm events and their communication protocols.
- The team also identified roadway levels of service and critical infrastructure within the potential floodplains.
- Most counties have a plan for responding to flooding events and are already coordinating with the region. Identified some areas of improvements for each agency.

## 7. Communication and Outreach

- Terry explained that there is a defined coordination effort, which includes meetings with both the study partners, and other supporting partners, such as the surrounding counties and H-GAC.
- As part of the Other Mitigation Actions task, the team met with emergency managers for each of the regional entities to understand protocol, and also conducted an emergency management workshop.
- The team also has an outreach plan, with the first round of community meetings in December 2019 and a second round planned for July. In addition, there is a study website that provides an overview of the study goals and progress. ([www.sanjacstudy.org](http://www.sanjacstudy.org)).
- Milton asked if the study team had worked with the Lake Houston Chamber of Commerce group. Jing stated that both HCFCD and SJRA had been attending meetings with the chamber. Milton stated that it may be added value to present to this group the overview of the study as they are an influential group in the region.

## 8. Study Schedule

- Terry presented the study schedule with the final report being submitted in August 2020.

## 9. CWA Lake Houston Gate Study Update

- Jing stated that the HCFCD is participating in the Lake Houston Gate project as a stakeholder. She stated that the project is FEMA funded and the team will be looking at benefit costs of the project, including minimizing downstream impacts to the additional gates.
- She stated the team is identifying successes and constraints of the project. She also mentioned that the project kicked off in mid-April and the H&H analysis is ongoing and will extend through October.
**Milton** stated he had concerns that the gate improvements would cause impacts downstream of the dam. He asked if the team had started a public engagement plan for the project. Jing stated that the City is planning to reach out to the appropriate precincts with a plan for public outreach in the fall in August or September timeframe.

| 10. | **Questions/Comments**  
|     | Milton stated that the Precinct has $30 million for three (3) projects within the watershed (F-15, F-110, F-111). He stated that according to the study analysis, these funds would not have a high cost benefit. Jing stated that it is not clear what the next steps are for current funding and projects, but coordination is likely needed between all stakeholders in the area. |
# PRECINCT BRIEFING AGENDA

*Harris County Precinct 3*

June 30, 2020  
San Jacinto Regional Watershed Master Drainage Plan  
Teams Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Precinct Briefing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>11:00 am</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>12:00 pm</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions**

2. **Goals and Objectives**
   - Conduct a comprehensive Flood Mitigation Plan
   - Identify vulnerability to flood hazards causing loss of life and property
   - Develop approaches to enhance public information and flood level assessment
   - Evaluate flood mitigation strategies to improve long-term resilience

3. **Existing Conditions**
   - Existing Conditions H&H Modeling Update
   - Analysis of Historical Storms
   - Sedimentation and Vegetation

4. **Primary Mitigation Planning**
   - Flood Mitigation Strategies
   - Primary Mitigation Tasks
   - Damage Center Identification
   - Flood Mitigation Projects
   - Additional Mitigation Measures
   - Implementation Planning

5. **Secondary Mitigation Planning**
   - Gage Recommendations

6. **Other Mitigation Actions Planning**
   - Coordination with Emergency Managers
   - Updated communication plans/protocols
   - Critical infrastructure and roadway flood frequency

7. **Community Outreach**
   - Partners and Stakeholder Communication
   - Community Outreach

8. **Study Schedule**

9. **Questions**
Agenda

- Goals and Objectives
- Existing Conditions
- Primary Mitigation Planning
- Secondary Mitigation Planning
- Other Mitigation Actions Planning
- Community Outreach
- Project Schedule and Status
- CWA Lake Houston Gate Study
- Questions
## San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Harris County Precinct 3

- Spring Creek/Willow Creek
- Cypress Creek
- Little Cypress Creek
Goals and Objectives

• The goal of the San Jacinto Regional Watershed Master Drainage Plan is to
  – Conduct a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Develop approaches to enhance public information and flood level assessment
  – Evaluate flood mitigation strategies to improve long-term resilience

• The plans specific objectives are:
  – Primary Flood Mitigation Planning (Detention, Conveyance, Buy-Outs)
  – Secondary Mitigation Planning (Flood Assessment/Warning)
  – Other Mitigation Actions (Communications Protocols, Flood Response)
  – Community Outreach & Education (Drainage, Maintenance, Projects)
Existing Conditions H&H Analysis

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Updated Infiltration/Transform Parameters
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994

- Leveraged Gage Adjusted Radar Rainfall (GARR) Data

- USGS Gages (Used 22/25)
  - Met with USGS
  - Gage Summary in Report

- Calibration Report Submitted
Sedimentation and Vegetation

• Strategies to reduce flow of sediments into Lake Houston
• Developed annual sediment rating curves for 7 watersheds
  – Predictive tool that relates sediment transport with stream flow
  – Cypress Creek is the highest contributor
• First step toward Regional Sediment Management Plan (RSM)
• Inventory of sediment sources
• Common sediment management strategies
• Recommended strategies for West Fork and Spring Creek
• Did NOT evaluate relationship between sediment and flooding
Flood Mitigation Strategies

- **Primary Flood Mitigation Planning (Flood Reduction)**
  - Primary Alternatives – Based on previously identified solutions
  - Secondary Alternatives – Developed additional flood reduction projects
  - Develop cost estimates
  - Evaluate potential benefits
  - Identify implementation path and challenges
- **Secondary Flood Mitigation Planning (Flood Warning)**
  - Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  - Recommend locations for additional FWS gages
- **Other Mitigation Actions (Flood Response)**
  - Coordinate with agencies responsible for Emergency Management
  - Provide recommendations for updated communications protocols
  - Identify potential flooding of roadways and critical infrastructure
Primary Mitigation Tasks

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Damage Center Identification

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers

Significant number of structures at risk during higher frequency storms (2-yr - 25-yr)
Damage Center Identification

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks

Instances from higher frequency storms (2-yr, 5-yr) were removed to avoid skewing the data.
Watershed Mitigation Potential

• Higher Potential
  – Spring Creek (Benefits in watershed; Potential reduction downstream)
  – East Fork (Major Lake Houston contributor; Available open space)
  – Peach/Caney Creek (Available open space; Benefits in watershed)

• Moderate Potential
  – Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

• Lower Potential
  – Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  – Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  – Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  – Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  – West Fork (Limited open space; High volume; Benefits in watershed)
Previously Recommended Projects

• Reviewed previous reports and master plans
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

- Considered 34 Previously Recommended Projects
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
San Jacinto Regional WMDP

San Jacinto River Master Drainage Plan

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway *</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Caney Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Caney Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
San Jacinto Regional WMDP

• Combined projects show increased local and regional benefits
• Current project combinations (by Watershed)
  – Spring Creek: Walnut Detention, Birch Detention, I-45 to Riley Fuzzell
  – Lake Creek: Caney Detention, Little Caney Detention, Garrett’s Detention
  – East Fork: Winters Detention, Lower East Fork Channel Improvements
  – Caney Creek: SH105 and FM1097 Detention, Channel D/S of I-69
  – Peach Creek: SH 105 and Walker Detention, Channel D/S of I-69
  – Full Combined Model: Ultimate Flood Reduction Improvements
• Projects in Spring Creek have the highest BCR (0.55 – 1.22)
San Jacinto Regional WMDP

- Plan Cost: $2.9B - $3.3B
- Overall Plan Benefits: $756 M
- BCR: 0.23 – 0.26

<table>
<thead>
<tr>
<th>Stream</th>
<th>Existing Structural Damages ($M)</th>
<th>Combined Alternatives Structural Damages ($M)</th>
<th>Structural Benefit ($M)</th>
<th>Cost Range ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>339.4</td>
<td>117.3</td>
<td>222</td>
<td>313.6 – 388.5</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>119</td>
<td>101.4</td>
<td>17.5</td>
<td>–</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>374.1</td>
<td>370.4</td>
<td>3.7</td>
<td>–</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>196.7</td>
<td>196.2</td>
<td>0.5</td>
<td>–</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>128.3</td>
<td>78.3</td>
<td>50.1</td>
<td>134.3 – 166.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>396.2</td>
<td>198.2</td>
<td>198</td>
<td>966</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>16.7</td>
<td>4.5</td>
<td>12.1</td>
<td>303 - 422</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>163.9</td>
<td>32.9</td>
<td>131.1</td>
<td>718.0 – 812.0</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>190.8</td>
<td>70.5</td>
<td>120.2</td>
<td>478.0 – 533.0</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>20</td>
<td>19.2</td>
<td>0.8</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,030.3</strong></td>
<td><strong>1,274.1</strong></td>
<td><strong>756.2</strong></td>
<td><strong>2,912.9 – 3,288.1</strong></td>
</tr>
</tbody>
</table>
Additional Regional Measures

• Detention Policy
  – Local detention provides critical mitigation for development and CIP
  – Regional benefits are dependent on location and timing of development
  – Future conditions modeling indicated limited detention impact, BUT
    • 2070 development was centered on lower basin (1-2% volume increase)
    • Ultimate development along the basin outer boundaries shows a higher increase in runoff volume (>5%)
  – Detention **DOES** have an impact on local flooding issues
  – Comprehensive impact analysis should be performed

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $3B
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
## Buyouts

- Summary of structures and expected damages in each watershed that flood in the 5-year event

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Structure Count</th>
<th>Existing Damages (NPV, 50-yr Period) ($M)</th>
<th>2019 Market Value ($M)</th>
<th>Estimated Buyout Cost (2.5× Mkt. Value) ($M)</th>
<th>Benefit-Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>34</td>
<td>46.65</td>
<td>4.38</td>
<td>10.96</td>
<td>4.3</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>39</td>
<td>29.92</td>
<td>9.61</td>
<td>24.02</td>
<td>1.2</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>40</td>
<td>69.92</td>
<td>16.80</td>
<td>42.01</td>
<td>1.7</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>30</td>
<td>31.02</td>
<td>6.05</td>
<td>15.13</td>
<td>2</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>31</td>
<td>36.53</td>
<td>5.53</td>
<td>13.83</td>
<td>2.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>38</td>
<td>40.29</td>
<td>6.41</td>
<td>16.02</td>
<td>2.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>5</td>
<td>4.72</td>
<td>1.02</td>
<td>2.55</td>
<td>1.9</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>71</td>
<td>59.46</td>
<td>8.67</td>
<td>21.67</td>
<td>2.7</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>85</td>
<td>74.05</td>
<td>7.80</td>
<td>19.49</td>
<td>3.8</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>9</td>
<td>4.76</td>
<td>1.08</td>
<td>2.70</td>
<td>1.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>58</td>
<td>57.07</td>
<td>7.34</td>
<td>18.34</td>
<td>3.1</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>1</td>
<td>1.51</td>
<td>0.21</td>
<td>0.52</td>
<td>2.9</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>2</td>
<td>1.57</td>
<td>0.97</td>
<td>2.43</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>443</strong></td>
<td><strong>457.46</strong></td>
<td><strong>75.87</strong></td>
<td><strong>189.67</strong></td>
<td><strong>2.4</strong></td>
</tr>
</tbody>
</table>
Implementation Planning

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Perform project prioritization
  - Update project costs and benefits
  - Select and weight metrics based on study partner input
  - Perform project prioritization
- Develop project phasing plan
  - Model projects cumulatively to ensure no negative impacts
  - Update environmental and cultural data, update utility information, ROW
  - Identify potential funding sources depending on criteria (BCR, LMI, etc.)
- Move forward with Feasibility, Preliminary Engineering, Design
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k (Plus Maintenance)
Other Mitigation Actions

- Other Mitigation Action Goals
  - Evaluate communications plan/protocol during emergencies
  - Identify critical infrastructure and compare to inundation
  - Determine expected flood frequency evacuation routes
- Conducted Emergency Management Workshop (March 11th)
- Working on draft memorandum
Communication and Outreach

• Communication
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (8)
  – Emergency Managers Workshop
  – H-GAC Coordination

• Outreach
  – 1st round of community meetings complete – December 2019
  – 2nd Community Meeting (Virtual) in planning – August 2020
  – Stakeholder Meetings (Jul/Aug)
  – Woodlands Drainage Task Force Meeting – January 28th
  – Study Website
    www.sanjacstudy.org
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Memorandum Submitted) – 90%
- Secondary Mitigation Planning (Finalized) – 100%
- Other Mitigation Actions (Memorandum Coming) – 90%
Study Submittals

• Submitted
  – Existing Conditions Memorandum (08/12/19)
  – Historical Storms Memorandum (04/07/20)
  – Future Conditions Memorandum (04/07/20)
  – Secondary Mitigation Memorandum (05/13/20)
  – Primary Mitigation Memo (06/08/20)
  – Updated Sedimentation/Vegetation Memo (06/26/20)

• Upcoming
  – Other Mitigation Actions Memo (06/30/20)
  – Draft Report (07/13/20)
    • Alternative Funding
    • Implementation Plan
  – Final Report (08/31/20)
STUDY PARTNERS MEETING NOTES

Harris County Precinct 3

June 30, 2020
San Jacinto Regional Watershed Master Drainage Plan
Teams Conference Call

Meeting called by: Jing Chen, P.E., CFM
Type of Meeting: Precinct Briefing
Facilitator: Terry M. Barr, P.E., CFM
Meeting Start Time: 11:00 AM
Meeting Stop Time: 12:00 PM

Agenda

1. Attendees
   • Terry Barr, Halff
   • Sam Hinojosa, Halff
   • Ryan Londeen, Halff
   • Jing Chen, HCFCD
   • Gary Bezemek, HCFCD
   • Dylan Epley, HCFCD
   • Matthew Lopez, HCFCD
   • Eric Heppen, Harris County Precinct 3
   • Randy Schillab, Harris County Precinct 3
   • Cory Stull, Freese & Nichols

2. Goals and Objections
   • Jing introduced the meeting.
   • Terry introduced the San Jacinto study. He showed the watershed included in the study and the funding partners. He presented the location of the watershed in reference to Precinct 3.
   • Terry showed the density of flood claims within the basin.
   • Terry introduced the goals and objectives of the San Jacinto Regional Watershed Master Drainage Plan.

3. Existing Conditions
   • Terry presented the update of the Existing Conditions analysis. He stated that all major streams in the basin have been included in a combined existing conditions model. The model utilized existing models from HCFCD as well as new models for the upper regions. The model utilizes the latest Atlas 14 rainfall and has been calibrated to historical storm events including Hurricane Harvey and Memorial Day 2016. The model has also been validated with the October 1994 and Tropical Storm Imelda events. The calibration and validation including comparing the model to 22 USGS gages in the watershed.

4. Primary Mitigation Planning
   • Terry summarized the primary mitigation process which included identifying mitigation strategies to reduce flooding for region.
   • The team identified damage centers to determine which locations should be targeted with the mitigation projects using the structural inventory tool and the updated existing
conditions modeling. Of the damage centers, the highest damage concentrations were in those centers closer to the confluence.

- Referring to the Spring Creek damage center slide, Eric Heppen asked what mile marker Cypress Creek intercepts Spring Creek. Terry said that the Cypress Creek intercept location is not far from the West Fork and that the Spring Creek damage center is near The Woodlands.
- Using the damage center information, the team identified tiers for mitigation planning to rank the potential mitigation projects based on number of damages, regional benefit, and potential mitigation volumes.
- The team reviewed and cataloged projects recommended in several previous reports to determine if any of these should be included in the analysis. Many of the projects are no longer feasible or were originally intended for water supply purposes; however, the information was used as a starting point for many of the projects that were evaluated as part of this study. In addition, the team also proposed new mitigation strategies.
- The team evaluated a total of 25 projects, choosing those deemed most effective to develop a regional master plan, which includes detention and channelization project spread throughout the watershed. The “most effective” projects are those that performed the best for each watershed as well as provided regional benefit. Terry stated that the projects improve the areas near the damage center within their respective watershed, but also provide flood reduction benefits further downstream, including beyond their confluences with receiving streams. He stated that Lake Houston limits the effectiveness of these projects downstream (ex. confluence with East Fork) and that reductions to the Lake Houston level would be needed to see further improvements. However, this study does not evaluate or recommend changes to the lake. A separate Lake Houston study is reviewing improvements for the Lake Houston area.
- The benefit-cost ratios (BCR) for Spring Creek were the highest (0.55-1.22) because more development in the Spring Creek Watershed. However, overall cost benefits are not positive for many of the projects (0.75 – 1 range). Terry stated that the BCR is not the only metric for funding the projects. FEMA will also consider social benefits for this BCR range of 0.75 to 1 and some funding may still be available for these projects.
- In addition, Terry showed the low-to-moderate income (LMI) areas as they relate to potential projects. Funding will vary based on LMI. Lower income areas could potentially be good candidates for CDBG or other funding sources that account for socio-economically disadvantaged areas.
- Terry discussed additional mitigation measures, including detention, floodplain preservation, and buyouts, as potential options. Detention associated with local development is needed to offset negative impacts for the local streets, sewers, and streams. Future projections show that the impact of local detention on the regional scale is minor, but much of the analysis depends on assumptions made about the development location and timing. Terry reiterated that detention is an important tool to mitigate drainage impacts of development especially when considering cumulative effects or hydrograph timing.
- Terry stated that floodplain preservation is recommended because losses in floodplain storage can have negative impacts downstream. The study did not evaluate specific areas or scenarios related to floodplain preservation. Future conditions do not include floodplain fill. Harris County has “no adverse impact” and floodplain fill mitigation policies in place and Terry agreed that those policies were beneficial.
• Terry indicated that while the proposed projects (detention, channel) will provide significant benefits, some structures, specifically those that flood during frequent storms (2- & 5-year), will likely continue to flood. For these structures, buyouts may be the recommended strategy. Buyout is more effective than the mitigation projects from a purely economic perspective.
• The next step is to finalize and prioritize the list of projects to be included in the overall master drainage plan and develop a project phasing plan and then finally move forward with feasibility, preliminary engineering, design, construction, etc.

5. **Secondary Mitigation Planning**

• Terry presented the additional gages that are recommended in the area including stage, flow, and rainfall. The gages provide first responders early information to flooding in the region. The team recommended 26 gages throughout the San Jacinto Basin, 5 of which are already being installed by HCFC. Many of the gages are proposed in the upper basin areas where there are currently minimal gages. This is a benefit to Harris County because the gages will identify, early in the storm event, the amount of runoff that is expected to be routed through Harris County from the upper basin.

6. **Other Mitigation Actions**

• Terry discussed coordinating with local agencies to determine how the agencies react to storm events and their communication protocols.
• The team also identified roadway levels of service and critical infrastructure within the potential floodplains.
• Most counties have a plan for responding to flooding events and are already coordinating with the region. Identified some areas of improvements for each agency.

7. **Communication and Outreach**

• Terry explained that there is a defined coordination effort, which includes meetings with both the study partners, and other supporting partners, such as the surrounding counties and H-GAC.
• As part of the Other Mitigation Actions task, the team met with emergency managers for each of the regional entities to understand protocol, and also conducted an emergency management workshop.
• The team also has an outreach plan, with the first round of community meetings in December 2019 and a second round planned for August 2020 (virtual). In addition, there is a study website that provides an overview of the study goals and progress.
  ([www.sanjacstudy.org](http://www.sanjacstudy.org)).

8. **Study Schedule**

• Terry presented the study schedule with the final report being submitted in August 2020.

9. **Questions/Comments**

• Eric Heppen stated that this was great and helpful information.
Meeting called by: Jing Chen, P.E., CFM  Type of Meeting: Precinct Briefing
Facilitator: Sam Hinojsoa, P.E., CFM  Meeting Start Time: 10:00 am
                                Meeting Stop Time: 11:00 am

Agenda

1. Introductions

2. Goals and Objectives
   - Conduct a comprehensive Flood Mitigation Plan
   - Identify vulnerability to flood hazards causing loss of life and property
   - Develop approaches to enhance public information and flood level assessment
   - Evaluate flood mitigation strategies to improve long-term resilience

3. Existing Conditions
   - Existing Conditions H&H Modeling Update
   - Analysis of Historical Storms
   - Sedimentation and Vegetation

4. Primary Mitigation Planning
   - Flood Mitigation Strategies
   - Primary Mitigation Tasks
   - Damage Center Identification
   - Flood Mitigation Projects
   - Additional Mitigation Measures
   - Implementation Planning

5. Secondary Mitigation Planning
   - Gage Recommendations

6. Other Mitigation Actions Planning
   - Coordination with Emergency Managers
   - Updated communication plans/protocols
   - Critical infrastructure and roadway flood frequency

7. Community Outreach
   - Partners and Stakeholder Communication
   - Community Outreach

8. Spring Creek Siting Study Update

9. Lake Houston Gates Study Update

10. Study Schedule
<table>
<thead>
<tr>
<th>11.</th>
<th>Questions</th>
</tr>
</thead>
</table>

Agenda

• Goals and Objectives
• Existing Conditions
• Primary Mitigation Planning
• Secondary Mitigation Planning
• Other Mitigation Actions Planning
• Community Outreach
• Project Schedule and Status
• CWA Lake Houston Gate Study
• Questions
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Harris County Precinct 4

- Spring Creek/Willow Creek
- Cypress Creek
- West Fork/Lake Houston
Flood Claim Density
Goals and Objectives

• The goal of the *San Jacinto Regional Watershed Master Drainage Plan* is to
  – Conduct a comprehensive Flood Mitigation Plan
  – Identify vulnerability to flood hazards causing loss of life and property
  – Develop approaches to enhance public information and flood level assessment
  – Evaluate flood mitigation strategies to improve long-term resilience

• The plans specific objectives are:
  – Primary *Flood Mitigation* Planning (Detention, Conveyance, Buy-Outs)
  – Secondary Mitigation Planning (*Flood Assessment/Warning*)
  – Other Mitigation Actions (Communications Protocols, *Flood Response*)
  – Community Outreach & Education (Drainage, Maintenance, Projects)
Existing Conditions H&H Analysis

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Updated Infiltration/Transform Parameters
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994

- Leveraged Gage Adjusted Radar Rainfall (GARR) Data

- USGS Gages (Used 22/25)
  - Met with USGS
  - Gage Summary in Report

- Calibration Report Submitted
Sedimentation and Vegetation

- Strategies to reduce flow of sediments into Lake Houston
- Developed annual sediment rating curves for 7 watersheds
  - Predictive tool that relates sediment transport with stream flow
  - Cypress Creek is the highest contributor
- First step toward Regional Sediment Management Plan (RSM)
- Inventory of sediment sources
- Common sediment management strategies
- Recommended strategies for West Fork and Spring Creek
- Did NOT evaluate relationship between sediment and flooding
Flood Mitigation Strategies

• **Primary Flood Mitigation Planning (Flood Reduction)**
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Develop cost estimates
  – Evaluate potential benefits
  – Identify implementation path and challenges

• **Secondary Flood Mitigation Planning (Flood Warning)**
  – Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommend locations for additional FWS gages

• **Other Mitigation Actions (Flood Response)**
  – Coordinate with agencies responsible for Emergency Management
  – Provide recommendations for updated communications protocols
  – Identify potential flooding of roadways and critical infrastructure
Primary Mitigation Tasks

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Damage Center Identification

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers

Significant number of structures at risk during higher frequency storms (2-yr - 25-yr)
Damage Center Identification

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks

Instances from higher frequency storms (2-yr, 5-yr) were removed to avoid skewing the data
Watershed Mitigation Potential

• Higher Potential
  – Spring Creek (Benefits in watershed; Potential reduction downstream)
  – East Fork (Major Lake Houston contributor; Available open space)
  – Peach/Caney Creek (Available open space; Benefits in watershed)

• Moderate Potential
  – Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

• Lower Potential
  – Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  – Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  – Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  – Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  – West Fork (Limited open space; High volume; Benefits in watershed)
Previously Recommended Projects

- Reviewed previous reports and master plans
  - 1943 – San Jacinto River Master Plan
  - 1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
  - 1989 – South Montgomery County Flood Protection Plan
  - 1997 – Lake Creek Reservoir Study
  - 2000 – Lake Houston Regional Flood Protection Study
  - 2015 – Cypress Creek Overflow Management Plan
  - 2019 – Estimate Land Cover Effects on Selected Watersheds
  - 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

• Considered 34 Previously Recommended Projects
  – 1943/1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
## San Jacinto Regional WMDP

### San Jacinto River Master Drainage Plan

<table>
<thead>
<tr>
<th>Project Included in Plan</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Caney Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Caney Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
Lake Houston

- Influence of Lake Houston extends from the dam to Lake Houston Parkway.
- Upstream of Lake Houston Parkway, the West Fork controls.

![Map of Lake Houston showing control areas and key locations such as W. Lake Houston Pkwy, East Fork Controlled, West Fork Controlled, Lake Houston Controlled, and Lake Houston Dam.](image-url)
San Jacinto Regional WMDP

• Combined projects show increased local and regional benefits
• Current project combinations (by Watershed)
  – Spring Creek: Walnut Detention, Birch Detention, I-45 to Riley Fuzzell
  – Lake Creek: Caney Detention, Little Caney Detention, Garrett’s Detention
  – East Fork: Winters Detention, Lower East Fork Channel Improvements
  – Caney Creek: SH105 and FM1097 Detention, Channel D/S of I-69
  – Peach Creek: SH 105 and Walker Detention, Channel D/S of I-69
  – Full Combined Model: Ultimate Flood Reduction Improvements
• Projects in Spring Creek have the highest BCR (0.55 – 1.22)
San Jacinto Regional WMDP

- Plan Cost: $2.9B - $3.3B
- Overall Plan Benefits: $756 M
- BCR: 0.23 – 0.26

<table>
<thead>
<tr>
<th>Stream</th>
<th>Existing Structural Damages ($M)</th>
<th>Combined Alternatives Structural Damages ($M)</th>
<th>Structural Benefit ($M)</th>
<th>Cost Range ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>339.4</td>
<td>117.3</td>
<td>222</td>
<td>313.6 – 388.5</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>119</td>
<td>101.4</td>
<td>17.5</td>
<td>–</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>374.1</td>
<td>370.4</td>
<td>3.7</td>
<td>–</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>196.7</td>
<td>196.2</td>
<td>0.5</td>
<td>–</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>128.3</td>
<td>78.3</td>
<td>50.1</td>
<td>134.3 – 166.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>396.2</td>
<td>198.2</td>
<td>198</td>
<td>966</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>16.7</td>
<td>4.5</td>
<td>12.1</td>
<td>303 - 422</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>163.9</td>
<td>32.9</td>
<td>131.1</td>
<td>718.0 – 812.0</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>190.8</td>
<td>70.5</td>
<td>120.2</td>
<td>478.0 – 533.0</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>20</td>
<td>19.2</td>
<td>0.8</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,030.3</strong></td>
<td><strong>1,274.1</strong></td>
<td><strong>756.2</strong></td>
<td><strong>2,912.9 – 3,288.1</strong></td>
</tr>
</tbody>
</table>
Low to Moderate Income (LMI) Areas
Additional Regional Measures

• Detention Policy
  – Local detention provides critical mitigation for development and CIP
  – Regional benefits are dependent on location and timing of development
  – Future conditions modeling indicated limited detention impact, BUT
    • 2070 development was centered on lower basin (1-2% volume increase)
    • Ultimate development along the basin outer boundaries shows a higher increase in runoff volume ( >5%)
  – Detention DOES have an impact on local flooding issues
  – Comprehensive impact analysis should be performed

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $3B
Buyouts

• Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
• Removed from the instances of flooding for damage centers
• Maintained in the BCR calculations
• Generally a higher BCR on buyouts than structural projects
• Best option may be to buyout structures in this category
Buyouts

• Summary of structures and expected damages in each watershed that flood in the 5-year event

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Structure Count</th>
<th>Existing Damages (NPV, 50-yr Period) ($M)</th>
<th>2019 Market Value ($M)</th>
<th>Estimated Buyout Cost (2.5× Mkt. Value) ($M)</th>
<th>Benefit-Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>34</td>
<td>46.65</td>
<td>4.38</td>
<td>10.96</td>
<td>4.3</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>39</td>
<td>29.92</td>
<td>9.61</td>
<td>24.02</td>
<td>1.2</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>40</td>
<td>69.92</td>
<td>16.80</td>
<td>42.01</td>
<td>1.7</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>30</td>
<td>31.02</td>
<td>6.05</td>
<td>15.13</td>
<td>2</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>31</td>
<td>36.53</td>
<td>5.53</td>
<td>13.83</td>
<td>2.6</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>38</td>
<td>40.29</td>
<td>6.41</td>
<td>16.02</td>
<td>2.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>5</td>
<td>4.72</td>
<td>1.02</td>
<td>2.55</td>
<td>1.9</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>71</td>
<td>59.46</td>
<td>8.67</td>
<td>21.67</td>
<td>2.7</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>85</td>
<td>74.05</td>
<td>7.80</td>
<td>19.49</td>
<td>3.8</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>9</td>
<td>4.76</td>
<td>1.08</td>
<td>2.70</td>
<td>1.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>58</td>
<td>57.07</td>
<td>7.34</td>
<td>18.34</td>
<td>3.1</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>1</td>
<td>1.51</td>
<td>0.21</td>
<td>0.52</td>
<td>2.9</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>2</td>
<td>1.57</td>
<td>0.97</td>
<td>2.43</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>443</strong></td>
<td><strong>457.46</strong></td>
<td><strong>75.87</strong></td>
<td><strong>189.67</strong></td>
<td><strong>2.4</strong></td>
</tr>
</tbody>
</table>
Implementation Planning

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Perform project prioritization
  - Update project costs and benefits
  - Select and weight metrics based on study partner input
  - Perform project prioritization
- Develop project phasing plan
  - Model projects cumulatively to ensure no negative impacts
  - Update environmental and cultural data, update utility information, ROW
  - Identify potential funding sources depending on criteria (BCR, LMI, etc.)
- Move forward with Feasibility, Preliminary Engineering, Design
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k (Plus Maintenance)
Other Mitigation Actions

- Other Mitigation Action Goals
  - Evaluate communications plan/protocol during emergencies
  - Identify critical infrastructure and compare to inundation
  - Determine expected flood frequency evacuation routes

- Conducted Emergency Management Workshop (March 11th)

- Submitted a draft memorandum
Communication and Outreach

• Communication
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (8)
  – Emergency Managers Workshop
  – H-GAC Coordination

• Outreach
  – 1st round of community meetings complete – December 2019
  – 2nd Community Meeting (Virtual) in planning – August 2020
  – Stakeholder Meetings (Jul/Aug)
  – Woodlands Drainage Task Force Meeting – January 28th
  – Study Website
    www.sanjacstudy.org
Schedule Update

- Existing H&H/Calibration – 100% (Finalized)
- Primary Mitigation Planning (Memorandum Submitted) – 90%
- Secondary Mitigation Planning (Finalized) – 100%
- Other Mitigation Actions (Memorandum Submitted) – 90%
Study Submittals

• Submitted
  – Existing Conditions Memorandum (08/12/19)
  – Historical Storms Memorandum (04/07/20)
  – Future Conditions Memorandum (04/07/20)
  – Secondary Mitigation Memorandum (05/13/20)
  – Primary Mitigation Memo (06/08/20)
  – Updated Sedimentation/Vegetation Memo (06/26/20)
  – Other Mitigation Actions Memo (06/30/20)
  – Draft Report (07/13/20)
    • Alternative Funding
    • Implementation Plan

• Upcoming
  – Final Report (08/31/20)
STUDY PARTNERS MEETING NOTES

*Harris County Precinct 4*

July 17, 2020
San Jacinto Regional Watershed Master Drainage Plan
Skype Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Precinct Briefing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Sam Hinojosa, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>10:00 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>11:00 AM</td>
</tr>
</tbody>
</table>

**Agenda**

1. **Attendees**
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - William Sherman, HCFCD
   - Victoria Bryant, HCP4
   - Freddie Jebousek, HCP4
   - Ron Layton, HCP4
   - Jacob Lee, HCP4
   - Kennedy Purser, HCP4
   - Landon Reed, HCP4
   - Pamela Rocchi, HCP4
   - Lindsey Trahan, HCP4
   - Charlie Williams, HCP4
   - Sam Hinojosa, Halff
   - Andrew Moore, Halff
   - Hector Olmos, FNI

2. **Goals and Objections**
   - Jing introduced the meeting.
   - Sam introduced the San Jacinto study. He showed the watershed included in the study and the funding partners. He presented the location of the watershed in reference to Precinct 4.
   - Sam showed the density of flood claims within the basin.
   - Sam introduced the goals and objectives of the San Jacinto Regional Watershed Master Drainage Plan.

3. **Existing Conditions**
   - Sam presented the update of the Existing Conditions analysis. He stated that all major streams in the basin have been included in a combined existing conditions model. The model utilized existing models from HCFCD as well as new models for the upper regions. The model utilizes the latest Atlas 14 rainfall and has been calibrated to historical storm events including Hurricane Harvey and Memorial Day 2016. The model has also been validated with the October 1994 and Tropical Storm Imelda events. The calibration and validation including comparing the model to 22 USGS gages in the watershed.

4. **Primary Mitigation Planning**
   - Sam summarized the primary mitigation process which included identifying mitigation strategies to reduce flooding for region.
   - The team identified damage centers to determine which locations should be targeted with the mitigation projects using the structural inventory tool and the updated existing conditions modeling. Of the damage centers, the highest damage concentrations were in those centers closer to the confluence.
Using the damage center information, the team identified tiers for mitigation planning to rank the potential mitigation projects based on number of damages, regional benefit, and potential mitigation volumes.

The team reviewed and cataloged projects recommended in several previous reports to determine if any of these should be included in the analysis. Many of the projects were no longer feasible or were originally intended for water supply purposes; however, the information was used as a starting point for many of the projects that were evaluated as part of this study. In addition, the team also proposed new mitigation strategies.

The team evaluated a total of 25 projects, choosing those deemed most effective to develop a regional master plan, which includes detention and channelization project spread throughout the watershed. The “most effective” projects are those that performed the best for each watershed as well as provided regional benefit. Sam stated that the projects improve the areas near the damage center within their respective watershed, but also provide flood reduction benefits further downstream, including beyond their confluences with receiving streams. He stated that Lake Houston limits the effectiveness of these projects downstream and that reductions to the Lake Houston level would be needed to see further improvements. However, this study does not evaluate or recommend changes to the lake. A separate Lake Houston study is reviewing improvements for the Lake Houston area.

The benefit-cost ratios (BCR) for Spring Creek were the highest, but overall cost benefits are not positive for many of the projects. Sam stated that the BCR is not the only metric for funding the projects. Acreage recovered, roadway miles removed, and raw structure counts should also be considered.

In addition, Sam showed the low-to-moderate income (LMI) areas as they relate to potential projects. Lower income areas could potentially be good candidates for CDBG or other funding sources that account for socio-economically disadvantaged areas.

Sam discussed additional mitigation measures, including detention, floodplain preservation, and buyouts, as potential options. Detention associated with local development is needed to offset negative impacts for the local streets, sewers, and streams. Future projections show that the impact of local detention on the regional scale is minor, but much of the analysis depends on assumptions made about the development location and timing. Development locations can change and alter the results. Sam reiterated that detention is an important tool to mitigate drainage impacts of development and specified that the study should be careful to clarify the team’s position on detention.

Sam stated that floodplain preservation is recommended because losses in floodplain storage can have negative impacts downstream. The study did not evaluate specific areas or scenarios related to floodplain preservation. Harris County has “no adverse impact” and floodplain fill mitigation policies in place and Sam agreed that those policies were beneficial.

Sam indicated that while the proposed projects (detention, channel) will provide significant benefits, some structures, specifically those that flood during frequent storms (2- & 5-year), will likely continue to flood. For these structures, buyouts may be the recommended strategy.

The next step is to finalize the list of projects to be included in the overall master drainage plan and develop a project phasing plan.

Sam briefly discussed the Sedimentation and Vegetation report, which identifies strategies to reduce flow of sediments into Lake Houston. The report is the first step toward a regional sediment management plan. Sam specified that the sediment and vegetation effort did not evaluate the impact of sedimentation on flooding.
<table>
<thead>
<tr>
<th></th>
<th>Secondary Mitigation Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Sam presented the additional gages that are recommended in the area including stage, flow,</td>
</tr>
<tr>
<td></td>
<td>and rainfall. The gages provide first responders early information to flooding in the region.</td>
</tr>
<tr>
<td></td>
<td>The team recommended 26 gages throughout the San Jacinto Basin, 5 of which are already</td>
</tr>
<tr>
<td></td>
<td>being installed by HCFCD.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Other Mitigation Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Sam discussed coordinating with local agencies to determine how the agencies react to</td>
</tr>
<tr>
<td></td>
<td>storm events and their communication protocols</td>
</tr>
<tr>
<td></td>
<td>The team also identified roadway levels of service and critical infrastructure within the</td>
</tr>
<tr>
<td></td>
<td>potential floodplains.</td>
</tr>
<tr>
<td></td>
<td>Most counties have a plan for responding to flooding events and are already coordinating</td>
</tr>
<tr>
<td></td>
<td>with the region. Identified some areas of improvements for each agency.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Communication and Outreach</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Sam explained that there is a defined coordination effort, which includes meetings with both</td>
</tr>
<tr>
<td></td>
<td>the study partners, and other supporting partners, such as the surrounding counties and H-</td>
</tr>
<tr>
<td></td>
<td>GAC.</td>
</tr>
<tr>
<td></td>
<td>As part of the Other Mitigation Actions task, the team met with emergency managers for each</td>
</tr>
<tr>
<td></td>
<td>of the regional entities to understand protocol, and also conducted an emergency management</td>
</tr>
<tr>
<td></td>
<td>workshop.</td>
</tr>
<tr>
<td></td>
<td>The team also has an outreach plan, with the first round of community meetings in December</td>
</tr>
<tr>
<td></td>
<td>2019 and a second round planned for August. In addition, there is a study website that</td>
</tr>
<tr>
<td></td>
<td>provides an overview of the study goals and progress. (<a href="http://www.sanjacstudy.org">www.sanjacstudy.org</a>).</td>
</tr>
<tr>
<td></td>
<td>Sam mentioned that the study is being presented to the SJRA board next week.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Study Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Sam presented the study schedule with the final report being submitted in August 2020.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CWA Lake Houston Gate Study Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Jing stated that the HCFCD is participating in the Lake Houston Gate project as a stakeholder.</td>
</tr>
<tr>
<td></td>
<td>She stated that the project is FEMA funded and the team will be looking at benefit costs of</td>
</tr>
<tr>
<td></td>
<td>the project, including minimizing downstream impacts to the additional gates.</td>
</tr>
<tr>
<td></td>
<td>She stated the team is identifying successes and constraints of the project. She also</td>
</tr>
<tr>
<td></td>
<td>mentioned that the project kicked off in mid-April and the H&amp;H analysis is ongoing and will</td>
</tr>
<tr>
<td></td>
<td>extend through October.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Questions/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Jing mentioned that the initial virtual public meeting will be August 13th and that the team</td>
</tr>
<tr>
<td></td>
<td>will be meeting with other agencies/groups to present the findings of the study.</td>
</tr>
</tbody>
</table>
Appendix A.3

Study Partners Progress Meetings
May 8, 2019
San Jacinto River Regional Flood Mitigation Plan
HCFCD, Brookhollow

**Meeting called by:** Jing Chen, P.E., CFM  **Type of Meeting:** Study Partners Kickoff Meeting

**Facilitator:** Terry M. Barr, P.E., CFM  **Meeting Start Time:** 1:30 PM

**Meeting Stop Time:** 3:00 PM

<table>
<thead>
<tr>
<th>Agenda</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td><strong>Introductions</strong></td>
</tr>
</tbody>
</table>
| **2.** | **Communications and Outreach (Crouch)**  
  - PowerPoint Presentation  
  - Comment Forms  
  - Study Fact Sheet |
| **3.** | **Activities Conducted this Month**  
  - Project Methodology Discussion (03/19/2019)  
  - Study Partners Kickoff Meeting (04/08/2019)  
  - TDEM Kickoff Meeting (04/26/2019)  
  - Started site work in all watersheds  
  - Started survey of bridges and culverts  
  - Initial hydrology work (watershed delineations, BDF)  
  - Community Outreach efforts |
| **4.** | **Activities Planned next Month**  
  - Complete site work for all watersheds; prepare field observation reports  
  - Continue survey for bridges and culverts  
  - Complete watershed and drainage area delineations  
  - Develop hydrologic parameters (BDF methodology)  
  - Develop cross section layouts and hydraulic parameters (n-values)  
  - Start conversion of existing HCFCD models to unsteady RAS  
  - Community Outreach efforts |
| **5.** | **Technical Discussion**  
  - None |
| **6.** | **Administrative Discussion**  
  - None |
| **7.** | **Questions** |
# MEETING MINUTES

**To:** Jing Chen, P.E., CFM  
**Attendees:** Jing Chen, HCFCD  
**From:** Terry Barr, P.E., CFM  
**Attendees:** Dena Green, HCFCD  
**Subject:** San Jacinto Regional Watershed Master  
**Attendees:** Matt Barrett, SJRA  
**Drainage Plan Progress Meeting**  
**Attendees:** Chuck Gilman, SJRA (phone)  
**Location:** HCFCD, Brookhollow Office  
**Attendees:** Diane Cooper, Montgomery County  
**Meeting Date:** 05/8/2019 – 1:30 pm  
**Attendees:** Gary Hill, City Houston PW  
**Minutes Date:** 5/28/2019  
**Attendees:** Terry Barr, Halff  
**AVO No.:** 033465.002  
**Attendees:** Sam Hinojosa, Halff  
**Conner Stokes, Crouch**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | **Introductions**  
Ms. Chen started the meeting.  |  |
| 2.   | **Communications and Outreach**  
Mr. Stokes described the PowerPoint presentation that Crouch was assembling for HCFCD. A general comment form for public meetings has been developed. The study fact sheet has been developed and has already been used at a meeting. Crouch is working on a communications plan memorandum. Branding was discussed and HCFCD is looking into using a round logo for the project. Mr. Stokes said that he would provide HCFCD a list of websites that they had developed for others.  
Ms. Cooper stated that she will be presenting the study goals to Montgomery County Commissioners. She asked if she needed to keep track of things presented to court. Ms. Green stated that keeping track of presentations and what is presented would be required for consistency.  | Crouch to provide a list of websites they have developed for others.  
Project partners are to keep track of what they present to the public. |
| 3.   | **Activities Conducted This Month**  
Mr. Barr summarized three meetings that had been held since March. A project methodology discussion was held 3/19/2019. The project kickoff meeting was held 4/8/2019. A kickoff meeting with TDEM was held on 4/26/2019. Ms. Chen stated that the TDEM consultant did not want HCFCD to stop work on the project even though some questions needed to be answered.  
Mr. Barr stated that the Halff team has started work on all the watersheds by conducting site visits. Survey has also started on select bridges and culverts. Initial hydrology using BDF methodology has started. Ms. Green would like to see how BDF performs in the upper region of the study area.  
HCFCD asked that Halff compare the survey data to the new LiDAR. Ms. Chen stated that since Halff has not received the LAS files, she will track them down and provide. Halff may need to bring back the hard drive.  | HCFCD to provide the LAS files. |
### Activities Planned Next Month

Mr. Barr stated that filed observation reports are being prepared. Survey work will continue on bridges and culverts. Hydrology will continue with basin delineation and BDF parameter development. Cross section layout for the hydraulic modeling will begin. The conversion process from steady to unsteady HEC-RAS for the existing models of Spring, Cypress, Willow and Jackson will begin.

Ms. Cooper stated that she has the plans for SH 99 and the plans for the TxDOT bridge on Caney Creek. She will provide the plans and models she has received.

Mr. Barr also stated that Primary Flood Alternatives (PFA) will also begin. The goal will be to review the available studies that have been collected by the Halff team and identify and rank potential projects. Ms. Cooper stated that Montgomery County is interested in the policy recommendations that may come from this study. The policy recommendations should consider detention requirements, floodplain mitigation and finished floor elevations. Consideration should also be given to regional detention vs local detention. Mr. Barr stated that the PFA task preliminary project identification should be complete by mid-August. The H&H portion would not begin until November. HCFCD would like to have a workshop on the PFA in the latter part of July. At this time, preliminary results for the Existing Conditions analysis could also be presented.

#### Technical Discussion

None

#### Administrative Discussion

None

#### General Discussion

Ms. Cooper asked for a better description of the Secondary Flood Mitigation Alternatives vs the Secondary Flood Mitigation Planning task. Mr. Barr describe that the alternatives are additional alternatives to be developed. The Secondary Flood Mitigation Planning Task primarily outline flood warning system improvements/enhancements.

Ms. Green stated that HCFCD will look at adopting Atlas 14 in mid-June. With the adoption will be revised detention rates as well as mitigation requirements for the 500-year. Ms. Cooper and Mr. Barr asked if 500-year mitigation will be for the current 500-year or for the Atlas 14 500-year. Ms. Green said she would look into it.

Ms. Chen/Ms. Green stated that USACE has provided data on the dredging of Lake Houston. HCFCD will provide to Halff. HCFCD will forward a Terracon report that discusses the sediment sizes/loads from the West Fork and Spring Creek. Ms. Green does not want the Halff team to just review the Brown and Root report but to also make

Ms. Cooper to provide plans and models for SH 99 and the new Caney Creek Crossing.

HCFCD to plan a PFA workshop near the end of July.

Ms. Green will look into the 500-year mitigation requirements with the new Atlas 14 changes.

HCFCD to provide the Lake Houston Terracon report and also the
Ms. Chen also has received some preliminary bathymetric data of Lake Houston from the TWDB. She will share with Halff. Ms. Green stated that HCFCD has received plans for the dredging and will share with the team. Apparently the USACE has found some areas where clay was found instead of the expected sand.

Mr. Barrett and Mr. Gilman stated that the Spring Creek Reservoir Sighting Study had been deferred as the WJPA MUDs decide to wait for finding from the state legislature. It is possible that the MUDs revisit the study with SJRA after the legislative session comes to an end.

Ms. Cooper stated that gates will be added to the Lake Houston dam in the next 5 to 7 years. The gates have the strongest BCA and should move forward according to the City of Houston.

Ms. Chen stated that she would ask the flood watch group to provide potential gage location as proposed by Flood Watch.

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>TWDB bathymetric data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Ms. Chen concluded the meeting.</td>
<td>Ms. Chen to provide potential gage location as proposed by Flood Watch.</td>
</tr>
</tbody>
</table>

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
### STUDY PARTNERS MONTHLY MEETING AGENDA

**Study Partners: HCFCD, City of Houston, Montgomery County, SJRA**

June 12, 2019  
San Jacinto River Regional Flood Mitigation Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Kickoff Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:00 PM</td>
</tr>
</tbody>
</table>

#### Agenda

| 1. | Introductions |
| 2. | Communications and Outreach (Crouch) |
|    | • PowerPoint Presentation |
|    | • Comment Forms |
|    | • Study Fact Sheet |
| 3. | Activities Conducted this Month |
|    | • Monthly Study Partners Kickoff Meeting (05/07/2019) |
|    | • Field Work Completed/Field Observations Reports nearly complete |
|    | • Report Review Complete (Based on current data) |
|    | • Survey of Bridges/Culverts (75% Complete) |
|    | • Hydrology (Watershed/Subbasin Delineation; Land Use; Preliminary BDF Work) |
|    | • Hydraulics (Stream and Cross Section Layouts; Unsteady Conversions, n-Values) |
|    | • Draft Communications Plan, Website Outline |
| 4. | Activities Planned next Month |
|    | • Complete all Field Observation Reports |
|    | • Complete Survey of Bridges and Culverts |
|    | • Complete BDF Parameter Calculations |
|    | • Complete Conversion of HCFCD Models to Unsteady RAS |
|    | • Preliminary HEC-RAS models of non-HCFCD streams |
|    | • Community Outreach efforts |
|    | • Start Primary Mitigation Actions Discussions |
| 5. | Technical Discussion |
|    | • None |
| 6. | Administrative Discussion |
|    | • None |
| 7. | Questions |
SAN JACINTO
Regional Watershed Master Drainage Plan

Study Partners Progress Meeting
June 12, 2019
San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Study Partners Meeting 5/7/2019
  – Weekly progress calls with HCFCD

• Communications
  – Collateral Items Developed (Presentation, Comment Form, Fact Sheet)
  – Communications Planning Memorandum
  – Stakeholder Database and Draft Stakeholder Letter
  – Draft Study Website
  – Study Partners Logos
Data Collection

- Field Recon
Data Collection

- Field Reconnaissance and Reporting
Data Collection

- Field Survey of Bridges and Culverts
Data Collection

- Field Survey
Existing Conditions

- Watershed Boundaries
Existing Conditions

- Preliminary Sub Drainage Areas
Existing Conditions

- Existing Land Use
  - Forest
  - Pasture
  - Development in southern area
Existing Conditions

- Caney Creek BDF Calculations
Existing Conditions

- Caney Creek % Impervious Calculations
Existing Conditions

- Stream Centerlines and Cross Section Layouts
Primary Mitigation Alternatives

• Previous Studies
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Primary Mitigation Alternatives

- Previous Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Year</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>East San Jacinto No. 1</td>
<td>1943</td>
<td>950 Acres</td>
</tr>
<tr>
<td>2</td>
<td>East San Jacinto No. 0</td>
<td>1943</td>
<td>22,000 Acres</td>
</tr>
<tr>
<td>3</td>
<td>East Fork Reservoir</td>
<td>1985</td>
<td>3-5 Feet of Storage</td>
</tr>
<tr>
<td>4</td>
<td>San Jacinto No. 3</td>
<td>1943</td>
<td>6,000 Acres</td>
</tr>
<tr>
<td>5</td>
<td>San Jacinto No. 1</td>
<td>1943</td>
<td>3,890 Acres</td>
</tr>
<tr>
<td>6</td>
<td>San Jacinto No. 4</td>
<td>1943</td>
<td>2,744 Acres</td>
</tr>
<tr>
<td>7</td>
<td>San Jacinto No. 2</td>
<td>1943</td>
<td>1,032 Acres</td>
</tr>
<tr>
<td>8</td>
<td>Lake Creek Reservoir</td>
<td>1985</td>
<td>6,000 Acres</td>
</tr>
<tr>
<td>9</td>
<td>Lake Creek No. 1</td>
<td>1943</td>
<td>6,000 Acres</td>
</tr>
<tr>
<td>10</td>
<td>Lake Creek No. 2</td>
<td>1943</td>
<td>1,018 Acres</td>
</tr>
<tr>
<td>11</td>
<td>Lake Creek Reservoir</td>
<td>1997</td>
<td>15,000 Acres</td>
</tr>
</tbody>
</table>
## Primary Mitigation Alternatives

- Previous Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Details</th>
<th>Year</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Spring Creek No. 1</td>
<td>1943</td>
<td>5,550 Acres</td>
</tr>
<tr>
<td>13</td>
<td>Spring Creek Reservoir 1</td>
<td>1985</td>
<td>1,000 Acres</td>
</tr>
<tr>
<td>14</td>
<td>Spring Creek Reservoir 2</td>
<td>1985</td>
<td>643 Acres</td>
</tr>
<tr>
<td>15</td>
<td>Spring Creek No. 2</td>
<td>1943</td>
<td>180 Acres</td>
</tr>
<tr>
<td>16</td>
<td>Caney Creek No. 1</td>
<td>1943</td>
<td>805 Acres</td>
</tr>
<tr>
<td>17</td>
<td>Caney Creek Reservoir</td>
<td>1985</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Peach Creek No. 1</td>
<td>1943</td>
<td>485 Acres</td>
</tr>
<tr>
<td>19</td>
<td>Peach Creek No. 2,</td>
<td>1943</td>
<td>1,277 Acres</td>
</tr>
<tr>
<td>20</td>
<td>Peach Creek Reservoir 1</td>
<td>1985</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek Reservoir 2</td>
<td>1985</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Stewart Creek No. 1</td>
<td>1943</td>
<td>300 Acres</td>
</tr>
</tbody>
</table>
Schedule Update

- Data Collection and Review – 80%
- Existing Conditions H&H – 20%
- Community Outreach and Education – 5-10%

**SAN JACINTO RIVER WMDP - PROJECT SCHEDULE**

<table>
<thead>
<tr>
<th>Task</th>
<th>Days Remaining</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Project Management, Coordination, and Document Control</td>
<td>54</td>
<td>9/21/2020</td>
</tr>
<tr>
<td>Task 2: Review and Assess Existing Data</td>
<td>47</td>
<td>6/17/2019</td>
</tr>
<tr>
<td>Task 3: Existing Conditions Hydrologic and Hydraulic Model Development</td>
<td>26</td>
<td>8/12/2019</td>
</tr>
<tr>
<td>Task 4: Analyze Historical Storm Events and Calibrate Models</td>
<td>84</td>
<td>10/14/2019</td>
</tr>
<tr>
<td>Task 5: Future Conditions Hydrologic and Hydraulic Models</td>
<td>56</td>
<td>12/9/2019</td>
</tr>
<tr>
<td>Task 6: Primary Flood Mitigation Planning</td>
<td>357</td>
<td>6/8/2020</td>
</tr>
<tr>
<td>Task 7: Secondary Flood Mitigation Planning</td>
<td>119</td>
<td>11/18/2019</td>
</tr>
<tr>
<td>Task 8: Other Flood Hazard Mitigation Actions</td>
<td>133</td>
<td>2/10/2020</td>
</tr>
<tr>
<td>Task 9: Community Outreach and Education</td>
<td>54</td>
<td>8/24/2020</td>
</tr>
<tr>
<td>Task 10: Final Deliverables</td>
<td>84</td>
<td>8/31/2020</td>
</tr>
</tbody>
</table>
Questions?
# MEETING MINUTES

**To:** Jing Chen, P.E., CFM  
**Attendees:** Jing Chen, HCFCD  
**From:** Terry Barr, P.E., CFM  
**Subject:** San Jacinto Regional Watershed Master Drainage Plan Progress Meeting  

**Meeting Date:** 06/12/2019 – 1:30 pm  
**Location:** HCFCD, Brookhollow Office  
**Minutes Date:** 6/19/2019  
**AVO No.:** 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | Introductions  
Ms. Chen started the meeting. |  |
| 2.   | Communications and Outreach  
Barr stated HCFCD and Project Team are coordinating meetings with stakeholders. The communications plan is currently under internal review. Stokes stated the website will be developed after the plan is accepted. He stated a domain name was being discussed as well as the dropbox folder structure for sharing information internally. Cooper asked why dropbox is being used instead of Sharepoint. Barr stated that dropbox is simpler for this use since there are only a few users. He stated that anyone is able to upload and download files. | Halff to finalize communications plan. |
| 3.   | Activities Conducted This Month  
Barr summarized the data collection task and presented the locations the team has photographed and documented. He stated that for each watershed a field observation report is being compiled with reference identifications for each photo. He stated the field survey effort is at approximately 85% with 4 major structures left. Green asked how were survey locations determined. Barr stated they were based on major crossings and locations were field recon did not make sense.  
Barr summarized the existing conditions analysis. Green asked what the changes in the unsteady conversion versus the effective models were. Barr stated comparisons were not available yet, but can be provided at the next meeting. Green asked if there was a major thoroughfare plan for Montgomery County which could impact the drainage basin delineation. Cooper stated there is one and would share with the group. Barr stated the plan could be used to adjust drainage basin breaks if needed.  
Cooper asked if the land use data would capture larger residential lots and how it will be used for determining detention locations. Barr explained that it is just used for loss and impervious percentage calculations and MCO to provide major thoroughfare plan. |  |
that detention locations will be verified with aerial imagery, parcel data, and field investigation.

Cooper asked if BDF will accurately depict the drainage infrastructure in Montgomery County since it is mostly roadside ditch. Barr stated that the BDF considers roadside ditches and rural areas and assigns values based on these parameters. Green stated that HCFCD had done testing throughout the watershed and has had good results. Hinojosa stated that all initial values will be adjusted through the calibration process. Green asked if the Census data would provide any information. Barr stated it likely wouldn’t be more detailed than the HGAC land use information. Moore stated the BDF parameters can be compared to the FEMA effective model for Lake Creek.

Barr presented the preliminary cross section alignments. He stated that cross sections will be edged matched near crossing locations.

Chen asked if the LAS information was still needed for Lake Houston. Barr stated it would be and that Halff is considering obtaining survey of the dam.

Barr asked if there are any historical flooding records for Montgomery County. Cooper stated she is requesting the data from FEMA. Barr mentioned he may be able to obtain and would contact FEMA.

Barr stated the project is currently on schedule.

<table>
<thead>
<tr>
<th>4.</th>
<th>Activities Planned Next Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barr presented a summary of the previous reports reviewed. He stated after combing through the alternatives a workshop would be needed with the study partners to determine the primary mitigation alternatives. Chen suggested the next progress meeting. Barr stated a half day would likely be needed and suggested toward the end of the existing conditions analysis.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.</th>
<th>Technical Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barr mentioned that Vieux could obtain rainfall information for the 1994 event. He stated that this event would be run as a validation event since it was the previous event of record. Olmos stated that the cost would be approximately $10,000 for the data. Cooper asked for the source of the rainfall data since this was an older storm. Olmos stated they would use whatever was best available. Barr stated they could include the fee in the additional scope of work developed for the community outreach. Green and Chen agreed with this approach.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6.</th>
<th>Administrative Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7.</th>
<th>General Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen asked for an update on the sedimentation report review. Olmos stated the reports are currently being reviewed and analyzed. She stated</td>
<td></td>
</tr>
</tbody>
</table>
she has another report request in for a Mouth Bar Report developed by the City of Houston Solid Waste Division. She stated it is different than the dredging conducted by the USACE. She stated that the report stated there are areas where they are hitting clay sooner than expected and that there is a lot of debris removal. Barr asked about a USACE report that was not provided to the team. Green stated the USACE stated it was a rough analysis of the dredging and the USACE requested it not be used for any engineering analysis.

8. Ms. Chen concluded the meeting.
### STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

July 10, 2019

San Jacinto River Regional Flood Mitigation Plan

HCFCD, Brookhollow

---

**Meeting called by:** Jing Chen, P.E., CFM  
**Type of Meeting:** Study Partners Kickoff Meeting  
**Facilitator:** Terry M. Barr, P.E., CFM  
**Meeting Start Time:** 1:30 PM  
**Meeting Stop Time:** 3:00 PM

<table>
<thead>
<tr>
<th>Agenda</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td><strong>Introductions</strong></td>
</tr>
</tbody>
</table>
| **2.** | **Communications and Outreach (Crouch)**  
• Project website development  
• Upcoming public meetings and supporting partner meetings |
| **3.** | **Activities Conducted this Month**  
• Monthly Study Partners Progress Meeting (06/12/2019)  
• Completed field observation reports  
• Completed survey of bridges and culverts  
• Completed watershed and sub-watershed delineations, preliminary BDF calculations, Developed preliminary HMS models for all watersheds  
• Developed preliminary RAS models for all streams (No structures)  
• Completed conversion and comparison of most HCFCD streams (Willow)  
• Stakeholder database and draft letter; Team Dropbox; Started study website |
| **4.** | **Activities Planned next Month**  
• Complete field observation reports  
• Complete survey for bridges and culverts  
• Complete HMS models for all watersheds  
• Refine hydrologic parameters (BDF methodology)  
• Complete RAS models for all streams  
• Work on Existing Conditions Memo preparation  
• Deliver preliminary alternatives matrix; prepare for August workshop  
• Continue developing study website; Start work on supporting partners briefing  
• Begin work on sedimentation and vegetation plan |
| **5.** | **Technical Discussion**  
• GARR data acquisition |
| **6.** | **Administrative Discussion**  
• Provided amendment documents to HCFCD for additional analysis and meetings |
| **7.** | **Questions** |
SAN JACINTO
Regional Watershed Master Drainage Plan

Study Partners Progress Meeting
July 10, 2019
### San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

**Coordination**
- Study Partners Meeting 5/7/2019
- Study Partners Meeting 6/12/2019
- Weekly progress calls with HCFCD

**Communications**
- Collateral Items Revised
- Communications Planning Memorandum
- Stakeholder Database and Draft Stakeholder Letter
- Team Dropbox
- Website in development (sanjacstudy.org)
Data Collection

• Field Survey of Bridges and Culverts
Existing Conditions

- Watershed Boundaries
Existing Conditions

- Sub Drainage Areas
- 381 sub drainage areas
- Avg. Size ~ 6.0 sq. mi.
Existing Conditions

- Hydrologic Parameters
Existing Conditions

- Preliminary HEC-HMS Models
Existing Conditions

- Preliminary HEC-RAS Models
Existing Conditions

- Preliminary HEC-RAS Models
Existing Conditions

- Lake Creek Comparisons
Existing Conditions

• HCFCD Effective Conversions
  – Similar WSELs for effective conversion
  – Increase in WSELs with Atlas 14 Rainfall
Existing Conditions

- HCFCD Effective Conversions
Existing Conditions

- HCFCD Effective Conversions
Primary Mitigation Alternatives

• Previous Studies
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Primary Mitigation Alternatives

- Previous Alternatives
# Primary Mitigation Alternatives

- Previous Reservoirs

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Reference #</th>
<th>Reservoir Alternatives</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Size</th>
<th>Wetlands</th>
<th>Percent Developable</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
<th>Rank</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Fork</td>
<td>1</td>
<td>East Fork Reservoir (EF-67)</td>
<td>1995</td>
<td>New dams at East Fork and Waters Barry/Deerom assumed to be using 3 of 5 of storage</td>
<td>$44,300,000</td>
<td>25,000 acres</td>
<td>No wetlands impact Montgomery Country</td>
<td>20% developed</td>
<td>2845</td>
<td>1287</td>
<td>BCR: 2.05; Reduction in 100-year flood from Montgomery &amp; Liberty Cty 455,000 acre-ft (10,000acre-ft) Increase in 100-year flood plan BCR: 0.87</td>
<td></td>
</tr>
<tr>
<td>West Fork</td>
<td>3</td>
<td>West Fork (San Jacinto No. 4)</td>
<td>1993</td>
<td>12,464 acres under water</td>
<td>$700,000</td>
<td>2,744 acres</td>
<td>No wetlands impact Montgomery County</td>
<td>10% developed</td>
<td>38</td>
<td>1286</td>
<td>Capacity: 12,000 acre-ft</td>
<td></td>
</tr>
<tr>
<td>Lake Creek</td>
<td>4</td>
<td>Lake Creek Dam (Combined)</td>
<td>1993</td>
<td>2,625,000</td>
<td>Approx. 20,000 acres tributary draining to 2007 level</td>
<td>3563.88 acres</td>
<td>40% developed</td>
<td>4825</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Lake Creek Reservoir</td>
<td>1997</td>
<td>On the upper portion of Lake Creek, would be 80% live of Lake Coleman</td>
<td>$275,000,000</td>
<td>16,858 acres</td>
<td>1259 acres</td>
<td>2 ft</td>
<td>3120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Creek</td>
<td>6</td>
<td>Spring Creek Reservoir No. 1</td>
<td>1993</td>
<td>At confluence of Spring and Cypress Creeks, 5,500 acres</td>
<td>$2,900,000</td>
<td>5537 acres</td>
<td>1139 acres</td>
<td>4% developed</td>
<td>229</td>
<td>Capacity: 94,000 acre-feet.</td>
<td>Based on similar proposed construction as indicated in the 1985 report.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Spring Creek Reservoir 1 (SC-51)</td>
<td>1995</td>
<td>1,000 acres, new storage at 1,548.5, assumed to have 50 storage above pool</td>
<td>$9,520,000</td>
<td>1004 acres</td>
<td>101 acres</td>
<td>25% developed</td>
<td>1592</td>
<td>Average % reduction in 1 week = 1.25, increase in 1.25.</td>
<td>Based on similar proposed construction as indicated in the 1985 report.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Spring Creek Reservoir 2 (SC-62)</td>
<td>1995</td>
<td>3,640 acres, upstream of Wadsworth confluence, assumed to have 50 storage above pool</td>
<td>$41,000,000</td>
<td>3719 acres</td>
<td>281 acres</td>
<td>20% developed</td>
<td>5667</td>
<td>BCR Ratio: 0.9; Average 386 reduction in flood and 223 WDR reduction</td>
<td>Based on similar proposed construction as indicated in the 1985 report.</td>
<td></td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>9</td>
<td>Cypress Creek (Spring Creek No. 2)</td>
<td>1993</td>
<td>West of Wadsworth, 4,193 acres</td>
<td>$1,500,000</td>
<td>4189 acres</td>
<td>876 acres</td>
<td>50% developed</td>
<td>2598</td>
<td>Capacity: 16,500 acre-ft.</td>
<td>Based on similar proposed construction as indicated in the 1985 report.</td>
<td></td>
</tr>
</tbody>
</table>
## Primary Mitigation Alternatives

- **Previous Reservoirs**

### Reservoir Alternatives Table

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Reference #</th>
<th>Reservoir Alternatives</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Size</th>
<th>Wetlands (Impact to Montgomery County)</th>
<th>Percent Developable</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
<th>Rank</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Fork</td>
<td>1</td>
<td>East Fork Reservoir</td>
<td>1965</td>
<td>New reservoir, 27.4 acres, 1.320 acres, in storage</td>
<td>$2,257,000</td>
<td>5.350 acres</td>
<td>No wetlands impacted in Montgomery County</td>
<td>40%</td>
<td>75%</td>
<td>1307</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>West Fork</td>
<td>2</td>
<td>West Fork Reservoir</td>
<td>1965</td>
<td>New reservoir, 27.4 acres, 1.320 acres, in storage</td>
<td>$2,257,000</td>
<td>5.350 acres</td>
<td>No wetlands impacted in Montgomery County</td>
<td>40%</td>
<td>75%</td>
<td>1307</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Lake Creek</td>
<td>3</td>
<td>Lake Creek Reservoir</td>
<td>1965</td>
<td>New reservoir, 27.4 acres, 1.320 acres, in storage</td>
<td>$2,257,000</td>
<td>5.350 acres</td>
<td>No wetlands impacted in Montgomery County</td>
<td>40%</td>
<td>75%</td>
<td>1307</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Spring Creek</td>
<td>4</td>
<td>Spring Creek Reservoir</td>
<td>1965</td>
<td>New reservoir, 27.4 acres, 1.320 acres, in storage</td>
<td>$2,257,000</td>
<td>5.350 acres</td>
<td>No wetlands impacted in Montgomery County</td>
<td>40%</td>
<td>75%</td>
<td>1307</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>5</td>
<td>Cypress Creek Reservoir</td>
<td>1965</td>
<td>New reservoir, 27.4 acres, 1.320 acres, in storage</td>
<td>$2,257,000</td>
<td>5.350 acres</td>
<td>No wetlands impacted in Montgomery County</td>
<td>40%</td>
<td>75%</td>
<td>1307</td>
<td>244</td>
<td></td>
</tr>
</tbody>
</table>
Schedule Update

- Data Collection and Review – 93%
- Existing Conditions H&H – 44%
- Community Outreach and Education – 14%
Questions?
# MEETING MINUTES

**To:** Jing Chen, P.E., CFM  
**Attendees:** Jing Chen, HCFCD  
Dena Green, HCFCD  
Gary Bezemek, HCFCD  
Matt Barrett, SJRA  
Heather Cook, SJRA  
Diane Cooper, Montgomery County  
Adam Eaton, COH  
Terry Barr, Halff  
Sam Hinojosa, Halff  
Mike Moya, Halff  
Andrew Moore, Halff  
Hector Olmos, FNI  
Greg Sevcik, Hollaway  
Janic Hayes, Hollaway  

**From:** Terry Barr, P.E., CFM  

**Subject:** San Jacinto Regional Watershed Master Drainage Plan Progress Meeting  

**Meeting Date:** 07/10/2019 – 1:30 pm  
**Location:** HCFCD, Brookhollow Office  
**Minutes Date:** 07/29/2019 (Revised)  
**AVO No.:** 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1. | **Introductions**  
Ms. Chen started the meeting. |  

| 2. | **Communications and Outreach**  
Sevcik discussed the updates on the communications plan. He stated Hollaway was developing a fact sheet and website for the project. He stated the website would include an interactive map showing the watersheds. He requested an MXD showing the watershed boundaries and stream centerlines.  
Cooper stated that SJRA was creating an interactive map and that it could be used in lieu of the SJR study map. Cook stated the SJRA map would include an address search for users to be able to search for the watershed they live and work in. Cooper asked if this website could be used. Cook stated the website was planning to go live in August. Sevcik stated they can put in a placeholder for the map and discuss further once the SJRA website is live.  
Olmos stated the SJR study website would have updated information regarding the watershed boundaries and stream centerlines based on the new study results. Moya stated it may be better to have one map that is referenced so the public is seeing one result from both agencies.  
Chen asked when the website would be complete. Sevcik stated the draft will be submitted by August 1st. He requested a few photos such as aerial photography or photos from the ground to use on the website. | Hollaway to provide draft website.  
Halff to provide MXD for map placeholder.  
SJRA and HCFCD to discuss interactive map for website. |
| 3. | **Activities Conducted This Month**  
Moore stated the initial field survey was complete and that Halff would potentially collect more based on the schedule and budget. Barr stated some channel cross sections may be needed on Luce Bayou as the |  

Page 1 of 3
LiDAR does not include the channel in some areas. Green asked if Fugro had been made aware of the issue and Barr stated they had but did not find any issues with the data.

Moore stated the subbasins and hydrologic parameters had been initially calculated for all watersheds. Cooper asked if the BDF would account for larger lots in Montgomery County. Hinojosa stated that the BDF was based on drainage infrastructure and less on development.

Moore stated preliminary HEC-HMS models and HEC-RAS models are in final stages of development. He presented flow and water surface elevation comparison results for Lake Creek stating the results were still preliminary and would require refinement during QC and during calibration occurring next month. Cooper mentioned she expected the water surface elevation downstream of Honea Egypt Road to increase. Green mentioned that the upstream flow was quite a bit different from the effective model. Barr stated the models still needed to be refined but the trends show similarities with the effective model.

Moore presented the map and decision matrix showing the detention alternatives previously recommended. Green mentioned it would be helpful to have information regarding preliminary cost in today’s dollars for discussion. She also mentioned it would be helpful to have smaller alternatives to consider. Chen mentioned the workshop needed to be set up to discuss the alternatives.

<table>
<thead>
<tr>
<th>4. Activities Planned Next Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moore stated the hydrologic and hydraulic models are being completed and submitted for QA/QC to be ready for the August 12th submittal. Barr stated the project is still on schedule.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Technical Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barr mentioned historical rainfall data would be needed next month to begin calibration. Olmos stated that HCFCD should have the data for the 2017 and 2016 storm events. Barr asked if Halff could go ahead and request the 1994 data from Vieux. Green requested Halff hold off until the new authorization was routed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. Administrative Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barr discussed the project performance certification and asked if Halff should be reporting the percent complete on the current authorization or the total level of effort. Green stated the total should be used to maintain consistency throughout the project. Chen requested Halff use the official project logo for future presentations and documentation.</td>
</tr>
</tbody>
</table>

HCFCD to set up primary alternatives workshop

Halff to submit existing conditions models and memorandum August 12th.

Halff to order rainfall data once authorization routed. HCFCD to provide 2016 and 2017 rainfall data.
Green stated the consultant logo will only be used in the report.

<table>
<thead>
<tr>
<th>7. General Discussion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bezemek asked what level of confidence we have in the data that would be used to</td>
<td></td>
</tr>
<tr>
<td>calibrate the models. Barr stated there are several USGS gauges that would be</td>
<td></td>
</tr>
<tr>
<td>used for calibration. He mentioned Halff can prepare a map showing the calibration</td>
<td></td>
</tr>
<tr>
<td>data points and the level of confidence for each of the gauges. Hinojosa stated he</td>
<td></td>
</tr>
<tr>
<td>will reach out to the USGS to meet and discuss their confidence in each of the</td>
<td></td>
</tr>
<tr>
<td>gauges to be used.</td>
<td></td>
</tr>
<tr>
<td>Chen requested Halff provide a hard drive to the USACE to get the report and</td>
<td></td>
</tr>
<tr>
<td>design plan information regarding the sedimentation in the West Fork and Lake</td>
<td></td>
</tr>
<tr>
<td>Houston. She stated Halff can coordinate with Michael Garske (HCFCD) directly.</td>
<td></td>
</tr>
</tbody>
</table>

| 8. Ms. Chen concluded the meeting.                                                  |  |

Halff to coordinate with USACE.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
STUDY PARTNERS MONTHLY MEETING AGENDA
Study Partners: HCFCD, City of Houston, Montgomery County, SJRA

August 14, 2019
San Jacinto River Watershed Master Drainage Plan
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:00 PM</td>
</tr>
</tbody>
</table>

**Agenda**

<table>
<thead>
<tr>
<th>1.</th>
<th>Introductions</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>2.</th>
<th>Communications and Outreach (Hollaway)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Project website provide to HCFCD; Go Live soon</td>
</tr>
<tr>
<td></td>
<td>• Supporting partner meetings ongoing</td>
</tr>
<tr>
<td></td>
<td>• Upcoming public meetings (Nov/Dec)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.</th>
<th>Activities Conducted this Month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Monthly Study Partners Progress Meeting (07/10/19)</td>
</tr>
<tr>
<td></td>
<td>• Started additional survey bridges and culverts</td>
</tr>
<tr>
<td></td>
<td>• QA/QC of H&amp;H complete, including External (Halff D/FW offices) and FNI Cross QA/QC</td>
</tr>
<tr>
<td></td>
<td>• Started working on Draft Existing H&amp;H Report</td>
</tr>
<tr>
<td></td>
<td>• Completed Alternatives Matrix/Exhibit (pending internal workshop changes)</td>
</tr>
<tr>
<td></td>
<td>• Continue work on Sedimentation and Vegetation Plan</td>
</tr>
<tr>
<td></td>
<td>• Draft project website submitted for comment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.</th>
<th>Activities Anticipated Next Month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Begin Supporting Partners Meetings</td>
</tr>
<tr>
<td></td>
<td>• Complete additional survey of channels and bridges/culverts</td>
</tr>
<tr>
<td></td>
<td>• Submit Draft Existing H&amp;H Report – 08/12/19</td>
</tr>
<tr>
<td></td>
<td>• Begin Calibration effort</td>
</tr>
<tr>
<td></td>
<td>• Conduct internal Primary Alternatives Workshop – 08/07/19</td>
</tr>
<tr>
<td></td>
<td>• Conduct Primary Alternatives Workshop with Study Partners – 08/14/19</td>
</tr>
<tr>
<td></td>
<td>• Start coordination for Secondary Alternatives (Flood Warning)</td>
</tr>
<tr>
<td></td>
<td>• Continue work on Sedimentation and Vegetation Plan</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.</th>
<th>Technical Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• None pending Existing H&amp;H Report/Model Review</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6.</th>
<th>Administrative Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Amendment 1 and Spring Creek Siting Study (Contract options)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7.</th>
<th>Questions</th>
</tr>
</thead>
</table>
## San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Data Collection

- Gage Locations
- High-Water Marks
- Terrain (2018 LiDAR)
Field Recon and Survey
Existing Conditions Hydrology

- Watershed Boundaries
Existing Conditions Hydrology

- Soils & Percent Impervious (Infiltration Losses)
Existing Conditions Hydrology

- BDF Value & Channel Slopes (Clark UH)
Existing Conditions Hydrology

- HEC-HMS Model
Existing Conditions Hydraulics

- FEMA Floodplain
Existing Conditions Hydraulics

- Manning’s n-values
Existing Conditions Hydraulics

- HEC-RAS Model
Existing Conditions Summary

- New or updated hydrologic and hydraulic models for each basin
- Flows and water surface elevations are generally higher than the effective models
- Calibration is required to determine loss parameters and n-values
Flooding Hot Spots

- Flood Damage Claim Density
Primary Mitigation Alternatives

• Previous Studies
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Primary Mitigation Alternatives

<table>
<thead>
<tr>
<th>Reference #</th>
<th>Watershed</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>East Fork</td>
<td>Reservoir assumes only using 3 of 5 of storage</td>
</tr>
</tbody>
</table>
# Primary Mitigation Alternatives

- **Alternatives Matrix**

<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Percent Developable</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>East Fork</td>
<td>East Fork (East San Jacinto No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$2,237,000</td>
<td>Near Cleveland</td>
<td>5,950 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>60%</td>
<td>1387</td>
<td>Capacity: 107,000 ac-ft</td>
</tr>
<tr>
<td>2</td>
<td>East Fork</td>
<td>East Fork Reservoir (EF-41)</td>
<td>1985</td>
<td>Reservoir assumes only using 3 of 5' of storage</td>
<td>$44,300,000</td>
<td>Near Junction of East Fork and Winters Bayou</td>
<td>29,000 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>2%</td>
<td>2645</td>
<td>80%-90% reduction in 100-year flow from WSEL, less than 10,000 acre-feet.</td>
</tr>
<tr>
<td>3</td>
<td>West Fork</td>
<td>West Fork (San Jacinto No. 4)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$700,000</td>
<td>Upstream of Lake Conroe</td>
<td>2,744 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>&gt;80%</td>
<td>35</td>
<td>Capacity: 25,210 ac-ft</td>
</tr>
<tr>
<td>4</td>
<td>Lake Creek</td>
<td>Lake Creek Dam (Combined)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$275,000,000</td>
<td>Upstream portion of Lake Creek</td>
<td>Approx. 20000 acres (based on drawing @ 200' line)</td>
<td>2689.98 acres</td>
<td>60%</td>
<td>4825</td>
<td>Capacity: 104,000 acre-feet</td>
</tr>
<tr>
<td>5</td>
<td>Lake Creek</td>
<td>Lake Creek Reservoir</td>
<td>1997</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$2,600,000</td>
<td>At confluence of Spring and Cypress Creeks</td>
<td>1795 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>96%</td>
<td>229</td>
<td>Capacity: 50,520 acre-feet</td>
</tr>
<tr>
<td>6</td>
<td>Spring Creek</td>
<td>Spring Creek Reservoir (No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$23,000,000</td>
<td>Near Woodlands at RD 26.642</td>
<td>1004 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>5%</td>
<td>1532</td>
<td>Average 1% reduction in flow with minimal (&lt;25) change in WSEL.</td>
</tr>
<tr>
<td>7</td>
<td>Spring Creek</td>
<td>Spring Creek Reservoir 1 (SC-31)</td>
<td>1985</td>
<td>Assumed to have 5' storage above pool</td>
<td>$6,500,000</td>
<td>Upstream of Walnut Creek confluence</td>
<td>101 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>77%</td>
<td>9699</td>
<td>B/C Ratio: &lt;0.09 Average 35% reduction in flow and 3rd WSEL reduction</td>
</tr>
<tr>
<td>8</td>
<td>Spring Creek</td>
<td>Spring Creek Reservoir 2 (SC-32)</td>
<td>1985</td>
<td>Assumed to have full depth of storage</td>
<td>$41,000,000</td>
<td>West of Westfield</td>
<td>4193 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>10%</td>
<td>19288</td>
<td>Capacity: 50,520 acre-feet</td>
</tr>
<tr>
<td>9</td>
<td>Cypress Creek</td>
<td>Cypress Creek Reservoir (No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$1,500,000</td>
<td>Located East of Conroe</td>
<td>850 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>99%</td>
<td>27</td>
<td>Capacity: 9,930 acre-feet</td>
</tr>
<tr>
<td>10</td>
<td>Caney Creek</td>
<td>Caney Creek Reservoir (CC-41)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$400,000</td>
<td>Located East of Conroe</td>
<td>850 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>99%</td>
<td>27</td>
<td>Capacity: 9,930 acre-feet</td>
</tr>
<tr>
<td>11</td>
<td>Caney Creek</td>
<td>Caney Creek Reservoir (CC-41)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$5,700,000</td>
<td>Located East of Conroe</td>
<td>850 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>99%</td>
<td>31</td>
<td>Capacity: 5,350 acre-feet</td>
</tr>
<tr>
<td>12</td>
<td>Peach Creek</td>
<td>Peach Creek Reservoir 1 (PC-41)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$3,500,000</td>
<td>Located in upstream part of Peach Creek</td>
<td>626 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>92%</td>
<td>49</td>
<td>Capacity: 5,350 acre-feet</td>
</tr>
<tr>
<td>13</td>
<td>Peach Creek</td>
<td>Peach Creek Reservoir 2 (PC-42)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$8,000,000</td>
<td>Located in upstream part of Peach Creek</td>
<td>1381 acres</td>
<td>No wetlands impact in Montgomery County</td>
<td>99%</td>
<td>12</td>
<td>Capacity: 2750 acre-feet</td>
</tr>
</tbody>
</table>
Sedimentation and Vegetation

- Sedimentation Data in Report
  - Sediment Measurement Reports (7)
  - Sediment Management Reports (5)
  - Digital Elevation Models (2)
  - Hydraulic Reports (2)
  - Introduction to Sedimentation
  - Peak Discharge Review
  - Sediment Material Size
  - Origin of Sedimentation
  - Sedimentation Rate
  - Historical Sediment Management Recommendations
## Schedule Update

- **Data Collection and Review** – 95% (Additional Survey)
- **Existing Conditions H&H** – 90% (Comments, Calibration)
- **Primary Mitigation Alternatives** – 10-15%
- **Community Outreach and Education** – 25%

### Current Progress

<table>
<thead>
<tr>
<th>Task</th>
<th>Name</th>
<th>Days Remaining</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1</td>
<td>Project Management, Coordination, and Document Control</td>
<td>126</td>
<td>9/21/2020</td>
</tr>
<tr>
<td>Task 2</td>
<td>Review and Assess Existing Data</td>
<td>0/17/2019</td>
<td></td>
</tr>
<tr>
<td>Task 3</td>
<td>Existing Conditions Hydrologic and Hydraulic Model Development</td>
<td>98</td>
<td>8/12/2019</td>
</tr>
<tr>
<td>Task 4</td>
<td>Analyze Historical Storm Events and Calibrate Models</td>
<td>21</td>
<td>10/14/2019</td>
</tr>
<tr>
<td>Task 5</td>
<td>Future Conditions Hydrologic and Hydraulic Models</td>
<td>56</td>
<td>12/9/2019</td>
</tr>
<tr>
<td>Task 6</td>
<td>Primary Flood Mitigation Planning</td>
<td>56</td>
<td>6/8/2020</td>
</tr>
<tr>
<td>Task 7</td>
<td>Secondary Flood Mitigation Planning</td>
<td>21</td>
<td>11/18/2019</td>
</tr>
<tr>
<td>Task 8</td>
<td>Other Flood Hazard Mitigation Actions</td>
<td>53</td>
<td>2/10/2020</td>
</tr>
<tr>
<td>Task 9</td>
<td>Community Outreach and Education</td>
<td>126</td>
<td>8/24/2020</td>
</tr>
<tr>
<td>Task 10</td>
<td>Final Deliverables</td>
<td>0/31/2020</td>
<td></td>
</tr>
</tbody>
</table>
Questions?
MEETING MINUTES

To: Jing Chen, P.E., CFM

Attendees: Jing Chen, HCFCD
Gary Bezemek, HCFCD
Rob Lazaro, HCFCD
Chuck Gillman, SJRA
Matt Barrett, SJRA
Heather Cook, SJRA
Diane Cooper, Montgomery County
Adam Eaton, COH
Terry Barr, Halff
Sam Hinojosa, Halff
Andrew Moore, Halff
Hector Olmos, FNI
Corey Stull, FNI
Connor Stokes, Hollaway
Greg Sevcik, Hollaway
Janice Hayes, Hollaway

From: Terry Barr, P.E., CFM

Subject: San Jacinto Regional Watershed Master Drainage Plan Progress Meeting

Meeting Date: 08/14/2019 – 1:30 pm

Location: HCFCD, Brookhollow Office

Minutes Date: 08/29/2019
09/22/2019 (Revised)

AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Introductions</strong></td>
<td>Ms. Chen started the meeting. Mr. Barr provided four (4) USB drives, one for each study partner, that included the Draft Existing Conditions H&amp;H Report.</td>
</tr>
<tr>
<td>2.</td>
<td><strong>Communications and Outreach</strong></td>
<td>Mr. Sevcik discussed the updates on the communications plan. He stated the plan is for the website to go live on 8/16/2019. Holloway is adjusting minor formatting comments. He said the website will not be fully completed by go-live date and will be updated with a full map, photo captions, and frequently asked questions throughout the project. He stated the domain name is sanjacstudy.org. Ms. Cooper asked how the contact form would work and how questions would be spread to all study partners. Mr. Sevcik stated the questions would be routed to HCFCD through Sales Force and HCFCD will spread comments to stakeholders. Ms. Chen stated in previous projects Holloway has compiled all questions and included in a report. Ms. Cooper asked for a way to track questions and responses. She also requested any comments from Montgomery County residents be routed through Montgomery County. Ms. Chen summarized the supporting partner meetings with Grimes, Walker, Waller, and City of Conroe explaining the study purpose, goals, and progress and requesting any input. Ms. Cooper, Mr. Gillman, and Ms. Cook requested SJRA and Montgomery County be included in any future stakeholder meetings. Ms. Chen stated a second round would be conducted in 2020 and that HCFCD would include all stakeholders in contact with any other partners. She also stated that the study partners</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Holloway to launch website.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>HCFCD and Hollaway to coordinate responses with agencies.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>HCFCD to include partners in future meetings.</strong></td>
</tr>
</tbody>
</table>
would be included on the remaining partner meetings this round. Mr. Sevcik stated that public meetings were beginning to be scheduled. All scheduled public meetings will be held in Harris County with an East/West distribution across the watershed. Mr. Barr stated the scope calls for two sets of meetings, with three meetings each. He mentioned 1 at the end of calibration/selection of alternatives and 1 at the end of the study. Mr. Sevcik requested 45-60 days of preparation for each meeting. He mentioned discussing at the next progress meeting on September 11.

<table>
<thead>
<tr>
<th>3. <strong>Activities Conducted This Month</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Barr stated that HCFC had been provided the existing conditions flood hazard assessment report. He stated the results are preliminary and would still need to be calibrated in the next effort. Mr. Moore presented the results of the existing conditions analysis comparing flows through some of the basins. The presentation included a recap of each of the tasks, including data collection (reports, models, survey, etc.), hydrologic modeling, and hydraulic modeling. Several of the report exhibits were included in the presentation to give the study partners an idea of what to expect.</td>
</tr>
<tr>
<td>Ms. Chen asked when the study team would know if the BDF methodology will work in the steeper terrains. Mr. Moore and Mr. Barr stated that it will be determined during and after calibration.</td>
</tr>
<tr>
<td>Ms. Chen asked which models were being used for the HCFC streams and if the new MAAPnext models would be used. Mr. Barr stated that the current effective models are being used as the basis but will be re-calibrated for the selected storm events. Ms. Cooper stated that the Woodlands residents may not trust the results of the existing effective models. Mr. Barr stated the MAAPnext models will not be complete until January/February.</td>
</tr>
<tr>
<td>Mr. Barr requested any comments from the existing report/models be complete by September 6.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. <strong>Activities Planned Next Month</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Barr stated calibration is going to occur over the next month as well as starting to combine all the models. He also mentioned that Halff would begin considering the meetings for the secondary alternatives discussion.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. <strong>Technical Discussion</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Barr requested the GARR data from HCFC for the 2016 and 2017 storm events. Ms. Chen stated she would request from the flood forecast group. Mr. Barr stated they needed to review the extents to ensure the entire SJR basin is covered. He stated the 1994 data had been requested through Vieux and is expecting it in September. Mr. Halff to review smaller storm event calibration.</td>
</tr>
</tbody>
</table>
Bezemek stated they may want to look into a smaller event for low flow calibration.

6. **Administrative Discussion**

Ms. Chen discussed the first amendment to the contract which includes budget for the public meetings in Harris County not included in the original scope as well as budget for general technical support to respond to questions. Ms. Cooper and Mr. Gillman stated that their respective boards may not be able to provide additional funds this early in the study. Mr. Gillman stated that SJRA can likely handle outside public meetings without additional budget.

Ms. Cooper stated the team needs to have a plan to respond to comments not related to the river study but that some of the questions may not require a response. Mr. Sevcik stated that an address or county box could be added to the comment form to determine where the resident lived to direct to the correct entity.

Ms. Chen stated the siting study is currently not listed in the amendment but may be included in the future as contingency.

7. **General Discussion**

There was no general discussion as part of the meeting

8. Ms. Chen concluded the meeting.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
<table>
<thead>
<tr>
<th>Agenda Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Introductions</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **2. Communications and Outreach (Hollaway)** | - Project website has gone live (sanjacstudy.org)  
- Study and Supporting Partner meetings ongoing (8 completed; 2 scheduled)  
- Upcoming public meetings (Nov/Dec) |
| **3. Activities Conducted this Month** | - Monthly Study Partners Progress Meeting (08/14/19)  
- Started additional survey bridges and culverts  
- Complete QA/QC of Existing Conditions H&H Models and Report  
- Submitted Draft Existing H&H Report (08/12/19)  
- Conducted Primary Alternatives Workshop (08/14/19)  
- Continue work on Sedimentation and Vegetation Plan  
- Started Existing Conditions Model Calibration |
| **4. Activities Anticipated Next Month** | - Complete Study and Supporting Partners Meetings  
- Complete additional survey of channels and bridges/culverts  
- Review Draft Existing H&H Report Comments and provide response (09/25/19)  
- Continue Calibration effort; Start documentation  
- Continue Primary Flood Mitigation Alternatives Development  
- Begin Secondary Flood Mitigation Alternatives Development  
- Start coordination for Secondary Mitigation Actions (Flood Warning)  
- Continue work on Sedimentation and Vegetation Plan |
| **5. Technical Discussion** | - Model Calibration discussion  
- Updated Alternatives Development Process (See Memo) |
<p>| <strong>6. Administrative Discussion</strong> | - Amendment for Spring Creek Siting Study on Commissioners Court (09/10/19) |
| <strong>7. Questions</strong> | |</p>
<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Study Partners Meetings (3)
  – Supporting Partners Meeting(5)
  – Additional meetings scheduled

• Communications
  – Website has gone live (sanjacstudy.org)
  – Public meeting planning starting
  – Nov/Dec 2019
Existing H&H Draft Report

- Submitted to Study Partners on 08/12/19
- Received report comments from SJRA and City of Houston
- Received hydrology comments from HCFCD
Historical Storm Evaluation

• Calibrating to Three (3) Historical Events
  – Hurricane Harvey (2017) – In progress
  – Memorial Day (2016) – In progress
  – October 1994 – After models are combined
Historical Storm Evaluation

- Calibration Adjustments
- Stage
  - Manning’s N-value
- Volume
  - Initial Loss (in)
  - Constant Loss (in/hr)
- Peak Flow
  - BDF Value
  - TC+R
- Hydrograph Shape
  - BDF
  - Manning’s N-value

<table>
<thead>
<tr>
<th>Variable</th>
<th>Calculated</th>
<th>Observed</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Flow (cfs)</td>
<td>21245.52</td>
<td>21100.00</td>
<td>145.52 (0.69%)</td>
</tr>
<tr>
<td>Volume (ac-ft)</td>
<td>73498.16</td>
<td>73280.04</td>
<td>218.12 (0.30%)</td>
</tr>
<tr>
<td>Time to Peak (hrs)</td>
<td>28 Aug 2017, 0800</td>
<td>28 Aug 2017, 0730</td>
<td>0.5 hours</td>
</tr>
</tbody>
</table>
Historical Storm Evaluation

- Lake Creek (Harvey 2017)
Historical Storm Evaluation

- Lake Creek (Harvey 2017)
Historical Storm Evaluation

- Caney Creek (Harvey 2017)
Historical Storm Evaluation

• Caney Creek (Harvey 2017)
Historical Storm Evaluation

- Peach Creek (Harvey 2017)
Historical Storm Evaluation

- Peach Creek (Harvey 2017)
Historical Storm Evaluation

- Spring Creek (Harvey 2017)
Historical Storm Evaluation

- Spring Creek (Harvey 2017)
Historical Storm Evaluation

- Willow Creek (Harvey 2017)
Historical Storm Evaluation

- Willow Creek (Harvey 2017)
Historical Storm Evaluation

- Jackson Bayou – Gum Gully (Harvey 2017)
Historical Storm Evaluation

- Luce/Tarkington (Harvey 2017)
Historical Storm Evaluation

- Luce/Tarkington (Harvey 2017)
Historical Storm Evaluation

- East Fork SJR (Harvey 2017)
Historical Storm Evaluation

- East Fork SJR (Harvey 2017)
Historical Storm Evaluation

- Work in progress
  - Cypress/Little Cypress Creeks
  - East Fork San Jacinto River
  - Combine models
  - West Fork San Jacinto River (after HEC-RAS models are combined)
  - October 1994 Storm (after HEC-RAS models are combined)
Supporting Partner Meetings

• San Jacinto River Authority
  – Concerned with flooding and impacts to communities (Grogan’s Point, MUD 386, Timber Lakes, Kingwood, Lake Houston, etc.)
  – Sedimentation that causes additional flooding or reduces reservoir capacity

• Montgomery County
  – Property Acquisition has been a focus of mitigation efforts
  – Interested in Lake Creek recommendations due to loss of life
  – Flood warning mapping and early detection
  – Additional gages to augment the network
  – Interested in Improved floodplain maps

• City of Houston
  – Including gates on Lake Houston
  – Reduction of flooding in Kingwood
  – Improvements to water quality and concern about impacts on treatment
Primary Flood Mitigation Planning

- Revised Primary Mitigation Planning Procedure
  - Combine HEC-RAS models
  - Simulate models for multiple storm events
  - Run Structural Inventory Tool
  - Identify Damage Centers
  - Select a target frequency
  - Determine high level improvements needed to achieve level of service

- Minor modifications to the alternatives schedule needed

- Final Report submittal dates will remain unchanged
Sedimentation and Vegetation

- Significant Sedimentation Data in Report
  - Measurement Reports
  - Introduction to Sedimentation
  - Sedimentation Rates
  - Historical Sediment Management Recommendations
  - Other data

- Continuing to work on the plan for Sedimentation and Vegetation
Secondary Flood Mitigation Planning

- Setting up meetings with partners to discuss gage network
  - HCFCD
  - SJRA
  - MOCO
  - COH
  - TXDOT
- Recommendations for additional ALERT 2 Rain and Stage gages
- Identify what type of gages are appropriate for the location within the drainage basin
Schedule Update

- Existing Conditions H&H – 95% (Comments, Calibration)
- Model Calibration – 40-50%
- Primary Mitigation Alternatives – 15-20%
- Minor modifications for calibration and flood mitigation planning
Questions?
**MEETING MINUTES**

**To:** Jing Chen, P.E., CFM  
**Attendees:** Jing Chen, HCFCD  
**From:** Terry Barr, P.E., CFM  
**Subject:** San Jacinto Regional Watershed Master Drainage Plan Progress Meeting  
**Meeting Date:** 09/11/2019 – 1:30 pm  
**Location:** HCFCD, Brookhollow Office  
**Minutes Date:** 09/13/2019  
**AVO No.:** 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Introductions</strong>&lt;br&gt;Ms. Chen started the meeting.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><strong>Communications and Outreach</strong>&lt;br&gt;Mr. Barr mentioned that coordination meetings have been held with SJRA, Montgomery County, and the City of Houston. The meeting with HCFCD is schedule for 9/12 and a follow up meeting with Montgomery County is scheduled for 9/13.&lt;br&gt;Mr. Barrett asked if a meeting had been set with Liberty County. Ms. Chen responded that they had not heard from the county and requested that if they had any contacts to reach out to the individuals.&lt;br&gt;Mr. Barr mentioned that logistics have started for Public meetings and that the meetings with be in Harris County only. Holloway stated that they were awaiting a PO from the HCFCD and are expecting it in the next few weeks.&lt;br&gt;Ms. Cook stated that SJRA had attended several community meetings and handed out fliers regarding the study. The SJRA has also launched the “Know Your Watershed” website. She mentioned posting a link to the SJRA site from the study website.</td>
<td>SJRA and HCFCD to follow up with Liberty County. Hollaway to continue public meeting preparation. Hollaway to include link to SJRA site.</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Activities Conducted This Month</strong>&lt;br&gt;Mr. Barr stated that the draft report had been submitted and that SJRA and the City of Houston had submitted comments. Ms. Cooper stated that she had not had a chance to review. Ms. Chen stated that HCFCD was still compiling comments and should be able to present within the next week. Mr. Barr stated that a revised report would not be submitted, but comments would be included with the ongoing report submittals.</td>
<td></td>
</tr>
</tbody>
</table>
He stated that each submittal builds upon the previous ones.
Mr. Hinojosa mentioned that Halff had met with the MAAPNext reviewer who provided comments on the hydrologic methodology. He said the comments were minor.

<table>
<thead>
<tr>
<th>4.</th>
<th>Activities Planned Next Month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ms. Chen mentioned that the team would be reviewing the MAAPNext team comments and submitting responses within approximately 2 weeks.</td>
</tr>
</tbody>
</table>

**Secondary Flood Mitigation Planning**

Mr. Barr stated that meetings needed to be set up to discuss the gage needs for each entity. Mr. Bezemek suggested what gages would be helpful and how gages can be used for future calibration events.

Mr. Barr said the report will include the discussion of the gage needs, exhibits, and recommendations. Ms. Chen mentioned starting with the HCFCD FWS to determine the locations and then request input from the stakeholders.

<table>
<thead>
<tr>
<th>5.</th>
<th>Technical Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Calibration</strong></td>
</tr>
<tr>
<td></td>
<td>Mr. Barr mentioned that calibration was in progress for the 2017 and 2016 events. He stated that the 1994 event will be a validation of the combined models.</td>
</tr>
</tbody>
</table>

Mr. Moore presented the calibration process and results. Mr. Bezemek requested Halff prepare a confidence analysis in the USGS gages for the events. He mentioned obtaining the rating curves and showing the highest actual measurement to understanding when the flows are extrapolated. He stated that this process was followed on Cypress Creek and led to an adjusted rating curve.

Ms. Cooper requested a cross reference with the USGS and NWS gages to show the need for more gages and updates to the rating curves. She also questioned how antecedent moisture conditions affected calibration. Mr. Moore stated that the initial loss factor allowed an adjustment for the antecedent conditions. Mr. Bezemek mentioned that initial loss generally doesn’t make a difference in the overall results. Moore confirmed and stated that it affects any early peaks.

Mr. Moore stated that the calibration still needed refinement and that the models need to be combined.

**Study Partners Meeting**

Mr. Barr presented the different goals from the study from each partner. Ms. Green asked if the City of Houston had any recommendations on how the gates were going to be implemented. Mr. Barr stated that the

Halff to provide hydrology responses.

HCFCD and Halff to setup gage meetings.

Halff to investigate USGS rating curves.
question was asked and that the City was going to look into the study.

**Primary Flood Mitigation Planning**

Mr. Barr presented the alternative primary mitigation planning process. He stated that a memo had been drafted summarizing the new process.

Ms. Cooper asked what the differences between the Atlas 14 rainfall and the FEMA effective models. She stated that the report and plan needs to clarify that the AEP storm is based on Atlas 14 rainfall. Mr. Bezemek mentioned showing changes in the floodplains based on the rainfall changes near the flooded areas. Mr. Barrett recommended referencing elevations and flows rather than storm frequency.

Mr. Hinojosa mentioned that the average BLE increase in flow due to the new rainfall was 30% and the base flood elevations increased by one foot. He said that the floodplains did not drastically change throughout the county due to the relief.

Mr. Barr stated that the initial pass of the alternative development would help understand the magnitude of the volumes and conveyance systems required. Mr. Stull stated that flooding reduction targets become a rating curve of flows, volumes, and structures reduced.

Mr. Barr stated that the process will help identify the solutions that can make a difference early on. The development would guide the direction of alternatives without detailed modeling. He said the benefits will focus on number of structures rather than structure values and focus on the damage centers.

Ms. Cooper asked how the siting study will play into this study. Mr. Hinojosa stated the siting study will focus on land available for a reservoir. He stated there will be some overlap and discussion between the two studies. Mr. Bezemek stated that a Spring Creek reservoir may or may not benefit much downstream of Spring Creek. Mr. Stull stated the siting study will supplement the overall study to help focus on where detention ponds could be placed throughout the project.

Ms. Chen asked how the future conditions will affect the alternatives. Mr. Barr stated that the future conditions will assume the projects are not in place. He stated that the alternatives are developed with future conditions in mind, but focus on current damage areas. Ms. Green said that the analysis will help understand how current policy with future development volumes impact Lake Conroe and Lake Houston.

Mr. Barr stated that there is a proposed adjustment to Primary Alternatives schedule to accommodate change in procedure.

<table>
<thead>
<tr>
<th>6. Administrative Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional Spring Creek Siting Study authorization passed</td>
</tr>
<tr>
<td>Halff to provide alternative memo.</td>
</tr>
<tr>
<td>Team to consider how to present changes in rainfall.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>7.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>8.</td>
</tr>
</tbody>
</table>

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the Mr. Barretter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
# STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

October 10, 2019  
San Jacinto River Watershed Master Drainage Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>2:00 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:30 PM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions**

2. **Communications and Outreach (Hollaway)**
   - Project website live (sanjaestudy.org)
   - Study and Supporting Partner meetings ongoing (10 completed; 1 scheduled)
   - Scheduling upcoming public meetings for early December
   - SJRA to present at Kingwood meeting and provide update on SJRWMDP

3. **Activities Conducted this Month**
   - Monthly Study Partners Progress Meeting (09/11/19)
   - Responding to existing conditions hydrology comments (MAAPnext team)
   - Provided revised Primary Mitigation Planning Strategy (09/12/19)
   - Continue working on Existing Conditions Model Calibration
   - Started combining Existing Conditions models
   - Meeting with USGS to discuss flow gages on East Fork, Peach, Caney
   - Continue work on Sedimentation and Vegetation Plan

4. **Activities Anticipated Next Month**
   - Complete additional Supporting Partners Meetings
   - Complete the existing conditions model calibration effort
   - Continue Primary/Secondary Flood Mitigation Alternatives Development
   - Start coordination for Secondary Mitigation Actions (Flood Warning)
   - Continue work on Sedimentation and Vegetation Plan
   - Supporting partner meeting with Grimes County

5. **Technical Discussion**
   - Model Calibration discussion
   - Revised Alternatives Development Process

6. **Administrative Discussion**
   - Amendment for Spring Creek Siting Study Approved/Authorized (09/24/19)
   - Working with Hollaway on contract for public meeting(s)

7. **Questions**
<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Study Partners Meetings (5)
    • 2nd Montgomery Co. Meeting
  – Supporting Partners Meeting (5)
  – Additional meetings scheduled
    • 2nd Grimes Co. Meeting

• Communications
  – Website has gone live (sanjacstudy.org)
  – Public meeting planning started 09/24
  – Early Dec 2019
  – SJRA to present to Kingwood
Historical Storm Evaluation

- Coordination meeting with USGS
  - Direct vs. Indirect Measurements
  - Several streams were measured indirectly during 2017
  - Level of accuracy
    - “Good” +/- 5%
    - “Fair” +/- 8%
    - “Poor” +/- 15%
  - Rating curves are based on all measurements
  - Encouraging use of velocity meters for future gages
Historical Storm Evaluation

- USGS Gage Rating Curve Charts
## Historical Storm Evaluation

- USGS Gage Flow Confidence

<table>
<thead>
<tr>
<th>Date</th>
<th>Period of Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-Jun-01</td>
<td>Flow (cfs)</td>
</tr>
<tr>
<td>17-Oct-94</td>
<td>Stage (ft)</td>
</tr>
<tr>
<td>14-Jul-73</td>
<td>36,500</td>
</tr>
<tr>
<td>28-Aug-17</td>
<td>144.89</td>
</tr>
<tr>
<td>1-Apr-45</td>
<td>36,000</td>
</tr>
<tr>
<td>19-Sep-98</td>
<td>144.84</td>
</tr>
<tr>
<td>28-May-16</td>
<td>35,000</td>
</tr>
<tr>
<td>10-Jun-01</td>
<td>144.74</td>
</tr>
<tr>
<td>19-Sep-19</td>
<td>21,100</td>
</tr>
<tr>
<td>5-Nov-46</td>
<td>145.07</td>
</tr>
<tr>
<td>19-Sep-19</td>
<td>10,700</td>
</tr>
</tbody>
</table>

### Highest Flows Measured

<table>
<thead>
<tr>
<th>Date</th>
<th>Highest Flows Measured</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-May-16</td>
<td>9,420</td>
<td>direct</td>
</tr>
<tr>
<td>19-Sep-19</td>
<td>9,220</td>
<td>direct</td>
</tr>
<tr>
<td>5-Nov-46</td>
<td>5560</td>
<td>other</td>
</tr>
<tr>
<td>11-Mar-16</td>
<td>4890</td>
<td>direct</td>
</tr>
<tr>
<td>19-Oct-94</td>
<td>4610</td>
<td>unspecified</td>
</tr>
<tr>
<td>10-Jun-01</td>
<td>4440</td>
<td>unspecified</td>
</tr>
<tr>
<td>19-Sep-19</td>
<td>9220</td>
<td>direct</td>
</tr>
</tbody>
</table>
## Historical Storm Evaluation

- **USGS Gage Flow Confidence**

<table>
<thead>
<tr>
<th>Stream</th>
<th>Gage</th>
<th>Max. Measured</th>
<th>2017 Flow</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Fork</td>
<td>34,000 cfs</td>
<td>108,000 cfs</td>
<td>Mid</td>
<td></td>
</tr>
<tr>
<td>East Fork</td>
<td>22,700 cfs</td>
<td>120,000 cfs</td>
<td>Mid</td>
<td></td>
</tr>
<tr>
<td>Peach Creek*</td>
<td>77,000 cfs</td>
<td>34,000 cfs</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Caney Creek</td>
<td>9,400 cfs</td>
<td>21,000 cfs</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Lake Creek</td>
<td>51,800 cfs</td>
<td>55,000 cfs</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

*Gage was measured during Imelda at peak flow and rating curve is being revised*
Historical Storm Evaluation

- Model Combination
Historical Storm Evaluation

- Calibrating to Three (3) Historical Events
  - Hurricane Harvey (2017) – In progress
  - Memorial Day (2016) – In progress
  - October 1994 – After model is calibrated
Historical Storm Evaluation

- Calibration Adjustments
- Stage
  - Manning’s N-value
- Volume
  - Initial Loss (in)
  - Constant Loss (in/hr)
- Peak Flow
  - BDF Value
  - TC+R
- Hydrograph Shape
  - BDF
  - Manning’s N-value

<table>
<thead>
<tr>
<th>Variable</th>
<th>Calculated</th>
<th>Observed</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Flow (cfs)</td>
<td>21245.52</td>
<td>21100.00</td>
<td>145.52 (0.69%)</td>
</tr>
<tr>
<td>Volume (ac-ft)</td>
<td>73498.16</td>
<td>73280.04</td>
<td>218.12 (0.30%)</td>
</tr>
<tr>
<td>Time to Peak (hrs)</td>
<td>28 Aug 2017, 0800</td>
<td>28 Aug 2017, 0730</td>
<td>0.5 hours</td>
</tr>
</tbody>
</table>
Historical Storm Evaluation

- Lake Creek (Harvey 2017)
Historical Storm Evaluation

- Lake Creek (Harvey 2017)
Historical Storm Evaluation

- Caney Creek (Harvey 2017)
Historical Storm Evaluation

- Caney Creek (Harvey 2017)
Historical Storm Evaluation

- Peach Creek (Harvey 2017)
Historical Storm Evaluation

- Peach Creek (Harvey 2017)
### Historical Storm Evaluation

- **Spring Creek (Harvey 2017)**

#### Historic Storm Evaluation

**Legend**

- **Stage**: Represents the height of the water level.
- **Obs Stage**: Observed stage, which is the actual water level measured.

#### Graph

![Graph showing water level over time](image_url)

- **Plan**: Harvey
- **River**: J100-00-00
- **Reach**: J100-00-00_0030
- **RS**: 86681.8
Historical Storm Evaluation

- Spring Creek (Harvey 2017)
Historical Storm Evaluation

- Willow Creek (Harvey 2017)
Historical Storm Evaluation

- Jackson Bayou – Gum Gully (Harvey 2017)
Historical Storm Evaluation

- Luce/Tarkington (Harvey 2017)
Historical Storm Evaluation

- Luce/Tarkington (Harvey 2017)
Historical Storm Evaluation

- East Fork SJR (Harvey 2017)
Historical Storm Evaluation

- East Fork SJR (Harvey 2017)
Historical Storm Evaluation

- East Fork SJR (Harvey 2017)
Historical Storm Evaluation

- East Fork SJR (Harvey 2017)
Historical Storm Evaluation

- Cypress Creek (Harvey 2017)
Historical Storm Evaluation

- Cypress Creek (Harvey 2017)
Historical Storm Evaluation

- Cypress Creek (Harvey 2017)

<table>
<thead>
<tr>
<th>Time</th>
<th>Stage (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug2017</td>
<td>60</td>
</tr>
<tr>
<td>Sep2017</td>
<td>65</td>
</tr>
</tbody>
</table>

Plan: Harvey   River: K100-00-00   Reach: Reach - 1   RS: 50807
Historical Storm Evaluation

- Cypress Creek (Harvey 2017)
Historical Storm Evaluation

- West Fork SJR (Harvey 2017)
Historical Storm Evaluation

- West Fork SJR (Harvey 2017)
Historical Storm Evaluation

- West Fork SJR (Harvey 2017)
Historical Storm Evaluation

- West Fork SJR (Harvey 2017)
Historical Storm Evaluation

- Lake Houston (Harvey 2017)
Historical Storm Evaluation

- Lake Houston (Harvey 2017)
Historical Storm Evaluation

- Work in progress
  - October 1994 Storm after HEC-RAS models are calibrated
Study Partner Meetings

• San Jacinto River Authority
  – Concerned with flooding and impacts to communities (Grogan’s Point, MUD 386, Timber Lakes, Kingwood, Lake Houston, etc.)
  – Sedimentation that causes additional flooding or reduces reservoir capacity

• Montgomery County
  – Property Acquisition has been a focus of mitigation efforts
  – Interested in Lake Creek recommendations due to loss of life
  – Flood warning mapping and early detection
  – Additional gages to augment the network
  – Interested in Improved floodplain maps

• City of Houston
  – Including gates on Lake Houston
  – Reduction of flooding in Kingwood
  – Improvements to water quality and concern about impacts on treatment
Primary Flood Mitigation Planning

- Primary and Secondary Alternatives Development
  - Revised Alternatives Evaluation
    - Combine HEC-RAS models
    - Simulate models for multiple storm events
    - Run Structural Inventory Tool
    - Identify Damage Centers
    - Select a target frequency
    - Determine high level improvements needed to achieve level of service
  - Perform Qualitative Analysis
  - Establish Project Ranking Methodology

- Primary and Secondary Alternatives H&H Analysis
  - Includes detailed modeling of the selected alternatives
Primary Flood Mitigation Planning

- Primary and Secondary will run concurrently
- Minor modifications to the alternatives schedule needed
- Final Report submittal dates will remain unchanged

**Primary Flood Mitigation Alternatives**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combine HEC-RAS Models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run HEC-RAS Frequency Storms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run Structural Inventory Tool</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify Damage Centers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select a Target Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine Improvements Needed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualitative Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Ranking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Alternatives Workshop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Secondary Flood Mitigation Alternatives**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combine HEC-RAS Models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run HEC-RAS Frequency Storms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run Structural Inventory Tool</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify Damage Centers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select a Target Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine Improvements Needed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualitative Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Ranking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Alternatives Workshop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BCA and Project Constraints**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCFCD Review</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Alternatives Funding Opportunities**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Alternatives Funding Memo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Project Implementation**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Implementation Memo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vegetation and Sediment Control**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Vegetation and Sediment Control Memo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Finalize Flood Mitigation Planning**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Primary Flood Mitigation Memo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* All dates listed in the schedule are on a Monday

1 Indicates an Alternatives Workshop
2 Indicates a Major Subtask
3 Indicates a Minor Subtask
5 Indicates a Primary Alternatives Submittal
Review Indicates HCFCD Review Period
Indicates a specific task identified in the Alternatives Memo
Sedimentation and Vegetation

- Significant Sedimentation Data in Report
  - Measurement Reports
  - Introduction to Sedimentation
  - Sedimentation Rates
  - Historical Sediment Management Recommendations
  - Other data

- Continuing to work on the plan for Sedimentation and Vegetation
Secondary Flood Mitigation Planning

- Working on a dialogue with partners to discuss gage network
  - HCFCD (scheduled for 10/21/19)
  - SJRA
  - MOCO (received recommendations)
  - COH
    - USGS (met with staff on 9/27/19)
- Additional ALERT 2 Rain and Stage gage recommendations
- Potentially some new flow gages (USGS)
- Identify what type of gages are appropriate for the location within the drainage basin
- Develop plan for implementation
Schedule Update

- Existing Conditions H&H – 98% (Comments, Calibration)
- Model Calibration – 75-80%
- Primary Mitigation Planning (Revised Methodology) – 15-20%
- Secondary Mitigation Planning (Adjusted Schedule) – 10-20%
## STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

November 13, 2019  
San Jacinto River Watershed Master Drainage Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:00 PM</td>
</tr>
</tbody>
</table>

### Agenda

1. **Introductions**

2. **Communications and Outreach (Hollaway)**
   - Study and Supporting Partner meetings ongoing (11 completed)
   - Planning and scheduling upcoming community public meetings in December
   - SJRA to present at Kingwood meeting and provide update on SJRWMDP

3. **Activities Conducted this Month**
   - Monthly Study Partners Progress Meeting (10/10/19)
   - Responded to existing conditions hydrology comments (MAAPnext team)
   - Submitted Existing Conditions Calibration models and memorandum
   - Continue work on Primary Mitigation Actions (Alternatives)
   - Continue work on Secondary Mitigation Actions (FWS Gages)
   - Continue work on Sedimentation and Vegetation Plan

4. **Activities Anticipated Next Month**
   - Provide updated calibration models (minor adjustments)
   - Begin work on Future Conditions Hydrology
   - Continue Primary/Secondary Flood Mitigation Alternatives Development
   - Provide preliminary recommendations for Secondary Mitigation Actions
   - Start working on Other Mitigation Actions (Flood Response)
   - Continue work on Sedimentation and Vegetation Plan

5. **Technical Discussion**
   - Model Calibration discussion
   - Spring Creek Siting Study

6. **Administrative Discussion**
   - Provided a proposal to Hollaway for public meeting(s)
   - General assistance item requested

7. **Questions**
### San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Study Partners Meetings (5)
  – Supporting Partners Meeting(6)

• Communications
  – Website is live and being updated monthly (sanjacstudy.org)
  – Public meetings planned for Dec 2019
  – SJRA presented to Kingwood
Historical Storm Evaluation

- Submitted draft calibration report 11/4/19
  - Will be included as Appendix to the final report
  - Some minor changes due to Time Zone issue
- Analysis of Historical Storms
  - Rainfall Information
  - USGS Gages
- Calibration Process
- Calibration Results
- Existing Conditions Flood Hazard Assessment
- Existing Conditions 100-year Comparisons
- Ongoing update to calibration models
Historical Storm Evaluation

- Lake Houston Results – Harvey 2017

![Graph showing Lake Houston Stage at USGS Gage near Sheldon, TX with data points from 08/25/17 to 09/04/17, comparing Model Stage and Obs Stage.](image-url)
Historical Storm Evaluation

• Lake Houston Results – Memorial Day 2016
Historical Storm Evaluation

- Lake Houston Results – October 1994
Historical Storm Evaluation

- Historical Storm Inundation Exhibits – West Fork
Historical Storm Evaluation

- Historical Storm Inundation Exhibits – Peach Creek
Historical Storm Evaluation

- Frequency Storm Inundation Exhibits – Lake Creek
Historical Storm Evaluation

- Frequency Storm Inundation Exhibits – East Fork
Future Conditions

• Utilizes detailed population projection layer (Urban Core)
  – Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties
  – Developed as part of the Harris-Galveston Subsidence District’s Regional Groundwater Update Project
  – Near-term estimates based on field research
  – Long-term projections utilizing the Small Area Model-Houston
  – Decadal population projections for 2020-2070 at census block level
  – Used to develop water user population projections for the Region H Regional Water Plan
    – https://hgsubsidence.org/science-and-research/

• TWDB population projections (2021 Regional Water Planning)
  – Grimes, Liberty, San Jacinto, Waller, and Walker Counties
  – Less detailed information
Future Conditions

(2013 Regional Groundwater Update Project)
Primary Flood Mitigation Planning

• Primary and Secondary Alternatives Development
  – Revised Alternatives Evaluation
    • Combine HEC-RAS models
    • Simulate models for multiple storm events
    • Run Structural Inventory Tool
    • Identify Damage Centers
    • Select a target frequency
    • Determine high level improvements needed to achieve level of service
  – Perform Qualitative Analysis
  – Establish Project Ranking Methodology

• Primary and Secondary Alternatives H&H Analysis
  – Includes detailed modeling of the selected alternatives
Primary Flood Mitigation Planning

- Structural Inventory
Primary Flood Mitigation Planning

- Identifying Damage Centers and Target Frequency

Luce Bayou – Flooded Structures

- 500yr: 46%
- 100yr: 3%
- 50yr: 5%
- 25yr: 11%
- 10yr: 5%
- 5yr: 21%
- 2yr: 10%
Primary Flood Mitigation Planning

- Water Surface Elevation Profile
Secondary Flood Mitigation Planning

- Working on a dialogue with partners to discuss gage network
  - HCFCD (met with staff 10/21/19)
  - MOCO (received gage recommendations)
  - USGS (met with staff on 9/27/19)
  - SJRA (no additional gages requested)
  - COH (will request input)
- Additional ALERT 2 Rain and Stage gage recommendations
- Potentially some new flow gages (USGS)
- Identify what type of gages are appropriate for the location within the drainage basin
- Develop plan for implementation
Secondary Flood Mitigation Planning

Gage Recommendations Received
Secondary Flood Mitigation Planning
Schedule Update

- Existing Conditions H&H – 98% (Comments, Calibration)
- Model Calibration – 95% (Minor Updates)
- Primary Mitigation Planning (Revised Methodology) – 30%
- Secondary Mitigation Planning (Adjusted Schedule) – 70%
Questions?
## MEETING MINUTES

**To:** Jing Chen, P.E., CFM  
**Attendees:** Jing Chen, HCFCD  
Dena Green, HCFCD  
Dimitri Hamilton, HCFCD  
Beth Walters, HCFCD  
Matt Barrett, SJRA  
Jeff Johnson, Montgomery County  
Terry Barr, Halff  
Sam Hinojosa, Halff  
Andrew Moore, Halff  
Corey Stull, FNI  
Connor Stokes, Hollaway  

**From:** Terry Barr, P.E., CFM  

**Subject:** San Jacinto Regional Watershed Master Drainage Plan Progress Meeting  

**Meeting Date:** 11/13/2019 – 1:30 pm  
**Location:** HCFCD, Brookhollow Office  
**Minutes Date:** 11/19/2019  
**AVO No.:** 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | **Introductions**  
Ms. Chen started the meeting. |  |
| 2.   | **Communications and Outreach**  
- Conner stated the team is coordinating with the precincts to finalize times and dates. Tentative dates are Dec. 16th, 17th, and 19th. The three locations are Kingwood, Huffman, and Spring. Draft public notice has been sent out for review internally.  
- Meetings will be open houses with introduction video. The video draft script will be sent out for review in the next week for approval.  
- Hollaway is developing a “how to participate” handout to describe the meeting to the public and where questions can be answered.  
- Jing stated that HCFCD is expecting to have separate tables for the different partners and wanted to see if they are interested in staffing the table. She requested study partners bring information they would like presented to each meeting. | **Hollaway to provide public notices for review.**  
**Hollaway to provide draft script.** |
| 3.   | **Activities Conducted This Month**  
- Barr stated the draft calibration report was submitted at the beginning of the month and was submitted as a technical appendix. He stated that a summary would be included in the next submittal.  
- Dena stated the report and public meeting information should present that the change in floodplain is related to increase in precipitation not necessarily a difference in channel capacity. | **Study partners to provide comments on calibration report.** |
• Terry presented the source of the future conditions data. Cory stated that the latest data was compiled in 2013 and that the study will be using the Water Planning group information. He stated that Harris and Montgomery County have more detailed data than the surrounding counties. The urban core data is down to the census block. Jing asked if the information was matching the H-GAC data and requested a comparison or inclusion of the H-GAC data since it is more readily available. Dena asked if there is a different methodology for surrounding counties. Cory stated that the base data for all counties is the same. He stated that the urban core data used for Montgomery and Harris is presented in more detail due to the urbanized areas.

• Terry stated that the structural tool is being adjusted as needed to remove structures that are potentially on stilts but shown to be flooded during frequent storm events.

• Jing asked for the density of the flooded structures in each watershed. She stated that we need to make sure we are consistent with data reporting. Dena recommended a break down by damage center. Sam stated to make sure that we are clear that this flooding is along the main stem and internal drainage is a separate issue not included in the analysis.

• Terry presented the new gage recommendations. Matt stated that there may be new gages on the SJRA/Lake Conroe that are not shown on the map that was presented and said he would provide additional information. Beth asked if any gages were recommended in the Kingwood area. Sam answered that these are recommendations for the large/regional watersheds and are not focused on the tributaries. Dena mentioned that we need to make sure the context of this study is presented at reports and presentations. Dena stated that the memorandum should include who recommended the gages.

Halff to review SJRA gages.

4. Activities Planned Next Month

• Cory stated that the Spring Creek Siting Study is on pace with the SJR study. He stated that the damage centers are being determined for the creek.

5. Administrative Discussion

• Jing mentioned meeting with the surrounding counties to discuss the emergency protocol. Terry mentioned that this was in the scope and should be scheduled relatively soon, likely early next year. Jing stated that these will be set up in the upcoming months and would let the study partners know. Terry mentioned that we need to formulate the questions for the meeting prior to scheduling the meetings.

HCFCD to coordinate emergency protocol meetings.
Administrative Discussion (cont.)

- Cory stated he would reach out to the City Engineer of Liberty to see if there is any new contact for Liberty County. Matt also said that they potentially have a contact for the County and would provide.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FNI</strong> and <strong>SJRA</strong> to provide Liberty County contacts.</td>
<td></td>
</tr>
</tbody>
</table>

6. Ms. Chen concluded the meeting.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
# STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

January 8, 2020  
San Jacinto River Watershed Master Drainage Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:00 PM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions**

2. **Communications and Outreach (Hollaway)**
   - Community Meetings (Set 1) Completed in December
   - Woodlands Drainage Task Force Meeting (01/28/20)

3. **Activities Conducted this Month**
   - Alternatives Workshop No. 2 (12/11/19)
   - Continue updates to calibrated models
   - Continue work on Primary Mitigation Actions (Alternatives) High Level Analysis
   - Continue work on Secondary Mitigation Actions (FWS Gages)
   - Continue work on Sedimentation and Vegetation Plan
   - Worked on Future Conditions hydrology
   - Sensitivity analysis for FFE and higher frequency flooding (2-, 5-year) removal

4. **Activities Anticipated Next Month**
   - Meet with MAAPnext (HDR) to discuss calibration comments (01/10/20)
   - Complete model calibration
   - Continue Primary/Secondary Flood Mitigation Alternatives analysis, including sensitivity
   - Start working on Other Mitigation Actions (Flood Response)
   - Submit Future Conditions Hydrology Memorandum
   - Submit Secondary Mitigation Actions Memorandum
   - Submit Sedimentation and Vegetation Memorandum

5. **Technical Discussion**
   - Preliminary recommendations for detailed alternatives analysis
   - Release of models to other agencies or engineering firms
   - Assumptions for Commercial and Industrial land uses for future conditions

6. **Administrative Discussion**
   - Public meeting(s) proposal authorized (Hollaway) – Lump Sum billing?
   - Procurement of Liberty and San Jacinto County CAD and property value data

7. **Questions**
SAN JACINTO
Regional Watershed Master Drainage Plan

Study Partners Progress Meeting
January 8, 2020
San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Study Partners Meetings (6)
  – Supporting Partners Meeting(7)

• Communications
  – 1st round of public meetings complete
  – Woodlands Drainage Task Force Meeting – January 28th
Historical Storm Evaluation

- Responding to comments from HCFCD MAAPnext Review Team (HDR)
- Meeting with HDR to discuss calibration – January 10th
- Addressing report comments
- Submit revised models
Future Conditions

- Utilizes detailed population projection layer (Urban Core)
  - Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties
  - Developed as part of the Harris-Galveston Subsidence District’s Regional Groundwater Update Project
  - Near-term estimates based on field research
  - Long-term projections utilizing the Small Area Model-Houston
  - Decadal population projections for 2020-2070 at census block level
  - Used to develop water user population projections for the Region H Regional Water Plan
    - [https://hgsubsidence.org/science-and-research/](https://hgsubsidence.org/science-and-research/)

- TWDB population projections (2021 Regional Water Planning)
  - Grimes, Liberty, San Jacinto, Waller, and Walker Counties
  - Less detailed information
Future Conditions
Future Conditions
Future Conditions

<table>
<thead>
<tr>
<th>Land Use Categories</th>
<th>Land Use Descriptions</th>
<th>% Impervious</th>
<th>% Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undeveloped</td>
<td>Unimproved, natural, or agricultural</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Residential – Rural Lot</td>
<td>≥ 5 acre ranch or farm</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Residential – Large Lot (Newer)</td>
<td>&gt; ½ acre new residential neighborhoods, storm sewers or roadside ditches with adequate capacity</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Residential – Large Lot (Older)</td>
<td>&gt; ¼ acre, older neighborhoods with limited capacity roadside ditches</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Residential – Small Lot</td>
<td>≤ ¼ acre</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Schools</td>
<td>Schools with non-paved areas</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Developed Green Areas</td>
<td>Parks or golf courses</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Light Industrial/Commercial</td>
<td>Office parks, nurseries, airports, warehouses, or manufacturing with non-paved areas</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td>High Density</td>
<td>Commercial, business, industrial, or apartments</td>
<td>85</td>
<td>100</td>
</tr>
<tr>
<td>Isolated Transportation*</td>
<td>Highway or major thoroughfare corridors</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Water</td>
<td>Detention basins, lakes, and channels</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Primary Flood Mitigation Planning

Workshop Summary

• Damage Centers
  – Sensitivity analysis of estimated finished floor elevations
  – Comparison of damage centers to actual damages
  – Removal of 2-year and 5-year frequency damages
  – Incorporate roadway level of service
  – Determine reductions in floodplains

• Alternatives
  – Regional detention volumes presented
  – Consideration for local benefits
  – Channelization, tunnels, buyouts, floodplain preservation
  – Impacts of future development and detention regulations
Secondary Flood Mitigation Planning

• Combined all input from stakeholders
• HCFCD, Montgomery County, SJRA, USGS
• Finalizing memorandum for January submittal
Secondary Flood Mitigation Planning
Other Mitigation Alternatives

- Begin setting up emergency protocol meetings
  - Harris County Hydrologic Operations
  - Harris County Office of Emergency Management
  - Montgomery County Office of Emergency Management
  - San Jacinto River Authority
  - City of Houston
  - TxDOT

- Communications Plan/Protocol Update
- Identification of Critical Infrastructure
- Identification of Evacuation Routes
Sedimentation

- Total Suspended Solid measurements by USGS and gage locations
- Predicted annual suspended sediment loads per watershed
Sedimentation

- Annual suspended sediment load compared to watershed area
Sedimentation

Sand Mining:

- Federal:

- State:
  - Under 30 Texas Administrative Code, Chapter 342, APOs are to register with TCEQ. This registration includes an annual renewal, annual fee, and inspection every three years. This act went into effect on September 1, 2012.
  - Mining and reclamation of aggregate pits are not regulated under state law.
  - If operations will affect groundwater, air, or produce hazardous waste the facility will have to obtain permitting including but not limited to, Industrial Multi-Sector General Permits for Stormwater (MSGP), Texas Pollutant Discharge Elimination System Permits (TPDES), and Industrial Hazardous Waste Permits.
  - Regulated from a safety aspect under the Texas Department of Transportation (TXDOT)

- Local:
  - No local or municipal regulations pertaining to GSMs were identified. There is speculation that the City of Houston will implement stricter regulation on GSMs within the next few years as a response to Hurricane Harvey
Schedule Update

- Existing Conditions H&H – 98% (Comments, Calibration)
- Model Calibration – 98% (Discussion with HDR/MAAPnext)
- Primary Mitigation Planning (Revised Methodology) – 50%
- Secondary Mitigation Planning (Adjusted Schedule) – 90%

**SAN JACINTO RIVER WMDP - PROJECT SCHEDULE**

- **Task 1: Project Management, Coordination, and Document Control**
  - Days Remaining: 268
  - Completion Date: 8/31/2020

- **Task 2: Review and Assess Existing Data**
  - Days Remaining: 243
  - Completion Date: 8/31/2020

- **Task 3: Existing Conditions Hydrologic and Hydraulic Model Development**
  - Days Remaining: 81
  - Completion Date: 8/12/2019

- **Task 4: Analyze Historical Storm Events and Calibrate Models**
  - Days Remaining: 30
  - Completion Date: 8/31/2020

- **Task 5: Future Conditions Hydrologic and Hydraulic Models**
  - Days Remaining: 58
  - Completion Date: 8/31/2020

- **Task 6: Primary Flood Mitigation Planning**
  - Days Remaining: 199
  - Completion Date: 6/8/2020

- **Task 7: Secondary Flood Mitigation Planning**
  - Days Remaining: 163
  - Completion Date: 1/20/2020

- **Task 8: Other Flood Hazard Mitigation Actions**
  - Days Remaining: 98
  - Completion Date: 4/13/2020

- **Task 9: Community Outreach and Education**
  - Days Remaining: 268
  - Completion Date: 8/31/2020

- **Task 10: Final Deliverables**
  - Days Remaining: 84
  - Completion Date: 8/31/2020

**Current Progress**

- **Days Remaining:** 478
- **Completion Date:** 8/12/2019
# MEETING MINUTES

**To:** Jing Chen, P.E., CFM  
**Attendees:** Jing Chen, HCFCD  
Rob Lazaro, HCFCD  
Gary Bezemek, HCFCD  
Matt Barrett, SJRA  
Darren Hess, Montgomery County  
Adam Eaten, City of Houston  
Terry Barr, Halff  
Sam Hinojosa, Halff  
Andrew Moore, Halff  
Connor Stokes, Hollaway  
Garrett Johnston, Freese & Nichols  
Hector Olmos, Freese & Nichols  

**From:** Terry Barr, P.E., CFM  
**Subject:** San Jacinto Regional Watershed Master Drainage Plan Progress Meeting  

**Meeting Date:** 1/8/2020 – 1:30 pm  
**Location:** Skype Conference Call  
**Minutes Date:** 1/10/2020  
**AVO No.:** 033465.002  

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | **Introductions**  
Ms. Chen started the meeting.  | |
| 2.   | **Communications and Outreach**  
- Conner stated that the team received 87 comments from public meetings and email correspondence. Hollaway is developing a master comment database and grouping comments into categories. He stated that they would begin responding to comments and would request for technical input from the study team. He is working to transcribe all comments and send out comments by 1/15/2020 and would like to have all comments responded by the end of January.  
- Gary asked how the comments would be grouped and distributed since several studies were included on the public meetings. Connor stated that Hollaway would try to filter out by study type.  
- Chen recommended creating a flow chart for the comment response process.  | |
| 3.   | **Activities Conducted This Month**  
- Sedimentation – The study team has reviewed previous reports to understand the. The team has developed new rating curves to determine the annual suspended sediment loads. Presented exhibit showing the contribution of TSS. Cypress Creek has the highest amount of annual sediment loads.  
- The study will look at the land cover changes over time considering changes from agriculture to developed land.  
- Jing asked if the study will include isolating sedimentation from land use and soil types. George replied that this would not be included but should be investigated in future studies.  | |
- George stated that the TSS does not account for dead load (wash load – fine clays, live load - TSS, dead load – tumblers around bottom of channel). Studies in the past have not looked at dead loads so future studies could look into this aspect.
- Study is looking at the GeoCores developed from the USACE to estimate where the sediment is coming from (dead load, TSS, or wash load).
- Only one or two consultants are needed for the Woodlands Drainage Task Force update. A presentation is not anticipated for the meeting.
- Gary recommended an executive briefing agenda and giving them highlights prior to the briefing.
- Calibration meeting with HDR on 1/10/2020 to discuss final comments on the SJR calibration.
- Terry asked how the study partners would be sharing models with other entities. Gary recommended HCFCD discuss with study partners before releasing models to others. Matt and Darren requested formal documentation of the requests to follow up with each entity. Gary stated HCFCD would submit a formal request.
- Garrett discussed the future conditions population estimates and how those are incorporated into the hydrologic parameters including the impervious percentage and BDF.
- Darren mentioned a large grant was awarded to Patton Village for mitigation improvements. He said he could provide drawings of the potential drainage plans.
- Hector stated that the impervious percentage presented in the current PCPM impervious values could be low and proposed revising some of the values. Jing requested submitting a new table for review.
-Matt stated that SJRA would send over a few formal comments on the Alternatives Workshop. He asked if HCFCD or Montgomery County had any damages reported for Tropical Storm Imelda. Jing stated she would contact Harris County and Darren said he could provide damages for Montgomery County.

### 4. Activities Planned Next Month

- Completing the secondary mitigation alternatives
- Completing the sedimentation analysis
- Completing the future conditions analysis

### 5. Administrative Discussion

- Terry stated he would develop a draft agenda for the emergency coordination meetings to begin setting up meetings.

### 6. Ms. Chen concluded the meeting.
This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
### STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

February 12, 2020  
San Jacinto River Watershed Master Drainage Plan  
HCFCD, Northwest Crossing

<table>
<thead>
<tr>
<th>Agenda Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td><strong>Introductions</strong></td>
</tr>
</tbody>
</table>
| **2.** | **Communications and Outreach (Hollaway)**  
  - Community Meetings (Set 1) Completed in December  
  - Public Meeting Comment Database |
| **3.** | **Activities Conducted this Month**  
  - Met with MAAPnext (HDR) to discuss calibration comments (01/10/20)  
  - Completed Calibration  
  - Nearing completion on the Future Conditions draft memo  
  - Nearing completion on the Sedimentation and Vegetation Plan draft  
  - Nearing completion on the Secondary Mitigation Alternatives (FWS Gages) draft memo  
  - Modeling Primary Mitigation Alternatives |
| **4.** | **Activities Anticipated Next Month**  
  - Nearing completion on the Future Conditions draft memo  
  - Nearing completion on the Sedimentation and Vegetation Plan draft  
  - Nearing completion on the Secondary Mitigation Alternatives (FWS Gages) draft memo  
  - Modeling Primary/Secondary Mitigation Alternatives  
  - Begin coordination with surrounding counties to discuss emergency management |
| **5.** | **Technical Discussion**  
  - Future Conditions results  
  - Secondary Mitigation Options results  
  - Primary Mitigation Alternatives |
| **6.** | **Administrative Discussion**  
  - HCFCD Executive Briefing (02/14/20) |
| **7.** | **Questions** |
## San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Study Partners Meetings (6)
  – Supporting Partners Meeting (7)

• Communications
  – 1st round of public meetings complete
  – Public Meeting Comment Database
Historical Storm Evaluation

- Met with HCFCD MAAPnext Team (HDR) – January 10th
- Submitted revised calibrated models
- Addressed the following issues
  - Lake Conroe inflow/outflow
  - Infiltration rates
Future Conditions

• Utilizes detailed population projection layer (Urban Core)
  – Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties
  – Developed as part of the Harris-Galveston Subsidence District’s Regional Groundwater Update Project
  – Near-term estimates based on field research
  – Long-term projections utilizing the Small Area Model-Houston
  – Decadal population projections for 2020-2070 at census block level
  – Used to develop water user population projections for the Region H Regional Water Plan

• TWDB population projections (2021 Regional Water Planning)
  – Grimes, Liberty, San Jacinto, Waller, and Walker Counties
  – Less detailed information
Future Conditions
Future Conditions
Future Conditions

Methodology Overview

- Aggregated population projections by subbasin
- Assessed currently developed areas to generate two generalized development patterns (suburban, rural)
- Applied development patterns by subbasin to produce future conditions land use data
- Used future conditions land use data to create future conditions hydrologic parameters
- Created hydrologic and hydraulic model runs based on future conditions parameters
Future Conditions
## Future Conditions

### Development Pattern Area

<table>
<thead>
<tr>
<th>Development Pattern Area</th>
<th>Development Pattern (Pct. of Developed Area)</th>
<th>2018 Population per Developed Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cypress and Spring</td>
<td>3%</td>
<td>54%</td>
</tr>
<tr>
<td>Lake Houston</td>
<td>5%</td>
<td>63%</td>
</tr>
<tr>
<td>Cleveland</td>
<td>13%</td>
<td>71%</td>
</tr>
<tr>
<td>Conroe</td>
<td>7%</td>
<td>70%</td>
</tr>
</tbody>
</table>

### Future Development Type

<table>
<thead>
<tr>
<th>Future Development Type</th>
<th>Development Pattern (Pct. of Developed Area)</th>
<th>Population per Future Developed Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban</td>
<td>5%</td>
<td>50%</td>
</tr>
<tr>
<td>Rural</td>
<td>5%</td>
<td>65%</td>
</tr>
</tbody>
</table>
## Future Conditions

<table>
<thead>
<tr>
<th>Subwatershed</th>
<th>2018 Population</th>
<th>2018 Developed Area (ac)</th>
<th>Change in Population 2018–2070</th>
<th>Area (ac) Req’d for Fut. Dev.</th>
<th>2070 Developed Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Creek</td>
<td>28,078</td>
<td>30,264</td>
<td>72,251</td>
<td>10,947</td>
<td>41,211</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>287,039</td>
<td>96,251</td>
<td>510,455</td>
<td>49,180</td>
<td>145,431</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>71,385</td>
<td>25,140</td>
<td>46,827</td>
<td>3,835</td>
<td>28,975</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>451,660</td>
<td>89,856</td>
<td>138,957</td>
<td>9,564</td>
<td>99,419</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>47,791</td>
<td>17,625</td>
<td>37,562</td>
<td>3,727</td>
<td>21,352</td>
</tr>
<tr>
<td>West Fork</td>
<td>420,196</td>
<td>133,906</td>
<td>593,614</td>
<td>69,166</td>
<td>203,072</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>8,817</td>
<td>5,669</td>
<td>5,792</td>
<td>673</td>
<td>6,341</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>12,228</td>
<td>10,476</td>
<td>4,852</td>
<td>735</td>
<td>11,211</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>80,492</td>
<td>36,361</td>
<td>182,619</td>
<td>25,285</td>
<td>61,647</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>29,005</td>
<td>18,011</td>
<td>73,295</td>
<td>11,098</td>
<td>29,109</td>
</tr>
<tr>
<td>East Fork</td>
<td>44,042</td>
<td>29,416</td>
<td>23,824</td>
<td>3,401</td>
<td>32,817</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4,377</td>
<td>1,981</td>
<td>1,844</td>
<td>183</td>
<td>2,165</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>11,830</td>
<td>3,519</td>
<td>9,152</td>
<td>911</td>
<td>4,430</td>
</tr>
</tbody>
</table>
## Future Conditions

### Development Patterns by Subwatershed (2018)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Creek</td>
<td>211,803</td>
<td>14%</td>
<td>3%</td>
<td>79%</td>
<td>8%</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>248,160</td>
<td>39%</td>
<td>3%</td>
<td>72%</td>
<td>13%</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>35,567</td>
<td>71%</td>
<td>6%</td>
<td>51%</td>
<td>15%</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>170,789</td>
<td>53%</td>
<td>3%</td>
<td>45%</td>
<td>28%</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>33,466</td>
<td>53%</td>
<td>5%</td>
<td>49%</td>
<td>16%</td>
</tr>
<tr>
<td>West Fork</td>
<td>504,123</td>
<td>27%</td>
<td>7%</td>
<td>66%</td>
<td>13%</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>53,728</td>
<td>11%</td>
<td>8%</td>
<td>74%</td>
<td>1%</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>83,611</td>
<td>13%</td>
<td>16%</td>
<td>72%</td>
<td>5%</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>139,442</td>
<td>26%</td>
<td>7%</td>
<td>82%</td>
<td>4%</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>101,496</td>
<td>18%</td>
<td>5%</td>
<td>89%</td>
<td>2%</td>
</tr>
<tr>
<td>East Fork</td>
<td>264,371</td>
<td>11%</td>
<td>10%</td>
<td>79%</td>
<td>4%</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4,747</td>
<td>42%</td>
<td>9%</td>
<td>63%</td>
<td>9%</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>11,846</td>
<td>30%</td>
<td>7%</td>
<td>68%</td>
<td>3%</td>
</tr>
</tbody>
</table>

### Development Patterns by Subwatershed (2070)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Creek</td>
<td>211,803</td>
<td>19%</td>
<td>3%</td>
<td>75%</td>
<td>9%</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>248,160</td>
<td>59%</td>
<td>4%</td>
<td>63%</td>
<td>19%</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>35,567</td>
<td>81%</td>
<td>5%</td>
<td>50%</td>
<td>18%</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>170,789</td>
<td>58%</td>
<td>3%</td>
<td>45%</td>
<td>25%</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>33,466</td>
<td>64%</td>
<td>5%</td>
<td>49%</td>
<td>18%</td>
</tr>
<tr>
<td>West Fork</td>
<td>504,123</td>
<td>40%</td>
<td>6%</td>
<td>62%</td>
<td>18%</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>53,728</td>
<td>12%</td>
<td>7%</td>
<td>72%</td>
<td>3%</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>83,611</td>
<td>13%</td>
<td>15%</td>
<td>71%</td>
<td>6%</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>139,442</td>
<td>44%</td>
<td>6%</td>
<td>73%</td>
<td>11%</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>101,496</td>
<td>29%</td>
<td>5%</td>
<td>80%</td>
<td>7%</td>
</tr>
<tr>
<td>East Fork</td>
<td>264,371</td>
<td>12%</td>
<td>9%</td>
<td>77%</td>
<td>5%</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4,747</td>
<td>46%</td>
<td>9%</td>
<td>62%</td>
<td>11%</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>11,846</td>
<td>37%</td>
<td>7%</td>
<td>64%</td>
<td>9%</td>
</tr>
</tbody>
</table>
Future Conditions

Impervious Cover Change
Future Conditions

BDF Change

Legend

- San Jacinto River Channels
- Non-BDF Subbasin

BDF Change

- 0.00 - 0.25
- 0.25 - 1.00
- 1.01 - 1.50
- 1.51 - 2.50
- 2.51 - 3.50
- 3.51 - 6.50
## Future Conditions

### Increase in 1% ACE Water Surface Elevations

#### Summary of Increases in Peak WSE (2018-2070)

<table>
<thead>
<tr>
<th>Stream</th>
<th>100-yr Increase</th>
<th>2-yr Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg (ft)</td>
<td>Max (ft)</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>West Fork</td>
<td>0.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Luca Bayou</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Casey Creek</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>East Fork</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stream</th>
<th>100-yr Increase</th>
<th>2-yr Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg (ft)</td>
<td>Max (ft)</td>
</tr>
<tr>
<td>San Jacinto River Channels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJRA Watersheds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- San Jacinto River Channels
- SJRA Watersheds

**Peak 100-year WSE Difference (ft):**
- <-0.25
- -0.25 to -0.125
- -0.125 to -0.05
- -0.05 to -0.05
- 0.05 to 0.125
- 0.125 to 0.25
- 0.25 to 0.375
- 0.375 to 0.5
- 0.5 to 0.75
- 0.75 to 1
- >1.0
Sedimentation Strategy for West Fork San Jacinto River And Spring Creek

- Sedimentation strategies developed using the following
  - Identified sediment sources
    - Potential erosion of landscape (Revised Universal Soil Loss Equation, RUSLE)
    - Erosion of river stream banks and valley walls (stream deflection and LiDAR comparison)
  - Identified sediment depositional areas (LiDAR elevation comparison)
  - Annual suspended sediment loads from each of San Jacinto watershed’s seven sub basins
  - Review of deposited sediment sizes of geotechnical cores from Lake Houston
  - Aggregate Production Operations (mapping APO boundaries)
- Over forty sediment strategies mapped on the West Fork and Spring Creek mainstems.
- Opportunities for public-private partnerships identified
- Extension of jurisdictional authority to implement sediment strategies recommended
Sediment Sources

• Evaluated potential erosion of landscape using comparison of 2018 Lidar to older LiDAR data: collected in 2008 (Montgomery County) or collected in 2001 (Harrison County)

• Two analyses were completed comparing recent LiDAR to older LiDAR
  – Stream deviation (the horizontal distance between the mainstem’s centerline measured in older LiDAR to the mainstem’s centerline measured in recent LiDAR).
  – Change in elevation (the vertical distance between older LiDAR and recent LiDAR)
    • Regions where the older LiDAR elevation is higher are potential areas of sediment loss (example: eroding stream banks)
    • Regions where the older LIDAR elevation is lower are potential areas of sediment deposit (example: sand bars)

### Stream Deviation Findings

- Most of the minimal deviation occurs in the mainstem’s headwaters
- Most of the severe deviations occur further downstream

<table>
<thead>
<tr>
<th>Deviation Severity (In Feet)</th>
<th>West Fork San Jacinto River</th>
<th>Spring Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal (&lt;30)</td>
<td>38.8%</td>
<td>49.6%</td>
</tr>
<tr>
<td>Moderate (30&lt;=60)</td>
<td>18.2%</td>
<td>19.6%</td>
</tr>
<tr>
<td>High (60&lt;=90)</td>
<td>13.2%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Severe (&gt;90)</td>
<td>29.8%</td>
<td>21.4%</td>
</tr>
</tbody>
</table>
Sediment Sources: Measured Sediment Transport

Updated annual suspended sediment loads for the seven major subwatersheds in the San Jacinto watershed.

<table>
<thead>
<tr>
<th>Subwatershed</th>
<th>Drainage Area (sq. mi)</th>
<th>Annual Suspended Sediment Load tons/year (tons/sq mi/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cypress Creek</td>
<td>324.1</td>
<td>51,600 (159.2)</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>437.6</td>
<td>23,400 (53.5)</td>
</tr>
<tr>
<td>West Fork San Jacinto River</td>
<td>587.7</td>
<td>36,500 (62.1)</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>406.9</td>
<td>14,000 (34.4)</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>216.7</td>
<td>6,390 (29.5)</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>156.2</td>
<td>15,300 (97.9)</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>212.8</td>
<td>12,900 (76.6)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,342.0</strong></td>
<td><strong>175,700 (75.0)</strong></td>
</tr>
</tbody>
</table>

**Finding**

1. Cypress Creek consistently has the largest annual suspended sediment load yet.
2. Annual suspended sediment load in acre-feet per year is 433-acre feet per year which is a reasonably good predictor of rate of loss of volume in Lake Houston
Overview of Sediment Management Strategies

Various techniques to stop sediments from depositing in area of concern

Protect river streambanks and valley walls
- Restore stream structure and function
- Aggregate mine operation protection

Improved Hydraulic Conveyances
- Increasing the steepness of the riverbed slope
- Increasing the channel’s hydraulic radius through a change in a channel’s ratio of width to depth
- Decreasing the roughness of the channel

Sediment Bypass Tunnel
- Tunnel that diverts sediment through a tunnel which begins upstream of the area of concern and ends downstream of the Lake Houston dam.

Improve Hydraulic Influence of Lake Houston Dam in area of concern
- Dam’s backwater effect reduces the West Fork’s ability to move sediment through the area of concern

<table>
<thead>
<tr>
<th>Cross Section Name</th>
<th>Energy Grade Line Slope (ft/ft)</th>
<th>Shear Power (lb/sq ft)</th>
<th>Stream Power (lb/ft sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>145228</td>
<td>0.000179</td>
<td>0.09</td>
<td>0.18</td>
</tr>
<tr>
<td>144602</td>
<td>0.000455</td>
<td>0.14</td>
<td>0.32</td>
</tr>
<tr>
<td>143196</td>
<td>0.000322</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>141781</td>
<td>0.000013</td>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>140359</td>
<td>0.000004</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>139211</td>
<td>0.000006</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Various techniques to stop sediments from depositing in area of concern

Sediment trapping

- Either construct an “in-line trap”, i.e. a facility that is within the average daily water flow lines or build an “off-line trap”, i.e. a facility that is parallel to but outside the average daily flow lines
  - Example of in-line trapping facility

- Example of off-line trapping facility
  - A portion of the river will be deflected into an abandoned aggregate mine pit. Bedload sediment will fall into the deep hole left by an aggregate pit that is no longer in use, and is trapped.
  - A portion of the river will be deflected into a side channel, whose hydraulics have been artificially manipulated to reduce the river’s power, leading to sediment deposition.
Specific Sedimentation Strategy 1 of 5

Protect Upland Soils

Numerous regions bordering both mainstems with high potential of landscape erosion

Map of a region bordering Spring Creek where potential soil loss is high, requiring protection of upland soils
Specific Sedimentation Strategy 2 of 5

Multiple locations to reduce sediment flowing to Lake Houston found in **Spring Creek**

<table>
<thead>
<tr>
<th>Potential to Reduce Sediments Flowing to Lake Houston</th>
<th>Strategy</th>
<th>Strategy Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Streambank/valley wall protection</td>
<td>19,23</td>
</tr>
<tr>
<td></td>
<td>Head cut protection</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Sediment trap</td>
<td>27,25,22</td>
</tr>
<tr>
<td></td>
<td>Stream Restoration</td>
<td>26</td>
</tr>
<tr>
<td>Moderate</td>
<td>Head cut protection</td>
<td>6,11</td>
</tr>
<tr>
<td></td>
<td>Sediment trap</td>
<td>13,16</td>
</tr>
<tr>
<td></td>
<td>Streambank/valley wall protection</td>
<td>10,18,28</td>
</tr>
<tr>
<td></td>
<td>Stream restoration</td>
<td>21,24</td>
</tr>
<tr>
<td>Lower</td>
<td>Upland soil protection</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Streambank protection</td>
<td>2,3,9,17</td>
</tr>
<tr>
<td></td>
<td>Stream restoration</td>
<td>4,14</td>
</tr>
<tr>
<td></td>
<td>Sediment trap</td>
<td>5,7,8</td>
</tr>
</tbody>
</table>
Specific Sedimentation Strategy 3 of 5

Multiple locations to reduce sediment flowing to Lake Houston found in **Spring Creek**

- This is one map from a series of map that depicts potential sediment sources, regions of sediment deposit and stream centerline deviation. Proposed specific sedimentation strategies are also presented.
Specific Sedimentation Strategy 4 of 5

Multiple locations to reduce sediment flowing to Lake Houston found in West Fork

- This is one map from a series of maps that depicts potential sediment sources, regions of sediment deposit and stream centerline deviation. Proposed specific sedimentation strategies are also presented.
Specific Sediment Source Protection: 5 of 5

This is an example of improving hydraulic conveyance to move sediment through the area of concern in the West Fork.
Sedimentation Strategy Recommendations

• Use stream gage data to predict the amount of suspended sediment from different regions within the West Fork and Spring Creek subwatersheds. There are multiple locations where suspended sediment is being measured in these subwatersheds.

• Install new stream gages to measure suspended sediment in Cypress Creek subwatershed to improve the understanding of where in the subwatershed most of its sediments originate.

• Complete a regional sedimentation mitigation plan and develop an annual sediment budget for the San Jacinto watershed, including individual subwatersheds and notable drainage areas within each subwatershed.

• Complete a GIS exercise to quantify potential sediment sources from eroding streambanks and valley walls to determine the percentage of sediments originating from eroding banks versus landscape erosion.
Primary Mitigation Planning

- Damage Centers
  - East Fork SJR, West Fork SJR
  - Peach, Caney, Spring Creeks
Primary Mitigation Planning

- Considering potential watershed mitigation strategies
  - Storage Reservoirs
    - East Fork SJR
    - Caney Creek
    - Peach Creek
    - Lake Creek
    - Spring Creek
  - Channelization
- Modeling various detention volumes and locations
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Considered variety of gage types (Rain, Flow, Stage)
- Flood warning and data for future calibration efforts
Other Mitigation Actions

- Evaluate communications plan/protocol during emergencies
- Identify critical infrastructure and compare to inundation
- Determine expected flood frequency evacuation routes
- Meeting with all Emergency Management Coordinators
  - Completed (Montgomery, Waller, Walker, Grimes, Conroe)
  - Scheduled (Liberty, San Jacinto, Harris, Houston)
  - Workshop (March 12th) to discuss preliminary findings
Schedule Update

- Existing Conditions H&H – 100% (Comments, Calibration)
- Model Calibration – 100% (Completed calibration update)
- Primary Mitigation Planning (Revised Methodology) – 50%
- Secondary Mitigation Planning (Adjusted Schedule) – 95%

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Days Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Project Management, Coordination, and Document Control</td>
<td>299</td>
</tr>
<tr>
<td>Task 2: Review and Assess Existing Data</td>
<td>212</td>
</tr>
<tr>
<td>Task 3: Existing Conditions Hydrologic and Hydraulic Model Development</td>
<td>6/17/2019</td>
</tr>
<tr>
<td>Task 4: Analyze Historical Storm Events and Calibrate Models</td>
<td>98</td>
</tr>
<tr>
<td>Task 5: Future Conditions Hydrologic and Hydraulic Models</td>
<td>105</td>
</tr>
<tr>
<td>Task 6: Primary Flood Mitigation Planning</td>
<td>85</td>
</tr>
<tr>
<td>Task 7: Secondary Flood Mitigation Planning</td>
<td>105</td>
</tr>
<tr>
<td>Task 8: Other Flood Hazard Mitigation Actions</td>
<td>194</td>
</tr>
<tr>
<td>Task 9: Community Outreach and Education</td>
<td>26</td>
</tr>
<tr>
<td>Task 10: Final Deliverables</td>
<td>205</td>
</tr>
</tbody>
</table>

Current Progress: 54

Days Remaining: 478

Completion Date: 8/12/2019
Questions?
DRAFT MEETING MINUTES

To: Jing Chen, P.E., CFM

From: Terry Barr, P.E., CFM

Subject: San Jacinto Regional Watershed Master Drainage Plan Progress Meeting

Meeting Date: 2/12/2020 – 1:30 pm

Location: Harris County Northwest Crossing

Minutes Date: 2/14/2020

AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introductions</td>
<td>Ms. Chen started the meeting.</td>
</tr>
<tr>
<td>2.</td>
<td>Communications and Outreach</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Developing public meeting summary report which will be provided to the team for technical responses. Report will be submitted by early next week for the full report. Total of 70 comments from meetings plus another 30 email comments.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Second round of meetings scheduled for April/May.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Individuals from the meeting stated that notice in local newspapers would be helpful for future meetings.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Olmos mentioned using NextDoor or other apps.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Mentioned posting on Facebook of local organizations. Chen mentioned keeping Beth Walters involved as she has HOA and other organization contacts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Green asked if we should move locations or change the approach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• HCFC and Hollaway have developed a comment database with standard responses to public meeting comments.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Activities Conducted This Month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Completed calibration models and submitted. Revised memorandum will be submitted.</td>
<td>Halff/FNI – Provide updated calibration memo</td>
</tr>
<tr>
<td></td>
<td>• Future conditions population changes were based on existing TWDB and HGAC population projections.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Green asked if we included the different drainage criteria from the various agencies. Olmos stated that they did include detention rates.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Green asked if we could add existing City Limits and communities on the expansion graphs.</td>
<td></td>
</tr>
</tbody>
</table>
• Green asked if we removed obvious areas where development cannot occur such as Lake Houston, Lake Conroe, Katy-Prairie area.
• Green asked to make sure the old methodology assumptions are matching the new BDF methodology and that the methods are picking up the differences and effectives of development. She mentioned that the parameters that effect TC+R values are not sensitive to small changes in development.
• Green mentioned that increases on Cypress are surprising due to HCFCD current regulations. Hinojosa and Stull mentioned that volume is likely the contributor. Green mentioned that previous studies showed 1-2 inches increase in water surface elevations.
• Chen asked if the team had looked at a no detention requirement for the watershed. Barr stated that the team was looking into a no detention solution. Barr said that development location can change the results.
• Green asked about the assumption of no floodplain fill. Is that a valid assumption and could that change results? She added that Upper Cypress has a higher detention rate in the upper basin.
• Hinojosa stated that the increases show that there is potential for a need of change of detention requirements.
• Chen asked that the memorandum for sedimentation include percentage breakdown of sedimentation contributors for each watershed.
• Chen mentioned that the public is expecting us to tie flooding to sedimentation; however, the scope of the project is not reviewing this claim. Green asked if the HCFCD had received a final report on the benefits of dredging. She asked if we could review the RAS models from the USACE. Recommendation should include further modeling to analyze the options and benefit to flood reduction.

4. Activities Planned Next Month

• Completion of future conditions memorandum and study.
• Meeting with various emergency management officers. Group meeting planned in March for all entities to coordinate together. Are there common steps that could be shared in each of the guidelines. Hinojosa stated that the agencies are beginning to coordinate during disasters. Smaller counties do not have written protocol which may be recommended in the report.

5. Ms. Chen concluded the meeting.
correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
## STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

March 11, 2020  
San Jacinto River Watershed Master Drainage Plan  
SJRA, G&A Division Office

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>2:00 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:30 PM</td>
</tr>
</tbody>
</table>

### Agenda

<table>
<thead>
<tr>
<th>1.</th>
<th>Introductions</th>
</tr>
</thead>
</table>
| 2. | Communications and Outreach (Hollaway)  
- Planning for Community Meetings (Set 2) Started – Tentatively scheduled for early July  
- Public Meeting Comment Database  |
| 3. | Activities Conducted this Month  
- Executive Briefing on 02/14/20  
- Completed Existing H&H Model Calibration  
- Discussed options for the Future Conditions draft memo  
- Continued Modeling Primary/Secondary Mitigation Alternatives  
- Submitted Sedimentation and Vegetation Plan draft  
- Submitted Secondary Mitigation Planning (FWS Gages) draft memo  
- Completed Other Mitigation Actions interviews with various County EMC  |
| 4. | Activities Anticipated Next Month  
- Complete Primary/Secondary Mitigation Alternatives modeling  
- Start work on cost estimates and benefits of alternatives  
- Provide revised Secondary Mitigation Planning (FWS Gages) memo  
- Conduct Other Mitigation Actions Workshop  
- Start Planning for second round of Community Meetings  |
| 5. | Technical Discussion  
- Future Conditions update  
- Primary Mitigation Alternatives update  |
| 6. | Administrative Discussion  
- N/A  |
| 7. | Questions |


<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Calibration discussion with J. Terry (HCFCD)
  – Coordination with MAAPnext
  – Woodlands JDTF

• Communications
  – Planning for Community Meetings (Set 2) Started
  – Public Meeting Comment Database
Historical Storm Evaluation

- Met with HCFCD MAAPnext Team (HDR) – January 10th
- Submitted revised calibrated models
- Addressed the following issues
  - Lake Conroe inflow/outflow
  - Infiltration rates
- Revised calibration memo this month
Future Conditions Updates

- 50-year Projection

<table>
<thead>
<tr>
<th>Stream</th>
<th>100-yr Increase Avg (ft)</th>
<th>Max (ft)</th>
<th>2-yr Increase Avg (ft)</th>
<th>Max (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Creek</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>0.1</td>
<td>1.6</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>0.1</td>
<td>0.4</td>
<td>0.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>West Fork</td>
<td>0.4</td>
<td>1.1</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Luca Bayou</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>East Fork</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-</td>
<td>0.1</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Summary of Increases in Peak WSE (2018-2070)

Legend
- San Jacinto River Channels
- SJRA Watersheds
- Peak 100-year WSE Difference (ft):
  - < 0.25
  - 0.25 - 0.125
  - 0.125 - 0.05
  - 0.05 - 0.05
  - 0.05 - 0.125
  - 0.125 - 0.25
  - 0.25 - 0.375
  - 0.375 - 0.5
  - 0.5 - 0.75
  - 0.75 - 1
  - > 1.0
Future Conditions Updates

- Ultimate Development Comparison (in progress)
Primary Mitigation Planning

Current Progress
- Identify Damage Centers
- Primary Alternative H&H
- Secondary Alternative H&H

Future Tasks
- BCA and Project Constraints
- Alternative Funding
- Project Implementation
Primary Mitigation Planning

• Damage Centers
  – East Fork SJR, West Fork SJR
  – Peach, Caney, Spring Creeks
Primary Mitigation Planning

• Primary Mitigation
  – East Fork (National Forest)
  – East Fork (Cleveland)
  – Spring Creek (Walnut Creek)
  – Lake Creek (U/S SH 105)

• Secondary Mitigation
  – Additional Reservoirs (Lake, Spring, Peach, Caney, East)
  – Channelization
  – Sand Mine Conversion
  – Detention Regulations
  – Sedimentation/Dredging
  – Others
Primary Mitigation Planning

Spring Creek
- Est. 25,000 acre-feet
- Walnut Creek Reservoir Alternative
  - 17,000 ac-ft
  - 1,500 acres
  - 43 ft dam
  - 3,000 flooding instances reduction (ex. 8,385)
Primary Mitigation Planning

Spring Creek
- Est. 25,000 acre-feet
- Birch Creek Reservoir Alternative
  - 11,000 ac-ft
  - 1,000 acres
  - 40 ft dam
  - 2,000 flooding instances reduction (ex. 8,385)
Primary Mitigation Planning

Spring Creek
- Est. 25,000 acre-feet
- Mill Creek Reservoir Alternative
  - 11,000 ac-ft
  - 900 acres
  - 50 ft dam
  - 1,400 flooding instances reduction (ex. 8,385)
## Alternatives Evaluation – Example Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Cumulative Number of Flooded Structures</th>
<th>Instances (50-yr Life)</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500-yr</td>
<td>100-yr</td>
<td>50-yr</td>
</tr>
<tr>
<td>East Fork – Existing</td>
<td>2,021</td>
<td>1,062</td>
<td>643</td>
</tr>
<tr>
<td>East Fork Dam Near FM 945</td>
<td>1,593</td>
<td>619</td>
<td>364</td>
</tr>
<tr>
<td>Winters Bayou Dam Near East Fork</td>
<td>1,491</td>
<td>594</td>
<td>350</td>
</tr>
<tr>
<td>Winters Bayou Dam Near Nebletts Creek</td>
<td>1,631</td>
<td>683</td>
<td>452</td>
</tr>
<tr>
<td>East Fork Channelization A</td>
<td>1,753</td>
<td>771</td>
<td>466</td>
</tr>
<tr>
<td>East Fork Channelization B</td>
<td>1,619</td>
<td>745</td>
<td>457</td>
</tr>
<tr>
<td>East Fork Channelization C</td>
<td>1,554</td>
<td>739</td>
<td>454</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>500-yr</td>
<td>100-yr</td>
<td>50-yr</td>
</tr>
<tr>
<td>Spring Creek – Existing</td>
<td>13,375</td>
<td>5,500</td>
<td>2,519</td>
</tr>
<tr>
<td>Walnut Creek Dam</td>
<td>11,856</td>
<td>3,985</td>
<td>1,606</td>
</tr>
<tr>
<td>Birch Creek Dam</td>
<td>12,421</td>
<td>4,502</td>
<td>1,847</td>
</tr>
<tr>
<td>Walnut and Birch Creek Dams</td>
<td>10,886</td>
<td>3,089</td>
<td>1,289</td>
</tr>
<tr>
<td>Mill Creek Dam</td>
<td>12,472</td>
<td>4,602</td>
<td>2,005</td>
</tr>
</tbody>
</table>
Alternatives Evaluation – Example Results

- “Instances of structural flooding” metric incorporates the probability of 10-year through 500-year frequency events occurring over 50 years

**Spring Creek** – Reduction in Instances of Structural Flooding (50-yr Project Life)
Primary Mitigation Planning

Lake Creek

- Prelim Est. 150,000 acre feet
- Tributary Reservoirs Alternative
  - 60,000 ac-ft (total)
  - 5,500 acres (total)
  - 35 ft dams
  - 2,000 flooding instances reduction
    (ex. 7,149*)

*includes West Fork basin
Primary Mitigation Planning

Lake Creek

- Prelim Est. 150,000 acre feet
- Lake Creek Main Stem Alternative
  - 80,000 ac-ft
  - 6,000 acres
  - 50 ft dam
  - 2,000 flooding instances reduction (ex. 7,149*)

*includes West Fork basin
Primary Mitigation Planning

West Fork (Upstream 59)

• Sand Mine Conversion Alternative
  – Southern Crushed Concrete
  – Investigating volumes

• Midreach Channelization Alternative
  – 3,000 ft wide
  – 20 miles
  – 1,200 flooding instances reduced (ex. 6,149)
Primary Mitigation Planning

West Fork (Downstream 59)

- Lower Reach Channelization Alternative
  - 3,000 ft wide
  - 5 miles
  - 1,200 flooding instances reduced (ex. 6,149)

- Lower Reach Benching Alternative
  - 8,000 ft wide
  - 5 miles
  - 1,400 flooding instances reduced (ex. 6,149)
Primary Mitigation Planning

Caney Creek

- Prelim Est. 40,000 acre-feet
- Reservoirs
  - 40,000 ac-ft
  - 4,200 acres
  - 50 ft dam
  - 2,000 flooding instances reduction (ex. 6,194)
- Downstream channelization
  - 400 ft wide channel
  - 40,000 LF
Primary Mitigation Planning

Peach Creek
- Prelim Est. 40,000 acre feet
- Reservoir
  - 45,000 ac-ft
  - 3,800 acres
  - 40 ft dam
  - 2,000 flooding instances reduction (ex. 4,901)
- Other potential locations
- Downstream channelization
  - In progress
Primary Mitigation Planning

East Fork

- Prelim Est. 100,000 acre feet
- Winters Bayou North Alternative
  - 35,000 ac-ft
  - 2,200 acres
  - 47 ft dam
  - 900 flooding instances reduction (ex. 4,513)
Primary Mitigation Planning

East Fork

- Prelim Est. 100,000 acre feet
- Winters Bayou South Alternative
  - 56,000 ac-ft
  - 3,000 acres
  - 52 ft dam
  - 1,200 flooding instances reduction (ex. 4,513)
Primary Mitigation Planning

East Fork

- Prelim Est. 100,000 acre feet
- East Fork Main Stem Alternative
  - 91,000 ac-ft
  - 3,700 acres
  - 54 ft dam
  - 1,100 flooding instances reduction (ex. 4,513)
Primary Mitigation Planning

East Fork

- Channelization
  - 11 miles prior to Lake Houston
  - 200 ft wide
    - 705 flooding instance reduction
  - 400 ft wide
    - 769 flooding instance reduction
  - 600 ft wide
    - 784 flooding instance reduction
Primary Mitigation Planning

Next Steps

• Finalizing alternative modeling
  – Volumes, Outlets, PMF elevations for reservoirs
• Combination and Regional Solutions
  – Caney Creek near Peach Creek Confluence
  – East Fork near Lake Houston
  – West Fork near Lake Houston
• BCA and Project Constraints
• Alternative Funding
• Project Implementation
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Considered variety of gage types (Rain, Flow, Stage)
- Flood warning and data for future calibration efforts
Other Mitigation Actions

• Other Mitigation Action Goals
  – Evaluate communications plan/protocol during emergencies
  – Identify critical infrastructure and compare to inundation
  – Determine expected flood frequency evacuation routes

• Met with all Emergency Management Coordinators

• Workshop (March 11th) to discuss preliminary findings
## Schedule Update

- **Existing Conditions H&H** – 100% (Comments, Calibration)
- **Model Calibration** – 100% (Completed calibration update)
- **Primary Mitigation Planning (Revised Methodology)** – 70%
- **Secondary Mitigation Planning (Adjusted Schedule)** – 99%

### SAN JACINTO RIVER WMDP - PROJECT SCHEDULE

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Project Management, Coordination, and Document Control</td>
<td>328</td>
<td>183</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/31/2020</td>
<td></td>
</tr>
<tr>
<td>Task 2: Review and Assess Existing Data</td>
<td>63</td>
<td>98</td>
<td>63</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/17/2019</td>
<td></td>
</tr>
<tr>
<td>Task 3: Existing Conditions Hydrologic and Hydraulic Model Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9/8/2019</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 4: Analyze Historical Storm Events and Calibrate Models</td>
<td>105</td>
<td>138</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3/27/2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 5: Future Conditions Hydrologic and Hydraulic Models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6/8/2020</td>
<td></td>
</tr>
<tr>
<td>Task 6: Primary Flood Mitigation Planning</td>
<td>203</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/10/2020</td>
<td></td>
</tr>
<tr>
<td>Task 7: Secondary Flood Mitigation Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4/13/2020</td>
<td></td>
</tr>
<tr>
<td>Task 8: Other Flood Hazard Mitigation Actions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/24/2020</td>
<td></td>
</tr>
<tr>
<td>Task 9: Community Outreach and Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/31/2020</td>
</tr>
<tr>
<td>Task 10: Final Deliverables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Questions?
# MEETING MINUTES

To: Jing Chen, P.E., CFM  
Attendees: Jing Chen, HCFCD  
Matt Barrett, SJRA  
Terry Barr, Halff  
Sam Hinojosa, Halff  
Andrew Moore, Halff  
Rachel Massey, Hollaway  
Thomas Mumford, Hollaway  
Garrett Johnston, Freese & Nichols  
Hector Olmos, Freese & Nichols  
Corey Stull, Freese & Nichols

From: Terry Barr, P.E., CFM  
Subject: San Jacinto River Watershed Master Drainage Plan Progress Meeting

Meeting Date: 03/11/2020 – 2:00 pm  
Location: SJRA, G&A Division Office  
Minutes Date: 03/18/2020  
AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | Introductions  
Ms. Chen started the meeting. | |
| 2.   | Communications and Outreach  
• Ms. Massey and Mr. Mumford gave an overview of the communications efforts to date. They provided copies of the *San Jacinto Regional Watershed Master Drainage Plan Public Meeting Summary Report* (Fall 2019), which includes a summary of the meeting attendance and comments at each location. A general overview of the study as well as a summary of the public input was included.  
• Hollaway also provided a draft schedule for the second set of public meetings to be conducted in July 2020. The schedule included specific dates and responsibilities for the various team members. They also noted that the public meeting located in Tomball for the first round will be moved to the Woodlands for the second round to increase participation. Additional measures will be taken to improve participation, leveraging social media and increased mailers and emails to local groups, including HOA’s and groups interested specifically in flooding issues. | Hollaway – provide schedule updates as needed or if there are comments |
| 3.   | Activities Conducted This Month  
• Mr. Moore provided a presentation to the group that reviewed the work performed over the last month. He indicated that the team had met with the MAAPnext lead, Duane Barrett, and addresses the concerns voiced by them. The calibration was completed and the study team is working on updating the memo. The revised memo will be provided by the end of March.  
• Mr. Moore also briefly discussed the Future Conditions | Halff/FNI – submit updated calibration memo |
modeling, which was initially presented in February. Mr. Johnston explained that the original future conditions analysis focused on a 50-year horizon and showed minimal increases in flows and WSEL along the streams. This was primarily a result of the development occurring in the central and lower parts of the watershed and almost none in the outer areas. Halff/FNI are currently looking at an Ultimate Conditions evaluation to determine what a “worst-case scenario” for development might look like. The future conditions memo should be complete by early April.

- The majority of the meeting was focused on preliminary results of the Primary and Secondary Alternatives analysis. Mr. Moore gave a brief overview of the tasks completed to date and those that are in progress or upcoming. He reiterated the damage centers that are the focus of the alternatives modeling effort, which include areas along the East Fork SJR, Peach Creek, Caney Creek, West Fork SJR, and Spring Creek. Alternatives are being evaluated on each of these streams as well as on Lake Creek. A breakdown of the “primary” and “secondary” alternatives was included. Primary alternatives are based on those flood reduction measures recommended in previous reports and with minor adjustments. Secondary alternatives include other options, such as additional reservoirs, channelization, sand mine detention, etc. Mr. Barrett mentioned the potential for a Lake Lowering alternative. This is discussed below in the Technical Discussion section.

- Mr. Moore started the detailed discussion of the alternatives findings with Spring Creek. He specified that the information provided in the slides for Spring Creek would be the same as slides for the other alternatives. The Spring Creek discussion included three separate reservoirs along Walnut, Birch, and Mill Creeks in Montgomery County. Information such as the approximate volume, acreage, dam height, and expected reduction of flooding instances were included. Mr. Barrett and Ms. Chen asked about the instances of flooding and if they included the lower level (i.e. 2-year, 5-year) storms. Mr. Moore indicated that the instances of flooding did not include the lower level storms because it is not likely that enough flood reduction could be achieved to provide protection. Those structures could potentially be good candidates for a buy-out program. However, in the final BCA calculation, it was agreed that all structures should be included as these structures may still receive benefit from the project and may not be bought out before the project is implemented.

- Mr. Moore presented a sample table of the results that will be included in the final report. The table included a summary of
the estimated reduction in flooding instances or “benefits” for each damage center and corresponding alternatives.

- Mr. Johnston presented graphics that show the reduction of flood instances per river mile. The graphic is based off the same one presented as part of the damage center evaluation and includes a corresponding number of reductions for a given alternative at each river mile. These graphics will be included in the report as well.

- Given the time constraints, Mr. Moore quickly mentioned the other streams for which the same information is provided. He stated that the presentation will be available on Dropbox for the study partners to review.

<table>
<thead>
<tr>
<th>4. Activities Planned Next Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Complete Primary/Secondary Mitigation Alternatives modeling</td>
</tr>
<tr>
<td>• Start work on cost estimates and benefits of alternatives</td>
</tr>
<tr>
<td>• Provide revised Secondary Mitigation Planning (Gages) memo</td>
</tr>
<tr>
<td>• Continue planning for second round of Community Meetings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Technical Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mr. Barrett mentioned that there was some conversation about modeling the seasonal lake lowering to evaluate its effectiveness as a flood reduction measure and wandered if there had been a resolution. Mr. Barr stated that it is a potential option and the study team had asked HCFCD if it could be included as an alternative. Mr. Hinojosa added that many of the local officials and congressional representative were interested in seeing if this was an effective measure.</td>
</tr>
</tbody>
</table>

Ms. Chen asked what would be involved and if it would have a negative impact on the schedule and budget. Mr. Olmos answered that the analysis is relatively simple and could include lowering the starting WSEL in the lake for a variety of options. Using the model developed as part of this study, the impacts could be evaluated all the way to IH-10. Ms. Chen asked the team to provide more specifics on the procedure. Mr. Barrett indicated he would discuss the possibility internally and provide a response to the team.

**UPDATE:** Subsequent to the meeting, the team provided additional information regarding modeling of the lake lowering alternative. Both HCFCD and SJRA indicated that because this was considered a temporary measure, it should not be included in the long-term regional plan as a flood reduction alternative. The study team will not include it moving forward.
5. **Administrative Discussion**
   - Mr. Barr indicated that the team would discuss the schedule internally and set a date for the Alternatives Workshop.
   
   **UPDATE:** Subsequent to the meeting, the team provided a schedule and prospective Workshop date. The meeting is currently being scheduled for April 27th.

6. Ms. Chen concluded the meeting.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
# STUDY PARTNERS MONTHLY MEETING AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

April 8, 2020  
San Jacinto River Watershed Master Drainage Plan  
Skype Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>2:30 PM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions**

2. **Communications and Outreach (Hollaway)**
   - Planning for Community Meetings (Set 2) Started – Tentatively scheduled for early July

3. **Activities Conducted this Month**
   - Submitted updated Calibration Memo
   - Submitted updated Future Conditions Memo
   - Continued Modeling Primary/Secondary Mitigation Alternatives
   - Started cost estimates and workshop fact sheets
   - Conducted Spring Creek Siting Study workshop
   - Working on updated Secondary Mitigation Planning (FWS Gages) Memo
   - Conducted Other Mitigation Actions workshop

4. **Activities Anticipated Next Month**
   - Complete Primary/Secondary Mitigation Alternatives modeling
   - Conduct Primary Mitigation Workshop
   - Start work on Primary Mitigation Memo
   - Continue work on Spring Creek Siting Study in parallel with Primary Mitigation
   - Address comments to the Sedimentation and Vegetation Memo
   - Submit revised Secondary Mitigation Planning (FWS Gages) Memo
   - Submit Draft Other Mitigation Actions Memo
   - Continue planning for second round of Community Meetings

5. **Technical Discussion**
   - Discussion of changes to Discharges and Water Surface Elevations

6. **Administrative Discussion**
   - N/A

7. **Questions**
# San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
</tbody>
</table>

**Total**: 535.6
Coordination and Communication

• Coordination
  – EMC Workshop
  – Spring Creek Siting Workshop

• Communications
  – Planning for Community Meetings (Set 2) Started
  – Public Meeting Comment Database
Study Submittals

- Submitted
  - Updated Analysis of Historical Storms (Calibration) Memo
  - Updated Future Conditions Memo

- Upcoming
  - Updated Secondary Mitigation Memo (04/17)
  - Other Mitigation Actions Memo (04/30)
  - Alternative Funding Memo (05/22)
  - Primary Mitigation Memo (06/08)
Primary Mitigation Planning

Current Progress
- Identify Damage Centers
- Primary Alternatives H&H
- Secondary Alternatives H&H
- Cost Estimates
- Benefit Determination
- Fact Sheet Preparation

Future Tasks
- **Alternatives Workshop**
- BCA and Project Constraints
- Alternative Funding
- Project Implementation
Alternatives Workshop

• Workshop Goals (April 27th)
  – Present alternatives analysis results
  – Discuss project fact sheets including costs, benefits, challenges
  – Consider preferred alternatives and possible combinations
  – Identify a path to implementation

• Workshop Materials
  – Project “fact sheets” (April 20th)
  – Workshop presentation (April 23rd)

Participation by all the study partners is critical so we can have an inclusive discussion and make decisions as a group.
Primary Mitigation Next Steps

- Complete modeling, cost estimates, etc. for Workshop
- Conduct Alternatives Workshop (April 27th)
- Update/combine alternatives based on recommendations
- Complete funding research and recommendations
- Complete detailed BCA of preferred alternatives
- Identify potential project challenges
- Implementation planning
- Draft study report
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Considered variety of gage types (Rain, Flow, Stage)
- Flood warning and data for future calibration efforts
Other Mitigation Actions

• Other Mitigation Action Goals
  – Evaluate communications plan/protocol during emergencies
  – Identify critical infrastructure and compare to inundation
  – Determine expected flood frequency evacuation routes

• Met with all Emergency Management Coordinators

• Workshop (March 11th) to discuss preliminary findings

• Draft memorandum (April 30th)
Schedule Update

- Existing H&H/Calibration – 100% (Comments, Calibration)
- Primary Mitigation Planning (Revised Methodology) – 80%
- Secondary Mitigation Planning (Adjusted Schedule) – 95%
- Other Mitigation Actions (Adjusted Schedule) – 75%

<table>
<thead>
<tr>
<th>Task</th>
<th>Days Remaining</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Project Management, Coordination, and Document Control</td>
<td>366</td>
<td>8/31/2020</td>
</tr>
<tr>
<td>Task 2: Review and Assess Existing Data</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td>Task 3: Existing Conditions Hydrologic and Hydraulic Model Development</td>
<td>98</td>
<td>8/12/2019</td>
</tr>
<tr>
<td>Task 4: Analyze Historical Storm Events and Calibrate Models</td>
<td>105</td>
<td>8/1/2019</td>
</tr>
<tr>
<td>Task 5: Future Conditions Hydrologic and Hydraulic Models</td>
<td>144</td>
<td>8/27/2020</td>
</tr>
<tr>
<td>Task 6: Primary Flood Mitigation Planning</td>
<td>296</td>
<td>6/8/2020</td>
</tr>
<tr>
<td>Task 7: Secondary Flood Mitigation Planning</td>
<td>177</td>
<td>4/20/2020</td>
</tr>
<tr>
<td>Task 8: Other Flood Hazard Mitigation Actions</td>
<td>72</td>
<td>5/1/2020</td>
</tr>
<tr>
<td>Task 9: Community Outreach and Education</td>
<td>366</td>
<td>8/24/2020</td>
</tr>
<tr>
<td>Task 10: Final Deliverables</td>
<td>84</td>
<td>8/31/2020</td>
</tr>
</tbody>
</table>
Updated Model Results

- Summary of changes from Effective Models to San Jacinto Regional WMDP Models

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Minimum Flow Change</th>
<th>Maximum Flow Change</th>
<th>Average Flow Change</th>
<th>Average % Change</th>
<th>Minimum Stage Change</th>
<th>Maximum Stage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luce/Tarkington Bayou</td>
<td>-21,616</td>
<td>13,609</td>
<td>2,247</td>
<td>18%</td>
<td>-2.37</td>
<td>3.68</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>-23,216</td>
<td>9,963</td>
<td>5,386</td>
<td>20%</td>
<td>-0.39</td>
<td>5.34</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>4,496</td>
<td>49,437</td>
<td>13,507</td>
<td>49%</td>
<td>1.1</td>
<td>6.63</td>
</tr>
<tr>
<td>East Fork San Jacinto</td>
<td>-3,449</td>
<td>64,343</td>
<td>19,066</td>
<td>2%</td>
<td>0.05</td>
<td>7.90</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>12,104</td>
<td>34,980</td>
<td>26,499</td>
<td>67%</td>
<td>3.55</td>
<td>5.14</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>-4,981</td>
<td>15,053</td>
<td>5,554</td>
<td>20%</td>
<td>0.39</td>
<td>5.79</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>-132</td>
<td>8,936</td>
<td>3,493</td>
<td>53%</td>
<td>0.06</td>
<td>5.00</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>-4,462</td>
<td>7,486</td>
<td>868</td>
<td>6%</td>
<td>-3.09</td>
<td>3.55</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>436</td>
<td>8,714</td>
<td>4,429</td>
<td>121%</td>
<td>0.67</td>
<td>3.69</td>
</tr>
<tr>
<td>West Fork San Jacinto</td>
<td>-29,803</td>
<td>82,586</td>
<td>8,418</td>
<td>7%</td>
<td>-5.56</td>
<td>3.48</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>-89</td>
<td>43</td>
<td>-9</td>
<td>-1%</td>
<td>-0.54</td>
<td>2.10</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>55,239</td>
<td>63,914</td>
<td>60,524</td>
<td>24%</td>
<td>-2.22</td>
<td>1.18</td>
</tr>
</tbody>
</table>
Questions?
MEETING MINUTES

To: Jing Chen, P.E., CFM
Attendees: Jing Chen, HCFCD
From: Terry Barr, P.E., CFM
Attendees: Beth Walters, HCFCD
Subject: San Jacinto Regional Watershed
Attendees: Dena Green, HCFCD
Master Drainage Plan Progress
Attendees: Matt Barrett, SJRA
Meeting
Attendees: Briana Gallagher, SJRA
Meeting Date: 04/08/2020 – 1:30 pm
Attendees: Chuck Gilman, SJRA
Location: WebEx Conference Call
Attendees: Terry Barr, Halff
Minutes Date: 04/15/2020
Attendees: Sam Hinojosa, Halff
AVO No.: 033465.002
Attendees: Andrew Moore, Halff
Attendees: Connor Stokes, Hollaway
Attendees: Thomas Mumford, Hollaway
Attendees: Garrett Johnston, Freese & Nichols
Attendees: Hector Olmos, Freese & Nichols
Attendees: Corey Stull, Freese & Nichols
Attendees: Adam Eaton, City of Houston
Attendees: Sharon Citino, City of Houston

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introductions</td>
<td>Ms. Chen started the meeting.</td>
</tr>
</tbody>
</table>
| 2.   | Communications and Outreach | • Mr. Stokes stated that the summary report from the public meetings is online and available.  
  • Ms. Walters stated that the comment matrix is rolling and would continue to collect responses throughout the project timeframe.  
  • Mr. Stokes stated that they are anticipating public meetings in July with 60 days of preparation beforehand. He stated that. Ms. Walters described that a plan for virtual meetings is being prepared by HCFCD and is being reviewed by management. |
| 3.   | Activities Conducted This Month | • Mr. Barr provided an update on the latest study submittals. He stated that Historical Storms memo and Future Conditions were recently submitted. He stated that Other mitigations and Secondary Mitigation would be completed this month.  
  • Mr. Barr covered the topics to discuss at the alternatives workshop. Ms. Chen mentioned that this would be the final workshop and input from all jurisdictions is needed. She added that study partners could invite anyone from their agency needed. Mr. Barr stated that the Fact Sheets would be available April 20th.  
  • Mr. Barr stated that other mitigation actions workshop was conducted in March and summary minutes were included in the |
study Dropbox.

- Mr. Barrett asked if the Southern Crushed Concrete area would be of value to the project. See Technical Discussion.

<table>
<thead>
<tr>
<th>4. Activities Planned Next Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Alternatives Workshop April 27th</td>
</tr>
<tr>
<td>Completing draft secondary mitigation memorandum</td>
</tr>
<tr>
<td>Completing draft other mitigation memorandum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Technical Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Barrett asked if the Southern Crushed Concrete area would be of value to the project. Mr. Moore stated that an initial simulation of the area showed only a slight benefit along the West Fork between I-45 and SH-242 for the 100-year storm event. Mr. Barrett asked if there were any reductions for smaller storm events. Mr. Moore stated he would have to look back at the modeling. He also stated that the pond could be used for detention for proposed channel improvements</td>
</tr>
<tr>
<td>Halff to provide update on the Southern Crushed Concrete potential project.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. Administrative Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Barr stated that the draft report would be submitted on July 6th with 4 weeks of stakeholder review. He stated that the end date of August 31st is the final deadline for the final report.</td>
</tr>
<tr>
<td>Ms. Chen asked if the June alternative submittal would include the implementation plan. Mr. Barr stated that the June Primary Mitigation would include an implementation plan along with the alternative funding summary.</td>
</tr>
<tr>
<td>Halff/FNI determine Alternatives Workshop date.</td>
</tr>
</tbody>
</table>

| 7. Ms. Chen concluded the meeting. |

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
STUDY PARTNERS MONTHLY MEETING AGENDA
Study Partners: HCFCD, City of Houston, Montgomery County, SJRA

May 13, 2020
San Jacinto River Watershed Master Drainage Plan
Skype Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>2:30 PM</td>
</tr>
</tbody>
</table>

### Agenda

1. **Introductions**

2. **Communications and Outreach (Hollaway)**
   - Planning for Community Meetings (Set 2) Started – Tentatively scheduled for early July
   - Kingwood Improvements Discussion Meeting – 05/11/20

3. **Activities Conducted this Month**
   - Adjustments to Calibrated Models – Finalize Existing Conditions
   - Conducted Future Conditions Meeting – 05/01/20
   - Conducted Mitigation Alternatives Workshop – 04/27/20
   - Conducted Sedimentation/Vegetation Meeting – 05/05/20
   - Submitted Secondary Mitigation Planning (FWS Gages) Memo – 05/13/20
   - Working on Other Mitigation Actions Memo

4. **Activities Anticipated Next Month**
   - Finalize Primary/Secondary Mitigation Alternatives modeling
   - Work on Primary Mitigation Memo (Due 06/08)
   - Continue work on Spring Creek Siting Study in parallel with Primary Mitigation
   - Address comments to the Sedimentation and Vegetation Memo
   - Submit Draft Other Mitigation Actions Memo
   - Continue planning for second round of Community Meetings

5. **Technical Discussion**
   - Additional information needed for Kingwood Area

6. **Administrative Discussion**
   - Discussion of Draft Report Outline

7. **Questions**
## San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – Alternatives Workshop (04/27/20)

• Communications
  – Planning for Community Meetings (Set 2)
  – Public Meeting Comment Database
  – Kingwood Area Improvements Discussion
Study Submittals

• Submitted
  – Secondary Mitigation Memorandum (05/13)
  – Updated Calibrated Models

• Upcoming
  – Other Mitigation Actions Memo (Late May)
  – Alternative Funding Memo (Early June)
  – Updated Sedimentation/Vegetation Memo (06/12/20)
  – Primary Mitigation Memo (06/08/20)
  – Draft Report (07/13/20)
Primary Mitigation Planning

Current Progress
- Preliminary Completion of H&H Models
- Preliminary Benefit Cost Determination
- Preliminary Fact Sheets
- Alternatives Workshop

Future Tasks
- Finalize H&H Modeling
- Alternative Funding
- Project Implementation
- Submit Alternatives Memo
Alternatives Workshop

- **Workshop (April 27th)**
  - Presented alternatives analysis results
  - Discussed project fact sheets including costs, benefits, challenges
  - Consider preferred alternatives and possible combination
  - 38 attendees (HCFCD, SJRA, MCO, COH, H-GAC, USACE)
  - Finalizing workshop minutes for delivery

- **Next Step**
  - Consider additional projects, combinations or data needed
  - Consider project metrics
  - Follow up with HCFCD ROW
  - Update costs and benefits
Secondary Mitigation Planning

- Received input from HCFCD, MCO, USGS, Others
- Updated Secondary Mitigation Memo (05/13/20)
  - 26 Gages recommended (HCFCD Currently installing 5)
  - Approximate installation cost range $240k - $330k
  - Additional costs for annual maintenance
Other Mitigation Actions

• Other Mitigation Action Goals
  – Evaluate communications plan/protocol during emergencies
  – Identify critical infrastructure and compare to inundation
  – Determine expected flood frequency evacuation routes

• Conducted Emergency Management Workshop (March 11th)

• Working on draft memorandum
Schedule Update

• Existing H&H/Calibration – 100% (Finalized)
• Primary Mitigation Planning (Workshops Completed) – 85%
• Secondary Mitigation Planning (Adjusted Schedule) – 100%
• Other Mitigation Actions (Adjusted Schedule) – 80%
Draft Report Outline

• Executive Briefing
  – Overall summary of report and recommendations. High level review of project geared toward public officials; Graphical in nature

• Report Narrative
  – More detailed discussion of the process and findings for the various report sections; Limited discussion of technical modeling details

  1.0 Project Management
  2.0 Data Collection
  3.0 Existing Conditions Flood Hazard Assessment
  4.0 Analysis of Historical Storms
  5.0 Future Flood Risk Planning Assessment
  6.0 Primary Flood Mitigation Planning
  7.0 Secondary Flood Mitigation Planning
  8.0 Other Flood Hazard Mitigation Actions
  9.0 Community Outreach and Education
Draft Report Outline

• Detailed Appendices
  – Detailed information for each section including figures, tables, and exhibits. Detailed information regarding each task. Geared toward technical audience: engineers and technical agencies.

Appendix A - Project Management and Coordination (meeting agendas, minutes, etc.)
Appendix B - Data Collection (field observation, survey, previous report summaries)
Appendix C - Existing Conditions Flood Hazard Assessment (technical discussion, results)
Appendix D - Analysis of Historical Storms (detailed calibration memo)
Appendix E - Future Flood Risk Planning Assessment (future conditions memo)
Appendix F - Primary Flood Mitigation Planning (technical discussion, results, BCR, etc.)
Appendix G - Secondary Flood Mitigation Planning (Secondary mitigation memo)
Appendix H - Other Flood Hazard Mitigation Actions (Other mitigation memo, meeting data)
Appendix I - Community Outreach and Education (public meeting info and exhibits)
Appendix J – Digital Data (all digital information)
STUDY PARTNERS MONTHLY MEETING AGENDA  
Study Partners: HCFCD, City of Houston, Montgomery County, SJRA

June 10, 2020  
San Jacinto Regional Watershed Master Drainage Plan  
Skype Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>2:30 PM</td>
</tr>
</tbody>
</table>

### Agenda

1. **Introductions**

2. **Communications and Outreach (Hollaway)**
   - Planning for Community Meetings (Set 2) Started – Tentatively scheduled for late-July
   - SJRA Board Meeting – 07/23/20
   - Upcoming Stakeholder Briefings in June/July

3. **Activities Conducted this Month**
   - Submitted Primary Mitigation Alternatives Memo – 06/08/20
   - Updating Sedimentation/Vegetation Memo
   - Working on Other Mitigation Actions Memo
   - Conducted Harris County Precinct 1 and 2 Briefings

4. **Activities Anticipated Next Month**
   - Alternatives Funding Memorandum
   - Other Mitigation Actions Memorandum
   - Implementation Planning
   - Planning for Stakeholder Briefings
   - Submit Revised Sedimentation and Vegetation Memo – 06/26/20
   - Draft Report – 07/13/20

5. **Technical Discussion**
   - Primary Mitigation Planning Memo Overview
   - Buyouts
   - Implementation Planning

6. **Administrative Discussion**
   - Draft Report Executive Summary

7. **Questions**
### San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – ROW Discussion – 06/05/20
  – SJRA Board Meeting – 07/23/20

• Communications
  – Plan Community Meetings (Set 2)
  – HC Precinct 1 Briefing – 05/21/20
  – HC Precinct 2 Briefing – 05/26/20
  – Late June Briefings
    • HC Precinct 4 Briefing
    • Council Member Dave Martin
    • Congressman Crenshaw
    • State Representative Huberty
  – July Briefings
    • Montgomery County Drainage Council
    • Kingwood Association Management
    • Lake Houston Area Chamber
    • Community Activists
      – Bob Rehak
      – Barbara Hillburn
Study Submittals

• Submitted
  – Primary Mitigation Alternatives Memo (06/08/20)
  – Secondary Mitigation Memorandum
  – Updated Calibrated Models

• Upcoming
  – Updated Sedimentation/Vegetation Memo (06/26/20)
  – Other Mitigation Actions Memo (Late June)
  – Alternatives Funding Memo (Late June)
  – Implementation Memo (Mid-July)
  – Draft Report (07/13/20)
  – Final Report (08/31/20)
Primary Mitigation Planning

Current Progress
• Preliminary Completion of H&H Models
• Preliminary Benefit Cost Determination
• Preliminary Fact Sheets
• Alternatives Workshop
• Finalize H&H Modeling
• Submit Alternatives Memo

Future Tasks
• Alternatives Funding
• Project Implementation
Alternatives Memorandum

• Intended to be Appendix F in the Draft/Final Report
• Memo Structure
  – Introduction (Goals, Tasks)
  – Damage Center Identification
  – Target Volume Determination
  – Flood Mitigation Alternatives Analysis (Focuses on process and parts)
  – Flood Mitigation Alternatives (Focuses on specific alternatives)
  – Additional Flood Reduction Measures (Policies)
  – Implementation Planning (Considerations moving forward)
  – Appendices (Detailed data developed during the process)
Introduction

• Alternatives Analysis Goals
  – Identify areas with high concentrations of significant flood damages
  – Determine project locations that have the highest potential for local and regional mitigation
  – Perform H&H analysis to determine project effectiveness
  – Identify estimated project costs, potential flood reduction benefits, and implementation challenges
  – Develop a path toward plan implementation for the Master Drainage Plan

• Alternatives Tasks
  – Updated version of the plan presented in Revised Alternatives Development Process memorandum (October 2019)
Damage Center Identification

- **Structural Inventory**
  - Data Source, Assumptions, Limitations
  - Summary of Results (Overall, Watershed)

- **Damage Center Identification**
  - Criteria for Damage Centers (Based on Instances of Flooding per Mile)
  - Summary of Damage Centers (48 Total)
  - Lower San Jac Centers
Target Volume Determination

- Volume Reduction Calculations
- LOS Improvements and Benefits (High-Level Analysis)
- Comparison of Volume and Benefits
- Watershed Mitigation Potential
  - High Potential (Spring, Peach, Caney, East Fork)
  - Moderate Potential (Lake)
  - Low Potential (Luce/Tarkington, Jackson, Willow, Little Cypress, Cypress)

<table>
<thead>
<tr>
<th>Design Frequency Storm Event</th>
<th>Estimated Detention Volume Required (acre-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2% ACE                        1% ACE</td>
</tr>
<tr>
<td></td>
<td>99,371                          56,396</td>
</tr>
<tr>
<td></td>
<td>86,429                          44,511</td>
</tr>
<tr>
<td></td>
<td>73,751                          33,426</td>
</tr>
<tr>
<td></td>
<td>57,112                          18,455</td>
</tr>
<tr>
<td></td>
<td>41,941                          7,036</td>
</tr>
<tr>
<td></td>
<td>26,567</td>
</tr>
<tr>
<td></td>
<td>2% ACE                          4% ACE</td>
</tr>
<tr>
<td></td>
<td>41,378                          28,627</td>
</tr>
<tr>
<td></td>
<td>30,167                          17,856</td>
</tr>
<tr>
<td></td>
<td>19,797                          9,075</td>
</tr>
<tr>
<td></td>
<td>6,597</td>
</tr>
<tr>
<td></td>
<td>10% ACE</td>
</tr>
<tr>
<td></td>
<td>14,937</td>
</tr>
<tr>
<td></td>
<td>5,534</td>
</tr>
<tr>
<td></td>
<td>20% ACE</td>
</tr>
<tr>
<td></td>
<td>6,532</td>
</tr>
<tr>
<td></td>
<td>50% ACE</td>
</tr>
<tr>
<td></td>
<td>20% ACE</td>
</tr>
<tr>
<td></td>
<td>10% ACE</td>
</tr>
<tr>
<td></td>
<td>4% ACE</td>
</tr>
<tr>
<td></td>
<td>2% ACE</td>
</tr>
<tr>
<td></td>
<td>1% ACE</td>
</tr>
<tr>
<td></td>
<td>0.2% ACE</td>
</tr>
</tbody>
</table>
Flood Mitigation Alternatives Analysis

- Primary vs. Secondary
- Previously Recommended Projects
- Project Types
- Opportunities and Challenges
- Project Costs (Including uncertainty)
- Project Benefits
Flood Mitigation Alternatives

- Presented by watershed
- All modeled alternatives included
- Overview of Alternatives (Costs vs. Benefits)

---

**San Jacinto River Master Drainage Plan**

<table>
<thead>
<tr>
<th>Drainage Plan</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway *</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Caney Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Caney Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
Additional Flood Reduction Measures

- Floodplain Preservation
- Buyouts
  - Should we consider specific recommendations for buyouts?
- Detention Policy
  - Additional Analysis to be done to refine the recommendations
Next Steps

- Alternatives Funding Memo (Some info included in Alts Memo)
- Implementation Planning
  - Finalize Metrics (Historical flooding, current damages, project costs, benefits, funding potential, LMI/SVI)
  - Determine appropriate weighting
  - Project Prioritization
  - Project Phasing
  - Identify the best project(s) to move forward (Feasibility, PER, Design)
- Develop Draft Report
  - Front End Summary
  - Narrative
  - Appendices
Draft Report Executive Summary

• Executive Summary is intended to be a front end stand-alone document that can be shown to decision makers and the public

• Potential information to be included:
  – Study Background (History, Goals, Info from video)
  – Current Flood Risks (Sources, Historical Damages, Future?)
  – Flood Mitigation Strategies (Projects, Policy, Warning, Response)
  – Implementation (Plan moving forward, Priority projects)

• Graphical in nature and user friendly

• Work with Communications team to prepare
Draft Report Executive Summary

THE STORMWATER MANAGEMENT PROGRAM

The Stormwater Management Program (SWMP) vision, mission, and strategic direction are direct outcomes of the program’s specific applications on the City’s comprehensive vision, mission, strategic goals, and City Values. The Comprehensive City Vision is memorialized and refreshed annually in the Fort Worth Comprehensive Plan. The City Council strategic goals summarize the primary focus areas City leadership has established to accomplish the vision.

CITY OF FORT WORTH VISION
Fort Worth will be the most livable and best managed City in the country.

CITY OF FORT WORTH MISSION
Working together to build a strong community.

CITY COUNCIL STRATEGIC GOALS
- Make Fort Worth the nation’s safest major City
- Improve mobility and air quality
- Create and maintain a safe and attractive City
- Strengthen the economic base, develop the future workforce, and create quality job opportunities
- Promote orderly and sustainable development

CITY VALUES
- Exceptional Customer Experience
- Accountability
- Ethical Behavior
- Diversity
- Mutual Respect
- Continuous Improvement

STORMWATER MANAGEMENT PROGRAM

The Stormwater Management Program vision, mission, and goals directly contribute to the City’s progress toward its comprehensive vision. Stormwater program priorities and strategies are always directed toward that end.

STORMWATER MANAGEMENT VISION
To be commonly recognized as an exceptionally effective and progressive municipal stormwater management program.

STORMWATER MANAGEMENT MISSION
- Protect people and property from harmful stormwater runoff

STORMWATER MANAGEMENT INITIAL STRATEGIC GOALS
When the SWMP was developed, a very simple, two-pronged framework for program goals was established.

Make things better
- Get the drainage system performing as designed (Maintenance and Repair)
- Identify and correct deficiencies in the drainage system (Flood and Erosion Mitigation Capital Improvement Program)
- Warn of stormwater-related hazards

Keep things from getting worse
- Keep the drainage system performing as designed (Maintenance and Repair)
- Review Development to ensure no adverse impact (Development Services)
INITIAL STORMWATER MANAGEMENT PROGRAM OBJECTIVES AND FUNDING

The Stormwater Program was established in conjunction with a Stormwater Utility in 2006. Table 3-2 summarizes the original SWMP fee plan and actual monthly fee schedule by fiscal year. Table 3-3 summarizes stormwater management activities prior to 2000 and the desired outcomes of the established Stormwater Management Program.

INITIAL SWMP OBJECTIVES

<table>
<thead>
<tr>
<th>PRE-2006</th>
<th>DESIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood reduction capital projects – over $50 million backlog</td>
<td>Funded capital program (stable funding source) that reduces backlog in a reasonable timeframe</td>
</tr>
<tr>
<td>Reactive maintenance</td>
<td>Proactive, prioritized, scheduled, effective, maintenance program</td>
</tr>
<tr>
<td>Incomplete inventory</td>
<td>Complete inventory and condition assessment of facilities</td>
</tr>
<tr>
<td>Planning – Limited studies (1% of City) focused only on water quantity issues</td>
<td>Comprehensive master planning – Setting priorities with cost-effective solutions (including water quality issues)</td>
</tr>
<tr>
<td>Development Service/Design Standards – 1967 are with limited exceptions</td>
<td>Up-to-date standards that protect from flooding &amp; erosion without slowing growth</td>
</tr>
<tr>
<td>Outsourced equipment/technology</td>
<td>Up-to-date hardware, software, and field equipment</td>
</tr>
<tr>
<td>Public Education primarily limited to water quality issues</td>
<td>Effective education/outreach on all aspects of stormwater issues</td>
</tr>
</tbody>
</table>

SWMP FEE PLAN

<table>
<thead>
<tr>
<th></th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
<th>FY12-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original projected monthly fee per billing unit</td>
<td>$2.90</td>
<td>$3.25</td>
<td>$3.75</td>
<td>$4.25</td>
<td>$4.50</td>
<td></td>
</tr>
<tr>
<td>Actual monthly fee/annual budget</td>
<td>$2.90 /$10.2M</td>
<td>$3.20 /$15.1M</td>
<td>$3.75 /$19.3M</td>
<td>$4.75 /$25.7M</td>
<td>$4.75 /$28.1M</td>
<td>$5.40 /$33.9M in FY12</td>
</tr>
</tbody>
</table>

* Billing units are calculated by measuring the hard surface area on a property and dividing by the Equivalent Residential Unit (ERU) of 2,600 square feet to determine the number of billing units on the property.
Program Wide Strategies

The following strategic direction is established in response to the identified community needs/priorities and the challenges faced by the overall program, specific program elements, and key policy areas.

Financial

- Leverage available resources and opportunities to expand the capacity of the SWMP to meet the established vision and mission.

Grant Opportunities

To provide potential financial resources for the SWMP, the City will look for and take advantage of state and federal grant funding for hazard mitigation. This implementation strategy is consistent with the June 2010 Floodplain Management Plan, which includes the mitigation section to “pursue grants to complete property acquisition projects.” In addition, other mitigation measures, such as drainage improvements, can be partially funded with grants. By pursuing state and federal grants, the City will create opportunities to leverage local funding to plans, develop, and complete projects to mitigate flood and erosion impacts.

The following potential grant sources will continue to be considered by the SWMP:

Federal Emergency Management Agency (FEMA)

- Provide substantial federal funding for the purchase of flood-prone homes through FEMA’s Flood Mitigation Assistance program (FMA) and the Pre-Disaster Mitigation program (PMI). The Voluntary Buyout policy, once developed, will provide guidance on the circumstances under which these grant funds would be pursued. FEMA currently provides grant funds through the Community Development Block Grant (CDBG) program that can assist with housing, economic development, and measures to reduce damage in future storms. In Texas, the General Land Office (GLO) administers this part of the CDBG program.

Housing and Urban Development (HUD)

- The Department of Housing and Urban Development (HUD) administers the Federal Community Development Block Grant (CDBG) program that can assist with housing, economic development, and measures to reduce damage in future storms. In Texas, the General Land Office (GLO) administers this part of the CDBG program.

U.S. Army Corps of Engineers (USACE)

- The USACE can provide funding for studies and implementation projects that include planning, analysis, and development of non-structural (shelterization and other damage reduction) and non-structural alternatives (such as flood-prone property acquisition) under Section 209 of the 1986 Flood Control Act and Section 92 of the Water Resources Development Act of 1974, as amended.

Texas Water Development Board

- Flood Protection Planning Grants provide funds to local governments to provide funds for structural and non-structural solutions to flooding problems.

Texas Department of Emergency Management

- The Hazard Mitigation Assistance Grant Program (HMAGP) provides post-disaster assistance, FEMA funding for eligible mitigation projects.

The Severe Repetitive Loss grant program, under the FEMA’s Hazard Mitigation Assistance Grant Program, provides federal funding to assist states and communities in implementing mitigation measures to reduce or eliminate the long-term risk of flood damage to severe repetitive loss residential structures insured under the NFIP.

The Clean Water State revolving fund (CWF) provides financial assistance to stormwater projects at below-market interest rates.

The Flood 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 insured under the National Flood Insurance Program (NFIP).
Draft Report Executive Summary

INTRODUCTION

DEVELOPMENT OF THE PLAN

The Southside Area Development Plan (SADP) is an element of the Plan CC Comprehensive Plan. The SADP is intended to provide an analysis of the Southside Area and create strategic recommendations to guide future development. As the community grows, the City should have plans in place to guide the anticipated growth. By understanding development patterns and the impact it has on the community, the City will be better prepared for the future. This plan serves as a guide for City leadership to make regulatory and policy decisions as well as prioritize infrastructure improvements to increase the quality of life.

The Southside Area of Corpus Christi is located south of South Padre Island Drive (SPID), east of the Crosstown Expressway, and is bounded by Oso Creek and Bay to the south and east. The Southside is experiencing most of the recent development in the City, and the growth is anticipated to continue.

The SADP was developed through a comprehensive public engagement process that integrated the examination of the existing conditions and the vision of the community.

An Advisory Committee was created to assist in guiding the planning process and provide a representation of the area’s residents, business owners, students, and stakeholders. The committee’s participation was essential to the development of the final plan. Although the Advisory Committee championed the process, the community was involved throughout the process and participated in multiple engagement events and activities. Residents and stakeholders gave their input regarding the future of the Southside through online surveys and various community engagement events, including a Community Open House and a four-day Community Think Tank. Many of the recommendations identified in this plan are a direct result of the input received, resulting in a community-driven plan.

WHAT IS MISSING MOST IN THE SOUTHSIDE?

- Parks & Trails: 26.9%
- Other: 18.3%
- Mixed-Use: 16.3%
- Restaurants: 9.8%
- Shopping: 9.6%
- Entertainment: 7.7%
- Office: 6.7%
- Housing: 4.8%

MY FAVORITE PART ABOUT SOUTHSIDE IS...

- Easy access to shopping, dining, & services: 31%

HOW CAN WE ENSURE OUR NEIGHBORHOODS THRIVE?

- High-performing jobs & schools: 5.9%
- Redevelopment improvements: 5.9%
- Enhanced Parks: 8.8%
- Sustainable urban amenities & growth patterns: 14.8%
- New Shopping & Lifestyle Centers: 17.6%
- Infrastructure improvements: 23.5%
- Traffic improvements & safe pedestrian facilities: 23.5%

MY VISION FOR SOUTHSIDE IS...

- More walking trails and park connecting commercial and neighborhood areas.
- Sidewalks lined with trees and flowers.
- Diverse in housing, jobs, entertainment, etc. We don’t all need or want to live in the same type of homes/neighborhoods.
- Improve traffic visibility when entering main roadways.
- Preserve and protect and enhance Oso Creek.

SOUTHSIDE AREA DEVELOPMENT PLAN
MARCH 17, 2020
Draft Report Executive Summary

DRAINAGE UTILITY MASTER PLAN

PUBLIC OUTREACH SURVEY & OBSERVATIONS
The project team engaged with the City’s preferred survey provider, J. Mary Coyne Marketing Communications (J/MCMC) of Amarillo, to begin the survey effort. The team met with J/MCMC to develop, coordinate the public outreach strategy, and conduct the survey through the survey process.

J/MCMC conducted the survey during June 2018. The survey was conducted by telephone and continued until it reached 300 Amarillo residential and 100 Amarillo commercial customers. Questions included demographic information, understanding of stormwater management, understanding of the role of the stormwater program, financial responsibility for stormwater improvements, preferred messaging type, and identification of flooding problem areas.

KEY OBSERVATION 1

Education: The survey results support the need for the Drainage Utility to educate the public about the makeup of the drainage system in the City of Amarillo and the role of the Drainage Utility in reducing flood risk.

KEY OBSERVATION 2

Financial Responsibility: Nearly half of respondents believe there should be a shared cost between the City and the developer for installation of new infrastructure relative to new development.

RECOMMENDATIONS

- Increase awareness and utilize monthly utility bills for primary education/communication of the drainage utility’s roles and responsibilities.
- Implement targeted messaging campaign.
- Conduct follow-up citizens survey to measure effectiveness of public outreach.

CAPITAL IMPROVEMENT PROJECT PROGRAM

The project team endeavored to develop an objective process to determine how best to prioritize the current list of stormwater CIPs and allow prioritization of future CIPs. The following steps were used to prioritize CIPs and to develop a 5-Year CIP plan options.

2. Perform 2D rapid assessment to identify flooding hot-spot locations on a city-wide scale.
3. Prioritize CIPs utilizing a uniform and objective approach to scoring so that each project is evaluated based on the same metrics.
4. Review top-tier CIPs in more detail to determine if the projects were reasonable, if they were contingent on other City projects, and if they would need to be phased (and how).
5. Update estimates of probable cost for each top-tier project.
6. Develop 5-year CIP plan options based on the top-tier projects including a drainage utility rate increase evaluation.

RAPID ASSESSMENT

The rapid assessment is a high-level analysis tool that was developed for the 2019 DRP to identify flooding hotspot locations on a city-wide scale. Rain-on-mesh HEC-RAS 2D modeling was applied across the entire City to identify low-lying areas that are prone to flooding. The results of the rain-on-the-mesh modeling in conjunction with emergency response and drainage complaint data allow for determination at high risk flood areas.

CIP PRIORITIZATION

Nine (9) evaluation criteria categories with relative importance based on weight were established as shown on the scoring matrix. A group of staff and consultants participated in an activity involving binary comparisons of the importance of one criterion relative to another. This process resulted in rankings of most important to least important, but also allowed for the placement of a weighted multiplier to be applied to each project score, reflecting the importance of that criterion.
# Schedule Update

- **Existing H&H/Calibration** – 100% (Finalized)
- **Primary Mitigation Planning (Workshops Completed)** – 95%
- **Secondary Mitigation Planning (Adjusted Schedule)** – 100%
- **Other Mitigation Actions (Adjusted Schedule)** – 85%

### SAN JACINTO REGIONAL WMDP - PROJECT SCHEDULE

<table>
<thead>
<tr>
<th>Task 1: Project Management, Coordination, and Document Control</th>
<th>April 19</th>
<th>May 19</th>
<th>June 19</th>
<th>July 19</th>
<th>August 19</th>
<th>September 19</th>
<th>October 19</th>
<th>November 19</th>
<th>December 19</th>
<th>January 20</th>
<th>February 20</th>
<th>March 20</th>
<th>April 20</th>
<th>May 20</th>
<th>June 20</th>
<th>July 20</th>
<th>August 20</th>
<th>September 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage Progress</td>
<td>429</td>
<td>82</td>
<td>8/31/2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Task 2: Review and Assess Existing Data | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|----------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 135 | 16 | 6/26/2020 |

| Task 3: Existing Conditions Hydrologic and Hydraulic Model Development | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|------------------------------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 202 | 105 | 8/1/2019 |

| Task 4: Analyze Historical Storm Events and Calibrate Models | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|-----------------------------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 144 | 105 | 8/1/2019 |

| Task 5: Future Conditions Hydrologic and Hydraulic Models | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|---------------------------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 359 | 105 | 8/1/2019 |

| Task 6: Primary Flood Mitigation Planning | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 359 | 105 | 8/1/2019 |

| Task 7: Secondary Flood Mitigation Planning | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|---------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 359 | 105 | 8/1/2019 |

| Task 8: Other Flood Hazard Mitigation Actions | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|------------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 359 | 105 | 8/1/2019 |

| Task 9: Community Outreach and Education | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|------------------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 359 | 105 | 8/1/2019 |

| Task 10: Final Deliverables | April 19 | May 19 | June 19 | July 19 | August 19 | September 19 | October 19 | November 19 | December 19 | January 20 | February 20 | March 20 | April 20 | May 20 | June 20 | July 20 | August 20 | September 20 | Completion Date |
|-------------------------------|---------|-------|--------|--------|-----------|--------------|------------|-------------|-------------|------------|-------------|----------|----------|--------|--------|--------|---------|-------------|
| Percentage Progress | 359 | 105 | 8/1/2019 |
MEETING MINUTES

To: Jing Chen, P.E., CFM
From: Terry Barr, P.E., CFM
Attendees: Jing Chen, HCFCD
Dena Green, HCFCD
Matt Barrett, SJRA
Terry Barr, Halff
Sam Hinojosa, Halff
Rachel Massey, Holloway
Rosaura Martinez, Holloway
Andrew Moore, Halff
Hector Olmos, Freese & Nichols
Adam Eaton, City of Houston

Subject: San Jacinto Regional Watershed Master Drainage Plan Progress Meeting
Meeting Date: 06/10/2020 – 1:30 pm
Location: Skype Conference Call
Minutes Date: 06/11/2020
AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introductions</td>
<td></td>
</tr>
</tbody>
</table>
Ms. Chen started the meeting. |  |
| 2.   | Communications and Outreach |  
• Terry mentioned the upcoming coordination meetings with the SJRA Board. He stated that future public meetings appear to be slated for late July. The team had coordinated with HC Precincts 1 and 2 as well as the HCFCD ROW team. There are several stakeholder briefings planned for June/July.  
• Jing stated that there were several (9) stakeholder meetings schedule including: HC Precinct 4, Councilman Martin, State Rep. Huberty, Congressman Crenshaw, the Lake Houston Area Chamber of Commerce, the Kingwood Association Management, Community Activists Barbara Corbin and Bob Rehak, and the Montgomery County Drainage Council. Jing asked if the briefings could be added to the slide. | Halff – Add Stakeholder Meetings to the slides |
| 3.   | Activities Conducted This Month |  
• Terry stated that the primary alternatives memo was submitted on Monday, June 8th. He stated that the sedimentation, other mitigation, and alternatives funding will be submitted in late June. The draft report will be submitted July 13th.  
• Jing asked that the final deliverable be added to the slide showing the final report.  
• Terry stated that the primary alternatives memorandum was submitted and that future tasks include the alternatives funding and project implementation. He stated that implementation will include the list of projects and what is the first project that | Halff – Add Final Report date to the slides |
should be explored.

- Terry summarized the primary alternative memorandum submittal and the information presented.
- Terry summarized the flood mitigation analysis. He mentioned that the team reviewed the previous projects and modeled the ones that showed ability to reduce flooding.
- Terry stated that the memo includes information for each project. The narrative section includes the detailed information needed to pursue the project. He said the fact sheets provide a high-level view of the projects.
- Jing asked if the memorandum would include a per watershed comparison of the improvements. Terry stated that it would be included in the report, but that the combined improvements show that information for each watershed other than the West Fork. He stated it would be included in the draft report.
- Terry stated that the report does not specifically recommend buyouts for particular areas, but the projects recommended are not focused on removing structures from the frequent storm events (2-year, 5-year) and these structures may be good candidates for buyouts.
- Jing stated that Darren Hess (MOCO) asked if buyouts would be included in the recommendation. Terry stated it could be but would like those thoughts from the study partners.

### 4. Activities Planned Next Month

- Terry stated the alternatives funding memorandum would include additional funding information from that presented in the primary alternatives memo. He stated the metrics would include flooding, damages, benefits, costs, funding, and social vulnerability/LMI areas.
- Terry stated that the report executive summary would be a stand-alone document focused on providing a comprehensive summary that is more user-friendly to non-engineers. He stated that the goal is to summarize the study and focus on the implementation of the projects. Dena agreed that this would be an important part of the messaging.
- Hector stated that the front-end document would be a good opportunity to answer the frequently asked questions.
- Jing asked when the executive summary would be complete. Terry stated it would be submitted with the draft report. Jing indicated that it would be a good idea to work on the Executive Summary document at the same time as developing the materials and message for the stakeholder and public meetings.
Terry agreed that these two objectives should share a consistent message and be developed in parallel.

5. **Technical Discussion**
   - Terry stated that he would like input on both the buyouts and detention policy on the language presented and if more information would be needed. Jing stated that Precincts 1 and 2 were interested in the detention policy recommendation.

   | Study Partners | Review detention and buyout sections and provide feedback. |
   | Study Partners | Review detention and buyout sections and provide feedback. |

5. **Administrative Discussion**
   - Terry asked that the stakeholders provide comments on the primary mitigation memo as soon as possible.
   - Terry asked if hard copies of the report needed to be printed. Jing stated that she would look into the requirements and ask stakeholders if they needed hard copies of the draft report.

   | Partners | to provide comments. |
   | Partners | to provide comments. |
   | HCFCD | to determine submittal requirements. |

6. Ms. Chen concluded the meeting.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
# STUDY PARTNERS MONTHLY MEETING AGENDA

**Study Partners: HCFCD, City of Houston, Montgomery County, SJRA**

July 8, 2020  
San Jacinto Regional Watershed Master Drainage Plan  
Teams Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:00 PM</td>
</tr>
</tbody>
</table>

## Agenda

<table>
<thead>
<tr>
<th></th>
<th>1. <strong>Introductions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td><strong>Communications and Outreach (Hollaway)</strong></td>
</tr>
<tr>
<td></td>
<td>• Planning for Community Meeting No. 2 – Scheduled for August 13th</td>
</tr>
<tr>
<td></td>
<td>• SJRA Board Meeting – 07/23/20</td>
</tr>
<tr>
<td></td>
<td>• Upcoming Stakeholder Briefings in July/Aug</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Activities Conducted this Month</strong></td>
</tr>
<tr>
<td></td>
<td>• Submitted Revised Sedimentation/Vegetation Memo</td>
</tr>
<tr>
<td></td>
<td>• Submitted Other Mitigation Actions Memo</td>
</tr>
<tr>
<td></td>
<td>• Work on Draft Report and Executive Summary</td>
</tr>
<tr>
<td></td>
<td>• Conducted Harris County Precinct 3 Briefings</td>
</tr>
<tr>
<td>4.</td>
<td><strong>Activities Anticipated Next Month</strong></td>
</tr>
<tr>
<td></td>
<td>• Submit Draft Report – 07/13/20</td>
</tr>
<tr>
<td></td>
<td>• Work on Final Report and Executive Summary</td>
</tr>
<tr>
<td></td>
<td>• Conduct COH Briefing</td>
</tr>
<tr>
<td></td>
<td>• Conduct Harris County Precinct 4 Briefing</td>
</tr>
<tr>
<td></td>
<td>• Conduct HCFCD Executive Briefing</td>
</tr>
<tr>
<td></td>
<td>• Conduct Stakeholder Briefings</td>
</tr>
<tr>
<td>5.</td>
<td><strong>Technical Discussion</strong></td>
</tr>
<tr>
<td></td>
<td>• Implementation Planning and Project Prioritization</td>
</tr>
<tr>
<td>6.</td>
<td><strong>Administrative Discussion</strong></td>
</tr>
<tr>
<td></td>
<td>• Draft Report Executive Summary</td>
</tr>
<tr>
<td>7.</td>
<td><strong>Questions</strong></td>
</tr>
</tbody>
</table>
Study Partners Progress Meeting
July 8, 2020 - DRAFT
<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Coordination and Communication

• Coordination
  – ROW Discussion – 06/05/20
  – SJRA Board Meeting – 07/23/20

• Communications
  – Plan Community Meeting No. 2
  – HC Precinct 3 Briefing – 06/30/20
  – July/August Briefings
    • HC Precinct 4 Briefing
    • Council Member Dave Martin
    • Congressman Crenshaw
    • State Representative Huberty
    • Montgomery County Drainage Council
    • Kingwood Association Management
    • Lake Houston Area Chamber
    • Community Activists (Bob Rehak, Barbara Hillburn)
Study Submittals

• Submitted
  – Primary Mitigation Alternatives Memo (06/08/20)
  – Secondary Mitigation Memorandum
  – Updated Calibrated Models
  – Updated Sedimentation/Vegetation Memo (06/26/2020)
  – Other Mitigation Actions (07/06/2020)

• Upcoming
  – Alternatives Funding and Implementation (07/13/20)
  – Draft Report (07/13/20)
  – Final Report (08/31/20)
Implementation

- **Metrics**
  - **Historical Damages** – Number of historically flooded structures based on the watershed
  - **Predicted Damages** – Number of instances of flooding per watershed based on a 50-year project life
  - **Flooding Instance Reduction** – Number of instances of flooding removed by the project
  - **Structures Removed** – Number of structures removed from the 1% ACE floodplain
  - **BCR** – Benefit Cost Ratio of the project
  - **Roadway** – Total depth of reduction of WSELs along modeled roadways for all frequency storm events
  - **SVI** – Average SVI of structures benefitted by project
  - **LMI** – Average LMI of structures benefitted by project
  - **Cost** – Total cost of project
Implementation

- Project Scoring
- Metrics are weighted based on priority
- Projects are assigned a score of 0 – 4 based on quartile compare to other projects
- Example: Walnut Creek Detention removes 1,296 structures from the 1% ACE. This project removes the most of all projects so receives a 4.0 as a score.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Assigned Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical Damages</td>
<td>10%</td>
</tr>
<tr>
<td>Predicted Damages</td>
<td>15%</td>
</tr>
<tr>
<td>Instance Reduction</td>
<td>20%</td>
</tr>
<tr>
<td>Structures Removed</td>
<td>20%</td>
</tr>
<tr>
<td>BCR</td>
<td>10%</td>
</tr>
<tr>
<td>Roadway</td>
<td>10%</td>
</tr>
<tr>
<td>SVI</td>
<td>10%</td>
</tr>
<tr>
<td>LMI</td>
<td>10%</td>
</tr>
<tr>
<td>Cost</td>
<td>5%</td>
</tr>
</tbody>
</table>
## Implementation

- Project Scoring

<table>
<thead>
<tr>
<th></th>
<th>Cost (SM)</th>
<th>Watershed Historical Damages&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Watershed Predicted Damages&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Instance Reduction&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Structures Removed from 1% ACE&lt;sup&gt;2&lt;/sup&gt;</th>
<th>BCR&lt;sup&gt;4&lt;/sup&gt;</th>
<th>Roadway</th>
<th>SVI</th>
<th>LMI&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Cost</th>
<th>Cost RAW</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walnut Creek</td>
<td>97.2–132.1</td>
<td>2.0</td>
<td>3.0</td>
<td>20%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
<td>0.0</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Birch Creek</td>
<td>81.6–121.6</td>
<td>2.0</td>
<td>3.0</td>
<td>20%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>DC2-200 Channel</td>
<td>53.6–203.6</td>
<td>2.0</td>
<td>3.0</td>
<td>0%</td>
<td>0%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
<td>0.0</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>I-45 Channel</td>
<td>81.2–231.2</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
<td>2.0</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>0.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Lake</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caney Creek Detention</td>
<td>98.0–163.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
<td>3.0</td>
<td>1.0</td>
<td>10%</td>
<td>10%</td>
<td>0.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Little Caney Creek</td>
<td>98.0–128.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Garret’s Creek Detention</td>
<td>107.0–131.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.95</td>
</tr>
<tr>
<td><strong>Peach</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walker Creek Detention</td>
<td>201.0–218.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>0.0</td>
<td>1.30</td>
</tr>
<tr>
<td>SH 105 Detention</td>
<td>356.0–433.0</td>
<td>1.0</td>
<td>1.0</td>
<td>3.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>0.0</td>
<td>4.0</td>
<td>0.0</td>
</tr>
<tr>
<td>I-69 Channel</td>
<td>161.0–311.0</td>
<td>1.0</td>
<td>1.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>0.0</td>
<td>4.0</td>
<td>1.30</td>
</tr>
<tr>
<td><strong>Caney</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detention at FM 1097</td>
<td>105.0–131.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
<td>1.0</td>
<td>2.25</td>
</tr>
<tr>
<td>Detention at SH 105</td>
<td>179.0–208.0</td>
<td>1.0</td>
<td>1.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>US 69 Channelization</td>
<td>194.0–209.0</td>
<td>1.0</td>
<td>1.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>East Fork</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter's Bayou Dam</td>
<td>134.0–166.6</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>West Fork</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River Plantation Channel</td>
<td>148.0–538.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>1.0</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Kingwood Benching</td>
<td>818.0–848.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>0.0</td>
<td>4.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
## Implementation

- **Project Ranking**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project</th>
<th>Score</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Caney - Detention at SH 105</td>
<td>3.00</td>
<td>179.0–208.0</td>
</tr>
<tr>
<td>2</td>
<td>Spring - Walnut Creek</td>
<td>2.60</td>
<td>97.2–132.1</td>
</tr>
<tr>
<td>3</td>
<td>Spring - I-45 Channel</td>
<td>2.60</td>
<td>81.2–231.0</td>
</tr>
<tr>
<td>4</td>
<td>Peach - I-69 Channel</td>
<td>2.55</td>
<td>161–311</td>
</tr>
<tr>
<td>5</td>
<td>East Fork - Winter's Bayou Dam</td>
<td>2.40</td>
<td>134.0–166.6</td>
</tr>
<tr>
<td>6</td>
<td>Caney - Detention at FM 1097</td>
<td>2.25</td>
<td>105.0–131.0</td>
</tr>
<tr>
<td>7</td>
<td>Spring - Birch Creek</td>
<td>2.10</td>
<td>81.6–121.6</td>
</tr>
<tr>
<td>8</td>
<td>Caney - US 69 Channelization</td>
<td>2.05</td>
<td>194.0–209</td>
</tr>
<tr>
<td>9</td>
<td>West Fork - Kingwood Benching</td>
<td>2.05</td>
<td>818.0–848</td>
</tr>
<tr>
<td>10</td>
<td>Peach - SH 105 Detention</td>
<td>1.75</td>
<td>356.0–433.0</td>
</tr>
<tr>
<td>11</td>
<td>West Fork - River Plantation Channel</td>
<td>1.75</td>
<td>148.0–593</td>
</tr>
<tr>
<td>12</td>
<td>Lake - Garret's Creek Detention</td>
<td>1.55</td>
<td>107.0–131.0</td>
</tr>
<tr>
<td>13</td>
<td>Peach - Walker Creek Detention</td>
<td>1.30</td>
<td>201.0–218.0</td>
</tr>
<tr>
<td>14</td>
<td>Lake - Caney Creek Detention</td>
<td>1.25</td>
<td>98.0–163.0</td>
</tr>
<tr>
<td>15</td>
<td>Spring - DC2-200 Channel</td>
<td>1.05</td>
<td>53.6–203</td>
</tr>
<tr>
<td>16</td>
<td>Lake - Little Caney Creek</td>
<td>0.95</td>
<td>98.0–128.0</td>
</tr>
</tbody>
</table>
# Implementation

- **Project Ranking - Adjusted**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project</th>
<th>Score</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Caney - Detention at SH 105</td>
<td>3.00</td>
<td>179.0–208.0</td>
</tr>
<tr>
<td>2</td>
<td>Spring - Walnut Creek</td>
<td>2.60</td>
<td>97.2–132.1</td>
</tr>
<tr>
<td>3</td>
<td>Spring - I-45 Channel</td>
<td>2.60</td>
<td>81.2–231.0</td>
</tr>
<tr>
<td>4</td>
<td>East Fork - Winter's Bayou Dam</td>
<td>2.40</td>
<td>134.0–166.6</td>
</tr>
<tr>
<td>5</td>
<td>Caney - Detention at FM 1097</td>
<td>2.25</td>
<td>105.0–131.0</td>
</tr>
<tr>
<td>6</td>
<td>Spring - Birch Creek</td>
<td>2.10</td>
<td>81.6–121.6</td>
</tr>
<tr>
<td>7</td>
<td>Caney - US 69 Channelization</td>
<td>2.05</td>
<td>194.0–209</td>
</tr>
<tr>
<td>8</td>
<td>West Fork - Kingwood Benching</td>
<td>2.05</td>
<td>818.0–848.0</td>
</tr>
<tr>
<td>9</td>
<td>Peach - SH 105 Detention</td>
<td>1.75</td>
<td>356.0–433.0</td>
</tr>
<tr>
<td>10</td>
<td>Peach - I-69 Channel</td>
<td>2.55</td>
<td>161–311</td>
</tr>
<tr>
<td>11</td>
<td>West Fork - River Plantation Channel</td>
<td>1.75</td>
<td>148.0–593</td>
</tr>
<tr>
<td>12</td>
<td>Lake - Garret's Creek Detention</td>
<td>1.55</td>
<td>107.0–131.0</td>
</tr>
<tr>
<td>13</td>
<td>Peach - Walker Creek Detention</td>
<td>1.30</td>
<td>201.0–218.0</td>
</tr>
<tr>
<td>14</td>
<td>Lake - Caney Creek Detention</td>
<td>1.25</td>
<td>98.0–163.0</td>
</tr>
<tr>
<td>15</td>
<td>Spring - DC2-200 Channel</td>
<td>1.05</td>
<td>53.6–203</td>
</tr>
<tr>
<td>16</td>
<td>Lake - Little Caney Creek</td>
<td>0.95</td>
<td>98.0–128.0</td>
</tr>
</tbody>
</table>
Draft Report Outline

• Executive Briefing
  – Overall summary of report and recommendations. High level review of project geared toward public officials; Graphical in nature

• Report Narrative
  – More detailed discussion of the process and findings for the various report sections; Limited discussion of technical modeling details

  1.0 Project Management
  2.0 Data Collection
  3.0 Existing Conditions Flood Hazard Assessment
  4.0 Analysis of Historical Storms
  5.0 Future Flood Risk Planning Assessment
  6.0 Primary Flood Mitigation Planning
  7.0 Secondary Flood Mitigation Planning
  8.0 Other Flood Hazard Mitigation Actions
  9.0 Community Outreach and Education
Draft Report Outline

• Detailed Appendices
  – Detailed information for each section including figures, tables, and exhibits. Detailed information regarding each task. Geared toward technical audience: engineers and technical agencies.

Appendix A - Project Management and Coordination (meeting agendas, minutes, etc.)
Appendix B - Data Collection (field observation, survey, previous report summaries)
Appendix C - Existing Conditions Flood Hazard Assessment (technical discussion, results)
Appendix D - Analysis of Historical Storms (detailed calibration memo)
Appendix E - Future Flood Risk Planning Assessment (future conditions memo)
Appendix F - Primary Flood Mitigation Planning (technical discussion, results, BCR, etc.)
Appendix G - Secondary Flood Mitigation Planning (Secondary mitigation memo)
Appendix H - Other Flood Hazard Mitigation Actions (Other mitigation memo, meeting data)
Appendix I - Community Outreach and Education (public meeting info and exhibits)
Appendix J – Digital Data (all digital information)
Executive Summary

• Outline
  – San Jacinto Regional Watershed Master Drainage Plan
  – San Jacinto River Watershed
    • Development in Watershed
    • Watershed Flood History
    • Sources of Flooding
    • Flood Damage Areas
    • Future Flooding Potential
  – Flood Reduction in the Upper San Jacinto River Watershed
    • Public Outreach
    • Data Collection and Review
    • Existing Conditions
    • Recommended Projects
    • Policy Recommendations
    • Flood Warning and Response
  – Project Implementation
  – Frequently Asked Questions
## Schedule Update

- **Existing H&H/Calibration** – 100% (Finalized)
- **Primary Mitigation Planning (Workshops Completed)** – 95%
- **Secondary Mitigation Planning (Adjusted Schedule)** – 100%
- **Other Mitigation Actions (Adjusted Schedule)** – 95%

### SAN JACINTO REGIONAL WMDP - PROJECT SCHEDULE

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Project Management, Coordination, and Document Control</td>
<td>457</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>457</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 2: Review and Assess Existing Data</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 3: Existing Conditions Hydrologic and Hydraulic Model Development</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 4: Analyze Historical Storm Events and Calibrate Models</td>
<td>105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 5: Future Conditions Hydrologic and Hydraulic Models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 6: Primary Flood Mitigation Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 7: Secondary Flood Mitigation Planning</td>
<td>189</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 8: Other Flood Hazard Mitigation Actions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 9: Community Outreach and Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 10: Final Deliverables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Current Progress:** 54%

**Days Remaining:** 478

**Completion Date:** 8/12/2019
### STUDY PARTNERS MONTHLY MEETING AGENDA

**Study Partners: HCFCD, City of Houston, Montgomery County, SJRA**

August 11, 2020  
San Jacinto Regional Watershed Master Drainage Plan  
Teams Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Progress Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:30 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:00 PM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>6.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>7.</td>
</tr>
</tbody>
</table>
Appendix A.4

Supporting Partners Meetings
### Agenda

#### 1. Attendees (See attached sign in sheet)
- Terry Barr, Halff Associates, Inc.
- Jing Chen, HCFCD
- Gary Bezemek, HCFCD
- David Lilly, Grimes County Emergency Manager
- Joe Fauth, Grimes County Judge

#### 2. Study Overview
- Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
- Terry provided an overview of the study goals and objectives:
  - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
  - Primary Mitigation Planning – Look at structural improvements and drainage policy
  - Secondary Mitigation Planning – Focus on gages and flood warning capability
  - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
  - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
- Terry provided an overview of the study schedule
- Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).

#### 3. Input from Local Jurisdiction
This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
- They are expecting significant growth in the SH249 corridor up to SH105 over the next 10 years; Major developers are already looking at the area
• Todd Mission is poised for growth; Economic and growth planning are needed
• Grimes/Montgomery County have several proposed developments and they are trying to get ahead of future development
• Along Mill Creek, there is significant flooding at the Grimes County line; they are considering buyouts in those areas
• There is not any flood data available or good modeling in that area; All of Grimes County mapping are Zone A, so there is no detailed H&H modeling
• Drainage Criteria
  ○ Floodplain Ordinance applicable to developments in the floodplain
  ○ Takes an aggressive approach (overall goal is No Adverse Impact)
  ○ Outside flood zone there are currently no detention requirements (Subdivision Regulations are only enforcement mechanism)
  ○ Any criteria for Todd Mission?
  ○ Unaware of Atlas 14 and no plans to implement it; HCFCD agreed to send a link to Atlas 14 data to the County. Data was subsequently sent on 8/7/19.
• Talking with USACE about adding gages so they are open to adding some (FWS, Emergency efforts, etc.)
• HCFCD is encouraging jurisdictions to use the information developed in the San Jac WMDP to update their respective Hazard Mitigation Plans (HMP). Grimes Co. is currently updating their HMP.
• Consider Mill/Lake Creek as a gauge location. Reach out to D. Lilly for more specific information.
• Judge Fauth – Requested that we reiterate the study timeline.
• Jing – Wrapped up the meeting
• David – Mill Creek near Grimes County line is one of their most impacted areas.
• Professor George Allen (Texas A&M) – Merit Hydro (KBTX)
• Judge – Appreciated our involvement and our sharing the information with them
• Consider gages up in the upper reaches. Currently some HCFCD gages (Stage Only)
• Our Spring Creek MAAPnext modeling will include a 1D model of Mill Creek in that area
### Agenda

#### 1. Attendees (See attached sign in sheet)
- Terry Barr, Halff
- Andrew Moore, Halff
- Jing Chen, HCFCD
- Gary Bezemek, HCFCD
- Yancy Scott, Waller County Engineer

#### 2. Study Overview
- Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
- Terry provided an overview of the study goals and objectives:
  - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
  - Primary Mitigation Planning – Look at structural improvements and drainage policy
  - Secondary Mitigation Planning – Focus on gages and flood warning capability
  - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
  - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
- Terry provided an overview of the study schedule
- Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).

#### 3. Input from Local Jurisdiction
This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
• The County Fire Marshal is the Emergency Management Coordinator and in charge of the Hazard Mitigation Plan (HMP); The County Engineer is the Floodplain Manager and can provide input to update the county HMP
• Per the HGAC 2040 Plan, development is expected along the US290 corridor and along FM1488 between Magnolia and Hempstead.
• Along FM1488 there is quite a bit of development, including 3-4 planned developments (MUDs) that encompass about 2000 ac.
• There is quite a bit of flooding in Clear Creek Forest
• The Waller County Strategic Plan was updated in 2018 and is on their website
• Drainage criteria is part of the Subdivision Regulations and requires that developers demonstrate no increase at the point of release (No Adverse Impact)
• The drainage criteria may be updated in the future when planning and development regulations are updated.
• The City of Waller uses Harris County regulations and Waller County may change at some point to follow a similar pattern; they have had a detention criteria since the 2000’s
• Flooding History
  o County has some maps for Tax Day/Memorial Day/Harvey (FEMA Claims)
  o No HWM program, resident information only
  o South of FM 1488 to Spring (Brushy, Three-mile, Walnut, Birch)
  o Development in many areas right up to the creeks.
  o FIRM Maps (fairly accurate) but there are still some areas with Zone A
  o Minimal CIP/Maintenance ability outside of county road ROW, which is limiting
  o Are MUD’s responsible for maintenance of their channels?
  o FM 1488 Regularly floods (2017)
• County is considering drainage districts by watershed, but politics may slow that down.
• Some new gages to be installed or have recently been installed.
• City of Waller participated in Upper Cypress Study. Prairie View has may or may not have or enforce detention requirements. PVAMU drains into Cypress Creek.
• Interested in detention; Waller Co. thinks they don’t have statutory authority to require detention for sites
# SUPPORTING PARTNERS MEETING NOTES

*City of Conroe*

August 13, 2019
San Jacinto River Watershed Master Drainage Plan
Conroe City Hall

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Supporting Partners Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>10:00 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>11:00 AM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Attendees (See attached sign in sheet)**
   - Terry Barr, Halff
   - Andrew Moore, Halff
   - Jing Chen, HCFCF
   - Gary Bezemek, HCFCF
   - Mike Legoues, Conroe Fire
   - Christy Bryant, Conroe EMS
   - Anne Tran, City of Conroe Floodplain Management
   - Norm McGuire, City of Conroe Public Works
   - Cams Bogert, City of Conroe City Engineer
   - Ann Colina, City of Conroe Floodplain Management

2. **Study Overview**
   - Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCF, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   - Terry provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Terry provided an overview of the study schedule
   - Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).
3. **Input from Local Jurisdiction**

This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.

- The City of Conroe currently regulates with the FEMA model (Halff model)
- There is currently an internal discussion about which model to use for regulating
- They City does not currently plan on using Atlas 14 rainfall
- They did not have too many issues with Hurricane Harvey but did have some flooding with the Tax Day 2016 storm
- They City is growing very rapidly in all sectors at all boundaries and internally.
- They have the ability to annex ETJ areas by providing utilities (N/W)
- The City is expected to double in size in 20 years (Metro Study done for their WWMP)
- Not too many issues with criteria except that there is a disconnect between the City of Montgomery County with respect to Atlas 14
- Conroe would like more updated FEMA maps
- Current TDWB Study was finalized this month and could be LOMR’d
- Hurricane Harvey impacts were limited to flooding caused by the Lake Conroe dam releases
- The Tax Day storm resulted in more flash flooding in town
- October 1994 storm had localized stream flooding and a berm breached at the sewer plant
- There are currently gages at SH 105 & IH-45 that they utilize, but the SH 105 gage does not provide much useful information. What about putting a gage at FM 2854?
- Conroe staff are working to convince the City Council that gages are needed and could possible leverage TWDB funding
- The study team asked about any additional studies in the area. They City indicated that we already have most of their studies (Little Caney?)
- Flood hotspots are at FM 2854, IH-45, residential neighborhoods along the West Fork; during Harvey – 1 lane blocked at SH105 and FM 2854 was not passable.
- Are there any plans available for the FM 2854 TXDOT improvements? They will look
- The City would like to help any way they can but can’t commit to maintaining additional channels that have been improved
- They currently maintain improved channels within their jurisdiction, but not unimproved channels
- The biggest challenges to projects that they face are ownership/maintenance
- Which benchmarks were used for survey? FEMA does not regularly maintain benchmarks. The TSARP benchmarks are being updated as part of the MAAPnext effort.
- Gary discussed the Harris County Flood Warning System and the MAAPnext program
- Jing – consider partnerships for programs (grants, projects)
- Buyouts – Many people took out a second mortgage to fix homes, so there is a concern that the buyout will not cover those additional costs, making buyouts unattractive to homeowners. For this reason, the City does not appear to look favorably on buyouts. In lieu of an actual buyout program, they may not issue permits to rebuild in flood damaged areas. Gary provided a brief overview of buyout program in Harris County.
### SUPPORTING PARTNERS MEETING NOTES

**Walker County**

August 13, 2019  
San Jacinto River Watershed Master Drainage Plan  
Bleyl Engineering, Conroe

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Supporting Partners Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>11:30 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>1:00 PM</td>
</tr>
</tbody>
</table>

#### Agenda

1. **Attendees (See attached sign in sheet)**
   - Terry Barr, Halff
   - Andrew Moore, Halff
   - Jing Chen, HCFCFD
   - Gary Bezemek, HCFCFD
   - Ryan Londeen, Bleyl Engineering
   - Steffanie Deloss, Bleyl Engineering
   - Andrew Isbell, Walker County Planning and Development Director

2. **Study Overview**
   - Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCFD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   - Terry provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Terry provided an overview of the study schedule
   - Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).

3. **Input from Local Jurisdiction**
   This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
• There are over 1,000 lots under development in the watershed (West Fork) and more going into Caney Creek (Texas Grand Ranch); Also I-45 commercial district (3000 Ac.) Large lots.
  • Walker County (WCO) has a detention criteria but does not currently use Atlas 14
  • Would be interested in the modeling that comes out of the study
  • WCO is experiencing development pressure from Houston and Sam Houston S.U.
  • In many of the new development there are “No Build” easements along floodplains, most of which are Zone A and are buffered (25-50 ft)
  • If WCO is going to implement change, they feel like they need to do soon since it is starting to develop rapidly
  • City of Huntsville has water contracts (ETJ), but floodplain permitting is county’s responsibility.
  • Most development is between the West Fork Main stem and I-45.
  • Mr. Isbell indicated he could provide any models that they have from development to study team.
  • The WCO detention criteria not great but they are working on new subdivision regulations to strengthen the county’s ability to prevent adverse impacts; this is expected to be ready in the next 30 days. WCO currently only look pre- vs. post-development discharge rates. Smaller lots (< 1 ac) are not regulated.
  • Harris Co. has different regulations than other counties; There are currently no statutes that allow enforcement of drainage criteria; maybe floodplain permitting; A drainage conveyance easement is not currently required, only a note on the plat indicating preserving drainage conveyance
  • A big part of flood mitigation is the regulatory aspect; the earlier the better
  • WCO needs to develop BFE’s in the floodplain (currently Zone A); Need FEMA approved detailed studies for major developments.
  • The San Jac study models potentially use our data as “Best Available” for Zone A regulation
  • WCO currently allows a max 1 ft rise within the development property boundary but they would prefer a “No Rise” criteria
  • Mr. Barr asked what mitigation actions they would like to see? WCO indicated that Lake Conroe is currently their detention.
  • WCO does not currently have traffic studies or a master plan; Their population growth estimates (HGAC) are likely underestimating the actual growth. They work with TXDOT Bryan District.
  • The Trinity River is not studied in detail south of the D/FW Metroplex
  • Most of WCO’s flooding is in the Trinity River basin. Not many issues in the SJR Basin
  • Steam gages would be of interest to WCO, particularly in the Wildwood Shores neighborhood; WCO is considering using a FEMA grant to get some gages
  • WCO is interested in seeing the information that comes out of this study.
  • WCO asked how we are handling Atlas 14 for the study? The study team is using the average depth for each watershed.
  • Walker County has had some issues with BLE accuracy and has concerns about the public seeing the data and coming back at FEMA/others.
  • How are we modeling Lake Conroe (In=Out; Per criteria; no release) Max elevation should be considered. Can lake ops be a potential alternative? They hope that we can identify future studies/mapping needs.
  • Interested in staying informed about and possibly participating in the regulatory discussion that could be a part of the alternatives analysis.
STUDY PARTNERS MEETING NOTES
San Jacinto River Authority

August 26, 2019
San Jacinto River Watershed Master Drainage Plan
SJRA Woodlands Office

Meeting called by: Jing Chen, P.E., CFM  Type of Meeting: Study Partners Meeting
Facilitator: Terry M. Barr, P.E., CFM  Meeting Start Time: 1:00 PM
                        Meeting Stop Time: 2:00 PM

Agenda

1. Attendees (See attached sign in sheet)
   - Terry Barr, Halff
   - Andrew Moore, Halff
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - Beth Walters, HCFCD
   - Matt Barrett, SJRA Engineering
   - Chuck Gilman, SJRA Director of Flood Management
   - Heather Cook, SJRA Communications
   - Michael Reedy, Freese & Nichols

2. Study Overview
   - Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities and collecting information to inform this planning effort. The results will be distributed throughout the watershed once planning is complete for communities to consider incorporating the results and updating their HMPs.
   - Terry provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Terry provided an overview of the study schedule
   - Terry provided an overview of the Community Outreach efforts and mentioned the website, which is www.sanjacstudy.org.
3. **Input from Local Jurisdiction**

This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.

- The study presents an opportunity for Montgomery County (MCO) and partnering agencies to reduce flood risk from the upper reaches through Lake Houston.
- SJRA expressed concerns related to flooding across the entire San Jacinto Basin, but historically have had more public input from residents in Grogan’s Point, MUD 386 (Woodlands), Timber Lakes/ Timber Ridge, Kingwood, and Lake Houston. There has not been as much public input from the east side residents.
- SJRA would like to provide guidance to local communities.
- Chuck stated that the drainage criteria and subdivision regulations are within the purview of the cities and counties within the watershed; SJRA has no enforcement authority but supports the efforts of Montgomery County.
- Jing asked if SJRA is concerned about erosion in the major rivers. Chuck stated that the SJRA is more concerned about sedimentation and the impacts on reservoir capacity and flooding.
- With respect to public outreach, Cook stated SJRA is working on a “Know Your Watershed” website.
- SJRA has partnered with HCFCD to study the feasibility of sand traps in the San Jacinto River Watershed.
- Planting/stabilization may be one option to help to reduce erosion.
- SJRA has a substantial network of ALERT gages but they rely on Montgomery County to perform road closures and evacuations.
- Cook asked how the public was going to be made aware of the new study website. Jing stated she would check with Hollaway on the process. Cook recommended a partnership in relaying information to the public.
**STUDY PARTNERS MEETING NOTES**  
*Montgomery County*

August 26, 2019  
San Jacinto River Watershed Master Drainage Plan  
SJRA Woodlands Office

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>3:00 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>4:00 PM</td>
</tr>
</tbody>
</table>

### Agenda

1. **Attendees (See attached sign in sheet)**
   - Terry Barr, Halff
   - Andrew Moore, Halff
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - Beth Walters, HCFCD
   - Michael Reedy, Freese and Nichols
   - Darren Hess, Montgomery County Emergency Manager

2. **Study Overview**
   - Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   - Terry provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Terry provided an overview of the study schedule
   - Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).

3. **Input from Local Jurisdiction**
   This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
• Several master planned communities are in progress and will be completed in the near future. They are all over Montgomery County, not just in one area. Approx. 20,000 new rooftops are expected in the southern portion of the county.

• There is an item on the agenda related to the detention policy and the allowance for an impact analysis to demonstrate that no detention is needed. Not sure how detention item will play out but they are still interested in looking at that alternative.

• Much of the urban flooding is along Stewart and Alligator Creeks

• Montgomery County is focusing on property acquisition; they are hoping to see 300+ buyouts.

• Interested in the study results and recommendations for Lake Creek; There has been a history of loss of life during major flooding events at low water crossings.

• They are also interested in early warning/detection along Lake Creek; The creek generally rises quickly but has a slow decent, so near flash flooding conditions followed by lengthy flooding period.

• The East Fork at the county line floods a lot (Plum Grove).

• Most of the state roads close during major rainfall events.

• They are looking at buyouts in Patton Village.

• Montgomery County would also like to see gages outside of MOCO so that they can get better warning for flood conditions in their jurisdiction. Focus on upland areas with sparse gage coverage, especially on the east side.

• MOCO preference would be to focus just on gages, not road closure arms, which are more expensive and were not approved when previously presented.

• MOCO will send road closure information for the study team’s use.

• Use of the National Forest for detention is of interest to MOCO.

• MOCO does not believe the current flood maps are very accurate. The floodplains are either too small or some area not included at all.

• The EOM relies on notifications from SJRA to alert them and then they start to make notifications.

• How can we help to improve this process? Would a shared network be beneficial? MOCO mentioned that having a better idea of response times from one area to the next would help them make decisions about road closures and, if needed, evacuations.

• How can we share this information most efficiently?
  
  o The HGAC system ties the counties together, but each county has their own notification systems.
  
  o They currently leverage Web EOC activity boards
  
  o HCFWS can send alerts – MOCO would like something similar.
  
  o What would they like to see? Rainfall? Elevations? Channel status? Response times? Flooded crossings?
  
  o They would like to see warnings go to the EOC rather than to the public all the time. The public can get worn out with alerts during a major event and may ignore the notifications.

• MOCO is responsible for everyone but (Conroe, Shennandoah) but the entities have good communication.

• They have a few locations called Instant Command Center (Regional EOC-like).
# SUPPORTING PARTNERS MEETING NOTES

**San Jacinto County**

August 27, 2019
San Jacinto River Watershed Master Drainage Plan
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Supporting Partners Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>10:30 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>11:30 AM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Attendees (See attached sign in sheet)**
   - Terry Barr, Halff Associates, Inc.
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - David Brandon, San Jacinto County Commissioner, Precinct 3
   - Laddie McAnally, San Jacinto County Commissioner, Precinct 1
   - Dena Green, HCFCD
   - Heather Cook, SJRA
   - Matt Barrett, SJRA

2. **Study Overview**
   - Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   - Terry provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Terry provided an overview of the study schedule
   - Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).

3. **Input from Local Jurisdiction**
   This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
Inundation data in the San Jacinto County (SJCO) is limited since Livingston is used for water supply and inundation around the lake is not recorded.

Mr. Brandon monitors rainfall and flood concerns in Grimes County to see what potential flooding may occur later in San Jacinto Co.

Their evacuation routes are very limited since most roads are flooded

They have noticed a dramatic difference in storms and resultant flooding due to sedimentation over the past several decades, particularly on Peach Creek and the East Fork.

Luce Bayou at US 59 is a major problem because it acts as a giant Levee; Harvey was worse than the October 1994 storm with tremendous flooding along US 59 corridor.

There is only 1 gage in San Jacinto Co. (Peach Creek)

Most of their roads underwater (SH 150, FM 945, FM 2025) by as much as 10-15 ft.

Dammed up vegetation on major/minor streams broke through and caused problems D/S during Hurricane Harvey.

Tarkington Bayou at US 59 is biggest area of concern.

Floods from 2004 to current (2016/2017) have had more impact at Cleveland.

Mr. Brandon follows the “flood wave” and can tell by condition of one area what potential conditions are downstream and when flooding may occur.

There are some written records about HWM but no survey data.

Creekwood Subdivision homes flooded during Harvey.

There was significant East Fork flooding during Harvey as well (Harvey Shaw Rd, FM 1945)

Large tracts are being subdivided/developed; Development is starting to get more dense and the number of permit requests to SJCO has tripled

US 190 going to be a loop at some point in the future.

Does SJCO have a development or drainage policy?

- Currently minimal but being worked on. Submitted NOI for drainage study (FEMA BLE; County is completely Zone A (unstudied)
- Limited enforcement capability (subdivision regs)
- 2017 Adopted NFIP changes (2ft above BFE)

Most county roads are old forest roads that were dedicated to SJCO; Title 3 funds are provided for the maintenance of those roads.

Project team asked about the potential for providing detention in the National Forest

- Mr. Brandon indicated that a dam was recommended for the East fork (DAM C) many years ago – Martin Dyess Park
- Mr. McAnally was not sure if we could dam through the National Forest (tree health, road access, property) – Eagles, woodpeckers
- We would need to talk to the National Forest Service Lufkin HQ
- Terrain could be problematic because the area is hillier than Harris Count
- There may be come flatter areas that could provide sufficient storage
- Possibly but it is large tract farmland; might be more conducive to storage (peach, boggy, gum) Look at terrain dataset.

Mr. Brandon revealed that Peach Creek was formed by an earthquake in 1922

Study team asked about the SCJO wish list – If you could change authority, what would help most?

- Building codes would help SJCO manage development more efficiently.
- Very limited ability to regulate RV’s (RV parks)
- People wait until last minute to evacuate.
| • As far as Emergency Management, SJCO has an EOC, rescue boats, deuces (large trucks from the NFS) |
| • SJCO works with TXDOT and has started dialogue to raise some of the roads. |
| • SJCO has issues with mandatory evacuations in the urban areas (other jurisdictions) that clog roadways. The county’s current policy is to stay in place. |
| • TRA communicates well during events. |
| • What kind of communication would you like? Better communication from neighboring counties; more gauges. |
| • Gages would be beneficial at: East Fork at SH 150; Winters Bayou at SH 150; Along SH 105 near FM 1725; the type of gage (rain, stage, flow) needed depends on location. |
| • TXDOT (10-20 years) is looking to elevate bridges at SH 150 and FM 945 S. This could potentially be leveraged in the long term for flood storage. Is there existing development in these areas? |
| • $12M road expansion of SH 150 from FM 945 to FM 1097 |
| • Flood wave travel time is 1 day from SH 150 to next major road (??) on Winters Bayou. |
STUDY PARTNERS MEETING NOTES  
City of Houston

September 6, 2019  
San Jacinto River Watershed Master Drainage Plan  
Skype Conference Call

Meeting called by: Jing Chen, P.E., CFM  
Type of Meeting: Study Partners Meeting
Facilitator: Terry M. Barr, P.E., CFM  
Meeting Start Time: 1:30 PM
Meeting Stop Time: 2:30 PM

<table>
<thead>
<tr>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Attendees (See attached sign in sheet)</strong></td>
</tr>
<tr>
<td>• Terry Barr, Halff</td>
</tr>
<tr>
<td>• Sam Hinojosa, Halff</td>
</tr>
<tr>
<td>• Andrew Moore, Halff</td>
</tr>
<tr>
<td>• Jing Chen, HCFCD</td>
</tr>
<tr>
<td>• Gary Bezemek, HCFCD</td>
</tr>
<tr>
<td>• Michael Reedy, Freese &amp; Nichols</td>
</tr>
<tr>
<td>• Cory Stull, Freese &amp; Nichols</td>
</tr>
<tr>
<td>• Adam Eaton, Houston Public Works Planning Department</td>
</tr>
</tbody>
</table>

| **2. Study Overview** |
| • Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs. |
| • Terry provided an overview of the study goals and objectives: |
|   • Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model |
|   • Primary Mitigation Planning – Look at structural improvements and drainage policy |
|   • Secondary Mitigation Planning – Focus on gages and flood warning capability |
|   • Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure |
|   • Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions |
| • Terry provided an overview of the study schedule |
| • Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org). |
3. Input from Local Jurisdiction

This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.

- Kingwood area is currently built out and they are not anticipating much development downstream of the lake. Adam stated he can look into any studies of population growth in that area.
- Looking for an update to the drainage criteria for the City. Currently the planning group is considering requiring both the City IDM and the Atlas 14 rainfall based on the HCFCD criteria for their drainage evaluations.
- What is the current status of the Lake Houston gates? Is the City of Houston wanting modeling done as part of this study?
  - The gates appear to be moving toward a design phase, which will include detailed analysis of the configuration, costs, and benefits.
  - KIT looking into a hydrodynamic model to determine any potential impacts. The City didn’t see flooding on the lake during Hurricane Harvey, except around the channels leading into the lake.
  - COH has determined that the flooding in Kingwood was a result of the flooding along the channels, not the backwater from Lake Houston.
  - Any changes to the lake need to consider the new 400 MGD treatment plant.
  - Houston Water is interested in how flood mitigation alternatives may impact the lake with an eye toward the treatment processes and water quality.
- Would the City be interested in looking at pre-release of the lake? Adam will check into the need for the City. Sam stated that looking into the gate operations will be needed. He asked for any information that is available as part of previous studies.
- Gary stated that many of the detention on the small channels that feed into Lake Houston may have some timing impacts on the lake, but not volume impacts. Is the City interested in reviewing the detention regulations for Lake Houston?
- Jing requested 4 reports from the City regarding dredging and sedimentation operations. Mike stated that all of these reports would be beneficial for the study. The reports requested include the following:
  1. USACE 2018 West Fork San Jacinto River Emergency Dredging (I-69 to Lake Houston):
     - HEC-RAS Model
     - Plans & Specs
     - Pre & Post Construction Surveys
     - Dredged Material Disposal Site Locations & Conveyance Corridors
     - Dredging logs or Lessons Learned
  2. TWDB Contract No. R1248011430 with U.S. Army Corps of Engineers, Fort Worth District, 2011 and Report - Planning Assistance to States (?).
  4. USACE individual permit number SWG-2018-00916 application by City of Houston for disposal of future dredged material, dated April 1, 2019.
- Mike also stated that the City had packaged a submittal to FEMA that included benefit cost information which would also be helpful to understand the benefits. Adam stated that he
has not been able to find the permit application. Mike stated that CWA may have the information.

- Gary asked if the flooding is caused by the West and East Fork Rivers, then will this study address the flooding issue and recommend a solution or will it be conducted in the gate study? Sam stated that the study should include the gates but will also look into the reduction flooding on the West Fork. The intent of the San Jacinto study is not necessarily to evaluate gate sizing and optimization on Lake Houston, but additional gates can be accounted for.

- How certain the City is that they will receive the federal funding for the gates? Gary stated that if the gates are tied to federal funding, then the benefit cost will have to be positive to receive the funding.

- Adam stated he is not sure of far upstream residents would notice the impacts of the gates.

- Gary stated that the study should identify how Kingwood flooded in historical events. The partners should coordinate with the gate study to understand the new gate study.

- Mike stated that the gate study will look into a BCR analysis based on several gate scenarios but it will be completed after this study. He stated that the team could make some assumptions based on what we know of the Lake Houston gates. Terry stated that any assumptions would have to be clearly identified in the report.

- Adam stated that the City is looking for any kind of reduction in flooding through Kingwood, no specific areas have higher priority than others.

- What do you see as a success for this study? Houston Water wants to make sure there are no major operation changes to the Lake Houston including sedimentation and quality. The City relies heavily on the gages coming into the lake to understand how to adjust the water treatment process.

- What are the City’s Flood Mitigation goals? To make Kingwood happy by addressing their needs; there is a lot of political pressure in that area, so we want to make sure that we are addressing that community

- Gary asked how big of an issue sedimentation and bacteria are. Adam indicated that improvements to the water quality would be seen as beneficial. Any increase in turbidity (sedimentation) would not be beneficial for the City. Proposed mitigation options that are recommended as part of the study may require a study of the future water quality to understand how the processes would be impacted.

- Jing asked for the status of the mouth bar dredging. Adam stated he was not sure at the moment but would look into the status.

- Jing stated that the Draft Existing H&H model review should be completed by 9/9/2019 with the report by the end of that week. She stated that HDR is reviewing the BDF parameters and is reviewing the methodology.

4. **Summary of Questions for City of Houston**

   - What is the current status of the Lake Houston gates? Is the City of Houston wanting modeling done as part of this study?
   - Would the City be interested in looking at pre-release of the lake?
   - Is the City interested in reviewing the detention regulations for Lake Houston?
   - How certain the City is that they will receive the federal funding for the gates?
   - What does the City see as a success for this study?
   - What are the City’s Flood Mitigation goals?
   - What is the status of the Mouth Bar dredging?
STUDY PARTNERS MEETING NOTES

Harris County Flood Control District

September 12, 2019
San Jacinto River Watershed Master Drainage Plan
HCFCD, Brookhollow

Meeting called by: Jing Chen, P.E., CFM  Type of Meeting: Study Partners Meeting
Facilitator: Terry M. Barr, P.E., CFM  Meeting Start Time: 11:00 AM
Meeting Stop Time: 12:00 PM

Agenda

1. Attendees (See attached sign in sheet)
   - Terry Barr, Halff
   - Sam Hinojosa, Halff
   - Andrew Moore, Halff
   - Cory Stull, FNI
   - Hector Olmos, FNI
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - Matt Zeve, HCFCD
   - Ataul Hanan, HCFCD
   - Dena Green, HCFCD

2. Study Overview
   - Terry introduced the meeting and the purpose for collecting goals and input from each local jurisdiction. He summarized the purpose of the study and the study deliverables.

3. Input from Local Jurisdiction
   This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
   - Terry introduced the meeting and the purpose for collecting goals and input from each local jurisdiction
   - Matt stated the goals should include 1) Educating the public, 2) coming up with a project to seek funding, 3) Cooperating with surrounding counties, and 4) determining a consistent drainage criteria for the watershed.
   - Matt stated that the focus should be on the plan to advocate to the public and governmental agencies and that the focus should be on which projects reduce flooding and watershed wide updates to drainage criteria
   - Gary expressed interest in knowing what future gages would have be beneficial for future calibration efforts for the basin noting the lack of gages in the upper reaches of the watershed.
   - Matt requested that progress updates be prepared and sent to both study partners and supporting partners to keep all entities involved in the project.
   - Sam asked for the district’s recommendation for modeling the Lake Houston gates since there is a potential project for increasing the gate capacity. Matt recommended modeling the existing gates only as the proposed gates will be modeled and optimized in a future study.
• Matt requested the study recommend a project(s) to be used for the State Flood Plan. Terry mentioned that dual use facilities achieve higher scoring. Matt mentioned looking into potential water supply or recreation as potential dual use facilities for the flood control reservoirs. Matt requested the study provide a one pager on the recommended project(s). He recommended the study team be involved on the State Flood Plan and coordinate with Saul Nuccitelli to understand what the state will be looking for concerning potential projects.

• Gary mentioned that some entities are wanting new maps. Matt mentioned that one goal can be developing a policy for new mapping. Ataul mentioned that HCFCD could host a workshop to discuss funding opportunities for creating new maps. Gary mentioned that the study could show the change in floodplain due to the new Atlas 14 rainfall.
# STUDY PARTNERS MEETING NOTES

*Montgomery County*

September 13, 2019  
San Jacinto River Watershed Master Drainage Plan  
Montgomery County Engineering

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Study Partners Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Sam Hinojosa, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>9:30 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>11:30 AM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Attendees (See attached sign in sheet)**
   - Sam Hinojosa, Halff
   - Andrew Moore, Halff
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - Beth Walters, HCFCD
   - Jeff Johnson, Montgomery County
   - Diane Cooper, Montgomery County

2. **Study Overview**
   - Sam introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. He stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collect information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   - Sam provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Sam provided an overview of the study schedule

3. **Input from Local Jurisdiction**
   This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
   - Jeff stated that the county wanted to minimize flooding for public safety concerns. He stated that the study should have a concrete set of recommendation for flood control
dams. He stated that the projects should have actual costs for publication to the general public and local officials. Diane added that frequency and amount of overtopping of roads would be

- Jeff mentioned that justification for the proposed flood mitigation projects would be beneficial for future implementation. He stated that getting public buy in for the plan would bolster the ability to access public funding.
- Diane mentioned that having accurate flood models will be a success for the project. She stated that the study should show the new Atlas 14 extents and identify potential drainage issues throughout the county. Gary mentioned having comparisons to the existing floodplain to show where the floodplain may especially be outdated.
- Diane stated that the final product should include an implementation plan that could be referenced in the event of a future disaster and public funding is available.
- Jeff stated that having a comprehensive gage network would be indispensable for public warning during storm events. He stated that the public needs a simple place to go to learn and reference during an event. Diane added that public education for reading and understanding the National Weather Service dataset would be beneficial.
- Diane stated that it would be helpful if the study recommended future study for the tributaries to the main streams as these are not currently updated mapping in the county.
- Diane stated that Darren Hess had a dataset of the flooded roads throughout the county. She also stated that the County had records of the impacted homes for the recent storm events.
- Diane stated that the engineer’s office has a high interest in updating the FEMA maps and models, however funding is limited. Gary stated that new maps would be beneficial to ensuring new development is not located within potential floodplains. Diane stated that the maps in East County needed refinement.
- Jeff stated that any policy recommendations would need to have significant engineering backing in order to be implemented in the county. He stated that policy changes are likely needed throughout the region.
- Diane stated that the new FEMA regulations and insurance rates proposed could alter the perception of large-scale projects and make them more appealing.
- Sam asked if the county had any high-water marks. Jeff and Diane stated they were not aware of any.
- Jeff stated that developers have to show no adverse impact for anything over 15,000 sq ft.
- Diane showed the Montgomery County Flood Story Map showing the structures inundated in major storm events. She stated that the map only showed the residential structures. She also stated that the numbers are likely low as renters do not typically report flooding in the homes.
- Diane recommended “moving the Hurricane Harvey event” around the San Jacinto River basin to determine how the storm would have affected the basin if it had taken a different path. She recognized that this effort was not part of the scope of work but should be considered.
- The meeting was concluded.
**Meeting called by:** Jing Chen, P.E., CFM  
**Type of Meeting:** Supporting Partners Meeting  
**Facilitator:** Sam Hinojosa, P.E., CFM  
**Meeting Start Time:** 11:00 AM  
**Meeting Stop Time:** 12:00 PM

### Agenda

**1. Attendees (See attached sign in sheet)**
- Sam Hinojosa, Halff Associates, Inc.
- Andrew Moore, Halff Associates, Inc.
- Jing Chen, Harris County Flood Control District
- Matt Barrett, San Jacinto River Authority
- Harry Walker, Grimes County Road and Bridge Engineer
- David Lilly, Grimes County Emergency Manager

**2. Study Overview**

- Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
- Sam provided an overview of the study goals and objectives:
  - Assess basin vulnerability – Update H&H modeling for the basin. Hydrology of Lake Creek is being updated in Grimes County. Calibrating base models to historical data and simulating Atlas 14 rainfall information. Goals do not include updating FEMA effective mapping.
  - Primary Mitigation Planning – Look at structural improvements to reduce flood risk and drainage policy
  - Secondary Mitigation Planning – Focus on gages and flood warning capability
  - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure. Identify funding sources
  - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
- Sam provided an overview of the study schedule
- Jing provided an overview of the public meetings within Harris County. She stated the meetings will be open house/expo style summarizing the different components of the project.
- Jing mentioned that the study team is meeting with supporting partners to obtain input and provide updates.
• Sam and Jing provided an overview of the Community Outreach efforts and mentioned the website, which is www.sanjacstudy.org.

3. **Input from Local Jurisdiction**

This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.

- Harry stated that the county does not have studied base flood elevations and asked whether this study will provide base flood elevations. Sam and Jing stated that elevations would be available for the main creeks that are being studied. He stated that hydraulic models for the tributaries of the main creek are not being developed for this study.
- David asked if the USACE was identifying potential sites for detention/retention reservoirs. He also asked if they are a major player in study? Sam stated that the USACE would possibly take the recommendations of the study done and perform a feasibility study. Any large reservoirs to be constructed would likely need federal funding and oversight.
- David asked if there any reservoirs or large detention basins are proposed in Grimes County. Sam stated that basins had yet to be identified, but that there is potential on Lake Creek. David mentioned that land may be available in the upper end of the Spring Creek watershed along Mill Creek. He mentioned that there are buyouts being conducted in this area near Todd Mission (Mill Creek Subdivision).  
  
  - Harry stated the Mill Creek is a flood prone area for the county.
  - David stated the SH249 corridor is hot spot for potential development. Currently plan for retention is inline in the center of the roadway.
  - Harry stated the County is interested in developing new criteria especially for detention. Harry is currently modifying subdivision regulations and can share new data when it is revised.
  - Harry stated that there is not currently a plan to adopt Atlas 14, but it can be considered as part of the new regulations.
SUPPORTING PARTNERS MEETING NOTES

Liberty County

November 22, 2019
San Jacinto River Watershed Master Drainage Plan
HCFCD, Brookhollow

Meeting called by: Jing Chen, P.E., CFM  Type of Meeting: Supporting Partners Meeting
Facilitator: Terry M. Barr, P.E., CFM  Meeting Start Time: 2:00 PM
Meeting Stop Time: 3:00 PM

Agenda

1. Attendees (See attached sign in sheet)
   • Terry Barr, Halff Associates, Inc.
   • Jing Chen, HCFCD
   • David Douglas, Liberty County
   • Rachael Todd, Halff Associates, Inc.
   • Cory Stull, Freese & Nichols, Inc.

2. Study Overview
   • Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   • Terry provided an overview of the study goals and objectives:
     ○ Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     ○ Primary Mitigation Planning – Look at structural improvements and drainage policy
     ○ Secondary Mitigation Planning – Focus on gages and flood warning capability
     ○ Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     ○ Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   • Terry provided an overview of the study schedule
   • Terry provided an overview of the Community Outreach efforts and mentioned the website, which is www.sanjacstudy.org.

3. Input from Local Jurisdiction
   This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.
   • David oversees FEMA mitigation and coordinates grants/permits for Liberty County (LC)
• Crysta Beasley is the Emergency Management Coordinator for LC
• LJA in Beaumont is LC’s consulting engineer rather than a LC having a county engineer. David provided the following names and contact information to help HCFCD with LC drainage criteria and previous studies.
  o Alan Sims, LJA Beaumont
  o Toby Davis, LJA Beaumont
• Currently there are no detailed studies for most of the streams in LC with most of the area unmapped. Current BLE models are based on the old rainfall, and LC has plans to adopt Atlas 14 rainfall. FEMA BFE’s in the area are sporadic with approximately 3-4 miles between BFE’s. Although LC has requirements for building in the floodplain, these BFE’s prove difficult to manage. No current “one-rule” applies to all development, each development must prove no impact.
• LC is ready to see long term solutions and implementation plans. From SJRWMDP the Primary Flood Hazard Mitigation Improvements – structural improvements and policy improvements. There is currently 1 gage on Luce Bayou, and LC is open to more for Secondary Flood Hazard Mitigation.
• LC is putting together a Liberty County Drainage District. This will be funded separately through a special district fee rather than through property taxes.
• Other judges from surrounding counties (8) are interested in a regional drainage study and plan – Liberty, Chambers, Jasper, Jefferson, Hardin, etc. More focused near the Sabine River.
• Areas of interest include: Cedar Bayou, Plum Grove, River Ranch (south of Dayton), developments south of Cleveland. LC is getting a lot of interest from heavy industry – mostly rail related development.
• Potential projects include:
  o Cedar Bayou: major detention south of Dayton, improvements on west side of LC
  o Luce & Tarkington: cleaning out channels and detention
Meeting called by: Jing Chen, P.E., CFM  Type of Meeting: Supporting Partners Meeting  
Facilitator: Terry M. Barr, P.E., CFM  Meeting Start Time: 10:30 AM  
Meeting Stop Time: 11:30 AM

**Agenda**

1. **Attendees (via Conference Call)**
   - Terry Barr, Halff Associates
   - Jing Chen, HCFCD
   - Gary Bezemek, HCFCD
   - Matt Barrett, SJRA
   - Cory Stull, FNI
   - Allen Sims, LJA Engineering
   - Manuel Mendoza, LJA Engineering
   - Dawn Filcher, LJA Engineering
   - John Grounds, LJA Engineering
   - Andrew Moore, Halff Associates

2. **Study Overview**
   - Jing introduced the study, highlighting that the San Jacinto Regional Watershed Master Drainage Plan (SJRWMDP) is funded by a FEMA HMGP grant and includes a partnership of HCFCD, SJRA, Montgomery County, and the City of Houston. She also stated that the purpose of the study is to provide consistently modeled and mapped baseline conditions data and inundation mapping for the San Jacinto watershed. The study team is contacting major stakeholder communities, collecting information to inform this planning effort, and will distribute results within the watershed once planning is complete for communities to consider incorporate results and update their HMPs.
   - Terry provided an overview of the study goals and objectives:
     - Assess basin vulnerability – Update H&H modeling for the basin and calibrate to set a reliable baseline conditions model
     - Primary Mitigation Planning – Look at structural improvements and drainage policy
     - Secondary Mitigation Planning – Focus on gages and flood warning capability
     - Other Mitigation Actions – Focus on communication between jurisdictions and identification of flooded infrastructure
     - Community Outreach and Education – Focus on sharing information with the public as well as decision makers in the affected jurisdictions
   - Terry provided an overview of the study schedule
   - Terry provided an overview of the Community Outreach efforts and mentioned the website, which is [www.sanjacstudy.org](http://www.sanjacstudy.org).
### 3. Input from Local Jurisdiction

This portion of the meeting included a conversation about anticipated growth in the area, current drainage criteria, flood history and hot spots, and mitigation alternatives.

- LJA currently serves as the County Engineer for Liberty County.
- Most of the current development is in the Plum Grove region.
- Allen stated development is anticipated along new Grand Parkway alignment.
- Allen stated new drainage criteria has been approved by Commissioner’s Court and LJA will provide. The criteria does not include Atlas 14 rainfall as it was not available at the time of approval.
- Allen stated that new criteria added a no negative impact requirement and information regarding how detention volumes should be calculated. The new criteria mimics Chambers County drainage criteria and Hays County subdivision rules.
- Allen stated that adopting a watershed wide drainage policy would help with maintaining consistency.
- Dawn mentioned that the Plum Grove area has had flooding as of recent. She stated they are also looking into flooding issues in Precinct 3 (northwest). She stated that the Plum Grove development may be receiving adverse flows from the adjacent developments.
- Allen stated that the County is currently interested in starting a countywide drainage district. Upon creation of the district, they may be interested in updating the FEMA maps depending on funding. The county is expecting a vote in May for the district. He stated that there are several drainage districts that maintain a portion of the channels. Cory stated that the County has new maps for the Trinity basin. Allen stated that the drainage district would take over maintenance of open channels and a master drainage study would be conducted to determine the improvements needed in the County.
- Allen is interested in adding gages throughout the watershed and county.
- Dawn stated that she would be interested in more rain gages upstream of the county. She stated that the County could do an agreement with the HCFFCD or USGS to implement and maintain the new gages.
- Allen stated that large regional detention would be beneficial to the County. Jing stated that future meetings would include preliminary alternative recommendations.
# H&H METHODOLOGY MEETING AGENDA

March 19, 2019  
Upper San Jacinto River Regional Flood Mitigation Plan  
Harris County Flood Control District

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen</th>
<th>Type of Meeting:</th>
<th>Methodology Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry Barr</td>
<td>Meeting Start Time:</td>
<td>10:00 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>11:30 AM</td>
</tr>
</tbody>
</table>

## Agenda

### 1. Terrain Information
- Survey will be taken at selected bridge/culverts and cross sections (II.D)
- Is the 2018 LiDAR available?
- Will any dredging survey be available for the San Jacinto River? Lake Houston Spillway?
- Is there recent bathymetric data for Lake Houston and/or Lake Conroe available?
- Horizontal datum (Central vs. South Central Zone)?

### 2. Hydrology
- Will Atlas 14 rainfall zones be determined? Do HCO, MCO, COH, SJRA agree?
- The intent is to use the BDF methodology to calculate TC&R parameters
  - Weighted methodology vs. Step-wise; Is there a preference?
  - Minimal alteration to HCFCD models for Spring, Cypress, etc. (III.A.1.c); Is there a preferred basin size for the remainder of the study area?
  - Scope identifies Initial & Constant as loss method; Is that flexible? (III.A.1.d)

### 3. Hydraulics
- New models based on most current LiDAR datasets with structure and cross section survey
- Topography for HCFCD streams will not be updated per the scope (III.B.1.b)

### 4. Future Conditions
- Currently no detention requirements along the East and West Fork corridors
  - Should future conditions consider some detention requirements?
  - Should that be one of the mitigation strategies that we consider?
  - How do we account for future development detention using BDF?

### 5. Benefit-Cost Analysis
- For the FEMA BCA Toolkit, the intent is it to leverage external GIS tools to populate the necessary data fields; confirm that this is acceptable.

### 6. Questions
MEETING MINUTES

To: Jing Chen, P.E., CFM
From: Terry Barr, P.E., CFM
Subject: Upper San Jacinto River Regional Flood Mitigation Plan – Methodology Discussion

Attendees: Gary Bezemer, HCFCD
Jing Chen, HCFCD
Dena Green, HCFCD
Ataul Hannan, HCFCD
Craig Maske, HCFCD
Terry Barr, Halff
Sam Hinojosa, Halff
Andrew Moore, Halff
Mike Moya, Halff
Hector Olmos, Freese & Nichols
Cory Stull, Freese & Nichols

Meeting Date: 03/19/2019 – 10:00 am
Location: HCFCD, Brookhollow Office
Minutes Date: 3/22/2019 (Revised 3/29/2019)
AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Meeting Introduction</strong></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Ms. Chen kicked off the meeting with a brief introduction. The meeting agenda and schedule were provided to the group (See attached agenda for reference). Mr. Barr discussed the intent of the meeting, which was to inform HCFCD about specific methodologies that will be used for the San Jacinto study and to ask questions relating to the approach. The original scope was prepared in early 2018 and since then there have been changes in the rainfall data, terrain data, and preferred methodologies. The intent of the Halff/FNI team is to develop models that are consistent with the MAAPnext products that will be developed in the coming year. The meeting order generally followed the questions provided on the attached agenda.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><strong>Terrain Information</strong></td>
<td>HCFC – Provide full LiDAR coverage data in State Plane South Central projection Halff/FNI – Evaluate the data and make a recommendation for the model development</td>
</tr>
<tr>
<td></td>
<td>Mr. Barr indicated that survey will be taken at limited locations and that the remainder of the modeling will be developed based on the most recent LiDAR, which will be provided by HCFCD.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>LiDAR Data and Projections</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per HCFCD, the 2018 LiDAR DEM should be ready within the next week or so, the LAS may lag behind that. The projection discrepancy between Harris County and the areas to the north was discussed. For the MAAPnext study, a projection of NAD83 State Plane South Central was requested; however, Central and UTM15 projections for the datasets created a bit of confusion as to what is being delivered. Depending on the data delivered, some stitching of the datasets may be needed. Ms. Green indicated that HCFCD will check into the status of the terrain and the coverage and projection that will be provided. The major concern amongst the group was that models developed in different projections will not be able to be combined. However, if the models are developed in the same projection, they will not be in the standard projection used by their respective jurisdictions. Both Halff and HCFCD agreed that the modeling procedure will depend on the LiDAR projection. Subsequent discussions with HCFCD indicated that the LiDAR will be delivered in one contiguous projection projection.</td>
<td></td>
</tr>
</tbody>
</table>
dataset with a State Plane South Central projection and will include the 2018 LiDAR as well as portions of pre-2018 LiDAR in parts of Montgomery and the surrounding counties.

**Dredging, Bathymetric, and Spillway Survey**

Survey data for the recent dredging of the San Jacinto River, the Lake Houston Spillway, and bathymetric data of Lakes Houston and Conroe was requested. HCFCD indicated that the dredging survey may be available through the USACE and that they would request the data. HCFCD also indicated that they have pre-dredging survey data, which may prove helpful during the calibration effort. Halff agreed to check with the TWDB for data related to the lake bathymetry. With respect to the Lake Houston Spillway, Mr. Olmos indicated that using the LAS data or construction drawings of the recent improvements may provide adequate information for the Lake Houston spillway. FNI agreed to check with CWA for available survey.

---

## Hydrology

### Atlas 14 Rainfall Data

Since the scope development, the release of Atlas 14 rainfall data has occurred, resulting in a significant increase in 24-hour rainfall depths for the region. HCFCD has updated the regions for Harris County. Currently Montgomery County has established a single depth of 16.1” for their 24-hour, 1% AEP storm. No information was available for the surrounding counties. HCFCD indicated that they are interested in the flow coming across the county line and that varying the rainfall across the watershed might provide more realistic results. Halff suggested pulling Atlas 14 depths at several locations within each major tributary watershed and developing an average for each watershed. Halff agreed to look at the depth information and provide a recommendation to HCFCD. It should be noted that a 24-hour rainfall event will be used for the Frequency Storms; however, the model run time will need to be several days to allow all flows to be routed and the lakes to reach their peaks and start to descend. Calibration storms will use historical rainfall data and the duration will depend on the data.

### BDF Methodology

Halff/FNI recommended using the BDF methodology for Clark UH parameters, specifically the Step-Wise methodology given the limited amount of development in much of the watershed. Harris County watersheds will not be updated with the new parameters. Mr. Bezemek expressed concern with the use of BDF in the basin due to steeper slopes, indicating that the older methodology provided good results. Mr. Maske indicated that the slope adjustment factors provided good returns for the Spring Creek basin. Mr. Hannan recommended that Halff/FNI run some tests using BDF and see how it compares to the older methodology. The primary adjustment method would be slope factors.

### Basin Size

A maximum or minimum basin size for the hydrologic model was also discussed. The basins would be developed with the augmented flood

---

| HCFCD – Check with USACE for dredging survey |
| Halff – Check with TWDB for Lake Bathymetry |
| FNI – Check with CWA for survey of Lake Houston Spillway |
warning system in mind, so basin breaks would occur at major roadways and where tributaries enter. The Halff/FNI team will work to develop basins that are of a consistent size as much as possible. Given the mostly undeveloped conditions in the upper reaches of the basin, some of the subbasins may be larger than those in the developed areas. HCFCD indicated that there was no specific requirement for basin sizes and the BDF methodology works well across basins of varying sizes.

**Loss Rate Methods**

The original scope called for the Initial & Constant (I&C) method to be used. The initial thought for the hydrology was to move toward Green & Ampt (G&A) for all the hydrology to maintain consistency across the model. Mr. Bezemek pointed out that the data for G&A may be limited in Montgomery and the surrounding counties. In addition to the limited data, Mr. Bezemek also pointed out that there is limited flexibility in the parameter adjustments without going outside the normal parameter ranges, which could hinder the calibration effort. Mr. Hinojosa suggested that the team leverage the I&C method for the areas outside Harris County and maintain the G&A parameters for the Harris County Basins (Spring, Cypress, etc.). Mr. Barr asked if there was any concern about using varying methodologies across the model. The group generally agreed that the different methods were appropriate for specific areas in the basin, but HCFCD will communicate any changes in methodology to TDEM/FEMA if the recommended approach requires a revision to the scope. The methodology will be discussed with TDEM at the study partners kickoff on April 8th. Mr. Stull and Mr. Hinojosa both indicated that modeling they have seen in the area using the I&C methodology has worked well with calibrations efforts.

**Hydraulics**

Mr. Barr indicated that when the study was scoped in early 2018, it was based on the current terrain dataset. Per the scope, new models will be based on the most current LiDAR data for that watershed and the existing Harris County models (Spring, Cypress, Willow, Little Cypress, Jackson) will not be updated for the study.

**2018 LiDAR Data**

The effective Harris County models were developed using the 2001 LiDAR. As such the terrain data is nearly 20 years old. There has been some development in the area; however, there are also pockets that remain unchanged. Mr. Hannan suggested comparing the terrain datasets (2001 and 2018) to determine the changes. HCFCD is developing an adjustment for the new GEOID12B. The current effective models will be used with major changes due to development or major drainage improvements added to the models. Cross sections will not be recut using the new terrain for the effective models. Mr. Hinojosa suggested considering where the damages are highest and where projects may be recommended. It may be beneficial to update the terrain in those areas where a project will be recommended to provide a better comparison. The project team needs to consider this internally and make a recommendation to HCFCD.
5. **Future Conditions**

Mr. Barr asked about the development of future conditions parameters and the detention criteria in Montgomery and the surrounding counties. The current MCO criteria allows for the engineer to prove no-impact on the receiving stream to avoid detention. Mr. Barr asked what should be assumed for detention in MCO and the surrounding area. If the area is developed without the benefit of detention, there is concern that will impact the lakes (Conroe, Houston) and the surrounding areas, such as Kingwood. In addition, Mr. Stull asked what should be assumed for future conditions. The growth projections to be performed by FNI use a 50-year horizon; however, there may still be areas that area not developed at the end of that timeframe.

Mr. Bezemek suggested that we consider full development to determine what impact detention might have on the basin, including the lakes. He indicated that some areas might benefit from detention while others may not see much difference with or without detention. Mr. Barr suggested that this evaluation be one of the potential flood reduction alternatives.

Mr. Maske asked about future conditions parameters using BDF. Mr. Stull indicated that the percent impervious would be increased based on the projected development. In addition, the project team will look at BDF for existing developed areas and determine an appropriate BDF for areas that are projected to develop in the future.

<table>
<thead>
<tr>
<th>Halff/FNI</th>
<th>– Review population projections and establish a methodology</th>
</tr>
</thead>
</table>

6. **FEMA BCA**

Mr. Barr indicated that the benefit-cost analysis will be done using FEMA BCA per the scope. The amount of data related to specific properties may be limited. Given the scale of the study, FFE will be estimated using the LiDAR data and some flat elevation increase to be determined. Property values will be based on County Appraisal District (CAD) data for the respective counties. The project team intends to utilize GIS tools to perform the damage calculations and then enter the data into FEMA BCA. Ms. Green suggested that the project team develop a specific methodology and present to TDEM at the study partners kickoff meeting in April. Ms. Chen mentioned that the LiDAR data may include building footprints per her conversation with Brian Edmonson (MAAPnext). Subsequent to the meeting, it was confirmed that the 2018 LiDAR does include building footprints. HCFCD GIS department is looking at pre-2018 LiDAR pieces to consider deriving building footprint data for the areas in the SE and SW corners of the current 2018 LiDAR coverage. In that case, the structure location data should be relatively easy to establish. The project team will check structure locations against recent aerial imagery to ensure correctness.

<table>
<thead>
<tr>
<th>Halff/FNI</th>
<th>– Develop a methodology for BCA data development and present to HCFCD and TDEM</th>
</tr>
</thead>
</table>

7. **Model Calibration**

Mr. Bezemek asked if specific storms have been identified for calibration. Mr. Barr indicated that Hurricane Harvey was to be included as well as the October 1994 storm. Mr. Stull and Mr. Olmos indicated that the 2015 and 2016 storms were to be included. Mr. Hannan suggested that whatever storms are used they need to have good coverage of the basin. The project team agreed to look at gage data.

<table>
<thead>
<tr>
<th>Halff/FNI</th>
<th>– Provide a recommendation for storms to be used during the</th>
</tr>
</thead>
</table>
and determine what storms were appropriate. Depending on the coverage, different storms may be used in different parts of the basin. However, it is important to note that using different storms in different parts of the basin will not provide accurate values at Lake Houston, since all the watersheds flow through it.

| 8. | Ms. Chen concluded the meeting. |

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
Meeting called by: Terry M. Barr, P.E., CFM  
Facilitator: Andrew Moore, P.E., CFM  
Type of Meeting: USGS Calibration Meeting  
Meeting Start Time: 11:00 AM  
Meeting Stop Time: 1:00 PM  

Agenda

1. Attendees  
   • Terry Barr, Half Associates, Inc.  
   • Sam Hinojosa, Half Associates, Inc.  
   • Andrew Moore, Half Associates, Inc.  
   • Hector Olmos, Freese & Nichols, Inc.  
   • Cory Stull, Freese & Nichols, Inc.  
   • Jason Pollender, USGS  
   • David Brown, USGS  

2. Gage and Measurement Discussion  
   • Hinojosa introduced the meeting presenting an overview of the study and purpose of the meeting. The general purpose was to collect information for how the USGS collects and publishes stage and flow measurements and to discuss the results of the calibration effort.  
   • Moore presented the gage locations where background information on gauges would be helpful for calibration on Peach Creek, Caney Creek, and the East Fork San Jacinto (EFSJR).  
   • Pollender presented the process of data collection for flows and water surface elevations during Hurricane Harvey on the EFSJR. He stated that the peak flow was estimated through indirect measurement. Peak flows on Peach Creek and Caney Creek were also estimated through indirect measurements.  
   • Pollender stated that 26 indirect measurements were taken during Harvey due to inability to access the streams. Pollender and Brown described how indirect measurements are obtained. Generally, hydraulic models are developed along the reach of the stream within the vicinity of the gauge. Flows are applied in the model until the water surface elevations match high water marks. The flow producing the matching elevations is used for the measurement. The resultant flow is compared to the rating curve. For Harvey, the estimated flow on Peach Creek was the highest estimated flow in the history of measurements. Brown stated that indirect measurements generally have a +/- 20% accuracy.  
   • Pollender described the process for obtaining direct measurements. These measurements are obtained with sonar during the storm event. A “Good” measurement is +/- 5% accuracy, a “Fair” measurement is +/- 8% accuracy, and a “Poor” measurement is greater than 8% accuracy. Pollender stated that vegetation and other factors can affect the accuracy of the measurement. Brown stated that a moving bed in the channel bottom in
sandy areas may interfere with the measurements. However, the measurements can be corrected with consideration to material.

- Pollender presented the process for developing and updating the gauge rating curves. The direct or indirect measurements are collected and stored in a program as points that are used to make adjustments to the curves. Moore asked which points were used in the rating curve development. Pollender stated that most data measurement points were used depending on the quality or if they were flagged as significant outliers. Pollender showed that the rating curves had not changed significantly in the recent updates.

- Pollender indicated that the backup information provided with each of the gages and rating curves could be provided but needed to be requested.

- Pollender discussed several gauges that are relevant to the San Jacinto study and Moore provided the Halff/FNI modeling results for comparison:
  - East Fork San Jacinto @ US59 (08070000) showed a Q of 108,000 (~15% error); the adjusted elevation measurement was within 0.05’ of the original; a measurement was taken during Hurricane Imelda
  - East Fork San Jacinto @ FM1485 (08070200) had an indirect measurement using a 1D HEC-RAS model
  - Peach Creek @ FM2090 (08071000) Harvey measurement will likely be revised, putting the estimated flows closer the Halff modeling
  - Caney Creek @ FM2090 (08070500) may have a potential datum issue that requires adjustment; Halff requested the records for datum adjustments; gages are currently on NGVD 1929 and need to be adjusted to Geoid 12B

- Pollender stated that the Hurricane Harvey flows for Peach Creek were going to be re-evaluated and adjusted as needed based on the Tropical Storm Imelda flow measurements. He also stated that the measurements are taken at the upstream end of I-59, not at the actual gage location.

- Brown stated that they now have capabilities to measure flows through reservoirs with accuracy and may be measuring flows in Lake Houston in the future.

- Brown stated that the USGS has a list of potential future gauge locations throughout the watershed and can provide to Halff. These gauges were desired for varying reasons: flood warning, rainfall measurements, flow measurements, water quality, etc. Not all the gauges were desired for USGS specific reasons.

- Hinojosa stated that Halff would reviewed the measurement types for each gauge and send a list to the USGS to confirm the quality and confidence of the measurements.

- Brown indicated that the USGS is encouraging the use of velocity meters for gages to local jurisdictions, which make flow measurements more reliable and easier to obtain

- Brown stated that a new area/capacity relationship for Lake Houston would be available on 10/21/19.
The San Jacinto Regional Watershed Master Drainage Plan is:

A comprehensive regional study led by local partners to identify future flood mitigation projects that can be implemented in the near- and long-term with the purpose of reducing flood risks to people and property throughout the San Jacinto River regional watershed.
<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
The goals of the San Jacinto Regional Watershed Master Drainage Plan are to:

- **Identify** the region’s vulnerabilities to flood hazards using Atlas 14 rainfall
- **Develop** approaches to enhance public information and flood level assessment capabilities during a flood disaster event
- **Evaluate** flood mitigation strategies to improve community resilience
- **Provide** a comprehensive Flood Mitigation Plan
Plan Objectives

• **Primary Flood Mitigation Planning**
  – Stormwater Detention
  – Buyouts
  – Channel Conveyance
  – Drainage Policy

• **Secondary Flood Mitigation Planning**
  – Flood Assessment/Warning

• **Other Mitigation Actions**

• **Community Outreach & Education**
Information to be developed includes:

- **Non-regulatory inundation maps** of the streams in the study area
- **Numbers** of structures, acres of land, properties, and miles of roadway located in the inundated area
- **Hazard Mitigation Plan** – Study data can be incorporated into existing plans
Identify Vulnerabilities

- **Update Existing H&H Models**
  - Current Terrain
  - Atlas 14 Rainfall
  - BDF Methodology

- **Calibrate to Historical Storms**
  - Harvey (2017)
  - Memorial Day (2016)
  - October 1994
  - Imelda (2019)

- **Damage Centers**
Improve Flood Assessment

- Review existing FWS
- Meet with stakeholders
  - HCFCD
  - USGS
  - SJRA
  - Montgomery County
- Identify potential additions
  - Gage type (flow, stage, rain)
  - Gage Locations
Evaluate Mitigation Strategies

• Primary Alternatives
  – Leverage previous reports
  – Detailed H&H Analysis

• Secondary Alternatives
  – Structural and Policy Ideas
  – Develop & Analyze additional strategies

• Sedimentation and Vegetation
  – Sedimentation Rates
  – Historical Sediment Management Recommendations
Public Outreach/Education

- Public Meetings (6)
- Project Website
  www.sanjacstudy.org
- Presentation Material
- Partner Meetings
  - Study Partners
  - Supporting Partners
## Major Project Milestones

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Hydrology &amp; Hydraulics Analysis and Calibration</td>
<td>Fall 2019</td>
</tr>
<tr>
<td>Primary Alternatives Analysis</td>
<td>Winter 2019</td>
</tr>
<tr>
<td>Vegetation and Sediment Control Analysis</td>
<td>January 2020</td>
</tr>
<tr>
<td>Draft Report Complete</td>
<td>Summer 2020</td>
</tr>
<tr>
<td>Final Report Complete</td>
<td>Fall 2020</td>
</tr>
</tbody>
</table>
Contact Us

- **Harris County Flood Control District**
  - Jing Chen, jing.chen@hcfcd.hctx.net
- **San Jacinto River Authority**
  - Matt Barrett, mbarrett@sjra.net
- **Montgomery County**
  - Darren Hess, darren.hess@mctx.org
- **City of Houston**
  - Adam Eaton, adam.eaton@houstontx.gov
### MEETING AGENDA

**Harris County Flood Control District**

May 12, 2020
San Jacinto River Watershed Master Drainage Plan
Microsoft Teams Meeting

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Kingwood Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>11:30 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>12:30 PM</td>
</tr>
</tbody>
</table>

#### Agenda

1. **Introduction**
   - Kingwood Questions

2. **Current Kingwood Flooding**
   - Flood Claims
   - West Fork and East Fork Profiles
   - Inundation Mapping

3. **Limitations to Kingwood Improvements**
   - Lake Houston Backwater (Inundation, Profiles)

4. **Recap of Recommended Projects**
   - Potential Projects and Combined Alternatives
   - WSEL Reductions
   - Structural Flood Damage Reductions

5. **Kingwood Benefits**
   - Reductions in Flooded Structures

6. **Additional Alternatives to Consider**
   - Lake Houston Lowering (Separate study)
   - Levee Protection
   - Buyouts of frequently flooded areas

7. **Kingwood Messaging**
   - Communicating the Benefits
   - Communicating the Limitations
   - Delivering the Message
San Jacinto River Basin

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
Kingwood Questions

• How does flooding currently affect Kingwood?
• How does the current plan benefit Kingwood?
• What are the limitations of the current plan?
• What are some alternative ideas to address flooding?
• How do we want to communicate the benefits and limitations?
Current Flooding


Legend
- Flood Claims
- Stream
- Kingwood Boundary
- County Line

Terrain Value
- High: 109.5
- Low: 34.9
Kingwood East Fork
## Current Flooding

### Inundation Area Structures

<table>
<thead>
<tr>
<th>Event</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>1</td>
</tr>
<tr>
<td>5-year</td>
<td>5</td>
</tr>
<tr>
<td>10-year</td>
<td>29</td>
</tr>
<tr>
<td>25-year</td>
<td>84</td>
</tr>
<tr>
<td>50-year</td>
<td>275</td>
</tr>
<tr>
<td>100-year</td>
<td>1,001</td>
</tr>
<tr>
<td>500-year</td>
<td>2,335</td>
</tr>
</tbody>
</table>
Current Flooding

Legend
- WS Max WS - 0.2%_EX
- WS Max WS - 1%_EX

Ground
Bank Sta
Lake Houston

- Influence of Lake Houston extends from the dam to Lake Houston Parkway.
- Upstream of Lake Houston Parkway, the West Fork controls
Kingwood West Fork/Lake Houston

G103-00-00 West Fork San Jacinto Water Surface Elevation Profile

Stream station above confluence with Interstate 10 (feet)
San Jacinto Regional WMDP

Project Included in Plan

Project Considered

San Jacinto River Master Drainage Plan

<table>
<thead>
<tr>
<th>San Jacinto River Master Drainage Plan</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Caney Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Caney Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
San Jacinto Regional WMDP

- Plan Cost: $3.1B - $3.5B
- Total Mitigation: 250,000 acre-feet
- Overall Plan Benefits: $677 M
- BCR: 0.19 – 0.22

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Damages, Existing ($M)</th>
<th>Damages, Combined Alts ($M)</th>
<th>Benefit ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>466.6</td>
<td>163.8</td>
<td>302.8</td>
</tr>
<tr>
<td>Willow</td>
<td>112.2</td>
<td>86.6</td>
<td>25.6</td>
</tr>
<tr>
<td>Cypress</td>
<td>213.2</td>
<td>211.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>30.9</td>
<td>30.8</td>
<td>0.1</td>
</tr>
<tr>
<td>East Fork</td>
<td>101.4</td>
<td>56</td>
<td>45.5</td>
</tr>
<tr>
<td>West Fork</td>
<td>269.7</td>
<td>132.7</td>
<td>137</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>10.1</td>
<td>3.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Peach</td>
<td>113.1</td>
<td>27.9</td>
<td>85.3</td>
</tr>
<tr>
<td>Caney</td>
<td>135.6</td>
<td>63.8</td>
<td>71.9</td>
</tr>
<tr>
<td>Luce</td>
<td>14.6</td>
<td>14</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1467.4</strong></td>
<td><strong>790.4</strong></td>
<td><strong>677.2</strong></td>
</tr>
</tbody>
</table>
Kingwood Area Benefits

- Highest WS reduction U/S of W. Lake Houston Pkwy
- Lake Houston controls lower reaches
- 58% Reduction in instances of flooding
- Most East Fork structures no longer in 100-year IA
## Kingwood Area Benefits

<table>
<thead>
<tr>
<th>Event</th>
<th>Numbers for Structural Flooding (Sta. 1300+00 to 1750+00)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>Proposed</td>
<td>Reduction</td>
<td>% Reduction</td>
</tr>
<tr>
<td>25-year</td>
<td>70</td>
<td>11</td>
<td>59</td>
<td>84%</td>
</tr>
<tr>
<td>50-year</td>
<td>315</td>
<td>56</td>
<td>259</td>
<td>82%</td>
</tr>
<tr>
<td>100-year</td>
<td>1,157</td>
<td>359</td>
<td>798</td>
<td>69%</td>
</tr>
<tr>
<td>500-year</td>
<td>2,333</td>
<td>1,952</td>
<td>381</td>
<td>16%</td>
</tr>
<tr>
<td>Instances of Flooding</td>
<td>1,469</td>
<td>611</td>
<td>858</td>
<td>58%</td>
</tr>
<tr>
<td>Damages ($M)</td>
<td>$118.4</td>
<td>$53.8</td>
<td>$64.6</td>
<td>55%</td>
</tr>
</tbody>
</table>
Kingwood Additional Options

• Lake Houston Dam Improvements
  – Reduction of peak water surface elevation at dam has influence up to W. Lake Houston Parkway
  – Lowering would result in WSEL decreases to W. Lake Houston Pkwy

• This study does NOT include evaluation of dam operations or lowering (gates, etc.)
Kingwood Additional Options

• Kingwood Levee (Concept not evaluated in detail)
  – East Fork near Caney Creek to West Fork at I-59
  – 14 miles in length
  – Max WSEL increase 0.25 feet
  – 13,000 acre feet of mitigation to offset impacts
Kingwood Additional Options

- Buyouts within frequency floodplains (current market value)
  - 500-year: $1.2 Billion
  - 100-year: $579 Million
  - 50-year: $72 Million
  - 25-year $14 Million
Kingwood Messaging

- Communicating the Benefits
- Communication the Limitations
- Delivering the Message
Kingwood Detention

- Approximate volumes located in Kingwood to achieve lower water surface elevations

<table>
<thead>
<tr>
<th></th>
<th>West Fork (I-69)</th>
<th>East Fork (Conf. w/ Caney)</th>
<th>Lake Houston (Dam)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-Year Volume Needed to Achieve Lower WSEL (acre-feet)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-year</td>
<td>520,000</td>
<td>270,000</td>
<td>800,000</td>
</tr>
<tr>
<td>25-year</td>
<td>280,000</td>
<td>150,000</td>
<td>460,000</td>
</tr>
<tr>
<td>50-year</td>
<td>90,000</td>
<td>60,000</td>
<td>165,000</td>
</tr>
</tbody>
</table>

| Reductions in 100-year WSEL (ft) |                      |                             |                   |
| 10-year                      | 9.0                 | 6.5                         | 5.6               |
| 25-year                      | 5.5                 | 4.5                         | 3.0               |
| 50-year                      | 2.5                 | 2.2                         | 1.5               |
Appendix A.6

Primary Alternatives Workshops
Meeting called by: Jing Chen, P.E., CFM  Type of Meeting: Primary Alternatives Workshop
Facilitator: Terry M. Barr, P.E., CFM  Meeting Start Time: 3:00 PM
          Meeting Stop Time: 4:30 PM

Agenda

1. Workshop Goals (2 Min)
   - Review previously identified improvements
   - Discuss opportunities and constraints
   - Introduce project ranking methodology
   - Select primary alternatives for detailed evaluation

2. Previously Identified Alternatives (15 Min)
   - Master Plan for Full-Scale Development of the San Jacinto River (1943, 1957)
   - San Jacinto Upper Watershed Drainage Improvement and Flood Control Planning (1985)
   - Lake Creek Reservoir Report (1997)
   - Regional Flood Protection Study for Lake Houston Watershed Program (2000)
   - Spring Creek & West Fork – Estimating Land Cover Effects on Selected Watersheds (2019)

3. Potential Project Challenges (3 Min)
   - Property Acquisition (Level of Development, Number of Parcels)
   - Site Conflicts (Environmental, Transportation, Utilities, Hazmat, Oil/Gas Well, etc.)
   - Operations & Maintenance

4. Potential Project Opportunities (5 min)
   - Ability to reduce flood damages
     - How many damage centers may benefit?
     - Drainage area to project vs. total drainage area
   - Opportunity to improve sedimentation issues
   - Opportunity for ancillary uses

5. Select Primary Alternatives (50 min)
   - Removed alternatives that are infeasible or already constructed
   - Identify alternatives that may be feasible and/or beneficial
   - Select Four (4) alternatives to develop
<table>
<thead>
<tr>
<th></th>
<th>Project Ranking Methodology Introduction (10 min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Establish Criteria</td>
</tr>
<tr>
<td></td>
<td>Determine Weighting Factors</td>
</tr>
<tr>
<td></td>
<td>Establish Scoring Process</td>
</tr>
<tr>
<td></td>
<td>Determine Rankings</td>
</tr>
<tr>
<td>7.</td>
<td>Recap &amp; Questions (5 min)</td>
</tr>
</tbody>
</table>
SAN JACINTO
Regional Watershed Master Drainage Plan

Primary Alternatives Workshop
August 14, 2019
Workshop Goals

*Primary Mitigation Planning:* Recommend action strategies to reduce or eliminate long-term flood risk to people and property. The flood risk reduction strategies will be prioritized and will likely include large regional detention facilities, channel conveyance improvements, vegetation and sedimentation removal, and property buy-outs. The action strategies will be provided to the local communities to update their respective Hazard Mitigation Plans.

- Review previously identified improvements
- Discuss opportunities and constraints
- Introduce project ranking methodology
- Select primary alternatives for detailed evaluation
Previously Identified Alternatives

- 1943 – San Jacinto River Master Plan
- 1957 – San Jacinto River Master Plan
- 1985 – Upper San Jacinto River Flood Control Study
- 1989 – South Montgomery County Flood Protection Plan
- 1997 – Lake Creek Reservoir Study
- 2000 – Lake Houston Regional Flood Protection Study
- 2015 – Cypress Creek Overflow Management Plan
- 2019 – Estimate Land Cover Effects on Selected Watersheds
- 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Identified Alternatives
Previously Identified Alternatives

<table>
<thead>
<tr>
<th>Reference #</th>
<th>Watershed</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>East Fork</td>
<td>Reservoir assumes only using 3 of 5' of storage</td>
</tr>
</tbody>
</table>
**Alternatives Matrix**

<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Percentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>East Fork</td>
<td>East Fork (East San Jacinto No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$2,257,000</td>
<td>Near Cleveland</td>
<td>5,950 acres</td>
<td>1534 acres</td>
<td>20%</td>
<td>1387</td>
<td>Capacity: 107,000 ac-ft</td>
</tr>
<tr>
<td>2</td>
<td>East Fork</td>
<td>East Fork Reservoir (EF-G1)</td>
<td>1985</td>
<td>Reservoir assumes only using 3 of 5' of storage</td>
<td>$44,300,000</td>
<td>Near Junction of East Fork and Winters Bayou</td>
<td>29,000 acres</td>
<td>1548 acres</td>
<td>12%</td>
<td>2645</td>
<td>80%-90% reduction in 100yr flow from Montgomery &amp; Liberty Co. (55,000 cfs to &lt;10,000cfs) 9 foot reduction in 100 year flood plain B/C Ratio: .07</td>
</tr>
<tr>
<td>3</td>
<td>West Fork</td>
<td>West Fork (San Jacinto No. 4)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$700,000</td>
<td>Upstream of Lake Conroe</td>
<td>2,744 acres</td>
<td>1116 acres</td>
<td>1%</td>
<td>35</td>
<td>Capacity: 25,210 ac-ft</td>
</tr>
<tr>
<td>4</td>
<td>Lake Creek</td>
<td>Lake Creek Dam (Combined)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td></td>
<td>Upstream portion of Lake Creek</td>
<td>Approx. 20000 acres (based on drawing @ 280' line)</td>
<td>3848 acres</td>
<td>10%</td>
<td>4825</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Lake Creek</td>
<td>Lake Creek Reservoir</td>
<td>1997</td>
<td>80% of the size of Lake Conroe</td>
<td>$275,000,000</td>
<td>On the lower portion of Lake Creek</td>
<td>16,800 acres</td>
<td>7461 acres</td>
<td>25%</td>
<td>3126</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Spring Creek</td>
<td>Spring Creek (Spring Creek No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$2,600,000</td>
<td>At confluence of Spring and Cypress Creeks</td>
<td>5537 acres</td>
<td>1117 acres</td>
<td>5%</td>
<td>229</td>
<td>Capacity 104,000 acre-feet,</td>
</tr>
<tr>
<td>7</td>
<td>Spring Creek</td>
<td>Spring Creek Reservoir 1 (SC-G1)</td>
<td>1985</td>
<td>Assumed to have 5' storage above pool</td>
<td>$6,500,000</td>
<td>Near Woodlands at RM 26.42</td>
<td>1004 acres</td>
<td>102 acres</td>
<td>14%</td>
<td>1532</td>
<td>Average 1% reduction in flow with minimal (&lt;0.5&quot;) change in WSEL</td>
</tr>
<tr>
<td>8</td>
<td>Spring Creek</td>
<td>Spring Creek Reservoir 2 (SC-G2)</td>
<td>1985</td>
<td>Assumed to have full depth of storage</td>
<td>$41,000,000</td>
<td>Upstream of Walnut Creek confluence</td>
<td>3719 acres</td>
<td>407 acres</td>
<td>23%</td>
<td>9607</td>
<td>B/C Ratio: 0.9. Average reduction in flow and 3 WSEL reduction</td>
</tr>
<tr>
<td>9</td>
<td>Cypress Creek</td>
<td>Cypress Creek (Spring Creek No. 2)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$1,500,000</td>
<td>West of Westfield</td>
<td>4193 acres</td>
<td>151 acres</td>
<td>84%</td>
<td>19288</td>
<td>Capacity 58,520 acre-feet,</td>
</tr>
<tr>
<td>10</td>
<td>Caney Creek</td>
<td>Caney Creek (Caney Creek No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$400,000</td>
<td>Located East of Conroe</td>
<td>850 acres</td>
<td>87 acres</td>
<td>19%</td>
<td>27</td>
<td>Capacity 6,930 acre-feet</td>
</tr>
<tr>
<td>11</td>
<td>Caney Creek</td>
<td>Caney Creek Reservoir (CC-G1)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$5,700,000</td>
<td>On upper Caney Creek near RM 34.71</td>
<td>677 acres</td>
<td>16 acres</td>
<td>13%</td>
<td>31</td>
<td>B/C=5.1, Average 100% flow reduction D/S of reservoir with 1&quot; change in WSEL (at mouth 16%, drop in flow and 1.1&quot; drop in WSEL). Reservoir can store all 100-yr runoff upstream</td>
</tr>
<tr>
<td>12</td>
<td>Peach Creek</td>
<td>Peach Creek Reservoir 1 (PC-G1)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event. Assumed to have full depth of storage</td>
<td>$3,500,000</td>
<td>Located in upstream part of Peach Creek</td>
<td>625 acres</td>
<td>142 acres</td>
<td>33%</td>
<td>49</td>
<td>Capacity 5,350 acre-feet</td>
</tr>
<tr>
<td>13</td>
<td>Peach Creek</td>
<td>Peach Creek Reservoir 2 (PC-G2)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event. Assumed to have full depth of storage</td>
<td>$8,000,000</td>
<td>Located in upstream part of Peach Creek, above Peach Creek No. 1</td>
<td>1381 acres</td>
<td>22 acres</td>
<td>0%</td>
<td>12</td>
<td>Capacity 2750 acre-feet</td>
</tr>
<tr>
<td>14</td>
<td>Stewart Creek</td>
<td>Stewart Creek Reservoir (St-Creek No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$175,000</td>
<td>At the edge of Conroe</td>
<td>301 acres</td>
<td>12 acres</td>
<td>3%</td>
<td>11</td>
<td>Capacity 2,400 acre-feet</td>
</tr>
</tbody>
</table>
# Alternatives Matrix

<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Precentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Caney Creek</td>
<td>CC-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Sycamore Drive R.M. 12.31</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.4 feet immediately upstream of bridges, B/C: 0.09</td>
</tr>
<tr>
<td>15</td>
<td>Caney Creek</td>
<td>CC-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Fire Tower Road R.M. 13.45</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.6 feet immediately upstream of bridges, B/C: 0.09</td>
</tr>
<tr>
<td>16</td>
<td>East Fork</td>
<td>EF-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$48,700,000</td>
<td>Between Harris County and San Jacinto County Line</td>
<td>Width Upstream: 480 Feet, Width Downstream: 500 Feet, Depth 20 Feet</td>
<td>2259 acres</td>
<td>3%</td>
<td>854</td>
<td>B/C: 0.67</td>
</tr>
<tr>
<td>16</td>
<td>East Fork</td>
<td>EF-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$3,400,000</td>
<td>Along the East Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 0.1 Foot reduction in 100 Year flood plane, B/C: 0.03</td>
</tr>
<tr>
<td>17</td>
<td>East Fork</td>
<td>EF-E2</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$3,000,000</td>
<td>Highway 165 bridge near Cleveland</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 1.2 feet immediately upstream of bridges, B/C: 0.03</td>
</tr>
<tr>
<td>18</td>
<td>East Fork</td>
<td>EF-E1</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$3,000,000</td>
<td>FM 1485 Bridge near Harris County line</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 1.6 feet immediately upstream of bridges, B/C: 0.08</td>
</tr>
<tr>
<td>19</td>
<td>Lake Creek</td>
<td>LC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$126,000,000</td>
<td>R.M. 43.3 to R.M. 0.0</td>
<td>Depth Upstream: 22 Feet, Depth Downstream: 31 Feet, Width Upstream: 260 Feet, Width Downstream: 670 Feet</td>
<td>2949 acres</td>
<td>2%</td>
<td>329</td>
<td>B/C: &lt;0.001</td>
</tr>
<tr>
<td>19</td>
<td>Lake Creek</td>
<td>LC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$5,100,000</td>
<td>Along Lake Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>50.3 Foot reduction in 100 Year flood plane, B/C: 0.0</td>
</tr>
<tr>
<td>20</td>
<td>Peach Creek</td>
<td>PC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$37,500,000</td>
<td>R.M. 40.4 to R.M. 0.0</td>
<td>Width Upstream: 100 Feet, Depth Upstream: 450 Feet, Depth Downstream: 10 Feet, Depth Downstream: 20 Feet</td>
<td>815 acres</td>
<td>5%</td>
<td>654</td>
<td>B/C: 0.33</td>
</tr>
<tr>
<td>20</td>
<td>Peach Creek</td>
<td>PC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$4,300,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Average 0.5 Foot reduction in 100 Year flood plane, Up to a 1.3 foot reduction B/C: 0.04</td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek</td>
<td>PC-D</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Applan Way R.M. 5.2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.4 feet immediately upstream of bridges, B/C: 0.09</td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek</td>
<td>PC-D</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Unnamed Road R.M. 7.1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 1.2 feet immediately upstream of bridges, B/C: 0.09</td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek</td>
<td>PC-D</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>FM 2090 R.M. 9.4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.6 feet immediately upstream of bridges, B/C: 0.09</td>
</tr>
<tr>
<td>22</td>
<td>Spring Creek</td>
<td>SC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$190,800,000</td>
<td>R.M. 48.2 to R.M. 0.0</td>
<td>Width Upstream: 200 Feet, Width Downstream: 500 Feet, Upstream Depth: 14 Feet, Downstream Depth: 35 Feet</td>
<td>796 acres</td>
<td>3%</td>
<td>396</td>
<td>B/C: 0.03</td>
</tr>
</tbody>
</table>
## Alternatives Matrix

<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Precentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Spring Creek</td>
<td>SC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$4,700,000</td>
<td>Along Spring Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 1 Foot reduction in 100 Year flood plane, B/C: 0.14</td>
</tr>
<tr>
<td>23</td>
<td>Spring Creek</td>
<td>SC-E2</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$19,000,000</td>
<td>Missouri Pacific RR, R.M. 13, 17</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 Year flood depth of 2.2 feet immediately upstream of bridges, B/C: 0.00</td>
</tr>
<tr>
<td>24</td>
<td>Spring Creek</td>
<td>SC-E1</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$10,000,000</td>
<td>Huffman Conroe Road RM 35, 44, Missouri Pacific RR, R.M. 37, 28, Chicago and Pacific RR at R.M. 38, 54</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 Year flood depth of 0.8 feet immediately upstream of bridges, B/C: 0.00</td>
</tr>
<tr>
<td>25</td>
<td>Spring Creek</td>
<td>SC-E3</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Missouri Pacific RR, R.M. 13, 17, and 140 spans at R.M. 16, 93 and 16, 99</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 Year flood depth of 0.5 feet immediately upstream of bridges, B/C: 0.00</td>
</tr>
<tr>
<td>26</td>
<td>West Fork</td>
<td>WF-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$137,000,000</td>
<td>Lake Conroe to Harris County</td>
<td>Depth: 30 Feet, Upstream Width: 500 Feet, Downstream Width: 600 Feet</td>
<td>1216 acres</td>
<td>4%</td>
<td>354</td>
<td>B/C: 0.40</td>
</tr>
<tr>
<td>26</td>
<td>West Fork</td>
<td>WF-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$5,700,000</td>
<td>Along The West Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 1 Foot reduction in 100 Year flood plane</td>
</tr>
<tr>
<td>27</td>
<td>West Fork</td>
<td>WF-C1</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 1</td>
<td>$8,600,000</td>
<td>Critical Area 1</td>
<td>N/A</td>
<td>179 acres</td>
<td>8%</td>
<td>35</td>
<td>B/C: 0.03</td>
</tr>
<tr>
<td>27</td>
<td>West Fork</td>
<td>WF-D1</td>
<td>1985</td>
<td>Design channel sections for critical area 1</td>
<td>$80,000</td>
<td>Critical Area 1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 0.00</td>
</tr>
<tr>
<td>28</td>
<td>West Fork</td>
<td>WF-C2</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 2</td>
<td>$17,300,000</td>
<td>Critical Area 2</td>
<td>N/A</td>
<td>97 acres</td>
<td>25%</td>
<td>34</td>
<td>B/C: 0.31</td>
</tr>
<tr>
<td>28</td>
<td>West Fork</td>
<td>WF-D2</td>
<td>1985</td>
<td>Design channel sections for critical area 2</td>
<td>$530,000</td>
<td>Critical Area 2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 0.31</td>
</tr>
<tr>
<td>29</td>
<td>West Fork</td>
<td>WF-C3</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 3</td>
<td>$31,200,000</td>
<td>Critical Area 3</td>
<td>N/A</td>
<td>125 acres</td>
<td>14%</td>
<td>216</td>
<td>B/C: 0.93</td>
</tr>
<tr>
<td>29</td>
<td>West Fork</td>
<td>WF-D3</td>
<td>1985</td>
<td>Design channel sections for critical area 3</td>
<td>$1,100,000</td>
<td>Critical Area 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 2.5</td>
</tr>
<tr>
<td>30</td>
<td>West Fork</td>
<td>WF-C4</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 4</td>
<td>$8,800,000</td>
<td>Critical Area 4</td>
<td>N/A</td>
<td>147 acres</td>
<td>29%</td>
<td>87</td>
<td>B/C: 0.75</td>
</tr>
</tbody>
</table>
## Alternatives Matrix

<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Percentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>West Fork</td>
<td>WF-D4</td>
<td>1985</td>
<td>Desnag channel sections for critical area 4</td>
<td>$270,000</td>
<td>Critical Area 4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 2.3</td>
</tr>
<tr>
<td>31</td>
<td>West Fork</td>
<td>WF-C5</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a concrete lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 3</td>
<td>$370,000,000</td>
<td>Critical Area 3</td>
<td>N/A</td>
<td>125 acres</td>
<td>14%</td>
<td>87</td>
<td>Channel reduction of flood depth by 5.5 feet in critical area 3, with a minor increase in depth downstream, B/C: 0.1</td>
</tr>
<tr>
<td>32</td>
<td>West Fork</td>
<td>WF-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$18,500,000</td>
<td>Atchinson</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1.2 Foot reduction in 100 Year flood plane, B/C: 0.085</td>
</tr>
<tr>
<td>33</td>
<td>Caney Creek</td>
<td>CC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$73,000,000</td>
<td>R.M. 46.1 to R.M. 0.0</td>
<td>Width Upstream: 200 Feet, Width Downstream: 460 Feet, Depth Upstream: 14 Feet, Depth Downstream: 30 Feet</td>
<td>N/A</td>
<td>4%</td>
<td>629</td>
<td>B/C: 0.09</td>
</tr>
<tr>
<td>34</td>
<td>Caney Creek</td>
<td>CC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$7,400,000</td>
<td>Along Caney Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 2.7 Foot reduction in 100 Year flood plane, B/C: 0.08</td>
</tr>
<tr>
<td>35</td>
<td>West Fork (San Jacinto No. 1)</td>
<td>1943/1957</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$925,000</td>
<td>At confluence with Lake Creek</td>
<td>3,800 acres</td>
<td>1,738 acres</td>
<td>14%</td>
<td>370</td>
<td>Capacity: 33,525 ac-ft</td>
</tr>
</tbody>
</table>

### Outlets

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Percentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-F25</td>
<td>1985</td>
<td>Purchase all property within the 25-y floodplain</td>
<td>$1,900,000</td>
<td>Along Caney Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 2.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC-F100</td>
<td>1985</td>
<td>Purchase all property within the 100-y floodplain</td>
<td>$4,600,000</td>
<td>Along Caney Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 1.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EF-F25</td>
<td>1985</td>
<td>Purchase all property within the 25-y floodplain</td>
<td>$3,400,000</td>
<td>Along the East Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EF-F100</td>
<td>1985</td>
<td>Purchase all property within the 100-y floodplain</td>
<td>$4,500,000</td>
<td>Along the East Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC-F25</td>
<td>1985</td>
<td>Purchase all property within the 25-y floodplain, which is the same as the 100-y floodplain.</td>
<td>$1,300,000</td>
<td>Along Lake Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC-F25</td>
<td>1985</td>
<td>Purchase all property within the 25-y floodplain</td>
<td>$6,200,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC-F100</td>
<td>1985</td>
<td>Purchase all property within the 100-y floodplain</td>
<td>$9,500,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC-F25</td>
<td>1985</td>
<td>Purchase all property within the 25-y floodplain</td>
<td>$6,300,000</td>
<td>Along Spring Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC-F100</td>
<td>1985</td>
<td>Purchase all property within the 100-y floodplain</td>
<td>$18,000,000</td>
<td>Along Spring Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WF-F25</td>
<td>1985</td>
<td>Purchase all property within the 25-y floodplain</td>
<td>$62,000,000</td>
<td>Along The West Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WF-F100</td>
<td>1985</td>
<td>Purchase all property within the 100-y floodplain</td>
<td>$97,000,000</td>
<td>Along The West Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C: 0.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Opportunities and Challenges

• Opportunities
  – Ability to reduce flood damages
    • How many damage centers may benefit?
    • Drainage area to project vs. total drainage area
  – Opportunity to improve sedimentation issues
  – Opportunity for ancillary uses

• Challenges
  – Property Acquisition (Level of Development, Number of Parcels)
  – Site Conflicts (Environmental, Transportation, Utilities, Hazmat, Oil/Gas Well, etc.)
  – Operations & Maintenance
Alternatives Removed

- Removed alternatives that are infeasible or already constructed
  - 7 (Spring Creek) – Extensive Development
  - 9 (Cypress Creek) – Extensive Development
  - 14 (Stewart Creek) – Not along studied channel
  - 15,17,18,21,23,24,25,32 (Multiple Bridges) – Isolated Impact
  - 26 (West Fork) – In Lake Conroe; Isolated Impact
Select Primary Alternatives

- Removed alternatives that are infeasible or already constructed
- Identify alternatives that may be feasible and/or beneficial
- Select Four (4) alternatives to develop
Project Ranking Methodology

1. Establish Criteria
2. Determine Weighting Factors
3. Establish Scoring Process
4. BUY IN
5. Project Priority Rankings
Establish & Weight Criteria

- Potential Criteria
  - Reduction in Flood Levels
  - BCR (Financials for project)
  - Development Potential
  - Environmental Constraints
  - Project Completion Risks
  - Long Term Risks
  - Citizen Satisfaction
  - ROW Needs
  - Population Benefitted
  - Maintenance Needs
  - Others?
Project Scoring Metrics

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score</th>
<th>Weight</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>40.54</td>
<td>30%</td>
<td>12.16</td>
</tr>
<tr>
<td>D1</td>
<td>56.93</td>
<td>30%</td>
<td>17.08</td>
</tr>
<tr>
<td>D3</td>
<td>29.87</td>
<td>15%</td>
<td>4.48</td>
</tr>
<tr>
<td>D4</td>
<td>44.11</td>
<td>15%</td>
<td>6.62</td>
</tr>
<tr>
<td>T1</td>
<td>60</td>
<td>10%</td>
<td>6</td>
</tr>
<tr>
<td>V1</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Combined Score: 46.34
Rank: 14
Questions?
<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Percentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
<th>Current Feasibility Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 East Fork</td>
<td>East Fork (East San Jacinto No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$2,237,000</td>
<td>Near Cleveland</td>
<td>5,950 acres</td>
<td>1534 acres</td>
<td>20%</td>
<td>1387</td>
<td>Capacity: 107,000 ac-ft</td>
<td>Small pockets of rural development in this area. Reservoir permit in Sam Houston National Forest is unlikely.</td>
<td></td>
</tr>
<tr>
<td>2 East Fork</td>
<td>East Fork Reservoir (EF-G1)</td>
<td>1985</td>
<td>Reservoir assumes only using 3 of 5' of storage</td>
<td>$44,300,000</td>
<td>Near Junction of East Fork and Winters Bayou</td>
<td>29,000 acres</td>
<td>1548 acres</td>
<td>12%</td>
<td>2645</td>
<td>80%-90% reduction in 100yr flow from Montgomery &amp; Liberty Co. (55,000 cfs to &lt;10,000cfs) 9 foot reduction in 100 year flood plan B/C Ratio: .07</td>
<td>Reservoir permit in Sam Houston National Forest is unlikely.</td>
<td></td>
</tr>
<tr>
<td>3 West Fork</td>
<td>West Fork (San Jacinto No. 4)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$700,000</td>
<td>Upstream of Lake Conroe</td>
<td>2,744 acres</td>
<td>1116 acres</td>
<td>1%</td>
<td>35</td>
<td>Capacity: 25,210 ac-ft</td>
<td>Reservoir permit in Sam Houston National Forest is unlikely.</td>
<td></td>
</tr>
<tr>
<td>4 Lake Creek</td>
<td>Lake Creek Dam (Combined)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$275,000,000</td>
<td>On the lower portion of Lake Conroe</td>
<td>16,800 acres</td>
<td>7461 acres</td>
<td>25%</td>
<td>3126</td>
<td>Feasibility compared to 1997 appears largely unchanged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Lake Creek</td>
<td>Lake Creek Reservoir</td>
<td>1997</td>
<td>80% the size of Lake Conroe</td>
<td>$6,500,000</td>
<td>Near Woodlands at RM 26.42</td>
<td>1004 acres</td>
<td>102 acres</td>
<td>14%</td>
<td>229</td>
<td>Capacity 104,000 acre-feet, Area surrounding reservoir boundary is highly developed. Review reservoir boundary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Spring Creek</td>
<td>Spring Creek (Spring Creek No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$2,600,000</td>
<td>At confluence of Spring and Cypress Creeks</td>
<td>5537 acres</td>
<td>1117 acres</td>
<td>5%</td>
<td>229</td>
<td>Capacity 104,000 acre-feet, Area surrounding reservoir boundary is highly developed. Review reservoir boundary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Spring Creek</td>
<td>Spring Creek Reservoir 1 (SC-G1)</td>
<td>1985</td>
<td>Assumed to have 5' storage above pool</td>
<td>$6,500,000</td>
<td>Near Woodlands at RM 26.42</td>
<td>1004 acres</td>
<td>102 acres</td>
<td>14%</td>
<td>1532</td>
<td>Average 1% reduction in flow with minimal (0-5') change in WSEL.</td>
<td>Area is now developed.</td>
<td></td>
</tr>
<tr>
<td>8 Spring Creek</td>
<td>Spring Creek Reservoir 2 (SC-G2)</td>
<td>1985</td>
<td>Assumed to have full depth of storage</td>
<td>$4,000,000</td>
<td>Upstream of Walnut Creek confluence</td>
<td>3719 acres</td>
<td>407 acres</td>
<td>23%</td>
<td>9607</td>
<td>B/C Ratio=0.39 Average 3% reduction in flow and 3’ WSEL. Reservoir is now partially developed. Review boundary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Cypress Creek</td>
<td>Cypress Creek (Spring Creek No. 2)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$1,500,000</td>
<td>West of Westfield</td>
<td>4193 acres</td>
<td>151 acres</td>
<td>84%</td>
<td>19288</td>
<td>Capacity 58,520 acre-feet, Area is now developed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Caney Creek</td>
<td>Caney Creek (Caney Creek No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$400,000</td>
<td>Located East of Conroe</td>
<td>850 acres</td>
<td>87 acres</td>
<td>19%</td>
<td>27</td>
<td>Capacity 6,930 acre-feet Feasibility compared to 1943/1957 appears largely unchanged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Caney Creek</td>
<td>Caney Creek Reservoir (CC-G1)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$5,700,000</td>
<td>On upper Caney Creek near RM 34.71</td>
<td>677 acres</td>
<td>16 acres</td>
<td>13%</td>
<td>31</td>
<td>B/C=51, Average 100% flow reduction D/S of reservoir with 14’ change in WSEL, (at mouth 16’ drop in flow and 11’ drop in WSEL). Reservoir can store all 100-yr runoff upstream</td>
<td>Small residential developments. Review reservoir boundary.</td>
<td></td>
</tr>
<tr>
<td>12 Peach Creek</td>
<td>Peach Creek Reservoir 1 (PC-G1)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$3,500,000</td>
<td>Located in upstream part of Peach Creek</td>
<td>625 acres</td>
<td>142 acres</td>
<td>33%</td>
<td>49</td>
<td>Capacity 5,350 acre-feet Reservoir permit in Sam Houston National Forest is unlikely.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Peach Creek</td>
<td>Peach Creek Reservoir 2 (PC-G2)</td>
<td>1985</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$8,000,000</td>
<td>Located in upstream part of Peach Creek above Peach Creek No. 1</td>
<td>1381 acres</td>
<td>22 acres</td>
<td>0%</td>
<td>12</td>
<td>Capacity 2750 acre-feet Reservoir permit in Sam Houston National Forest is unlikely.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Stewart Creek</td>
<td>Stewart Creek (Stewart Creek No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$175,000</td>
<td>At the edge of Conroe</td>
<td>301 acres</td>
<td>12 acres</td>
<td>3%</td>
<td>11</td>
<td>Capacity 2,400 acre-feet There is development just downstream of reservoir location that was built around the year 2000. Area where reservoir is located remains undeveloped.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Caney Creek</td>
<td>CC-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Sycamore Drive R.M. 12.31</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.4 feet immediately upstream of bridges, B/C: 0.00</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
</tr>
<tr>
<td>16 East Fork</td>
<td>EF-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$48,700,000</td>
<td>Between Harris County and San Jacinto County Line</td>
<td>Width Upstream: 480 Feet, Width Downstream: 530 Feet, Depth 20 Feet</td>
<td>2259 acres</td>
<td>3%</td>
<td>884</td>
<td>B/C: 0.07 Feasibility compared to 1985 appears largely unchanged. Channel width may be restricted in some locations due to development.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Watershed</td>
<td>Name</td>
<td>Year</td>
<td>Description</td>
<td>Cost (When Proposed)</td>
<td>Location</td>
<td>Size</td>
<td>Wetlands</td>
<td>Percentage Developed</td>
<td>Number of Tracts of Land</td>
<td>Beneﬁt</td>
<td>Current Feasibility Notes</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
<td>------</td>
<td>------</td>
<td>-------------</td>
<td>---------------------</td>
<td>----------</td>
<td>------</td>
<td>----------</td>
<td>----------------------</td>
<td>-------------------------</td>
<td>--------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>16</td>
<td>East Fork</td>
<td>EF-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$3,400,000</td>
<td>Along the East Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 0.1 Foot reduction in 100 Year flood plane, B/C: 0.03</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>17</td>
<td>East Fork</td>
<td>EF-E2</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$3,000,000</td>
<td>Highway 105 bridge near Covington</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 1.2 feet immediately upstream of bridges, B/C: 0.03</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>18</td>
<td>East Fork</td>
<td>EF-E1</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$3,000,000</td>
<td>FM1485 Bridge near Harris County line</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 1.6 feet immediately upstream of bridges, B/C: 0.08</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>19</td>
<td>Lake Creek</td>
<td>LC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$126,000,000</td>
<td>R.M. 43.3 to R.M. 0.0</td>
<td>Depth Upstream: 22 Feet, Depth Downstream: 31 Feet, Width Upstream: 260 Feet, Width Downstream: 670 Feet</td>
<td>2949 acres</td>
<td>2%</td>
<td>329</td>
<td>B/C: &lt;0.001</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>19</td>
<td>Lake Creek</td>
<td>LC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$3,100,000</td>
<td>Along Lake Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.03 Foot reduction in 100 Year flood plane, B/C: 0.0</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>20</td>
<td>Peach Creek</td>
<td>PC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$37,500,000</td>
<td>R.M. 40.4 to R.M. 0.0</td>
<td>Width Upstream: 100 Feet, Width Downstream: 450 Feet, Depth Upstream: 10 Feet, Depth Downstream: 20 Feet</td>
<td>815 acres</td>
<td>5%</td>
<td>664</td>
<td>B/C: 0.33</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>20</td>
<td>Peach Creek</td>
<td>PC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$4,300,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Average 0.5 Foot reduction in 100 Year flood plane, Up to a 1.3 foot reduction, B/C: 0.24</td>
<td>Feasibility compared to 1985 appears largely unchanged. Permitting through Sam Houston National Forest may be an issue.</td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek</td>
<td>PC-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Applan Way R.M. 5.2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.4 feet immediately upstream of bridges, B/C: 0.05</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek</td>
<td>PC-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Unnamed Road R.M. 7.1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 1.6 feet immediately upstream of bridges, B/C: 0.0</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>21</td>
<td>Peach Creek</td>
<td>PC-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>FM2090 R.M. 9.4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.6 feet immediately upstream of bridges, B/C: 0.0</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>22</td>
<td>Spring Creek</td>
<td>SC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$190,800,000</td>
<td>R.M. 48.2 to R.M. 0.0</td>
<td>Width Upstream: 20 Feet, Width Downstream: 500 Feet, Upstream Depth: 14 Feet, Downstream Depth: 35 Feet</td>
<td>795 acres</td>
<td>3%</td>
<td>386</td>
<td>B/C: 0.03</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>22</td>
<td>Spring Creek</td>
<td>SC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$4,700,000</td>
<td>Along Spring Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 1 Foot reduction in 100 Year flood plane, B/C: 0.14</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>23</td>
<td>Spring Creek</td>
<td>SC-E2</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$19,000,000</td>
<td>Missouri Pacific RR R.M. 13.17</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.2 feet immediately upstream of bridges, B/C: 0.0</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>24</td>
<td>Spring Creek</td>
<td>SC-E1</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$10,000,000</td>
<td>Huffsmith Conroe Road RM 35.44, Missouri Pacific RR R.M. 37.28, Chicago and Pacific RR at R.M. 38.54</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 0.8 feet immediately upstream of bridges, B/C: 0.0</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>25</td>
<td>Spring Creek</td>
<td>SC-E3</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>Not Calculated</td>
<td>Missouri Pacific RR R.M. 13.17, and 1.46 spans at R.M. 16.83 and 16.89</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth of 5.5 feet immediately upstream of bridges, B/C: 0.0</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>26</td>
<td>West Fork</td>
<td>WF-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$137,000,000</td>
<td>Lake Conroe to Harris County</td>
<td>Depth: 30 Feet, Upstream Width: 500 Feet, Downstream Width: 600 Feet</td>
<td>1216 acres</td>
<td>4%</td>
<td>354</td>
<td>B/C: 0.40</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
</tbody>
</table>

C:sers\ah2364\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\T3ZXTVVG\Matrix_Alternatives_V42_feasibility.xlsx
<table>
<thead>
<tr>
<th>Project</th>
<th>Watershed</th>
<th>Name</th>
<th>Year</th>
<th>Description</th>
<th>Cost (When Proposed)</th>
<th>Location</th>
<th>Size</th>
<th>Wetlands</th>
<th>Precentage Developed</th>
<th>Number Tracts of Land</th>
<th>Benefit</th>
<th>Current Feasibility Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>West Fork</td>
<td>WF-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$5,700,000</td>
<td>Along The West Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>51 Foot reduction in 100 Year flood plane</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>West Fork</td>
<td>WF-C1</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 1</td>
<td>$8,600,000</td>
<td>Critical Area 1</td>
<td>N/A</td>
<td>179 acres</td>
<td>8%</td>
<td>35</td>
<td>B/C: 0.03</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>27</td>
<td>West Fork</td>
<td>WF-D1</td>
<td>1985</td>
<td>Desnag channel sections for critical area 1</td>
<td>$270,000</td>
<td>Critical Area 1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 0.00</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>West Fork</td>
<td>WF-C2</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 2</td>
<td>$17,300,000</td>
<td>Critical Area 2</td>
<td>N/A</td>
<td>97 acres</td>
<td>25%</td>
<td>34</td>
<td>B/C: 0.31</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>28</td>
<td>West Fork</td>
<td>WF-D2</td>
<td>1985</td>
<td>Desnag channel sections for critical area 2</td>
<td>$530,000</td>
<td>Critical Area 2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 0.31</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>West Fork</td>
<td>WF-C3</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 3</td>
<td>$31,200,000</td>
<td>Critical Area 3</td>
<td>N/A</td>
<td>125 acres</td>
<td>14%</td>
<td>216</td>
<td>B/C: 0.93</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>29</td>
<td>West Fork</td>
<td>WF-D3</td>
<td>1985</td>
<td>Desnag channel sections for critical area 3</td>
<td>$1,100,000</td>
<td>Critical Area 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 2.5</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>West Fork</td>
<td>WF-C4</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a grass lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 4</td>
<td>$8,800,000</td>
<td>Critical Area 4</td>
<td>N/A</td>
<td>147 acres</td>
<td>29%</td>
<td>87</td>
<td>B/C: 0.75</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>30</td>
<td>West Fork</td>
<td>WF-D4</td>
<td>1985</td>
<td>Desnag channel sections for critical area 4</td>
<td>$270,000</td>
<td>Critical Area 4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Reduction of 100 year flood depth ≤0.6, B/C: 2.3</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>West Fork</td>
<td>WF-C5</td>
<td>1985</td>
<td>Replace the existing West Fork channel section with a concrete lined channel, with the bottom of the current channel as the bottom of the new channel, for the length of Critical Area 3</td>
<td>$370,000,000</td>
<td>Critical Area 3</td>
<td>N/A</td>
<td>125 acres</td>
<td>14%</td>
<td>87</td>
<td>Channel reduction of flood depth by 5.5 feet in critical area 3, with a minor increase in depth downstream, B/C: 0.1</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
</tr>
<tr>
<td>32</td>
<td>West Fork</td>
<td>WF-E</td>
<td>1985</td>
<td>Modify the bridge(s) to be less hydraulically restrictive</td>
<td>$18,500,000</td>
<td>Atchinson</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1.2 Foot reduction in 100 Year flood plane, B/C: 0.085</td>
<td>Feasibility compared to 1985 appears largely unchanged.</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Caney Creek</td>
<td>CC-B</td>
<td>1985</td>
<td>Replace the Existing Channel with a large grass lined channel for the entirety of the watershed</td>
<td>$73,000,000</td>
<td>R.M. 46.1 to R.M. 0.0</td>
<td>Width Uplstream: 200 Feet, Width Downstream: 460 Feet, Depth Uplstream: 14 Feet, Depth Downstream: 30 Feet</td>
<td>663 acres</td>
<td>4%</td>
<td>829</td>
<td>B/C: 0.09</td>
<td>Feasibility compared to 1985 appears largely unchanged. Permitting along Sam Houston National Forest may be an issue.</td>
</tr>
<tr>
<td>33</td>
<td>Caney Creek</td>
<td>CC-D</td>
<td>1985</td>
<td>Remove debris, and vegetation along the banks of the channel to increase hydraulic efficiency.</td>
<td>$7,400,000</td>
<td>Along Caney Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>About 2.7 Foot reduction in 100 Year flood plains, B/C: 0.08</td>
<td>Feasibility compared to 1985 appears largely unchanged. Permitting along Sam Houston National Forest may be an issue.</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>West Fork</td>
<td>West Fork (San Jacinto No. 1)</td>
<td>1943/1957</td>
<td>Creation of a reservoir at the described location, with the intent of managing water release during a specific storm event.</td>
<td>$295,000</td>
<td>At confluence with Lake Creek</td>
<td>3,890 acres</td>
<td>1,738 acres</td>
<td>14%</td>
<td>370</td>
<td>Capacity: 33,525 ac-ft</td>
<td>Some small pockets of development near reservoir location. Review reservoir boundary.</td>
</tr>
<tr>
<td>35</td>
<td>East Fork</td>
<td>East Fork Reservoir</td>
<td></td>
<td></td>
<td></td>
<td>Downstream of Cleveland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replaces infeasible alternative from above</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Lake Creek</td>
<td>Lake Creek Reservoir</td>
<td></td>
<td></td>
<td></td>
<td>Upstream portion of Lake Creek outside Sam Houston National Forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replaces infeasible alternative from above</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Watershed</td>
<td>Name</td>
<td>Year</td>
<td>Description</td>
<td>Cost (When Proposed)</td>
<td>Location</td>
<td>Size</td>
<td>Wetlands</td>
<td>Percentage Developed</td>
<td>Number Tracts of Land</td>
<td>Benefit</td>
<td>Current Feasibility Notes</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
<td>---------------</td>
<td>------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>-------------------</td>
<td>------</td>
<td>----------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>---------</td>
<td>------------------------</td>
</tr>
<tr>
<td>37</td>
<td>Peach Creek</td>
<td>Peach Creek Reservoir</td>
<td>1985</td>
<td>Downstream of Sam Houston National Forest</td>
<td>$1,900,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>2.7</td>
<td>B/C: 1.3</td>
<td>Replaces infeasible alternative from above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caney Creek</td>
<td>CC-F25</td>
<td>1985</td>
<td>Purchases all property within the 25-yr floodplain.</td>
<td>$4,600,000</td>
<td>Along Caney Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>1.20</td>
<td>B/C: 0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Fork</td>
<td>EF-F25</td>
<td>1985</td>
<td>Purchases all property within the 25-yr floodplain.</td>
<td>$3,400,000</td>
<td>Along the East Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>0.81</td>
<td>B/C: 0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Fork</td>
<td>EF-F100</td>
<td>1985</td>
<td>Purchases all property within the 100-yr floodplain.</td>
<td>$4,500,000</td>
<td>Along the East Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>0.77</td>
<td>B/C: 0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lake Creek</td>
<td>LC-F25</td>
<td>1985</td>
<td>Purchases all property within the 25-yr floodplain; Same as the 100-yr floodplain.</td>
<td>$1,300,000</td>
<td>Along Lake Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>0.09</td>
<td>B/C: 0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peach Creek</td>
<td>PC-F25</td>
<td>1985</td>
<td>Purchases all property within the 25-yr floodplain.</td>
<td>$6,200,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>1.9</td>
<td>B/C: 0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peach Creek</td>
<td>PC-F100</td>
<td>1985</td>
<td>Purchases all property within the 100-yr floodplain.</td>
<td>$9,500,000</td>
<td>Along Peach Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>1.3</td>
<td>B/C: 0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring Creek</td>
<td>SC-F25</td>
<td>1985</td>
<td>Purchases all property within the 25-yr floodplain.</td>
<td>$6,300,000</td>
<td>Along Spring Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>0.84</td>
<td>B/C: 0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring Creek</td>
<td>SC-F100</td>
<td>1985</td>
<td>Purchases all property within the 100-yr floodplain.</td>
<td>$18,000,000</td>
<td>Along Spring Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>0.36</td>
<td>B/C: 0.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>West Fork</td>
<td>WF-F25</td>
<td>1985</td>
<td>Purchases all property within the 25-yr floodplain.</td>
<td>$62,000,000</td>
<td>Along The West Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>0.76</td>
<td>B/C: 0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>West Fork</td>
<td>WF-F100</td>
<td>1985</td>
<td>Purchases all property within the 100-yr floodplain.</td>
<td>$97,000,000</td>
<td>Along The West Fork</td>
<td>N/A</td>
<td>N/A</td>
<td>0.57</td>
<td>B/C: 0.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MEETING MINUTES

To: Jing Chen, P.E., CFM
Attendees: Jing Chen, HCFCD
From: Terry Barr, P.E., CFM
Gary Bezemek, HCFCD
Subject: Upper San Jacinto River Regional
Jonathan Holley, HCFCD
Flood Mitigation Plan – Primary
Myron Jones, HCFCD
Alternatives Workshop
Rob Lazaro, HCFCD

Meeting Date: 08/14/2019 – 3:00 pm
Dena Green, HCFCD
Location: HCFCD, Brookhollow Office
Jeremy Ratcliff, HCFCD
Minutes Date: 08/30/2019
Chuck Gilman, SJRA
AVO No.: 033465.002
Matt Barrett, SJRA
Heather Cook, SJRA
Diane Cooper, Montgomery County
Darren Hess, Montgomery County
Adam Eaton, COH
Terry Barr, Halff
Sam Hinojosa, Halff
Andrew Moore, Halff
Hector Olmos, FNI
Corey Stull, FNI
Greg Sevcik, Hollaway
Connor Stokes, Hollaway
Janice Hayes, Hollaway

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introductions</td>
<td>Ms. Chen started the meeting.</td>
</tr>
<tr>
<td>2.</td>
<td>Workshop Goals</td>
<td>Mr. Barr summarized the workshop goals. He mentioned that the previous alternatives had been explored and Halff is developing a ranking system matrix to summarize the options. He summarized the potential opportunities and constraints that are currently being weighed.</td>
</tr>
<tr>
<td>3.</td>
<td>Previously Identified Alternatives</td>
<td>Mr. Moore summarized the previous alternatives that had been explored through historical studies. He mentioned that options ranged from large reservoirs, to channel improvements, to localized de-snagging and sedimentation removal. He stated that benefit cost ratios of previous alternatives were very low due to the lack of development within the watershed.</td>
</tr>
<tr>
<td>4.</td>
<td>Primary Alternative Discussion</td>
<td>Mr. Barr presented the maps and matrices summarizing the previous alternatives. He stated that locations of reservoirs were preliminary and based on descriptions and limited figures from the reports. Ms. Cooper asked what the base data for the complaint hot spots included. Mr. Hinojosa stated that it was FEMA loss data for Harris...</td>
</tr>
</tbody>
</table>
Mr. Hinojosa stated that the damages occur along Cypress Creek, Spring Creek and Kingwood in Harris County while damages are sparse in Montgomery County with centers around River Plantation, McDade Estates, and Caney Creek near I-59.

Mr. Hinojosa discussed the potential for a Lake Creek reservoir. Mr. Bezemek stated that you could easily remove the hydrology to see what happens downstream. He asked how it would help population centers. Mr. Hinojosa stated that there are not a significant number of centers along Lake Creek but the volume could impact the Lake Houston area.

Mr. Hinojosa discussed the potential for an East Fork Reservoir in the Sam Houston National Forest. He asked whether there would be potential for impounding water in the national forest. Mr. Holley stated the USACE has done a study on the impact of temporary impoundment on vegetation. He stated they have not noticed a big change in a vegetated state on the two Harris County reservoirs due to recent flooding. He stated that forested lands can coexist with floodplains.

Mr. Hinojosa discussed how a Spring Creek reservoir will be included in the alternative discussion even though it had not been proposed in the past. He stated that the conservancy may pose a challenge with creating a reservoir along the main stem, but smaller basins can also be looked at for potential detention.

Mr. Hinojosa stated that smaller basins on Caney and Peach Creeks may prove to help out the volumes and flows at Lake Houston. He stated that these creeks have flatter terrain so there is less land depth for a large reservoir, but smaller ones could generate enough volume. He said that development is currently sparse through the watersheds, but development is growing in the region.

Mr. Bezemek stated that previous studies along Cypress Creek are being updated with the new terrain and new model techniques. He stated that the updates are reviewing mitigation along the tributaries and larger detention to reduce flows downstream. He stated one option is rice field detention which includes building berms along current rice fields to reduce runoff during a storm event. He stated the reports will be complete by the end of 2019.

Mr. Hinojosa stated that there is potential for alternatives on Luce and Tarkington Bayous but large reservoirs may be challenging due to the flat terrain.

Mr. Gilman asked if the alternatives would include the proposed gates for Lake Houston. He stated that the City had received a grant for studying the gates as a separate effort. Mr. Bezemek recommended modeling with a lower water surface elevation to show the impact of improved gates.
Mr. Barrett asked how many land-owners correlate to the number of parcels in the spreadsheet. He stated that ROW acquisition process could potentially be simplified if multiple parcels are owned by the same entity. One example where that could occur is in the national forest.

Ms. Cooper stated she had provided new developments being constructed in Montgomery County and it could be used for potential damage centers and future conditions modeling. She stated that development will occur in Montgomery County.

Ms. Cooper asked if Halff had obtained any flooding damages from Cleveland. Hinojosa stated that they had not obtained that information yet but would enquire.

Ms. Green asked how future conditions will impact the alternatives. Mr. Hinojosa stated that volumes and flows will likely change due to development and that it would be reviewed as part of the process.

| 4. | Ms. Chen concluded the meeting. |

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Phone Number</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terry Barr</td>
<td>Halff Associates, Inc.</td>
<td>(713) 588-2451</td>
<td><a href="mailto:tbarr@halff.com">tbarr@halff.com</a></td>
</tr>
<tr>
<td>Sam Hinojosa</td>
<td>Halff Associates, Inc.</td>
<td>(936) 777-6372</td>
<td><a href="mailto:shinojosa@halff.com">shinojosa@halff.com</a></td>
</tr>
<tr>
<td>Andrew Moore</td>
<td>Halff Associates, Inc.</td>
<td>(936) 777-6377</td>
<td><a href="mailto:amoore@halff.com">amoore@halff.com</a></td>
</tr>
<tr>
<td>Jing Chen</td>
<td>HCFCD</td>
<td>(713) 684-4264</td>
<td><a href="mailto:jing.chen@hcfcd.hctx.net">jing.chen@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Matt Barrett</td>
<td>SJRA</td>
<td>936 588 7177</td>
<td><a href="mailto:mbarrett@sjra.net">mbarrett@sjra.net</a></td>
</tr>
<tr>
<td>Chuck G. Ilum</td>
<td>SJRA</td>
<td>936-588-1111</td>
<td><a href="mailto:cgilman@sjra.net">cgilman@sjra.net</a></td>
</tr>
<tr>
<td>Hector Olmos</td>
<td>FNI</td>
<td>713-600-6856</td>
<td><a href="mailto:beo@preese.com">beo@preese.com</a></td>
</tr>
<tr>
<td>Diane Cooper</td>
<td>Montgomery Co</td>
<td>934-939-8111</td>
<td><a href="mailto:diane.cooper@metx.org">diane.cooper@metx.org</a></td>
</tr>
<tr>
<td>Jonathan Holly</td>
<td>HCFCD</td>
<td>346-286-4155</td>
<td><a href="mailto:jonathan.holly@hcfcd.hctx.net">jonathan.holly@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Gary Bezeman</td>
<td>HCFCD</td>
<td>713 684 4000</td>
<td><a href="mailto:gary.bezeman@hcfcd.hctx.net">gary.bezeman@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Myron Jones</td>
<td>HCFCD</td>
<td>346-286-4056</td>
<td><a href="mailto:myron.jones@hcfcd.hctx.net">myron.jones@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Darren Hees</td>
<td>Martin Co</td>
<td>934-522 3980</td>
<td><a href="mailto:darren.hees@metx.org">darren.hees@metx.org</a></td>
</tr>
<tr>
<td>Janice Haycs</td>
<td>Holloway</td>
<td>713-868-4100</td>
<td>Janice @ hollawayenv.com</td>
</tr>
<tr>
<td>for UAZA</td>
<td>HCFCD</td>
<td>713-868-7127</td>
<td>rebert. <a href="mailto:lazsa@hcfcd.org">lazsa@hcfcd.org</a></td>
</tr>
<tr>
<td>Adam Eaton</td>
<td>Cott</td>
<td>832 395 3682</td>
<td>Adam. <a href="mailto:Eaton@metx.gov">Eaton@metx.gov</a></td>
</tr>
<tr>
<td>Dana Green</td>
<td>HCFCD</td>
<td>346-286-4252</td>
<td><a href="mailto:dana.green@hcfcd.hctx.net">dana.green@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Connor Stokes</td>
<td>Holloway Env.</td>
<td>713-868-1043</td>
<td><a href="mailto:connor@hollawayenv.com">connor@hollawayenv.com</a></td>
</tr>
<tr>
<td>Jeremy Patern</td>
<td>HCFCD</td>
<td>(713) 684-4005</td>
<td><a href="mailto:jeremy.patern@hcfcd.org">jeremy.patern@hcfcd.org</a></td>
</tr>
<tr>
<td>Gary Still</td>
<td>FNI</td>
<td>(713) 600-6809</td>
<td><a href="mailto:gary_still@fries.com">gary_still@fries.com</a></td>
</tr>
</tbody>
</table>
# Alternatives Workshop No. 2 Agenda

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

December 11, 2019  
San Jacinto River Watershed Master Drainage Plan  
HCFCD, Brookhollow

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Alternatives Workshop No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:00 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>4:00 PM</td>
</tr>
</tbody>
</table>

## Agenda

1. **Introductions, Agenda, Purpose (5 min)**

2. **Workshop Goals (2 min)**
   - Review and provide input on damage center identification
   - Prioritization of damage centers
   - Provide feedback on magnitude and type of projects
   - Determine ranking metrics list

3. **Alternatives Evaluation Process (3 min)**
   - Combine HEC-RAS models for all streams
   - Run models for frequency storm events
   - Develop the Structural Inventory Tool
   - Identify “Damage Centers”
   - Select a Target Frequency
   - Determine Improvements needed to achieve the desired level of service
   - Qualitative Analysis
   - Ranking Methodology

4. **Calibration Discussion (10 min)**
   - Combined Models
   - Calibration
   - HDR Discussion

5. **Frequency Analysis (20 min)**
   - Analysis Results
   - Watershed Volume Sensitivity

6. **Structural Inventory (10 min)**
   - Process and Inventory Development
   - Flooded Structure Statistics
7. Damage Center Identification (30 min)
   - Identification Process
   - Damage Center Locations (Maps)
   - Questions for Study Partners

8. Break (10 min)

9. Target Frequency Discussion (30 min)
   - Flood Risk Reduction Volumes
   - Volume Calculation Process
     - Determining Volumes
     - Volume Differences by Frequency
     - Benefits Determination
   - Issues with Selecting a “Target Frequency”

10. Potential Improvements (30 min)
    - Total Volume Needs and Locations
    - Volume required vs. Structures Removed
      - 100-Year Level of Service
      - Most Cost-Effective Level of Service
    - Study Partner Input

11. Project Metrics (25 min)
    - Ranking Methodology
    - Study Partner Input

12. Closing Remarks and Questions (5 min)
Workshop Goals

- Review and provide input on damage center identification
- Prioritization of damage centers
- Provide feedback on magnitude and type of projects
- Determine ranking metrics list
Alternatives Evaluation Process

- Combine HEC-RAS models for all streams
- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify “Damage Centers”
- Select a Target Frequency
- Determine Improvements needed to achieve the desired level of service
- Qualitative Analysis
- Ranking Methodology
Combined Models

- Submitted draft calibration report and models 11/4/19
- Continued updates including the Lake Conroe elevation and Memorial Day 2016
- Initial Review discussions with HDR
  - Some gages match very well
  - Some gages did not match flow/stage as well
  - Confidence in some flow gages discussed with USGS
  - Initial loss seemed high for some of the watersheds
Frequency Analysis

- 100-year inflow volumes to Lake Houston

100-year Frequency Storm Event
Lake Houston Inflow Volume = 1.7 Million ac-ft

- West Fork 7.6%
- Caney Creek 7.5%
- Peach Creek 6.5%
- Luce Bayou 9.2%
- East Fork 15.0%
- Lake Conroe 12.2%
- Cypress Creek 9.2%
- Lake Creek 12.2%
- Spring Creek 20.6%
Frequency Analysis

• 100-year flow hydrograph comparisons
Frequency Analysis

- Watershed Volume Sensitivity
- Table shows 100-year WSEL reduction at Lake Houston as a result of removing entire watershed from model
- Lake Houston 100-year = 51.73’

<table>
<thead>
<tr>
<th>WSEL Reduction</th>
<th>Luce Bayou</th>
<th>East Fork</th>
<th>Caney Creek</th>
<th>Peach Creek</th>
<th>Lake Creek</th>
<th>Spring Creek</th>
<th>Cypress Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-59</td>
<td>0</td>
<td>0</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-1.26</td>
<td>-2.8</td>
<td>-0.63</td>
</tr>
<tr>
<td>East Fork</td>
<td>-0.06</td>
<td>-1.62</td>
<td>-2.49</td>
<td>-1.83</td>
<td>-0.01</td>
<td>-0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td>FM 1960</td>
<td>-0.49</td>
<td>-0.65</td>
<td>-0.65</td>
<td>-0.48</td>
<td>-0.59</td>
<td>-1.2</td>
<td>-0.24</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.42</td>
<td>-0.56</td>
<td>-0.56</td>
<td>-0.41</td>
<td>-0.5</td>
<td>-1.04</td>
<td>-0.2</td>
</tr>
</tbody>
</table>
Frequency Analysis

- Watershed Volume Sensitivity
- Table shows 100-year WSEL reduction at Lake Houston as a result of removing entire watershed from model
- US59 and Lake Houston 100-year Example
Structural Inventory

- Identified structures near floodplains
- Assigned finished floor elevations based on terrain + 6-inches
## Structural Inventory

- Structures identified within frequency floodplains

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Luce</th>
<th>East Fork</th>
<th>Caney</th>
<th>Peach</th>
<th>West Fork</th>
<th>Lake Creek</th>
<th>Spring</th>
<th>Cypress</th>
</tr>
</thead>
<tbody>
<tr>
<td>2yr</td>
<td>5</td>
<td>20</td>
<td>139</td>
<td>77</td>
<td>58</td>
<td>16</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>5yr</td>
<td>19</td>
<td>103</td>
<td>289</td>
<td>293</td>
<td>223</td>
<td>31</td>
<td>269</td>
<td>94</td>
</tr>
<tr>
<td>10yr</td>
<td>34</td>
<td>236</td>
<td>546</td>
<td>505</td>
<td>624</td>
<td>49</td>
<td>644</td>
<td>250</td>
</tr>
<tr>
<td>25yr</td>
<td>68</td>
<td>523</td>
<td>1,078</td>
<td>789</td>
<td>1,399</td>
<td>89</td>
<td>1,324</td>
<td>638</td>
</tr>
<tr>
<td>50yr</td>
<td>96</td>
<td>828</td>
<td>1,497</td>
<td>1,086</td>
<td>2,227</td>
<td>154</td>
<td>2,524</td>
<td>1,345</td>
</tr>
<tr>
<td>100yr</td>
<td>184</td>
<td>1,247</td>
<td>2,023</td>
<td>1,315</td>
<td>4,979</td>
<td>205</td>
<td>5,669</td>
<td>2,910</td>
</tr>
<tr>
<td>500yr</td>
<td>369</td>
<td>2,120</td>
<td>4,124</td>
<td>1,838</td>
<td>10,298</td>
<td>333</td>
<td>11,982</td>
<td>8,750</td>
</tr>
</tbody>
</table>
Damage Centers

• Identification Process
  – “hotspots” based on structures within floodplain
  – Tabulated structures at risk of flooding per frequency event
  – Tabulated instances of flooding based on a 50-year project
Damage Centers

• Identification Process
  – “hotspots” based on structures within floodplain
  – Tabulated structures at risk of flooding per frequency event
  – Tabulated instances of flooding based on a 50-year project

*Spring Creek* – Instances of Structural Flooding (50-yr Project Life)
Damage Centers

- Identification Process
  - “hotspots” based on structures within floodplain
  - Tabulated structures at risk of flooding per frequency event
  - Tabulated instances of flooding based on a 50-year project
Damage Centers

- Map of Damage Centers (47 total)
Damage Centers

• Luce Bayou; Tarkington Bayou
  – Very flat terrain, not much relief
  – Minimal flood damages
  – Improvements upstream would likely help overflow into Cedar, not Lake Houston
  – Smaller % of volume being contributed by Luce/Tarkington Bayous
  – 0-0.5’ reduction in Lake Houston (Low Sensitivity)
Damage Centers

• East Fork San Jacinto River
  – Large availability of undeveloped land
  – Slightly steeper; More relief
  – Contributes large % of volume into Lake Houston
  – Damages within the watershed are relatively low
  – Winters Bayou plays a significant role in drainage
  – 0.5-1.6’ reduction downstream (High Sensitivity)
Damage Centers

- Peach Creek; Caney Creek
  - Relatively high number of damages
  - Undeveloped land available
  - Confluence near Kingwood
  - Combines into significant portion of the East Fork
  - 1.0-4.0’ reduction downstream
  (High Sensitivity)
Damage Centers

- West Fork San Jacinto
  - Previous study indicates limited opportunity near Conroe
  - Possible improvements at River Plantation
  - Limited space due to development
  - Minimal benefit upstream of Lake Conroe
  - Much higher volume needed
  - Detention needed along Lake Creek
Damage Centers

• Lake Creek
  – Relatively small number of damages
  – Limited development in the upper watershed
  – History of consideration for detention project
  – Potential local and West Fork benefits
  – 0.5-1.2’ reduction downstream
    (Moderate Sensitivity)
Damage Centers

- Spring Creek
  - Availability of undeveloped land upstream
  - Slightly steeper; More relief
  - Contributes large % of volume into Lake Houston
  - Significant damages within the watershed
  - Siting study is a focus in the watershed
  - 1.0-2.8’ reduction downstream (High Sensitivity)
Damage Centers

- Cypress Creek; Little Cypress Creek; Willow Creek
  - Limited land availability for large projects in much of the watershed area
  - Projects being developed as part of separate HCFCD efforts
  - Projects in Upper Cypress would influence the overflow, not Lake Houston
  - Small volume contributions from Willow and Little Cypress
  - 0.2-0.6' reduction downstream
    (Low Sensitivity)
Damage Centers

• Jackson Bayou
  – Very limited detention possibilities due to size
  – Outfalls downstream of Lake Houston; no upstream benefits
  – Small fraction of flow into San Jacinto; minimal improvement
  – Being investigated through Watershed Planning Study
  – Potential channel conveyance project
    (No Sensitivity to Lake Houston)
Damage Centers

- Higher Priority Centers
Damage Centers

- Map of roadways inundated
  - Color coded based on frequency overtopped
Damage Centers

- Questions for Study Partners
  - Are there other Damage Centers that need to be included for other reasons than those presented?
  - Are there other factors that could change the current priority?
  - Which Damage Centers will need to be addressed with a project no matter the BCA?
Flood Risk Reduction Volumes

• Goal is to determine high level detention volumes needed throughout the watershed
• Select “target frequency” based on no or minimal structures flooding in the damage center
• Calculate detention volume needed to reduce greater storm events to a lower frequency
• Calculate estimated total volume needed for each watershed
• Optimization will occur during modeling
Flood Risk Reduction Volumes

- Target Frequency
  - Selected a target frequency based on profiles showing potentially inundated structures
  - DC_J100_002
Flood Risk Reduction Volumes

- Volume calculation process
  - Hydrograph subtraction per damage center
  - Calculated volume needed for various frequencies
Flood Risk Reduction Volumes

- Volume calculation process
  - Hydrograph subtraction per damage center
  - Calculated volume needed for various frequencies

<table>
<thead>
<tr>
<th>Frequency (yr)</th>
<th>500yr</th>
<th>250yr</th>
<th>219,495</th>
<th>168,485</th>
<th>123,390</th>
<th>78,745</th>
</tr>
</thead>
<tbody>
<tr>
<td>100yr</td>
<td>163,114</td>
<td>127,434</td>
<td>96,786</td>
<td>52,374</td>
<td>20,639</td>
<td></td>
</tr>
<tr>
<td>50yr</td>
<td>113,143</td>
<td>83,538</td>
<td>54,781</td>
<td>17,821</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25yr</td>
<td>74,866</td>
<td>47,875</td>
<td>22,771</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10yr</td>
<td>36,503</td>
<td>13,448</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5yr</td>
<td>14,164</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Hydrograph

Difference in Volumes (ac-ft)

DRAFT - 8/26/2020
Flood Risk Reduction Volumes

- Volume calculation process
  - Hydrograph subtraction per damage center
  - Calculated volume needed for various frequencies
  - Determined reduction in potentially impacted structures

<table>
<thead>
<tr>
<th>Start</th>
<th>Target</th>
<th>Vol, ac-ft</th>
<th>Cumulative number of flooded structures</th>
<th>Benefit</th>
<th>B/V</th>
<th>Incr. V</th>
<th>Incr. B</th>
</tr>
</thead>
<tbody>
<tr>
<td>500yr</td>
<td>100yr</td>
<td>78,745</td>
<td>946 498 271 100 43 9 0</td>
<td>1638</td>
<td>21</td>
<td>78,745</td>
<td>1638</td>
</tr>
<tr>
<td>500yr</td>
<td>50yr</td>
<td>123,390</td>
<td>498 271 100 43 9 0 0</td>
<td>2298</td>
<td>19</td>
<td>44,645</td>
<td>660</td>
</tr>
<tr>
<td>500yr</td>
<td>25yr</td>
<td>168,485</td>
<td>271 100 43 9 0 0 0</td>
<td>2568</td>
<td>15</td>
<td>45,095</td>
<td>269</td>
</tr>
<tr>
<td>500yr</td>
<td>10yr</td>
<td>219,495</td>
<td>100 43 9 0 0 0 0</td>
<td>2671</td>
<td>12</td>
<td>51,011</td>
<td>103</td>
</tr>
<tr>
<td>500yr</td>
<td>5yr</td>
<td>257,190</td>
<td>43 9 0 0 0 0 0</td>
<td>2704</td>
<td>11</td>
<td>37,694</td>
<td>33</td>
</tr>
<tr>
<td>500yr</td>
<td>2yr</td>
<td>289,914</td>
<td>9 0 0 0 0 0 0</td>
<td>2715</td>
<td>9</td>
<td>32,724</td>
<td>11</td>
</tr>
<tr>
<td>100yr</td>
<td>50yr</td>
<td>20,639</td>
<td>1829 498 271 100 43 9 0</td>
<td>1462</td>
<td>71</td>
<td>20,639</td>
<td>1462</td>
</tr>
<tr>
<td>100yr</td>
<td>25yr</td>
<td>52,374</td>
<td>1829 271 100 43 9 0 0</td>
<td>2032</td>
<td>39</td>
<td>31,736</td>
<td>570</td>
</tr>
<tr>
<td>100yr</td>
<td>10yr</td>
<td>96,786</td>
<td>1829 100 43 9 0 0 0</td>
<td>2256</td>
<td>23</td>
<td>44,411</td>
<td>224</td>
</tr>
<tr>
<td>100yr</td>
<td>5yr</td>
<td>127,434</td>
<td>43 9 0 0 0 0 0</td>
<td>2325</td>
<td>18</td>
<td>30,648</td>
<td>69</td>
</tr>
<tr>
<td>100yr</td>
<td>2yr</td>
<td>163,114</td>
<td>9 0 0 0 0 0 0</td>
<td>2347</td>
<td>14</td>
<td>35,680</td>
<td>22</td>
</tr>
</tbody>
</table>
Flood Risk Reduction Volumes

- Volume calculation process
  - Hydrograph subtraction per damage center
  - Calculated volume needed for various frequencies
  - Determined reduction in potentially impacted structures
Flood Risk Reduction Volumes

- Volume required versus structures removed from floodplain
- Target frequency is the 100-year frequency storm event

<table>
<thead>
<tr>
<th>Stream</th>
<th>Volume Required</th>
<th>Benefit</th>
<th>Volume Per Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luce Bayou</td>
<td>87,000</td>
<td>780</td>
<td>112</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>1.6 M</td>
<td>4,569</td>
<td>350</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>89,000</td>
<td>1,487</td>
<td>60</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>214,000</td>
<td>8,480</td>
<td>25</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>4.3 M</td>
<td>9,948</td>
<td>432</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>232,000</td>
<td>705</td>
<td>329</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>458,256</td>
<td>10,915</td>
<td>42</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>128,332</td>
<td>4,812</td>
<td>27</td>
</tr>
</tbody>
</table>

*Addicks Reservoir capacity 204,500 acre-feet and 26 sq. miles*
Flood Risk Reduction Volumes

- Volume required versus structures removed from floodplain
- Target frequency varies based on anticipated benefit

<table>
<thead>
<tr>
<th>Stream</th>
<th>Volume Required</th>
<th>Benefit</th>
<th>Volume Per Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luce Bayou</td>
<td>7,713</td>
<td>653</td>
<td>12</td>
</tr>
<tr>
<td>East Fork SJR</td>
<td>500,000</td>
<td>3,653</td>
<td>137</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>25,373</td>
<td>1,257</td>
<td>20</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>65,687</td>
<td>7,030</td>
<td>9</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>1.8 M</td>
<td>8,329</td>
<td>216</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>79,619</td>
<td>595</td>
<td>134</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>132,302</td>
<td>9,331</td>
<td>14</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>128,332</td>
<td>3,962</td>
<td>32</td>
</tr>
</tbody>
</table>

*Addicks Reservoir capacity 204,500 acre-feet and 26 sq. miles
Flood Risk Reduction Volumes

• Volume required for prioritized damage centers

<table>
<thead>
<tr>
<th>Stream</th>
<th>Max Beneficial Volumes</th>
<th>Volume Required</th>
<th>Benefit</th>
<th>Volume Per Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Fork SJR</td>
<td>25 Yr</td>
<td>393,000</td>
<td>3,187</td>
<td>123</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>10 Yr</td>
<td>50,000</td>
<td>1,421</td>
<td>35</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>10 Yr</td>
<td>121,000</td>
<td>7,958</td>
<td>15</td>
</tr>
<tr>
<td>West Fork SJR</td>
<td>10-25 Yr</td>
<td>1.1 M</td>
<td>5,270</td>
<td>209</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>25 Yr</td>
<td>160,000</td>
<td>9,674</td>
<td>17</td>
</tr>
</tbody>
</table>

*Addicks Reservoir capacity 204,500 acre-feet and 26 sq. miles
Watershed Mitigation Potential

- **High Potential**
  - Spring Creek (Benefits in watershed; Potential reduction downstream)
  - East Fork (Major Lake Houston contributor; Available open space)
  - Peach/Caney Creek (Available open space; Benefits in watershed)

- **Moderate Potential**
  - Lake Creek (Available open space; large portion of West Fork, Limited benefits in the Lake Creek watershed)

- **Low Potential**
  - Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  - Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  - Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  - Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  - West Fork (Limited open space; High volume; Benefits in watershed)
Flood Risk Reduction Volumes

- Initial volume estimates show significant volume may be needed for the 100-year storm event
- What types of projects should be considered?
  - Detention
  - Buyout
  - Channelization
  - Other
- What about policy considerations?
  - Detention
  - Floodplain Preservation
Ranking Methodology

Metrics from Scope of Work:

- Reduction in structural flooding
- Project Cost
- Design Life
- Maintenance
- Feasibility
- Constructability
- Public Benefit
- Public Safety
- Multi use
- Environmental Constraints
Ranking Methodology

Other Metrics to Consider

- Reduction in road flooding
- Community/Agency favor
- Erosion Control
- Impact to water quality
- Multi-function
- Implementation schedule

Input from Stakeholders:
Is there anything missing?
Questions?
**MEETING MINUTES**

To: Jing Chen, P.E., CFM  
From: Terry Barr, P.E., CFM  
Subject: Upper San Jacinto River Regional Flood Mitigation Plan – Alternatives Workshop No. 2  
Meeting Date: 12/11/2019 – 1:00 pm  
Location: HCFCD, Northwest Crossing Office  
Minutes Date: 12/19/2019  
AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1.   | Introductions, Agenda, Purpose  
Mr. Barr introduced the meeting.  
There was a discussion concerning the public meeting exhibits. The 100-year event will be presented instead of the Harvey event to be less “Harvey-centric”. Also, volumes will be reported instead of flows. Line weights will be removed to avoid confusion with a floodplain map. The pie chart showing volumes will be retained. The West Fork watershed could be split into two at Lake Conroe. Cumulative drainage area may also be included on the map if beneficial.  
Mr. Barr asked if there would be any issues with showing the calibrated inundation map from Harvey. All agreed to put “DRAFT” on all exhibits for the public meeting, as the analysis is unfinished.  
Ms. Chen asked about the status of the sedimentation report. Mr. Stull stated they are on track to submit a draft in January. This includes a literature review, update, and synthesis of existing data, including data received from USACE. | Halff to upload the revised exhibit onto the Dropbox by 12/12. |
| 2.   | Workshop Goals  
Mr. Barr presented the workshop goals.  
Ms. Green stated that the workshop attendees should brief others in their respective organizations about the outcomes of this workshop. A separate briefing for Montgomery County may be provided if needed. | Halff to set up a briefing for Montgomery County. |
| 3.   | Alternatives Evaluation Process  
Mr. Barr presented the alternatives evaluation process, with each step being discussed in detail during the remainder of the workshop. |
4. **Calibration Discussion**

Mr. Moore presented an update on the calibration effort. The HEC-RAS models have been combined into one. The combined model will be fine-tuned further but is approximately 90% complete. Draft calibration report and models were submitted to HCFCD on 11/4/19.

Mr. Moore talked with Mr. Duane Barrett (HDR) on 12/6/19. Mr. Barrett did not have a chance to do a full review of the calibrated model at that time but commented on discrepancies between gauge readings and model results. Mr. Moore said there are known issues with certain gauge readings. A meeting is scheduled with HDR on 12/17/19 to review comments on the calibrated model.

5. **Frequency Analysis**

The frequency analysis was presented. The “Lake Conroe” hydrograph on Slide 6 does not include dam operations and should be labeled “West Fork” instead. Mr. Barrett stated that the West Fork peak could potentially be reduced and the timing may be delayed after dam operations are included.

The figure shows that proposing a reservoir on just one of the watersheds could not solve the regional problem. Mr. Bezemek recommended adding the combined hydrograph to the figure to provide perspective on hydrograph timing. The combined hydrograph may need to be on a different scale or secondary axis so as not to “flatten” the other hydrographs.

Entire watersheds were removed from the combined model one at a time to test the sensitivity of each watershed’s contribution. The scenario where Spring Creek is removed from the model shows the most significant reductions including 2.8 ft at US59 and more than 1 ft at the Lake Houston dam. For perspective, Mr. Olmos explained that if an alternative was sought that would reduce Lake Houston stage by three feet, the alternative would be substantial and likely not feasible from a cost perspective.

Ms. Chen asked if regional ponds would be modeled for the upcoming Spring Creek workshop. Mr. Stull said the analysis would be similar to this high-level exercise, and that they would consider the impact to damage centers. Mr. Barr stated that an alternative in Spring Creek may be recommended as a regional option.

6. **Structural Inventory**

FNI presented an update on the structural inventory. Finished floor elevations were assigned based on the terrain plus six inches. On the first pass, many structures were within the 2-year inundation. Google Street View spot checks revealed that many of these structures were built on
Whole neighborhoods were identified in this way as raised on piers for the following iterations of the analysis. Ms. Green stated a six-inch adjustment could potentially be too low. She suggested rerunning the analysis for other adjustments (e.g., 1 foot) to test the sensitivity. The results could be included in the data tables. Mr. Stull said they can add in a sensitivity check for FFEs. Mr. Johnston stated another adjustment was made in the Cypress Creek watershed because of the Inverness Forest Levee system. For the neighborhood protected by the levee, the FFEs were assigned to the levee height.

Ms. Chen asked if the study team’s structural inventory tool was the same format as HCFCD’s structural inventory tool. Mr. Stull explained that this process was created ad hoc for this study, but the nature of the tool is the same as HCFCD’s. It is comprised of a spreadsheet that is linked to GIS data.

<table>
<thead>
<tr>
<th>7. Damage Center Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>The table on Slide 10 shows the number of structures with FFE below the water surface elevation of each frequency storm event. Mr. Johnston presented the figures on Slides 11 through 13, which boil the number of structures at risk of flooding down to one number: the statistically expected “instances of flooding” over a 50-year project life. Each damage center was identified based on “instances of flooding” per river mile. Mr. Stull stated that this analysis can be extended to include appraisal district structure values and depth-damage curves. Mr. Moore stated that BCA will eventually be included after the modeling and analysis. The following discussion took place concerning the damage centers for each watershed:</td>
</tr>
<tr>
<td>Luce Bayou / Tarkington Bayou: Ms. Chen stated that the “Huffman analysis” recommended a detention pond in this watershed.</td>
</tr>
<tr>
<td>EFSJR: Mr. Moore stated that one regional pond on just EFSJR may not be a solution since Winters Bayou (tributary of EFSJR) also has a large drainage area.</td>
</tr>
<tr>
<td>Peach Creek / Caney Creek: Ms. Green said that they get a lot of calls from Splendora. Mr. Moore said that Montgomery County Precinct 2 Commissioner was interested in this study because they have known drainage issues.</td>
</tr>
<tr>
<td>WFSJR: Mr. Moore said a previous Halff study showed that the channel improvements required to reduce the damage center between Conroe and Lake Conroe was cost prohibitive. Mr. Olmos mentioned that though Kingwood spans both EFSJR and WFSJR, it is currently shown as separate damage centers.</td>
</tr>
<tr>
<td>Lake Creek: It was found that many watershed studies from the past mention a regional pond on Lake Creek. This will likely be a proposed alternative.</td>
</tr>
</tbody>
</table>

| FNI to perform sensitivity check for FFE adjustments. |
| Ms. Chen to follow up with Bruce (HCFCD) for Imelda flooding complaint data. |
Spring Creek: Spring Creek has the highest concentration of damaged structures. Mr. Bezemek asked if the structural inventory is backed up by historical complaints. Mr. Moore said that historical complaints are available for comparison and that structural flooding for Montgomery County is available online. Mr. Bezemek said to verify that the damage numbers here are correct.

Cypress/Little Cypress/Willow Creek: Mr. Bezemek stated that the Frontier Program on Little Cypress Creek should provide relief to the local damage centers there. Mr. Olmos said that the Frontier projects may not help much further downstream of the confluence of Cypress Creek and Little Cypress Creek. Mr. Holley said dredging Cypress Creek would be very costly.

Jackson Bayou: This watershed is downstream of Lake Houston Dam and will have no upstream benefits.

General Comments: Mr. Bezemek said that damage center rings could be color-coded for future exhibits. He also said the damage center rings are useful information for future locally driven projects.

Ms. Green stated that there needs to be more clarity on what benefit there is to reducing the volume into Lake Houston. It makes it seem as though Lake Houston is the focus.

Mr. Bezemek said that the metric for determining damage centers may be adjusted by filtering out the 2-year, 5-year, and maybe 10-year damage incidents (“hopelessly deep in the floodplain”) to see if any damage centers disappear or are significantly changed. He also suggested that the damage centers that didn’t “make the cut” could be retained on the map in a different color, just so the public does not wonder why the study missed a known damage center. Otherwise, a note can be included about the filtering process.

Ms. Chen said this narrative (explaining each watershed) would be helpful in the report.

Mr. Eaton mentioned that the most downstream WFSJ damage center on Slide 23 will be of value to the Lake Houston gates project. According to the structural inventory, there are approximately 2,500 instances of flooding over a 50-year period within that damage center.

The legend on Slide 24 should be renamed from “None” to “less than 2-year.”

Ms. Green said that the relative severity of each damage center should be checked again after the FFE sensitivity analysis is completed.

Mr. Bezemek mentioned drainage tunnels as a potential alternative. For example, could it be used to take water off of Cypress Creek? Mr. Stull said a narrative could be provided about certain potential projects that may help locally, but not considered for this study. Ms. Green said however that if there are a lot of local damages, a potential local
alternative could still be proposed that may not have a regional impact. Ms. Green cautioned not to discount a potential solution just because some other entity may work on those solutions.

Mr. Moore asked the workshop participants if there was anything that the study has missed so far. Ms. Green asked about Atascosita. Mr. Bezemek commented that while the typical metric for ranking flood projects is based on structural risk, road closures and navigability of roads may need to be factored into the metric. Ms. Chen asked if the Harvey and Imelda flooding complaint layers could be overlain on the damage center map.

8. Target Frequency

The flood risk reduction volumes were discussed. The flood risk reduction volumes were estimated for each damage center based on approximate hydrograph volume differences that could be provided by detention. Mr. Moore said some checks were made with the estimated volume in the model for Spring Creek. Mr. Olmos noted that these calculated volumes would need to be located within the immediate vicinity of each damage center to provide full benefit. It was acknowledged that one project could benefit more than one damage center.

The “benefit” (y-axis) on Slide 31 refers to instances of flooding over a 50-year period. Ms. Chen asked how the target frequency will be determined. The optimal benefit curves are provided for each damage center and can be used to help determine a target detention frequency for each individual damage center.

Mr. Bezemek said it may never make sense in this regional study to alleviate flood risk for a structure that floods in the 2-year and thus suggested that deep flooding should perhaps be filtered out. Shallow flooding may see more benefit from a regional perspective. Mr. Bezemek suggested cutting out the 2-year, 5-year, and potentially 10-year structures from this analysis. Mr. Olmos said that once the data is coupled with the economics, BCA could be calculated for buyouts. HCFCD typically uses grants to help with buyouts.

Ms. Chen said that in urbanized areas, FFEs should be adjusted by closer to 12 inches instead of 6 inches. Mr. Stull said that each subdivision usually uses the same foundation type, so sampling of the more-frequently flooded structures is likely sufficient to make a determination at the subdivision level. Date of construction and associated criteria could be used to infer individual FFEs, but this data is not readily available for the entire study area.

Compared to other watersheds, Peach and Spring Creek watersheds particularly seem to not require as much volume to get a good amount of benefit. Mr. Barrett asked if the benefits calculated for the various watersheds are limited to that watershed or if benefits are determined in the receiving watersheds (i.e. Benefits on the West Fork from storage on Lake Creek). Mr. Moore said these benefits are calculated only for the
respective damage centers. And Mr. Barr noted that there could still be further benefits downstream.

Mr. Bezemek asked if the study has produced floodplains for all storm frequencies. A: Yes, at least in raw form.

Mr. Bezemek said an alternative way of showing benefit would be to show shrinkages in floodplain.

Mr. Barrett asked if an alternative on WFSJR ever looks feasible. Mr. Johnston said those benefit curves are generally flatter and all require large volumes.

Mr. Bezemek said we need to be able to incorporate transit LOS in the overall project ranking metric.

Mr. Barrett indicated that the study team will need to carefully explain this methodology in future reports as it is complex and difficult to understand. The tables show a significant amount of data and context will need to be provided.

<table>
<thead>
<tr>
<th>9. Potential Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Bezemek commented that the term “low potential” could be changed to “not a regional solution”. Local and regional benefits could be differentiated, but we need to reinforce that regional benefits will be the scope of this analysis.</td>
</tr>
<tr>
<td>Mr. Bezemek said diversions and parallel channels are some things that HCFCD does but may not be valid in other areas. HCFCD is currently doing a study on Upper Cypress and considering building berms on their big properties. A bypass could work if there are a cluster of homes.</td>
</tr>
<tr>
<td>Mr. Bezemek said another policy is to bar development in the floodplain. HCFCD sees floodplain preservation as pursuing buyouts to keep a floodplain undeveloped.</td>
</tr>
<tr>
<td>Ms. Green asked if the study team has the necessary data to estimate a future condition. She assumes that the effective criteria for each jurisdiction would be consulted. For example, if the criteria requires detention, then detention should be included in future conditions. Montgomery County drainage criteria allows for zero detention if the timing of the hydrograph allows. Mr. Moore is considering estimating a future condition with and without detention, as Montgomery County was very interested in that. Mr. Moore said that Montgomery County staff is interested in getting rid of the loophole, but the commissioner does not want to get rid of something if it makes sense. It may be better for people not to detain, depending on where you are in the watershed. The project team will assume future conditions without detention in Montgomery County in order to reflect current interpretation of the rules. Future conditions with stricter detention regulation could be investigated as one of the alternatives.</td>
</tr>
</tbody>
</table>
10. **Project Metrics**

The following question was asked: Are we successful in this if we end up proposing huge projects that will never get built? Mr. Barr said that when working on master drainage plans, the goal is generally to propose a range of potential project scales, including costly projects with high benefit and more affordable projects with lower benefit. Mr. Bezemek said the study partners should have further discussion on this topic. Is HCFCD OK if the number one project is a multi-billion dollar project? Ms. Green said the scope began by imagining those large-scale projects that they would have to target funding for, but things might be changing now. This is a question that needs to be run by HCFCD executives.

Ms. Green suggested giving minutes with exhibits to executives, and to plan for an executive briefing later. Executive briefing would require about an hour and should include Matt Zeve, Alan Black, and Russ Poppe.

Ms. Green said that the large-scale projects can be an incentive for other partners to join. Funding from the state’s “Rainy Day” fund could potentially be used to fund some of these local projects.

| Halff to send memo and exhibits. Aim to have executive briefing as quickly as possible (early February), and Ms. Green and Ms. Chen to check in with their executives before then. Study partners to have answers to the study team by mid-January. |

11. **Closing Remarks and Questions**

The workshop was adjourned.
# Alternatives Workshop No. 2

**HCFCD, City of Houston, Montgomery County, SJRA**  
December 11, 2019

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Phone Number</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terry Barr</td>
<td>Halff Associates, Inc.</td>
<td>(713) 588-2451</td>
<td><a href="mailto:tbarr@halff.com">tbarr@halff.com</a></td>
</tr>
<tr>
<td>Andrew Moore</td>
<td>Halff Associates, Inc.</td>
<td>(936) 777-6377</td>
<td><a href="mailto:amoore@halff.com">amoore@halff.com</a></td>
</tr>
<tr>
<td>Jing Chen</td>
<td>HCFCD</td>
<td>(713) 684-4264</td>
<td><a href="mailto:jing.chen@hcfcd.hctx.net">jing.chen@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Matt Barrett</td>
<td>SJRA</td>
<td>936-850-0717</td>
<td><a href="mailto:mbarrett@sjra.net">mbarrett@sjra.net</a></td>
</tr>
<tr>
<td>Johnny Kim</td>
<td>Halff Associates</td>
<td>(713) 380-4387</td>
<td><a href="mailto:jkim@halff.com">jkim@halff.com</a></td>
</tr>
<tr>
<td>Garrett Johnston</td>
<td>Freeze &amp; Nichols</td>
<td>512 311-3160</td>
<td><a href="mailto:jgj@freeze.com">jgj@freeze.com</a></td>
</tr>
<tr>
<td>Hector Oliver</td>
<td>FMI</td>
<td>713-600-6856</td>
<td><a href="mailto:heco@freeze.com">heco@freeze.com</a></td>
</tr>
<tr>
<td>Dena Green</td>
<td>HCFCD</td>
<td></td>
<td><a href="mailto:dema.green@halff.hctx.net">dema.green@halff.hctx.net</a></td>
</tr>
<tr>
<td>Cory Still</td>
<td>FMI</td>
<td>713-600-6809</td>
<td><a href="mailto:Cory.Still@freeze.com">Cory.Still@freeze.com</a></td>
</tr>
<tr>
<td>Jonathan Holley</td>
<td>HCFCD</td>
<td>346-286-4155</td>
<td><a href="mailto:jonathan.holley@hcfcd.hctx.net">jonathan.holley@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Gary Bezemek</td>
<td>HCFCD</td>
<td></td>
<td><a href="mailto:gary.bezemek@hcfcd.hctx.net">gary.bezemek@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Adam Eaton</td>
<td>Cott</td>
<td>832 395 3082</td>
<td>Adam.Eaton.houstontx.gov</td>
</tr>
</tbody>
</table>
# ALTERNATIVES WORKSHOP NO. 3 AGENDA

*Study Partners: HCFCD, City of Houston, Montgomery County, SJRA*

April 27, 2020
San Jacinto Regional Watershed Master Drainage Plan
WebEx Conference Call

<table>
<thead>
<tr>
<th>Meeting called by:</th>
<th>Jing Chen, P.E., CFM</th>
<th>Type of Meeting:</th>
<th>Alternatives Workshop No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitator:</td>
<td>Terry M. Barr, P.E., CFM</td>
<td>Meeting Start Time:</td>
<td>1:00 PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meeting Stop Time:</td>
<td>3:30 PM</td>
</tr>
</tbody>
</table>

**Agenda**

1. **Introductions, Agenda, Purpose**
   - Basin Overview
   - San Jacinto Basin Mitigation Strategies

2. **Workshop Goals**
   - Present mitigation planning results and receive feedback on projects, combinations & metrics
   - Review damage center identification and target volumes
   - Present flood reduction alternatives (Location, configuration, costs, benefits, constraints)
   - Identify most effective alternatives and potential combinations
   - Discuss metrics and project prioritization

3. **Existing Conditions Modeling Recap**
   - Model Calibration/Validation

4. **Alternatives Evaluation Recap**
   - Damage Center Recap
   - Flood Reduction Volume Recap
   - Previously Recommended Projects
   - Watershed Mitigation Potential

5. **Flood Reduction Projects Summary**
   - Summary of Project Location
   - Fact Sheet Overview
   - Summary of Project Information
   - Cost Uncertainty

6. **Spring Creek**
   - Overview of Potential Projects
   - Most Effective Project Discussion

7. **Lake Creek**
   - Overview of Potential Projects
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.</strong></td>
<td>Caney Creek</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overview of Potential Projects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Most Effective Project Discussion</td>
<td></td>
</tr>
<tr>
<td><strong>BREAK (10 min)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>9.</strong></td>
<td>Peach Creek</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overview of Potential Projects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Most Effective Project Discussion</td>
<td></td>
</tr>
<tr>
<td><strong>10.</strong></td>
<td>East Fork San Jacinto</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overview of Potential Projects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Most Effective Project Discussion</td>
<td></td>
</tr>
<tr>
<td><strong>11.</strong></td>
<td>West Fork San Jacinto</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overview of Potential Projects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Most Effective Project Discussion</td>
<td></td>
</tr>
<tr>
<td><strong>12.</strong></td>
<td>San Jacinto Regional WMDP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overview of Potential WMDP Projects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low to Moderate Income (LMI) Areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Potential Project Combinations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Watershed Implementation Approach vs. Combined Regional Approach</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Additional Flood Mitigation Measures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Buyouts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Study Partner Input</td>
<td></td>
</tr>
<tr>
<td><strong>13.</strong></td>
<td>Implementation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Potential Ranking Metrics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Implementation Steps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Study Partner Input</td>
<td></td>
</tr>
<tr>
<td><strong>14.</strong></td>
<td>Study Deliverables Schedule</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Preliminary Mitigation Planning Memo (June 8th)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Draft Report (July 13th)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Final Report (August 31st)</td>
<td></td>
</tr>
<tr>
<td><strong>15.</strong></td>
<td>Closing Remarks and Questions</td>
<td></td>
</tr>
</tbody>
</table>
SAN JACINTO
Regional Watershed Master Drainage Plan

Alternatives Workshop No. 3
April 27, 2020 - DRAFT
San Jacinto River Basin

- 75% HMGP Funded
- 25% Local Funded

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Stream Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork San Jacinto River</td>
<td>61.4</td>
</tr>
<tr>
<td>East Fork San Jacinto River</td>
<td>73.2</td>
</tr>
<tr>
<td>San Jacinto River</td>
<td>16.3</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>58.9</td>
</tr>
<tr>
<td>Cypress Creek</td>
<td>60.5</td>
</tr>
<tr>
<td>Little Cypress Creek</td>
<td>20.8</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>69.6</td>
</tr>
<tr>
<td>Willow Creek</td>
<td>19.8</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>49.3</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>53.5</td>
</tr>
<tr>
<td>Luce Bayou</td>
<td>10.8</td>
</tr>
<tr>
<td>Tarkington Bayou</td>
<td>36.9</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535.6</strong></td>
</tr>
</tbody>
</table>
San Jacinto Flood Mitigation Strategies

• **Primary Flood Mitigation Planning (Flood Reduction)**
  – Primary Alternatives – Based on previously identified solutions
  – Secondary Alternatives – Developed additional flood reduction projects
  – Develop cost estimates
  – Evaluate potential benefits
  – Identify implementation path and challenges

• **Secondary Flood Mitigation Planning (Flood Warning)**
  – Coordinate with HCFCD, MCO, SJRA, TXDOT, USGS, NWS
  – Recommend locations for additional FWS gages

• **Other Mitigation Actions (Flood Response)**
  – Coordinate with agencies responsible for Emergency Management
  – Provide recommendations for updated communications protocols
  – Identify potential flooding of roadways and critical infrastructure
Workshop Goals

• Present primary mitigation planning results and receive feedback on projects, combinations, and metrics
• Recap damage center identification and target volumes
• Present flood reduction alternatives (Location, configuration, costs, benefits, constraints)
• Identify effective alternatives and potential combinations
• Discuss metrics and the path toward project prioritization
Workshop Questions

• Projects:
  – Are the projects we have looked at appropriate for the study?
  – Are there any other projects that we should have considered?

• Costs
  – Are cost assumptions appropriate and reasonable?
  – Is there anything else we should consider or revise?

• Implementation
  – What project implementation approach is preferred?
  – What metrics are important for prioritizing projects?
Existing Conditions Modeling

- Developed Comprehensive Model
- Limited Updates to M3 Models
- Hydrology
  - Atlas 14 Rainfall (varies by watershed)
  - Updated Watershed Delineation
  - Soils, % Impervious, BDF (TC+R)
  - HEC-HMS Model Development
- Hydraulics
  - Updated cross section geometry
  - New/updated bridges and culverts
  - Reviewed and adjusted n-values
  - Developed unsteady RAS models
Analysis of Historical Storms

- Historical Storms
  - Memorial Day (2016)
  - Hurricane Harvey (2017)
  - TS Imelda (2019)
  - October 1994

- Leveraged Gage Adjusted Radar Rainfall (GARR) Data

- USGS Gages (Used 22/25)
  - Met with USGS
  - Peach Creek Adjustment
  - Gage Summary in Report

- Calibration Report Submitted
Alternatives Evaluation Recap

- Evaluate flood damages using the Structural Inventory Tool
- Identify “Damage Centers”
- Determine volume reduction for a range of LOS improvements
- Compare reduction volumes to potential benefits
- Estimate preliminary target volumes for each damage center
- Consider previously identified projects
- Develop new potential projects
- Select watersheds with highest potential for improvements
Damage Center Recap

- Run models for frequency storm events
- Develop the Structural Inventory Tool
- Identify Damage Centers

Significant number of structures at risk during higher frequency storms (2-yr - 25-yr)
Damage Center Recap

- East Fork SJR, West Fork SJR
- Peach, Caney, Spring Creeks

Instances from higher frequency storms (2-yr, 5-yr) were removed to avoid skewing the data
Flood Risk Reduction Volumes

- Volume Reduction
  - Extract hydrographs from models at damage centers for frequency events
  - Calculated volume difference for frequency ranges (i.e., 100-yr to 10-yr)

![Hydrograph Comparisons](image)

- Estimated Volume
### Flood Reduction Volume Recap

- **Volume for LOS Improvement Ranges**
  - Prepared table of volume differences for a range of LOS improvements
  - Determine reductions in potentially impacted structures for each volume

#### Table: Volume Differences

<table>
<thead>
<tr>
<th>Difference in Volumes (ac-ft)</th>
<th>500yr</th>
<th>200yr</th>
<th>100yr</th>
<th>50yr</th>
<th>25yr</th>
<th>10yr</th>
<th>5yr</th>
<th>2yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>500yr</td>
<td>289,914</td>
<td>257,190</td>
<td>219,485</td>
<td>168,485</td>
<td>123,390</td>
<td>78,745</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100yr</td>
<td>163,114</td>
<td>127,434</td>
<td>96,786</td>
<td>52,374</td>
<td>20,639</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50yr</td>
<td>113,143</td>
<td>83,538</td>
<td>54,781</td>
<td>17,821</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25yr</td>
<td>74,866</td>
<td>47,875</td>
<td>22,771</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10yr</td>
<td>36,503</td>
<td>13,448</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5yr</td>
<td>14,164</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table: Existing Conditions

<table>
<thead>
<tr>
<th>Vol, ac-ft</th>
<th>500yr</th>
<th>200yr</th>
<th>100yr</th>
<th>50yr</th>
<th>25yr</th>
<th>10yr</th>
<th>5yr</th>
<th>2yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>1829</td>
<td>946</td>
<td>498</td>
<td>271</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

#### Table: Cumulative Number of Flooded Structures

<table>
<thead>
<tr>
<th>Start</th>
<th>Target</th>
<th>Vol, ac-ft</th>
<th>500yr</th>
<th>200yr</th>
<th>100yr</th>
<th>50yr</th>
<th>25yr</th>
<th>10yr</th>
<th>5yr</th>
<th>2yr</th>
<th>Benefit</th>
<th>B/V</th>
<th>Incr. V</th>
<th>Incr. B</th>
</tr>
</thead>
<tbody>
<tr>
<td>500yr</td>
<td>100yr</td>
<td>78,745</td>
<td>946</td>
<td>498</td>
<td>271</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>1638</td>
<td>21</td>
<td>78,745</td>
<td>1638</td>
</tr>
<tr>
<td>500yr</td>
<td>50yr</td>
<td>123,390</td>
<td>498</td>
<td>271</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2298</td>
<td>19</td>
<td>44,645</td>
<td>660</td>
</tr>
<tr>
<td>500yr</td>
<td>25yr</td>
<td>168,485</td>
<td>271</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2568</td>
<td>15</td>
<td>45,095</td>
<td>269</td>
</tr>
<tr>
<td>500yr</td>
<td>10yr</td>
<td>219,495</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2671</td>
<td>12</td>
<td>51,011</td>
<td>103</td>
</tr>
<tr>
<td>500yr</td>
<td>5yr</td>
<td>257,190</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2704</td>
<td>11</td>
<td>37,694</td>
<td>33</td>
</tr>
<tr>
<td>500yr</td>
<td>2yr</td>
<td>289,914</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2715</td>
<td>9</td>
<td>32,724</td>
<td>11</td>
</tr>
<tr>
<td>100yr</td>
<td>50yr</td>
<td>20,639</td>
<td>1829</td>
<td>498</td>
<td>271</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>1462</td>
<td>71</td>
<td>20,639</td>
<td>1462</td>
</tr>
<tr>
<td>100yr</td>
<td>25yr</td>
<td>52,374</td>
<td>1829</td>
<td>271</td>
<td>100</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2032</td>
<td>39</td>
<td>31,736</td>
<td>570</td>
</tr>
<tr>
<td>100yr</td>
<td>10yr</td>
<td>127,434</td>
<td>1829</td>
<td>43</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2256</td>
<td>23</td>
<td>44,411</td>
<td>224</td>
</tr>
<tr>
<td>100yr</td>
<td>5yr</td>
<td>163,114</td>
<td>1829</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2325</td>
<td>18</td>
<td>30,648</td>
<td>69</td>
</tr>
<tr>
<td>100yr</td>
<td>2yr</td>
<td>163,114</td>
<td>1829</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2347</td>
<td>14</td>
<td>35,680</td>
<td>22</td>
</tr>
</tbody>
</table>
Flood Risk Reduction Volumes

- Comparison of Volumes to Benefits
  - Plot volumes vs. potential benefits
  - Look for point where curves start to flatten
  - Estimate preliminary target volume for the given damage center

Benefits vs. amount of volume required are maximized at around 50,000 acre-ft
Previously Recommended Projects

• Reviewed previous reports and master plans
  – 1943 – San Jacinto River Master Plan
  – 1957 – San Jacinto River Master Plan
  – 1985 – Upper San Jacinto River Flood Control Study
  – 1989 – South Montgomery County Flood Protection Plan
  – 1997 – Lake Creek Reservoir Study
  – 2000 – Lake Houston Regional Flood Protection Study
  – 2015 – Cypress Creek Overflow Management Plan
  – 2019 – Estimate Land Cover Effects on Selected Watersheds
  – 2019 – Hurricane Harvey San Jacinto River Flooding (presentation)
Previously Recommended Projects

- Considered 34 Previously Recommended Projects
  - 1943/1957 – San Jacinto River Master Plan
  - 1985 – Upper San Jacinto River Flood Control Study
Watershed Mitigation Potential

- **Higher Potential**
  - Spring Creek (Benefits in watershed; Potential reduction downstream)
  - East Fork (Major Lake Houston contributor; Available open space)
  - Peach/Caney Creek (Available open space; Benefits in watershed)

- **Moderate Potential**
  - Lake Creek (Available open space; large contributing area to West Fork, Limited benefits in the Lake Creek watershed)

- **Lower Potential**
  - Cypress Creek (Limited open space; Other HCFD efforts; Overflow)
  - Willow Creek/Little Cypress Creek (Small contribution; Limited space)
  - Luce/Tarkington Bayou (Limited damages; Smaller contribution; Flat)
  - Jackson Bayou (Very small contribution; Downstream of Lake Houston)
  - West Fork (Limited open space; High volume; Benefits in watershed)
Flood Reduction Projects Summary
**Project Information**
- Approximate location
- General Objective
- How the project functions
- Immediate Downstream Frequency Benefit

The immediate downstream frequency benefit shows the incremental LOS improvement resulting from the project. The reduction listed (i.e., 100-year to 50-year) means that the 100-year flow/elevations are now close to the 50-year flow/elevations. This is consistent with the target volume determination that was presented at Workshop 2.

**Project Location Map**
The project location is identified by the magenta shape (Detention) or line (Channel) and includes an inset for general location.

**Improvement Specifications**
Provides approx. information for:
- Dam acreage (100-yr and PMF)
- Storage volume (100-year)
- Volume of Excavation (channel) or Embankment (detention)
- Dam height and length

**Benefits**
- Reduction in structural flooding
- Reduction in instances of flooding: 1.594
- Location of improved structures
  - Tomball, The Woodlands
- Improves LOS for 0 Highways, 2 State Roads, 1 FM Roads, and 3 County Roads and 2 Railroad Crossings
- Net Present Value Benefit: $123.0M
- BCR: 1.02-1.55

**Opportunities/Challenges**
Potential partners for projects
- FEMA/USACE (If BCR > 1.0)
- GLO (Areas with LMI)
- TWDB (Potential FIF)
- Local Agencies

**Real Estate (10-yr & PMF inundation)**

**Environmental Mitigation**
Potential impacts to streams and wetlands at the proposed embankments.

Estimated Relocation or Reconstruction of roads and utilities.

**Project Costs**
- Planning level summary of the design/construction costs
- Estimated environmental mitigation for wetlands and streams
- Estimated ROW cost has been provided for 100-year and PMF scenarios (Range of costs)
- Cost escalation factor to estimate the cost for the same project in 20-years.
# Flood Reduction Projects Summary

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Walnut Creek 10 miles U/S of Spring Creek</td>
<td>91 - 120</td>
<td>123</td>
<td>1.02 - 1.35</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Mill Creek 10 miles U/S of Spring Creek</td>
<td>96 - 126</td>
<td>81.6</td>
<td>0.65 - 0.85</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Detention</td>
<td>Birch Creek 10 miles U/S of Spring Creek</td>
<td>77 - 117</td>
<td>82.6</td>
<td>0.70 - 1.07</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>I-45 to 3 miles D/S of Riley Fuzzell</td>
<td>81</td>
<td>145.3</td>
<td>1.79</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>Between Gosling Road and I-45</td>
<td>123</td>
<td>82.6</td>
<td>0.66</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-200 U/S of I-45</td>
<td>59</td>
<td>53</td>
<td>0.89</td>
</tr>
<tr>
<td>Spring Creek</td>
<td>Bench</td>
<td>DC2-500 U/S Kuykendahl Rd. to Willow Creek</td>
<td>142</td>
<td>70.3</td>
<td>0.49</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Caney Creek 0.3 miles North of SH 105</td>
<td>98 - 163</td>
<td>34</td>
<td>0.21 - 0.35</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Little Caney Creek 1.1 miles U/S of Lake Creek</td>
<td>98 - 128</td>
<td>27.6</td>
<td>0.22 - 0.28</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Garrett's Creek 0.74 miles U/S of Lake Creek</td>
<td>107 - 131</td>
<td>35.4</td>
<td>0.27 - 0.33</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>Detention</td>
<td>Lake Creek Mainstem 0.6 miles U/S of SH 105</td>
<td>187 - 264</td>
<td>61.8</td>
<td>0.15 - 0.33</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach 12 miles U/S of New Caney @ SH105</td>
<td>299 - 428</td>
<td>57</td>
<td>0.13 - 0.19</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Detention</td>
<td>Peach/Walker 19 miles U/S of New Caney</td>
<td>203 - 222</td>
<td>68</td>
<td>0.30 - 0.33</td>
</tr>
<tr>
<td>Peach Creek</td>
<td>Channel</td>
<td>Peach Creek D/S of I-59</td>
<td>180</td>
<td>75.9</td>
<td>0.42</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.0 miles U/S of FM 1097</td>
<td>104 - 131</td>
<td>19.8</td>
<td>0.15 - 0.19</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Detention</td>
<td>Caney Creek 1.9 miles U/S of SH 105</td>
<td>177 - 207</td>
<td>26.3</td>
<td>0.13 - 0.15</td>
</tr>
<tr>
<td>Caney Creek</td>
<td>Channel</td>
<td>Caney Creek D/S of US-69 to the East Fork</td>
<td>140</td>
<td>75.9</td>
<td>0.54</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou Nebletts 2 miles U/S Cleveland</td>
<td>128 - 176</td>
<td>39.8</td>
<td>0.15 - 0.20</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>Winters Bayou 5 miles U/S of Cleveland</td>
<td>132 - 163</td>
<td>44.2</td>
<td>0.26 - 0.33</td>
</tr>
<tr>
<td>East Fork</td>
<td>Detention</td>
<td>East Fork 10 miles U/S of Cleveland near FM945</td>
<td>138 - 141</td>
<td>34.3</td>
<td>0.15 - 0.16</td>
</tr>
<tr>
<td>East Fork</td>
<td>Bench</td>
<td>East Fork FM 1485 to Luce Bayou</td>
<td>326</td>
<td>24.9</td>
<td>0.08</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to SH 242</td>
<td>148</td>
<td>33.8</td>
<td>0.22</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork from I-45 to 3.2 miles D/S of SH 242</td>
<td>179</td>
<td>30.3</td>
<td>0.15</td>
</tr>
<tr>
<td>West Fork</td>
<td>Channel</td>
<td>West Fork D/S of I-59</td>
<td>722</td>
<td>67</td>
<td>0.09</td>
</tr>
<tr>
<td>West Fork</td>
<td>Bench</td>
<td>West Fork D/S of I-59</td>
<td>818</td>
<td>55.6</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Cost Uncertainty

- **Construction Pricing**
  - Construction priced vary depending on economic conditions, availability of materials, access, etc.
  - 30% Contingency included on construction unit costs
  - Utility relocation accounted for but requires more detailed information

- **ROW Acquisition**
  - Cost estimates assume 2.5 x Market Value for parcels
  - Assumed full parcels is acquired if > 20% inundation
  - Range of parcels considers 100-yr vs. PMF inundation limits

- **Environmental**
  - Actual wetlands coverage vs. NWI data
  - Mitigation via bank vs. Mitigation in place
  - Quality of wetlands and degree of aquatic resource loss
### Spring Creek

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Detention</td>
<td>Walnut Creek 10 miles U/S of Spring Creek</td>
<td>91 - 120</td>
<td>123</td>
<td>1.02 - 1.35</td>
</tr>
<tr>
<td>2</td>
<td>Detention</td>
<td>Mill Creek 10 miles U/S of Spring Creek</td>
<td>96 - 126</td>
<td>81.6</td>
<td>0.65 - 0.85</td>
</tr>
<tr>
<td>3</td>
<td>Detention</td>
<td>Birch Creek 10 miles U/S of Spring Creek</td>
<td>77 - 117</td>
<td>82.6</td>
<td>0.70 - 1.07</td>
</tr>
<tr>
<td>4</td>
<td>Bench</td>
<td>I-45 to 3 miles D/S of Riley Fuzzell</td>
<td>81</td>
<td>145.3</td>
<td>1.79</td>
</tr>
<tr>
<td>5</td>
<td>Bench</td>
<td>Between Gosling Road and I-45</td>
<td>123</td>
<td>82.6</td>
<td>0.66</td>
</tr>
<tr>
<td>6</td>
<td>Bench</td>
<td>DC2-200 U/S of I-45</td>
<td>59</td>
<td>53</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>Bench</td>
<td>DC2-500 U/S Kuykendahl Rd. to Willow Creek</td>
<td>142</td>
<td>70.3</td>
<td>0.49</td>
</tr>
</tbody>
</table>
Spring Creek

- Most Effective Projects
  - Birch Creek Detention
  - Walnut Creek Detention
  - Channel Improvements from I-45 to Riley Fuzzell

- Total Cost: $249M - $318M

- Spring Creek WSEL Reduction (Watershed & Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>Spring Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with West Fork</td>
<td>-0.16</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.12</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.16</td>
</tr>
<tr>
<td>I-69</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

Spring Creek Redductions

<table>
<thead>
<tr>
<th>Spring Creek Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH249</td>
<td>-2.53</td>
</tr>
<tr>
<td>Kuykendahl</td>
<td>-1.96</td>
</tr>
<tr>
<td>Gosling</td>
<td>-1.45</td>
</tr>
<tr>
<td>I-45</td>
<td>-6.65</td>
</tr>
<tr>
<td>Riley Fuzzell</td>
<td>-6.61</td>
</tr>
</tbody>
</table>
Spring Creek

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Proposed</th>
<th>Reduction</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Proposed Damages</td>
<td>6,744</td>
<td>2,555</td>
<td>4,189</td>
<td>62%</td>
</tr>
</tbody>
</table>

Instances of Structural Flooding (50-yr):

- Existing: 6,744
- Proposed: 2,555
- Reduction: 4,189
- % Reduction: 62%

Graph showing cumulative damages and benefits per river mile.
Lake Creek

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Detention</td>
<td>Caney Creek 0.3 miles North of SH 105</td>
<td>98 - 163</td>
<td>34</td>
<td>0.21 - 0.35</td>
</tr>
<tr>
<td>9</td>
<td>Detention</td>
<td>Little Caney Creek 1.1 miles U/S of Lake Creek</td>
<td>98 - 128</td>
<td>27.6</td>
<td>0.22 - 0.28</td>
</tr>
<tr>
<td>10</td>
<td>Detention</td>
<td>Garrett's Creek 0.74 miles U/S of Lake Creek</td>
<td>107 - 131</td>
<td>35.4</td>
<td>0.27 - 0.33</td>
</tr>
<tr>
<td>11</td>
<td>Detention</td>
<td>Lake Creek Mainstem 0.6 miles U/S of SH 105</td>
<td>187 - 264</td>
<td>61.8</td>
<td>0.15 - 0.22</td>
</tr>
</tbody>
</table>
Lake Creek

- Most Effective Projects
  - Garrett’s Creek Detention
  - Little Caney Creek Detention
  - Caney Creek Detention

- Total Cost: $303M - $422M

- Lake Creek WSEL Reduction

Regional Project Reductions

<table>
<thead>
<tr>
<th>Lake Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Garrett’s Det.</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.63</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-0.48</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-0.56</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-0.15</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.14</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.09</td>
</tr>
</tbody>
</table>

Lake Creek Reductions

<table>
<thead>
<tr>
<th>Lake Creek Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 105</td>
<td>-4.5</td>
</tr>
<tr>
<td>FM 149</td>
<td>-3.63</td>
</tr>
<tr>
<td>Superior Road</td>
<td>-3.32</td>
</tr>
<tr>
<td>Splendora Ranch (Fish Crk)</td>
<td>-4.7</td>
</tr>
</tbody>
</table>
Lake Creek

| Instances of Structural Flooding (50-yr) |
|-----------------|-----------------|-----------------|-----------------|
| Existing        | Proposed        | Reduction       | % Reduction     |
| 230             | 73              | 157             | 68%             |

Lake Creek – Benefit Summary (50-yr Project Life)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>$10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>$9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>$8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>$7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>$6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>$5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>$4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>$3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>$2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>$1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- Incr. Existing
- Incr. Benefit
- Cumul. Existing
- Cumul. Proposed
Caney Creek

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Detention</td>
<td>Caney Creek 1.0 miles U/S of FM 1097</td>
<td>104 - 131</td>
<td>19.8</td>
<td>0.15 - 0.19</td>
</tr>
<tr>
<td>16</td>
<td>Detention</td>
<td>Caney Creek 1.9 miles U/S of SH 105</td>
<td>177 - 207</td>
<td>26.3</td>
<td>0.13 - 0.15</td>
</tr>
<tr>
<td>17</td>
<td>Channel</td>
<td>Caney Creek D/S of I-69 to the East Fork</td>
<td>140</td>
<td>47</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Map of Caney Creek showing project locations.

- **Project #15**: Caney Creek 1.0 miles U/S of FM 1097
- **Project #16**: Caney Creek 1.9 miles U/S of SH 105
- **Project #17**: Caney Creek D/S of I-69 to the East Fork

Legend:
- **Project Included in Plan**
- **Project Considered**
Caney Creek

- Most Effective Projects
  - Mainstem detention upstream of SH105
  - Mainstream detention upstream of FM1097
  - Channel Improvements from US59 to East Fork Confluence
- Total Cost: $421M - $478M
- Caney Creek WSEL Reduction (Watershed & Basin-wide)

### Regional Project Reductions

<table>
<thead>
<tr>
<th>Caney Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SH 105 Det.</td>
</tr>
<tr>
<td>Confluence with Peach</td>
<td>-0.79</td>
</tr>
<tr>
<td>Confluence with East Fork</td>
<td>-0.55</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.08</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-0.05</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.04</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

### Caney Creek Reductions

<table>
<thead>
<tr>
<th>Caney Creek Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 105</td>
<td>-6.94</td>
</tr>
<tr>
<td>FM 2090</td>
<td>-4.64</td>
</tr>
<tr>
<td>HWY 242</td>
<td>-2.46</td>
</tr>
<tr>
<td>I-69</td>
<td>-15.59</td>
</tr>
<tr>
<td>FM 1485</td>
<td>-12.1</td>
</tr>
</tbody>
</table>
Caney Creek

<table>
<thead>
<tr>
<th>Instances of Structural Flooding (50-yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
</tr>
<tr>
<td>2,680</td>
</tr>
</tbody>
</table>

Caney Creek – Benefit Summary (50-yr Project Life)
Peach Creek

- **Most Effective Projects**
  - Mainstem detention upstream of SH105
  - Mainstream detention upstream of FM1097
  - Channel Improvements from US59 to East Fork Confluence

- **Total Cost:** $682M - $830M

- **Peach Creek WSEL Reduction (Watershed & Basin-wide)**

### Regional Project Reductions

<table>
<thead>
<tr>
<th>Peach Creek Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
<th>SH 105 Det.</th>
<th>Walker Det.</th>
<th>Chl. D/S of I-69</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Caney</td>
<td>-1.02</td>
<td>-0.56</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Confluence with East Fork</td>
<td>0.23</td>
<td>0.01</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>0.13</td>
<td>0.06</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>0.08</td>
<td>0.03</td>
<td>-0.08</td>
<td></td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>0.05</td>
<td>0.02</td>
<td>-0.04</td>
<td></td>
</tr>
<tr>
<td>I-69</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

### Peach Creek Reductions

<table>
<thead>
<tr>
<th>Peach Creek Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 105</td>
<td>-3.76</td>
</tr>
<tr>
<td>FM 2090</td>
<td>-5.39</td>
</tr>
<tr>
<td>I69</td>
<td>-13.88</td>
</tr>
<tr>
<td>Roman Forest</td>
<td>-10.75</td>
</tr>
<tr>
<td>FM 1485</td>
<td>-1.38</td>
</tr>
</tbody>
</table>
Peach Creek

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Proposed</th>
<th>Reduction</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instances of Structural Flooding (50-yr)</td>
<td>2,363</td>
<td>542</td>
<td>1,821</td>
<td>77%</td>
</tr>
<tr>
<td>Proj. No.</td>
<td>Project Type</td>
<td>General Location</td>
<td>Estimated Costs ($M)</td>
<td>Present Value Benefit ($M)</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------</td>
<td>-----------------------------------------</td>
<td>----------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>18</td>
<td>Detention</td>
<td>Winters Bayou Nebletts 2 miles U/S Cleveland</td>
<td>128 - 176</td>
<td>39.8</td>
</tr>
<tr>
<td>19</td>
<td>Detention</td>
<td>Winters Bayou 5 miles U/S of Cleveland</td>
<td>132 - 163</td>
<td>44.2</td>
</tr>
<tr>
<td>20</td>
<td>Detention</td>
<td>East Fork 10 miles U/S of Cleveland near FM945</td>
<td>138 - 141</td>
<td>34.3</td>
</tr>
<tr>
<td>21</td>
<td>Bench</td>
<td>East Fork FM 1485 to Luce Bayou</td>
<td>326</td>
<td>24.9</td>
</tr>
</tbody>
</table>

**East Fork SJR**

![Map of East Fork SJR with project locations marked]
East Fork SJR

- Most Effective Projects
  - Mainstem detention upstream of SH105
  - Mainstream detention upstream of FM1097
  - Channel Improvements from US59 to East Fork Confluence
- Total Cost: $458M - $489M
- East Fork SJR WSEL Reduction (Watershed & Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>East Fork Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winters Det.</td>
<td>Chl. D/S FM1485</td>
</tr>
<tr>
<td>Confluence with Caney</td>
<td>0.08</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.50</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.37</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>-0.30</td>
</tr>
<tr>
<td>I-69</td>
<td>0.00</td>
</tr>
</tbody>
</table>

East Fork Reductions

<table>
<thead>
<tr>
<th>East Fork Combined Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM 945</td>
<td>-0.02</td>
</tr>
<tr>
<td>SH 105</td>
<td>-2.16</td>
</tr>
<tr>
<td>I-69</td>
<td>-1.96</td>
</tr>
<tr>
<td>FM 2090</td>
<td>-2.39</td>
</tr>
<tr>
<td>FM 1485</td>
<td>-9.74</td>
</tr>
</tbody>
</table>
East Fork SJR

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Proposed</th>
<th>Reduction</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instances of Structural Flooding (50-yr)</td>
<td>1,994</td>
<td>1,063</td>
<td>931</td>
<td>47%</td>
</tr>
</tbody>
</table>

**Graph of East Fork – Benefit Summary (50-yr Project Life):**

The graph illustrates the cumulative damages (in millions of dollars) over a 50-year project life along the river mile. The graph compares the existing scenario and the proposed scenario with additional benefit. The key features include:

- **Cumulative Damages:** The y-axis represents the cumulative damages in millions of dollars, ranging from $0 to $180 million.
- **River Mile:** The x-axis represents the river mile, ranging from 64 to 0.
- **Legend:**
  - **Incr. Existing**: Blue line indicating incremental damages in the existing scenario.
  - **Incr. Benefit**: Green bars indicating additional benefits.
  - **Cumul. Existing**: Blue line indicating cumulative damages in the existing scenario.
  - **Cumul. Proposed**: Green line indicating cumulative damages in the proposed scenario.

The graph highlights the expected reduction in damages and the incremental benefits associated with the proposed scenario, particularly noticeable at various river mile markers such as FM-945, TX-105, US-59, and FM-1485.
West Fork SJR

<table>
<thead>
<tr>
<th>Proj. No.</th>
<th>Project Type</th>
<th>General Location</th>
<th>Estimated Costs ($M)</th>
<th>Present Value Benefit ($M)</th>
<th>Benefit-Cost Ratio (BCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Channel</td>
<td>West Fork from I-45 to SH 242</td>
<td>148</td>
<td>33.8</td>
<td>0.22</td>
</tr>
<tr>
<td>23</td>
<td>Channel</td>
<td>West Fork from I-45 to 3.2 miles D/S of SH 242</td>
<td>179</td>
<td>30.3</td>
<td>0.15</td>
</tr>
<tr>
<td>24</td>
<td>Channel</td>
<td>West Fork D/S of I-59 (3000' Wide)</td>
<td>722</td>
<td>67</td>
<td>0.09</td>
</tr>
<tr>
<td>25</td>
<td>Bench</td>
<td>West Fork D/S of I-59 (3500' Wide)</td>
<td>818</td>
<td>55.6</td>
<td>0.07</td>
</tr>
</tbody>
</table>
West Fork San Jacinto

• Most Effective Projects
  – West Fork Channelization from I-45 to SH242
  – West Fork Channelization downstream of US59
• Total Cost: $966M
• West Fork SJR WSEL Reduction (Basin-wide)

Regional Project Reductions

<table>
<thead>
<tr>
<th>West Fork Improvements</th>
<th>1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper WF 750</td>
</tr>
<tr>
<td>Confluence with West Fork</td>
<td>-0.17</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-3.07</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>0.13</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>0.05</td>
</tr>
<tr>
<td>Lake Houston Parkway</td>
<td>0.05</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>0.02</td>
</tr>
</tbody>
</table>
West Fork SJR

<table>
<thead>
<tr>
<th>Instances of Structural Flooding (50-yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>4,033</td>
</tr>
</tbody>
</table>

West Fork – Benefit Summary (50-yr Project Life)
San Jacinto Regional WMDP

San Jacinto River Master Drainage Plan

<table>
<thead>
<tr>
<th>Project Location</th>
<th>Combined 1% ACE WSEL Reductions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confluence with Lake Creek</td>
<td>-2.38</td>
</tr>
<tr>
<td>West Fork I-45</td>
<td>-5.94</td>
</tr>
<tr>
<td>West Fork SH99</td>
<td>-1.67</td>
</tr>
<tr>
<td>West Fork I-69</td>
<td>-5.07</td>
</tr>
<tr>
<td>Lake Houston Parkway *</td>
<td>-0.75</td>
</tr>
<tr>
<td>Lake Houston Dam</td>
<td>-0.59</td>
</tr>
<tr>
<td>Confluence with Spring Creek</td>
<td>-4.82</td>
</tr>
<tr>
<td>Caney Confluence with Peach</td>
<td>-9.74</td>
</tr>
<tr>
<td>Caney Confluence with East Fork</td>
<td>-2.82</td>
</tr>
<tr>
<td>Confluence with East Fork *</td>
<td>-0.79</td>
</tr>
</tbody>
</table>

* WSEL influenced by Lake Houston Elevation
Low to Moderate Income (LMI) Areas
San Jacinto Regional WMDP

- Combined projects show increased local and regional benefits
- Current modeled combinations
  - Spring Creek: Walnut Detention, Birch Detention, I-45 to Riley Fuzzell
  - Lake Creek: Caney Detention, Little Caney Detention, Garrett’s Detention
  - East Fork: Winters Detention, Lower East Fork Channel Improvements
  - Caney Creek: SH105 and FM1097 Detention, Channel D/S of I-69
  - Peach Creek: SH 105 and Walker Detention, Channel D/S of I-69
  - Full Combined Model: Ultimate Flood Reduction Improvements
San Jacinto Regional WMDP

- Plan Cost: $3.1B - $3.5B
- Overall Plan Benefits: $677 M
- BCR: 0.19 – 0.22

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Damages, Existing ($M)</th>
<th>Damages, Combined Alts ($M)</th>
<th>Benefit ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>466.6</td>
<td>163.8</td>
<td>302.8</td>
</tr>
<tr>
<td>Willow</td>
<td>112.2</td>
<td>86.6</td>
<td>25.6</td>
</tr>
<tr>
<td>Cypress</td>
<td>213.2</td>
<td>211.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>30.9</td>
<td>30.8</td>
<td>0.1</td>
</tr>
<tr>
<td>East Fork</td>
<td>101.4</td>
<td>56</td>
<td>45.5</td>
</tr>
<tr>
<td>West Fork</td>
<td>269.7</td>
<td>132.7</td>
<td>137</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>10.1</td>
<td>3.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Peach</td>
<td>113.1</td>
<td>27.9</td>
<td>85.3</td>
</tr>
<tr>
<td>Caney</td>
<td>135.6</td>
<td>63.8</td>
<td>71.9</td>
</tr>
<tr>
<td>Luce</td>
<td>14.6</td>
<td>14</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1467.4</strong></td>
<td><strong>790.4</strong></td>
<td><strong>677.2</strong></td>
</tr>
</tbody>
</table>
Kingwood Area Benefits

- Highest reduction U/S of W. Lake Houston Pkwy
- Lake Houston controls lower reaches
- 58% Reduction in instances of flooding
- Most East Fork structures no longer in 100-year FP
## Kingwood Area Benefits

<table>
<thead>
<tr>
<th>Event</th>
<th>Numbers for Structural Flooding (Sta. 1300+00 to 1750+00)</th>
<th></th>
<th>Reduction</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>Proposed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-year</td>
<td>70</td>
<td>11</td>
<td>59</td>
<td>84%</td>
</tr>
<tr>
<td>50-year</td>
<td>315</td>
<td>56</td>
<td>259</td>
<td>82%</td>
</tr>
<tr>
<td>100-year</td>
<td>1,157</td>
<td>359</td>
<td>798</td>
<td>69%</td>
</tr>
<tr>
<td>500-year</td>
<td>2,333</td>
<td>1,952</td>
<td>381</td>
<td>16%</td>
</tr>
<tr>
<td>Instances of Flooding</td>
<td>1,469</td>
<td>611</td>
<td>858</td>
<td>58%</td>
</tr>
<tr>
<td>Damages ($M)</td>
<td>$118.4</td>
<td>$53.8</td>
<td>$64.6</td>
<td>55%</td>
</tr>
</tbody>
</table>

Map of Kingwood Area with buffers and floodplains.
Watershed vs. Regional Approach

**Project Implementation**

**Watershed Approach**
- Prepare plan based on completing full watersheds
- Prioritize watersheds based on maximum regional benefit
- Spring Creek has highest benefit as a watershed

**Regional Approach**
- Consider individual projects in all watersheds
- Prioritize projects based on maximum benefit
- Identify top 5-10 projects to implement

**Items to consider**
- Social vulnerability
- Low to Moderate Income Areas
- Metrics besides “benefits”

**Input from Stakeholders:**
Which approach do you think is the most effective?
Additional Regional Measures

• Detention Policy
  – Detention associated with local development provides critical mitigation, but the regional benefits associated with local detention are highly dependent on the location and timing of development
  – 2070 modeling indicated limited detention impact, but development was centered on the urban core lower in the basin (1-2% volume increase)
  – Ultimate development along the basin outer boundaries shows a higher increase in runoff volume (>5%); detention impact may increase
  – Detention **DOES** have an impact on local flooding issues

• Floodplain Preservation
  – Losses to floodplain storage could negatively impact downstream areas
  – Future Conditions modeling does not include floodplain fill
  – Approx. market value of all flooded structures in the 100-year ~ $3B
Buyouts

- Structures currently located in the 2-, 5-year floodplains may see some benefits, but will continue to flood
- Removed from the instances of flooding for damage centers
- Maintained in the BCR calculations
- Generally a higher BCR on buyouts than structural projects
- Best option may be to buyout structures in this category
Buyouts

- Summary of structures and expected damages in each watershed that flood in the 5-year event

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Count</th>
<th>Market Value</th>
<th>Mkt Value * 1.25</th>
<th>Existing NPV 50-yr damage</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>87</td>
<td>12,184,636</td>
<td>15,230,795</td>
<td>80,537,873</td>
<td>5.3</td>
</tr>
<tr>
<td>Willow</td>
<td>43</td>
<td>13,197,517</td>
<td>16,496,896</td>
<td>30,707,624</td>
<td>1.9</td>
</tr>
<tr>
<td>Cypress</td>
<td>31</td>
<td>12,790,373</td>
<td>15,987,966</td>
<td>55,385,994</td>
<td>3.5</td>
</tr>
<tr>
<td>Little Cypress</td>
<td>13</td>
<td>2,468,448</td>
<td>3,085,560</td>
<td>11,513,834</td>
<td>3.7</td>
</tr>
<tr>
<td>East Fork</td>
<td>34</td>
<td>4,083,750</td>
<td>5,104,688</td>
<td>21,596,467</td>
<td>4.2</td>
</tr>
<tr>
<td>West Fork</td>
<td>10</td>
<td>1,412,655</td>
<td>1,765,819</td>
<td>6,244,840</td>
<td>3.5</td>
</tr>
<tr>
<td>Lake Creek</td>
<td>3</td>
<td>519,100</td>
<td>648,875</td>
<td>2,390,871</td>
<td>3.7</td>
</tr>
<tr>
<td>Peach</td>
<td>71</td>
<td>7,536,240</td>
<td>9,420,300</td>
<td>44,668,723</td>
<td>4.7</td>
</tr>
<tr>
<td>Caney</td>
<td>82</td>
<td>7,288,986</td>
<td>9,111,233</td>
<td>56,872,257</td>
<td>6.2</td>
</tr>
<tr>
<td>Luce</td>
<td>5</td>
<td>583,203</td>
<td>729,004</td>
<td>2,845,449</td>
<td>3.9</td>
</tr>
<tr>
<td>Tarkington</td>
<td>60</td>
<td>6,657,070</td>
<td>8,321,338</td>
<td>45,279,121</td>
<td>5.4</td>
</tr>
<tr>
<td>Jackson Bayou</td>
<td>2</td>
<td>518,533</td>
<td>648,166</td>
<td>1,529,131</td>
<td>2.4</td>
</tr>
<tr>
<td>Gum Gully</td>
<td>1</td>
<td>211,015</td>
<td>263,769</td>
<td>1,514,652</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>442</td>
<td><strong>69,451,526</strong></td>
<td><strong>86,814,408</strong></td>
<td><strong>361,086,836</strong></td>
<td><strong>4.2</strong></td>
</tr>
</tbody>
</table>
Project Metrics

Metrics from Scope of Work:
- Reduction in structural flooding
- Project Cost
- Design Life
- Maintenance
- Feasibility
- Constructability
- Public Benefit
- Public Safety
- Multi-function
- Environmental Constraints

Other Metrics to Consider:
- Social Vulnerability
- Low to Moderate Income
- Reduction in road flooding
- Community/Agency favor
- Erosion Control
- Impact to water quality
- Implementation schedule

Input from Stakeholders:
- Is there anything missing?
- Which are preferred?
## Project Metrics

### Recommended Metrics and Weight

<table>
<thead>
<tr>
<th>Metric</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in Structural Flooding</td>
<td>25%</td>
</tr>
<tr>
<td>Project Cost</td>
<td>20%</td>
</tr>
<tr>
<td>Funding potential</td>
<td>10%</td>
</tr>
<tr>
<td>Long Term Maintenance</td>
<td>10%</td>
</tr>
<tr>
<td>Constructability</td>
<td>15%</td>
</tr>
<tr>
<td>Transportation Improvement</td>
<td>10%</td>
</tr>
<tr>
<td>Erosion Control</td>
<td>5%</td>
</tr>
<tr>
<td>Implementation Schedule</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Input from Stakeholders:**

- Is weighting appropriate?
- Other items to use in prioritization?
Implementation Planning

- Identify projects to be included in MDP
- Finalize modeling of individual selected projects
- Prioritize projects (Watershed or Regional Approach)
  - Select and weight metrics based on study partner input
  - Update project costs and benefits
  - Gather information on the selected metrics
  - Perform project prioritization
- Develop project phasing plan based on priority
  - Model projects cumulatively (i.e. Project 1, Project 1 & 2,...All projects) to ensure no negative impacts
  - Update environmental and cultural data, update utility information, ROW
  - Identify potential funding sources depending on criteria (BCR, LMI, etc.)
- Move forward with Feasibility, Preliminary Engineering, Design
Study Deliverables Schedule

- Preliminary Mitigation Planning Memo (June 8th)
- Draft Report (July 13th)
- Final Report (August 31st)
**ALTERNATIVES WORKSHOP MINUTES**

To: Jing Chen, P.E., CFM  
Attendees: See attached list  

From: Terry Barr, P.E., CFM  

Subject: Upper San Jacinto River Regional Flood Mitigation Plan – Alternatives Workshop No. 3  

Meeting Date: 04/27/2020 – 1:00 pm  

Location: WebEx Conference Call  

Minutes Date: 05/05/2020  

AVO No.: 033465.002

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Introductions, Agenda, Purpose</strong></td>
<td></td>
</tr>
</tbody>
</table>
Mr. Barr introduced the study team and began the meeting.  

| 2.   | **Workshop Goals** |  
Mr. Barr presented the workshop goals.  
- Present primary mitigation planning results and receive feedback on projects, combinations, and metrics  
- Recap damage center identification and target volumes  
- Present flood reduction alternatives (Location, configuration, costs, benefits, constraints)  
- Identify effective alternatives and potential combinations  
- Discuss metrics and the path toward project prioritization  

| 3.   | **Existing Conditions Modeling Recap** |  
Mr. Barr presented the existing conditions modeling recap which included an analysis of historical storms. The team developed a comprehensive model of the San Jacinto River basin, which included updated hydrologic and hydraulic models for streams outside of HCFCD jurisdiction. For those streams with HCFCD M3 models, minor modifications were made to account for development since the model adoption. The HEC-HMS models were updated to include Atlas 14 Volume 11 rainfall and to incorporate the Basin Development Factor (BDF) methodology for non-M3 models. All HEC-RAS models were converted to unsteady in order to account for volume and timing.  

*Model Calibration*  
The models were calibrated to observed gage data for Hurricane Harvey (2017) and Memorial Day (2016). Gage Adjusted Radar Rainfall (GARR) data was run in the USGS and HCFCD gage information was used as a...
basis for comparison to the modeled data. Adjustments were made to the hydrologic and hydraulic model to bring the modeled stages, flows, and volumes within the acceptable tolerances. More detailed information is available in the Calibration memorandum submitted to HCFCD in April 2020.

### 4. Alternatives Evaluation Recap

Mr. Barr presented the alternatives evaluation recap which included damage centers, flood risk reduction volumes, previously recommended projects, and watershed mitigation potential.

**Damage Center Identification**

Mr. Barr provided an overview of the damage center identification process, which utilized the HCFCD Structural Inventory tool to identify flooded structures for a range of frequency rainfall events. Based on a combination of structures flooded and the frequency of expected flooding, the study team calculated the “instances of flooding” expected for each river mile on each major stream. Using this information, the team identified several “damage centers”. These centers were used to guide where expected damages were the highest and where projects should potentially be located to achieve maximum benefit. Major damage centers were identified along Spring Creek, Peach Creek, Caney Creek, East Fork and West Fork SJR.

**Flood Reduction Target Volumes**

Rather than focus on arbitrarily setting a target frequency for reduction, the study team’s approach looked at a range of volume targets for level of service (LOS) increases (i.e. how much detention volume would it take to lower 100-year flows to 10-year flows, etc.) This was run for the full complement of storms from the 2- to 500-year events. Using this information, the team determined the reduction in instances of flooding (benefits) associated with each volume. The volume and benefits were plotted and used to determine the target volume that provides the most relative benefit before a point of diminishing returns was reached and additional volume provided minimal increase in benefits. Once these target volumes were determined, the team started to look at projects.

**Previously Recommended Projects**

Per the study scope, the team considered projects that were recommended in previous reports. Mr. Barr explained that the team looked at numerous documents that had been prepared dating back to 1943, which recommended a variety of projects. In particular, the 1943 and 1957 San Jacinto River Master Plans (they were nearly identical in recommendations), as well as the 1985 Upper San Jacinto River Flood Control Study, provided numerous projects for consideration. The study team evaluated the efficacy of 34 projects in those studies. Many of them are infeasible due to current development or other factors, including the fact that many were proposed as water supply reservoirs, with a limited
amount of flood reduction benefit. Several of the larger reservoirs, including locations on Lake Creek, East Fork, Peach Creek and Caney Creek were included with some modifications to the size and configuration. Several additional alternatives were evaluated, including channel conveyance improvements and other detention locations.

Mr. Bezemek asked if there was any consideration of coupling water supply with the proposed detention basins as was done with several of the projects in the older studies. The addition of water supply to the projects could provide additional funding opportunities and benefits. Mr. Stull stated that there may be limited potential for a dual use reservoir, but that it was not included in the alternatives modeling – volume can generally be used for detention or water supply purposes, but not both.

Watershed Mitigation Potential

Mr. Barr briefly discussed the findings of the high-level analysis of each watershed. Based on a qualitative evaluation of volume in each of the watersheds, the team determined which watersheds show the most potential for providing benefits, but within their respective watersheds and further downstream. The watersheds with the highest mitigation potential included Spring Creek, East Fork SJR, Peach Creek, and Caney Creek. Lake Creek provided moderate potential, but it contributes a significant portion of the total West Fork drainage area.

Several of the watersheds were classified as having lower mitigation potential and were not considered for flood reduction projects. Willow Creek and Little Cypress Creek did not have a large enough contributing area to have a significant impact on the downstream flooding. Luce/Tarkington Bayous had very limited damages and provided a smaller contribution to the overall watershed. Jackson Bayou is very small and confluentes with the San Jacinto River downstream of Lake Houston, making it impossible to address flooding issues upstream of the Lake. Cypress Creek is a significant contributor; however, there are other planning efforts being considered, there is limited open space downstream of the overflow, and efforts upstream of the overflow would not have an impact on flood conditions downstream.

5. Flood Reduction Projects Summary

Mr. Barr presented the flood reduction projects summary. The proposed projects are located throughout the basin along the 6 streams identified for potential improvements (Spring, Lake, West Fork, East Fork, Peach, Caney) and include both channel conveyance improvements and detention projects. Mr. Barr included an overview of the Project Fact Sheet, which includes the following information for each project:

- General project information
- Project location map
- Project specifications
- Cost breakdown
Opportunities/Challenges/Potential Partners

Mr. Barr discussed some of the factors that create potential cost uncertainties for the projects discussed. Among these uncertainties were construction pricing changes, ROW acquisition needs and cost multiplier above current market value, and environmental impacts, permitting, and mitigation. In particular, the current ROW acquisition multiplier of 2.5 could be considered too conservative and may be reduced with input from HCFCD ROW acquisition staff. There were several questions relating to the fact sheets and cost uncertainty that were discussed, which related to the ROW needs.

Mr. Barr reiterated that the costs/benefits were still preliminary and subject to change as the configurations, costs, and benefits were refined.

Mr. Barr opened a discussion for feedback regarding ROW acquisition. Ms. Green asked to clarify the distinction between 100-YR and PMF cost estimates. Mr. Barr explained that this provides a cost range and a buffer for how much property might need to be acquired. Mr. Hannan asked to keep the range for future entities to make decisions.

Mr. Bezemeke asked who the owner of these projects would be, would it be a current stakeholder or a new entity. Furthermore, Mr. Bezemeke asked how maintenance would occur and who would be responsible. Mr. Barr explained the need to consider who could potentially own each project. Mr. Bezemeke asked if maintenance is included in the benefit cost for BCR. Mr. Barr explained that the BCR does not include maintenance at this time. As implementation planning is started and the cost estimates are updated, it would be considered.

Ms. Green asked about the berm elevations and whether they were designed for the 100-year, PMF or something else. Mr. Barr explained that the berm elevations were set such that the 100-year elevation was below the spillway and was controlled by the primary outfall. Flow above the 100-year event would outfall via a spillway, up to and including the PMF. This was done with TCEQ dam permitting in mind, as it will require the structure to pass the PMF. Ms. Green asked if the detention basins include freeboard. Mr. Olmos explained that freeboard was considered and, in many cases, the PMF freeboard was 3-3.5 ft to top of dam to account for wave run-up. Ms. Green mentioned that USACE released guidance related to reservoirs and may include information about ROW and easements.

With respect to the discussion of buying property up to the 100-year elevation vs. the PMF, Ms. Green asked about the possibility of an easement outside of the 100-year elevation properties as a potential cost savings measure. Mr. Bezemeke said that purchasing easement to restrict development, would be a possibility, but would likely still cost 90% of the property value, so there may not be much in the way of cost savings.
<table>
<thead>
<tr>
<th></th>
<th><strong>Spring Creek</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Mr. Barr discussed project details for the Spring Creek watershed. Out of 4 total projects evaluated, 3 were considered most effective:</td>
</tr>
</tbody>
</table>
|   | • Birch Creek Detention  
|   | • Walnut Creek Detention  
|   | • Channel Improvements from I-45 to Riley Fuzzell  
|   | The estimated total cost of the projects ranged from $249M - $318M. The total cumulative benefits within the Spring Creek watershed are approximately $300M. |

<table>
<thead>
<tr>
<th></th>
<th><strong>Lake Creek</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Mr. Barr discussed project details for the Lake Creek watershed. Out of 7 total projects evaluated, 3 were considered most effective:</td>
</tr>
</tbody>
</table>
|   | • Garrett’s Creek Detention  
|   | • Little Caney Creek Detention  
|   | • Caney Creek Detention  
|   | The estimated total cost of the projects ranged from $303M - $422M. The total cumulative benefits within the Lake Creek watershed are approximately $7M, with most of the benefits accruing in the West Fork watershed downstream. |

<table>
<thead>
<tr>
<th></th>
<th><strong>Caney Creek</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>Mr. Barr discussed project details for the Caney Creek watershed. Out of 3 total projects evaluated, 3 were considered most effective:</td>
</tr>
</tbody>
</table>
|   | • Caney Creek Detention at FM1097  
|   | • Caney Creek Detention at SH105  
|   | • Channel Improvements D/S of US59 to East Fork Confluence  
|   | The estimated total cost of the projects ranged from $421M - $478M. The total cumulative benefits within the Caney Creek watershed are approximately $75M. |

<table>
<thead>
<tr>
<th></th>
<th><strong>Peach Creek</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>Mr. Barr discussed project details for the Peach Creek watershed. Out of 3 total projects evaluated, 3 were considered most effective:</td>
</tr>
</tbody>
</table>
|   | • Peach Creek Detention at SH105  
|   | • Peach Creek Detention at Walker Creek U/S of New Caney  
|   | • Channel Improvements D/S of US59  
|   | The estimated total cost of the projects ranged from $682M - $830M. The total cumulative benefits within the Caney Creek watershed are approximately $84M. |

|   | **East Fork San Jacinto** |
Mr. Barr discussed project details for the East Fork of San Jacinto watershed. Out of 4 total projects evaluated, 2 were considered most effective:
- Winters Bayou U/S of Cleveland
- Channel Improvements D/S of FM1485 to Luce Bayou Confluence

The estimated total cost of the projects ranged from $458M - $489M. The total cumulative benefits within the East Fork watershed are approximately $55M.

11. West Fork San Jacinto

Mr. Barr discussed project details for the West Fork of San Jacinto watershed. Out of 4 total projects evaluated, 2 were considered most effective:
- Channel Improvements from I-45 to FM242
- Channel Improvements D/S of US59

The estimated total cost of the projects is $966M. The total cumulative benefits within the East Fork watershed are approximately $145M.

12. San Jacinto Regional WMDP

Mr. Barr presented an overview of San Jacinto Regional WMDP. The overall map indicated that the “most effective” projects were located throughout the basin and included both channel improvement and detention projects. Mr. Barr also presented information about the project coverage as compared to the Low to Moderate Income (LMI) areas. Several of the projects on the east side of the basin (Peach, Caney, East Fork) have the potential to benefit LMI areas, which may make them eligible for CDBG funding through the GLO.

Project Combinations and Cost

Mr. Barr briefly discussed the combinations of projects, indicating that project combinations had been modeled for each of the watersheds as well as an overall combined model for all the proposed projects. He indicated that additional combinations can be considered once the projects are selected. Mr. Barr presented the total estimated project costs, which range between approximately $3.1B and $3.5B, depending on the ROW and environmental factors. Mr. Barr reiterated that these costs will be refined as the team moves into the implementation stage.

Kingwood Area Benefits

Mr. Barr discussed the potential benefits of projects in the Kingwood area specifically, which include a 58% decrease in the instances of flooding. There is a nearly 70% decrease in the number of structures at risk from flooding during a 100-year event and more than 80% reduction for flooding during less frequent events. It was noted that Lake Houston controls the water surface elevations (WSE) below Lake Houston Parkway, limiting the potential WSE reductions in that area unless the
lake elevation is reduced. This study does not include an investigation of options to reduce Lake Houston WSE.

Watershed vs. Regional Approach

Mr. Hinojosa presented two potential approaches for moving forward with the MDP, one which focused on prioritizing watersheds and completing all projects in a watershed before moving to the next priority watershed. In the case of this study, Spring Creek provided the most overall benefit. The second option looked at each project on its own and prioritizing projects based on metrics, independent of the watershed in which it is located. While the highest BCR projects were in Spring, other projects can provide significant benefit, even if their BCR is lower. In most cases, the lower BCR is a function of limited development, particularly on the east side of the basin. Mr. Hinojosa solicited input from the group regarding the watershed vs. regional approaches.

Mr. Barrett explained that the funding source and potential partners would be a significant factor in driving the projects and implementation and that a regional approach would provide the most variety of partnerships. He asked if the team had considered evaluating the combined project costs and benefits similar to the target volume determination, using the point of inflection to identify the most cost-beneficial path forward. Mr. Barrett suggested that if funding cannot be secured for an entire project, it would help to research to see if funding is available for a portion of a project.

Mr. Stull recommended having “anchor” projects which have the most advantageous BCR and adding smaller project for LMI areas or other areas as funding permits. Ms. Green preferred the approach of identifying funding first and determining the first few projects that will provide the most benefit. She suggested that developing a roadmap for the communities for the future of the region would be a good approach. Furthermore, Ms. Green explained that securing funding for the watershed approach may pose a challenge. Mr. Eaton agreed that a regional approach makes the most sense and that the team needs to consider cumulative benefits when selecting the projects to be implemented. The general consensus among the group was that the regional approach is the best option.

Additional Regional Measures

Mr. Barr discussed additional regional flood mitigation measures, which included evaluating detention policy for jurisdictions in the San Jacinto basin and the possibility of flood preservation policies. Need to determine what is the combination of buyouts plus structural measures.

Buyouts

Ms. Green asked if the structures that flood during the 2-YR and 5-YR were scattered or located in close proximity (clustered). Mr. Johnston explained that there are some clusters of structures, but they are generally spread out. Ms. Green explained that it is most cost effective
for buyouts to be clustered and reduces the impact buyouts have on communities. Intermittently purchasing properties can degrade the character of a neighborhood. Ms. Green and Mr. Maske asked if RL/SRL information is available for the buyout structures. Mr. Johnston explained that information regarding the structures can be reviewed. Mr. Barr mentioned that the structures are available for Harris County but need to be confirmed.

**FEMA Mapping vs. Updated with Atlas 14**

Mr. Bezemek asked if there are any comparisons to the current FEMA maps. Filling in the Atlas 14 floodplain could affect results if the maps are not updated or adopted based on the new information. A key first step would be to update the floodplain mapping based on the Atlas 14 models. It is important that the mapping information in potential buyout areas is up to date so that there is a good sense of actual at-risk properties. Ms. Chen mentioned that HCFCD could facilitate a workshop to help communities navigate the FEMA mapping process. Mr. Hannan explained that a positive outcome of the San Jac study would be adopting the modeling as "best available".

### 13. Implementation

**Potential Ranking Metrics**

A discussion regarding the project metrics was opened by Mr. Barr, who provided a list of potential considerations. These included costs, benefits, maintenance, constructability, among others. Additional metrics, such as social vulnerability, low to moderate income area benefits, and reductions in road flooding were also included. Mr. Bezemek asked how the outlined project metrics compared with FEMA metrics. The team should consider aligning project metrics with FEMA metrics to determine if eligible for FEMA funded opportunities.

Mr. Barrett explained that funding potential, maintenance, and which agency will lead the project are important considerations. The viability of operations and maintenance would largely depend on which jurisdiction is responsible.

Mr. Bezemek commented that the Harris County watershed planning studies have focused recent studies on areas with the worst flooding. This includes weighting structures with roads based on historical flooding. Considerations would include constructability and primary damages. Once the areas are identified, then consider other metrics as this would help to focus improvements in areas of historical flooding.

Ms. Chen commented that erosion control and channel damage weights should be higher for watersheds that contribute more erosion to Lake Houston. Considerations could include how the structural improvements would tie in with the sedimentation recommendations to reduce sedimentation into Lake Houston.
Mr. Bezemek commented that different sources of funding may require different metrics and weights. Selecting hard numbers and ranking metrics may limit funding opportunities. Current rankings may not include future grant funding depending on the language. May need to consider multiple sets of metrics depending on potential funding sources. Mr. Barr replied that projects need to be prioritized with funding sources and availability in mind. Mr. Barrett suggested two sets of criteria to rank the projects, reductions in structural flooding and then everything else. Mr. Eaton explained that funding potential may need to be a secondary consideration as funding availability and sources can change over the years. Ranking a small set of metrics first may provide more flexibility. Mr. Olmos suggested incorporating rankings for projects based on LMI area, areas of improvement, and inclusion of multiple jurisdictions which could improve possibility for funding. Mr. Barrett explained that LMI and multi-jurisdictional areas are funding criteria for several sources, including the TWDB FIF. Ms. Chen said TxDOT may have new bridges constructed on some of the roadways, which could tie into some of the proposed flood reduction projects.

Implementation Planning

Mr. Barr presented the implantation planning details including steps:

- Identify projects to be included in the MDP
- Finalize modeling of the individual projects
- Prioritize projects
- Develop project phasing plan
- Move forward with feasibility, preliminary engineering, design

Ms. Chen explained that HCFCDF that can provide high level presentation to the study partners in June if they are interested. Ms. Green reminded the group that while the project costs appear daunting, the data developed as part of the analysis provides very helpful information including mapping, models, identification of hazards, etc.

14. Study Deliverables Schedule

- Preliminary Mitigation Planning Memo (June 8th)
- Draft Report (July 13th)
- Final Report (August 31st)

15. Closing Remarks and Questions

The workshop was adjourned.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Phone Number</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Hamilton</td>
<td>USACE</td>
<td>(409) 766-3102</td>
<td><a href="mailto:paul.b.hamilton@usace.army.mil">paul.b.hamilton@usace.army.mil</a></td>
</tr>
<tr>
<td>Mike Reedy</td>
<td>Freese &amp; Nichols</td>
<td>(713) 600-6828</td>
<td><a href="mailto:mvr@freese.com">mvr@freese.com</a></td>
</tr>
<tr>
<td>Rachel Massey</td>
<td>Hollaway</td>
<td>(346) 250-8661</td>
<td><a href="mailto:rachel@hollawayenv.com">rachel@hollawayenv.com</a></td>
</tr>
<tr>
<td>Reece Fickes</td>
<td>HCFCD</td>
<td></td>
<td><a href="mailto:reece.fickes@hcfcd.hctx.net">reece.fickes@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Terry Barr</td>
<td>Halff</td>
<td>(713) 588-2451</td>
<td><a href="mailto:tbarr@halff.com">tbarr@halff.com</a></td>
</tr>
<tr>
<td>Jing Chen</td>
<td>HCFCD</td>
<td>(346) 286-4264</td>
<td><a href="mailto:jing.chen@hcfcd.hctx.net">jing.chen@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Justin Bower</td>
<td>H-GAC</td>
<td>(713)-499-6653</td>
<td><a href="mailto:justin.bower@h-gac.com">justin.bower@h-gac.com</a></td>
</tr>
<tr>
<td>Dena Green</td>
<td>HCFCD</td>
<td>(346) 286-4252</td>
<td><a href="mailto:dena.green@hcfcd.hctx.net">dena.green@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Russ Poppe</td>
<td>HCFCD</td>
<td></td>
<td><a href="mailto:russ.poppe@hcfcd.hctx.net">russ.poppe@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Stephen Benigno</td>
<td>HCFCD</td>
<td></td>
<td><a href="mailto:stephen.benigno@hcfcd.hctx.net">stephen.benigno@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Alan Black</td>
<td>HCFCD</td>
<td>(346)-286-4260</td>
<td><a href="mailto:alan.black@hcfcd.hctx.net">alan.black@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Andrew Moore</td>
<td>Halff</td>
<td>(936) 777-6377</td>
<td><a href="mailto:amoore@halff.com">amoore@halff.com</a></td>
</tr>
<tr>
<td>Adam Eaton</td>
<td>City of Houston</td>
<td>(832) 395-3082</td>
<td><a href="mailto:adam.eaton@houstontx.gov">adam.eaton@houstontx.gov</a></td>
</tr>
<tr>
<td>Atual Hannan</td>
<td>HCFCD</td>
<td>(346) 286-4117</td>
<td><a href="mailto:ataul.hannan@hcfcd.hctx.net">ataul.hannan@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Briana Gallagher</td>
<td>SJRA</td>
<td></td>
<td><a href="mailto:bgallagher@sjra.net">bgallagher@sjra.net</a></td>
</tr>
<tr>
<td>Brandyn Littleton</td>
<td>Halff</td>
<td>(512) 942-6214</td>
<td><a href="mailto:blittleton@halff.com">blittleton@halff.com</a></td>
</tr>
<tr>
<td>Chuck Gilman</td>
<td>SJRA</td>
<td>(936) 538-8111</td>
<td><a href="mailto:cgilman@sjra.net">cgilman@sjra.net</a></td>
</tr>
<tr>
<td>Cory Stull</td>
<td>Freese &amp; Nichols</td>
<td>(713) 600-6809</td>
<td><a href="mailto:cory.stull@freese.com">cory.stull@freese.com</a></td>
</tr>
</tbody>
</table>
# PRIMARY MITIGATION PLANNING WORKSHOP

*HCFCD, City of Houston, Montgomery County, SJRA*

*April 27, 2020*

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Phone Number</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craig Maske</td>
<td>HCFCD</td>
<td>(346) 286-4041</td>
<td><a href="mailto:craig.maske@hcfcd.hctx.net">craig.maske@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Garrett Johnson</td>
<td>Freese &amp; Nichols</td>
<td>(512) 617-3160</td>
<td><a href="mailto:jgi@freese.com">jgi@freese.com</a></td>
</tr>
<tr>
<td>Gary Bezemek</td>
<td>HCFCD</td>
<td>(512) 617-3160</td>
<td><a href="mailto:gary.bezemek@hcfcd.hctx.net">gary.bezemek@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Hector Olmos</td>
<td>Freese &amp; Nichols</td>
<td>(713) 600-6856</td>
<td><a href="mailto:heo@freese.com">heo@freese.com</a></td>
</tr>
<tr>
<td>Jeff Johnson</td>
<td>Montgomery County</td>
<td></td>
<td><a href="mailto:jeff.johnson@mctx.org">jeff.johnson@mctx.org</a></td>
</tr>
<tr>
<td>Jonathan Holley</td>
<td>HCFCD</td>
<td>(346)-286-4155</td>
<td><a href="mailto:jonathan.holley@hcfcd.hctx.net">jonathan.holley@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Justin Terry</td>
<td>HCFCD</td>
<td>(346)-286-4060</td>
<td><a href="mailto:justin.terry@hcfcd.hctx.net">justin.terry@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Jenny Lam</td>
<td>Halff</td>
<td>(713) 588-2463</td>
<td><a href="mailto:jlam@halff.com">jlam@halff.com</a></td>
</tr>
<tr>
<td>Lisa Mairs</td>
<td>USACE</td>
<td>(713) 588-2463</td>
<td><a href="mailto:lisa.m.mairs@usace.army.mil">lisa.m.mairs@usace.army.mil</a></td>
</tr>
<tr>
<td>Matt Zeve</td>
<td>HCFCD</td>
<td>(346)-286-4055</td>
<td><a href="mailto:matthew.zeve@hcfcd.hctx.net">matthew.zeve@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Matt Barrett</td>
<td>SJRA</td>
<td>(936) 588-7177</td>
<td><a href="mailto:mbarrett@sjra.net">mbarrett@sjra.net</a></td>
</tr>
<tr>
<td>Darren Hess</td>
<td>Montgomery County</td>
<td></td>
<td><a href="mailto:darren.hess@mctx.org">darren.hess@mctx.org</a></td>
</tr>
<tr>
<td>Michael Moya</td>
<td>Halff</td>
<td>(512) 777-4550</td>
<td><a href="mailto:mmoya@halff.com">mmoya@halff.com</a></td>
</tr>
<tr>
<td>Sam Hinojosa</td>
<td>Halff</td>
<td>(936) 777-6372</td>
<td><a href="mailto:shinojosa@halff.com">shinojosa@halff.com</a></td>
</tr>
<tr>
<td>Johnny Kim</td>
<td>Halff</td>
<td>(713) 380-4387</td>
<td><a href="mailto:jkim@halff.com">jkim@halff.com</a></td>
</tr>
<tr>
<td>James Wade</td>
<td>HCFCD</td>
<td>(346)-286-4260</td>
<td><a href="mailto:james.wade@hcfcd.hctx.net">james.wade@hcfcd.hctx.net</a></td>
</tr>
<tr>
<td>Steve Costello</td>
<td>City of Houston</td>
<td></td>
<td><a href="mailto:stephen.costello@houstontx.gov">stephen.costello@houstontx.gov</a></td>
</tr>
<tr>
<td>Megan Gallego</td>
<td>Halff</td>
<td>(936) 777-6391</td>
<td><a href="mailto:mgallego@halff.com">mgallego@halff.com</a></td>
</tr>
<tr>
<td>Name</td>
<td>Organization</td>
<td>Phone Number</td>
<td>Email</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>----------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Sharon Citino</td>
<td>City of Houston</td>
<td>(713) 205-5342</td>
<td><a href="mailto:sharon.citino@houstontx.gov">sharon.citino@houstontx.gov</a></td>
</tr>
<tr>
<td>Amber Batson</td>
<td>SJRA</td>
<td></td>
<td><a href="mailto:abatson@sjra.net">abatson@sjra.net</a></td>
</tr>
</tbody>
</table>