SAN JACINTO

REGIONAL WATERSHED MASTER DRAINAGE PLAN

Harris County Flood Control District
San Jacinto River Authority
Montgomery County
City of Houston

APPENDIX I
SECONDARY FLOOD MITIGATION PLANNING

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12/07/2020
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Appendix I: Secondary Flood Mitigation Planning

December 2020

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1.0 Introduction

As part of the San Jacinto Regional Watershed Master Drainage Plan (SJMDP), the study team assessed the current Harris County Flood Warning System (FWS) and identified additional rainfall, stage, and flow gage locations to be considered. With approximately 184 gages in the system, the majority in Harris County, the team considered areas outside of Harris County that contribute to the San Jacinto River and ultimately flow through Harris County. The intent of these recommendations is to bolster the flood warning capabilities of the system outside of Harris County, as well as provide additional data points that could be used for calibration points in future studies.

1.1 History of the Flood Warning System[1]

The installation of the gage system began in 1982 under the direction of the Flood Control District and initially included 13 gage stations. The first test of this system occurred during Hurricane Alicia in 1983, and the system provided invaluable information, including rainfall totals and bayou/stream level data that was not previously available. From 1983 to 2018, the number of gage stations increased to today's total of 177, expanding the ability to monitor and gather information from many more bayous and streams.

1.2 How the Information is Used[1]

The primary function of the Flood Warning System is to transmit rainfall and bayou/stream level data for use by the public and by government officials in taking steps to protect the public. The information received is collected and analyzed by the Flood Control District also to develop post-flood reports. These reports detail the extent and impact of flooding, including an approximation of the number of structures inundated from a flood. In addition, the Flood Control District uses this information to perform engineering analyses for identifying locations of future projects as well as to determine the effectiveness of constructed projects.

2.0 Data Collection

The project team collected existing and proposed gage data from several of the agencies responsible for flood management, flood warning, and emergency operations within the watershed area to assess the current system and plan for improvements. The data collected from those agencies has been summarized in **Figure 1 – Proposed Gages (Received Data)**.

Meetings were conducted in September and November 2019 and included the SJMDP team and all responsible agencies with gages used in the FWS. The objective was to verify that existing gage location data were representative of the gages in place. The agencies included were San Jacinto River Authority (SJRA), Woodlands Waters Agency (WWA), Harris County Flood Control District (HCFCD), United States Geological Survey (USGS), and Montgomery County (MOCO).

Comments from and subsequent to these meetings and online USGS and HCFCD interactive gage maps were used to verify and update the existing gage data. In addition, the HCFCD, Montgomery County, and the USGS proposed additional gages, along with specific locations to be considered. A total of 28 additional gages were proposed by the various agencies and shown in **Figure 1**, including:

- 21 rainfall-stage gages (Harris (2), Montgomery (13), Liberty (3), San Jacinto (2), Grimes (1))
- 3 stage gages (USGS)
- 4 stage-flow gages (USGS)

[1] https://www.harriscountyfws.org/about

3.0 Recommended Gages

Based on these interviews and internal review, the study team originally recommended 29 additional gages to enhance the Flood Warning System for the SJMDP. Further refinement resulted in a recommendation of 26 gages of various types, some of which have recently or are currently being installed. **Figure 2** presents existing gage information and gage recommendations following coordination with study partners.

- 19 rainfall-stage gages
- 3 stage gages
- 3 stage-flow gages
- 1 rainfall-stage-flow gage (Winter's bayou at SH150)

These recommendations include several gage types, some of which may be used together:

- **Rainfall Gages** – The Lake Creek, Luce Bayou, East Fork, Peach Creek, and Caney Creek subbasins have sparse rainfall gage coverage. Since these subbasins are at the upstream end of the watershed and contribute significant flow to the SJR basin, additional rainfall gages in the upstream end of these subbasins will provide early indications of rainfall. These gages are recommended to close coverage gaps. Locations were determined based on proximity to the major streams and limited tree cover. Several of the proposed rainfall gages along Spring Creek recommended by Montgomery County were not incorporated due to close proximity to other proposed gages, or because they were duplicates of proposed USGS gages.
- **Stage Gages** – Stage gages are also recommended alongside rainfall gages to ensure adequate water surface elevation information could be obtained for both flood warning and model calibration purposes. Stage gages were also placed along areas where the roads frequently overtopped, majority of which occurred in Montgomery County.
- **Flow Gages** – Flow gages along the mainstems and tributaries are used to predict peak discharges and flow hydrographs. Each gage has a rating curve for predicting discharges based on stage information. The rating curve is developed and updated using measurements (direct and indirect) taken by the USGS. This information can enhance early warning and future model calibration. Gages are recommended on major tributaries to Spring Creek, West Fork, and the East Fork based on input from the USGS. Location and access for field measurements were considered for placement of the proposed gages.

Based on all the received information, the project team evaluated the current FWS gage coverage and recommended additional gages to fill in gaps, provide additional FWS data, and assist in future model calibrations. **Table 1** below lists the recommended proposed gage locations.

Table 1: Proposed Gages

Proposed Gage #	Watershed	Gage Location	Gage Type
1	Spring Creek	Spring Creek @ Roberts Cemetery Rd	Rainfall & Stage
2	Spring Creek	Spring Creek @ Sanders Cemetery Rd	Rainfall & Stage
3	Spring Creek	Decker Branch @ Wright Rd	Rainfall & Stage
4	Lake Creek	Lake Creek @ Superior Rd	Rainfall & Stage
5	Caney Creek	McRae Creek @ McRae Circle	Rainfall & Stage
6	Caney Creek	Camp Creek @ Rose Rd	Rainfall & Stage
7	Caney Creek	West Fork of Spring Branch @ Old TX 105	Rainfall & Stage
8	Spring Creek	Sam Bell Gully Diversion Chl. @ Rayford Rd	Rainfall & Stage
9*	East Fork SJR	East Fork San Jacinto River @ SH 105	Rainfall & Stage
10*	East Fork SJR	East Fork San Jacinto River @ SH 150	Rainfall & Stage
11*	East Fork SJR	Winter's Bayou @ Tony Tap Rd	Rainfall & Stage
12*	East Fork SJR	Winter's Bayou @ FM 2693	Rainfall & Stage
13	Spring Creek	Mill Creek @ Highway 1488	Stage & Flow
14	Lake Creek	Mound Creek @ Highway 2854	Stage
15	Lake Creek	Fish Creek @ Most downstream dam	Stage
16	West Fork SJR	Stewarts Creek @ North Loop 336	Stage & Flow
17	West Fork SJR	East Fork of Crystal Creek @ Highway 1484	Stage & Flow
18	West Fork SJR	White Oak Creek @ Longmire Road	Stage
19	Caney Creek	Caney Creek @ SH 105	Rainfall & Stage
20	Caney Creek	Caney Creek Trib @ SH 59	Rainfall & Stage
21	Lake Creek	Lake Creek @ FM 149	Rainfall & Stage
22	Lake Creek	Lake Creek @ Johnson Rd	Rainfall & Stage
23	Luce Bayou	Luce Bayou @ Grand Parkway (approx.)	Rainfall & Stage
24	Peach Creek	Peach Creek @ SH 105	Rainfall & Stage
25*	Tarkington Bayou	Tarkington Bayou @ SH 105	Rainfall & Stage
26†	East Fork SJR	Winters Bayou @ SH 150	Rainfall, Stage & Flow

* Currently being added or has already been added by HCFCD

† Included as part of a Flood Infrastructure Fund (FIF) grant request by the SJRA

4.0 Current Gage Installation Efforts

Both the HCFCD and SJRA are being proactive in updating the gage network in the San Jacinto watershed, in some cases with local partners. The specific gage locations that have been installed or are in process are included in the sections below. Continuing coordination efforts between the various counties and agencies in the region will be an important part of planning and installing additional gages in the basin and linking them to a common system.

4.1 HCFCD Gage Updates

The HCFCD has installed or is currently in the process of installing several of the recommended gages along streams in the San Jacinto basin. These gages are intended to provide information about rainfall and stages along several of the major contributors to Lake Houston but are upstream of the Harris County border. These include gages at the following locations:

- East Fork at SH 105 (Location #9) – Installed 06/04/2020
- East Fork at SH 150 (Location #10)
- Winters Bayou at Tony Tap Road (Location #11)
- Winters Bayou at FM 2693 (Location #12)
- Tarkington Bayou at SH 105 (Location #25) – Installed 02/12/2020

4.2 SJRA Gage Updates

In addition, the SJRA has applied for a Flood Infrastructure Fund (FIF) grant from the Texas Water Development Board (TWDB) to add 3 gages to the network. These are all located within San Jacinto County and the county has expressed interest in partnering with the SJRA. The Winters Bayou at SH150 location was requested by Montgomery County and included in the recommendations to the SJMDP team, but the others were not. The gage locations are listed below.

- Winters Bayou at SH 150 (included in our recommendations)
- Peach Creek at FM 3081
- East Fork at FM 945

5.0 Gage Costs

Gages recommended for the basin would require a sponsor agency for installation and maintenance. The HCFCD provides this service and requires the sponsor agency to enter into an interlocal agreement with the HCFCD for installation and maintenance of the gages. Installation cost ranges from $7,000 - $12,000 depending on the parts used in the gage. Additional maintenance is required to ensure the gage is functioning property and to replace parts as needed.

The SJRA is also currently partnering with San Jacinto County to seek grant funding for installation of gages and could potentially partner with other entities in the future. SJRA can provide grant application/grant contract management support, as well as gage/equipment installation, engineering support, project management, and other in-kind services, but does not have a dedicated funding source for these efforts. Estimated cost for rain and stage gage installation at one site is $10,000, with a yearly maintenance cost of up to $500, plus approximately 10 hours of labor, if no major repairs or maintenance are required. SJRA would seek grant funds and/or agreements with entities to fund installation and maintenance. Data from any installed gages could potentially be displayed on SJRA's Contrail system,

though further coordination with SJRA will be necessary to determine the feasibility and requirements of doing so.

The USGS maintained flow gages require regular maintenance for updating the stage-flow rating curves. Installation of the gages is approximately $30,000 and yearly maintenance is approximately $15,900 for the full flow and stage gages. The USGS will partner with state, local, non-profit, and private entities for installing and maintaining the gages.

Table 2 summarizes the cost of the proposed gages by watershed, excluding the gages being installed by the HCFCD. Costs will vary depending on agency and gage type and do not include the yearly maintenance and repair required.

Table 2: Approximate Gate Installation Cost

Watershed	Approximate Cost Range
Spring Creek	$58,000 - $78,000
Lake Creek	$35,000 - $60,000
Caney Creek	$35,000- $60,000
West Fork San Jacinto	$67,000 - $72,000
East Fork San Jacinto	$30,000
Peach Creek	$7,000 - $12,000
Luce Bayou	$7,000 - $12,000
Gage Subtotal	**$239,000 - $324,000**
Additional Repeater	$100,000 - $150,000
Improvement Total	**$239,000 – $474,000**

The costs shown only include the gage installation. Maintenance costs will vary depending on the type of gage with rain gage and stage gage maintenance significantly less than the flow gages. In addition, there may be improvements to the data transmission infrastructure needed in order to effectively relay the data via radio frequency.

The HCFWS gages currently transmit data to four primary repeaters, which are located in Huffman, Clodine, League City, and Tomball. Given that the location of the proposed gages extends north of Harris County, an additional repeater may be needed to provide adequate coverage for data transmission. The addition of a repeater in the northern San Jacinto watershed could cost between $100,000 and $150,000. Specific locations and numbers of repeaters will need to be determined by HCFCD based on their system needs.

The total estimated cost range of these improvements is between $240,000 and nearly $500,000.

Harris County Flood Control District
San Jacinto Regional Watershed Master Drainage Plan
Proposed Gage Information Received

HALFF A/O NO.	033465.002
PI PROJECT NO.	HAF18900
DATE CREATED	Date: 8/29/2020
DATUM & COORDINATE SYSTEM	NAD83 (2011) State Plane (feet) Texas S Central
FILE NAME	Name: I1_PropGageReceived_20200829

SAN JACINTO REGIONAL WATERSHED MASTER DRAINAGE PLAN

APPENDIX I

1

Miles
0 1.5 3 6 9

Miles
0 0.75 1.5 3

Miles
0 0.75 1.5 3

N
W E
S

Legend

Proposed Gages
- Rain+Stage - Montgomery County
- Rain+Stage+Flow - Montgomery County
- Stage - USGS
- Stage+Flow - USGS
- Rain+Stage - HCFCD
- Stage - HCFCD

Existing Gages
- Rain - SJRA
- Rain+Stage - SJRA
- Stage - SJRA
- Rain - WWA
- Rain+Stage - WWA
- Rain - HCFCD
- Rain+Stage - HCFCD
- Stage - USGS
- Stage+Flow - USGS

- Grand Parkway
- San Jacinto River Basins
- County Boundaries
- San Jacinto River Channels

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Harris County Flood Control District
San Jacinto Regional Watershed Master Drainage Plan
Recommended Gages

HALFF A/O NO. 033465.002
FH PROJECT NO. HAF19300
DATE CREATED Date: 8/29/2020
DATUM & COORDINATE SYSTEM NAD83 (2011) State Plane (feet) Texas S Central
FILE NAME Name: I2_RecommendedGages_20200829

SAN JACINTO REGIONAL WATERSHED MASTER DRAINAGE PLAN

APPENDIX I

2

Miles
0 1.5 3 6 9

1 in = 2 miles

Miles
0 0.75 1.5 3

Miles
0 0.75 1.5 3

Legend

Proposed Gages
- Stage
- Stage+Flow
- Rain+Stage
- Rain+Stage+Flow

Existing Gages
- Rain - SJRA
- Rain+Stage - SJRA
- Stage - SJRA
- Rain - WWA
- Rain+Stage - WWA
- Rain - HCFCD
- Rain+Stage - HCFCD
- Stage - USGS
- Stage+Flow - USGS

- Grand Parkway
- San Jacinto River Basins
- County Boundaries
- San Jacinto River Channels

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