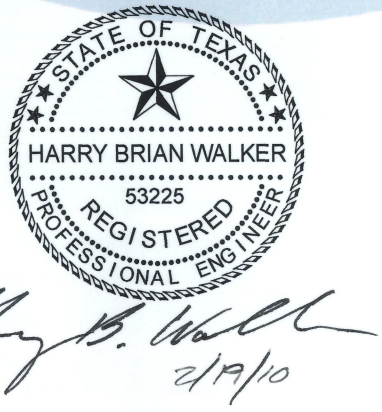
April 28th & 29th, 2009 Storm Flood Study Report

for

The City of Spring Valley Village, Texas



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February, 2010

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February 18, 2010

Mayor and City Council Members
The City of Spring Valley Village
1025 Campbell Road
Houston, Texas 77055

Re: April 27 -28, 2009 Flood Study Report
HDR|C&M Job No. 09-001

Dear Mayor and Council Members:

The accompanying report documents the findings and recommendations of our study of the flooding that occurred in Spring Valley Village and the surrounding areas on April 27th and 28th of 2009. Spring Valley Village's residents suffered flooding of 17 homes an 10 garages, while the overall area experienced flooding of more than 2300 homes and businesses. Based on stream flow measurements by the Harris County Flood Control District, this storm was the worst storm on record for Buffalo Bayou in the Memorial Villages area. High water marks along Briar Branch creek indicate that water levels reached or exceeded the 100-year flood levels in Spring Valley Village within portions of the stream from upstream of Voss Road to upstream of Campbell Road.

Recommendations of this study include ongoing maintenance activities, further investigations, and coordination of efforts with other entities affected by this event. In addition, it has been recommended that the City pursue the completion of the Briar Branch Diversion project that was previously proposed.

We appreciate the cooperation and assistance of the City officials and staff who helped in the data collection and documentation of events that went into of this study.

Sincerely,

HDR|CLAUNCH & MILLER

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April 27-28 Storm Analysis

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Introduction

On April 27th and 28th, 2009 a major storm event occurred in the northwestern portion of Harris County bringing substantial rainfall which resulted in significant runoff and flooding within portions of the Buffalo Bayou watershed, including Spring Valley Village. Appendix 5 provides photos of the Spring Valley Village during and shortly after the event. Structural flooding was reported at twenty seven locations in Spring Valley Village. Of these locations, 16 properties suffered house flooding and 10 had garage flooding only. Exhibit 1 shows the locations of the flooded properties within Spring Valley Village.

Spring Valley Village is located in the Buffalo Bayou (W100-00-00) watershed, and is in the area drained by Spring Branch (W140-00-00) and Briar Branch (W140-01-00), which are tributaries of Buffalo Bayou. Both Spring Branch and Briar Branch are Harris County Flood Control District streams and are not under the direct jurisdiction of the City of Spring Valley Village. The Addicks Reservoir watershed is a tributary to Buffalo Bayou, and is controlled by a US Army Corps of Engineers dam and gate structure. Exhibit 1a shows the various watersheds and channel designations in the Memorial Villages area that are referred to herein.

Exhibits 2 and 3 show the areas of highest rainfall accumulation, as reported by the National Weather Service. As can be seen on this exhibit, the greatest rainfall amounts occurred within the upper portions of Addicks Reservoir, with substantial rainfall amounts extending throughout the western half of Harris County. The largest rainfall accumulation recorded was 11.30 inches over the 24-hour period from 3:00 PM on April 27th until 3:00 PM on April 28th. For comparison purposes, Exhibits 2a, 2b, 3a and 3b show similar rainfall data for Tropical Storm Allison and Hurricane Ike.

Rain gauge data from the Harris County Office of Emergency Management and other sources show that the vast majority of this rainfall fell within an approximate 12 hour period from the afternoon of the 27th through the morning of the 28th. Exhibits 7 and 8 show rainfall data for representative gauges in the watershed.

As a result of the large amount of rainfall, and the wet ground conditions existing prior to the start of this event, runoff from this storm was extremely heavy and resulted in flooding conditions on many of the streams within the area. Substantial house flooding occurred within the western portion of Harris County, with more than 2300 homes throughout the Houston area being flooded. Approximately 450 homes were flooded in the Addicks Reservoir watershed, just to the west of the upper end of the drainage basins that serve Spring Valley Village. This storm event ***eclipsed the previous storm of record*** on Buffalo Bayou in the Memorial Villages area, which occurred in March of 1992, becoming the new storm of record. As a result of rainfall runoff from this storm, Spring Valley Village experienced overbank flooding along portions of Briar Branch upstream of Fries Road, with house flooding reported at 27 addresses, including 17

homes that flooded and 10 with garage flooding only. Exhibit 1 shows the locations of flooded properties within Spring Valley Village. Most of the other Memorial Villages experienced significant structural flooding during this event as well. Appendix 6 contains a newspaper article which describes this event and the flooding associated with this storm event.

Of the locations experiencing house flooding, 60% reported water entering the house and garage, with the remainder with water entering the garage only. The vast majority of the homes where flooding occurred are located in close proximity to Briar Branch. Other locations experiencing flooding resulted from specific circumstances affecting the local drainage system, such as inlets blocked by debris.

There have also been some reports of problems associated with drainage being impaired by the sound wall north of I-10, with one house flooded in that area. Drainage structures conveying water from north of the sound wall into the I-10 drainage system experienced blockages due to debris accumulation on the grate structures.

Historical Data

Development: The City of Spring Valley Village was incorporated in 1955. Aerial photos of the region including Spring Valley Village and areas surrounding the City have been obtained. Exhibit 9 is the latest aerial of the region, taken in 2008. Exhibits 10 - 13 were taken in 1956, 1965, 1976 and 1985 respectfully. Development occurred within both the Briar Branch and Spring Branch watersheds steadily throughout the decades, increasing the impervious ground cover and the run off from storm events in the region. Currently, the Briar Branch and Spring Branch watersheds are considered essentially completely developed. Prior to the early 1980's, much of this development occurred with little consideration to the effects of increased runoff on the receiving streams.

Due to the steady increase in development, runoff from the Briar Branch watershed has increased over the years; however, the channel capacity has not been increased since the mid-1970's, as discussed below.

Stream Improvements and Studies on Briar Branch: The Harris County Flood Control District (HCFCD) is the regulatory agency with jurisdiction over both Briar Branch and Spring Branch. From 1975 to 1980, the District began a series of projects to improve the channel of Briar Branch, which consisted primarily of the construction of an 8' x 4' concrete low flow channel as the bottom of the stream. The first project was in 1975 to improve the section from Anne Street to just downstream of Fries Road. The second project began in 1976 starting at the end of the first project and continuing downstream to Voss Road. The third project was built later in 1976 and improved the section from Anne Street upstream to Bunker Hill Road. The fourth project

was done in 1980 and improved the section from Witte Road to Bunker Hill Road. HCFCD also performed several projects in which maintenance was done on Briar Branch in order to keep the stream at current capacity levels. In 1992, following the flooding that occurred in March of that year, HCFCD authorized a drainage study of the Memorial Villages area and followed up that study in 1994 to analyze particular options for Briar Branch (including the by-pass for Briar Branch recommended in the 1992 study). The 1994 study found that "overbank flooding will result from the 100 year storm should not improvements be made." No major improvements have been made to the channel since the report.

Rainfall

Harris County's Office of Emergency Management (HCOEM) maintains a network of rainfall and stream flow gauges throughout the County. In addition, there is an extensive network of private gauges throughout the area that provide supplemental rainfall data. Exhibits 2 and 3 show the gauge locations for a number of the gauges in the vicinity of Spring Valley Village. Appendix 3 shows the rainfall amounts for the HCOEM gauges for various time periods. The gauge located on Spring Branch creek at Bingle (2250) recorded 8.07 inches of rainfall within the 24 hour period, while the gauge located on Buffalo Bayou at West Belt (2270) recorded 9.4 inches in 24 hours. The gauge on Buffalo Bayou at San Felipe (2260) recorded 7.7 inches in 24 hours. For the 12 hour period when the bulk of the rainfall actually fell, these gauges recorded 7.1, 8.9, and 7.4 inches respectively. The 12-hour rainfall amounts are in excess of the 25 year return interval event for the Bingle and San Felipe gauges, and in excess of the 50-year event for the Beltway 8 gauge. For the 3-hour period, which corresponds to the design storm duration, these gauges recorded 5.0, 5.2, and 7.0 inches respectively, representing 25-year events at Bingle and San Felipe, and in excess of a 100-year event at Beltway 8**.**

Exhibits 7 and 8 show recorded rainfall data for private gauges 9 and 49, located in the upper portions of the watershed. This data shows peak rainfall rates on the morning of the 28th of 4.5 inches per hour.

Analysis of the rainfall data (see Appendix 2) shows that the storm actually consisted of two relatively short, very intense periods of rainfall, roughly between the hours of 4:30 and 8:30 PM on the 27th and between the hours of 4:00 and 7:00 AM on the 28th.

For the gauge on Spring Branch at Bingle, the rainfall amounts during these two periods were approximately 3 inches in the initial period and approximately 5 inches in the second period. For comparison purposes, the City's design criteria for drainage systems is a 2-year, 3-hour duration event, with a rainfall amount of 2.6 inches. This criteria is also used by the City of Houston and most other entities in the region. When used in conjunction with extreme event design concepts, the 2-year design criteria has proven to be an effective level of protection with a reasonable cost of construction. Analyzed individually, these rainfall amounts represent

something greater than a 2-year, 3-hour event, followed by about a 20-year, 3 hour event. Taken together, over the storm duration of about 14 hours, the total rainfall approaches a 25-year event for that time period.

It is important to note that the rainfall amounts were greater in the areas further west of Spring Valley than in the immediate vicinity. Although HCFCD does not maintain any other gauges in the upper portions of these watersheds, the network of privately maintained gauges that includes this area show that the rainfall received in the upper portions of the Briar Branch and Spring Branch watersheds was somewhat greater than was measured at the Bingle gauge, totaling about 9 inches, which would increase the rainfall totals to slightly more than a 25-year event, for the storm duration.

For comparison purposes, Exhibits 3a and 3b show rainfall totals for Hurricane Ike and Tropical Storm Allison. These totals represent the cumulative rainfall over the entire duration of these events, which were 2 days and 5 days respectively, as compared to slightly more than one-half day for the April storm. Hurricane Ike produced a 24-hour maximum rainfall at the Bingle gauge of 8.5 inches, as compared to 8.07 inches over 14-hours in the April storm. While these historical events had higher total rainfall amounts than the April storm, the rainfall was spread over much longer time frames, so that the intensity of the rainfall was much less in each case.

Stream Flow

HCFCD reported that the stream flow measured at the gauge on Buffalo Bayou at Piney Point exceeded the historical flood of record, which occurred in 1992. At the gauge on Spring Branch at Bingle, the water level reached an elevation of 63.86 feet MSL at about 5:00 AM on the 28th. For comparison purposes, the 50-year water level at this location is 63.50 feet, and the 100-year water level is 64.50 feet, which would put this event in the range of a 65- to 70-year water level. Appendix 4 contains stream flow data.

Briar Branch does not have a stream gauge, so the water levels reached are not recorded. However, there is documentation from photographs and high water marks to indicate the levels the water reached. At Campbell Road, it has been documented by photographs and high water marks that Briar Branch overtopped the roadway at the bridge, including the raised sidewalk adjacent to the roadway. At the Tamy Lane bridge the water level exceeded the height of the bottom of the bridge (low chord), but apparently did not go over the top of the bridge. Further downstream at Fries Road, water levels also exceeded the low chord of the bridge, but did not overtop the roadway. The Fries Road bridge was built with the low chord set at the 50-year flood elevation (at that time). At Voss Road, the water level approached the elevation of the low chord of the bridge. We know that the low chord of the Voss Road bridge is approximately 7.5 inches above the 100-year level.

Throughout the portion of Briar Branch between Adkins and Voss Road, there is extensive evidence of high water marks at or above the top of bank level. Exhibit 9 shows the 100-year water surfaces from both the official FEMA flood plain study and from Dodson's separate study done for the City. This exhibit also shows the slab heights of some of the flooded properties adjacent to the channel. By comparing the water surface elevations to the slab heights, it can be seen that the runoff resulting from the April storm ***exceeded the official 100-year floodplain elevations*** in the area where flooding occurred.

Based on previous studies of Briar Branch, conducted by Dodson & Associates, the bank full capacity of Briar Branch just downstream of Campbell Road is about 1,300 cubic feet per second (cfs), while the peak flow rate of Briar Branch at Campbell Road is about 1,700 cfs for the 100-year event. In other words, the channel does not have sufficient capacity to handle the 100-year runoff. The actual capacity of the channel is only about three quarters of that needed for the 100-year runoff. The FEMA flood plain maps show that the section of Briar Branch upstream of Fries Road has a 100-year flood plain that extends beyond the banks of the channel. Upstream of Tamy Lane, in the Mickey Way area, there is an extensive 100-year overbank floodplain. However, it should be noted that the FEMA flood plain mapping is based on a 100-year flood flow of only 1,088 cfs. This discrepancy would help to explain the higher than expected stream flow levels. This issue is discussed in more detail later in this report.

Based on the data available, the runoff from the storm of April 27-28 substantially exceeded the relative rainfall amounts, in terms of probability of recurrence; i.e. a 25-year rainfall produced a 100-year runoff. This phenomenon is possible because the runoff resulting from a given amount of rainfall is highly dependant on the conditions in the watershed, particularly in terms of antecedent moisture – i.e., if recent rainfall has saturated the ground and filled the depressions, more runoff will occur than if conditions have been dry. In the case of this storm, the area had experienced three substantial rainfall events within the 10 days prior to the April 27-28 storm, resulting in fully saturated ground conditions, with little or no available storage or infiltration to mitigate the runoff. Total rainfall received for the month of April was more than double the average for the month.

The initial rainfall event on the afternoon of the 27th completely saturated the ground, so that the extremely heavy rainfall rates on the 28th resulted in significantly higher runoff than would have been experienced if the same rainfall had occurred with "normal" antecedent moisture conditions. Hence, a 25-year rainfall resulted in a 100-year runoff.

The portion of the Briar Branch watershed located upstream of Campbell Road encompasses 1,763 acres, while the portion downstream of Campbell within Spring Valley is only 485 acres; therefore, more than 75 % of the watershed is upstream of Campbell Road. The upstream area of the watershed received an average of 8.75 inches of rainfall, which represents 1,285 acre feet of water (1 acre by 1 foot deep = 1 acre foot); the area downstream of Campbell Road to I-10

received an average of about 8.25 inches of rainfall, which equals 333 acre-feet of water. Because of the amount of runoff produced outside of Spring Valley Village, the capacity of Briar Branch was already greatly taxed by runoff originating further upstream before the main rainfall event started in Spring Valley Village on April 28th.

Based on the Dodson report, the channel capacity downstream of Campbell Road is approximately 1,300 cfs. From the FEMA Flood Plain Mapping reports developed after Tropical Storm Allison, the channel cross sectional area just downstream of the Tamy Lane bridge is about 210 square feet. These figures equate to an average velocity in the stream of about 6.2 feet per second.

Flooding Locations

Appendix 1 lists the reported flooding locations within Spring Valley Village. Exhibit 1 shows these locations graphically. A total of 27 locations had reported structural flooding, including 17 with house flooding, and 10 with garage flooding only. Properties have been color-coded on Exhibit 1 to show house flooding versus garage flooding. This exhibit also includes an overlay of the 100-year and 500-year flood plains within the City. All of the flooding locations are within the Briar Branch drainage basin, and most are in close proximity to the creek. As can be seen, the majority of the homes that flooded were located within the defined flood plain areas of the city.

In other locations, outside the defined flood plain areas, reports indicate that there were specific circumstances that caused the flooding. In the case of the two homes on Lupton, reports indicate that water came across the back lot line of these homes, from the Windsor Court development. Windsor Court had substantial ponding within the streets of the development. This development has an internal detention system that utilizes the street system for storage, with a restricted outfall that ties into the Campbell Road storm sewer system. It appears that high tail water conditions in the Campbell Road system prohibited proper drainage of the Windsor Court system, resulting in excessive ponding levels that overflowed the drainage divide between Windsor Court and Lupton.

The flooding location on Inverness Park Way apparently was related to a blocked inlet, according to the homeowner's report. One of the locations on Burkhart reported that water flowing down the roadside ditch was diverted by the raised curb/headwall on the driveway and ran down the driveway into the garage.

One flooded home was located in the Penn Manor area, adjacent to the sound wall that parallels I-10, and other locations adjacent to the sound wall experienced high water conditions

due to grate inlets that became blocked with debris. These inlet structures are designed to convey water from areas north of the sound wall into the TxDOT drainage system along I-10.

Reports have not been received for all of the flooding locations, but additional information will be gathered to help determine the cause of flooding at each location. The City has conducted interviews with most of the owners of the flooded properties, to gather their reports of the events that took place.

Exhibit 9 shows the profiles of 100-year water surface elevations on Briar Branch from the FEMA and Dodson models, along with the slab heights for flooded properties adjacent to the stream.

Exhibits 10 and 11 show the survey data collected following the storm, including elevations of the flooded houses and garages, high water marks, and key points in the drainage system.

Observations

Key observations of the events of April 27-28, 2009 that help explain what happened are as follows:

1. Major flooding occurred throughout western Harris County, particularly within the Buffalo Bayou watershed. More than 2300 homes were flooded across the area.
2. Flooding in Spring Valley Village was reported at 27 structures, including 17 homes and 10 garages.
3. Rainfall amounts received during the storm were in the 20-25 year range.
4. Runoff resulting from the event was measured in the 65-70 year range on Spring Branch Creek, and projected to be in the 100-year range on Briar Branch.
5. Rainfall received on the 27th was greater than the 2-year design storm amount, and no flooding was reported to have occurred on that day.
6. All of the reported flooding occurred on the 28th, after the second rainfall event.
7. The majority of the flooding in Spring Valley occurred in close proximity to Briar Branch.
8. Briar Branch reached or exceeded bank full levels through the reach from Adkins to Fries.
9. Briar Branch overtopped Campbell Road and exceeded the low chord elevations of the Tamy and Fries Road bridges.
10. Water from the Campbell Road and Westview Drive storm sewer systems was observed to reverse flow direction, discharging water from inlets and other structures.
11. Reports have been received indicating that sheet flow from the area north of Westview and west of Campbell was observed flowing into Westview.
12. Westview Drive ponded water in the area of Buetel and the FBISD Tax Office.
13. Water from Westview Drive was reported to have overtopped the high point on Mickey Way, and flowed south along Mickey Way Drive.
14. Along Westview water was observed to be flowing out of, rather than into the inlets.

15. On Larston, at the cul de sac, water was observed flowing out of, rather than into the culverts at the outfall to Campbell Road.
16. On Elizabeth, water was observed flowing out of the storm sewer connections to Campbell, rather than into them.
17. Water from Windsor Court overtopped the rear lot elevations along the south side of the development.
18. Randy Drive and a large portion of Tamy Lane were completely inundated, from right of way line to right of way line.
19. Individual homeowner's improvements adjacent to and within the Briar Branch right of way may have aggravated the situation in some instances, due to impeding sheet flow from reaching the main channel or by encroaching on the channel.
20. Reports were received indicating that a reversal of normal flow direction occurred on Adkins Road, with water that should have entered the I-10 system running north to Briar Branch instead.
21. Virtually all of the houses that reported garage or house flooding were older homes built in the 1950's or 60's, with slab heights only minimally above the surrounding grade, and built prior to any determination of flood plain elevations.
22. Many of the homes that were flooded are located in designated floodplain areas, and many have experienced repetitive flooding.

Conclusions and Recommendations

Analysis of the data available indicates that the April 27-28 storm was a major event, which produced widespread flooding throughout the area. The rainfall received in this storm substantially exceeded the design criteria used for infrastructure improvement projects by the City. The flooding that occurred within Spring Valley Village was not a result of the ongoing construction projects in recent years. By all reports, the drainage systems within the project areas performed properly in the initial event on April 27th. However, in the subsequent rainfall on the 28th, Briar Branch reached or exceeded its bank full capacity because of contributing run-off from outside Spring Valley Village, and left no where for the local rainfall runoff to go. In addition, it has been documented that the high tail water conditions at Campbell Road caused the local storm sewer system to reverse its normal flow direction, resulting in the discharge of excess water into the adjacent drainage systems.

The runoff that produced the flooding within Spring Valley Village originated primarily in the upper portion of the watershed, above Campbell Road. The majority of the drainage area upstream of Campbell Road lies outside of the city limits of Spring Valley, and is not under the city's jurisdiction. Sheet flow from areas to the north and west of the Campbell/Westview intersection also entered the drainage system from outside the city limits.

Approximately 1,278 acres (72%) of the Briar Branch watershed lies outside of Spring Valley's city limits. Jurisdiction over this portion of the watershed is with the City of Houston and Harris County Flood Control District. Channel improvements were made on Briar Branch in the period between 1975 and 1980, bringing the channel to its current configuration in the reach between Bunker Hill Road and Voss Road. In 1975, at the time of the channel improvements, the watershed is estimated to have been approximately 85 % developed. Limitations on runoff from new development were not imposed by these jurisdictions until the early 1980's. By this time, the Briar Branch watershed was more than 90 % developed, with significant increases in the percentage of impervious cover.

Based on previous studies done by outside consultants, the capacity of Briar Branch within Spring Valley Village is significantly less than the 100-year runoff from this watershed. Dodson & Associates reported in their August 2001 study that the peak flow rate for Briar Branch upstream of Campbell Road for the 100-year event is approximately 1,700 cfs, but that the bank full channel capacity of Briar Branch downstream of Campbell Road is only about 1,300 cfs. Earlier, Espey, Huston & Associates concluded in their December, 1992 report that the 100-year event exceeds the channel capacity by approximately 900 cfs or 80%. Espey's work was done in the aftermath of the March, 1992 flood, which inundated 122 homes in Spring Valley. Significantly, Espey concluded that the 1992 flood was a 40- to 50-year event.

It is noteworthy that the stream flow for Briar Branch at Campbell Road as reported in the Harris County Flood Control District's official model used for the floodplain determination by FEMA is only 1,088 cfs – substantially less than that reported by Dodson and Espey.

The 1992 Espey study includes the recommendation for the 10' x 10' box culvert along Campbell Road that was intended to divert flows from Briar Branch and provide flood relief for the portion of Briar Branch downstream of that point. The upper portion of this diversion was constructed in conjunction with the Campbell Road reconstruction in 1996, but the lower portion of the diversion has never been completed. As a result, the benefits of the proposed diversion have not been achieved.

Examination of the flood profiles shown on Exhibit 9 suggest that the event of April 27-28 produced ***runoff in excess of FEMA's 100-year event***, and may have also exceeded the Dodson 100-year event. This exhibit also shows that the completion of the proposed Briar Branch By Pass project would have eliminated the flooding that occurred in the immediate vicinity of the stream.

Reports prepared by other consultants indicate that there is an overlap between the watersheds of W-151 and W-140-01 (Briar Branch), and that overflows from the W-151 system enter Briar Branch, in the vicinity of Witte Road. This situation would aggravate the conditions reported by Espey and Dodson regarding the lack of sufficient capacity in W-140-01.

Conclusions of this analysis are as follows:

1. The subject storm event produced rainfall in excess of the 25-year amounts for durations up to 12 hours at most gauges in the area. Higher rainfall amounts, in the 50- to 100-year range were experienced for shorter durations at some of the gauges.

2. Runoff from this event was in the range of a 65-70 year event on Spring Branch (the nearest stream flow gauge location) and exceeded the previous storm of record on Buffalo Bayou at Piney Point, making this the ***new storm of record*** for this segment of Buffalo Bayou. Water surfaces on Briar Branch ***exceeded the official 100-year flood elevations*** in the stream segment upstream of Fries Road.

3. Design rainfall/runoff amounts for storm sewer and roadside ditch systems in the area were significantly exceeded, resulting in extreme event flow conditions.

4. The high water conditions experienced on Briar Branch at Campbell caused changes in normal flow paths, resulting in inter-basin transfers of water between systems, and flow reversals in some cases. These conditions overloaded the capacity of the affected systems.

5. Survey data gathered after the storm event confirms that the observed water surface elevation on Briar Branch at Campbell Road was higher than the inlets and culverts connected to the Campbell Road storm sewer system at Elizabeth, Larston cul-de-sac, Westview at Buetel, and Westview at Mickey Way. This tail water condition would have created the reversal of flow reported at these locations. The discharge of water from the Campbell drainage system at these locations entered the adjacent drainage systems, contributing excessive quantities of water to the normal runoff from the Mickey Way watershed.

6. Sheet flow from areas outside the drainage basin during this event also contributed to overloading the Westview, Mickey Way, and Adkins drainage systems in particular.

7. High water levels in Briar Branch downstream of Campbell Road exceeded bank full levels in some locations. High tail water elevations along Briar Branch caused storm sewers and outfall ditches to back up.

8. The channel capacity in Briar Branch was inadequate to handle the volume of runoff resulting from this storm event due to the amount of run-off generated in areas outside of Spring Valley Village. This lack of capacity in Briar Branch and the resulting high water levels is the primary cause of the flooding that occurred.

9. Inter-basin transfers and flow reversals contributed to the flooding that occurred.

10. Secondary factors in the flooding include drainage structures that were clogged by debris and channel obstructions due to debris, utility crossing structures, and channel encroachments.

Recommendations

The following recommendations are based on the observations and conclusions reached in this analysis. The Short Term and Mid Term Actions will help to alleviate some of the drainage issues during storm events; however their significance will lessen significantly as the intensity of future storms increases.

A. Short Term Action

    a. Remove fallen trees and other debris from the Briar Branch channel.

        i. The City has completed this work since the April storm event.

    b. Clean out storm sewer inlets, outfall pipes, and culverts that are blocked by debris.

        i. The City has undertaken this work since the April storm event.

    c. Repair erosion damage to slope protection at the Voss Road bridge over Briar Branch.

        i. The City has authorized work to begin on this project. Currently the project is in the engineering design phase.

    d. Identify any channel crossing structures that impede flow along Briar Branch, determine ownership, and evaluate possible alternatives for removal or relocation.

        i. The City has undertaken this task since the April storm event.

    e. Review reports of previous regional studies of drainage in and around the Spring Valley/Memorial Villages area;

        i. Identify previously recommended alternatives for regional drainage improvements that have not yet been implemented.

            1. The City has completed this task since the April storm event.

        ii. Review reports on W-151 and investigate reported overflows from W-151 to W-140-01.

1. The City has completed this task since the April storm event. Further, TIRZ 17 is studying the interaction between these two streams and the City is monitoring that study.

iii. Summarize previously identified alternatives and identify current status of approval/implementation, stakeholders, impediments to implementation, and required activities to further their implementation.

1. The City has begun this task since the April storm event, and continues to work on it.

B. Mid-Term Action

a. Work out agreements with pipeline and utility companies with channel crossing structures identified above for removal or relocation, and proceed with corrective actions.

i. The City has begun this task since the April storm event.

ii. Centerpoint/Entex is working on the design of a relocation of their pipeline crossing of Briar Branch.

b. Evaluate remedial actions that can be taken to address various drainage structures and other features of the drainage system that were observed to not perform adequately.

i. Adkins Road

1. The City is currently designing the inlet structure modifications needed at I-10.

2. The City has begun design work on a ditch improvement and culvert replacement project. Discussions are underway with Harris County Precinct 3 concerning possible assistance in this effort.

ii. Inlet structures at Traweek and Lariat at I-10 soundwall

1. The City has authorized work to begin on this project as of the date of this report. Currently the project is in the engineering design phase.

c. Evaluate potential for installing backflow prevention features on outfall structures along Briar Branch, including Campbell Road, to help prevent the flow reversals.

i. The City is currently studying possible installations of backflow prevention features.

d. Evaluate impact of possible bridge improvements

    i. Tamy Lane bridge removal/raising

e. Identify channel encroachments, channel erosion, right of way issues and other factors impacting Briar Branch capacity. Evaluate potential benefits of correcting these items.

f. Assess previously identified alternatives from earlier studies for benefits to be achieved, potential for successful implementation, cost, and feasibility. Identify specific alternatives for further study and pursuit. Identify key partners and resources need for successful implementation.

    i. Evaluate W-151 studies to assess the overlap in the drainage areas, and the reported overflows into the W-140-01 system.

    ii. Develop approach to verifying W-151 impacts on W-140-01; identify possible intergovernmental efforts to address W-151 impacts.

    iii. Develop a strategic approach to implementing the completion of the Briar Branch by-pass project. Identify opportunities for coordination of efforts involving W-151 improvements upstream, and W-140-01 improvements downstream. Identify key partners required to implement these improvements.

g. Engage HCFCD in a review of the official floodplain models to evaluate the drainage areas and stream flows along Briar Branch, and re-assess the floodplain limits and base flood levels as appropriate. Prepare floodplain map revisions if warranted.

h. Identify additional work required to advance selected alternatives identified above.

i. Develop strategic plan for implementing selected alternative identified above.

j. Work with other entities to develop an overall drainage improvement program for the Memorial Villages and surrounding areas.

k. Review administrative policies regarding repairs and re-construction of flooded properties.

C. <u>Long Term Action</u>

a. <u>W151</u>

i. Implement a joint study of the upper end of W-140-01 and W-151 to evaluate the overlap in these watersheds and the resulting flow contribution to each channel. Harris County Flood Control District, the City of Houston, and TIRZ 17 are potential participants with Spring Valley Village.

ii. Develop alternatives for eliminating the inter-basin transfers between the W-140-01 and W-151 watersheds. Determine the impacts of these alternatives on Briar Branch through modeling efforts.

iii. Evaluate the impacts identified above, and determine the preferred alternative(s) to pursue. Determine the requirements for channel improvements, right of way acquisition, inter-local agreements and regulatory approvals, costs, and obstacles to implementation of the preferred alternative(s).

b. <u>Briar Branch (W140-01)</u>

i. Re-evaluate alternatives for completion of Briar Branch By-Pass

1. Diversion back to Briar Branch at Bingle

2. Identify other possible diversion alternatives.

ii. Re-evaluate channel improvement alternatives along Briar Branch

iii. Identify opportunities for channel improvements to provide incremental capacity increases that are achievable and affordable.

c. Consider regulatory measures to reduce potential for future structural flooding, including measures to address existing and future residential construction.

d. Coordinate efforts identified above with FEMA, Harris County Flood Control, the City of Houston, and the other Memorial Villages.

City of Spring Valley Village, Texas

Flooded Properties
April 27 - 28, 2009 Storm

CITY OF SPRING VALLEY VILLAGE
TEXAS

SPRING BRANCH EDUCATION CENTER
SPRING BRANCH TAX OFFICE
City Park
City Hall
Police
Sound Wall
Sound Wall
Sound Wall
KATY FREEWAY
INTERSTATE TEXAS 10
SPRING BRANCH CREEK

Legend

- Reported Garage Flooded
- Reported Homes Flooded

FEMA Flood Plain

Zones

- 500 Yr.
- 100 Yr.
- Floodway

0 270 540 1,080 1,620 2,160 Feet

1 inch = 500 feet

Printed January, 2007

N W E S

Exhibit 1

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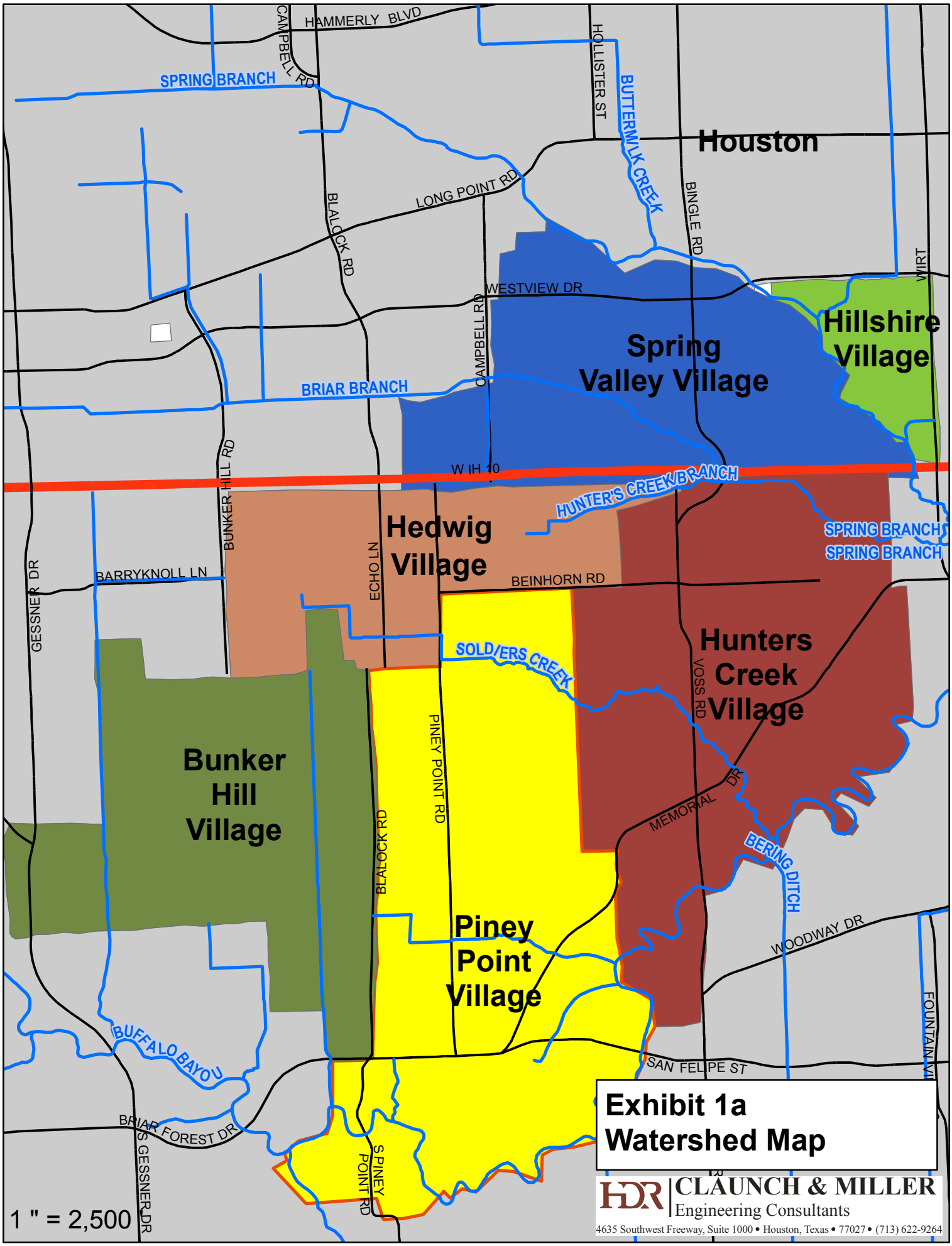
HAMMERLY BLVD
CAMPBELL RD
SPRING BRANCH
HOLLISTER ST
BUTTERMILK CREEK
Houston
LONG POINT RD
BLALOCK RD
BINGLE RD
WIRT
WESTVIEW DR
CAMPBELL RD
Hillshire Village
Spring Valley Village
BRIAR BRANCH
BUNKER HILL RD
W IH 10
HUNTER'S CREEK BRANCH
SPRING BRANCH
SPRING BRANCH
Hedwig Village
ECHO LN
BEINHORN RD
GESSNER DR
BARRYKNOLL LN
SOLDIERS CREEK
Hunters Creek Village
VOSS RD
PINEY POINT RD
Bunker Hill Village
MEMORIAL DR
BERING DITCH
BLALOCK RD
Piney Point Village
WOODWAY DR
FOUNTAIN VI
BUFFALO BAYOU
SAN FELIPE ST
BRIAR FOREST DR
S GESSNER DR
S PINEY POINT RD
Exhibit 1a
Watershed Map
1 " = 2,500
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Engineering Consultants
4635 Southwest Freeway, Suite 1000 • Houston, Texas • 77027 • (713) 622-9264

City of Spring Valley Village, Texas
Buffalo Bayou Watershed
Spring Branch & Briar Branch Sub Basins

1 inch = 4,000 feet

Legend

- Total Rainfall - April 27 - 28, 2009

Rain Gauges

Owner

- Harris County Flood Control
- Private
- Spring Valley Village City Limits
- Buffalo Bayou Watershed Channels
- Briar Branch Sub-Watershed
- Spring Branch Sub-Watershed
- Buffalo Bayou WaterShed
- Buffalo Bayou WaterShed

49
1081.03 Ac.
BUTTERMILK CREEK
1457.1 Ac.
SPRING BRANCH
1763.12 Ac.
2250
1394.87 Ac.
SPRING BRANCH
BRIAR BRANCH
1256.15 Ac.
HUNTER'S CREEK/BRANCH
BRIAR BRANCH
575
535
580
2110
9
2010
2290
2270
2260
7.5
8
8.5
9
9.5
6
6.5
5
5.5
4.5
4
TANNER RD
CLAY RD
BRITTMOORE RD
BLALOCK RD
SPINEMONT DR
HOLLISTER ST
PINEMONT DR
US 290US 290
W 43RD ST
HEMPSTEAD RD
MANGUM RD
W TIDWELL RD
KEMPWOOD DR
CAMPBELL RD
HAMMERLY BLVD
BINGLE RD
ANTOINE DR
W 34TH ST
DACOMA RD
NIEMANN BRANCH
LONG POINT RD
WIRT RD
WESTVIEW DR
BUNKER HILL RD
BEINHORN RD
MEMORIAL DR
PARK ROW DR
TURKEY CREEK
OLD KATY RD
W IH 10
BARKER DITCH
GRISBY RD
SSH6S S SH 6
LANGHAM CREEK
BUFFALO BAYOU
DAIRY ASHFORD RD
N KIRKWOOD RD
N WILCREST DR
RUMMEL CREEK
BARRYKNOLLLN
SOLDIERS CREEK
VOSS RD
PINEY POINT RD
BLALOCK RD
CHIMNEY ROCK RD
WOODWAY DR
SAN FELIPE ST
S POST OAK LN
SAGE RD
ENCLAVE PKWY
S ELDRIDGE PKWY
S DAIRY ASHFORD RD
S KIRKWOOD RD
WILCREST DR
BRIAR FOREST DR
S GESSNER DR
SPINEY POINT RD
CLODINE DITCH
WESTHEIMER RD

Exhibit 2

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City of Spring Valley Village, Texas
Buffalo Bayou Watershed
Spring Branch & Briar Branch Sub Basins

1 inch = 4,000 feet

Legend

- Total Rainfall - Hurricane Ike

Rain Gauges

Owner

- Harris County Flood Control
- Private
- Buffalo Bayou WaterShed
- Spring Valley Village City Limits
- Buffalo Bayou Watershed Channels
- Spring_Branch_WS
- BriarBranchWS
- Buffalo Bayou WaterShed

575
535
580
49
2110
9
2010
2290
2270
2250
2260
BUTTERMILK CREEK
SPRING BRANCH
NIEMANN BRANCH
BRIAR BRANCH
HUNTER'S CREEK BRANCH
RUMMEL CREEK
TURKEY CREEK
BARKER DITCH
LANGHAM CREEK
SOLDIER'S CREEK
BUFFALO BAYOU
CROQUET DITCH
16
15
14
13
12
11
10
8
6

Exhibit 2a

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City of Spring Valley Village, Texas
Buffalo Bayou Watershed
Spring Branch & Briar Branch Sub Basins

1 inch = 4,000 feet

Legend

- Total Rainfall - TS Allison

Rain Gauges

Owner

- Harris County Flood Control
- Private
- Buffalo Bayou WaterShed
- Spring Valley Village City Limits
- Buffalo Bayou Watershed Channels
- Spring_Branch_WS
- BriarBranchWS
- Buffalo Bayou WaterShed

575
535
580
49
2250
2110
9
2010
2290
2270
2260

BUTTERMILK CREEK
SPRING BRANCH
NIEMANN BRANCH
BRIAR BRANCH
HUNTER'S CREEK BRANCH
URKEY CREEK
RUMME CREEK
BARKER DITCH
LANGHAM CREEK
BUFFALO BAYOU
SOLDIERS CREEK
CLODINE DITCH

Exhibit 2b

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City of Spring Valley Village, Texas
Harris County Flood Control District
Rain Gauge Location Map

LANGHAM CREEK
WHITE OAK BAYOU
HORSEPEN CREEK/GULLY
HALLS BAYOU
VOGEL CREEK
ROLLING FORK
BEAR CREEK
DINNER CREEK LANGHAM CREEK
SOUTH MAYDE CREEK
COLE CREEK
TURKEY CREEK
LANGHAM CREEK
BRICKHOUSE GULLY
BUTTERMILK CREEK
SPRING BRANCH
NIEMANN BRANCH
LITTLE THICKET
MASON CREEK
BARKER DITCH
BRIAR BRANCH
RUMMEL CREEK
SOLDIERS CREEK
BUFFALO BAYOU
UPPER BUFFALO BAYOU/CANE
CLODINE DITCH
BRAYS BAYOU

2180 2120 2160 2150 2110 2040 2020 2010 2290 2270 2260 2250 550 545 590 575 535 580 530 49 9 485

SH 249
US 290
W IH 10
W BW 8 N
W BW 8 S
N IH 610 W
S IH 610 W
S US 59

Legend

Rain Gauges

Owner

- Harris County Flood Control
- Private
- Spring Valley Village City Limits
- Total Rainfall April 27 - 28, 2009

1 inch = 8,000 feet

Exhibit 3

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City of Spring Valley Village, Texas
Harris County Flood Control District
Rain Gauge Location Map

LANGHAM CREEK
HORSEPEN CREEK/GULLY
WHITE OAK BAYOU
HALLS BAYOU
VOGEL CREEK
ROLLING FORK
BEAR CREEK
DINNER CREEK LANGHAM CREEK
SOUTH MAYDE CREEK
COLE CREEK
BRICKHOUSE GULLY
TURKEY CREEK
LANGHAM CREEK
BUTTERMILK CREEK
SPRING BRANCH
NIEMANN BRANCH
BRIAR BRANCH
RUMMEL CREEK
SOLDIERS CREEK
BARKER DITCH
BUFFALO BAYOU
CLODINE DITCH
BRAYS BAYOU
LITTLE THICKET BAYOU

US 290
SH 249
W IH 10
W IH 610 N
W IH 610 S
S US 59
WBW 8 N
WBW 8 S

2180
2120
2160
2150
2110
2020
2010
2290
2270
2260
2250
550
545
590
575
535
580
530
49
9
485

Legend

Rain Gauges

Owner

- Harris County Flood Control
- Private
- Spring Valley Village City Limits
- Total Rainfall Hurricane Ike

Hurricane Ike

Total Rainfall (in)

- 18 - 20
- 16 - 18
- 14 - 16
- 12 - 14
- 10 - 12
- 8 - 10
- 6 - 8
- 5.3 - 6

1 inch = 8,000 feet

Exhibit 3a

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City of Spring Valley Village, Texas
Harris County Flood Control District
Rain Gauge Location Map

Legend

Rain Gauges

Owner

- Harris County Flood Control
- Private
- Spring Valley Village City Limits
- Total Rainfall TS Allison

TS Allison

Total Rainfall (in)

- 30 - 32
- 28 - 30
- 26 - 28
- 24 - 26
- 22 - 24
- 20 - 22
- 18 - 20
- 16 - 18
- 14 - 16
- 12 - 14
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 1.3 - 2

1 inch = 8,000 feet

WHITE OAK BAYOU
LANGHAM CREEK
HORSEPEN CREEK/GULLY
DINNER CREEK LANGHAM CREEK
ROLLING FORK
HALLS BAYOU
VOGEL CREEK
SH 249
US 290
550
545
2120
COLE CREEK
590
575
535
580
2160
TURKEY CREEK
W BW 8 N
49
BRICKHOUSE GULLY
BUTTERMILK CREEK
SPRING BRANCH
LITTLE THICKET BAYOU
530
2150
2110
9
BRIAR BRANCH
2250
NIEMANN BRANCH
W IH 10
BARKER DITCH
RUMMEL CREEK
SOLDIERS CREEK
BUFFALO BAYOU
2020
2010
2290
2270
2260
W BW 8 S
CLODINE DITCH
BRAYS BAYOU
485
WESTPARK TOLL
S US 59

Exhibit 3b

HDR | CLAUNCH & MILLER
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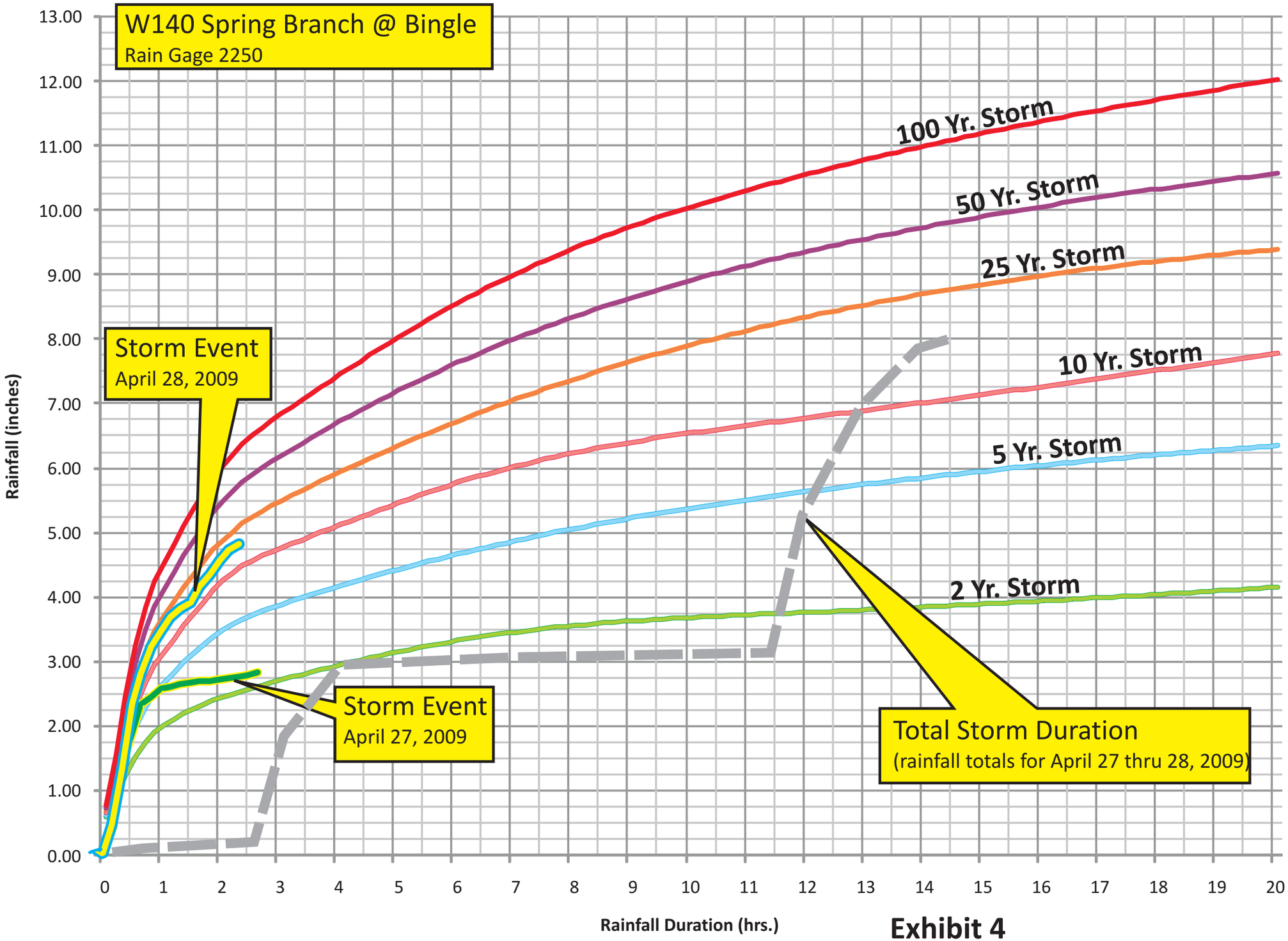

Exhibit 4

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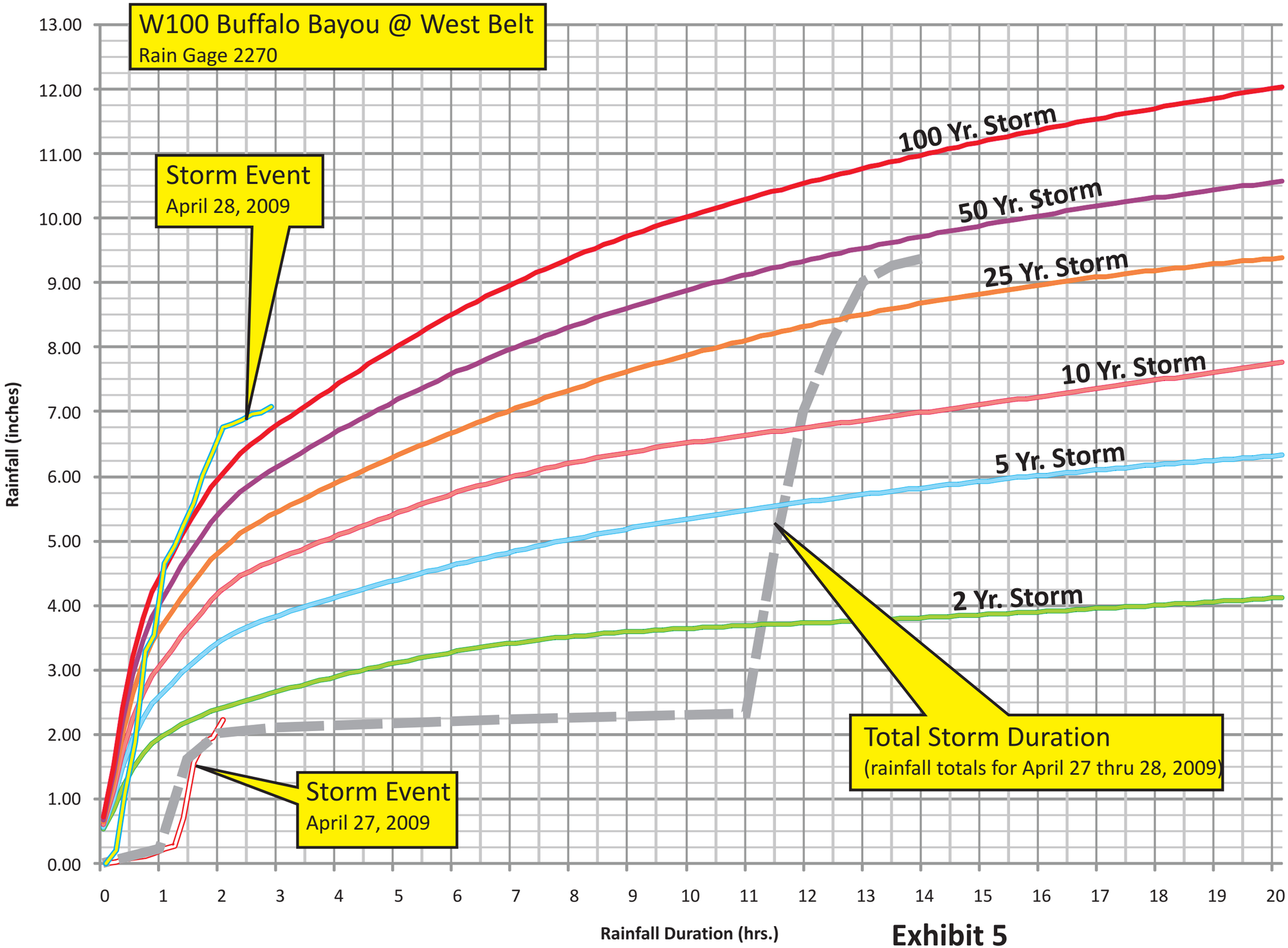

Exhibit 5

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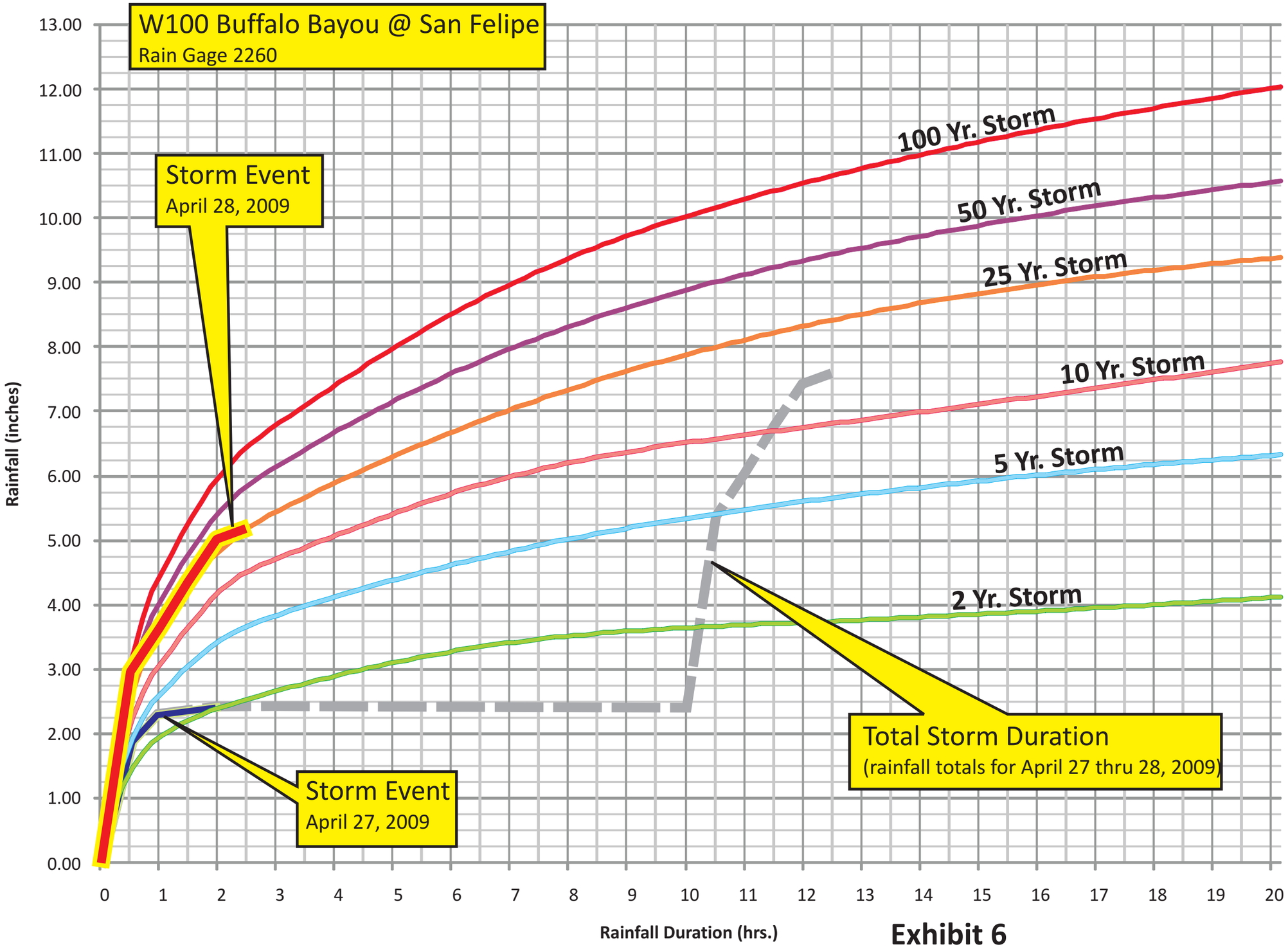

Exhibit 6

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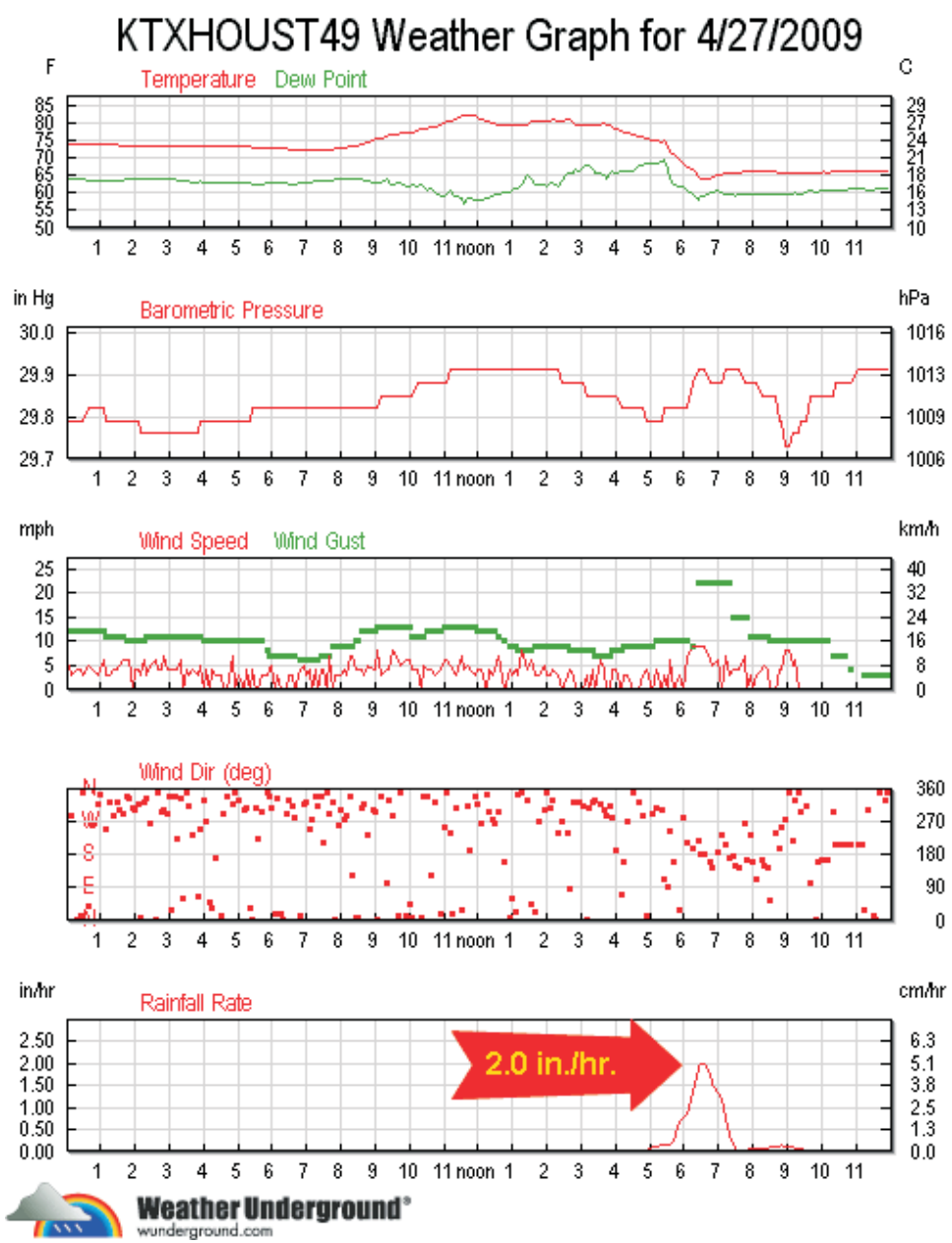

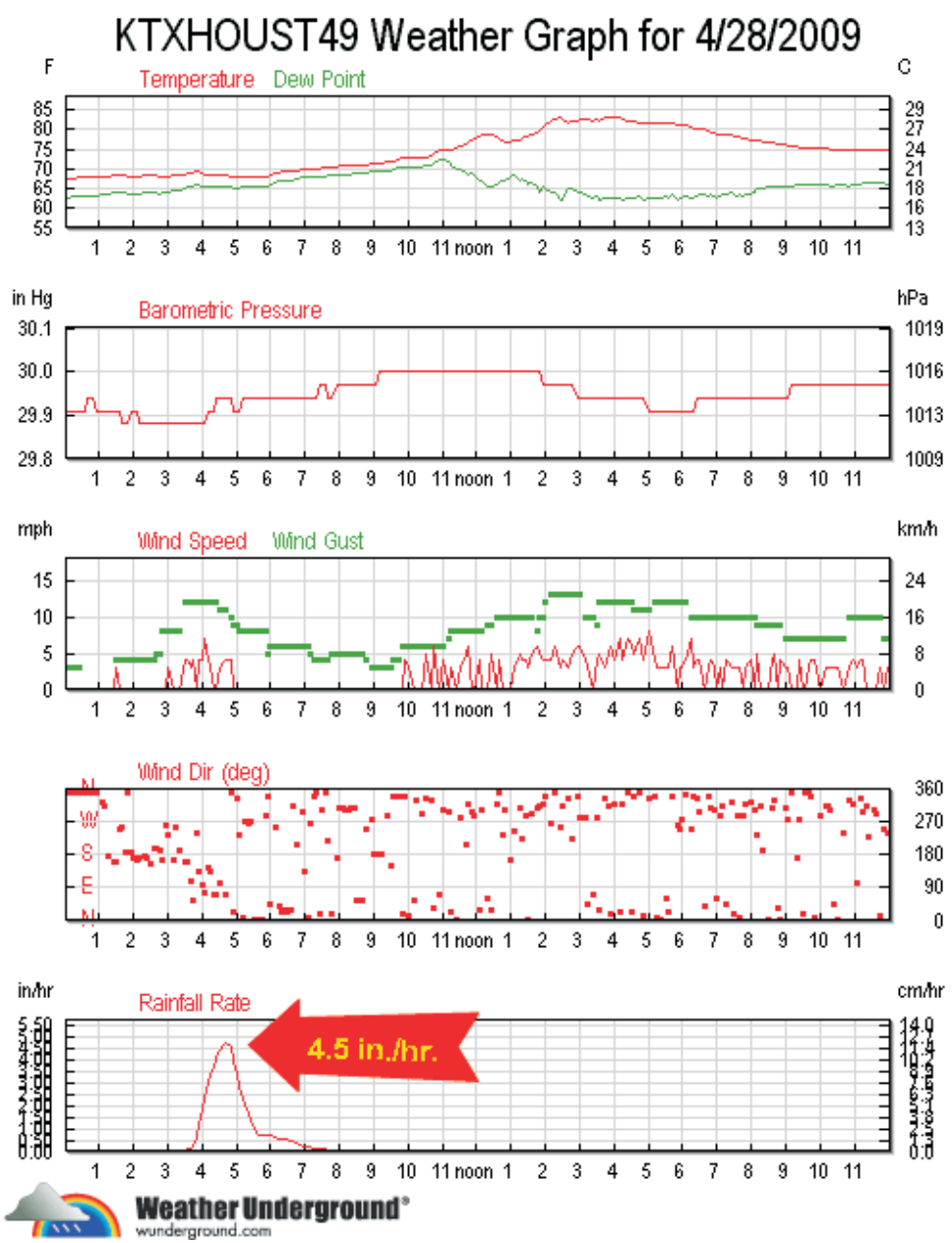

Exhibit 7

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Engineering Consultants
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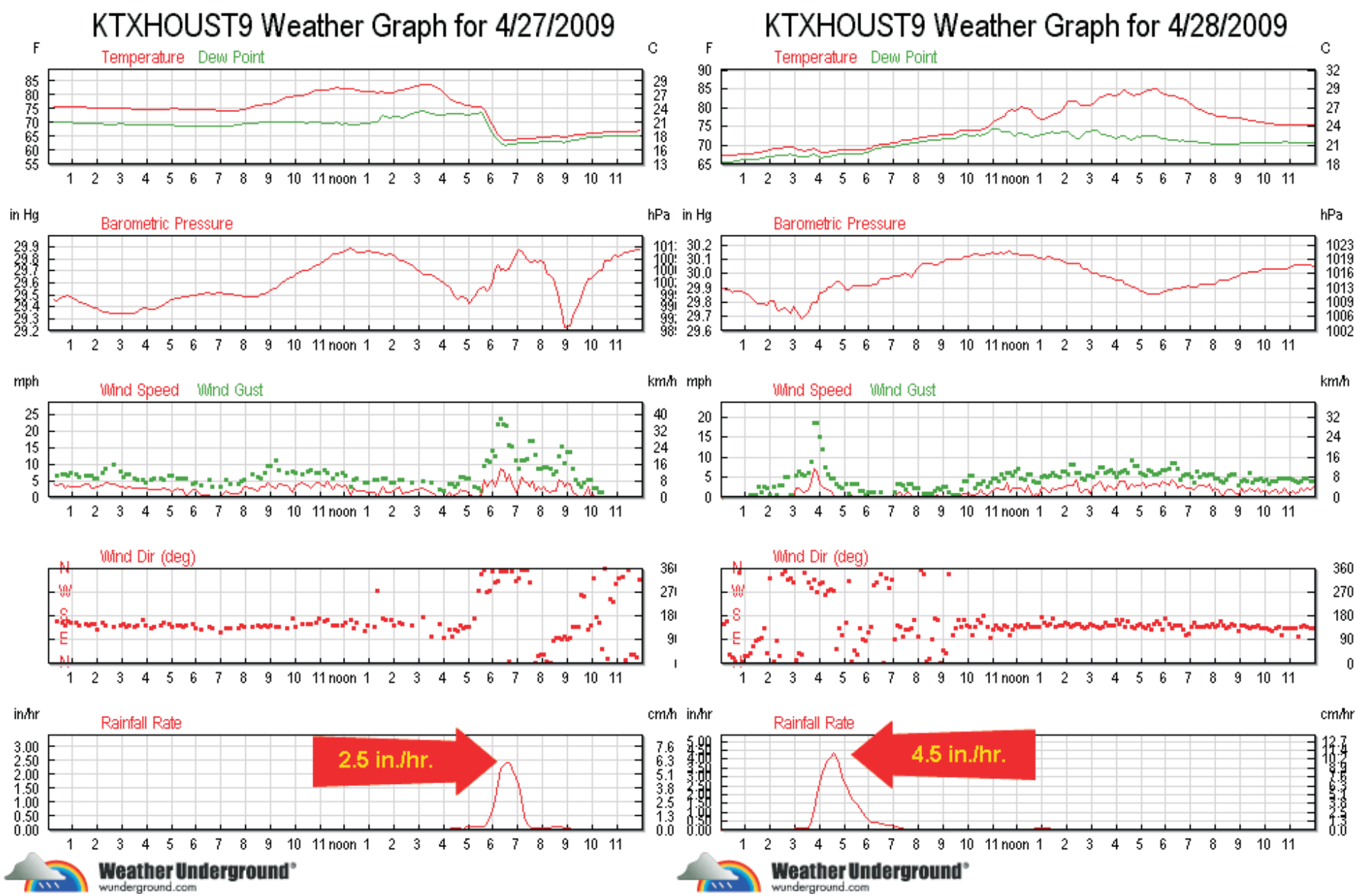

Exhibit 8

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Briar Branch
W140-01-00

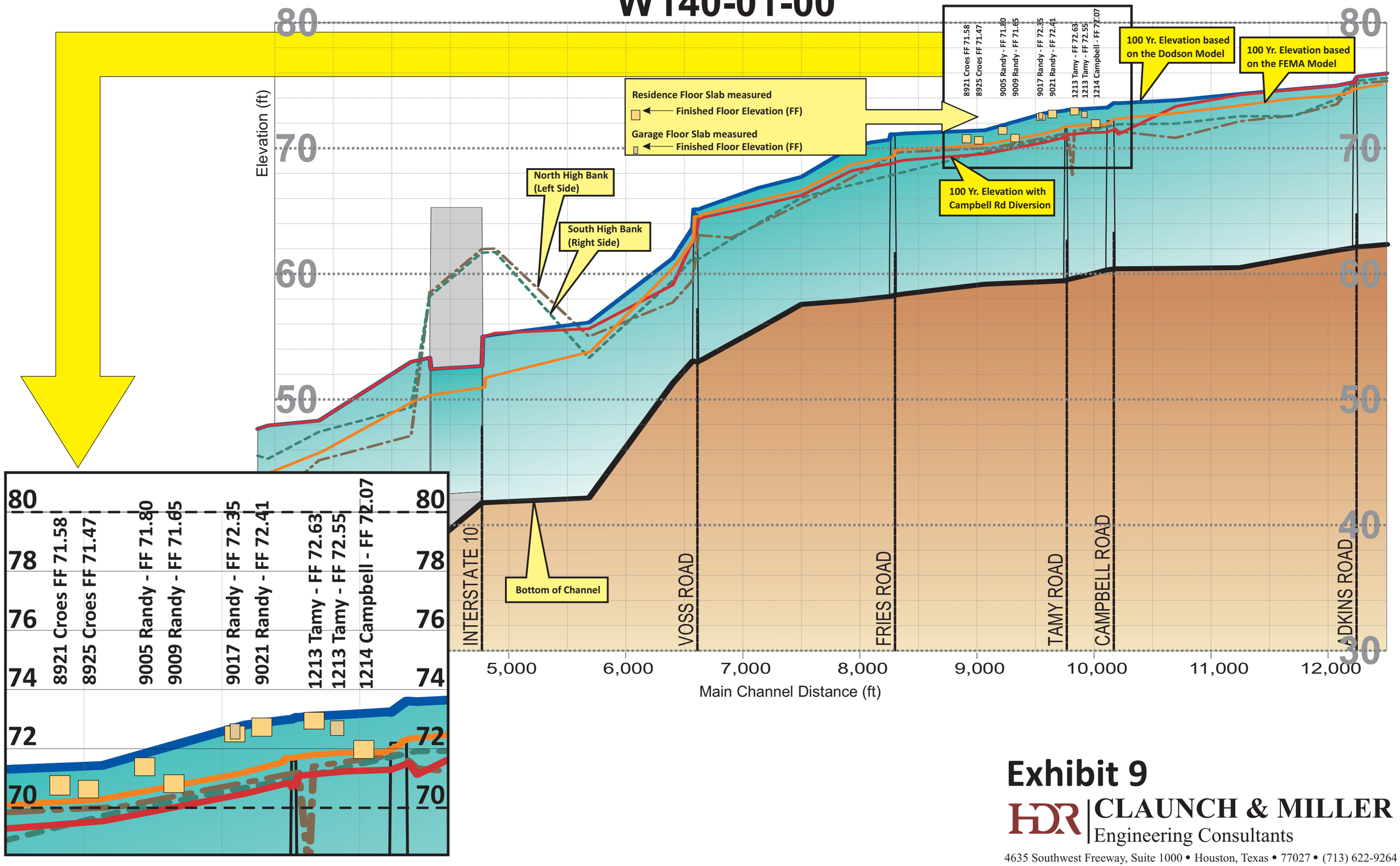

Exhibit 9

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Aerial Photo - 1956

Exhibit 10

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Aerial Photo - 1965

Exhibit 11

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Aerial Photo - 1976

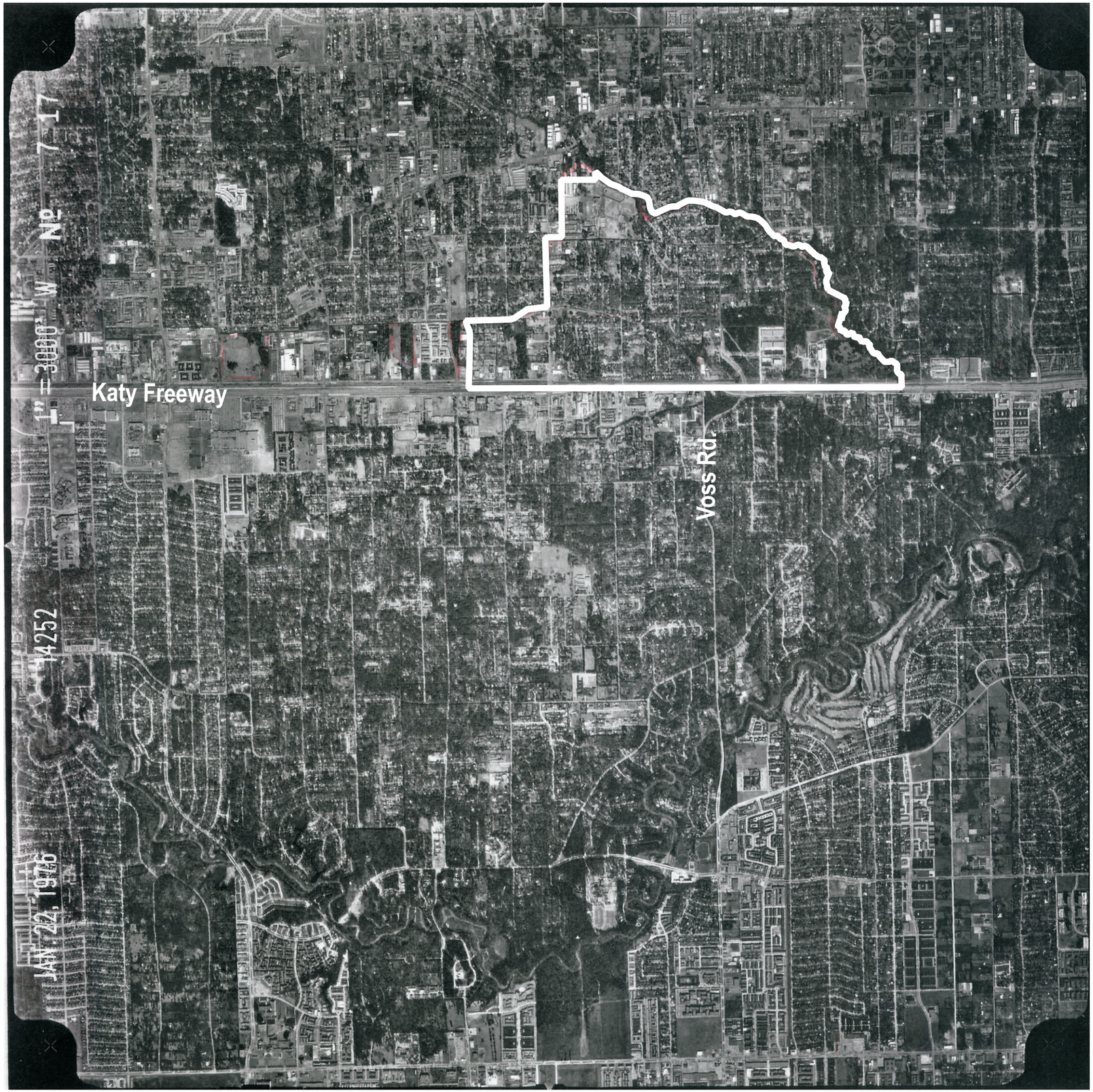

Exhibit 12

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Aerial Photo - 1985

Exhibit 13

HDR | CLAUNCH & MILLER
Engineering Consultants
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The City of Spring Valley, Texas

Exhibit 14

Flood Study Map

1 inch = 100 feet

HDR | CLAUNCH & MILLER Engineering Consultants

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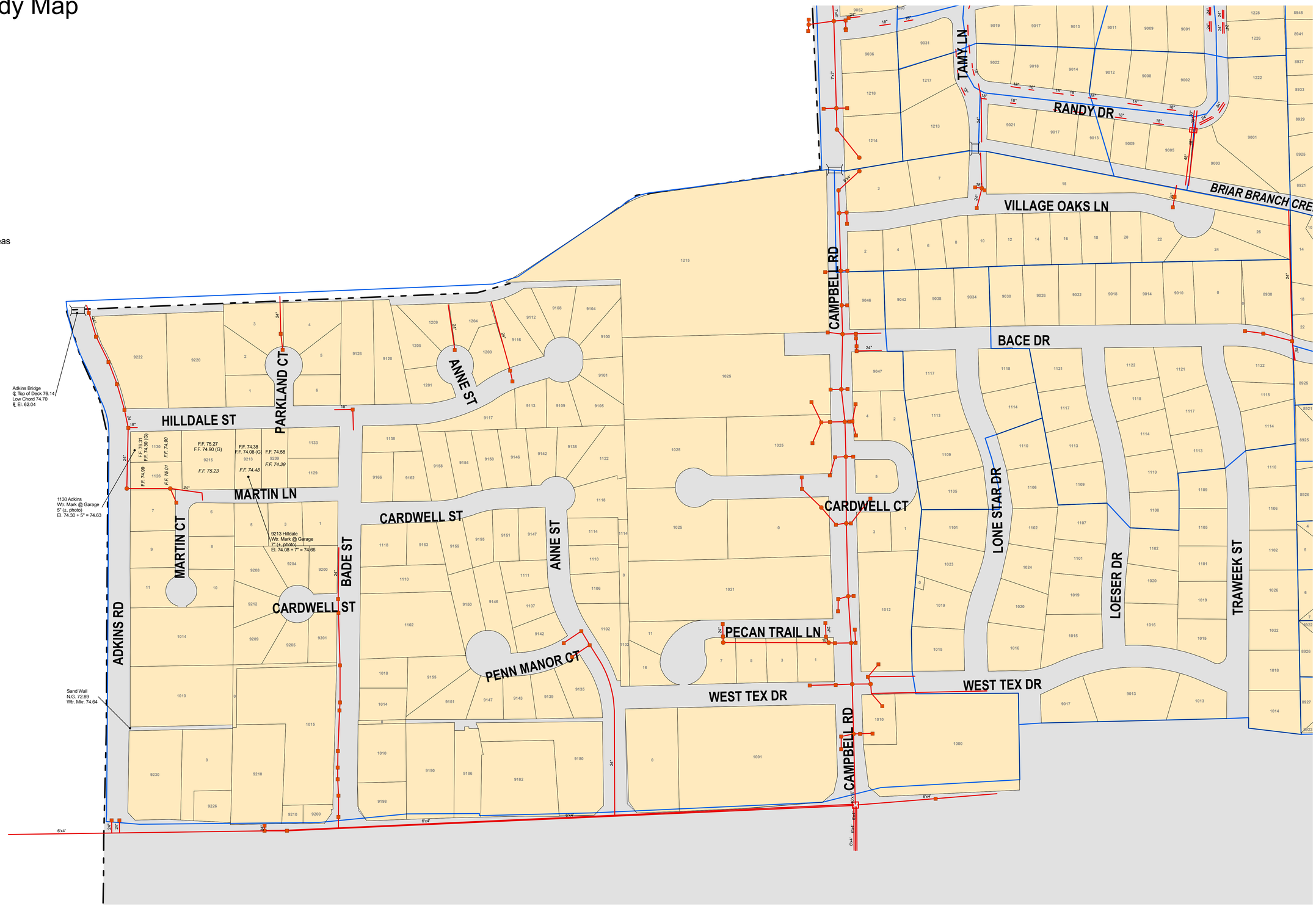
The City of Spring Valley, Texas

Exhibit 15
Flood Study Map

Legend

- Inlets
- Stm Manholes
- Bridge
- Storm Sewer
- Parcels
- Spring Valley Drainage Areas
- ROW All
- City Limits / ROW
- (G) Garage
- F.F. Finish Floor Elev.
- N.G. Natural Ground Elev.
- Wtr. Water
- Mkr Mark
- MH Manhole
- ℄ Flow Line
- ℄ Center Line



1 inch = 100 feet

HDR | CLAUNCH & MILLER
Engineering Consultants
4635 Southwest Freeway, Suite 1000 ● Houston, Texas 77027 ● 713-622-9264

City of Spring Valley Village
Flooding Locations - 4-27 & 28-09 Storm
HDR Job No. 09-001
4-May-09

Appendix 1

No.	Address	Type of Flooding Reported	2009 Comments	1992 Flood Comments		
1	1126 Adkins	House	Vacant			
2	1130 Adkins	Garage	3"	Y	HOUSE	1-3"
3	9014 Bace	Garage	1"	Y	GARAGE	1-3"
4	8817 Burkhart	Garage	Vacant			
5	8821 Burkhart	Garage	No Data	Y	REPEAT/GARAGE	4-8"
6	1214 Campbell	House	12"	Y	REPEAT/HOUSE	4-8"
7	1218 Campbell	House	5"	Y	REPEAT/HOUSE	1-3"
8	8810 Croes	House	1/2" (former garage)			
9	8921 Croes	House	6"			
10	8925 Croes	House	4"			
11	8929 Croes	House	6" (house raised)	Y	REPEAT/GARAGE	1-3"
12	9031 Elizabeth	Garage	4"			
13	9036 Elizabeth	Garage	4"	Y	HOUSE	4-8"
14	9209 Hildale	House	3"	Y	HOUSE	1-3"
15	9213 Hildale	House	8"	Y	HOUSE	1-3"
16	9215 HIldale	Garage	1/2"			
17	15 Inverness Park Way	House	2"			
18	9006 Lupton	House	1"	Y	GARAGE/REPEAT/4-8"	
19	9010 Lupton	House	6" house/1" garage			
20	9155 Penn Manor Ct.	House	2"	Y	REPEAT/HOUSE	4-8"
21	9005 Randy	House	3" (former garage)			
22	9009 Randy	House	8" house/11" garage	Y	REPEAT/HOUSE	4-8"
23	9017 Randy	Garage	4"			
24	9021 Randy	Garage	??? House/4" garage	Y	HOUSE	4-8"
25	9022 Randy	House	3" (former garage)	Y	GARAGE	1-3"
26	1213 Tamy	Garage	4"			
27	1217 Tamy	Garage	6"	Y	HOUSE	4-8"

MEMORANDUM

Harris County
Flood Control District
9900 Northwest Freeway
Houston, Texas 77092
713 684-4000

DATE: April 30, 2009

TO: Distribution

FROM: Jeff Lindner
Meteorologist / Flood Watch Coordinator

RE: Immediate Report – # 1
April 28, 2009 Storm and Flood Information

This is the first report summarizing the flooding that occurred from excessive rainfall over the western part of Harris County on April 27-28.

GENERAL FLOODING STATEMENT

A large thunderstorm complex that originated in northwest Texas moved into Harris County late in the afternoon on Monday, April 27th producing very heavy rainfall and significant street flooding. The complex pushed offshore before midnight and weakened while the old outflow boundary on the western end retreated northward from Matagorda and Brazoria Counties. As this boundary entered into western Harris County a cluster of thunderstorms developed between Tomball and Katy and remained nearly stationary. Hourly rainfall rates of 3.0-4.0 inches per hour on top of 4.0-5.0 inches of rainfall in the late afternoon of the 27th produced major flooding across the western half of Harris County. The cluster began to drift east-southeast across the upper portions of Brays, Buffalo, and White Oak Bayous around 5:30 a.m. and then weakened as it tracked into the central part of the county. Rainfall resulted in rapid rises along upper Brays, Buffalo, and upper White Oak Bayous and major flooding of creeks in the western and northern portions of the county. Extensive street flooding closed portions of I-10 W feeder roads, part of US 59 at the 610 Loop, mainlanes of I-45 at Spring Stuebner, and parts of the west Sam Houston Tollway.

The event was the third in a series of excessive rainfall events across Harris County which began on the April 18th. Grounds were wet going into the rainfall on the afternoon of the 27th and completely saturated prior to the onset of the excessive rains during the morning hours of the 28th. The saturated grounds and intense rainfall rates led to the rapid and in places near record flood levels. In fact the flows recorded by the USGS gage at Piney Point on Buffalo Bayou exceeded the flood of record in March of 1992. Tremendous inflow into Addicks Reservoir resulted in the flooding of HWY 6 and Eldridge Pkwy for the first time since October of 2002, and for several hours during the morning of Tuesday, April 28th water from overflowing Bear Creek was flowing across HWY 6.

RAINFALL

Duration –Heavy rains fell between 4:00 p.m. and 10:00 p.m. on the 27th with a brief break before the development and onset of excessive rainfall just after midnight on the 28th and continuing through 8:00 a.m. The most extreme rainfall fell between 1:00 a.m. and 4:00 a.m. over much of Addicks Reservoir.

Total Amounts – 24-hr storm totals averaged 6.0-8.0 inches from just west of The Woodlands to northeast of Katy with totals of 9.0-11.5 inches across the upper portions of Bear Creek within Addicks Reservoir. Along and west of US 59 from Kingwood to Sugar Land rainfall totals averaged 4.0-6.0 inches with totals generally less than 2.0 inches east of US 59. Another rainfall maximum of 7.0-9.0 inches fell in a small band from near Hunter Creek Village to just north of The Meadows.

Exceedance Probability – The highest short term rainfalls occurred over Addicks Reservoir and Buffalo Bayou. The maximum 30-min rainfall recorded was 2.9 inches at Addicks Dam which is near the .1% (100-yr) frequency. 1-hr rainfall totals of 4.2 to 4.8 inches was recorded over Addicks, upper Brays Bayou, and upper Buffalo Bayou which equates to over a .1% (100-yr) frequency. For the 6-hr to 24-hr time periods the rainfall totals over Addicks, upper Brays, middle and upper Buffalo, Cypress Creek, Spring Creek, and upper White Oak Bayou ranged from a 10% (10-yr) to 2% (50-yr) event. See attached rainfall analysis table for detailed rainfall and frequency exceedance at each ALERT gage station.

While the rainfall rates were near or exceeded the .1% (100-yr) level at a few gages in Buffalo and Addicks, they are far below the 6.9 inches in an hour recorded on Clear Creek only 10 days before this event.

The magnitude of rainfall over the central part of Addicks Reservoir especially upper Bear Creek for a 24-hr time period has not been experienced in this part of the county since detailed rainfall analysis collection began in the early 1980's. The last time similar rainfall occurred on upper Buffalo Bayou was in March of 1992 and this event averaged 1.0-2.0 inches higher than the 1992 rainfall. The areas heavily impacted in this event have largely escaped excessive rainfall events in the recent past including the floods of Tropical Storm Allison and Hurricane Ike.

OVERBANK FLOODING

Overbanks conditions occurred on the following channels:

Bear Creek
South Mayde Creek
Langham Creek (spotty above W Little York and widespread below W Little York)
Cypress Creek
Little Cypress Creek
Willow Creek
Spring Creek below SH 249
Buffalo Bayou (and several tributaries)

Brickhouse Gully
West Fork of the San Jacinto River

Bankfull conditions were noted on the following channels:

White Oak Bayou (FM 1960 to Beltway 8 and below Heights to downtown Houston)
Brays Bayou (SH 6 to above Bellaire)
Lemm Gully (K120)
Faulkey Gully (K142) below Louetta.

HOUSE FLOODING ESTIMATES

Extensive house flooding has been reported in several locations from both the public, HCFCD field crews, and damage survey teams across the western, northern, and central part of Harris County. Harris County Permits are currently reporting around 450 homes flooded mainly in the Addicks watershed. The largest concentration reported is across the lower portions of the creeks feeding in Addicks Reservoir with flooding occurring from overbanks flooding along these channels and internal drainage systems being overwhelmed from high short term rainfall rates.

Many homes were flooded along the lower end of Langham Creek downstream of HWY 6 and just north of Clay Rd west of the channel. House flooding was also noted along the lower part of South Mayde Creek below Barker Cypress and above Greenhouse and in several areas along lower Bear Creek.

100-150 homes have been reported to have flooded along W167 and W167-04 along the eastern side of Addicks Reservoir along a tributary that runs into Buffalo Bayou. Several houses built on the side slopes of Buffalo Bayou and its oxbows experienced flooding to their first floors. Additionally, extensive sheetflow flooding has been reported across portions of Spring Branch and The Villages area with homes reported to have flooded.

Along Cypress Creek overbank flooding threatened many homes from downstream of US 290 to just above SH 249. Some house flooding many have occurred in this area, and portions of the HP facilities just west of SH 249 were inundated from Cypress Creek.

Scattered house flooding likely occurred along the lower portions of Little Cypress Creek around Kluge Rd and along Willow Creek east of SH 249 and along Dowdell Rd.

10-20 houses along the west fork of the San Jacinto River experienced flooding with many other elevated structures surrounded by water and cut-off on both the south and north sides of the river downstream of the US 59 bridge.

Field crews have just begun house damage assessments and greater information on house flooding locations will be available in future releases of this report.

PROJECTS THAT HELPED REDUCE HOUSE FLOODING

- Along White Oak Bayou average rainfall of 5.5-7.5 inches above Jersey Village resulted in a significant rise along the channel however the completion of 10 stormwater detention basins with a combined capacity of 1 billion gallons is credited to helping reduce levels within White Oak Bayou in both Jersey Village and downstream of Beltway 8 where previous rainfall of this magnitude would likely have caused house flooding. While overbank conditions occurred along Brickhouse Gully, a recently completed detention basin upstream of US 290 helped reduce flood levels along the channel.

- Substantial work on Brays Bayou including large stormwater detention basins at Beltway 8, Old Westheimer, and Eldridge Pwky with the capacaity to store 2.6 billion gallons of stormwater likely prevented house flooding downstream in Myerland.

- Current work on Willow Water Hole including a stormwater detention area (50% complete) likely helped prevent house flooding along Willow Water Hole and downstream along portions of Brays Bayou.

BUYOUT

Some homes that flooded previously from similar rainfall events have been purchased by HCFCD and other cities in partnership with FEMA. Locations that received heavy rainfall and approximate number of homes that have been removed are listed below:

- Cypress and Little Cypress Creeks Watershed
  256 homes have been removed that would have likely flooded

- White Oak Bayou Watershed
  906 homes have been removed that may have flooded

- San Jacinto River Watershed
  403 homes have been removed that would have likely flooded

In the significantly impacted watersheds from this rainfall event a total of almost 1,600 homes have been bought out and removed many of which would have flooded.

ADDICKS RESERVOIR

Widespread rainfall of 7.0-9.0 inches fell across the creeks that feed into the reservoir with an area of 9.0-11.5 inches over the middle and upper portions of Bear Creek. Tremendous inflow on Langham, Bear, and South Mayde Creeks resulted in a significant rise in Addicks to levels not experienced since October of 2002. Large amounts of inflow overtopped portions of HWY 6 from Bear Creek and Clay Rd from

Langham Creek for many hours on Tuesday, April 28. As of the writing of this report Addicks is still rising from upstream run-off and flooding portions of Hwy 6 and Eldridge Pkwy. The Corps of Engineers began release water (1,000 cfs) out of Addicks on Wednesday, April 29 and opened 2 gates with an additional 500 cfs out of Barker early Thursday, April 30th. Current forecast from the Corps of Engineers indicate that the pool elevation will crest in the 100-101 foot range. The flood pool record is 101.58 ft set in March of 1992.

AERIAL RECONNASIANCE

HCFCD personnel conducted aerial tour of White Oak Bayou and Addicks Reservoir on the afternoon of Tuesday, April 28th and a second tour to Addicks, the Cypress Creek overflow zone, Cypress Creek, Little Cypress Creek, Willow Creek, Spring Creek, and the west fork of the San Jacinto River on Wednesday, April 30th. These missions were flown to determine how HCFCD channels and stormwater detention basins preformed, help with locating house flooding areas, and determine the extent and magnitude of Cypress Creek overflow into upper Addicks Reservoir.

CYPRESS CREEK OVERFLOW

Aerial survey of the overflow zone along with HCFCD ground crew reports indicate that water levels in the upper reaches of Cypress Creek did overflow into the northwestern portions of Addicks Reservoir. Shallow overland flow flooding was noted along and west of Katy Hockley Rd to Sharp Rd. The highest water level recorded at the Katy Hockley ALERT station was 159.50 feet or between a .1% (100-yr) and .2% (500-yr) level. This level is 1.0-3.0 feet below the levels experienced on the upper part of Cypress during the floods of the fall of 1998 and the October 1994 flood (current record stage).

HIGH WATER MARKING

Five HCFCD crews marked and surveyed high water marks on Wednesday April 29 and Thursday April 30 along the following channels: Cypress Creek, Little Cypress Creek, Willow Creek, Spring Creek, Langham Creek, Bear Creek, South Mayde Creek, Mason Creek, Buffalo Bayou, White Oak Bayou (between FM 1960 and North Houston Rosslyn, Brickhouse Gully, and the following and several tributaries along cypress Creek (Turkey Creek and Faulkey Gully)

HARRIS COUNTY FLOOD CONTROL DISTRICT FACILITIES CONDITIONS

All HCFCD channels and detention basins were in good condition prior to the onset of the rainfall. Debris blockages along Cypress Creek at Cypresswood and The Hardy Toll Rd bridges were removed prior to the flooding. Additional debris along several watersheds in the southern part of the county due to recent flooding in the past 10 days had been removed before the rainfall on the 27th and 28th. The regular seasonal mowing contracts will begin on May 15, 2009

A portion of a subdivision stormwater detention basin (U506-05) along the upper portion of U106 (Horsepen Creek) was overtopped by flow in the creek, heavily eroded, and

then breached into the detention basin. HCFCD crews are currently assessing the situation. Heavy erosion and slope failures were also noted at several locations along upper Langham Creek.

Distribution:
Wayne Crull
Fred Garcia
Mike Talbott
Heather Saucier
Steve Fitzgerald
Jeff Lindner
Clay Haynes
Jim Greeson
Curtis Lampley
Jack Peterson
Glenn Laird
Richard Scott
Gary Zika
Beth Walters
David Randolph
Jeremy Phillips, HCPID
Richard Scott
John Randolph
Art Storey, HCPID
John Blount, HCPID
Bill Hunter, HC Permits
Bill Wheeler, HCOEM
Mark Sloan, HCOEM
Jennifer Suter, HCOEM
Franciso Sanchez, HCOEM
Mike Montogmery, HCFMO
Gene Hafele, NWS
Dave Schwertz, NWS
Dan Reilly, NWS
Terry Moore, COH
Shannon Watson, HC Permits

April 28 Rainfall Maximums by Watershed

Monday 4/27 10AM to Tuesday 4/28 at 10AM

CLEAR CREEK, A100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
100	0.2	0.4	0.7	1.1	1.2	1.2	1.2	1.2	2nd Outlet
105	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	Melodywood @ Mary's
110	0.2	0.5	1.0	1.5	1.7	1.7	1.7	1.7	I-45
115	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baker @ Chigger
120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	FM 528
125	0.4	0.9	1.5	2.0	2.2	2.2	2.2	2.2	Windsong @ Chigger
130	0.3	0.7	1.2	1.6	1.8	1.8	1.8	1.8	Bay Area Blvd
135	0.5	1.1	1.5	2.5	2.6	2.6	2.7	2.7	FM 2351
140	0.6	0.9	1.1	1.4	1.4	1.6	2.5	2.6	FM 1959 @ A119
150	0.4	1.0	1.5	2.4	2.5	2.6	2.6	2.6	Country Club
160	0.6	1.0	1.5	2.4	2.7	2.8	2.8	2.9	Hughes @ A120
170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nassau Bay
180	0.3	0.7	1.1	1.4	1.6	1.7	1.7	1.8	Telephone
185	0.3	0.7	1.0	1.2	1.4	1.6	1.7	1.7	Mykawa
190	0.4	1.0	1.5	2.1	2.3	2.4	2.5	2.5	SH 288
200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nasa Rd 1 @ A104

ARMAND BAYOU, B100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
210	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Nasa Rd 1
220	0.2	0.5	0.7	1.2	1.6	1.6	1.6	1.6	Genoa-Red Bluff
230	0.2	0.4	0.7	1.2	1.7	1.9	2.0	2.0	Fairmont @ B106
240	0.2	0.4	0.8	1.1	1.2	1.2	1.2	1.2	Beltway 8
250	0.3	0.7	1.0	1.7	2.0	2.0	2.0	2.0	Bay Area Blvd @ B104
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B112 @ Fairmont

SIMS BAYOU, C100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
310	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nevada @ C106
320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Forest Oaks @ C106
340	0.4	0.6	0.8	1.1	1.5	1.7	1.7	1.9	Telephone
360	0.3	0.8	1.4	1.8	2.1	2.3	2.3	2.3	MLK
370	0.6	1.5	2.4	2.8	3.0	3.0	3.0	3.1	SH 288
380	0.2	0.6	0.9	1.3	1.4	1.5	1.6	1.6	Hiram Clarke

Return Period: 10year 25year 50year 100year 500year

April 28 Rainfall Maximums by Watershed

Monday 4/27 10AM to Tuesday 4/28 at 10AM

BRAYS BAYOU, D100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
400	0.3	0.7	1.2	1.8	1.9	1.9	2.5	2.7	S. MacGregor @ D109
410	0.2	0.6	1.0	1.4	1.7	1.8	1.8	2.0	Lawndale
415	0.3	0.5	0.5	0.5	0.5	0.5	0.8	0.8	MLK
420	0.4	0.8	1.2	1.4	1.7	1.8	2.5	2.7	S Main
430	0.4	0.9	1.2	1.6	1.9	1.9	3.5	3.6	Stella Link
435	0.4	0.9	1.3	1.5	1.6	1.7	2.9	3.0	Willowbend @ D112
440	0.5	1.0	1.4	2.1	2.4	2.4	4.2	4.3	Rice
460	0.3	0.8	1.4	1.8	2.2	2.2	4.0	4.1	Gessner
465	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Beltway 8
470	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Belle Park
475	0.6	1.5	2.5	3.8	5.5	5.5	7.0	7.5	Bellaire Blvd
480	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Roark @ D118
485	0.6	1.8	2.8	4.3	5.4	5.5	7.8	8.2	SH 6
490	0.4	1.1	2.0	3.2	3.5	3.5	5.0	5.2	Keegans @ D118

WHITE OAK BAYOU, E100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
520	0.4	0.4	0.6	1.0	1.6	1.6	2.5	3.0	Heights
530	0.3	0.7	1.0	1.8	2.6	2.6	4.0	4.8	Ella
535	0.5	1.0	1.4	1.7	1.9	2.0	3.0	3.6	Pinemont
540	0.4	0.8	1.2	1.9	2.8	3.0	4.4	4.9	Alabonson
545	0.4	0.8	1.2	1.8	3.0	3.2	4.8	5.5	Fairbanks-N. Houston
550	0.3	0.9	1.4	2.3	3.4	3.7	5.3	5.7	Lakeview
555	0.4	1.0	1.9	3.4	4.9	5.1	7.3	7.6	Jones
560	0.2	0.4	0.6	1.0	1.7	1.7	2.3	3.0	Trimble @ E101
570	0.4	0.4	0.7	1.0	1.7	1.8	2.6	3.1	Tidwell @ E101
575	0.7	1.2	1.6	2.0	2.4	2.4	3.9	4.7	Tidwell
580	0.5	1.0	1.6	2.1	2.9	2.9	4.7	5.4	Costa Rica @ E115
585	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Victory @ E121
590	0.4	0.9	1.4	2.0	2.8	3.0	4.7	5.2	Deihl @ E117
595	0.4	0.8	1.1	1.4	2.1	2.4	3.7	4.2	Gulf Bank @ E121

LITTLE CEDAR BAYOU, F216

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
610	0.3	0.4	0.6	1.0	1.2	1.3	1.3	1.4	
620	0.2	0.3	0.5	0.7	1.3	1.4	1.5	1.5	F216 @ 8th St
640	0.3	0.4	0.5	0.8	1.2	1.4	1.5	1.5	F101 @ 26th

SAN JACINTO RIVER, G103

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
710	0.3	0.7	1.1	1.2	1.6	1.8	1.8	1.9	G103-07-05
720	0.1	0.3	0.5	0.6	0.8	1.0	1.1	1.2	US 90
750	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Lake Houston Dam
755	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	West Fork @ G103-36
760	0.2	0.5	0.8	1.2	1.8	1.9	3.3	3.4	US 59
790	0.3	0.5	0.7	1.2	1.6	1.8	2.1	2.3	FM 1485 @ East Fork

Return Period: 10year 25year 50year 100year 500year

April 28 Rainfall Maximums by Watershed

Monday 4/27 10AM to Tuesday 4/28 at 10AM

HUNTING BAYOU, H100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
820	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I-10
830	0.2	0.2	0.4	0.6	1.1	1.1	1.3	1.4	Loop 610
840	0.4	0.5	0.6	0.9	1.5	1.6	1.8	2.0	Lockwood

VINCE BAYOU, I100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
920	0.3	0.7	1.0	1.4	1.7	1.8	1.8	1.8	W. Ellaine
940	0.2	0.4	0.7	0.9	1.2	1.2	1.2	1.2	Jackson

SPRING CREEK, J100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1020	0.4	0.9	1.4	2.2	2.4	2.5	3.0	3.2	
1040	0.3	0.7	1.2	2.0	3.0	3.3	4.3	5.2	FM 2979
1050	0.2	0.6	0.6	0.6	0.6	0.8	0.8	0.8	I-45
1060	0.3	0.7	1.0	1.7	2.4	2.7	3.8	4.6	Kuykendahl
1070	0.7	1.3	2.5	3.2	4.0	4.4	7.2	8.1	SH 249
1090	0.5	0.9	1.2	1.3	1.7	1.9	3.2	3.4	Hegar

CYPRESS CREEK, K100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1110	0.4	1.0	1.5	2.0	2.6	2.6	4.0	4.1	Cypresswood
1115	0.3	0.6	1.0	1.4	2.4	2.8	4.5	4.5	Inverness Forest
1120	0.3	0.9	0.9	1.4	2.6	3.1	4.7	4.7	I-45
1130	0.6	1.3	1.8	1.8	2.8	3.3	5.6	5.6	Kuykendahl
1140	0.5	1.3	1.7	2.0	2.4	2.4	4.4	4.8	Stuebner-Airline
1150	0.5	1.1	1.4	1.6	2.4	2.7	4.9	5.2	249
1160	0.3	0.8	1.2	1.4	2.9	3.2	5.2	5.5	Grant
1170	0.5	1.3	1.9	2.4	4.5	4.9	8.0	8.2	Huffmeister
1175	0.5	1.3	2.2	2.8	3.8	4.2	7.8	8.3	290
1180	0.3	0.7	1.2	2.0	4.1	4.9	7.0	7.6	Katy-Hockley
1190	0.2	0.5	0.8	1.0	2.0	2.2	3.1	3.4	Mathis @ K166 in Waller
1210	0.5	1.3	2.2	2.6	3.6	3.9	7.2	7.6	Kludge @ L100
1220	0.4	0.9	1.5	2.5	4.1	4.4	7.2	7.6	Cypress-Rosehill@L100

WILLOW CREEK, M100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Kuykendahl
1340	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	SH 249

CARPENTERS BAYOU, N100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1420	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I-100
1440	0.3	0.7	0.9	1.1	1.4	1.4	1.4	1.4	Wallisville
1460	0.3	0.6	1.2	1.6	1.8	1.9	2.0	2.1	US 90

Return Period: 10year 25year 50year 100year 500year

April 28 Rainfall Maximums by Watershed

Monday 4/27 10AM to Tuesday 4/28 at 10AM

GOOSE CREEK, O100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1520	0.3	0.4	0.6	1.3	1.6	1.8	1.8	1.8	SH 146
1540	0.7	1.3	1.6	0.8	1.1	1.1	1.1	1.1	Baker Rd

GREENS BAYOU, P100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1600	0.3	0.8	1.0	1.4	1.7	1.8	2.3	2.4	Mt. Houston Pkwy
1610	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.4	Normandy
1620	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Ley Rd
1630	0.4	0.7	0.8	1.1	1.5	1.8	2.3	2.4	Betlway 8 @ P130
1640	0.2	0.4	0.6	0.8	0.9	1.0	1.4	1.6	US 59
1645	0.4	0.8	1.2	1.6	1.8	1.9	3.4	3.5	Beltway 8
1650	0.3	0.8	1.2	1.5	1.8	2.0	2.9	3.0	Rankin @ P130
1660	0.3	0.4	0.6	1.1	1.4	1.7	3.0	3.0	Knobcrest
1665	0.7	1.3	1.6	1.9	2.4	2.5	4.5	4.7	Bammel-N Houston
1670	1.0	1.1	1.1	1.4	2.7	2.8	4.4	4.5	Cutten
1685	0.2	0.4	0.7	0.9	1.3	1.5	2.0	2.2	Tidwell

HALLS BAYOU, P118

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1675	0.2	0.4	0.7	0.9	1.3	1.4	1.8	1.9	Tidwell
1680	0.2	0.5	0.5	0.9	1.2	1.4	1.7	1.8	Jensen
1690	0.4	0.7	1.0	1.4	1.9	2.1	3.1	3.1	Airline
1695	0.1	0.1	0.1	0.2	0.4	0.5	0.8	0.8	

CEDAR BAYOU, Q100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1720	0.2	0.4	0.5	0.8	1.1	1.2	1.2	1.3	SH 246
1740	0.3	0.6	0.9	1.0	1.2	1.3	1.5	1.5	US 90

JACKSON BAYOU, R100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1840	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Diamond Head

LUCE BAYOU, S100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1940	0.3	0.8	1.4	2.0	2.2	2.5	2.7	2.9	FM 2100

Return Period: 10year 25year 50year 100year 500year

April 28 Rainfall Maximums by Watershed

Monday 4/27 10AM to Tuesday 4/28 at 10AM

BARKER RESERVOIR, T100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
2010	0.2	0.3	0.4	0.4	0.6	0.6	0.6	0.6	Barker Dam
2020	0.6	1.6	2.4	3.5	5.1	5.4	6.2	7.6	Prince Creek @ T101
2040	0.3	0.9	1.6	1.9	3.6	3.9	4.7	6.0	US 90 @ T100

ADDICKS RESERVOIR, U100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
2110	0.6	1.7	2.9	4.2	5.5	5.6	7.6	8.3	Addicks Dam
2120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	W Little York @ U100
2150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Greenhouse @ U101
2160	0.4	1.2	2.2	3.7	6.2	6.8	7.4	8.4	Clay @ U102
2180	0.6	1.5	2.6	3.8	5.2	5.9	10.4	11.3	FM 529 @ U102

BUFFALO BAYOU, W100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
2210	0.2	0.6	1.0	1.4	2.0	2.1	2.1	2.2	Turning Basin
2220	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Main St.
2230	0.1	0.2	0.4	0.6	0.9	1.0	1.0	1.0	
2240	0.3	0.4	0.8	1.1	1.9	2.0	3.0	3.4	Sheperd
2250	0.7	1.7	2.5	3.6	5.0	5.0	7.7	8.1	Bingle
2260	0.6	1.7	2.8	3.6	5.2	5.2	7.4	7.7	San Felipe
2270	0.6	1.7	2.8	4.8	7.0	7.1	8.9	9.4	Beltway 8
2280	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I-10 @ W156
2290	0.5	1.5	2.8	4.7	6.8	7.1	8.8	9.6	Dairy Ashford
3990	0.3	0.7	1.0	1.5	1.7	1.7	2.4	2.6	Metro

Return Period: 10year 25year 50year 100year 500year

Data to determine color codes based on the midpoint between the rainfall amounts for each frequency.

Region 1--Addicks, Barker, Cypress, Spring, and Willow

Exceedance Probability	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	2-day
50% (2-yr)	0.7	1.1	1.4	1.9	2.5	2.9	3.4	4.1	4.7
20% (5-yr)	0.8	1.3	1.6	2.2	2.9	3.5	4.1	5.0	5.7
10% (10-yr)	1.0	1.5	2.0	2.7	3.6	4.5	5.4	6.5	7.4
4% (25yr)	1.1	1.7	2.3	3.1	4.4	5.5	6.7	8.1	9.1
2% (50-yr)	1.2	1.9	2.6	3.6	5.2	6.7	8.1	9.8	11.0
1% (100-yr)	1.3	2.1	2.9	4.0	6.1	7.9	9.5	11.5	12.7
0.2% (500-yr)	1.4	2.5	3.5	4.9	7.8	10.4	12.5	15.1	16.2

Region 2--Brays, Buffalo, Greens, Hunting, Luce, West Fork San Jacinto, and White Oak

Exceedance Probability	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	2-day
50% (2-yr)	0.7	1.1	1.5	2.0	2.6	3.1	3.7	4.4	5.0
20% (5-yr)	0.8	1.3	1.7	2.3	3.1	3.7	4.4	5.3	6.1
10% (10-yr)	0.9	1.5	2.0	2.7	3.8	4.7	5.7	6.9	7.9
4% (25yr)	1.0	1.6	2.3	3.2	4.6	5.8	7.0	8.6	9.7
2% (50-yr)	1.1	1.8	2.6	3.6	5.4	7.0	8.5	10.5	11.7
1% (100-yr)	1.2	2.0	2.9	4.1	6.3	8.3	10.0	12.3	13.5
0.2% (500-yr)	1.3	2.4	3.4	4.9	8.0	10.9	13.2	16.1	17.3

Region 3--Armand, Carpenters, Ceder, Clear, Galveston Bay, Goose, Jackson, Lower San Jacinto River, Sims, Ship Channel and Vince

Exceedance Probability	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	2-day
50% (2-yr)	0.7	1.1	1.5	2.0	2.7	3.2	3.8	4.5	5.3
20% (5-yr)	0.8	1.3	1.7	2.3	3.1	3.8	4.6	5.5	6.4
10% (10-yr)	0.9	1.5	2.0	2.7	3.9	4.9	5.9	7.1	8.3
4% (25yr)	1.0	1.6	2.3	3.2	4.7	6.0	7.2	8.8	10.1
2% (50-yr)	1.1	1.8	2.6	3.6	5.5	7.2	8.8	10.7	12.2
1% (100-yr)	1.2	2.0	2.9	4.1	6.4	8.4	10.3	12.6	14.1
0.2% (500-yr)	1.3	2.3	3.4	4.9	8.1	11.1	13.5	16.4	17.9

Source: TSARP White Paper for rainfall from USGS

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CLEAR CREEK, A100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
100	0.2	0.4	0.7	1.1	1.2	1.2	1.2	1.2	2nd Outlet
105	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	Melodywood @ Mary's
110	0.2	0.5	1.0	1.5	1.7	1.7	1.7	1.7	I-45
115	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Baker @ Chigger
120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	FM 528
125	0.4	0.9	1.5	2.0	2.2	2.2	2.2	2.2	Windsong @ Chigger
130	0.3	0.7	1.2	1.6	1.8	1.8	1.8	1.8	Bay Area Blvd
135	0.5	1.1	1.5	2.5	2.6	2.6	2.7	2.7	FM 2351
140	0.6	0.9	1.1	1.4	1.4	1.6	2.5	2.6	FM 1959 @ A119
150	0.4	1.0	1.5	2.4	2.5	2.6	2.6	2.6	Country Club
160	0.6	1.0	1.5	2.4	2.7	2.8	2.8	2.9	Hughes @ A120
170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nassau Bay
180	0.3	0.7	1.1	1.4	1.6	1.7	1.7	1.8	Telephone
185	0.3	0.7	1.0	1.2	1.4	1.6	1.7	1.7	Mykawa
190	0.4	1.0	1.5	2.1	2.3	2.4	2.5	2.5	SH 288
200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nasa Rd 1 @ A104

ARMAND BAYOU, B100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
210	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Nasa Rd 1
220	0.2	0.5	0.7	1.2	1.6	1.6	1.6	1.6	Genoa-Red Bluff
230	0.2	0.4	0.7	1.2	1.7	1.9	2.0	2.0	Fairmont @ B106
240	0.2	0.4	0.8	1.1	1.2	1.2	1.2	1.2	Beltway 8
250	0.3	0.7	1.0	1.7	2.0	2.0	2.0	2.0	Bay Area Blvd @ B104
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B112 @ Fairmont

SIMS BAYOU, C100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
310	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Nevada @ C106
320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Forest Oaks @ C106
340	0.4	0.6	0.8	1.1	1.5	1.7	1.7	1.9	Telephone
360	0.3	0.8	1.4	1.8	2.1	2.3	2.3	2.3	MLK
370	0.6	1.5	2.4	2.8	3.0	3.0	3.0	3.1	SH 288
380	0.2	0.6	0.9	1.3	1.4	1.5	1.6	1.6	Hiram Clarke

Return Period: 10year 25year 50year 100year 500year

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BRAYS BAYOU, D100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
400	0.3	0.7	1.2	1.8	1.9	1.9	2.5	2.7	S. MacGregor @ D109
410	0.2	0.6	1.0	1.4	1.7	1.8	1.8	2.0	Lawndale
415	0.3	0.5	0.5	0.5	0.5	0.5	0.8	0.8	MLK
420	0.4	0.8	1.2	1.4	1.7	1.8	2.5	2.7	S Main
430	0.4	0.9	1.2	1.6	1.9	1.9	3.5	3.6	Stella Link
435	0.4	0.9	1.3	1.5	1.6	1.7	2.9	3.0	Willowbend @ D112
440	0.5	1.0	1.4	2.1	2.4	2.4	4.2	4.3	Rice
460	0.3	0.8	1.4	1.8	2.2	2.2	4.0	4.1	Gessner
465	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Beltway 8
470	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Belle Park
475	0.6	1.5	2.5	3.8	5.5	5.5	7.0	7.5	Bellaire Blvd
480	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Roark @ D118
485	0.6	1.8	2.8	4.3	5.4	5.5	7.8	8.2	SH 6
490	0.4	1.1	2.0	3.2	3.5	3.5	5.0	5.2	Keegans @ D118

WHITE OAK BAYOU, E100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
520	0.4	0.4	0.6	1.0	1.6	1.6	2.5	3.0	Heights
530	0.3	0.7	1.0	1.8	2.6	2.6	4.0	4.8	Ella
535	0.5	1.0	1.4	1.7	1.9	2.0	3.0	3.6	Pinemont
540	0.4	0.8	1.2	1.9	2.8	3.0	4.4	4.9	Alabonson
545	0.4	0.8	1.2	1.8	3.0	3.2	4.8	5.5	Fairbanks-N. Houston
550	0.3	0.9	1.4	2.3	3.4	3.7	5.3	5.7	Lakeview
555	0.4	1.0	1.9	3.4	4.9	5.1	7.3	7.6	Jones
560	0.2	0.4	0.6	1.0	1.7	1.7	2.3	3.0	Trimble @ E101
570	0.4	0.4	0.7	1.0	1.7	1.8	2.6	3.1	Tidwell @ E101
575	0.7	1.2	1.6	2.0	2.4	2.4	3.9	4.7	Tidwell
580	0.5	1.0	1.6	2.1	2.9	2.9	4.7	5.4	Costa Rica @ E115
585	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Victory @ E121
590	0.4	0.9	1.4	2.0	2.8	3.0	4.7	5.2	Deihl @ E117
595	0.4	0.8	1.1	1.4	2.1	2.4	3.7	4.2	Gulf Bank @ E121

LITTLE CEDAR BAYOU, F216

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
610	0.3	0.4	0.6	1.0	1.2	1.3	1.3	1.4	
620	0.2	0.3	0.5	0.7	1.3	1.4	1.5	1.5	F216 @ 8th St
640	0.3	0.4	0.5	0.8	1.2	1.4	1.5	1.5	F101 @ 26th

SAN JACINTO RIVER, G103

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
710	0.3	0.7	1.1	1.2	1.6	1.8	1.8	1.9	G103-07-05
720	0.1	0.3	0.5	0.6	0.8	1.0	1.1	1.2	US 90
750	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Lake Houston Dam
755	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	West Fork @ G103-36
760	0.2	0.5	0.8	1.2	1.8	1.9	3.3	3.4	US 59
790	0.3	0.5	0.7	1.2	1.6	1.8	2.1	2.3	FM 1485 @ East Fork

Return Period: 10year 25year 50year 100year 500year

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HUNTING BAYOU, H100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
820	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I-10
830	0.2	0.2	0.4	0.6	1.1	1.1	1.3	1.4	Loop 610
840	0.4	0.5	0.6	0.9	1.5	1.6	1.8	2.0	Lockwood

VINCE BAYOU, I100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
920	0.3	0.7	1.0	1.4	1.7	1.8	1.8	1.8	W. Ellaine
940	0.2	0.4	0.7	0.9	1.2	1.2	1.2	1.2	Jackson

SPRING CREEK, J100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1020	0.4	0.9	1.4	2.2	2.4	2.5	3.0	3.2	
1040	0.3	0.7	1.2	2.0	3.0	3.3	4.3	5.2	FM 2979
1050	0.2	0.6	0.6	0.6	0.6	0.8	0.8	0.8	I-45
1060	0.3	0.7	1.0	1.7	2.4	2.7	3.8	4.6	Kuykendahl
1070	0.7	1.3	2.5	3.2	4.0	4.4	7.2	8.1	SH 249
1090	0.5	0.9	1.2	1.3	1.7	1.9	3.2	3.4	Hegar

CYPRESS CREEK, K100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1110	0.4	1.0	1.5	2.0	2.6	2.6	4.0	4.1	Cypresswood
1115	0.3	0.6	1.0	1.4	2.4	2.8	4.5	4.5	Inverness Forest
1120	0.3	0.9	0.9	1.4	2.6	3.1	4.7	4.7	I-45
1130	0.6	1.3	1.8	1.8	2.8	3.3	5.6	5.6	Kuykendahl
1140	0.5	1.3	1.7	2.0	2.4	2.4	4.4	4.8	Stuebner-Airline
1150	0.5	1.1	1.4	1.6	2.4	2.7	4.9	5.2	249
1160	0.3	0.8	1.2	1.4	2.9	3.2	5.2	5.5	Grant
1170	0.5	1.3	1.9	2.4	4.5	4.9	8.0	8.2	Huffmeister
1175	0.5	1.3	2.2	2.8	3.8	4.2	7.8	8.3	290
1180	0.3	0.7	1.2	2.0	4.1	4.9	7.0	7.6	Katy-Hockley
1190	0.2	0.5	0.8	1.0	2.0	2.2	3.1	3.4	Mathis @ K166 in Waller
1210	0.5	1.3	2.2	2.6	3.6	3.9	7.2	7.6	Kludge @ L100
1220	0.4	0.9	1.5	2.5	4.1	4.4	7.2	7.6	Cypress-Rosehill@L100

WILLOW CREEK, M100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Kuykendahl
1340	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	SH 249

CARPENTERS BAYOU, N100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1420	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I-100
1440	0.3	0.7	0.9	1.1	1.4	1.4	1.4	1.4	Wallisville
1460	0.3	0.6	1.2	1.6	1.8	1.9	2.0	2.1	US 90

Return Period: 10year 25year 50year 100year 500year

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GOOSE CREEK, O100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1520	0.3	0.4	0.6	1.3	1.6	1.8	1.8	1.8	SH 146
1540	0.7	1.3	1.6	0.8	1.1	1.1	1.1	1.1	Baker Rd

GREENS BAYOU, P100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1600	0.3	0.8	1.0	1.4	1.7	1.8	2.3	2.4	Mt. Houston Pkwy
1610	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.4	Normandy
1620	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Ley Rd
1630	0.4	0.7	0.8	1.1	1.5	1.8	2.3	2.4	Betlway 8 @ P130
1640	0.2	0.4	0.6	0.8	0.9	1.0	1.4	1.6	US 59
1645	0.4	0.8	1.2	1.6	1.8	1.9	3.4	3.5	Beltway 8
1650	0.3	0.8	1.2	1.5	1.8	2.0	2.9	3.0	Rankin @ P130
1660	0.3	0.4	0.6	1.1	1.4	1.7	3.0	3.0	Knobcrest
1665	0.7	1.3	1.6	1.9	2.4	2.5	4.5	4.7	Bammel-N Houston
1670	1.0	1.1	1.1	1.4	2.7	2.8	4.4	4.5	Cutten
1685	0.2	0.4	0.7	0.9	1.3	1.5	2.0	2.2	Tidwell

HALLS BAYOU, P118

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1675	0.2	0.4	0.7	0.9	1.3	1.4	1.8	1.9	Tidwell
1680	0.2	0.5	0.5	0.9	1.2	1.4	1.7	1.8	Jensen
1690	0.2	0.4	0.6	1.4	1.9	2.1	3.1	3.1	Airline
1695	0.4	0.7	1.0	0.2	0.4	0.5	0.8	0.8	

CEDAR BAYOU, Q100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1720	0.2	0.4	0.5	0.8	1.1	1.2	1.2	1.3	SH 246
1740	0.3	0.6	0.9	1.0	1.2	1.3	1.5	1.5	US 90

JACKSON BAYOU, R100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1840	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Diamond Head

LUCE BAYOU, S100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
1940	0.0	0.0	0.0	2.0	2.2	2.5	2.7	2.9	FM 2100

Return Period: 10year 25year 50year 100year 500year

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BARKER RESERVOIR, T100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
2010	0.2	0.3	0.4	0.4	0.6	0.6	0.6	0.6	Barker Dam
2020	0.6	1.6	2.4	3.5	5.1	5.4	6.2	7.6	Prince Creek @ T101
2040	0.3	0.9	1.6	1.9	3.6	3.9	4.7	6.0	US 90 @ T100

ADDICKS RESERVOIR, U100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
2110	0.6	1.7	2.9	4.2	5.5	5.6	7.6	8.3	Addicks Dam
2120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	W Little York @ U100
2150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Greenhouse @ U101
2160	0.4	1.2	2.2	3.7	6.2	6.8	7.4	8.4	Clay @ U102
2180	0.6	1.5	2.6	3.8	5.2	5.9	10.4	11.3	FM 529 @ U102

BUFFALO BAYOU, W100

GAGE ID	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	LOCATION
2210	0.2	0.6	1.0	1.4	2.0	2.1	2.1	2.2	Turning Basin
2220	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Main St.
2230	0.1	0.2	0.4	0.6	0.9	1.0	1.0	1.0	
2240	0.3	0.4	0.8	1.1	1.9	2.0	3.0	3.4	Sheperd
2250	0.7	1.7	2.5	3.6	5.0	5.0	7.7	8.1	Bingle
2260	0.6	1.7	2.8	3.6	5.2	5.2	7.4	7.7	San Felipe
2270	0.6	1.7	2.8	4.8	7.0	7.1	8.9	9.4	Beltway 8
2280	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	I-10 @ W156
2290	0.5	1.5	2.8	4.7	6.8	7.1	8.8	9.6	Dairy Ashford
3990	0.3	0.7	1.0	1.5	1.7	1.7	2.4	2.6	Metro

Return Period: 10year 25year 50year 100year 500year

POINT RAINFALL - ANNUAL EXCEEDANCE PROBABILITIES FOR HARRIS COUNTY

Region 1--Addicks, Barker, Cypress, Spring, and Willow

Exceedance Probability	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	2-day
50% (2-yr)	0.7	1.1	1.4	1.9	2.5	2.9	3.4	4.1	4.7
20% (5-yr)	0.9	1.4	1.8	2.5	3.3	4.0	4.8	5.8	6.6
10% (10-yr)	1.0	1.5	2.1	2.8	3.9	4.9	5.9	7.1	8.1
4% (25yr)	1.1	1.8	2.4	3.4	4.8	6.1	7.4	9.0	10.1
2% (50-yr)	1.2	2.0	2.7	3.8	5.6	7.2	8.7	10.6	11.8
1% (100-yr)	1.3	2.2	3.0	4.2	6.5	8.5	10.2	12.4	13.6
0.2% (500-yr)	1.5	2.7	3.9	5.5	9.0	12.2	14.7	17.7	18.7

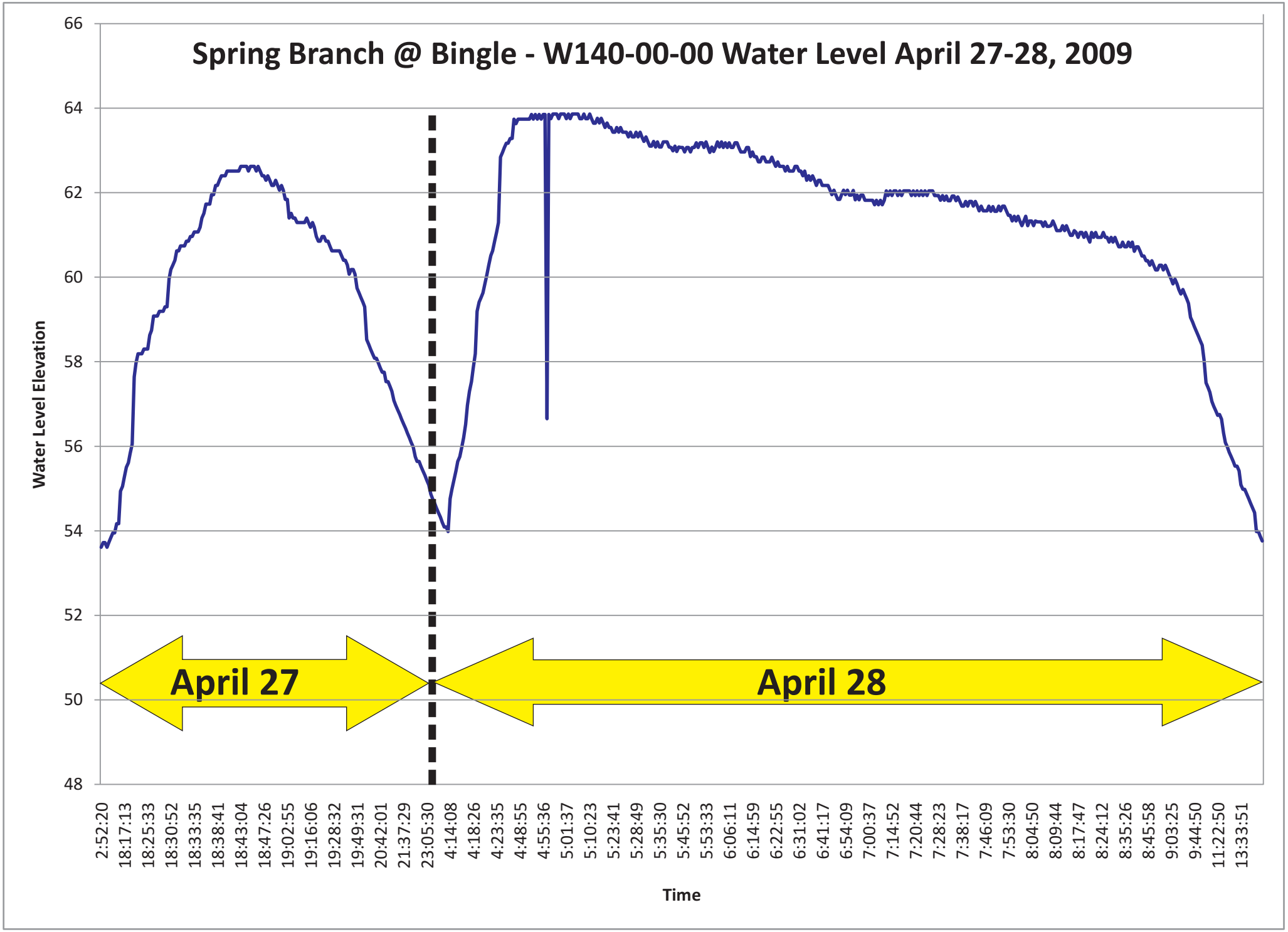
Region 2--Brays, Buffalo, Greens, Hunting, Luce, West Fork San Jacinto, and White Oak

Exceedance Probability	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	2-day
50% (2-yr)	0.7	1.1	1.5	2.0	2.6	3.1	3.7	4.4	5.0
20% (5-yr)	0.8	1.4	1.8	2.5	3.5	4.3	5.1	6.2	7.1
10% (10-yr)	0.9	1.5	2.1	2.9	4.1	5.1	6.2	7.6	8.6
4% (25yr)	1.0	1.7	2.4	3.4	5.0	6.4	7.8	9.6	10.8
2% (50-yr)	1.1	1.9	2.7	3.8	5.8	7.6	9.2	11.3	12.5
1% (100-yr)	1.2	2.1	3.0	4.3	6.7	8.9	10.8	13.2	14.5
0.2% (500-yr)	1.4	2.6	3.8	5.5	9.2	12.8	15.5	18.9	20.0

Region 3--Armand, Carpenters, Ceder, Clear, Galveston Bay, Goose, Jackson, Lower San Jacinto River, Sims, Ship Channel and Vince

Exceedance Probability	5-min	15-min	30-min	1-hour	3-hour	6-hour	12-hour	24-hour	2-day
50% (2-yr)	0.7	1.1	1.5	2.0	2.7	3.2	3.8	4.5	5.3
20% (5-yr)	0.8	1.4	1.9	2.5	3.5	4.4	5.3	6.4	7.5
10% (10-yr)	0.9	1.5	2.1	2.9	4.2	5.3	6.4	7.8	9.0
4% (25yr)	1.0	1.7	2.4	3.4	5.1	6.6	8.0	9.8	11.2
2% (50-yr)	1.1	1.9	2.7	3.8	5.9	7.7	9.5	11.6	13.1
1% (100-yr)	1.2	2.1	3.0	4.3	6.8	9.1	11.1	13.5	15.1
0.2% (500-yr)	1.4	2.5	3.7	5.5	9.4	13.1	15.9	19.3	20.7

Source: TSARP White Paper for rainfall from USGS


Spring Branch @ Bingle - W140-00-00 Water Level April 27-28, 2009
Water Level Elevation
66
64
62
60
58
56
54
52
50
48
April 27
April 28
2:52:20
18:17:13
18:25:33
18:30:52
18:33:35
18:38:41
18:43:04
18:47:26
19:02:55
19:16:06
19:28:32
19:49:31
20:42:01
21:37:29
23:05:30
4:14:08
4:18:26
4:23:35
4:48:55
4:55:36
5:01:37
5:10:23
5:23:41
5:28:49
5:35:30
5:45:52
5:53:33
6:06:11
6:14:59
6:22:55
6:31:02
6:41:17
6:54:09
7:00:37
7:14:52
7:20:44
7:28:23
7:38:17
7:46:09
7:53:30
8:04:50
8:09:44
8:17:47
8:24:12
8:35:26
8:45:58
9:03:25
9:44:50
11:22:50
13:33:51
Time

Briar Branch at Fries Rd.

Briar Branch at Voss

Appendix 5

HDR | CLAUNCH & MILLER
Engineering Consultants
4635 Southwest Freeway, Suite 1000 ● Houston, Texas 77027 ● 713-622-9264

Lone Star at Bace

Elizabeth St.

Appendix 5

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Bridge at Tamy

Westview west of Fries

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Briar Branch at Fries Rd.

Akins at Hilldale

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Briar Branch at Akins

Elizabeth at Campbell

Appendix 5

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Don’t believe the flooding ‘myths’
Insuring your home is well worth the cost
By MICHAEL D. TALBOTT
HOUSTON CHRONICLE
Feb. 8, 2010, 1:53AM

The announcement came last week: The price tag carried by Hurricane Ike totals $15 billion in damages, making it the costliest storm to hit Texas and the third costliest in the United States, trailing hurricanes Katrina in 2005 and Andrew in 1992.

The official tally serves as a reminder of how costly natural disasters can be. While wind-related damages comprise the bulk of Ike's bill, flooding damages total $2.2 billion, according to the Insurance Council of Texas, reporting on the amount of claims covered by the National Flood Insurance Program. That amount, however, does not include what uninsured home and business owners who flooded will pay out of pocket.

Perhaps more staggering than the damages caused by Ike is the number of people without flood insurance. Of the 1.4 million households in Harris County, roughly one in every five is protected with flood insurance. Approximately 290,000 policies are in force.

The number is alarming considering that the average amount of damages expected from flooding in Harris County every year is several hundred million dollars. That amount is reflective of the fact that flooding is the No.1 natural threat to our area.

Notable historical floods include those of 1929 and of 1935, which severely crippled downtown Houston and threatened to wipe the city off the map — prompting creation of the Harris County Flood Control District in 1937. In more recent times, Tropical Storm Frances flooded 1,400 homes in 1998, Tropical Storm Allison flooded 73,000 homes in 2001, and most recently, a nontropical rainfall event flooded 2,300 homes last April.

Given our area's flooding history and natural risk for flooding, why don't more residents protect themselves with flood insurance? The reasons are speculative, of course, but they most likely boil down to three common misconceptions: The belief that flood insurance is too expensive, that not all people are eligible and a false sense of security — the most prevalent flooding “myth.”

Many people are fortunate enough to live in homes that have never flooded or have not experienced flooding in decades. When 30 or 40 years pass and homes remain dry, it's understandable that homeowners might conclude they will not flood. Such was the case last April on the west side of town when 8 to 10 inches of rain fell in 12 hours and 7 inches of rain fell in three hours in isolated areas. Residents scurried to find answers to their “sudden” flooding problem, as many had not seen water in their homes in roughly 30 years. Many were surprised to learn the rainfall they experienced in April was greater than the rain they saw from Hurricane Alicia in 1983, from Allison in 2001 and from Ike in 2008. In fact, the last time their area saw comparable amounts of rain was the early 1980s.

Furthermore, about 70 percent of the homes that flooded last April were not located in a mapped flood plain. Many people believe if they are not located in a mapped flood plain they are not at risk for flooding, and they view flood insurance as an extended warranty on an appliance: comforting yet nonessential. However, they may not realize that flood insurance rate maps only show flooding risks from bayous and streams leaving their banks during certain theoretical floods. They do not show risks from street flooding, which occurs when water begins to rise in streets and eventually inundates homes. Unfortunately, half or more of the flooding that occurs in our area falls into this category.

Many also mistakenly believe that if their homes did not flood during Tropical Storm Allison — an unprecedented storm that dropped 28.5 inches of rain in just 12 hours and 35 inches of rain in five days — they will never flood. But it's important to note that Allison did not distribute rain evenly over the county. Many areas experienced less than 5 inches of rain. Using Allison as a benchmark for flooding risks could be a costly mistake for many.

Billions of dollars have been spent widening bayous, excavating stormwater detention basins and helping families move outside the flood plain — projects that have spared thousands of homes from floods. However, more work needs to be done. Everyone in Harris County is at risk for flooding to varying degrees. All are eligible for flood insurance, which is relatively inexpensive, especially for those outside a mapped flood plain. Don't forget that homeowners insurance does not cover flooding.

For those who still may question its worth, let the numbers speak for themselves: In terms of paid flood insurance claims, Houston and Harris County rank third and fourth, respectively, in the nation, trailing only New Orleans and Jefferson Parish in Louisiana.

Flooding is a costly natural disaster. Flood insurance determines who will ultimately pay for it.

Talbott is director of the Harris County Flood Control District.

to a misdemeanor charge of obstructing justice, federal prosecutors said.

Benjamin Bates received one year probation, agreed to resign from the U.S. Marshals Service and not seek employment in law enforcement again as part of a plea agreement, the U.S. Attorney's Office said.

— FROM STAFF AND WIRE REPORTS

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April rain flooded 2,300 homes

■ Most of them not in a mapped flood plain

By MIKE SNYDER
HOUSTON CHRONICLE

About 2,300 Houston area homes flooded during downpours April 27 and 28, among the highest totals since Tropical Storm Allison pushed water into 73,000 homes in 2001, officials said Wednesday.

The figure includes about 1,350 residences in Houston, 800 in unincorporated Harris County and the rest in other towns and cities within the county, said Heather Saucier, a spokeswoman for the county flood control district.

More than half of the flooded houses were not in a mapped flood plain, a reminder that every property owner in Houston and Harris County is at risk for flooding and should purchase flood insurance, Saucier said.

Ditches can back up

Flood plain maps show risks only from bayous or streams that overflow their banks, she said. They don't show the potential for flooding from overloaded ditches or storm sewers.

"Oftentimes, we see streets filling up with water and inundating homes long before nearby tributaries and bayous reach their capacity," Saucier said.

Residents of neighborhoods where many homes flooded said they're still waiting for word on whether Gov. Rick Perry would seek a disaster declaration that could free up funds for temporary housing or other assistance.

State and local inspectors were still in the field this week assessing damage, and Perry will make a decision about what assistance is appropriate after that work is complete, spokeswoman Katherine Cesinger said.

Melanie Hogue, a teacher in the Spring Branch school district, said the late-April rainstorms flooded her family's house in northwest Harris County for the second time in seven months. More than 11 inches of rain fell within a few hours in some parts of the Houston area.

'Twice within a year'

"It is very scary to wake up to a flooding house," Hogue said in an e-mail message. "It is very sad to finally have our dream house only to be torn apart twice within a year."

Major local floods since Allison include storms that flooded 2,000 homes in 2002 and 3,370 homes in 2006, Saucier said.

mike.snyder@chron.com

Morales, 52, said his d
parture came because of
disagreements with city
ficials about how the 911 c
center should operate. T
center's early operations w
plagued with shutdowns; M
rales blamed the proble
on faulty systems and pl
acquired before his arrival.

On his previous statem
about his role with the H
Start program, Morales s
"Did I say 'managed'? I di
mean 'managed.'"

Voter support at risk?

Hector Carreño, a Hous
public affairs consultant
companies, nonprofits
campaigns, said candid
risk losing voter support
exaggerating their cred
tials.

"I don't think voters
pect candidates to exagger
quite the opposite," said
reño, who said he is neutr
the mayor's race. "I know
as a voter, I expect the ca
dates to tell the truth, bu
ery year you hear candid
caught up in it, whether i
little lie or a big lie."

April 27th & 28th Storm Analysis
Glossary of Terms

Term	Definition
Acre Feet	Volume of water representing one foot of depth over an acre of area.
Backflow Prevention	Devices that can be placed on drainage structures to prevent water from flowing in the opposite direction as it was designed to flow.
Bank Full Capacity	The capacity of a body of water up to the top of the bank, after which water begins to come out of the banks. (also referred to as Channel Capacity)
CFS	Units to express the flow of liquid/water. Cubic Feet per Second
Channel	A body which includes but not limited to ditch, stream, bayou, or creek in which water flows.
Channel Cross Section Area	The area of a channel perpendicular to the flow.
Design Criteria	The technical standards set by the controlling jurisdiction for the design of drainage systems.
Design Storm Event	The storm event which the design criteria specifies a drainage system should be designed to handle.
Drainage Basin	The total area in which all drainage from the area flows to one outfall. Synonymous with watershed.
Drainage Divide	The point which separates drainage basins, typically a ridge line.
Drainage System	Systems that handle drainage within a certain area. Theses systems could include storm sewers, open ditches, natural channels and detention ponds.
Extreme Event	An event greater than the design storm event for a given system.
FEMA	Federal Emergency Management Agency
Flood of Record	The greatest flood on historical record for a given area, in terms of stream flow.
Flood Plain	The area flooded during a specified storm event. For example, the area within the 100 year flood plain will be flooded during the 100 year storm event. Generally, FEMA creates and maintains flood plain maps which approximate the flood plain areas during given storm events.
Flood Plain Elevation	The maximum theoretical elevation of water in the flood plain during the specified storm event.
Flood Plain Limits	The theoritical limits of the flood plain during the specified storm event.
Flood Plain Models	Engineered models used to generate approximations of the theoritical flood plain based on a specified storm event.
Flood Profiles	The profile of a drainage system showing elevations of the water surface, and other significant features, such as top of bank.
Flow Reversal/Reverse Flow	When flow in a given channel, drainage system, drainage basin reverses the direction of flow from that anticipated or designed for.
High Water Mark	The evidence remaining after a flood showing the highest point that the water reached as the flood's peak.
Improvements - Long Term	Improvements referenced within this report which are assumed to require a longer term to feasibly undertake than the mid term improvements.

Improvements - Mid Term	Improvements referenced within this report which are assumed to be feasibly undertaken within 3 years.
Improvements - Short Term	Improvements referenced within this report which are assumed to be feasibly undertaken within one year.
Inter-basin Transfers	The transfer of flood waters during a storm event between two different drainage basins because one or both basins have exceeded their capacity.
Internal Detention System	A system designed to detain excess runoff created within a localized area during a storm event. For example, detention ponds are a type of internal detention systems.
Low Chord	The elevation of the lowest beam on a bridge or similar structure; the bottom of a bridge.
MSL	Mean Sea Level
Overbank Flooding	Flooding which occurs once the channel capacity has been exceeded.
Rainfall Event	The amount of rainfall (usually measured in inches) in a given span of time. For example, the 100 year rainfall event over a 24 hour period has a 1% probability of occuring in any given year.
Repetitive Flooding	Flooding which has occurred on a repeated basis during a given storm event.
Return Interval	The probability of an event occurring in any one year; i.e. - a storm with a 1 % chance of occuring in any given year is said to have a 100-year return interval, while a storm with a 50 % probability of occuring in any given year has a 2-year return interval; i.e. it is expected to occur one time in two years on a statistical basis.
Runoff	Rainfall which is not absorbed into the ground, but rather flows through the drainage system.
Sheetflow	Runoff which has not been channelized and is flowing over natural ground.
Storm of Record	The greatest storm on historical record for a given area, in terms of rainfall amount.
Storm Sewer System	A designed drainage system utilizing closed conduits (storm sewers) instead of open channels.
Structural Flooding	Flooding which affects structures such as houses, buildings, garages, etc. and not just land.
Top of Bank	The highest elevation of the bank adjacent to a channel.
Tributary	Smaller channels which contribute flow to a larger channel.
Watershed	The area contributing runoff to a channel or other drainage system. Interchangeable with Drainage Basin.