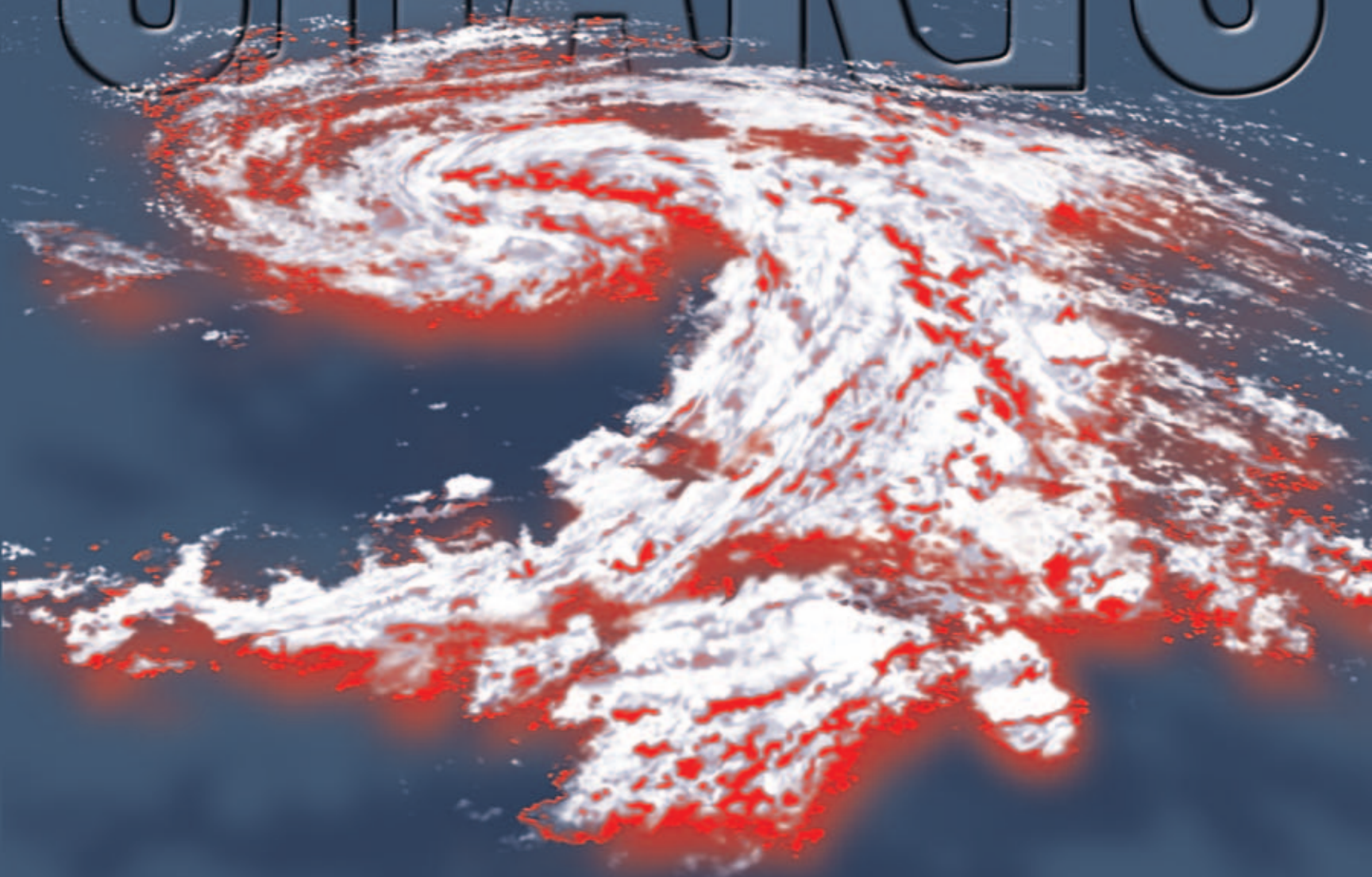


# OFF THE TROPICAL STORM **ALLISON** PUBLIC REPORT CHARTS



UNPRECEDENTED DAMAGE  
UNPRECEDENTED RELIEF  
UNPRECEDENTED RECOVERY



THE CATASTROPHE OF TROPICAL STORM ALLISON  
IS UNPRECEDENTED FOR ANY MAJOR METROPOLITAN  
U.S. CITY.

BUT, A STORM OF THIS MAGNITUDE WILL HAPPEN AGAIN.  
IT'S ONLY A MATTER OF WHEN...

...AND WHERE.



This report is a product of the Tropical Storm Allison Recovery Project, a partnership between the Federal Emergency Management Agency and the Harris County Flood Control District.





**W**hen Tropical Storm Allison suddenly formed 80 miles off the coast of Galveston, Texas, on Tuesday, June 5, 2001, no one expected that, five days later, it would go on record as one of the most devastating rain events in the history of the United States. Neither historical data nor weather forecasts could adequately predict this extraordinary storm that, before leaving Texas, would dump as much as 80 percent of the area's average annual rainfall over some Houston and Harris County neighborhoods, simultaneously affecting more than 2 million people. When the local rains finally eased, Allison had left Harris County, Texas, with 22 fatalities, 95,000 damaged automobiles and trucks, 73,000 damaged residences, 30,000 stranded residents in shelters, and over \$5 billion in property damage in its wake. Simply put, everything about Allison was “off-the-charts.”

One thing everyone in our area learned, without qualification, is that it does not take a “perfect storm” to be a perfect flood maker. Allison's slow and erratic progress – first moving inland to the north, then meandering back to the Gulf of Mexico – combined for a horrific one-two punch that dealt many localities in the Houston region a critical blow. After flooding about 1,000 residences during its initial pass through the area June 5-7, Allison returned June 8-9 to deliver its knockout shot. At one point during this second pass, 28 inches of rain fell during a 12-hour period just northeast of downtown Houston. Such incredibly intense cloudbursts over heavily populated areas set Allison apart from every storm to hit Texas in the past century.

The storm's ferocious intensity is not the only unique aspect of this story. Just as uncommon was the response directed by the federal, state and local relief agencies – not to mention the thousands of volunteers and everyday citizens who put the needs of their neighbors and even strangers ahead of their own. Millions witnessed the bravery and commitment displayed by rescue and relief workers, and anonymous individuals that unfolded on television, radio, and in newspapers day after day. Behind the scenes, as the aftermath of this drama played out, the [Federal Emergency Management Agency \(FEMA\)](#)

**Residences:**

Residences, as referenced in this document, are any dwellings in which people live, including single-family houses, apartment units, mobile homes and travel trailers.







At Flood Control District headquarters, Mike Talbott, Director (standing) and Steve Fitzgerald, Chief Engineer (front) monitor storm developments and track Allison's unprecedented path.

#### Tropical Storm Allison Recovery Project (TSARP):

The Tropical Storm Allison Recovery Project is a joint-effort project between FEMA and the District to gather information about Tropical Storm Allison and to create new flood hazard information for all of Harris County. It will result in the citizens of Harris County having more information about flooding and being better prepared for the next flood.




The District's Director of Communications, Fred Garcia, has been vigilant in keeping the community informed.



FEMA Director Joe Allbaugh (front), Houston Mayor Lee Brown (middle), Texas Governor Rick Perry (rear) and Harris County Judge Robert Eckels (next to Perry) prepare to assess damages caused by Allison's extraordinary rainfall in the Houston area.

and the [Harris County Flood Control District \(the District\)](#) were presented with a watershed moment. The lasting devastation and widespread impact of Allison persuaded officials to adjust their recovery strategies in fundamental ways – also putting people first and placing the worst-hit flood victims on a “fast track” to getting the help they desperately needed.

To this day, many remain vigilant in the post-storm recovery effort. Allison is no longer on the front page, but it's still the first thing on many people's minds as they start their days. Lives are still being rebuilt, thanks in part to volunteers and citizens who continue to lend a helping hand whenever needed. FEMA and the District continue to push forward with the Tropical Storm Allison Home Buyout Program, a voluntary program that will forever remove the hardest hit houses from harm's way and reduce the damages from future flooding. The efforts don't stop there, as FEMA and the District have also initiated the [Tropical Storm Allison Recovery Project \(TSARP\)](#), which utilizes highly innovative technology and techniques to better arm both officials and citizens with knowledge that will make Houston a more damage resistant community.

FEMA and the District hope this report will (1) provide information about the unprecedented scope of Allison's destruction, (2) address the questions of how and why the flooding happened, (3) empower citizens to prepare themselves for the next major storm to move through our area, and (4) outline the projects already in motion that are aimed at reducing future flood damages. The hard fact is: In addition to the many attributes that have attracted people to this area through the years, Houston and Harris County also have an established history of violent weather – the kind of history that frequently repeats itself. We should expect another deadly rainmaker to visit the area someday, so the primary question facing county residents, then, concerns what every resident can do to try to reduce the level of financial and emotional trauma caused by Tropical Storm Allison. Getting [flood insurance](#) immediately and having a family disaster plan in place are some of the first steps everyone should take. 



# PATH OF DESTRUCTION

## NATIONWIDE

**A**FTER TROPICAL STORM ALLISON MADE LANDFALL IN TEXAS, swept through the southeast U.S., moved into the Mid-Atlantic states, and migrated to the northeast off the coasts of Delaware and Maryland into the Atlantic Ocean on June 18, 2001, it had:

Claimed at least 41 lives nationwide, including 22 fatalities in Harris County and six in Philadelphia;

Flooded some 80,000 residences in Texas, including 73,000 in Harris County, in addition to hundreds of businesses in the greater Houston area;

Flooded approximately 3,000 properties in Louisiana, another 1,000 in Jacksonville, Florida, and thousands more in the eastern United States;

Caused 31 counties in Texas, 25 parishes in Louisiana, nine counties in Florida, five counties in Mississippi and two counties in Pennsylvania to be declared national disaster areas by the President of the United States;

Dumped 32 trillion gallons of rain – enough to meet U.S. water needs for an entire year; and

Earned the infamous distinction as the costliest tropical storm in U.S. history.

**O**riginally a mere “disturbance” passing through the Yucatan Peninsula into the Gulf of Mexico, Tropical Storm Allison formed Tuesday, June 5th, 80 miles off the Southeast Texas coastline. That night, it made landfall west of Galveston, with sustained winds of 48 miles per hour. Remaining over Harris County initially for four hours, it dumped as much as 12 inches of rain and flooded some 800 residences as it drifted



slowly to the north. During the next day, Allison would continue its inland track and eventually reach Lufkin on Thursday morning, where it appeared to weaken and stall. Even then, when the storm appeared to be moving away from Harris County, it still produced enough rainfall locally on Thursday the 7th to flood an additional 200 area residences.

Unfortunately, Allison slowly looped back to the southwest – drawing new moisture off the Gulf and re-intensifying. The heavy rains, both on Tuesday evening and Thursday morning, had saturated the ground, which caused immediate, excessive runoff when Allison returned to deliver the knockout punch Friday night and early Saturday morning. Friday night, as much as 28 inches of rain had fallen in parts of the county – flooding thousands of residences, stranding thousands of cars on hundreds of roads, and prompting Governor Perry and President Bush to declare Harris County a disaster area. On Saturday alone, units of the Coast Guard, the National Guard, and local emergency agencies rescued nearly 7,000 people. In addition to these documented rescues, individual citizens acting on their own rescued thousands of other flood victims. Monday night, some 30,000 Houston area residents sought refuge in 51 shelters countywide.

Leaving Texas, Allison produced rainfall amounts ranging from 20 to almost 30 inches over parts of southeastern Louisiana. The storm also brought heavy rains across the northern Gulf Coast, with amounts of 10 to 12 inches from Gulfport, Mississippi, to Tallahassee, Florida. Areas of North Carolina received as many as 21 inches of rain, while southeastern Pennsylvania recorded amounts of eight to ten inches - capping nearly two weeks of devastation. 🌀

#### Runoff:

Runoff is the water from rainfall not absorbed by the ground that flows into the local drainage system and, ultimately, streams and bayous.

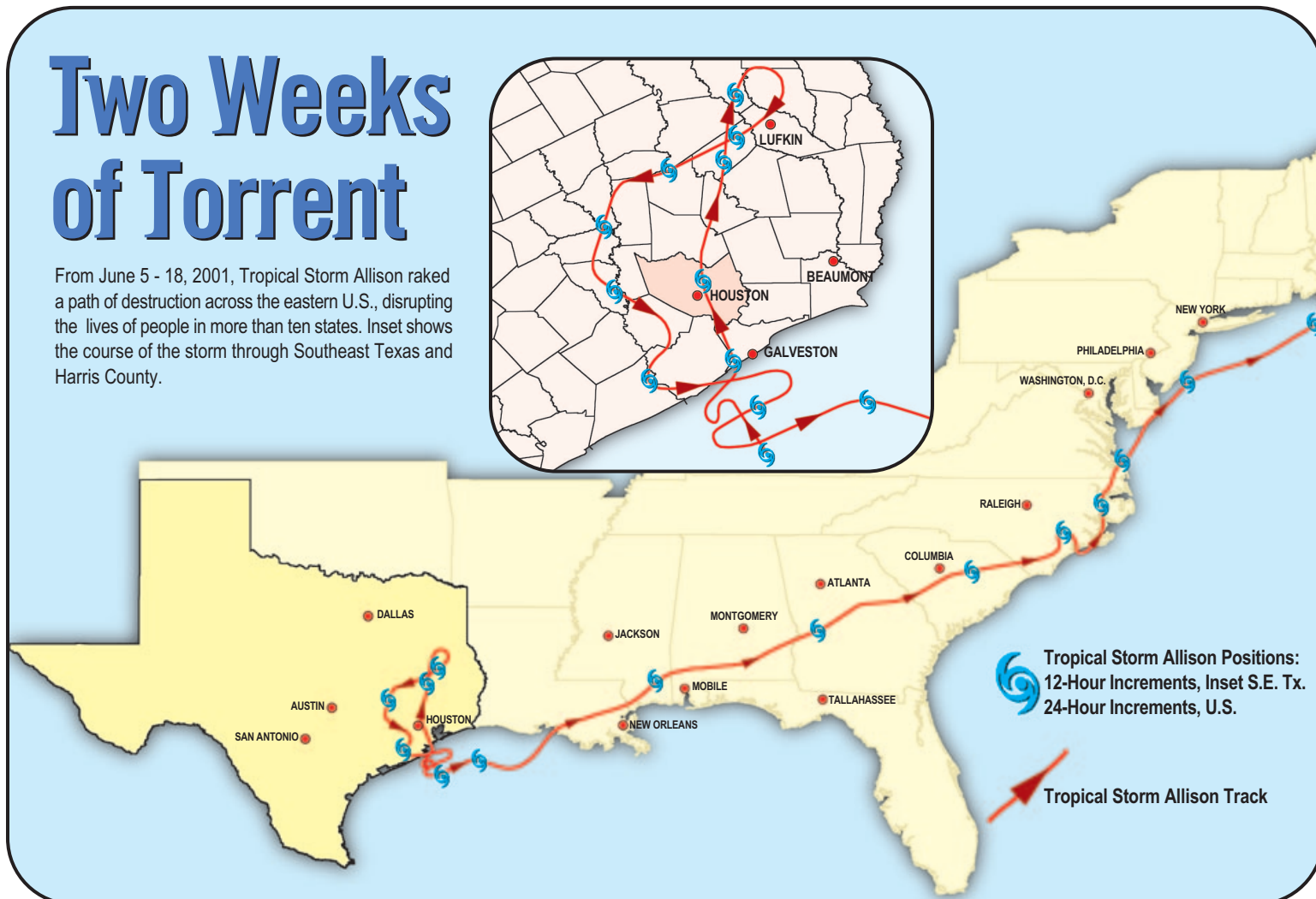
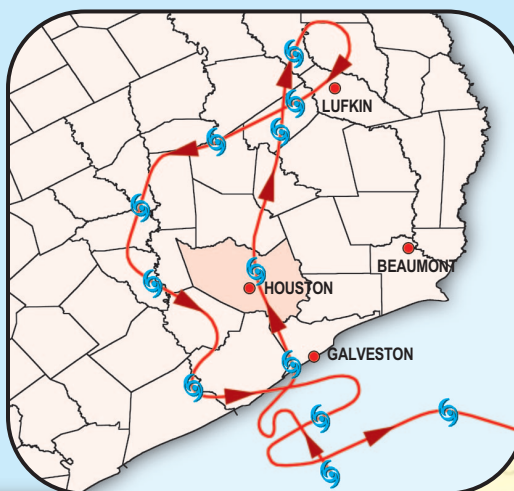
#### Disaster Area:

When a disaster is beyond the capabilities of state and local government to respond, the Governor must make a formal request to the President to declare the affected region a "disaster area." When the presidential declaration is enacted, federal assistance is made available to public and certain non-profit entities, as well as to individuals who were adversely affected by the disaster. The assistance is available in many forms, including monetary, temporary housing, crisis counseling and even legal assistance. For more on the Disaster Declaration process, go to:

[www.fema.gov/r-n-r/dec\\_guid.htm](http://www.fema.gov/r-n-r/dec_guid.htm)

## Two Weeks of Torrent

From June 5 - 18, 2001, Tropical Storm Allison raked a path of destruction across the eastern U.S., disrupting the lives of people in more than ten states. Inset shows the course of the storm through Southeast Texas and Harris County.

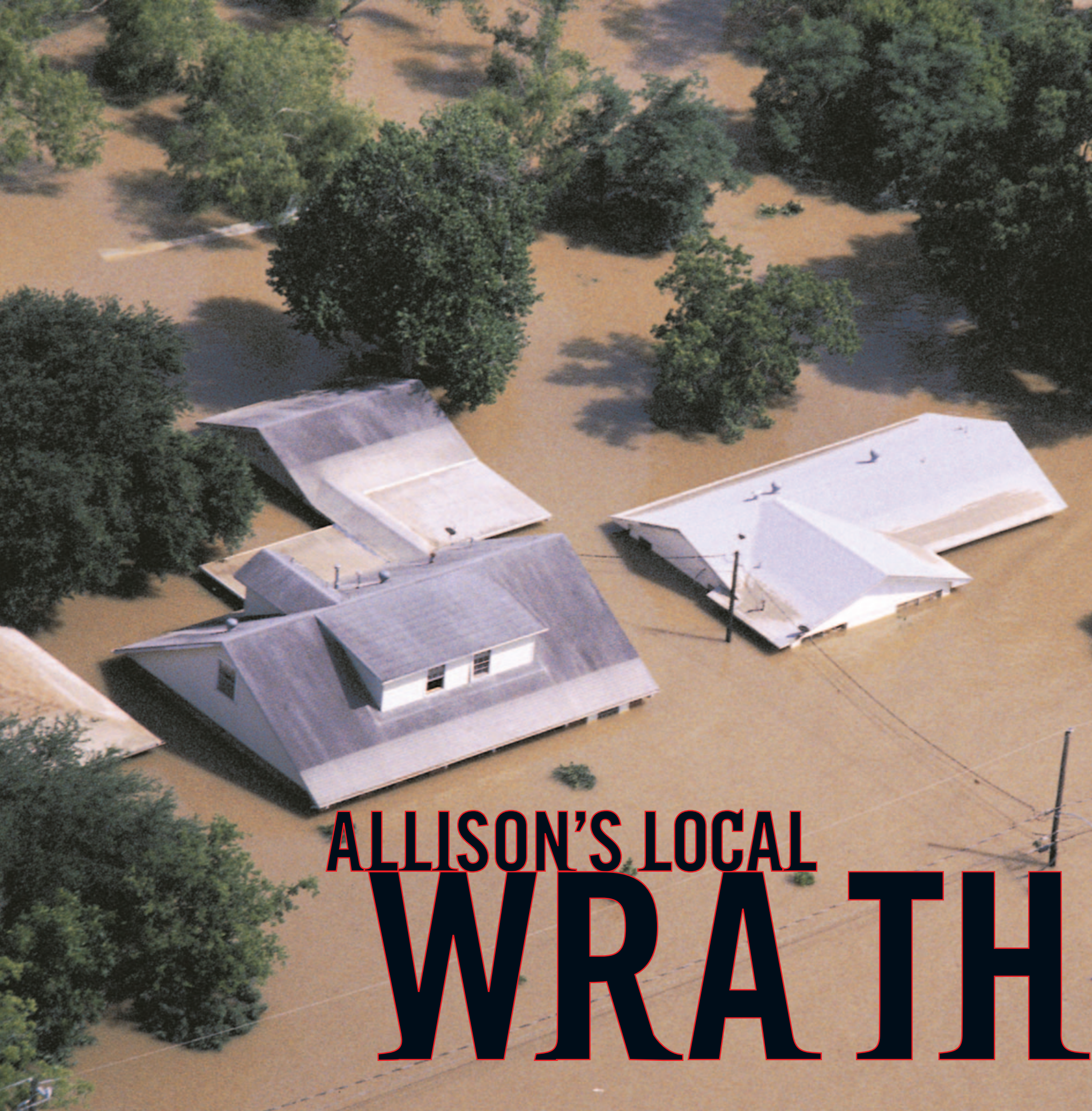






Although Houston and Harris County were the hardest hit, scenes like this were not uncommon in its path, as Allison left many communities reeling from extraordinary rainfall amounts.





# ALLISON'S LOCAL WRATH

**A**MONG HISTORICALLY SIGNIFICANT STORMS IN TEXAS DURING THE PAST CENTURY, ALLISON RANKS NEAR THE TOP IN TERMS OF HIGHEST RECORDED RAINFALL, WITH A MAXIMUM RECORDED RAINFALL OF 38 INCHES OVER FIVE DAYS. ONLY THREE OTHER SUCH EVENTS, INCLUDING TROPICAL STORM CLAUDETTE IN 1979, WERE GREATER RAINMAKERS THAN ALLISON DURING THE PAST CENTURY.

Claudette's 43-inch, one-day rainfall measured in Alvin remains the highest 24-hour rainfall ever recorded in the United States. The 40 inches recorded in the town of Thrall, near Austin, in 1921 and the 48 inches measured in Medina, near San Antonio, in 1973 were the other two events that exceeded Allison's rains. ►►►

*The Greens Bayou watershed (left) was one of the hardest-hit areas in Houston and Harris County. Flood levels in some portions of the watershed reached 15 feet or higher. Most other hard-hit areas of the county experienced flood levels of a few feet or less.*



What truly set Allison apart, however, was its intensity. Allison drenched large areas of the Houston area with 3 to 5 inches of rain per hour for several hours. Such volume and intensity ranks Allison as one of the worst rain-producing storms in U.S. history. It is likely that no urban area in the U.S. has ever experienced such a severe rainfall as Houston and Harris County did with Tropical Storm Allison.

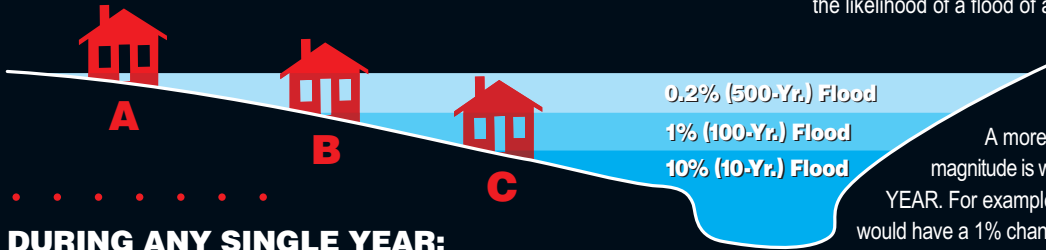
Over one-half of Harris County received rainfall totals that equaled or exceeded the **1% chance (100-year)** rainfall (see “What Does All This Really Mean” below). Much of this area received rainfall that equaled or exceeded the **0.2% chance (500-year)** rainfall. Furthermore, the 28 inches that fell on Greens Bayou late Friday night and early Saturday morning approached the physical limits of how much rain

can fall in that short of a time period in the southeast Texas region.

Fortunately, as bad as Allison was for much of Houston and the county, the worst of Allison’s rain fell on less populated areas and the runoff generated by Allison’s rain had a relatively short distance to travel before draining into the Houston Ship Channel and finally Galveston Bay. Some areas in west Harris County received only two inches of rain during the entire week. If the same intense rainfall that was recorded at Greens Bayou had occurred farther to the west, the runoff would have had to travel a greater distance to reach the Houston Ship Channel and Galveston Bay – across the most heavily populated area of the city. The damages, in this scenario, would have been much worse than those that Allison exacted on the area. ▶▶▶

**10-Year Flood: 10% Chance**  
**100-Year Flood: 1% Chance**  
**500-Year Flood: 0.2% Chance**

## What Does All This Really Mean?



### **DURING ANY SINGLE YEAR:**

- House A:**  
Has a **0.2%** chance of flooding.
- House B:**  
Has a **1%** chance of flooding.
- House C:**  
Has a **10%** chance of flooding.

### **DURING ANY 30-YEAR MORTGAGE:**

- House A:**  
Has a **6%** chance of flooding.
- House B:**  
Has a **26%** chance of flooding.
- House C:**  
Has a **95%** chance of flooding.

### **BUT...**

The deeper these houses are in the floodplains, the **WORSE** the damages will be.

You may have heard references to Tropical Storm Allison as a 100-year flood, or perhaps that it was even greater than a 500-year flood. The truth is, it doesn't make sense to attach just one of these terms to Allison, or to any flood for that matter. The rainfall amounts from Tropical Storm Allison varied so greatly in many parts of the county that different areas experienced different flood events, even though Allison was one storm. Flood events are often described by their anticipated rate of recurrence. Hence, the so-called "100-year flood." But, this can be confusing terminology relating to the likelihood of a flood of a specific size.

### **So, let's take it one-year-at-a-time.**

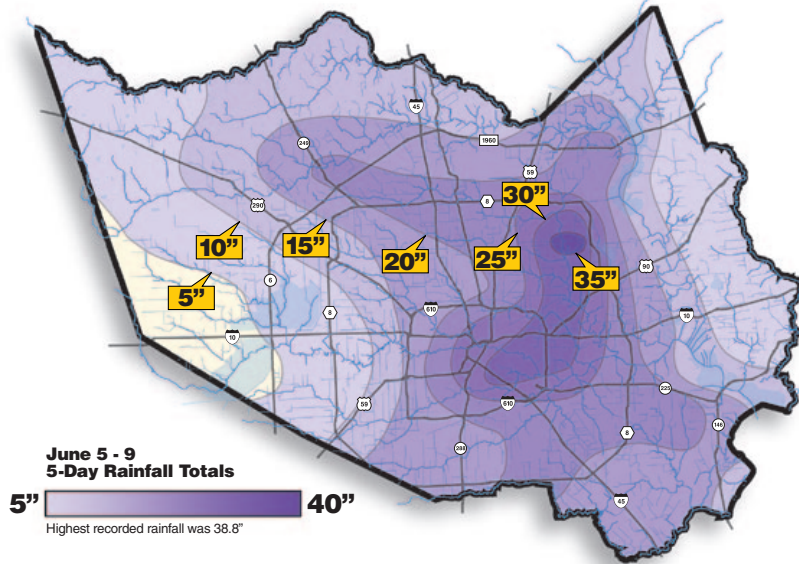
A more straightforward way to describe a flood's magnitude is with its likelihood of happening within ANY SINGLE YEAR. For example, a flood that is referred to as a "100-year flood" would have a 1% chance of being equaled or exceeded in a given year at a given location. Over thousands of years, such an event would occur, on average, about once every 100 years, which gives us the term "100-year flood." In other words, a 1% flood and a 100-year flood are the same thing. But 1% flood makes better sense for the course of our lifetime, and is a more straightforward term. Similarly, a so-called "500-year flood" has a 0.2% chance of being equaled or exceeded in any given year at a given location, or on average about once every 500 years. Let's stick with "0.2% chance."

The risk of experiencing any of these rare events increases when periods of more than one year are considered. Remember, it's not necessarily once-in-a-hundred years for that 100-year, or 1% event. It's at least a 1% chance EVERY year. As the years stack up, so do the chances. For a homeowner located on the very edge of the 1% floodplain, the increased likelihood of experiencing a 1% flood as the mortgage period progresses becomes quite a serious consideration. Over 30 years, this house has a 26% chance that it will experience at least one storm that is equal to or greater than the 1% event. But, these odds are only true for houses on the very edge of the 1% floodplain. If a house is located somewhere between the creek or bayou and the edge of the floodplain it would have a much higher chance of experiencing a flood. This house is not only in the 1% floodplain but also in a higher frequency floodplain, which greatly increases its chances of flooding. With odds like that – risking everything you own – what better reason is needed to buy flood insurance?

As you'll see throughout this document, portions of the county experienced a rain event that exceeded even our highest calculations. Tropical Storm Allison was truly "off the charts."

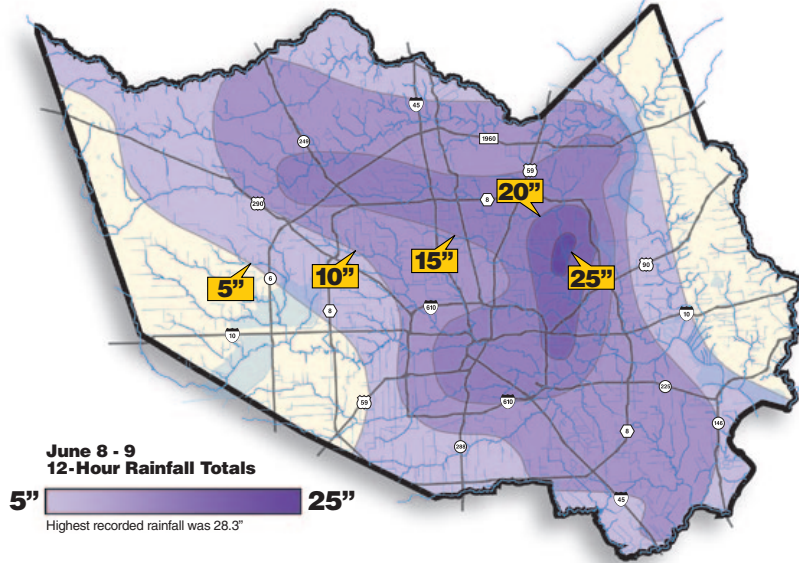
## 5-Day Rainfall Totals

June 5 - 9



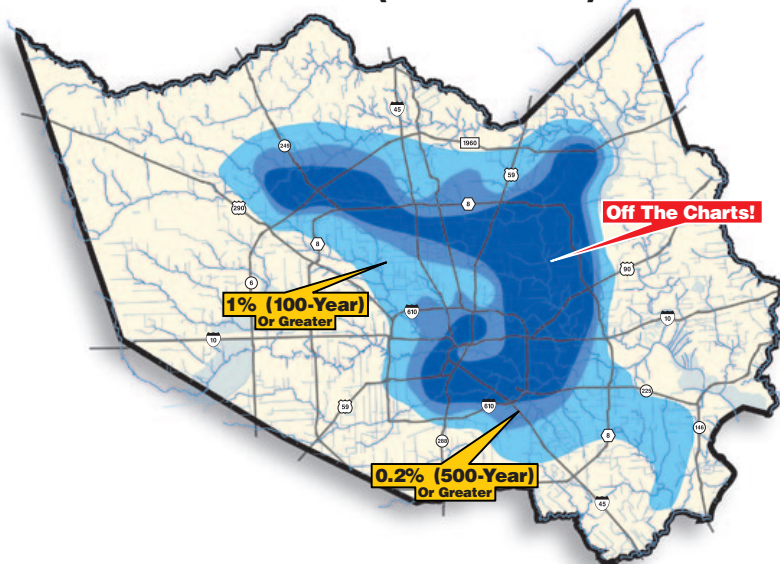
## 12-Hour Rainfall Totals

June 8 - 9



## Resulting Rainfall Magnitude

June 8 - 9 (12 Hr. Period)



## Water, Water Everywhere...

Everyone who lived in and around Houston last June will never forget the indelible images of flooding that they personally experienced, or saw on TV and in photographs. Many residents have personal accounts of how the devastation wrought by Allison impacted them directly, and still more have heard countless stories from friends, neighbors, relatives and associates. People who had never before experienced flooding, and did not even live in close proximity to a major creek or bayou, found water in their residences and businesses. Additionally, commuters were stranded and were forced to seek refuge in unfamiliar places while trying to get home to their families. Overall, areas in about one-half of Harris County had some residences or businesses that sustained flood damage.

So why did it happen? The flooding was primarily the result of large amounts of extremely intense rainfall that kept falling in the same area. For example, the central portion of the county received between 15 and 28 inches of rainfall Friday night into Saturday morning. In addition, the most intense rains fell over areas where the ground was already saturated from Allison's initial rainfalls earlier in the week. Although our region's





clay soils drain poorly, and typically only absorb about one inch of rainfall when dry, the fact that the ground was saturated did contribute to the flooding. The end result: Nearly all of this second massive rainfall immediately became stormwater runoff.

The storm sewers and roadside ditches in Houston and Harris County are typically designed to handle a rainfall rate of about one to two inches per hour. When the street drainage system capacity is exceeded, streets and roadside ditches store the excess runoff; but if enough additional rain falls, the excess runoff collects and flows overland, following the natural lay of the land. Eventually, yards and even residences may become flooded – even in areas significantly distant from a creek or bayou. In areas where Allison dumped one to two feet of water in 12 hours, many residences and businesses were flooded by the resulting overland flow. Overall, roughly 65 percent of the areas flooded from Allison were outside the 1% (100-year) floodplain.

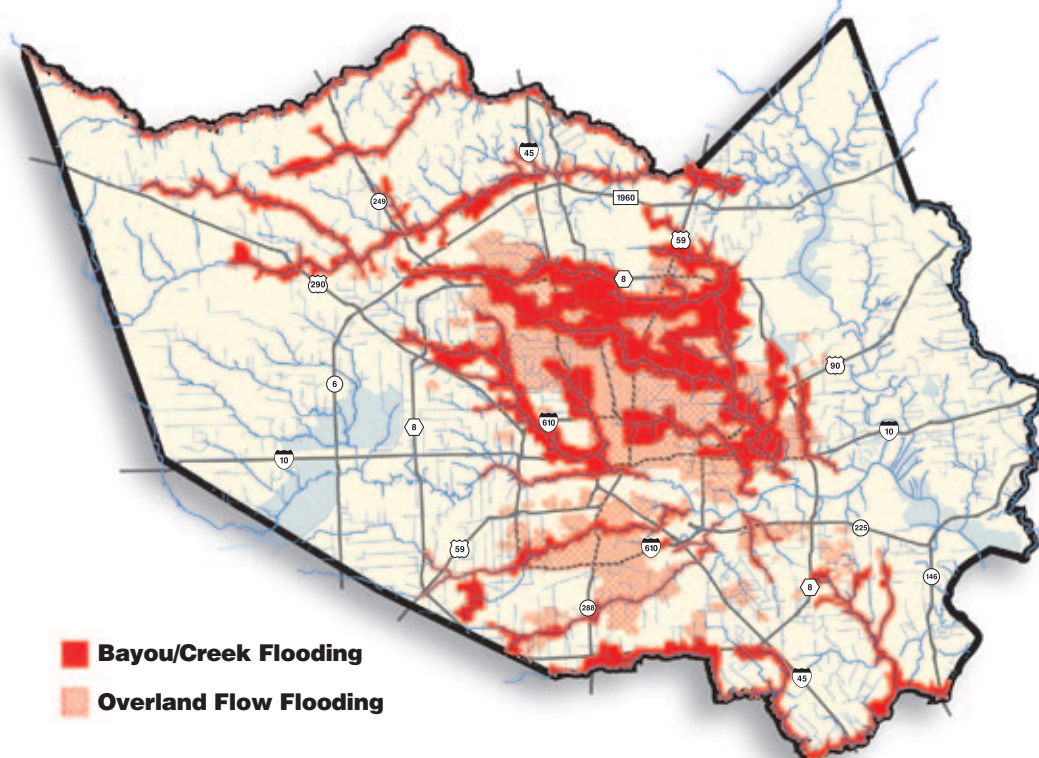
In addition to the flooding that resulted from the local drainage system being overwhelmed, there was also devastating flooding along many of the creeks and bayous in Harris County. Generally, flooding begins along Harris County’s creeks and bayous when there is 4 to 6 inches of rainfall in several hours. Channels that have been significantly enlarged can usually handle 6 to 8 inches of rainfall in several hours. Because Allison delivered “off the charts” rainfall amounts, the flooding was widespread. Many of the creeks and bayous in Harris County experienced flooding that ranged from “severe” to “record.” Sections of Armand Bayou, Brays

Bayou, Buffalo Bayou, Clear Creek, Cypress Creek, Little Cypress Creek, Garners Bayou, Greens Bayou, Halls Bayou, Hunting Bayou, Sims Bayou, Vince Bayou, White Oak Bayou, and Little White Oak Bayou all experienced flood levels in excess of the 1% (100-year) event. Twenty of the 45 U.S. Geological Survey flood gages in Harris County logged record flood levels. The data from some of these gages were used to calculate streamflow rates that proved to be twice as high as previous record rates.

Fortunately, the creeks, bayous, channels, and stormwater detention basins performed well and recovered quickly enough to move most of the water into Galveston Bay. Without such efficient performance, much of Houston would have remained under water for days, or even weeks. Throughout the week of Allison's fury, the creeks, bayous, and drainage channels sustained less major damage from flooding than might have been expected. The integrity of the creeks, bayous, and channels is partly attributable to the success of the District's vegetation establishment, maintenance and rehabilitation programs. Also, since this tropical system had low winds, debris in the creeks, bayous, and channels was minimal, and debris build-up at bridges did not contribute to flood levels.

Which area was hardest hit? The peak flow on Greens Bayou at Ley Road for Tropical Storm Allison was estimated to have been approximately 70,000 cubic feet per second. This means that approximately 525,000 gallons, or over 2,000 tons of water, was flowing down Greens Bayou every second during the peak flood period. This amount of water would fill the Reliant Astrodome in just over 16 minutes. 🌀

## Estimated Flood Damage Areas

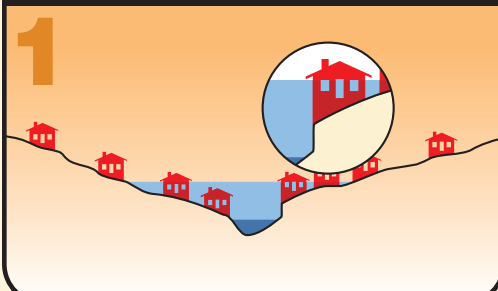


# Understanding Our Flooding

## HARRIS COUNTY'S 4 TYPES OF FLOODPLAINS

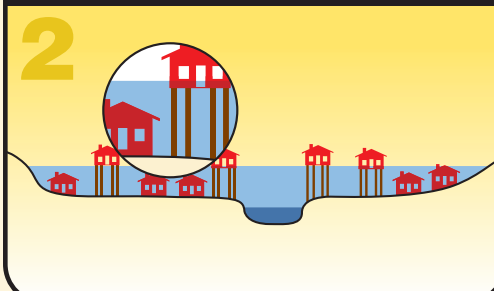
When flooding occurs, one question is always in the forefront: Why did it flood? Unfortunately there's not just one simple answer. Tropical Storm Allison was responsible for many types of flooding across Harris County. Basically, our county contains four types of floodplains, each with its own flooding characteristics. But, there is also a fifth "scenario" that occurs in many areas, due to the extraordinary intensity of some of the rainfall. In this fifth scenario, it's not necessarily an identifiable floodplain, but rather the street drainage system's inability to move stormwater to the nearest channel. There's simply too much rain in too short a time period. This exhibit explains the difference in our floodplains, and also what is known as ponding and overland flow – the "fifth scenario."

### VALLEY FLOODPLAIN



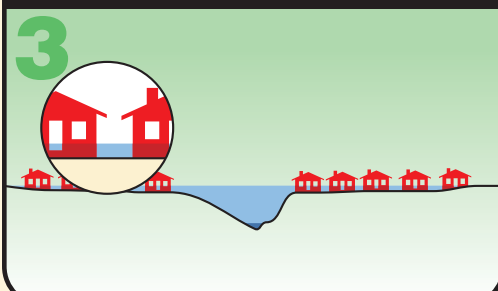
Valley floodplains are generally located in the northwestern portion of the county. The ground in the area is more "defined," with creek valleys. Flooding can be very deep and usually extends for a few days.

### MAJOR RIVER FLOODPLAIN



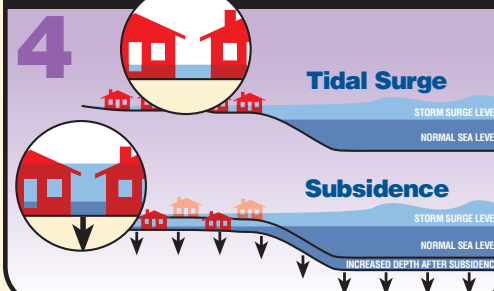
There is only ONE major river floodplain in Harris County. It is along the San Jacinto River. The floodplain is large, deep and swift, and flooding conditions may sometimes last a week or more.

### SHALLOW FLOODPLAIN



Shallow floodplains exist throughout much of the county and affect thousands of residences and businesses. When the channel capacity is exceeded, flooding begins, but usually lasts hours, rather than days.

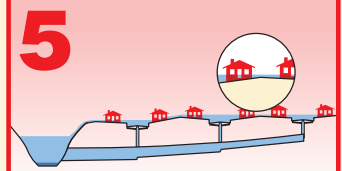
### COASTAL FLOODPLAIN



The top diagram shows coastal flooding when unusually high tides or hurricane surge can flood low-lying structures. Ground subsidence can result in more frequent and severe coastal flooding.

### THE FIFTH FLOODING SCENARIO

#### PONDING/OVERLAND FLOW



This type of flooding isn't restricted to any one area of the county. It can occur almost ANYWHERE. When intense local rainfall exceeds storm sewer or roadside ditch capacity, the water can "pond" in the streets deep enough to flood residences that are not even near a creek or bayou. The water will seek a path to the channel by flowing overland (sheet flow). When residences and other structures are in that path, additional flooding occurs. This type of flooding is not identified on the Flood Insurance Rate Maps, which is another reason why FLOOD INSURANCE is so important for everyone!





# special section

A WATERSHED-

BY-WATERSHED

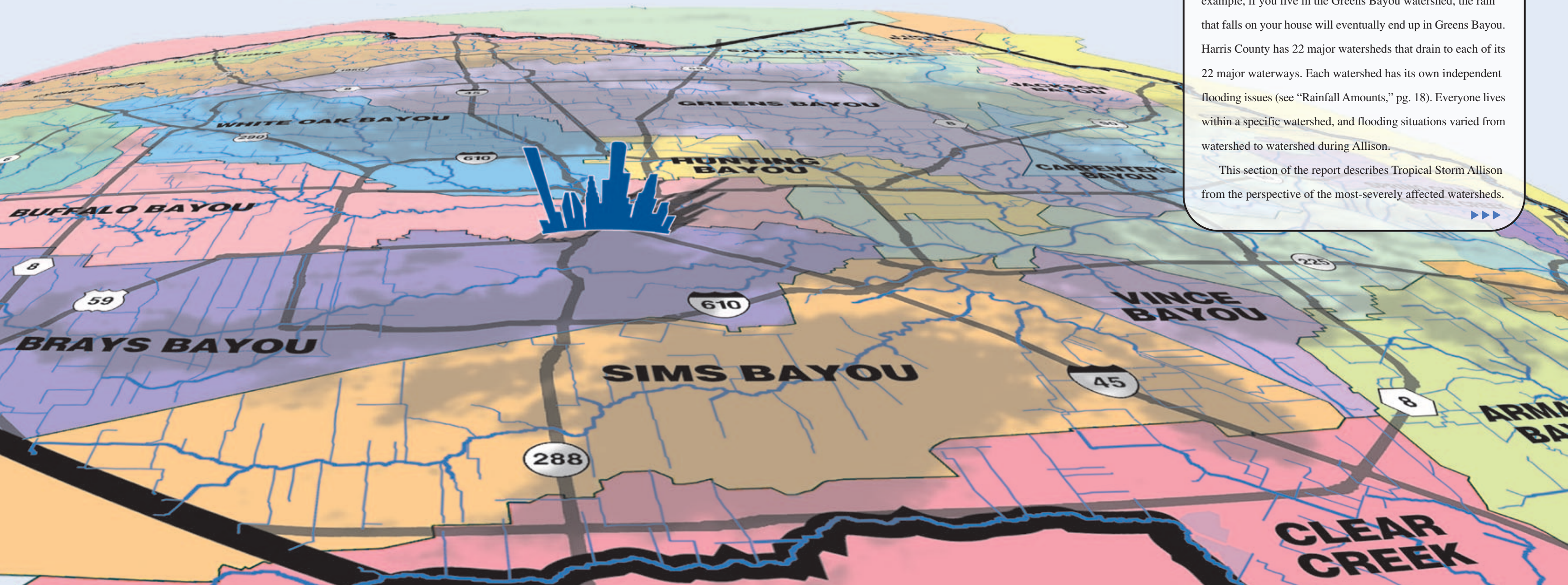
ACCOUNT OF ALLISON'S

FLOOD DAMAGES

**T**HE RECORD RAINFALL DELIVERED BY TROPICAL STORM ALLISON RESULTED IN FLOODING THAT AFFECTED MOST OF THE WATERSHEDS IN HARRIS COUNTY.

You may ask, "What exactly is a watershed?" Basically, a watershed is the land area that ultimately drains to a specific body of water – mostly creeks and bayous in Harris County. For example, if you live in the Greens Bayou watershed, the rain that falls on your house will eventually end up in Greens Bayou. Harris County has 22 major watersheds that drain to each of its 22 major waterways. Each watershed has its own independent flooding issues (see "Rainfall Amounts," pg. 18). Everyone lives within a specific watershed, and flooding situations varied from watershed to watershed during Allison.

This section of the report describes Tropical Storm Allison from the perspective of the most-severely affected watersheds.





## Greens Bayou and Halls Bayou Watersheds

Greens Bayou and Halls Bayou are located in the northeast and central parts of Harris County. Although Halls Bayou is often considered an independent watershed, it is a tributary of Greens Bayou and experienced much of the same devastation due to its proximity to that waterway. The Greens Bayou area experienced the most severe rainfall in the county during Tropical Storm Allison. Up to 28 inches of rain was recorded in a 12-hour period between Friday and Saturday – two-and-a-half times

the 1% chance (100-year) rainfall and approaching the physical limits of how much rain can fall during that amount of time for this region.

As a result, the Greens Bayou and Halls Bayou watersheds experienced some of the most devastating flooding ever recorded in Harris County, far exceeding previous record flood levels. Over 28,000 residences flooded within these watersheds, 13,000 of which were in the Halls Bayou watershed. Deep overland flow, caused by one to two feet of rainfall, occurred over most of the watersheds.

Floodwaters were so high in several places that water actually flowed overland from bayou to bayou – a very rare occurrence.

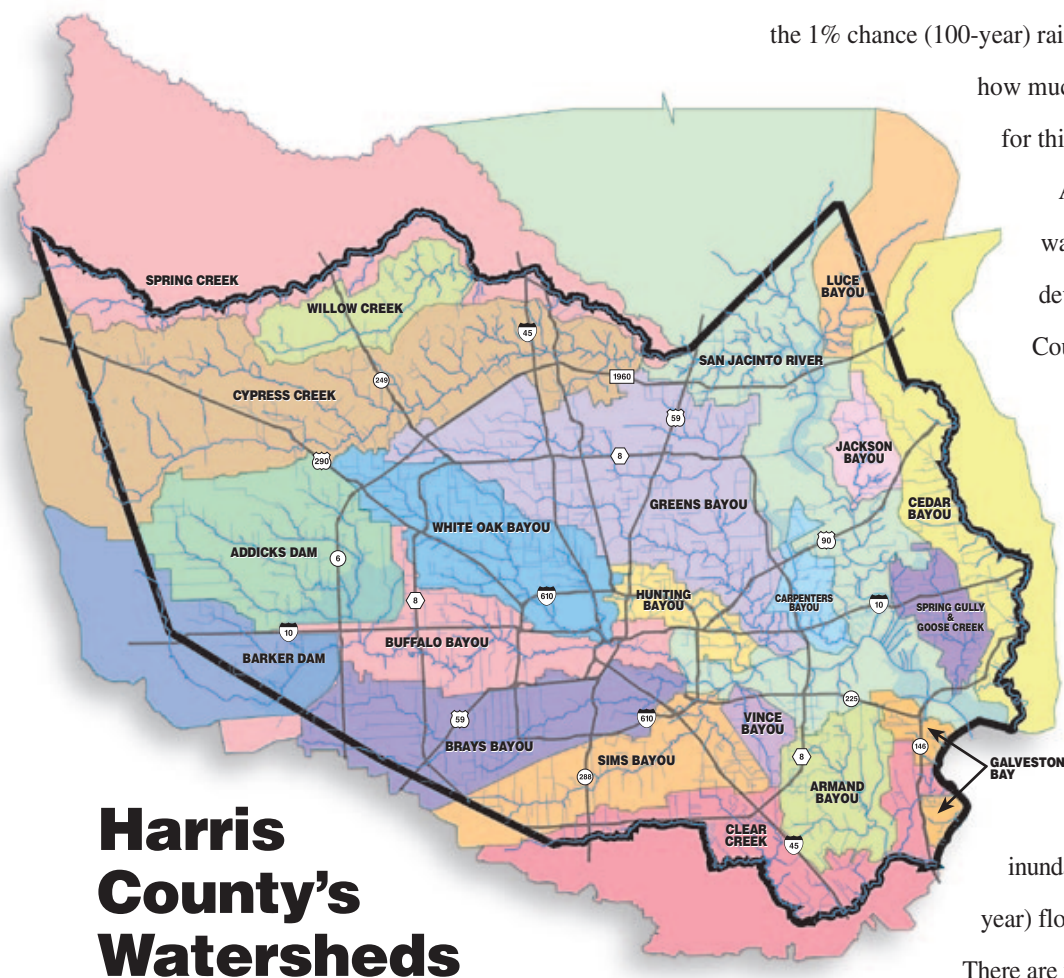
This severe overland flooding caused the inundation of many residences outside the 1% (100-year) floodplain.

There are three large regional detention basins along

Greens Bayou, along with numerous smaller detention basins constructed to offset excess stormwater runoff from new land developments. Each of these filled up early in the week, emptied, and then filled up again on Friday evening. They all held significant amounts of excess runoff that kept the flooding of residences and businesses from being much worse than it actually was.

## Hunting Bayou Watershed

Located just to the northeast of downtown Houston, the Hunting Bayou watershed also experienced some of the area's most intense rainfall. During a 12-hour period between Friday and Saturday, 14 to 22.5 inches of rain fell near Hunting Bayou. The recorded figure of 22.5 inches is two times the 1% chance (100-year) rainfall.





Flooding in this watershed was extensive, with severe and mostly record flood levels being recorded. Over 8,000 residences along the entire length of Hunting Bayou flooded, with the most devastating flooding occurring in neighborhoods near U.S. 59, Interstate 610, Interstate 10, and along the bayou. Additionally, deep overland flow inundated most of the upper watershed.

The upstream portion of Hunting Bayou has been enlarged over the years, which better enabled the watershed to drain excess runoff despite the bayou being overwhelmed. There is a small regional detention basin along Hunting Bayou, along with numerous smaller detention basins constructed to offset excess stormwater runoff from new land developments. Throughout the week of June 5th, as these detention basins filled up, emptied, and re-filled, each took in significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Clear Creek Watershed

The Clear Creek Watershed is one of the largest watersheds in the Houston Area. Clear Creek forms the southern boundary of Harris County with Brazoria and Galveston Counties. This watershed received two large rainfall events during Tropical Storm Allison. The first occurred on Tuesday, when between 5 and 11 inches of rain were recorded in a six-hour period and about 300 residences flooded. The second began Friday night, with 5 to 11 inches recorded in a 12-hour period. Since Clear Creek is a slow-draining stream, and since the ground was so saturated from the first rain event, the second rainfall severely aggravated the flooding situation.

Flood levels along Clear Creek were generally the second highest on record. Overall, approximately 3,000 residences flooded along Clear Creek and its tributary channels. This figure includes residences in Harris, Brazoria and Galveston Counties.

Some flood damage reduction can be attributed to a second channel designed and constructed by the [U.S. Army Corps of Engineers](#), in partnership with the Harris County Flood Control District, to allow for additional flow from Clear Lake to Galveston Bay. The gates on the second outlet channel were opened from late Tuesday evening through Thursday morning, and reopened late Friday morning until Monday evening to drain the runoff from the watershed and reduce flooding around Clear Lake. Tropical Storm Allison was a weak tropical system, so the storm surge was of short duration and minimal size. However, some flooding did occur in the communities around Clear Lake from both overland flow and the storm surge.

Numerous detention basins in this area offset excess stormwater runoff from new land developments. These detention basins filled up early in the week. Although, Clear Creek was slow to drain, most of the detention basins had emptied by Friday, and then filled up again on Friday evening. They all held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## White Oak Bayou Watershed

The White Oak Bayou watershed, located in central Harris County, also includes Little White Oak Bayou. Areas within this watershed received rainfall amounts of 8 to 15 inches over the 12-hour period Friday night, approaching or exceeding 1% chance (100-year) rainfall amounts.

Record flood levels were recorded along the full length of Little White Oak Bayou, while flood levels along White Oak Bayou varied from moderate to record, depending on the location. Over 11,000 residences were flooded within the White Oak Bayou watershed.

White Oak Bayou has been significantly enlarged over time. During the late 1960s and early 1970s, the U.S. Army Corps of Engineers, in cooperation with the Harris County Flood Control District, made the most dramatic enlargement starting near its confluence with Buffalo Bayou and extending 10 miles upstream to Cole Creek. The District also executed additional channel enlargements between West Tidwell and North Houston-Rosslyn Road in the 1990s. Although this enlarged downstream channel has a relatively high flow capacity, it was no match for the intense rainfall delivered by Allison.

There are also six large regional detention basins along White Oak Bayou, along with numerous smaller detention basins constructed to offset excess stormwater runoff from new land developments. These detention basins all held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Brays Bayou Watershed

Located in the south central portion of Harris County, the Brays Bayou watershed was the focus of some of the most far-reaching damages witnessed during Tropical Storm Allison. Rainfall amounts in the watershed varied greatly, from 2 to 13 inches Friday and Saturday alone. Overall, more than 6,000 residences flooded near and along Brays Bayou, most of which were located inside the 610 loop. The area near downtown was the hardest hit within the watershed, which is where the Texas Medical Center (TMC) is located. ►►►

The TMC experienced record flooding from Allison after the area received nearly eight inches of rain in a three-hour period and 12 inches in a 12-hour period. The intensity of the rains overwhelmed the underground storm sewer, known as Harris Gully, that drains much of that area into Brays Bayou. Although Brays Bayou floodwaters did not inundate the TMC, it did slow the drainage from the Harris Gully watershed. The TMC was inaccessible for many hours on Saturday and several hospitals were shut down for days.

The U.S. Army Corps of Engineers, in cooperation with the Harris County Flood Control District, straightened and enlarged almost the entire length of Brays Bayou in the 1950s and 1960s. The resulting channel possesses the capacity necessary to move stormwater runoff into the Houston Ship Channel in an extremely efficient manner. Without this channel, the flooding would have been much more widespread and for a much longer duration. Two high capacity stormwater detention basins located near West Sam Houston Parkway provided additional flood damage reduction within the watershed. However, this flood damage reduction was minimal, due to the fact that the heaviest rains fell far downstream, east of the location of these detention basins. In addition, numerous smaller detention basins have been constructed to offset excess stormwater runoff from new land developments. These detention basins filled up early in the week, emptied, and then filled up again on Friday evening. They all held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Sims Bayou Watershed

Located in southern Harris County, south of Brays Bayou, the Sims Bayou watershed was hit with three rounds of rainfall during Tropical Storm Allison – 4 to 8 inches in a 12-hour period on Tuesday, 3 to 5 inches in a six-hour period on Wednesday, and 6 to over 13 inches in a 12-hour period, starting late Friday night. Since Sims Bayou is a fast-draining system, stormwater levels were able to fully recede between each of these rainfall events.

However, severe flooding did occur within the watershed in areas west of Almeda Road – due, for the most part, to such intense rainfall amounts occurring over a short period. Over 6,000 residences flooded, some of them twice, with the highest flood levels recorded after the Friday and Saturday rainfall.

Although some of the most intense rainfalls occurred over the eastern portion of the Sims Bayou watershed, minimal flooding was recorded in this area, due to the successful construction of the downstream portion of the Sims Bayou Federal Flood Control Project – an ongoing U.S. Army Corps of Engineers and Harris County Flood Control District project. Unfortunately, residences in upstream areas flooded even though

Sims Bayou stayed in its banks. This flooding occurred because of the high-intensity rainfalls overwhelming the local drainage system.

Two large stormwater detention basins located along upper Sims Bayou, along with numerous smaller detention basins constructed to offset excess stormwater runoff from new land developments, helped to reduce potential flood damage in the area. These detention basins filled up and emptied three times during the week. They all held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Armand Bayou Watershed

The Armand Bayou watershed, located in southeast Harris County, received 5 to 6 inches of rain in a 12-hour period on Tuesday, and 7 to 13 inches in a 12-hour period, starting late Friday night.

Low-lying areas flooded from the Tuesday rains, but the majority of record and severe flooding occurred after the Friday-Saturday rains. Almost 2,000 residences flooded within the watershed.

Armand Bayou drains into Clear Lake. A second outlet from Clear Lake to Galveston Bay built by the U.S. Army Corps of Engineers, in cooperation with the Harris County Flood Control District, helps drain the high flows from Armand Bayou into the Galveston Bay. There are also three regional detention basins located within the Armand Bayou watershed, along with numerous smaller detention basins constructed to offset excess stormwater runoff from new land developments. These detention basins filled up early in the week, emptied, and then filled up again on Friday evening. They all held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Buffalo Bayou Watershed

The Buffalo Bayou watershed runs through the central portion of the county, starting west and flowing through downtown Houston, ultimately to the Houston Ship Channel. Very intense rain fell over the eastern portion of the watershed, while the western portion experienced only minimal rainfall amounts.

Ten to 15 inches of rain fell over the area between the Houston Ship Channel and Shepherd Drive in a 12-hour period, starting late Friday night. Over 2,500 residences flooded within the watershed, along with portions of downtown Houston.

The flooding in downtown Houston was the most severe since the construction of Addicks and Barker Reservoirs in the 1940s. Although only



a small portion of downtown actually flooded, stormwater entered the underground tunnels and parking garages, which eventually led to the flooding of some buildings. In addition, all of the major highways and roadways going into downtown flooded. As was the case throughout much of the county, the initial flooding in downtown Houston was largely due to the intense rainfall, producing runoff that simply could not get into the bayou fast enough. Later, flooding occurred because the bayou rose from flows coming from White Oak Bayou. Since very little rain fell in the westernmost portion of the watershed, the Addicks and Barker reservoirs provided only minimal flood damage reduction.

Numerous small detention basins offset excess stormwater runoff from new land developments. These detention basins held excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Cypress Creek Watershed

The Cypress Creek Watershed extends westward from its confluence with Spring Creek across northern Harris County. Most of Cypress Creek experienced significant rainfall, between 3 and 18 inches over a 12-hour period, starting late Friday night, with most of the watershed receiving at least nine inches or more.

Both Cypress and Little Cypress Creek experienced severe flooding downstream of U.S. Highway 290, with over 1,000 residences being flooded.

Over the past ten years, to reduce flood damages, the District – in various partnerships with FEMA, the U.S. Army Corps of Engineers and the Harris County Engineering Department – has purchased approximately 120 of the lowest houses along Cypress Creek. It is estimated that most, if not all, of these houses would have flooded from Tropical Storm Allison.

Two regional detention basins located between State Highway 249 and U.S. Highway 290, along with numerous smaller detention basins, offset excess stormwater runoff from new land developments. These detention basins held excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Vince Bayou Watershed

Located in southeast Harris County, this watershed experienced severe rainfall on Tuesday, but the most intense rainfall occurred when 10 to 14 inches fell within a 12-hour period, starting Friday night. Record flooding was recorded along the entire length of Little Vince Bayou and portions of Vince Bayou, with just under 1,500 residences being damaged by floodwaters, primarily from overland flow.

In the early 1970s, the U.S. Army Corps of Engineers, in partnership with

the Harris County Flood Control District, completed channel enlargement projects along Vince and Little Vince bayous that resulted in a higher carrying capacity and tremendous flood damage reduction benefits for the area. However, the rainfall from Allison was so intense that it even exceeded the capacity of these modified channels.

There are numerous small detention basins constructed to offset excess stormwater runoff from new land developments. These detention basins filled up early in the week, emptied, and then filled up again on Friday evening. They all held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Carpenters Bayou Watershed

The Carpenters Bayou watershed is located in the eastern portion of Harris County. Like so many others, this watershed received its heaviest rainfall amounts starting on Friday evening, when between 8 and 14 inches fell in a 12-hour period, starting late Friday night – flooding approximately 500 residences.

Two large regional detention basins are located along Carpenters Bayou near U.S. Highway 90. Numerous smaller detention basins have also been constructed to offset excess stormwater runoff from new land developments. These detention basins filled up on Friday evening, and held significant amounts of excess runoff that would have otherwise contributed to additional flooding of residences and businesses.

## Spring Creek, Willow Creek, and the San Jacinto Watersheds

Located in northern Harris County, Willow Creek drains into Spring Creek and, ultimately, the San Jacinto River. The San Jacinto River flows generally north to south through the eastern portion of Harris County into the Houston Ship Channel.

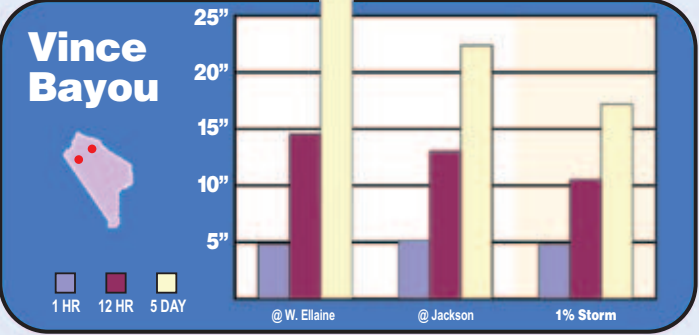
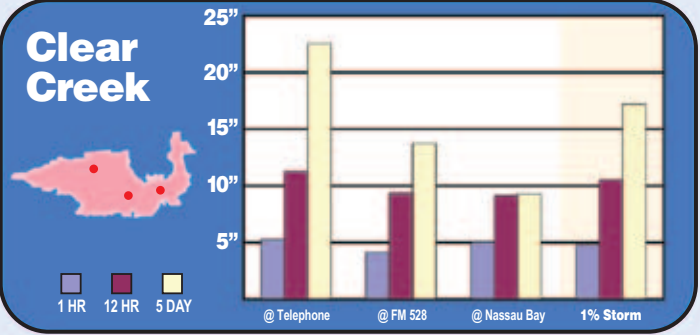
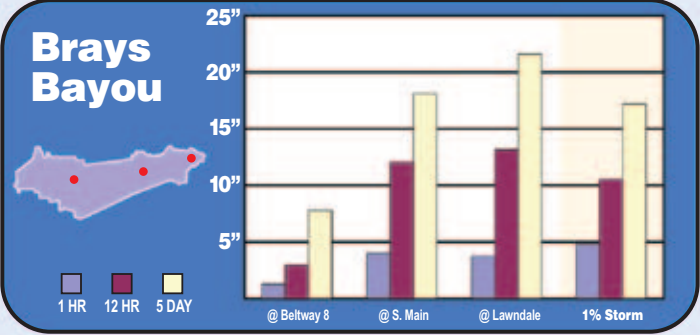
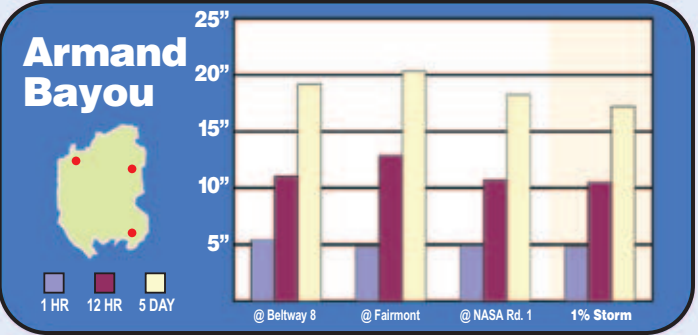
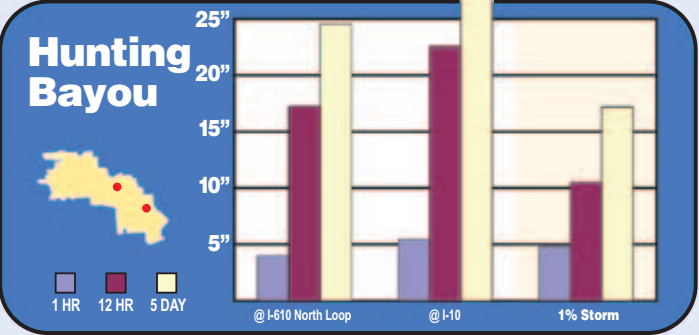
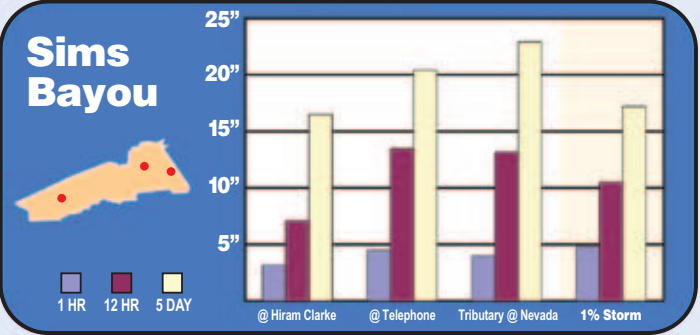
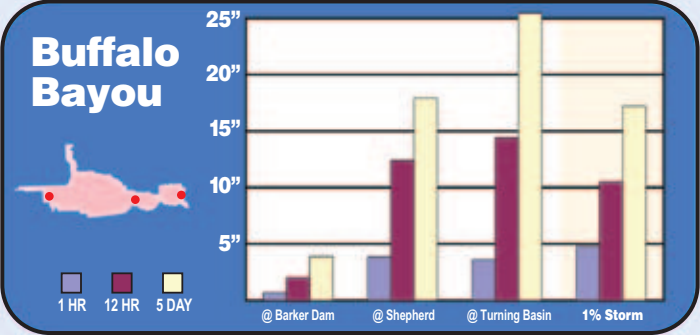
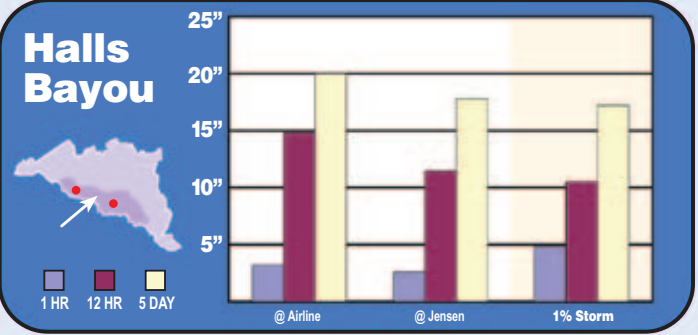
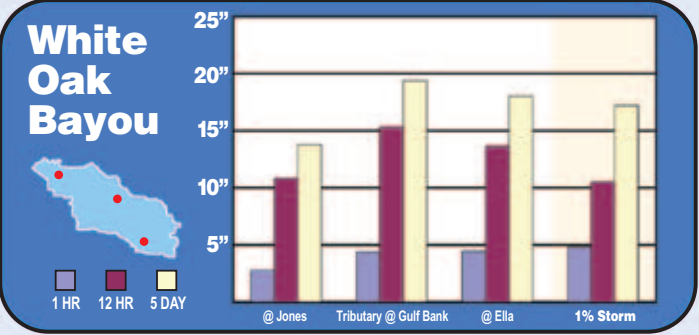
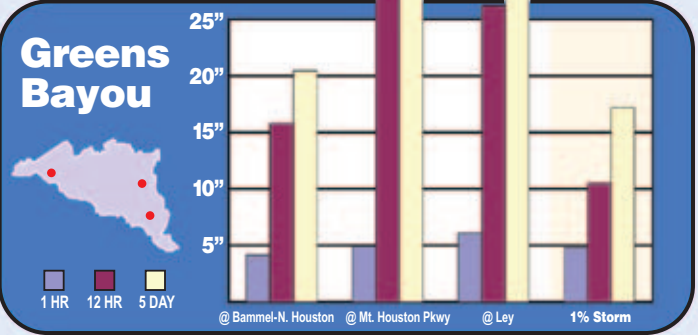
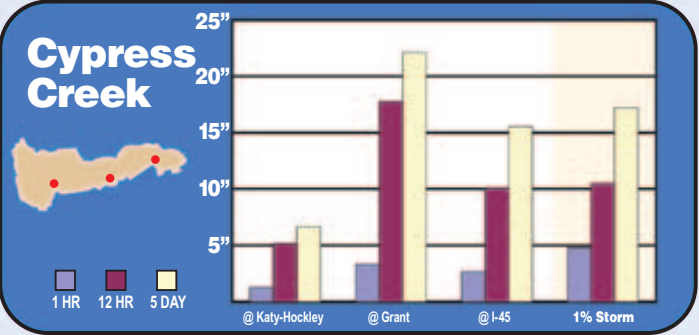
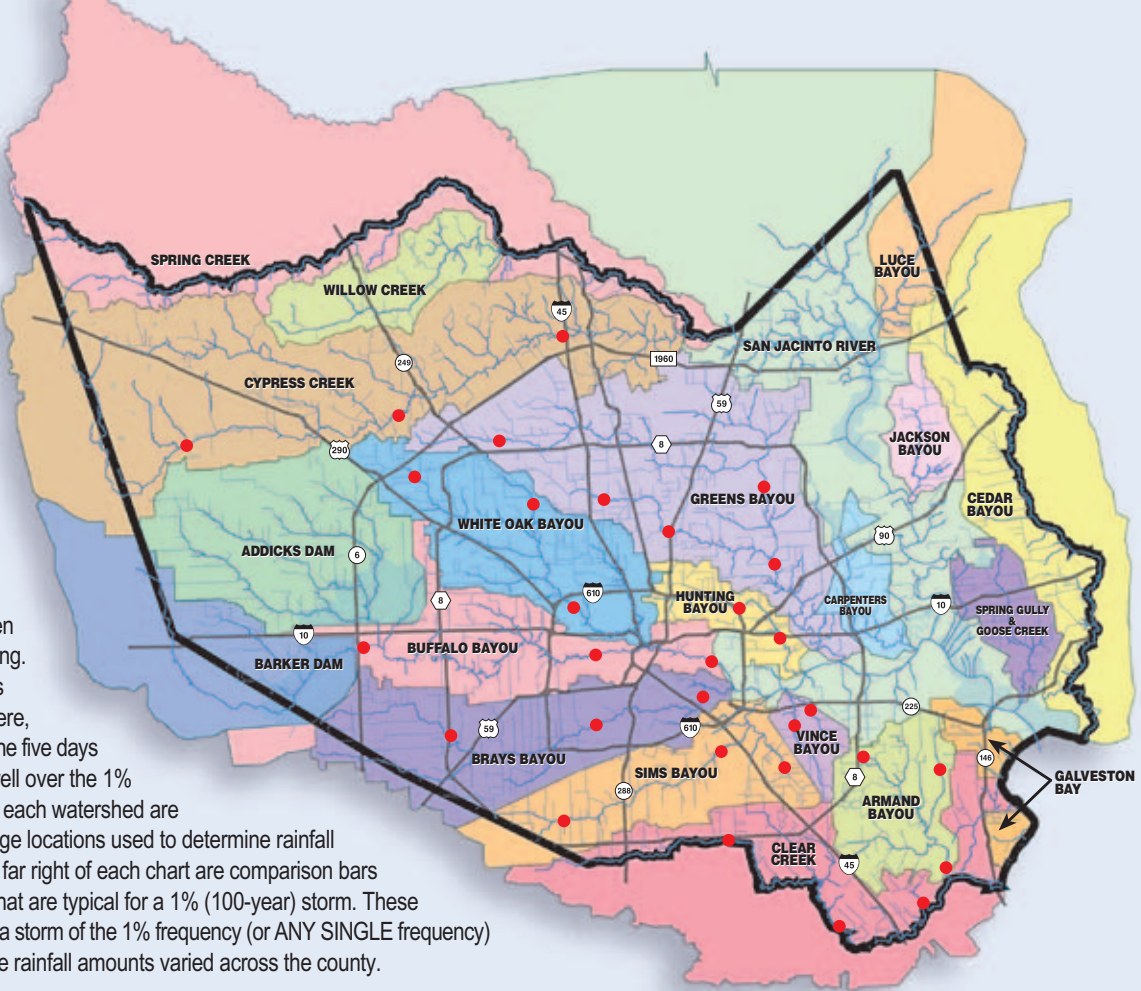
Rainfall along these streams ranged between 5 and 11 inches over a 12-hour period Friday night, averaging about eight inches during that period. Moderate flooding was observed in the Willow Creek and Spring Creek watersheds, with about 100 residences flooding near Willow Creek and 300 residences flooding near Spring Creek, including residences in neighboring Montgomery County. More significant flooding occurred near the San Jacinto River, with over 3,000 residences damaged from floodwaters.

Over the past ten years, to reduce flood damages, the Harris County Flood Control District – in various partnerships with FEMA, the U.S. Army Corps of Engineers and the Harris County Engineering Department – has purchased approximately 300 houses along the San Jacinto River. It is estimated that many of these residences would have flooded from Tropical Storm Allison.



# Rainfall Amounts for Harris County's Most Severely Affected Watersheds

These charts depict the watersheds in Houston and Harris County that were most severely affected by the rains from Tropical Storm Allison. Of the 22 major watersheds in Harris County, eleven experienced severe to record flooding. In several of these watersheds, it is evident that the rainfall amounts were, quite literally, "off the charts." Over the five days in June, many of them sustained well over the 1% (100-year) rainfall amounts. Within each watershed are RED DOTS ● that depict rain gauge locations used to determine rainfall amounts for the bar charts. On the far right of each chart are comparison bars that illustrate the rainfall amounts that are typical for a 1% (100-year) storm. These charts show that labeling Allison as a storm of the 1% frequency (or ANY SINGLE frequency) would not be accurate, because the rainfall amounts varied across the county.



## THE "MAX"

There is, theoretically, a maximum amount of rainfall that can be physically produced by a storm system at a given location, in a given period of time. The National Weather Service refers to this amount of rainfall as the **Probable Maximum Precipitation (PMP)**. For the Harris County area, the PMP is estimated at just over 31 inches during a 12-hour period. Note that these charts illustrate how several rain gauges in the most-devastated parts of the county recorded values that were approaching the PMP. These gauges underscore the "off the charts" nature of Tropical Storm Allison.



# Unprecedented Damages AND Unprecedented Recovery



Photo: Houston Chronicle



Photo: Bob Eury, Central Houston, Inc.



Photo: Houston Chronicle



Photo: Houston Chronicle



Photo: Houston Chronicle

**T**HERE IS NO PRECISE WAY TO COUNT THE LOSS, HURT AND PLAIN FRUSTRATION HARRIS COUNTY RESIDENTS HAVE EXPERIENCED AS A RESULT OF TROPICAL STORM ALLISON.

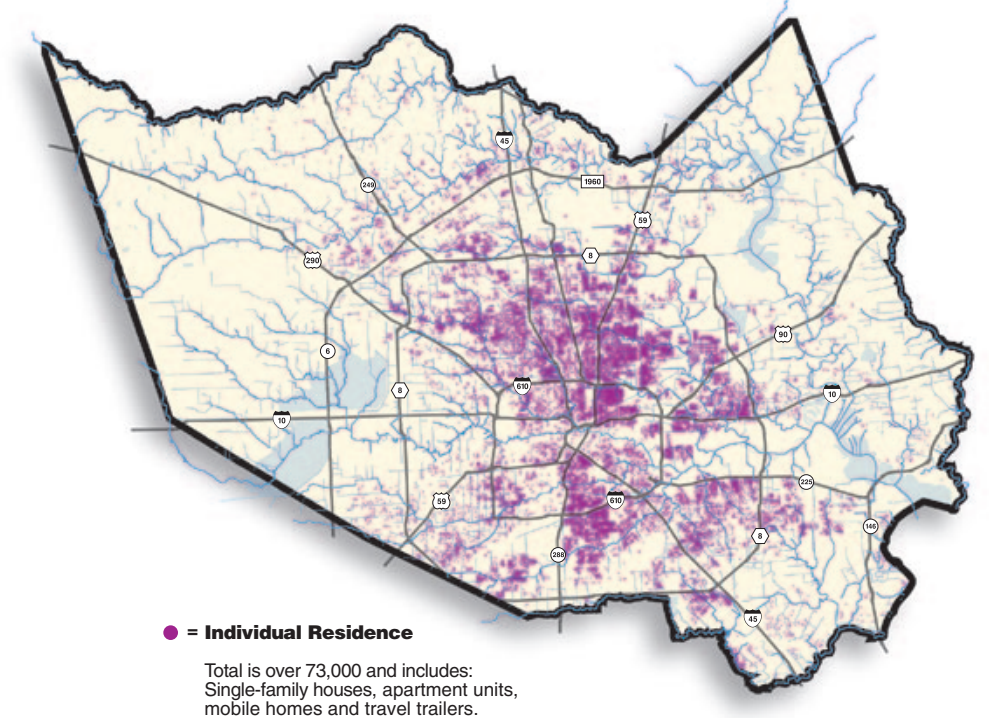
There is simply no accurate way to measure the 22 lives the storm claimed, the priceless possessions and precious mementos it ruined, and the subsequent worry and hardship it has randomly cast upon so many families and business owners. Furthermore, there is no scientific method to calculate the sense of community lost with the dozens of neighborhoods Allison destroyed.

Yet, to start placing the damage Tropical Storm Allison caused in Houston and Harris County into perspective, consider the following facts:

- Total damages directly associated with Tropical Storm Allison are estimated to be over \$5 billion in Harris County alone.
- Of the 73,000 flooded residences, some were completely destroyed, while over 2,000 sustained what is termed as “substantial damage” (damage that is 50 percent or greater than a structure’s pre-flood value, not including land).
- Flooding in downtown Houston was responsible for tens of millions of dollars worth of damages to buildings, the tunnel system and related infrastructure, and parking garages – not to mention the displacement of many workers from their places of business and lost productivity.
- Four hospitals in the Texas Medical Center (TMC) were closed temporarily because of flooding and damage to electric service equipment. Although this flooding did not cause loss of life at the TMC, it certainly made situations difficult for affected patients and healthcare providers alike. Also, of the county’s two level-one trauma centers, one was closed while the other was at times unreachable due to the flooding.
- Approximately 95,000 vehicles sustained \$450 million in damages in Harris County. The damages resulted from the flooding of vehicles at residences, in underground parking garages and along flooded roads and highways.
- State and local highway facilities sustained approximately \$5.5 million in damages. Impassable highways and major roads paralyzed many parts of the city throughout Allison.

- About 200 Houston area schools and three major Houston college campuses sustained significant damage. Rice University and Texas Southern University experienced significant flood damage, while the University of Houston main campus was especially hard hit. Of the University of Houston’s 105 buildings, 90 sustained water damage – with 55 critically affected. The total damages to area schools are estimated at over \$250 million.
- Damages to Harris County’s facilities have reached approximately \$40.5 million, with the Criminal Justice Center facing repairs and flood proofing costs of \$19.6 million. Eleven other county buildings were also damaged.
- The City of Houston has spent over \$53 million to repair city-owned facilities and expects the total damage figure to approach \$80 million. ▶▶▶

## Flood-Damaged Residences







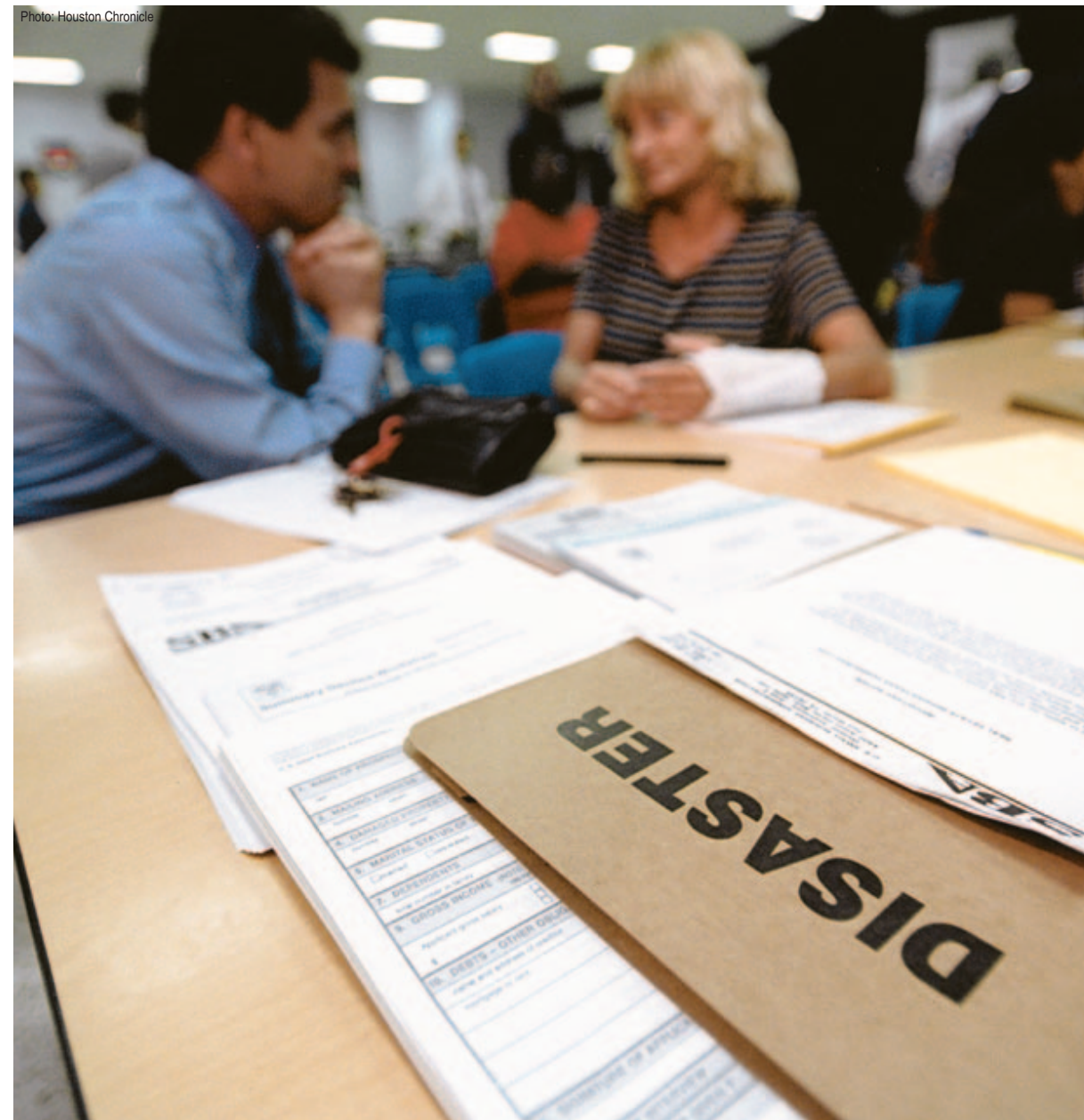
## Helping Hands Aboard...

If true character shows through in the face of adversity, Houstonians once again demonstrated great courage and compassion while helping their fellow citizens during and after the devastation of Tropical Storm Allison. There are countless stories of Houstonians going the extra mile to assist one another during this perilous time. Even as the rains continued the unstoppable destruction, people were being rescued from their homes and cars. On Saturday alone, fire and police departments and other emergency personnel rescued over 7,000 people – and friends, neighbors, and concerned citizens rescued thousands of other flood victims throughout the county. In the end, the Red Cross, Salvation Army and others had opened 51 shelters countywide, and more than 30,000 Houstonians had sought refuge in those shelters.

By Saturday afternoon, many area churches and relief organizations had begun to collect food and clothing for the displaced victims of the flooding – and the immediate response was overwhelming. Lakewood Church, for example, collected so much food, clothing and supplies that they had to turn donors away.



Immediate relief response after Tropical Storm Allison was unprecedented for this area. Donations at some locations were so overwhelming that the donors had to be turned away.



Financial relief was swift in the fallout of the storm. Major relief efforts have amounted to over a billion dollars.

In the days and weeks following the flooding, the response to those impacted by Allison's devastation took the form of financial assistance. FEMA established ten Disaster Recovery Offices and one mobile Disaster Recovery Office. As of December 2001, almost 120,000 residents of Southeast Texas had registered for assistance, and \$1.05 billion in federal and state disaster assistance had been provided to affected residences and businesses. This figure includes \$179.9 million to help with temporary housing costs and \$389.6 million in U.S. Small Business Administration (SBA) low-interest disaster relief loans. The State of Texas also has disbursed \$239.6 million in grants for essential disaster-related needs unmet by other assistance programs.

These numbers do not even include the money paid out to Texas residents through flood insurance policies, making Allison the first "billion-dollar" storm for flood insurance claims alone.

Others provided assistance as well. Charitable organizations collected food and clothing and distributed these to flood victims. Churches organized work crews to help out with repairs of flooded residences, while neighborhoods banded together to help flood victims. It should not surprise anyone to know the level of giving and commitment has not lessened: In January 2002, a United Way concert to re-focus other local efforts on the continuing plight of Allison's victims raised over \$1.5 million. ▶▶▶

## Damages to the Texas Medical Center Reach Far Beyond Our Community

The Texas Medical Center is the largest collection of medical facilities in the world. It houses 13 hospitals, two medical schools and four nursing schools. The Houston area's only two "Level 1" trauma centers are also located in the Texas Medical Center. After bearing massive damages from Tropical Storm Allison, one of the trauma centers had to be closed, and the other was inaccessible for nearly nine hours, creating a dire situation for critical trauma care in our community. As a result, the U.S. Air Force deployed their combat Expeditionary Medical Support Hospital to supplement an overly-taxed trauma and critical patient care situation, and the U.S. Department of Public Health air-lifted in nearly 70 nurses to accommodate the demand.

The destruction left by Allison extended far beyond Houston's trauma centers, far beyond our community, affecting lives across the globe. It should be noted that not one patient's life was lost as a result of the flooding damage to the Texas Medical Center.

The Houston Chronicle reported on just a few of the far-reaching implications of Allison's wreckage: A UT Health Science Center - Houston million-dollar nuclear magnetic resonance machine that had been in operation for less than a month was completely destroyed. Experts say it will be at least a year-and-a-half before it can be replaced.

The Chronicle noted that "scientists had lost entire labs, sensitive research equipment, genetically engineered animals, tissue samples and long-term cell samples data from studies that had taken years to accumulate."

All told, more than 10 million gallons of water inundated UT - Health Science Center - Houston, causing more than \$95 million in damages.

Baylor College of Medicine fared no better. In addition to the loss of three electron microscopes, the Houston Chronicle reported that the medical school suffered "the destruction of some 60,000 tumor samples from a 25-year breast cancer project and the delay of a 10-year infantile diarrhea project in which researchers are trying to develop a vaccine for the bacteria that causes the problem – a major killer of children in the developing world."

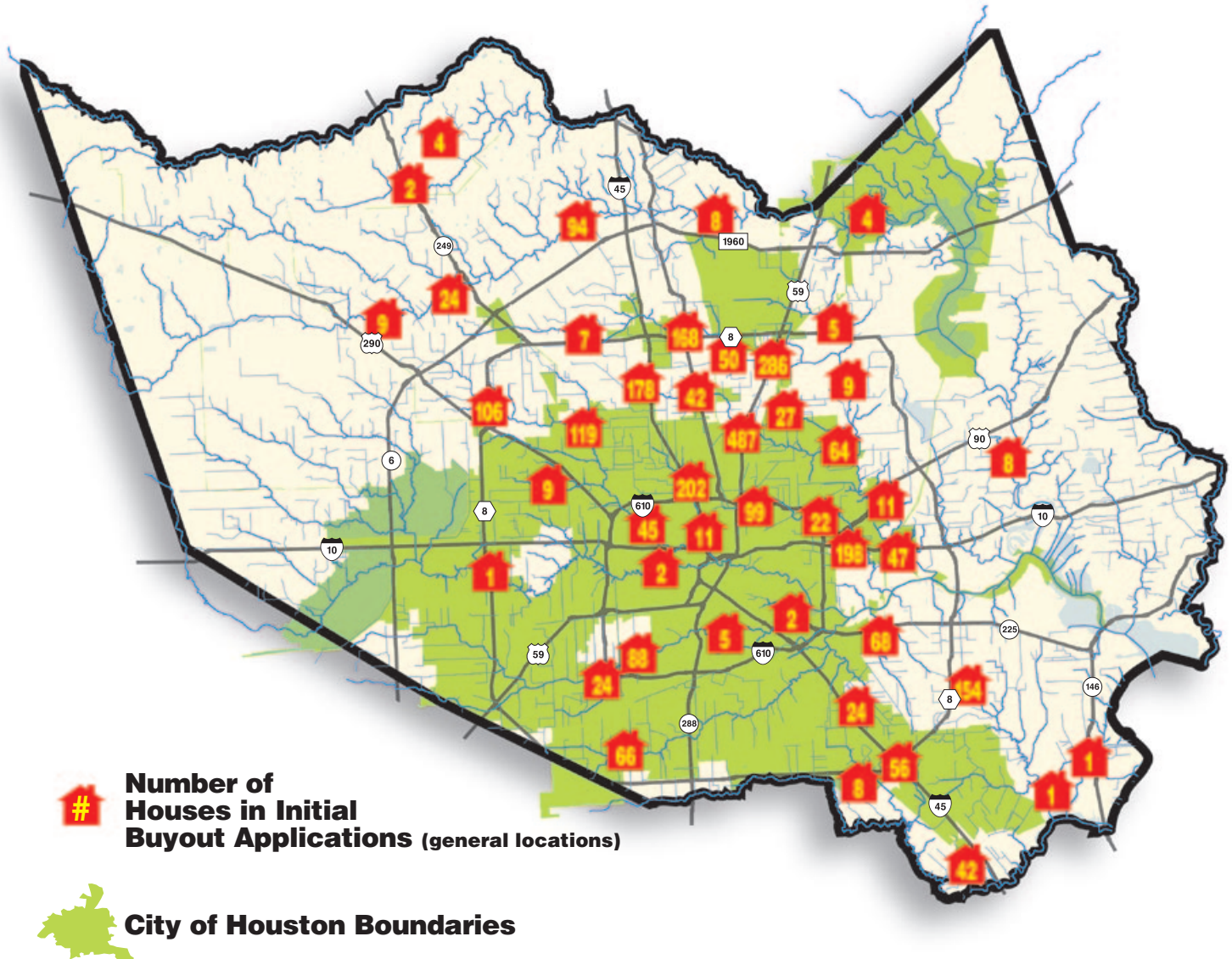
The Chronicle also reported that, "St. Luke's Hospital might have been the site of the implantation of the world's first self-contained mechanical heart instead of Jewish Hospital in Louisville, Ky., if Allison had not washed away the Texas Heart Institute hogs that were to be implanted with the device."

Organizations within the Texas Medical Center are making great strides to minimize the area's risk from the next big flood. Even though damages in the medical center totaled more than \$2 billion, and setbacks to medical research that could benefit the entire world are incalculable, the medical center, like the rest of our community, is well on its way to coming back better than ever.





# Initial Applications For Home Buyout



The Tropical Storm Allison Home Buyout Program is funded from a 75% - 25% partnership between FEMA and the Harris County Flood Control District, respectively. Participation in the program is completely voluntary, and the residents may decline at any time. There are two segments to the post-Allison home buyout program. This exhibit depicts the first segment - the "Fast-Track" buyout that commenced immediately following the flood. The second segment is an extended buyout of additional houses (including repetitive loss houses and houses that are deep in the floodplain) that are not included in the initial fast track. This buyout includes additional funding, and could extend for several years.

For more information about the Tropical Storm Allison Home Buyout Program, contact the District at 713-684-4035 or 713-684-4020, or by e-mail at [TSABuyout@hcfcd.co.harris.tx.us](mailto:TSABuyout@hcfcd.co.harris.tx.us)



Once the buyout process is complete, the site of the home to be demolished is prepared by ensuring that all hazardous materials are removed. Demolition then commences, and it usually takes no more than a matter of hours. When complete, the sites are cleaned up and, in some instances, may be transformed into open spaces, parks, nature areas or other publicly beneficial areas.

## Buyout Brings Quicker Help

Another type of financial assistance is the voluntary Tropical Storm Allison Home Buyout Program. In this program, FEMA and the District are combining funds to purchase flooded houses, at pre-flood value, allowing the residents who volunteer to move to higher ground. The home is then demolished and forever removed from harm's way, thus reducing the threat of future flood damages. Buyout funds are limited, so initial priority has been given to those houses that were "substantially damaged," meaning damage repair estimates are 50% or greater than the pre-flood value of the structure.

Simply put, the Tropical Storm Allison Home Buyout Program is massive. It is estimated that just over 2,000 houses fall into the highest priority category of being "substantially damaged." Buying out those houses, plus all of the others that may ultimately be included, is estimated to cost \$248 million. Of the 2,000 houses in the highest priority category, 1,400 were quickly approved by FEMA for purchase at a cost of \$96.5 million, and more houses should qualify in the future. The difference between this program and previous buyout programs, however, is the speed with which it is being implemented. In the past, homeowners who sold their flood-damaged houses to the government have waited as many as 18 months, or longer, for the approval process to be completed, not to mention the time until their house was actually bought. After Allison, FEMA, the District and the State of Texas created a "fast track" buyout process – to ensure that the worst hit homeowners got the critical help they desperately needed as quickly as possible. The first buyout transaction was completed on October 3, 2001, and over 200 houses were bought in the first ten months after the flood. It is anticipated that additional funding and additional buyouts will be approved over the course of several years.

The bottom line is this: Rather than risk being flooded again, these homeowners have been offered the opportunity to sell their at-risk houses to the government so the property could be converted into publicly-owned open space that will never be resold. In fact, not only will these converted open spaces help reduce the damage caused by future flooding, many of them will also be converted to community assets. Community officials are developing plans to transform some of these open spaces into recreational parks, athletic fields, nature areas or other publicly beneficial areas.

The Tropical Storm Allison Home Buyout Program is totally voluntary. Disaster-stricken residents whose houses were "substantially damaged" and who want to keep living in their current location – which is well within their right – nevertheless face a costly choice. Before they can get a permit to begin making repairs on their home, federal regulations mandate that the local permitting authority certify that the house structure's first floor elevation must be raised to a specified height (usually 12 to 18 inches) above the 1% chance (100-year) floodplain elevation. The home may also be demolished and replaced with a new one that is in compliance with floodplain management regulations and/or ordinances. Because of this, many residents are now choosing to join the buyout program and eventually move to higher and safer ground. 🌀



*This site is the result of another successful buyout program. Years after the house is removed, the area is left in a natural state. It's worth noting that the house that was here would have flooded again during Tropical Storm Allison.*

**As the massive relief efforts continue, local citizens remain concerned about the area's vulnerability to such unforeseeable future devastation. That concern immediately prompts the following question:**

**What is being done for the future?**



**WHAT IS  
BEING DONE  
FOR THE  
FUTURE?**

**W**ith the passing of time since June's devastation, local concern has gradually shifted from the provision of assistance to flood victims to minimizing the havoc that another storm of Allison's magnitude would wreak on the area. Tropical Storm Allison's "off-the-charts" flooding has caused many to ask: "Can we prevent another Allison?" No one can control how much rain falls from the sky, and as such, flooding can, and will, happen in the future. However, we can always strive to reduce the number of lives lost and the amount of damages incurred. On an individual level, everyone should have a plan of action in place should a flood threaten their lives or property (see "Family Flood Preparedness Plan," pg. 34). On a governmental level, flood damage reduction projects are constantly being planned, designed and implemented. To say the least, the task of somehow controlling the unpredictable and awesome forces of nature is a formidable one, but there are several key programs underway that are designed to help the District carry out its duty to reduce the risk of flooding with ever-increasing efficiency and effectiveness.

The District has three primary tactics for reducing the risk of flooding. First, the District performs extensive maintenance of its channel systems to ensure that the intended flood carrying capacity is available when the rains come. Second, the District works with local building permit officials to help ensure that new development does not make existing flooding problems worse by adding an additional burden to the primary drainage system. Third, the most comprehensive effort to actually reduce flood levels and flood damages comes from implementing projects, which the District carries out on its own and through partnerships with others.

Our waterways form an integral and distinguishing part of the local landscape, offering distinctive vistas, whether in their original natural condition, or sculpted by modernization. Accordingly, the mission of the Harris County Flood Control District is to build urban flood control projects that work, with appropriate regard for community and natural values. The District pursues this mission through implementation of projects, such as channels, detention basins (stormwater holding areas) and buying at-risk houses. Each year, the District presents a 5-year Capital Improvement Program (CIP) to its governing body – Harris County Commissioners Court. Ironically, the most substantial and enduring flood damage relief will come from a new approach to funding the CIP approved by the Harris County Commissioners Court on Tuesday, June 5th – the same day Tropical Storm Allison was named 80 miles offshore. The culmination of over a year of preparation, this funding approach supported an initial 5-year CIP that identified \$590 million, to be comprised of both local and federal funds, to provide flood damage reduction projects and land acquisition. At five times the funding of any previous budget, the 2001 5-year CIP (and future annual 5-year programs) represents a serious and sustained commitment by the Harris County Commissioners Court and the District to reduce flood damages in our area. ▶▶▶



**What We're Doing:**

*Our mission is to build urban flood control projects that work, with appropriate regard for community and natural values. And, our new Capital Improvement Program, ironically approved the very day Tropical Storm Allison was named, will provide more flood damage reduction in Harris County than ever before.*



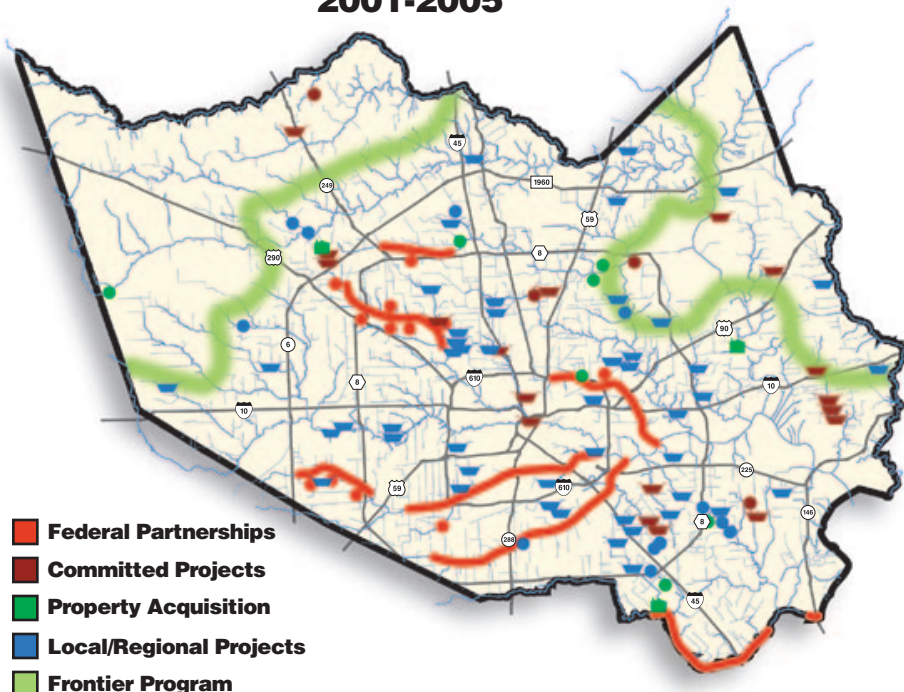
Foremost among the several key components of the CIP is the District's partnership with the U.S. Army Corps of Engineers. The District and the Corps have maintained a strong partnership for over 60 years, and this association has helped bring about federal funding assistance for flood damage reduction projects on Buffalo Bayou including Addicks and Barker Reservoirs, Brays Bayou, White Oak Bayou, Vince Bayou, Little Vince Bayou, Clear Creek and Cypress Creek. In the 1990s, county and federal officials worked closely together to pass federal legislation that allows the District to assume a larger role in the federal partnership. This expanded presence on the part of the District has greatly increased the capability of the partnership to design and implement flood damage reduction projects in Harris County. At present, the partnership has projects underway that will reduce flooding along Sims Bayou, Brays Bayou, Greens Bayou, Clear Creek, Hunting Bayou, and White Oak Bayou. Each of these areas had devastating flooding during Tropical Storm Allison – but help is on the way!

A second aspect of the District's CIP is the Regional Program, which began in the mid-1980s. This effort provides for the construction of projects that simultaneously address existing flood risks and future development drainage needs. For the most part, these plans are funded locally by the District and from new development impact fees.


Another important aspect of the CIP is the Frontier Program – the purpose of which is to acquire and reserve necessary land in developing areas. In scouting these areas before major development occurs and establishing adequate land for conservation, flood storage, and future facilities and structures, the District is taking a pro-active stance and pursuing projects that will reduce the risk of flooding, provide sustainable facilities and ensure a higher quality of life. As part of the Frontier Program, the District, with assistance from the Texas Water Development Board, is currently developing the Cypress Creek Stormwater Management Plan, which will produce a blueprint for land needs for flood damage reduction and conservation as new development in that area is underway. It will also introduce new concepts for multi-use facilities along creeks and drainage corridors. ▶▶▶



## 5-Year Capital Improvement Program 2001-2005





There is yet another initiative, outside of the CIP, that will help us better understand the areas at risk of flooding from the primary bayou systems. This initiative is known as the Tropical Storm Allison Recovery Project, or TSARP, and it will yield many products. At an estimated cost of over \$19 million, funded by both FEMA and the District, the project will result in fully updated computer models and floodplain maps for all of Harris County. A new set of Flood Insurance Rate Maps resulting from this project will be issued (see LIDAR & Flood Insurance Rate Maps). The upshot of TSARP will be a more disaster resistant community that is better prepared for the next “Allison.” Visit the project website at [www.tsarp.org](http://www.tsarp.org) for periodic updates and more information about TSARP. 

## LIDAR A Vital New Use of Laser Technology

LIDAR stands for Light Detection and Ranging. As part of the Tropical Storm Allison Recovery Project (TSARP), highly-detailed ground elevation data for all of Harris County will be acquired through this cutting-edge technology that utilizes the projection of millions of laser signals to the ground from a specially-equipped aircraft. Using powerful software, the data from these LIDAR reflections is collected by measuring the time it takes for the aircraft to receive each of the millions of laser reflections. The resulting data is then combined and converted into an image that looks exactly like the terrain below, including buildings, trees, roadways, creeks and bayous.

### So, what will we do with this new data?

In order to identify areas of higher flood risk, engineers need a detailed and accurate representation of the shape of the ground. It is just not economical to obtain such detailed information for an area as large as Harris County using conventional survey methods. But LIDAR makes it possible.

The LIDAR data will be combined with surveyed creek and bayou cross sections in order to develop detailed computer simulations to determine an estimate of areas that have a higher risk of flooding.

## Flood Insurance Rate Maps What they are. What they are not.

Many of our citizens know that there are floodplain maps for our area. And many, including those who use them on a regular basis, have a fundamental misunderstanding of these maps. Here's some information about what these maps really are, and what they are not:

The floodplain maps are published by FEMA to establish flood insurance rates and to assist local communities in regulating development activities. They are not depictions of which specific areas are and are not subject to flooding. In fact, the official name is “Flood Insurance Rate Map,” not floodplain map.

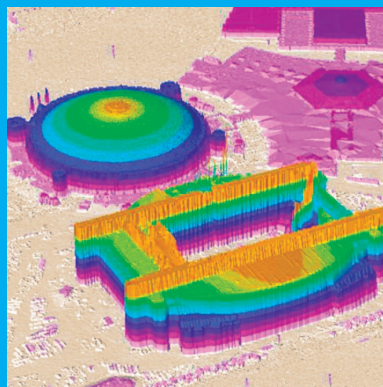
Does this mean that the maps are inaccurate? No, it does not. The maps define the regulatory “floodplain,” and other information, based on the “estimated” flooding from an assumed amount of rainfall. It could always rain more, and history tells us that it sometimes does. Furthermore, the maps only define flooding that occurs when a creek or bayou becomes overwhelmed. They do not define flooding when an area receives an extraordinarily intense rainfall and is not able to drain quickly enough through street or roadside drainage systems. This was the case for many areas across the county during Tropical Storm Allison.

As mentioned, the regulatory floodplains are estimates of the potential for flooding. Analysis after past flood events has indicated that the estimates are, for the most part, relatively accurate. However, these estimates are only as good as the technical data on which they are based. So, there is some generally accepted range of uncertainty in these estimates. In other words, the floodplain maps are accurate, but only to a point. They provide a reasonable depiction of higher-risk flood areas along the primary bayous and creeks.

Over time, our knowledge of where the floodplain is has improved. And occasionally, floodplain maps are changed. This is typically the result of large scale flood damage reduction projects or a new study that uses more current and modern data and technologies to estimate flooding and define the regulatory floodplain. New studies can result in smaller or larger 1% chance regulatory floodplains in a given area because the floodplains are more clearly defined by using the new data and technology.

So, the maps change, but do the floodplains really change? Most often, the answer is that the floodplain did not change. It is our understanding of the floodplain that actually changed.

### LIDAR will help provide a better understanding of flooding and will benefit every citizen in Harris County.



Color-enhanced image of the Reliant Stadium and Astrodome, produced from LIDAR data.



Image of White Oak Bayou near I-10 produced from LIDAR data.



# IN SUMMARY

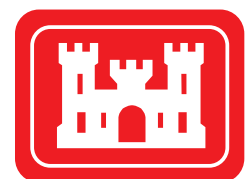
If you talk to the 73,000 Harris County families who watched as their residences and places of business were totally or partly destroyed by Tropical Storm Allison – to say nothing of the families and friends of the 22 people who died as a result of the storm – what remains today for many, if not all of them, is the increasing sense of helplessness they felt as the floodwaters first approached and then overwhelmed area neighborhoods in June of 2001. The universal questions confronting these frustrated victims – two questions fielded often by FEMA and the Harris County Flood Control District – are “How could this happen?” and “How do we make sure it never happens again?”

The unfortunate reality that confronts us all is that a storm like this WILL happen again. It’s only a matter of when and where. We simply cannot control nature’s forces. This report, we hope, addresses those questions. It tracks the highly unusual movements of this immense and relentless weather system as it meandered back and forth across southeastern Texas – and in the process dumped up to 80 percent of Harris County’s average ANNUAL rainfall in just five days. This report also details the conditions that contributed to Allison becoming the costliest tropical storm in U.S. history. Finally, it outlines the unique scope of the response coordinated between federal, state, and local agencies to help people start recovering from this remarkable natural disaster and to reduce future losses.

It will undoubtedly – and understandably – be of little comfort to Allison’s victims to know that the affected watershed systems operated at full capacity with no major problems both during and after the storm’s two passes through the region. From the perspective of these victims, the fact that Greens Bayou drained a Reliant Astrodome’s worth of water every sixteen minutes (to cite but one example) did not do enough to save property in neighborhoods like theirs. Now, after months of costly, time-consuming repairs that interrupted their lives and disrupted their families, most victims wonder what they, as residence and business owners, can do to prepare themselves for the next major storm to hit our area. The answer to this question is simple: **Get flood insurance today and have a family flood preparedness plan!**

Nature always fights on its own terms and periodically exacts a heavy toll in terms of property damage. In this context, Tropical Storm Allison was an extremely rare event – with rainfall of dangerous intensity that spawned “off-the-charts” rainfall and flooding levels in many heavily populated parts of Harris County. Even if you are not moved by the physical danger such a storm presents, consider this: Repaying a \$50,000 flood-related loan from the Small Business Administration costs about \$300 a month over many years, while the average flood insurance policy usually runs about \$300 annually. The savings in money and misery are obvious.

Many victims and taxpayers are concerned about what the Harris County Flood Control District and its partner agencies like FEMA and the U.S. Army Corps of Engineers are doing to help reduce the damage caused by flooding in the future – and the short answer is “plenty.” For example, the same day that Tropical Storm Allison formed 80 miles off the coast of Galveston, the Harris County Commissioners Court approved a new funding approach for the District’s Capital Improvement Program (CIP). ▶▶▶



**US Army Corps  
of Engineers**



# Flood Insurance: Who Needs it? EVERYONE!

Unfortunately, Tropical Storm Allison has taught thousands of us a very expensive lesson: Just because your home is not mapped within the 1% (100-year) floodplain does not mean that you are safe from potential floods. Tens of thousands of residences flooded because rainfall amounts were either greater than the 1% (100-year) levels, or runoff from the extremely intense rains could not drain fast enough to prevent localized ponding from reaching the inside of a home. Nationally, one-third of flood loss claims are from property located outside of the mapped 1% (100-year) floodplains, and Allison proved to be a frightening example of that statistic.


The [National Flood Insurance Program \(NFIP\)](http://www.fema.gov/nfip), administered by FEMA, makes flood insurance available to any resident of Harris County and incorporated cities within the county. For a homeowner, flood insurance covers structure and content losses that occur from flooding. For a renter, it covers contents. Remember that flood insurance is not included on your standard homeowner's or renter's policy. You must purchase it separately, but the cost usually averages just a few hundred dollars per year. It is sold through private insurance companies and is financially backed by the federal government. You can learn more about the NFIP at <http://www.fema.gov/nfip> or by contacting your insurance agent.

Photo: Houston Chronicle



This includes an initial commitment of \$590 million in county and federal dollars over five years to implement flood damage reduction projects, conduct further studies, generate engineering designs and acquire land for future projects. It merits noting that the budget level for the 2001 5-year CIP is five times the budget commitment of any previous program.

The Tropical Storm Allison Recovery Project (or TSARP) is another forward-looking study that should help local residents better understand the risks associated with heavy rain events and better prepare to meet the challenge of such occurrences in the future. A crucial product of TSARP will be a much clearer picture of the primary flood-hazard areas for the major flooding sources in Harris County.

These unprecedented projects – taken together with such measures as the “fast-track” home buyout program spearheaded by FEMA, the District, and the other state and local agencies to provide relief to residents affected by the flood – are part of a long-term, common sense, strategic vision being coordinated by a myriad of federal, state, and local agencies. The Harris County Flood Control District has many partners, but we all share the same goals: Safeguarding lives and property and preserving our natural resources in a manner consistent with community and natural values. 



## The Great Galveston Storm

### 100 YEARS OF HARRIS

1900

**September 1900**  
Major hurricane hits Galveston. The "Great Galveston Storm" was the worst natural disaster of the time in U.S. history. Loss of life reported to be 6,000 to 8,000 citizens. Harris County experienced widespread flooding, with property damage at \$30 to \$40 million.

**1907**  
Major storm floods much of Houston and Harris County.

1910

**December 1913**  
Major Brazos River storm spreads to Harris County. Entire area was hard hit. Buffalo, White Oak, Brays and Greens Bayous were all out of their banks. Many citizens evacuated.

**August 1915**  
Another Galveston hurricane causes major damages throughout Harris County. Buffalo Bayou and widespread areas of Houston experienced heavy flooding. Damage estimated at \$56 million.

1920

**April 1929**  
Enormous gulf storm descends on Houston and Harris County and lasts 14 hours. Many areas of county report rainfall of close to 10 inches. Extensive damage sustained to businesses and residences in almost all areas of Harris County. All bayous are reported to be out of their banks.

**May 1929**  
As the area is still reeling from the last storm, another major storm hits Harris County. Structural damage, heavy street flooding and widespread crop damage reported. San Jacinto River 30 feet above normal.

1930

**May 1930**  
Large rainstorm cell remains stationary over Harris County for 3 days. Rainfall amounts reported as high as 12.5 inches. Entire area averages 8 inches.

**August 1932**  
Hurricane hits Freeport, taking 40 lives. Harris County has widespread flooding on all bayous.

**December 1935**  
Massive storm inundates Houston and Harris County. Buffalo Bayou 52 feet above normal. Overwhelming devastation leads to creation of the Harris County Flood Control District in 1937.

1940

**November 1940**  
Heavy rains last for 5 days in Northeast Harris County. 10,000 head of cattle lost.

**July 1943**  
Hurricane near Galveston creates extensive flooding for Harris County. \$16.5 million in damages.

**October 1943**  
Hurricane near Freeport. Over 11,000 residences flooded in Harris County.

**August 1945**  
Area hurricane produces heaviest rainfall previously recorded in Harris County – over 15 inches in 24 hours. Flooding reported on all bayous and streams.

Tropical Storm Allison was a horrific reminder of how prone we are to such a costly natural disaster – flooding. Harris County has always flooded. And, unfortunately, it always will, due to the area's flat terrain, impervious soils, heavy rainfall and annual threats of hurricanes and tropical storms.

Over the years, the efforts of the Harris County Flood Control District, the U.S. Army Corps of Engineers, FEMA and other partners have significantly reduced the threat of damages from flooding. But, sometimes nature will have its way.

Here's a look at some of the major flood events from the last 100 years in Harris County and the surrounding area.

### COUNTY'S SOAKED HISTORY

1950

**February 1950**  
Thunderstorm precedes cold front, resulting in Greens Bayou running out of its banks. Area residents evacuated. Baytown reports flooding as well.

**May 1955**  
Major thunderstorm hits northern portion of Harris County. House flooding reported in the area.

**June 1957**  
Hurricane Audrey crosses the Louisiana/Texas coast. Flooding is reported in Harris County.

**October 1959**  
Thunderstorm floods over 100 residences in Houston area.

1960

**June 1960**  
Thunderstorm inundates many areas throughout Harris County. Cypress Creek, Spring Creek and San Jacinto River experience flooding. Over 200 families evacuated.

**September 1961**  
Hurricane Carla pounds the Gulf Coast, taking 34 lives. It was the largest hurricane previously recorded, with property damages exceeding \$300 million. Heavy flooding reported in southern Harris County.

**February 1969**  
Thunderstorm precedes cold front, flooding over 250 area residences and business. Damages exceed \$3.3 million.

1970

**March 1972**  
Thunderstorm precedes cold front and floods much of northern Harris County. Over 700 families are evacuated.

**June 1973**  
Major storm hits Harris County and brings 10 - 15 inches of rain. Sims and Greens Bayous are reported out of banks. 10 lives are lost and damages exceed \$50 million.

**July 1979**  
Tropical Storm Claudette brings record rainfall amounts to the area. 43 inches of rain in 24 hours fell in Alvin – a U.S. record that still stands today. Total damages exceeded \$700 million.

1980

**May 1983**  
Large thunderstorm floods areas along several creeks and bayous. Damages exceed \$14 million.

**August 1983**  
Hurricane Alicia strikes Galveston and Harris County. Damages approach \$1 billion, mostly due to wind.

**September 1983**  
Nine inches of rain falls south of downtown. Over 1,000 residences flood along Brays Bayou. Damages top \$38 million.

**May 1989**  
Major storm delivers 7 to 14 inches of rain over much of Harris County. 1,400 residences flooded.

**June 1989**  
A tropical storm named "Allison" delivers 6-12 inches of rain over portions of Harris County. Nearly 1,100 residences are flooded.

1990

**March 1992**  
Major storm floods over 1,500 residences and businesses, and many bayous are out of banks. Much of I-10 is under water.

**October 1994**  
Major storm inundates Southeast Texas, dumping 4 to 29 inches of rain in three days over Harris County alone. Countywide, nearly 3,400 residences in 90 subdivisions are flooded.

**September 1998**  
Tropical Storm Frances causes extensive flooding along White Oak Bayou and other bayous. Over 1,300 residences are flooded.

**October & November 1998**  
Adding insult to injury, two more major storms flood hundreds more residences, mainly in north Harris County.

2000

**June 2001**  
Tropical Storm Allison makes for an unfortunate bookend to the last 100 years of flooding in Harris County. Referred to as "The Great Flood of 2001," this storm hits Harris County and Houston with a "one-two" punch, beginning June 5th, and dealing the final blow three days later as the storm returned to the gulf. The second pass through the area produces extraordinary rainfall amounts northeast of Downtown Houston. The Texas Medical Center is essentially "shut down." The North portion of Downtown Houston is decimated. Two million people are simultaneously impacted. Over 70,000 residences are flooded. 22 lives are lost. And damages exceed \$5 billion.

## Allison: The Great Flood of 2001



# FAMILY FLOOD PREPAREDNESS PLAN

The American Red Cross and FEMA have jointly published excellent brochures entitled “Your Family Disaster Plan” and “Your Family Disaster Supplies Kit.” Every family should obtain these and follow them. They cover more than just floods and will also be useful for other potential disasters. Knowing what to do is your best protection and your responsibility. To obtain a copy of the brochures, contact the Houston Red Cross office at: 713-526-8300 or search their web site at [www.houstonredcross.org](http://www.houstonredcross.org) for related information.

## Before A Flood

Find out what could happen to you and your family. Where will your family be when it floods? They could be anywhere – at work, at school, or in the car. How will you find each other? Will you know if your children or parents are safe?

Find out about the disaster plans at your workplace, your children’s school or daycare, and other places where your family spends time.

### Create a Family Preparedness Plan

Discuss with your family why you need to prepare for a flood and the dangers associated with a flood. Plan to share responsibility and work together as a team. Pick a place to meet outside your neighborhood in case you can’t return home. Everyone must know the address and phone number.

Ask an out-of-town or out-of-state friend or family member to be your “family check-in contact.” If you have trouble contacting each other during or after a flood, call this person and tell them where you are.

If infants, elderly, or handicapped individuals are present, know what their special needs are if you stay in your residence, if you need to evacuate in a hurry, or go to a shelter after the flood.

Get to know your neighbors and discuss how you can help each other.

Plan how to take care of your pets. Most emergency shelters do not allow pets.

### Implement Your Plan

Post emergency, family and neighbor telephone numbers by the phones.

Make sure all family members have the family check-in contact person’s phone number, and the location and phone number of the family meeting place outside your neighborhood.

Show each responsible family member how to turn off the electricity to your residence at the main breaker or switch.

Keep flood insurance coverage current.

Prepare and maintain a family emergency kit. Replace items, as necessary.

Prepare and maintain an emergency kit for your car.

Practice and maintain your plan with all family members.

Pay attention to all National Weather Service Flood watches and warnings.

## FAMILY EMERGENCY KIT

### WATER

- One gallon per person per day (two quarts drinking/two quarts food preparation and sanitation).
- Keep or be prepared to store a three-day supply per person at home.

### FOOD

- Compact non-perishable food that requires little preparation.
- Manual can opener
- Sterno or camping stove, if you must heat food.

### FIRST AID KIT

- Use the items recommended by the Red Cross
- Prepare one for both your home and car

### TOOLS and SUPPLIES

- Battery operated radio and extra batteries
- Flashlight and extra batteries
- Utility knife
- Compass
- Map of the area (for locating shelters)
- Paper, pencil
- Matches in a waterproof container
- Personal hygiene items
- Toilet paper, towelettes
- Plastic garbage bags, ties (for personal sanitation)
- Needles, thread
- Duct tape
- Mess kits, or paper cups, plates and plastic utensils
- Plastic storage bags
- Soap, liquid detergent
- Plastic sheeting
- Fire extinguisher: small canister, ABC type

### CLOTHING and BEDDING

- Rain gear
- Blankets or sleeping bags
- Sturdy shoes or work boots
- Clothing appropriate for conditions

### SPECIAL ITEMS

- Cash or traveler’s checks, change
- Prescription drugs
- Books and games
- Important family documents in waterproof, portable container
  - Birth, marriage, death certificates
  - Will, insurance policies, deeds, contracts, etc.
  - Passports, social security cards, immunization records
  - Bank and credit card account numbers and contacts
- Inventory of valuable household goods
- Important telephone numbers
- Special items for infants, elderly, or handicapped, if applicable.

## When Flooding is Imminent

Put your family preparedness plan into action.

Contact your family members and confirm plan of action and alternatives.

Confirm your family emergency kit is complete and ready.

Move emergency supply items and valuables to highest inside part of your residence.

Locate and put pets in a safe place.

Make sure you have an adequate water supply in case service is cutoff.

If you can do so safely, turn off the electricity at the breaker before water enters your residence.

If you have time, and can do so safely, move vehicles to higher ground.

Your safest option is to stay put. However, if you must evacuate to a safe location or a shelter, take your emergency supply kit and tell your family check-in contact you’re leaving. **Don't drive through flooded streets.**

## During a Flood

If you did not get the electricity turned off before the water entered your residence, do not turn it off. Get out of the water.

Move valuables and emergency supplies to highest inside part of your residence. If necessary, use the attic or roof. Wait for help.

Don't try to swim or wade to safety. Wait for the water to recede or rescue. There are environmental and biological dangers in the water such as oil, gasoline, sewage, fire ants, etc. Downed power lines can electrify floodwaters. Don't let your kids play in the water.

Stay calm and wait. Don’t try to walk or drive through floodwaters. Most deaths occur from people walking or driving through floodwaters. If your car stalls in rising waters, get out immediately and get to higher ground.

## After A Flood

Although floodwaters may be down in some areas, many dangers still exist. If you come upon a barricade or a flooded road, wait or go another way.

Keep listening to the radio for news about what to do, where to go, or places to avoid.

If you must walk or drive in areas that have been flooded, stay on firm ground. Standing water may be electrically charged from underground or downed power lines. Avoid flood debris.

**When you are faced with a flooding situation: STAY PUT wherever you are, unless your life is threatened.**

**If you evacuated your home, check for the following when you return:**

Use flashlights to check your home - do not light matches or turn on electrical switches.

### Electricity:

- If the water has risen above the electrical outlets in the home, contact a licensed electrician before turning on the main circuit breaker or trying to restore power.
- Allow all electrical appliances and electronic equipment that were submerged in water to dry thoroughly for at least one week. Have them checked by a qualified repairperson before turning them on. Attempting to repair a flood-damaged appliance could result in electrical shock or death.
- If the outside unit of an air conditioning system has been under water, mud and water may have accumulated in the controls. Attempting to restart it could result in further damage and costly repairs. Have the unit checked by a qualified air conditioning technician.

### Gas:

- If you smell gas when you return to your home, leave the house and call Reliant Energy Entex at 713-659-2111 from a neighbor’s house or a remote location as soon as possible.
- If your home was flooded, call a licensed plumber or a gas appliance technician to inspect your appliances and gas piping to make sure it is in good operating condition before calling Reliant Energy Entex to reconnect service. This includes outdoor gas appliances, such as pool heaters, gas grills, and gas lights.
- If you’ve had no flooding in your home and your natural gas is turned off at the meter, please call Reliant Energy Entex to reconnect service.

Check for fire hazards and other household hazards.

Clean up spilled medicines, bleaches and flammable liquids immediately.

Contact your insurance agent to discuss claims.

Listen to your local radio stations to find out where to go for assistance. The Red Cross can help by providing vouchers to purchase items to meet emergency needs and can also provide a clean-up kit: mop, broom, etc. You can obtain a copy of the book “Repairing Your Flooded Home” available free from the Red Cross. Other organizations also provide additional assistance.

If you hire cleanup or repair contractors, be sure they are qualified to do the job. Check references. Get written estimates. Keep all receipts. Be wary of people who drive through neighborhoods offering home repair.

A flood can cause emotional and physical stress. You need to look after yourself and your family as you focus on cleanup and repair.





# ALLISON

## The Costliest Tropical Storm in U.S. History

“

*Tropical Storm Allison stands as the most devastating tropical storm in U.S. History, causing approximately \$5 billion in damages. Allison caused unprecedented flooding and taught us that all tropical cyclones, regardless of wind speeds, can be killers. State and local officials worked tirelessly to help those affected by Allison. It never ceases to amaze me how the people of greater Houston came together.*

**Joe M. Allbaugh**  
Director, Federal Emergency Management Agency

*Allison reinforced the fact that everyone needs flood insurance. Due to the intense rainfall, many areas flooded from water simply trying to get to the channels – areas not shown in the mapped floodplain.*

**Mike Talbott, P.E.**  
Director, Harris County Flood Control District

*I am deeply affected by the unpleasant memories and the inconvenience associated with the disruption of life's routine. It would not be prudent to think it will never happen again. Like so many other people, our lives have just returned to a semblance of normalcy.*

**W. David High**  
Greens Bayou Watershed Resident

*Any time you have rainfall rates of four to six inches per hour, or more – and that continues for several hours – no drainage system that I know of in the world is going to handle the kind of flooding that results. Also, when you have rainfall rates like that, then flooding is not confined to floodplains. Allison taught us that a whole lot of us should've had flood insurance that didn't.*

**Dr. Neil Frank**  
Chief Meteorologist, KHOU-TV 11

*There are several ways to categorize storms: the strongest winds, lowest pressure, highest storm surge, largest rainfall, number of associated tornadoes, total dollar damage and loss of life. What really counts to me is the impact on people. The National Hurricane Center counted 41 direct deaths associated nationwide with Allison, and over \$5 billion in damages. Allison will be remembered most because of this large impact on thousands of people.*

**Max Mayfield**  
Director, National Hurricane Center

*The unusually heavy rains and flooding that occurred late at night between June 8th and 9th were really no fluke. The cooling effect of nighttime causes rain near the centers of these storms to intensify significantly. A look in the recent past shows our heaviest floods have occurred during the night.*

**Bill Read**  
Meteorologist In Charge,  
Houston/Galveston National Weather Service

*On the night of June the 8th in the Texas Medical Center, more civilian damage was done in one day than has ever occurred in the history of America before 9-11.*

**Richard E. Wainerdi, PhD**  
President, Chief Executive Officer and Chief Operating Officer  
Texas Medical Center

*A year later, we are still rebuilding houses that were damaged or destroyed by Tropical Storm Allison. It's a lot of business for us, but every single job comes with a sad story. Most of these folks lost everything.*

**Tracy Thompson**  
General Contractor

”





## **We haven't seen the last "Allison."**

A tropical weather system does not have to be a hurricane to be a killer storm or even damaging to your home and property. In fact, tropical storms and depressions generally produce the heaviest rainfalls and worst flooding.

Remember, it's impossible to control the extraordinary forces of nature. Keep yourself and your family prepared for another storm of this magnitude.

It's only a matter of when...

...and where.



## **Federal Emergency Management Agency**

WASHINGTON  
500 C Street, SW  
Washington, D.C. 20472

Phone: 202-646-4600  
[www.fema.gov](http://www.fema.gov)

### REGION VI FEDERAL CENTER

Federal Regional Center  
800 N. Loop 288  
Denton, TX 76209-3698

[www.fema.gov/reg-vi/index.htm](http://www.fema.gov/reg-vi/index.htm)

• • • • •

## **Harris County Flood Control District**

9900 Northwest Freeway  
Houston, TX 77092

Phone: 713-684-4000

• • • • •

## **Tropical Storm Allison Recovery Project**

16225 Park Ten Place, Suite 420  
Houston, TX 77084

Phone: 281-579-4656  
[www.tsarp.org](http://www.tsarp.org)



This document was funded by the Harris County Commissioners Court through the Harris County Flood Control District (the District) and by the Federal Emergency Management Agency (FEMA). The District would like to acknowledge the assistance and input provided by numerous public agencies, municipalities, and individuals as presented below. Data used in this report was provided by numerous public agencies. The Harris County Office of Emergency Management provided rainfall and flood elevation data from its flood-warning network. The Harris County Permit Department supplied high water elevation data from flooded areas in the unincorporated areas of Harris County. The U.S. Geological Survey provided the flood flow, flood elevation and rainfall data that it collects in the Harris County area. The U.S. National Weather Service and the National Climatic Data Center provided rainfall data as well as reports on the path and progress of Tropical Storm Allison. The Cities of Houston, Pasadena, La Porte, Bellaire, Deer Park, Friendswood, Galena Park, Humble, Jacinto City, Jersey Village, El Lago, Seabrook, Taylor Lake Village, Tomball and Webster provided information concerning the number of flooded residences and businesses. The Texas Department of Transportation provided information on highway flood damages. The Texas Natural Resources Conservation Commission provided information on damages to water and wastewater systems. Insurance Services Office, Incorporated provided information on automobile damages.