

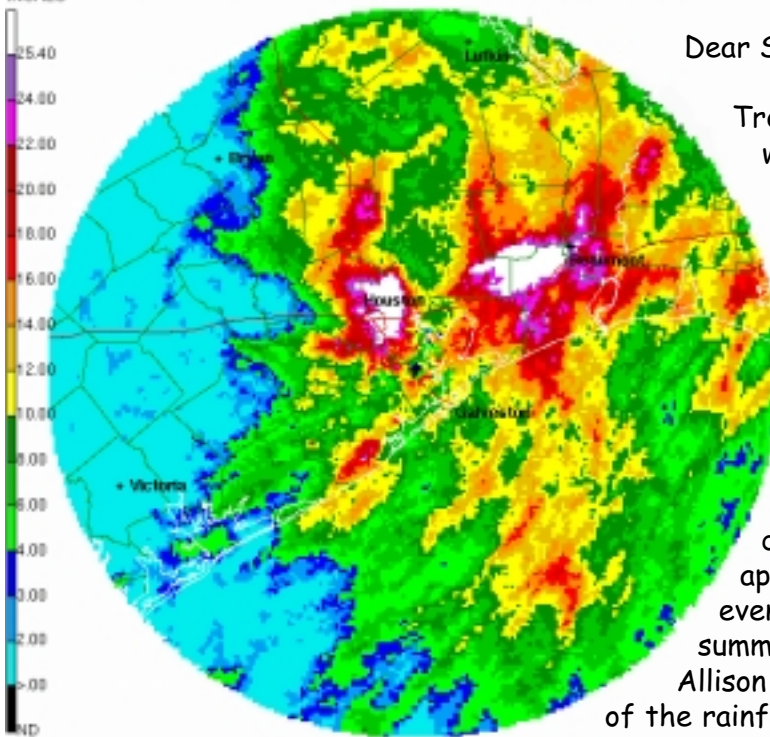


Storm Signals

Houston/Galveston National Weather Service Office Volume 58



Radar Image from National Weather Service: KHGX 22:34 UTC 06/10/2001



Dear Storm Signal Reader,

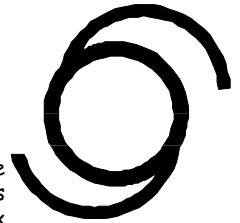
Tropical Storm Allison hit as we were preparing our annual summer issue of Storm Signals. The impact of this storm on the citizens of southeast Texas was huge and we decided to change gears and dedicate the entire issue to articles related to Allison. Almost all of you either experienced the heavy rains and flooding produced June 5-9 or know someone who did. We felt it would be appropriate to document the events of that week, including a summary of the weather aspects of Allison and her remnants, a presentation of the rainfall that occurred, a summary of the severe flooding that resulted, a comparison to other southeast Texas heavy rain events, and commentary on lessons learned and implications for future events. We hope you find this information useful for historic documentation as well as helpful in preparing for the inevitable next weather disaster to visit our area.

Sincerely,

Bill Read

Commentary on Allison

By Bill Read



Following an event like Allison, where a number of people lost their lives and major property damage occurred, the National Weather Service conducts a formal Service Assessment. A team of leaders within the NWS and an outside recognized expert in flood warning review met in Houston a week after the flood. They reviewed the products and services issued by our office, met with our staff, and met with emergency management officials and members of the news media. A final report will be published in September. In addition, our office conducted our own internal review of the event and our procedures. The purpose of these reviews, of course, is to assess what worked, what didn't, and to develop lessons learned to hopefully improve warnings and forecasts in the future. There will be a number of mostly nuts and bolts recommendations for improving flood warnings for our area and a few that may have national implications.

However, to me the key finding from talking to the Service Assessment team was how impressed they were with how well the key groups in the warning system, emergency management, the news media, and the NWS, worked together during this event. I don't think this was by chance. Emergency management leaders in our area have taken the initiative over the past decade in developing a coordinated, planned approach to dealing with major weather events. The ongoing effort to prepare for these events through various regional, county and local emergency management associations payed off during Allison. Lessons learned in previous events, training about hazards impact on our area, the use of communication avenues such as pager systems, conference calls, media alerts, the Internet, and one on one communication between our office and local officials were put to a major test on the night of June 8th. Because of the above mentioned efforts, we were all pretty much aware of the escalating severity of the flood and on the same page as to what we were passing to the public. We were able to keep ahead of the flood in our warnings. The ability to share much more information than in the past led to us (NWS) being more informed on the impact of the meteorological events and to local emergency managers being more informed on what to expect. Local media with weather and news departments quickly recognized the seriousness of the event and began "wall to wall" coverage. Visual and factual reporting of the level of flooding that was consistent with what we and local officials were reporting gave citizens vital, non-conflicting information during the event. The bottom line is that further loss of life was likely prevented by the concerted efforts of all involved in the warning process.

As bad as the Allison flooding was, we can and likely will experience worse. I read a number of well thought out editorials concerning the social/political realities that got the Houston metropolitan area where it is today regarding flood vulnerability. We prepare for "design" floods. Allison pointed out big time how meaningless the 100 year flood plain is versus real flood threat. Roy Dodson, whose firm conducted a "worst case" study on the impact of tide, wind, and rainwater flooding for Harris County after Hurricane Mitch, commented to me how close the reality of Allison came to the projections from his study in many parts of the county. And that was just the rainwater...

We have not had a direct hit from a category 4 hurricane since 1915. A similar storm today with the eye making landfall on the west end of Galveston Island near Jamaica Beach then moving north northwest across Houston would produce damage that would vastly eclipse what happened in Florida from Andrew. Storm surge would start at 15 feet or so on the Island and reach 20 to more than 25 feet on the west side of Galveston Bay. That would flood most of Galveston County east of I-45, all of the Clear Lake area southeast of Ellington Field, much of LaPorte to Baytown and much of area along the Ship Channel. Also, sustained winds of 130 mph or more lasting for up to several hours will be impacting houses and businesses "built to code" (similar to "design flood") which are designed to withstand winds less than 100 mph. The impacted number of homes would be huge. According to the State of Texas, over 600,000 people live in the category 4 surge zone. Moreover, winds in excess of 100 mph will penetrate through most of Houston, causing much damage outside the surge zone. Business losses would also be significant. Big ticket industry such as our petrochemical plants, the Johnson Space Center, and the recreational complex in the Clear Lake area are all in the surge zone. And we all remember what Alicia did downtown, don't we?

Many of the issues raised in editorials about our flood problem can also be raised for the surge and wind threat. We continue to build houses and businesses in the surge zone with little restriction and settle for wind resistant measures less

than what a major hurricane produces. Unlike the rainwater flooding, where the vast majority of people impacted were relatively safe staying in their homes, the combined surge and wind impact will require an evacuation of many of those 600,000 citizens in the surge zone in order to save lives. Our unrestricted growth has led to an ever more complex evacuation which would require more than a day to complete.

I do not see much chance for a change in philosophy about growth and land use in this area before the next big hurricane hits. The social and political realities are we prefer not to have restrictions. I do not think it is fair to point the blame at our elected officials, they are primarily acting on the will of the voters. Most of us really like our lifestyle here. We have good jobs, affordable homes in good neighborhoods, good schools and many recreational and cultural activities nearby. Fact is, most of us either don't know the risk, know of the risk but deny it will happen, or know of the risk and are willing to live with it.

As for me, I guess I am willing to live with the risk, for I surely know what the risk is, I don't deny that it can and will happen, yet I live in a home deep in the category 4 surge zone that wasn't built to withstand 130 mph winds. Do you see the problem?

Tropical Storm Allison

By Josh Lichter

Tropical Storm Allison formed in the northwest Gulf of Mexico on June 5th, only five days into the 2001 Hurricane Season. The system that became Allison could be traced back to a tropical wave that moved off the west coast of Africa on May 21st. By May 29th, the disorganized system reached the western Caribbean Sea and crossed into the Pacific Ocean on June 1st. The system then moved north into the Bay of Campeche late on June 4th. Organization began to take place on June 5th and by the afternoon hours, reconnaissance aircraft along with ship and buoy reports indicated that Tropical Storm Allison was born while located 80 miles south of Galveston. At her peak, Allison had tropical storm force winds, up to 60 m.p.h., which were confined to offshore oil platforms and the Sea Rim State Park area in western Jefferson County. Two to three foot tides along the Texas coast had little impact on the area. Allison moved inland on the west end of Galveston Island Tuesday less than 12 hours after forming. Over the next five days Allison produced record rainfall that led to devastating flooding across portions of Southeast Texas, including the Houston area.

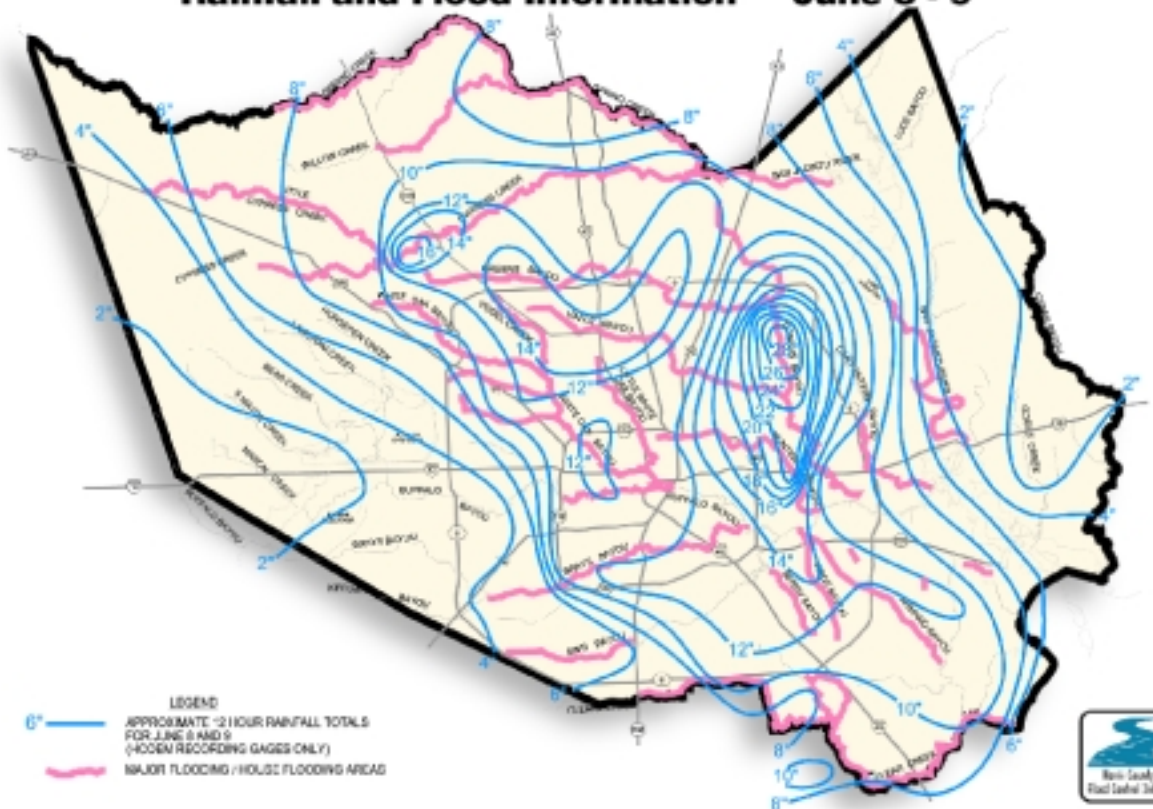
The first significant flooding occurred as Allison was a tropical storm and poised to move onshore on the 5th. A large spiral band with very heavy rainfall moved inland from Galveston to the Houston area while Allison's low level circulation center was still offshore. The rain began late in the afternoon, and by mid evening 8 to 12 inch totals were common from northern Galveston County into southern Harris County. As a result, flash flooding was observed across these areas, but no deaths or injuries occurred with this first round of storms. Heavy rain continued over inland portions of Southeast Texas overnight with 3 to 5 inch amounts common.

Allison, being steered by two subtropical ridges (one centered east of Florida and one centered west of Texas), moved inland and weakened overnight. On Wednesday the 6th, the remnants of Allison steadily moved northward into East Texas. By the evening hours, the center was near Lufkin and moving less than 5 m.p.h.. Rainfall amounts averaged 4 to 6 inches across the northern portions of our county warning area (CWA), well north of the Houston area, resulting in some minor flooding. The most significant rainfall that day was found across east Texas into Louisiana.

On Thursday June 7th, the subtropical ridge off Florida weakened and drifted to the south. At the same time, the ridge west of Texas strengthened. This caused the circulation center of Allison (which was still well defined on radar) to make a clockwise loop and begin a drift to the southwest. By the time the center was around the Huntsville area (before sunrise), a band of heavy rain began to back build from Louisiana and the

Tropical Storm Allison

Rainfall and Flood Information June 8 - 9



Beaumont area westward into Liberty County. This band produced 5 to 10 inches of rain. Another area of thunderstorms developed over the Sugarland–Stafford areas of Fort Bend and Harris Counties during the same overnight hours and produced another 8 to 12 inches of rain. No deaths or injuries were observed with these rains, but there was abundant street flooding, and water did get into some homes. During the day, moderate to heavy rains continued to wrap around the circulation center in our northern CWA resulting in additional reports of street flooding.

Friday June 8th began with another 5 to 10 inch swath of rain developing during the early morning hours along the immediate coast from around Freeport to the Beaumont area. This rain band moved onshore and weakened during the morning hours, resulting in clear skies across most of the CWA by the early afternoon. With the circulation center now between College Station and Huntsville and drifting slowly to the southwest, it became evident that daytime heating combined with a strong moist feed across the center of the CWA would set up the most significant round of rainfall so far. Rains just east of the center drifted south over Montgomery County and produced heavy rain all afternoon. During the mid to late afternoon hours, convection began to develop where skies had been sunny and thunderstorms began to rapidly intensify over southern Montgomery and eastern Harris counties. At this time, thunderstorms began to train and merge across the Houston metro area, and the system evolved into a powerful

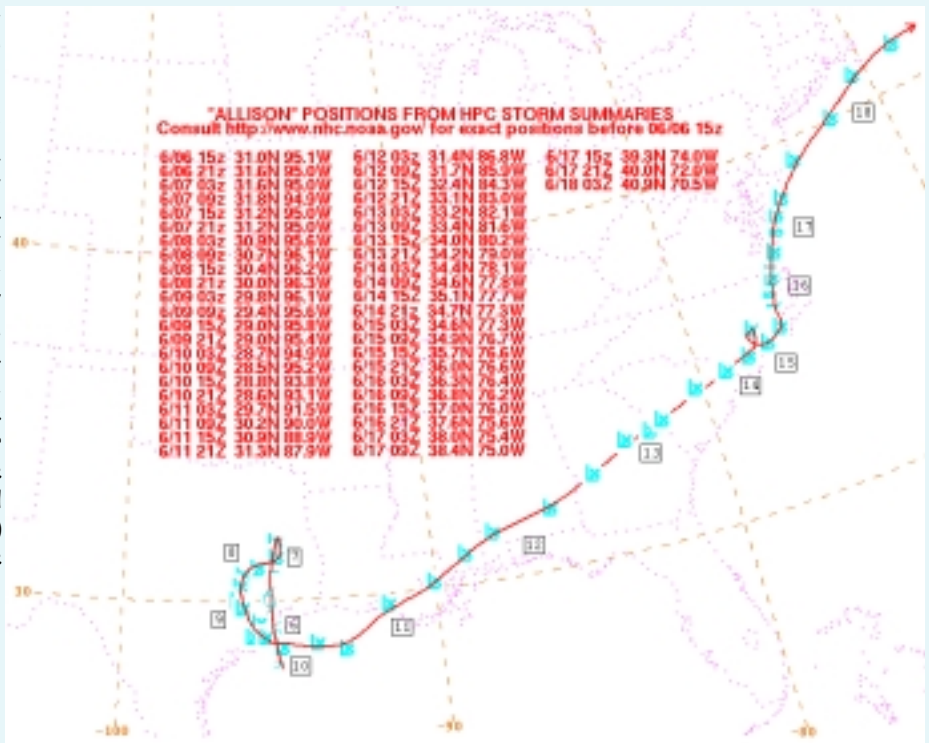
complex right over the most populated portion of our CWA that evening. This complex progressed south and east into the early morning hours of Saturday the 9th. Very heavy rainfall was observed for up to 10 hours in some locations, and rainfall rates of 4 inches or more per hour were observed throughout the night. A station in northeast Houston recorded over 26 inches of rain in almost 10 hours.

Flash flooding initiated quite rapidly during rush hour late Friday afternoon and on into the evening hours. Widespread street flooding was the initial threat, but the high rainfall amounts forced almost all the major Houston area bayou systems into severe flooding, with some to record levels. At least one location on all major freeways in the Houston area was severely flooded during this event. During this single event alone, rainfall in Harris County ranged from just 2 inches in the extreme west to in excess of 20 inches over Green's Bayou in the east. Countywide, the average rainfall was almost 10 inches in the 48 hours ending Saturday evening, June 9th.

The circulation center gradually made its way toward Palacios by the evening on the 9th. Before moving offshore, another round of heavy rain - between 4 and 8 inches - developed across extreme southern Harris and extreme northern Galveston Counties. Some homes along Clear Creek which had escaped significant flooding from the heavy rains on Friday night ended up flooding from these rains on Saturday. The Federal Emergency Management Agency (FEMA) declared a large part of east and southeast Texas and portions of Louisiana disaster areas.

The circulation center finally moved off to the east on Sunday the 10th and ended the event for our area. The remnants of Allison went on to wreak havoc across several Gulf Coast states with tornadoes and heavy rainfall, and eventually made its way up the east coast of the United States and continued to produce devastating floods. Allison will go down as the costliest tropical storm in United States history.

As of the completion of this article, damage totals are still being determined. Early estimates have total damage across Southeast Texas at almost \$6 billion. Twenty-four deaths were caused by Allison in Texas, with twenty-two of these occurring in Harris County. By comparison, Hurricane Alicia, the last major hurricane to strike the Upper Texas Coast, caused \$3 billion (in 2001 Dollars) damage and twenty-one fatalities.



Water Water Everywhere... How About Another Drought?

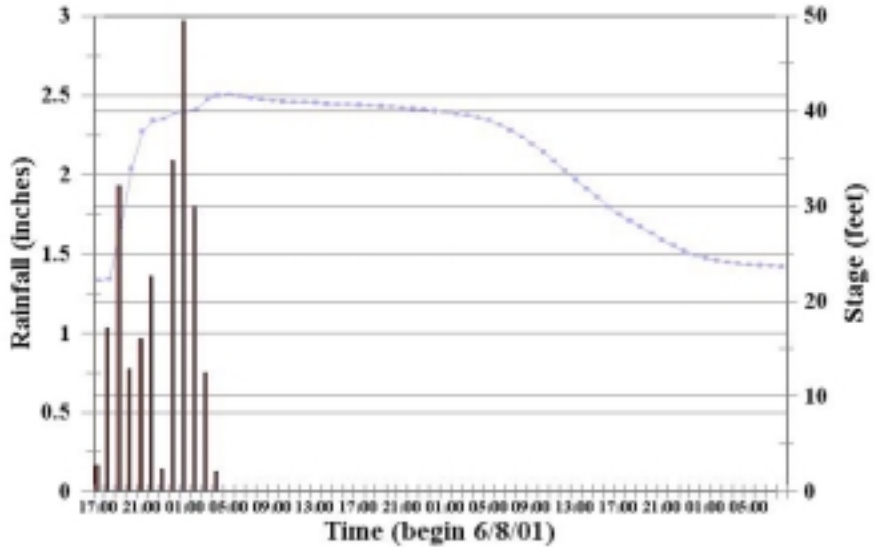
By David C. Schwertz, Service Hydrologist

Tropical Storm Allison produced the most severe flooding the Houston area has seen in decades. Forming during the afternoon hours of June 5, 2001 this storm lingered over southeast Texas several days before moving off to the east. Heavy rainfall, averaging 3 to 6 inches centered over Clear Creek producing moderate flooding above State Highway 288 near Pearland to Clear Lake. Minor to moderate flooding also occurred on the lower portions of Greens Bayou as well as Halls, Garners, and Hunting Bayous. The remnants of Tropical Storm Allison produced an additional 3 to 5 inches of rainfall over southwest Harris County during the morning hours of Thursday June 7th resulting in minor to moderate flooding on Keegans Bayou and the upper portions of Sims Bayou. By Friday morning, June 8th many areas in Galveston, Harris, and Montgomery County were saturated. Very heavy rainfall over eastern Montgomery and Northern Harris Counties during the afternoon produced in excess of 10 inches of rain over the Caney Creek watershed by 7 PM Friday evening. This resulted in record flooding on Caney Creek and major flooding down the West Fork of the San Jacinto River as well as Spring and Cypress Creeks. The center of the low pressure area continued drifting south during the evening hours into Saturday morning producing intense rainfall over most areas of Harris County. Ground conditions in most areas were already saturated from rains earlier in the week resulting in excessive runoff and by sunrise Saturday June 9th all but extreme eastern and western portions of Harris County were flooded.

An average of 9.72 inches of rain fell over Harris County in the 48 hours ending at 7 PM Saturday June 9th (radar estimated rainfall was 9.15 inches). This converts to about 300 billion gallons of water or enough to fill the Astrodome more than 5600 times. This volume of water is greater than the total volume of both Lake Conroe and Lake Houston (256 billion gallons combined) at the peak of the October 1994 flood. There was a complete shutdown of downtown Houston, including all major roadways and both airports for more than 12 hours. The Texas Medical Center along Brays Bayou sustained severe damage resulting in the complete shutdown of several hospitals and a significant loss of research data. The arts district in downtown Houston sustained severe damage as well from flooding at the confluence of White Oak and Buffalo Bayous. Record flooding along Buffalo Bayou flooded the lobby area of Channel 11, the CBS affiliate in Houston. Hundreds of homes along Clear Creek in Pearland, Friendswood, and League City were flooded as the creek reached its highest levels since Hurricane Chantal in 1989. Reports from the Texas Department of Emergency Management indicated there were 22 fatalities associated with this flood event. One thousand six hundred fifty six businesses in Harris County alone were severely damaged or destroyed. Over 46,000 homes sustained

Hunting Bayou at East Loop 610

Tropical Storm Allison

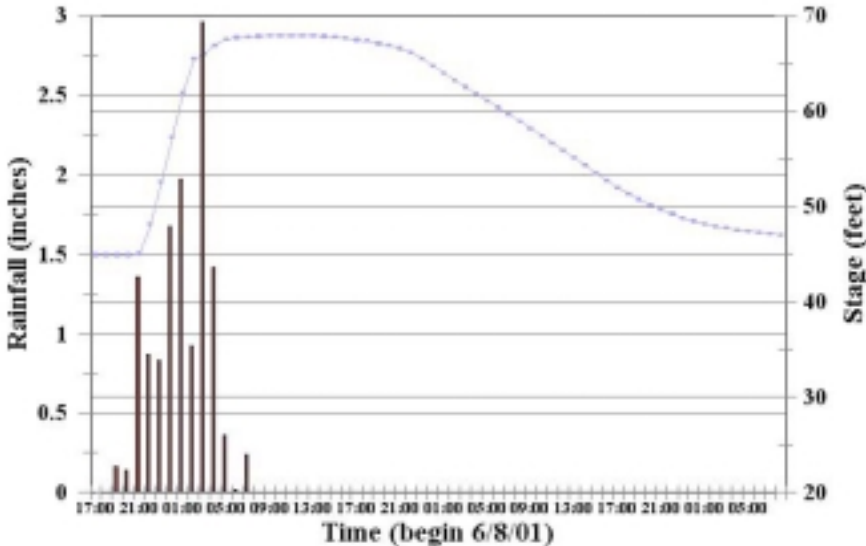


flood damage, 3600 were completely destroyed and almost 11,000 received major damage. More than 70,000 cars were flooded in the Houston Metro area.

The eastern portion of Harris County, among the hardest hit areas, includes Greens, Halls, Garners, and Hunting Bayous. Rainfall over the entire 182 square mile Greens Bayou watershed averaged 15.75 inches with the lower portion, below U.S. Highway 59 receiving almost 25.5 inches of rain. Average rainfall over the

Greens Bayou at U.S. Hwy 59

Tropical Storm Allison



20 square mile Hunting Bayou watershed was 18.4 inches. Record flooding occurred over all but the upper portions of Greens Bayou.

Of the 53 USGS river gages in the San Jacinto River Basin including the 13 primary watersheds in Houston/Harris County, 22 record flood elevations were set and 7 near record elevations were reached. Record flooding was observed on Caney Creek, the upper portions of Spring Creek, Willow Creek, White Oak Bayou, Cole Creek, Brickhouse Gully, Little White Oak

Bayou, Buffalo Bayou, Brays Bayou, Hunting Bayou, and Vince Bayou. Major flooding occurred on the West Fork of the San Jacinto River below Lake Conroe to Lake Houston, Lower Spring Creek, Cypress Creek, Carpenters Bayou, and Clear Creek. Some of the more significant stages are listed in the table below (record levels are red and near record blue).

Station Name	Old Record Stage (feet)	Old Record Date	New Record Stage (feet)
Little Cypress Creek near Cypress	81.41	October 18, 1994	80.70
Cypress Creek at Grant Road near Cypress	47.38	October 18, 1994	46.71
Cypress Creek at Stuebner-Airline Road near Westfield	39.61	October 19, 1994	41.34
Buffalo Bayou at Shepard Drive, Houston	36.33	September 11, 1998	40.00
Whiteoak Bayou at Alabonson Road, Houston	48.54	September 11, 1998	51.11
Whiteoak Bayou at Heights Blvd, Houston	50.43	March 4, 1992	52.84
Little Whiteoak Bayou at Trimble Street , Houston	43.17	March 4, 1992	46.21
Whiteoak Bayou at Main Street, Houston	32.75	September 11, 1998	38.59
Brays Bayou at South Main Street, Houston	52.13	June 15, 1976	54.37
Sims Bayou at Hiram Clarke Street, Houston	57.12	June 15, 1976	55.96
Berry Bayou at Forest Oaks Street, Houston	23.85	September 20, 1979	25.99
Vince Bayou at West Ellaine Drive, Pasadena	18.3	May 3, 1981	23.39
Hunting Bayou at Loop 610, Houston	39.91	June 26, 1989	41.77
Greens Bayou at U.S. Highway 59 near Houston	66.04	June 27, 1989	67.81
Garners Bayou at Beltway 8 near Humble	56.77	May 20, 2000	59.41
Halls Bayou at Jensen Drive Houston	62.86	June 27, 1989	64.99
Greens Bayou at Ley Road, Houston	39.4	June 27, 1989	44.02

NWS STORM-READY - Ninety percent of all presidentially declared disasters are weather related, leading to around 500 deaths per year and nearly \$14 billion in damage. To help Americans guard against the ravages of severe weather, the National Weather Service has designed StormReady, a program aimed at arming America's Communities with the communication and safety skills necessary to save lives and property. www.nws.noaa.gov/stormready



Disaster Supply Kit

The following is guidance on building a Disaster Supply Kit. Your needs may require the addition of other items.

- WATER - At least 1 gallon daily per person for 3 to 7 days.
- FOOD - At least enough for 3 to 7 days.
- BLANKETS / PILLOWS, etc.
- CLOTHING
Seasonal/rain gear/sturdy shoes
- FIRST AID KIT / MEDICINES / PRESCRIPTION DRUGS
- SPECIAL ITEMS - For babies and the elderly
- TOILETRIES - Hygiene items
- MOISTURE WIPES
- FLASHLIGHT / BATTERIES
- RADIO - Battery operated and NOAA weather radio
- CASH - Banks and ATMs may not be open or available for extended periods.
- KEYS
- TOYS, BOOKS and GAMES
- IMPORTANT DOCUMENTS
In a waterproof container
- TOOLS - Keep a set with you during the storm.
- VEHICLE FUEL TANKS FILLED
- PET CARE ITEMS

Hurricane Action Box

- Know if you live in an evacuation area. Know your home's vulnerability to storm surge, flooding and wind. Have a written plan based on this knowledge.
- Check your supplies, replace batteries and use food stocks on a rotating basis.
- During hurricane season, monitor the tropics.
- Monitor NOAA Weather Radio.
- If a storm threatens, heed the advice from local authorities. Evacuate if ordered.
- Execute your family plan.

TROPICAL CYCLONE MYTH

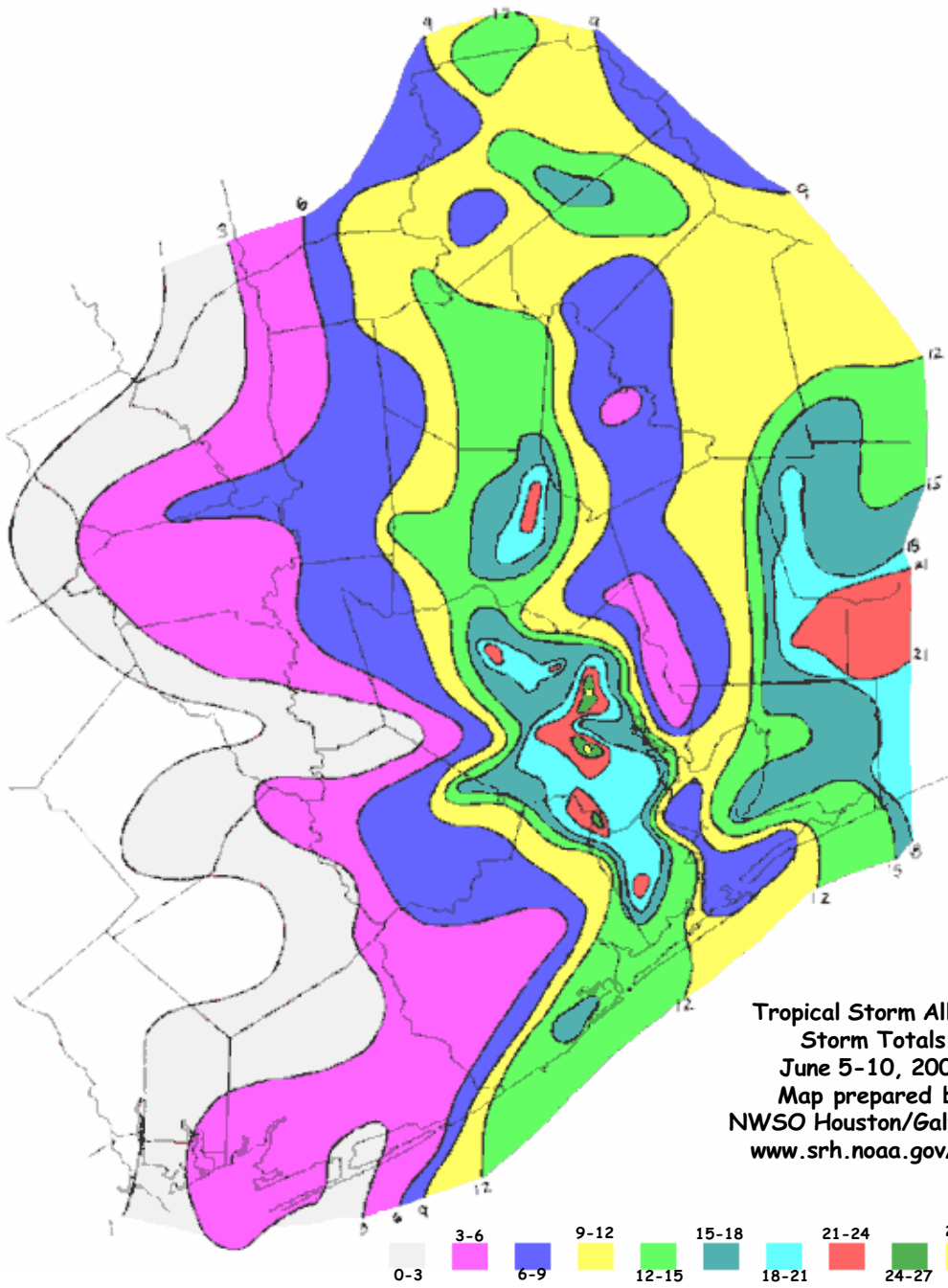
Subject: During a hurricane are you supposed to have the windows and doors on the storm side closed and the windows and doors on the lee side open?

No! All of the doors and windows should be closed (and shuttered) throughout the duration of the hurricane. The pressure differences between inside your house and outside in the storm do not build up enough to cause any damaging explosions. (No house is built airtight.)

The winds in a hurricane are highly turbulent and an open window or door - even if in the lee side of the house - can be an open target to flying debris. All exterior windows should be boarded up with either wooden or metal shutters.

Greatest Five Day Rainfall Totals for Harris County by Watershed

Upper Cypress Creek Cypress Creek at Huffmeister - 13.04 inches	Garners Bayous Garners Bayou at Beltway 8 - 24.68 inches
Lower Cypress Creek Cypress Creek at Grant Road - 21.41 inches	Halls Bayou Halls Bayou at Airline Drive - 19.37 inches
Little Cypress Creek Little Cypress Creek at Kluge Road - 13.90 inches	Hunting Bayous Hunting Bayou at I-10 - 35.75 inches
Upper Brays Bayou Brays Bayou at Beltway 8 - 7.68 inches	Carpenters Bayou Carpenters Bayou at U.S. Hwy 90 - 20.19 inches
Lower Brays Bayou Brays Bayou at Lawndale - 21.46 inches	Spring Creek Spring Creek at Kuykendahl - 12.32 inches
Keegans Bayou Keegans Bayou at Roark Road 8.70 inches	Willow Creek Willow Creek at Kuykendahl - 12.67 inches
Sims Bayou Sims Bayou at Telephone Road - 19.95 inches	San Jacinto River - including Luce and Jackson Bayous Lake Houston Spillway - 16.15 inches
Berry Bayou Berry Bayou at Nevada Street - 22.13	Cedar Bayou - including Little Cedar Bayou Little Cedar Bayou at 8th Street - 16.34 inches
Vince Bayou... including Little Vince Bayou Vince Bayou at West Ellaine - 23.70 inches	Goose Creek Goose Creek at State Hwy 146 - 9.72 inches
Upper White Oak Bayou - including Cole Creek White Oak Bayou at Alabonson - 16.19 inches	Armand's Bayou Big Island Slough at Fairmont Parkway - 20.23 inches
Vogel Creek Vogel Creek at Gulf Bank - 19.22 inches	Clear Creek Clear Creek at Telephone Road - 22.01 inches
Lower White Oak Bayou - including Brickhouse Gully White Oak Bayou at Ella - 18.36 inches	Clear Creek Tributaries Coward Creek at Baker - 27.95 inches
Little White Oak Bayou Little White Oak Bayou at Tidwell - 15.20 inches	Upper Buffalo Bayou - including Addicks and Barker Reservoirs Langham Creek at West Little York - 6.27 inches
Upper Greens Bayou Greens Bayou at Beltway 8 - 23.78 inches	Lower Buffalo Bayou Buffalo Bayou at Turning Basin - 22.09 inches
Lower Greens Bayou Greens Bayou at Mount Houston - 35.76 inches	



Tropical Storm Allison
Storm Totals
June 5-10, 2001
Map prepared by
NWSO Houston/Galveston
www.srh.noaa.gov/hgx

Deaths and Damages as a result of Tropical Storm Allison

By Gene Hafele

Tropical Storm Allison will go down as the costliest natural disaster in Texas History and one of the deadliest in recent time. Preliminary damage estimates for the 14 counties in the Houston Galveston National Weather Service warning area that were affected by the disaster will be over \$5.15 Billion dollars in damage. If you add the damage from the other counties in southeast Texas, including Jefferson and Orange the total damage will be close to \$6.0 Billion. This damage exceeds the damage caused by Hurricane Alicia in 1983 by nearly double. The damage by Hurricane Alicia (category 3 Hurricane) was around \$3 Billion. The flood of October 1994 affected all of the 23 counties in the Houston/Galveston NWS warning area and the damage was near \$1 Billion. Even Hurricane Carla in 1961, a category 4 Hurricane, only produced a little over \$2.2 Billion in damage.

Why was Allison so costly? Allison was costly because 20 to 30 inches of rain fell over a large portion of Harris County and the City of Houston which is heavily populated. Over 44,000 family homes were damaged by the flood with around 3500 homes destroyed. Much of the downtown area was hit hard in addition to the Medical Center. Anytime you have a major weather disaster hit a large metropolitan area the damage is going to be astronomical. If you take Harris County out of this disaster the amount of damage would be less than \$1 billion for all of Texas which is still a disaster of major proportions.

In addition to damage, Tropical Storm Allison was also a deadly storm. Twenty four individuals lost their lives during this event with twenty two being in Harris County. Most of these deaths occurred late Friday night and early Saturday morning. It is important for us to know what these people were doing when they lost their lives so we can learn from their mistakes. One lady had taken an elevator into the basement to move her vehicle when the basement was suddenly flooded trapping her. This particular death was one that would be hard to foresee and prevent. The only people to die in their homes during the flood were three folks who were electrocuted. Anytime your home has rising water the main power switch should be shut off. This not only prevents

Recent Weather Disasters Compared to Allison

Name of Storm	Year	Damage	Deaths
*TS Allison	2001	\$6 Billion	24
Alicia	1983	\$3 Billion	21
Carla	1961	\$2.2 Billion	46
TS Claudette	1979	\$750 Million	1
Southeast TX	OCT 1994	\$900 Million	17
Central TX	OCT 1998	\$428 Million	31

*Damage and deaths for Allison is for Texas only. Damages from the other storms have been adjusted for today's dollars.

electrocutions but will also save many of your appliances from being damaged as the water rises. Ten individuals died while in their vehicles or while trying to escape from their flooded vehicle. . Your vehicle is not a safe refuge during a flood. The National Weather Service , Red Cross and Emergency Management have been educating people for years not to drive your vehicle into flooded roadways. Take an alternative route or find a high and dry spot and wait for the water to recede. Getting to your destination late is better than never getting there. Seven individuals drowned while walking, trying to get home or to pick up a love one. Walking and or driving in flooded roadways is not recommended due to the potentially strong currents. One remarkable finding is no individuals actually drowned in their homes. Your home is probably a safer refuge than your automobile in almost all flood events that occur in southeast Texas.

After reviewing where these people were and what they were doing during the flood most of these deaths could have been prevented if they had not attempted to reach their destination. If you are safe where you are then stay put or wait till you can be rescued. If you are at home and flood waters are invading your home turn your power off. Instead of 22 deaths in Harris County maybe only 2-3 deaths would have occurred if these simple safety measures would have been taken.

DAMAGE BY ALLISON

(Preliminary Damage Estimates)

	# Homes Estimated Cost	# Business Estimated Cost	Roads and Bridges	Public Estimated Cost	Total Damage Cost
Brazoria	616 \$ 21,600,000		\$506,000	\$116,000	\$22,200,000
Chambers			\$574,000	\$23,000	\$ 597,000
Fort Bend	214 \$ 7,700,000			\$40,000	\$7,740,000
Galveston	862 \$31,030,000		\$62,000	\$650,000	\$31,740,000
Grimes	2 \$70,000				\$70,000
Harris	44147 \$1,760,000,000	1656 \$1,080,000,000	\$148.600,000	\$2,040,000,000	\$5,029,000,000
Houston			\$966,000	\$100,000	\$1,066,000
Liberty	116 \$4,176,000		\$3,313,000	\$113,000	\$7,602,000
Madison	0	0	0	0	0
Montgomery	531 \$19,116,000		\$590,000	\$400,000	\$20,106,000
Polk	2 \$70,000		\$172,000	\$3,016,000	\$3,258,000
San Jacinto	65 \$1,260,000		\$2,800,000	\$3,000	\$4,060,000
Trinity	50 \$18,000,000		\$2,500,000		\$20,500,000
Walker			\$738,500	\$2,500	\$741,000
Total	46605 \$1,863,000,000	\$1,080,000,000	\$160,821,000	\$2,044,000,000	\$5,150,000,000

Allison in Historical Perspective

By Daniel Huckaby

Tropical Storm Frances (September 1998)	
Angleton	19.47
Bay City	17.14
Houston-Heights	15.25
Cypress	12.84
Sugar Land	12.58
League City	11.49
Intercontinental	9.33
Tomball	8.22
Huntsville	6.87
Conroe	4.89

With 19.21" of rainfall at Intercontinental Airport, June 2001 became the wettest month ever recorded in Houston. The rainfall totals in the wake of Tropical Storm Allison were tremendous, and the flooding was as widespread as it was devastating. However, Southeast Texas is no stranger to heavy rain events. In fact, the unique geography and climate of our coastal plain makes the region prone to, if not a very favorable location for, torrential rains. Thankfully, such events are uncommon; but as the following statistics iterate, flooding is an inevitable facet of life along the Upper Texas Coast.

As destructive as hurricane winds and storm surge can be, it is usually not hurricanes that produce the greatest rainfall totals. Tropical storms and other slower-moving systems are able to inundate the region with immense precipitation, feeding off of abundant tropical moisture. While the impact of Allison's aftermath was enormous, there have been several other events with equally impressive rainfall, some of which occurred just in the last 25 years.

The '94 Floods (October 1994)	
Liberty	26.37
Baytown	25.66
Conroe	23.89
Port of Houston	21.23
Hobby Airport	18.03
Tomball	14.82
Huntsville	14.10
Sugarland	11.86
Intercontinental	9.50
League City	4.36

Most of the rainfall totals below are 3- to 5-day periods. Although some are of shorter or somewhat longer duration, the storm totals here attempt to encompass as accurately as possible the event of interest. In general, these past data compare appropriately with the duration of Tropical Storm Allison.

The most recent of these events were in 1998. Ending a severe drought, Tropical Storm Frances brought copious rainfall during September. Two other heavy rain events followed in October and November, both of which brought storm total rainfall of over 10 inches to some locations.

Perhaps the most widespread heavy rain event of the last quarter-century was in October of 1994, flooding that occurred without the aid of a tropical cyclone.

Three tropical cyclones menaced the Upper Texas Coast in 1989. Like the 2001 storm of the same name, Tropical Storm Allison of 1989 also stalled in Southeast Texas, bringing repeated heavy rains to the region in late June and early July. Oddly, both Allison of 1989 and Allison of 2001 made landfall near the west end of Galveston Island, headed into East Texas, and then moved back to the southwest, producing torrential rains in the Houston area, before finally drifting off to the east. Two hurricanes followed that year, Chantal at the end of July and Jerry in October; but only Chantal had considerable rainfall. Some locations near Houston picked up 8 to 10 inches of rain during Chantal. (Interestingly, no hurricane has made landfall on the Upper Texas Coast since Jerry.)

Tropical Storm Allison (June–July 1989)

Anahuac	20.50
Baytown	18.20
Angleton	14.34
Intercontinental	13.98
Hobby Airport	12.69
Alvin	11.16
Downtown Houston	10.78
Tomball	10.06
Galveston	9.61
Sugar Land	5.24

Memorable Hurricane Alicia in August of 1983 brought rainfall totals of 6 to 8 inches across the Houston/Galveston area, but Tropical Storm Claudette in July of 1979 produced incredible rainfall totals. An observer near Alvin recorded 43 inches of rain in a 24-hour period, a U.S. record that stands to this day. Areas to the southeast of Houston were hit particularly hard, with other locations receiving only scant totals.

The above are the most significant heavy rain events of the last quarter-century. Many previous hurricanes and tropical storms have also brought torrential rainfall to the region, as have some fierce non-tropical systems. One such occasion was the Houston flood of December 1935, during which Buffalo Bayou rose 46 feet above its normal level, and water reached the third story of some downtown buildings.

As devastating as June's flooding was, Southeast Texas had already seen its share of heavy rain events. While Tropical Storm Allison of 2001 ranks among the most impressive, this look at some recent floods certainly shows that such events are not unprecedented.

Tropical Storm Claudette (July 1979)

Alvin (observer)	45.00
Alvin (NWS)	30.70
League City	24.90
Freeport	23.59
Pearland	22.60
Angleton	18.61
Galveston	14.47
Hobby Airport	11.02
Sugar Land	3.83
Intercontinental	3.13

INLAND FLOODING

Consider the following: When it comes to hurricanes, wind speeds do not tell the whole story. Hurricanes produce storm surges, tornadoes, and often the most deadly of all - inland flooding.

While storm surge is always a potential threat, more people have died from inland flooding in the last 30 years. Intense rainfall is not directly related to the wind speed of tropical cyclones. In fact, some of the greatest rainfall amounts occur from weaker storms that drift slowly or stall over an area.

Inland flooding can be a major threat to communities hundreds of miles from the coast as intense rain falls from these huge tropical air masses.

Freshwater floods accounted for more than half (59%) of U.S. tropical cyclone deaths over the past 30 years. These floods are why 63% of U.S. tropical cyclone deaths during that period occurred in inland counties.

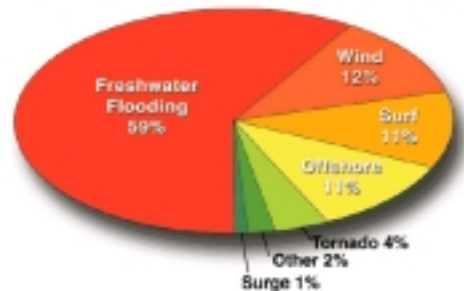
At least 23% of U.S. tropical cyclone deaths occur to people who drown in, or attempting to abandon, their cars.

78% of children killed by tropical cyclones drowned in freshwater floods.

So, the next time you hear hurricane — think inland flooding!

What can you do? When you hear hurricane, think inland flooding. Determine whether you live in a potential flood zone. If advised to evacuate, do so immediately. Keep abreast of road conditions through the news media. Move to a safe area before access is cut off by flood water. Do not attempt to cross flowing water. As little as six inches of water may cause you to lose control of your vehicle. Develop a flood emergency action plan. Have flood insurance. Flood damage is not usually covered by homeowners insurance. Do not make assumptions. Check your policy.

Leading Causes of Tropical Cyclone Deaths in the U.S. 1970-1999



Source: Edward Rappaport—Chief, Technical Support Branch, Tropical Prediction Center