



EYE OF THE STORM

Report of the Governor's Commission to Rebuild Texas

REBUILD  TEXAS
The Governor's Commission to Rebuild Texas

John Sharp, Commissioner



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FOREWORD

On September 1 of last year, as Hurricane Harvey began to break up, I traveled from College Station to Austin at the request of Governor Greg Abbott. The Governor asked me to become Commissioner of something he called the Governor's Commission to Rebuild Texas. The Governor was direct about what he wanted from me and the new commission: "I want you to advocate for our communities, and make sure things get done without delay," he said.

I agreed to undertake this important assignment and set to work immediately. On September 7, the Governor issued a proclamation formally creating the commission, and soon after, the Governor and I began traveling throughout the affected areas seeing for ourselves the incredible destruction the storm inflicted on a swath of Texas larger than New Jersey.

Since then, my staff and I have worked alongside other state agencies, federal agencies and local communities across the counties affected by Hurricane Harvey to carry out the difficult process of recovery and rebuilding.

More than a year has now passed. We know now what we only suspected on September 1, 2017: Harvey was one of the worst disasters in U.S. history. It caused at least \$125 billion in damage in Texas, more than any other natural disaster except Hurricane Katrina. Thousands of Texans were left to salvage what they could. Ultimately, it produced the largest disaster response in Texas history, and I am proud to have been part of the response.

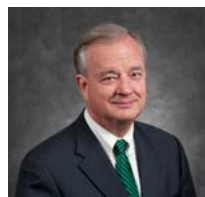
In the past year, much has been accomplished, but much remains to be done before Texas can declare itself fully recovered from the devastation of a few days at the end of last summer. But Texans are resilient, and eventually all will be set right.



Before the difficulties our communities faced because of Harvey fade from memory, it is critical that we examine what happened and how our preparation for and response to future disasters can be improved.

In this report, we try to create as clear a picture of Hurricane Harvey as possible. We document how the storm developed and how it affected our state. We also offer a frank assessment of the federal, state and local response and recommendations for how Texas can be better prepared to withstand future disasters. The report is both a record of a milestone event in the state's history and a guide to "future-proofing" our state to mitigate the impact of future Harveys.

Hurricane Harvey was an inestimable tragedy for many Texans, but the lessons it taught us should not be forgotten or ignored.



John Sharp
*Commissioner
The Governor's Commission to
Rebuild Texas*

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EXECUTIVE SUMMARY

Hurricane Harvey slammed into the Texas Gulf Coast just before 10 pm on August 25, 2017. The storm came ashore just northeast of Corpus Christi and quickly devastated Texas coastal communities with 130 mile-per-hour winds and a six-foot storm surge. From there, the storm moved eastward, leaving a path of destruction that covered an area of Texas the size of New Jersey. By the time the storm left the state, dozens of Texas counties and millions of Texans had been affected.

As part of his effort to respond quickly and effectively in the storm's aftermath, Governor Greg Abbott created the Governor's Commission to Rebuild Texas headed by Texas A&M University System Chancellor John Sharp. The commission's role was to "oversee the response and relief effort between the state and local governments to ensure victims of the storm get everything they need as quickly as possible" and to be "involved in the rebuilding process, focusing on restoring roads, bridges, schools and government buildings in impacted communities."

This report of the commission describes how our state responded to the disaster, and how Texans began the long road to recovery. The report is the product of months of effort by the commission and its many

partners, based on hundreds of hours of interviews and after-action reports. It provides a detailed account of the storm and offers recommendations for improving our response to future disasters.

The clearest and most important message we took from the commission's work is that Hurricane Harvey was a warning we should heed. The magnitude of the devastation caused by the storm is almost unimaginable to those who didn't live through it or visit the disaster area repeatedly, as Governor Abbott and Commissioner Sharp did in the weeks following the storm. The enormous toll on individuals, businesses and public infrastructure should provide a wakeup call underlining the *urgent* need to "future-proof" the Gulf Coast — and

indeed all of Texas — against future disasters. This report includes the commission's recommendations about how we can begin this process.

We found that Texas is a national leader in responding to disasters, whether a hurricane along the Gulf Coast or a Panhandle wildfire. Emergency management in Texas is highly organized and well run by professionals who know their jobs and move quickly and decisively. However, we have identified ways the state can improve the current system by unifying the state's response and recovery responsibilities, and by providing better information, training and more effective application of emerging technologies. Texas must be an innovator in the field of emergency management as well as a leader.

We particularly need to do a better job during the long and difficult process of recovery — what is done in the weeks and months after a disaster to restore Texans, their communities and economies to a point where they are as good as or better than before disaster struck.

In this regard, the task ahead matches the Federal Emergency Management Agency's (FEMA) national strategic priorities: To build a culture of preparedness, to be ready for future disasters, and to reduce complexity.

Texas also needs to be better prepared for future disasters. Harvey was a tragedy for many Texans, but it also taught us valuable lessons about how to build a state that is ready for future challenges. We should not allow the opportunity for improvement to pass without action. We need to ensure that state capabilities for emergency response are organized, trained and equipped for whatever challenges lie ahead. We need to have better trained local officials and emergency managers.

Accomplishing these goals requires better communication with the communities affected by a disaster, better and timelier assistance to survivors, better coordination of recovery efforts, stronger partnerships with the federal agencies that provide funding and assistance during major disasters, and improved strategies for bringing state and federal resources to bear in time of need.

For example, during Hurricane Harvey, Texas A&M AgriLife Extension Service agents in a new role aided state-local communications by serving as a "force multiplier" for professionals already in the field and working with city and county officials on a daily basis. We believe this strategy should be developed and extended further. We should work more closely with our federal partners like FEMA to streamline

assistance programs and simplify the inevitable mountains of paperwork.

We also need to help individual Texans be better prepared by providing them with better and more accessible information about future risks. We need to stop making the old mistakes in local development that expose homes and businesses to risks that only become apparent when disaster strikes. To paraphrase the old saying, an ounce of preparation is worth a pound of cure.

We must make the Texas Gulf Coast — and indeed the entire state — more resilient and better able to withstand future disasters, whether the threat comes from hurricanes, tornadoes, wildfires, flooding or other disasters, a process Governor Abbott has called "future-proofing" our state.

The effects of an event like Harvey can't be eliminated but they *can* be reduced. With billions of federal, state and local dollars being spent in Texas to repair and replace what Harvey destroyed, it is essential that we don't simply replace what was destroyed but that we also increase the state's resilience. As Commissioner Sharp said last year: "Future-proofing the state's coastal areas requires a long-term commitment and investment to improve the resiliency of our communities and institutions. To succeed, the task needs both the continued partnership and financial support of the federal government."

To accomplish this, we must do a better job of setting priorities and identifying the key improvements that can contribute to a more resilient Texas. That means maintaining an inventory of what needs to be done when funding is available. It means creating an effective state-local planning process for improvement of our infrastructure and our communities, both along the coast and, again, in all of Texas.

Future-proofing Texas means recognizing that the future is uncertain and that investing in strategic improvements now in recognition of future uncertainties is not only a good idea, but also good policy.

In 1900, the most devastating hurricane in U.S. history swept Galveston, killing between 6,000 and 12,000 people. While many storms have lashed the island since then, many fewer people have suffered and much less damage has been done. The reason for this can be attributed to two lessons learned in that tragic year. First, the people of Galveston were better prepared and took approaching storms more seriously. And second, they elevated an entire island and built a seawall. We should recognize that those lessons remain vital and relevant to Texas today — and tomorrow.

RECOMMENDATIONS

CHAPTER 4

1. Reorganize emergency management functions to unify the most critical emergency response and recovery functions.
2. Update and expand the Texas Emergency Management Council.

CHAPTER 5

1. Consider appropriating additional funds from the existing Emergency Radio Infrastructure Account to fund radio infrastructure.
2. Strengthen the role of the Texas A&M Veterinary Emergency Team by giving it a more appropriate designation in the State of Texas Emergency Management Plan and consider additional appropriations.

CHAPTER 6

1. Create a catastrophic debris management plan and model guide for local use.
2. Improve contracting for debris removal.
3. Study the issues surrounding the removal of “wet” debris.
4. Improve the process for applying for D-SNAP benefits during a major disaster.
5. Investigate the possibility of creating a state case management program administered by the Health and Human Services Commission.
6. Determine the feasibility of developing a single intake form for disaster victims to complete to determine their eligibility for disaster programs.
7. Improve oversight, accountability, and availability of individuals in the building trades offering services to disaster survivors.

8. Institutionalize the use of extension agents from the Texas A&M AgriLife Extension Service as a “force extender” in support of the Texas Division of Emergency Management.
9. Use available state resources, such as staff from AgriLife Extension, TEEX and other state agencies, to create a recovery task force to provide specialized assistance for communities and individuals in areas like financial issues, federal assistance programs, and recovery and resiliency planning to speed recovery at the local level.
10. Set up a response team at the state level to respond to questions and other inquiries from local emergency management officials.
11. Organize ongoing briefings at least quarterly or as needed to inform legislators, their staffs, and appropriate agency personnel on hazard threats and disasters.
12. Ensure the state is prepared to quickly develop and present a well-reasoned report to the federal government listing projects requiring federal funding after large-scale disasters.
13. Clarify requirements local elected officials must meet to communicate in emergency situations under the state’s Open Meetings Act.
14. Develop a process to capture vehicle identification information in FEMA’s vehicle assistance program.
15. Explore ways to solve the issue of titling trailers in the FEMA temporary housing program.
16. Compile and maintain a comprehensive list of all the regulatory waivers needed during a disaster to expedite suspensions in any future event.
17. Increase utility customers’ awareness of utility payment relief programs.
18. Grant the Texas Department of Transportation (TxDOT) authority to pre-purchase food and water and stockpile these essentials for each hurricane season.
19. Study and recommend ways to resolve restrictions of home owner associations or local jurisdictions impeding debris removal or trailer placement for short-term housing during disasters.

CHAPTER 7

1. Establish a special study committee to evaluate and propose options for a state-local partnership to help future-proof Texas against flood events on a watershed basis.
2. Establish and fund a new Institute for a Disaster Resilient Texas to be established within Texas A&M University.
3. Investigate ways to improve the hardening of utilities and facilities.
4. Create a comprehensive inventory of needed mitigation and resiliency projects statewide and develop a prioritization methodology to guide local, state and federal decision makers.

CHAPTER 8

1. Develop for the Legislature a proposal for training and credentialing emergency management personnel.
2. Review current training courses with the goal of strengthening training for recovery operations for state and local personnel in emergency management.
3. Explore possible expansion of current degree programs in emergency management.
4. Examine and report on ways to strengthen the quality and sharing of data used in emergency management operations.
5. Emphasize to emergency management personnel the importance of working out partnership agreements and contracted services before a disaster strikes.
6. Explore whether the purchasing programs of the Texas Comptroller's office could be tailored to help local jurisdictions with their emergency management needs.
7. Collaborate with Congress and the federal government to improve emergency management laws and policies.
8. Embrace the basic tenets of FEMA's Strategic Plan with its emphasis on cooperation among federal emergency management agencies, state government, local government, non-governmental organizations, the private sector and individual citizens to meet the critical basic goals of making the Nation better prepared for and better able to deal with future disasters.

9. Review laws and practices affecting the use of drones during emergency events and recommend changes in operations to promote their use.
10. Establish a single, well publicized state website at the Texas A&M University System that is easy to use and presents important post-disaster information about response and recovery activities.
11. Consider ways to make better use of 911 and social media during disaster response.
12. Explore expansion of the capabilities of the Rebuild Texas application or development of a new mobile app to deliver important information to responders and disaster victims alike.
13. Examine the costs and benefits of promoting a technology standard enabling a wider video representation of a disaster area for first responders.
14. Continue to cultivate relationships with private technology providers to coordinate their assistance in the early days of a disaster when communications systems are damaged or destroyed.
15. Examine ways for the state to apply data analytics to improve disaster management through more effective and timely information.
16. Examine ways to better inform the public about how to prepare for and survive a disaster.
17. Consider appropriating additional funds to expand and improve the state's trauma care network to be better prepared for future disasters.

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CHAPTER 1

1 A LANDMARK EVENT

Hurricane Harvey slammed into the Texas Gulf Coast just before 10 pm on August 25, 2017. The storm came ashore just northeast of Corpus Christi and quickly devastated Port Aransas, Rockport and other communities along the coast with 130 mile-per-hour winds and a six-foot storm surge.

As they hunkered down in shelters or fled from the storm's path, coastal residents couldn't know the full extent of Harvey's destruction, but all of Texas — and the nation — soon understood its devastating impact. Rockport resident Robert Jackson, who rode out the storm, said it "sounded like a freight train with square wheels."¹ Port Aransas city manager David Parson said the dorm where he was sheltering "sounded like it was getting hit with a .50 caliber machine gun. It blasted out every window in that building."²

When Harvey moved northward, its character changed. As its winds slowed, the storm stalled over

the size of the entire state of New Jersey. Cedar Bayou on the outskirts of Houston saw nearly 52 inches of rain; about 11,000 square miles of the region received at least 30 inches.⁶ Entire cities were cut off by flooded rivers and bayous.

But Harvey wasn't finished. By August 28, the storm was moving slowly eastward, lashing Beaumont, Port Arthur and Orange. The storm weakened to a tropical depression in the evening of August 29, but not before it swamped southeast Texas with record levels of rain, unleashing flash flooding and forcing residents to flee to local shelters.⁷ Beaumont's water system failed and a massive fire broke out at a chemical plant in Crosby. Flooding forced the evacuation of a shelter in Port Arthur's civic center.⁸

By August 31, a much-weakened Harvey moved inland over Louisiana, but rains continued in parts of Southeast Texas for three more days. In its path through Texas, Hurricane Harvey left behind record flooding and almost unimaginable damage. Eventually, Governor Greg Abbott would extend his original disaster declaration from 30 counties to 60. The federal disaster declaration eventually would include 53 counties (**Exhibit 1, next page**).

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It blasted out every window in that building.

the Houston region, inundating the area with trillions of gallons of water — enough to fill the Astrodome more than 3,300 times, the *Houston Chronicle* would report.³

“THIS IS A LANDMARK EVENT”

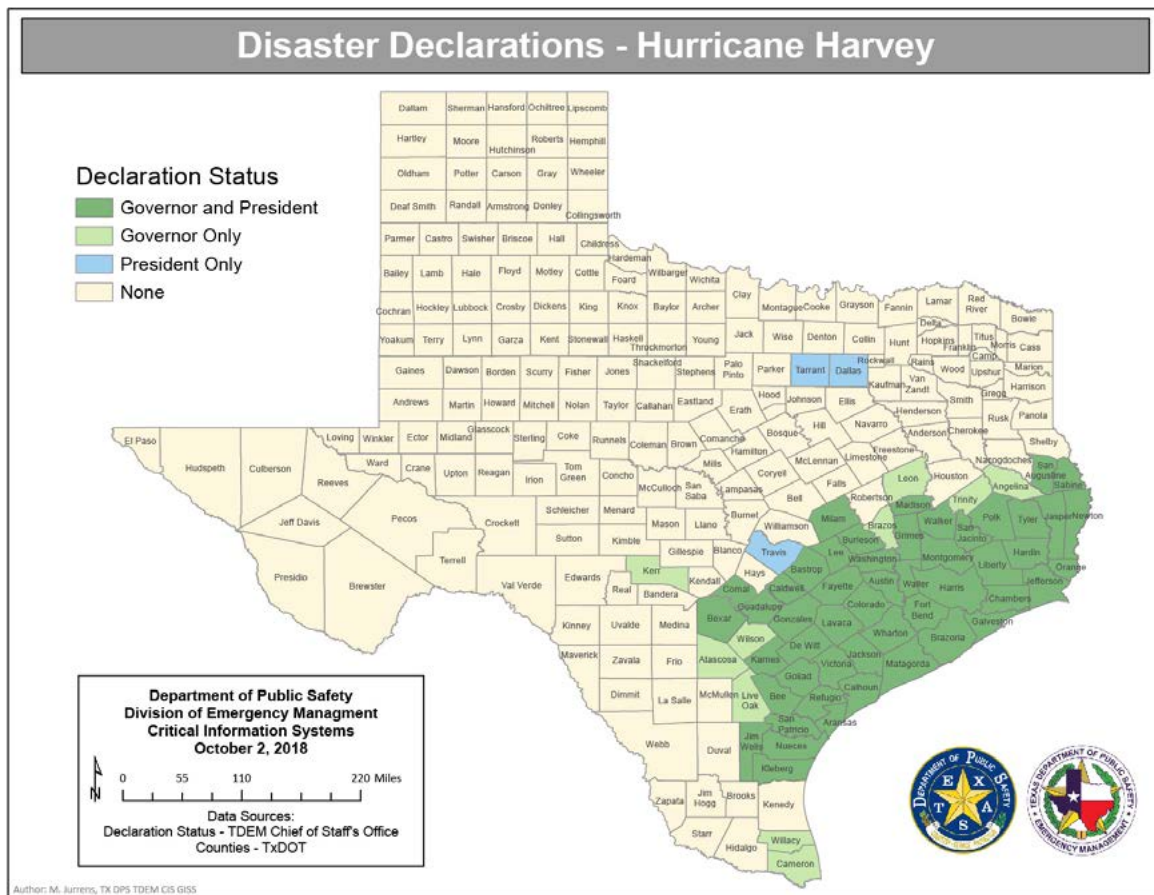
On August 27, with the storm still raging, the National Weather Service issued a warning on social media: “This event is unprecedented & all impacts are unknown & beyond anything experienced. Follow orders from officials to ensure safety.” Federal Emergency Management Agency (FEMA) Administrator Brock Long said in a briefing: “This is a landmark event. We have not seen an event like this. You could not draw this forecast up. You could not dream this forecast up.”⁴ In the wake of the storm, the National Weather Service said it had to alter its color scale for rainfall amounts because the previous version couldn't depict the sheer volume of rain hitting Houston.⁵

In the end, it became a 1,000-year flood event for Houston, exceeding anything seen in modern recorded history. Flooding covered an area of southeast Texas

“TEXANS BELIEVE IN TAKING ACTION”

Natural disasters are nothing new to Texas. Since 1953, the state has averaged one federally declared disaster — whether flooding, tornado, hurricane, wildfire or windstorm — every eight months. But Hurricane Harvey was the strongest hurricane to strike Texas since Carla in 1961.

Given their history, Texans don't wait for storms such as Harvey to strike before they respond. The National Weather Service first named Harvey, then a tropical depression, on August 17.⁹ Three days later, as weather reports became increasingly severe, the Texas

Exhibit 1 Texas Counties Covered by Hurricane Harvey Disaster Declarations

Department of Public Safety's Division of Emergency Management (TDEM) raised the readiness level of the State Operations Center (SOC) in Austin, the centralized operations center for the state's coordinated response to disasters.

The state's Emergency Management Council, representing 28 state agencies and universities, as well as the Red Cross and Salvation Army, first convened on Monday, August 21. On the morning of August 23, Governor Abbott preemptively declared a state of disaster for 30 counties along the coast and ordered the SOC to increase its readiness level.

"Texans believe in taking action and always being prepared in the event of an emergency," said Abbott. "That is why I am taking every precaution prior to Tropical Depression Harvey making landfall. Preemptively declaring a state of disaster will allow Texas to quickly deploy resources for the emergency response effort in anticipation of the storm's hazardous conditions."¹⁰ The SOC's readiness level was raised to

Level III (Increased Readiness Conditions).

Events began to move more rapidly. By 7:00 pm on August 23, the SOC raised the readiness level to Level II (Escalated Response Conditions). Governor Abbott said he had made available any and all state resources to assist in preparation, rescue and recovery efforts. The next morning, the SOC began around-the-clock operations for the Texas Emergency Management Council and increased its response level to Level I, Emergency Conditions.

Federal agencies also began preparing for the coming storm. On August 24, FEMA announced it had established an Incident Support Base at Randolph Auxiliary Airfield near Seguin, Texas, to position supplies including water, meals, blankets and other resources. FEMA Regional Incident Management Assistance Teams (IMATs) were sent to other emergency operations centers in Austin and Baton Rouge, Louisiana.¹¹

The state emergency managers mobilized hundreds of field responders, plus helicopters, water craft, buses

for evacuation, mobile kitchens, ambulances, mobile communication units and search and rescue teams. Supplies including water and ice were stockpiled in strategic locations well ahead of the storm and could be dispatched and tracked through a sophisticated GPS system. By the time Harvey made landfall on August 25, thousands of state and federal resources were in place. On that day, Governor Abbott sent a letter to President Donald Trump requesting a federal disaster declaration for Texas.

Texas was as close to ready as possible.

The storm battered the Texas Gulf coast for more than a week. Its rains finally subsided on September 3. In all, Texas officials said more than a quarter of a million Texas homes had been damaged, and more than 15,500 were destroyed. Thousands of businesses also were damaged or destroyed, as were about a quarter-million vehicles.¹² FEMA later said 24 hospitals were evacuated, 61 communities lost drinking water, 23 ports closed and 781 roads were impassable at some point.¹³

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According to the National Hurricane Center, at least 68 people died directly due to Harvey's effects, nearly all from drowning.

68 people died directly due to Harvey's effects, nearly all from drowning, and about 35 more people died from indirect effects such as vehicle accidents and the inability to reach medical aid.¹⁴ Thousands of Texans were left homeless. FEMA reported that nearly 780,000 Texans evacuated their homes. More than 42,000 Texans were housed in 692 shelters; first responders rescued more than 122,000 people — and 5,234 pets.¹⁵

Harvey caused \$125 billion in damage in Texas, more than any other natural disaster in U.S. history except Hurricane Katrina.¹⁶ Thousands of Texans were left to salvage what they could.

In his report on the economic impact of the hurricane, Texas Comptroller Glenn Hegar estimated that the net impact of Hurricane Harvey will be a loss of \$3.8 billion in gross state product during the first year following the storm, with a cumulative gain of approximately \$800 million over three years as the state recovers and rebuilds.¹⁷ A Houston reporter aptly said Harvey left “Texas-sized problems” in its wake, but Texans were already beginning to pick up the pieces and beginning the long process of recovery.¹⁸ Governor Abbott committed the state government to doing its

part to make the recovery as quick and effective as possible. “We will be here until we restore this region back to normal as soon as possible,” the governor said at a Corpus Christi meeting days after the storm. “We recognize it will be a new normal.”¹⁹

RESPONSE AND RECOVERY

On August 28, Governor Abbott activated the entire Texas National Guard, about 17,000 members, to assist in search and rescue efforts.²⁰ Utility companies ordered thousands of workers into the region to begin restoring power, a process that lasted into September. About 21,000 federal employees were dispatched to Texas and Louisiana to help with response and recovery efforts.²¹

Much of the state's first response to Harvey fell to Task Forces 1 and 2, search and rescue teams managed by the Texas A&M Engineering Extension Service (TEEX) and the Dallas Fire-Rescue Department respectively, as well as other members from the Texas A&M Forest Service, the Texas A&M Engineering Experiment Station, the Texas Division of Emergency Management (TDEM), the Texas Department of Public Safety, the Texas Department of State Health Services, the Texas Intrastate Fire Mutual Aid System (TIFMAS) and many more.

Texas Task Force 1 (TX-TF 1) includes about 240 firefighters, medical specialists, animal rescue experts, heavy equipment operators, structural engineers and other experts drawn from local governments around the state and the Texas A&M University System. TX-TF 1 also coordinates the state's swift-water rescue program and a helicopter search and rescue team that works in conjunction with Texas Military Department. Members of TX-TF 1 come from areas of the state that allow them to report to College Station within four hours of notification.

Texas Task Force 2, a similar organization based in Dallas, also was mobilized due to the scope of the devastation created by Harvey. (Subsequent to Hurricane Harvey, both organizations were moved under the sponsorship and management of TEEX under TDEM's overall direction.) In all, thousands of responders were mobilized and many more volunteers from Texas and other states joined in the effort. The Texas A&M RELIS research campus, along with staging areas in San Antonio, Katy, Beaumont, Victoria and Beeville, served as a major staging area for supplies moving into the counties affected by Hurricane Harvey.

As the days passed, the federal, state and local

response to the storm gradually gave way to recovery efforts, a process that continues today. Crews worked to restore electricity and other services. Spraying began to suppress mosquito populations. Local governments, private contractors and the Texas Department of Transportation began clearing debris from the disaster zone. As of late February 2018, FEMA estimated that nearly 13 million cubic yards of debris had been cleared from the disaster areas. The city of Rockport alone accounted for 2.5 million cubic yards.²²

The state worked with FEMA to ensure that federal disaster aid moved into affected communities quickly and efficiently. State officials also began meeting with federal officials and Congress to secure additional federal assistance, including FEMA disaster relief funds and Community Development Block Grants for disaster recovery. In addition, Governor Abbott committed millions in state emergency funding to the affected areas to help them attract matching federal funds for debris removal.

The damaged communities also worked hard to recover; local officials logged long hours dealing with the problems of residents displaced by the storm, the impact on local economies, the repair and replacement of public infrastructure and the seemingly endless task of debris removal. “Harvey knocked us to our knees,” said Aransas County Judge Burt Mills, Jr., whose county saw 35 percent of its buildings destroyed. “The next day we got on our feet and every day it gets a little better.”²³

THE GOVERNOR'S COMMISSION TO REBUILD TEXAS

While the disaster was still unfolding, Governor Abbott decided to spearhead a new effort to improve Texas disaster recovery. He announced the creation of the Governor’s Commission to Rebuild Texas on September 7, less than two weeks after Hurricane Harvey smashed into the Texas Gulf Coast.

Governor Abbott created the commission and appointed Chancellor John Sharp of the Texas A&M University System to “oversee the response and relief effort between the state and local governments to ensure victims of the storm get everything they need as quickly as possible.” He directed Sharp and the commission to be “involved in the rebuilding process, focusing on restoring roads, bridges, schools and government buildings in impacted communities”²⁴ (Appendix).

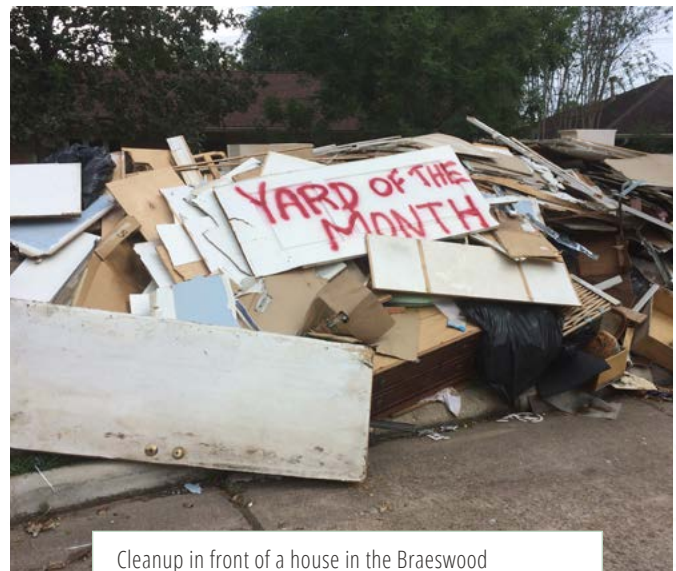
“Although the storm is over, the recovery process is just beginning, and it will require a Texas-sized

response,” Governor Abbott said. “This new commission, led by Chancellor Sharp, will ensure victims get everything they need, and seamlessly provide resources to these devastated communities. Texas will not rest until this process is complete, and I thank Chancellor Sharp for his leadership on this commission.”²⁵

As a final challenge, Governor Abbott directed the commission to consider ways to improve the process of disaster response and to develop strategies for protecting the Gulf Coast against future storms.

The commission’s first responsibility was to work with TDEM and dozens of other state and local agencies to begin the process of recovery. The commission initially served as a communications channel between communities and state and federal agencies. Governor Abbott and Commissioner Sharp traveled to the stricken counties repeatedly in the weeks after the storm to listen to local officials and survivors and to ensure their needs were met as quickly and effectively as possible.

Commissioner Sharp called upon the resources of the Texas A&M University System to bolster recovery efforts. He mobilized 130 agents from the Texas A&M AgriLife Extension Service. These agents knew their areas and quickly helped establish clear lines of communication among mayors, county judges and commissioners, school superintendents, local emergency managers and Rebuild Texas’ central operation in College Station. The extension agents and members of the System’s Government Relations team stayed in constant touch with local officials and relayed their requests for information and assistance to a center in College Station where answers could be found



Cleanup in front of a house in the Braeswood neighborhood of Houston, two weeks after Harvey. (Billy Hamilton)

"A LOT OF GOOD CAN COME OUT OF TRAGEDY..."

Cindi Bonifer

On the Friday before the new school year was to start, the classrooms at A.C. Blunt Middle School in Aransas Pass were set up and ready to receive new students. By the time Monday rolled around, they were destroyed. The roof could not withstand the force of Hurricane Harvey, and everything inside the building was thoroughly saturated.

Cindi Bonifer, who teaches writing at the school, was no stranger to loss. Eight weeks prior to the storm, she had lost her home to a fire.

"I was in a position where I was able to help those who needed extra support," said Bonifer, whose condo was undamaged in the storm. "I was able to relate to people in trauma, and I encouraged them to focus on what we still have, as opposed to what we don't have."

Meanwhile, they waited for word about when – or if – they would begin the school year.

Bonifer and her colleagues used social media to connect with organizations and other schools eager to help replace the materials that had been destroyed by the storm. A middle school classroom in Dallas ended up taking on Bonifer's classroom as yearlong project, organizing fundraisers for them and shipping down supplies.

In October, the middle school students started up school again, but in their old elementary school space, a transition that was not met with enthusiasm by the children.

Bonifer, who has a master's degree in school counseling, attended a workshop called "Writing and Healing after Hurricane Harvey" put on by the Coastal Bend Writing Project at Texas A&M University-Corpus Christi. She returned to her classroom determined to put the strategies discussed there into practice.

"A lot of students lost everything they had," she said of her students. "I encouraged them to write about that, and eventually to start focusing on gratitude for what we still have and the people we still have."

Bonifer encouraged her fellow teachers to adopt similar practices and to keep an eye out for signs of trauma in their students, including an inability to focus and other uncharacteristic behaviors.

"Most of these teachers live in the area, so they know these kids personally, and they know what is normal and not normal behavior for them," she said.

She also observed that it was important that teachers stay attuned to similar changes in themselves. "I could tell some of them were in shock and not really ready to start teaching," she said.

To make up for lost time, the academic calendar compressed. Holidays were shortened or even canceled. The teachers and students persevered. In March, the newly renovated middle school building opened, allowing the academic year to end on a high note. Though, Bonifer cautioned that there is still a lot of healing to be done.

"A lot of good can come out of tragedy, but it takes a while to get there," Bonifer said. "I saw so much healing this year, but there is still a ways to go. They are still rebuilding."



Gov. Greg Abbott speaks at A.C. Blunt Middle School in Aransas Pass to announce a \$100,000 donation to the campus from Lumber Liquidators due to damage sustained by Hurricane Harvey. (Photo: Tim Acosta/Caller-Times)

quickly and passed back. The requests also were logged into a GPS system for analysis and future reference by state emergency officials. In addition, members of the System's Government Relations also established and maintained ongoing contact and worked with members of the Legislature representing the affected counties.

In the days following the storm, a major part of the Rebuild effort involved providing local officials with assistance and information on mosquito suppression, debris management, federal forms and many other issues. Rebuild Texas developed solutions on the spot, working in close coordination with Governor Abbott's office, TDEM, FEMA and other state and federal agencies.

The Rebuild Texas staff also began compiling lists of possible projects for rebuilding public infrastructure damaged or destroyed in the disaster. By late September, these data were compiled into a detailed report for Governor Abbott that identified \$61 billion in local needs. This report became a crucial source of data for the state to use in seeking increased federal disaster assistance.

"A STORM TO REMEMBER"

More than a year has passed since Hurricane Harvey ravaged the Texas Gulf Coast. Thousands of tons of debris have been removed and many — but not all — Texans along the coast have returned to their normal lives. Recovery efforts continue, and *will* continue for years. In the months since its creation, the commission has continued its work alongside TDEM, FEMA, the Texas General Land Office (GLO) and many other Texas state and local agencies.

Now is the time to make changes. A year has provided the opportunity for the state, local jurisdictions and everyone involved in the storm to review, assess and address what can be done to improve the ability of Texans to meet the disasters they all know will come.

The response to Hurricane Harvey was a remarkable effort given the scope and magnitude of the devastation. But Texans know for certain that Harvey wasn't our last catastrophic storm. The commission recognizes that improvements and changes are needed to improve disaster management.

In his report on Hurricane Harvey, Comptroller Hegar called it "a storm to remember." This report of the Governor's Commission to Rebuild Texas shows how state and local governments responded to the disaster and began the long process of recovery. The report is the product of months of effort by

the commission and its many partners, based on hundreds of hours of interviews and after-action reports. It provides a detailed account of the storm and offers recommendations for improving our disaster management across Texas.

THE LESSON OF STORMS

In Erik Larson's 1999 account of the Galveston hurricane in 1900 — still the most deadly hurricane in U.S. history — he notes that in the early 1800s scientists of the day began trying to understand the nature of hurricanes:

Hurricanes, once such a surprise to Columbus, became lodged firmly in the public psyche as just another hazard of venturing upon the sea — acts of God, still, and against which one could do nothing. With tragic regularity, captains sailed their ships right into the worst storms that ever danced upon the earth. Seamen resigned themselves to the inevitability of hurricanes and prayed they would never have to experience their full fury. But others were not so willing to surrender. They began an earnest search for the elusive "Law of Storms," the physical code that scientists hoped would help mariners predict and avoid — perhaps even profit from — the hurricanes and typhoons that so threatened the welfare of nations.²⁶

Eventually the scientists developed a Law of Storms which explained the environmental forces that created hurricanes and typhoons. From there, they hoped to develop the science to predict or even control these monstrous weather events. And yet decades later, the Galveston storm would surprise almost everyone on the island and kill between 6,000 and 12,000 people, according to the National Oceanic and Atmospheric Administration.²⁷

Today, we have far better understanding of these storms, and yet the Law of Storms remains imperfect at best. Hurricanes are the last major weather event that meteorologists can track for days and still not reliably predict. As a 2011 article on hurricanes explained: "For long-term predictions, the best meteorologists can do is the 'cone of uncertainty,' the wide alley that gets painted across large swaths of the coast offering possible targets."²⁸ This uncertainty means that we must be ready to deal with an unpredictable force whenever and wherever it might strike Texas.

In that regard, Hurricane Harvey taught us valuable lessons about how to deal with future hurricanes and other emergencies that can help shape our future

preparations. Scientists will continue improving the Law of Storms, and we can continue improving our ability to deal with them. This report offers the observations about how the state dealt with Hurricane Harvey and how we should improve our approach to dealing with emergencies in the future based on the lessons the commission has learned over the past year. These include:

- 1. Harvey was a warning we should heed.** The sheer magnitude of the devastation Harvey caused is almost unimaginable to those who didn't live through it or visit the disaster area repeatedly, as Governor Abbott and Commissioner Sharp did in the weeks following the storm. The enormous toll on individuals, businesses and public infrastructure should provide a wakeup call for federal, state and local officials, underlining the *urgent* need to "future-proof" the Gulf Coast against future storms. **Chapter 2** of this report describes Harvey's impact using detailed state and local data, showing how the storm struck and spread havoc throughout the Gulf Coast region.
- 2. Hurricane Harvey brought four types of devastation to a broad area along the Texas Gulf coast: river flooding, urban flooding, storm surge and hurricane-force winds.** Harvey's impacts were shaped by meteorological factors, the human ("built") environment and the dynamic interaction of the two. Future Texas coastal risks are likely to involve all of these elements and planning should be based on that fact. **Chapter 3** describes these forces and how they interacted.
- 3. Texas' organizational structure for responding to emergencies, whether a hurricane along the Gulf Coast or a Panhandle wildfire, is highly organized and well run by professionals who know their jobs and move quickly and decisively.** Nevertheless, Harvey revealed areas where the state can continue to improve. One concerns simple communication within the disaster area and between local officials and the state government. Texas A&M AgriLife Extension agents greatly aided communications during this disaster, serving as a "force multiplier" for professionals already in the field. We believe this strategy should be developed and extended further. We also can improve the overall structure of the state's response efforts and the processes associated with tracking response and recovery. Improvements can also be made in providing immediate transparency

on aid pouring into the disaster, and we can work more closely with our federal partners to streamline the response effort. **Chapter 4** of the report describes the current governance of emergency management in Texas and potential improvements.

- 4. The response of Texas government in the days leading up to and immediately following Hurricane Harvey — its response — has rightly been called a model for the nation.** In any disaster, the first few days of response are critical to saving lives and meeting demands that change dramatically from day to day if not hour to hour. Given its size and scope, it is not surprising that the response to Hurricane Harvey was one of the largest in U.S. history and the single largest in Texas history. It involved thousands of responders from local, state and federal governments as well as individual Texans, businesses and organizations pitching in to help get the affected counties through the storm. **Chapter 5** discusses the actions of local, state, federal and private responders in the days leading up to Harvey's landfall and in the weeks immediately following the disaster and the immediate problems that they encountered, such as the need for a more interoperable communications systems for responders.



Member of TX-TF1 secures a fallen US flag, as members conduct search & rescue in the Rockport, Texas area following landfall of Hurricane Harvey.

- 5. Recovery from a major disaster like Harvey must begin even as the response phase continues to help communities get back on their feet and begin the much longer process of recovery.** Even before the flood waters of Harvey had fully receded federal, state and local partners began the initial work of recovery — clearing debris, insuring health, safety and temporary sheltering of survivors. Critical to this process are effective lines of communication between the various levels of government involved, others involved from the private and nonprofit sectors and individual citizens. In particular, the provision of both temporary and permanent housing assistance for those affected by the storm has posed significant challenges. The state and local efforts to recover from Hurricane Harvey reveals the need for a more organized approach to recovery from future disasters as described in **Chapter 6**.
- 6. Texas needs to work toward making the Texas Gulf Coast — and indeed the entire state — more resilient in the face of future risks, whether the threat comes from hurricanes, tornadoes, wildfires, flooding or other disasters.** The effects of an event like Harvey can't be eliminated but they can be reduced. With billions of federal, state and local dollars being spent in Texas in the next few years to repair and replace what Harvey destroyed, it is essential that this spending doesn't simply replace what Harvey destroyed that it also increases the state's resilience against future threats. In this regard, Harvey provides a unique opportunity for state and local government to work together on ways to make the state and its infrastructure better able to withstand future disasters. Recommendations for how this process could work and its goals are discussed in **Chapter 7**.
- 7. Texas state and local governments can do more to prepare for future disasters.** Local officials have other responsibilities beyond emergency management, and they faced an overwhelming situation in the case of Hurricane Harvey. Nevertheless, state and local officials should work together to make sure that all levels of response and recovery are better prepared for future emergencies and that Texans understand the risks they face and their options for avoiding future disasters. **Chapter 8** describes how the state can work with local governments to develop the tools they need to prepare for future emergencies more effectively.
- 8. "Future-proofing" Texas means making strategic improvements in all areas of emergency management, including preparedness, planning, response and recovery.** Both Governor Abbott and Commissioner Sharp have spoken repeatedly of the need to "future-proof" Texas against future disasters. The state's history — and recent research — shows that Texas will face more emergency situations going forward, and the best way of future-proofing the state is to be prepared in all areas of emergency management and to have effectively planned through a process involving the state, our federal partners and local governments of all types. This need is discussed in **Chapter 9**.

Many decisions about strategies for hardening the coast will depend on local decisions and the availability of funding. The commission believes, however, that many of the most important changes needed to better prepare the state for disaster can be made through state law and policy.



Members of TX-TF1 launch rescue boats to conduct searches in a flooded Houston-area neighborhood, following the historic rainfall from Hurricane Harvey.

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An aerial photograph of a residential development. On the left, a large, dark, irregularly shaped pond or lake is visible. To the right of the pond, a road runs vertically, with several small, light-colored buildings or structures along its edge. Further to the right, a large, rectangular area is filled with a dense grid of small, dark-colored houses or buildings. The overall scene is captured from a high angle, showing the layout of the development and the surrounding landscape.

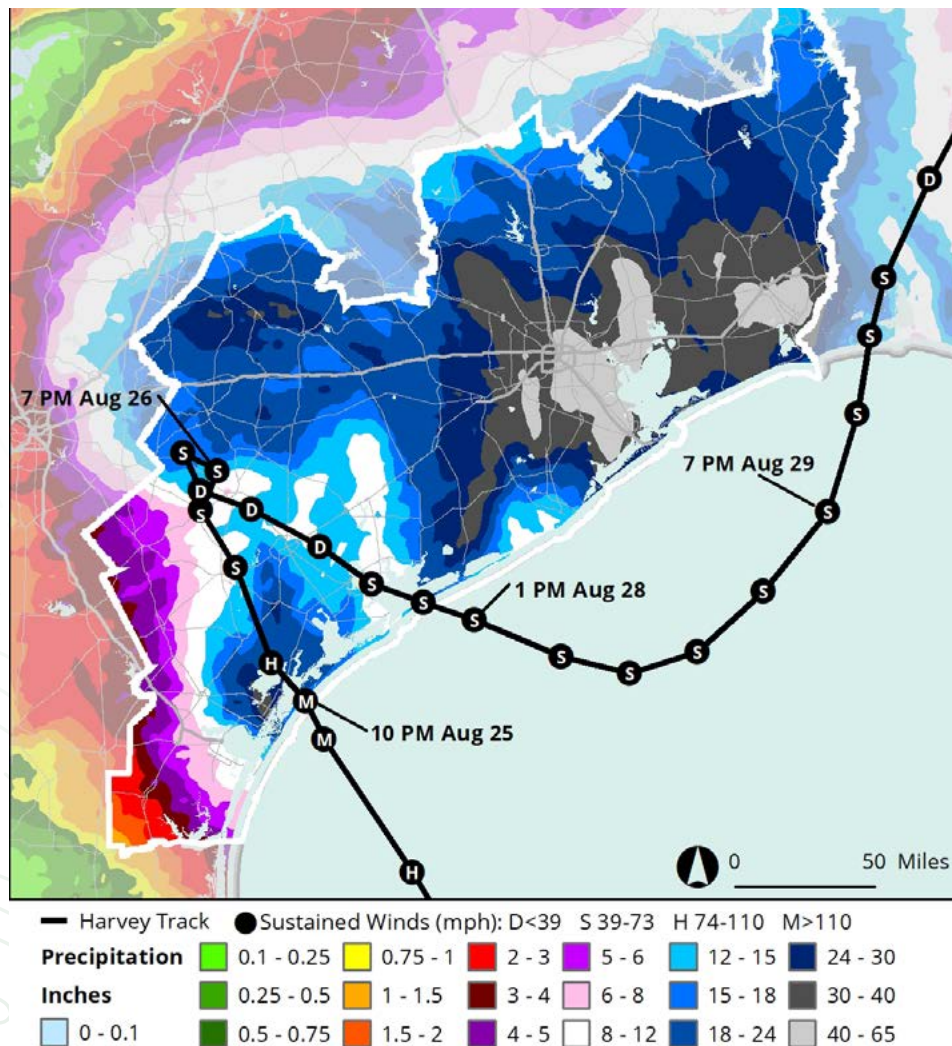
CHAPTER 2

2 HURRICANE HARVEY AND ITS TOLL

Hurricane Harvey began as a tropical wave that formed off the African coast in early August 2017.¹ As it traveled across the Atlantic Ocean, it gained strength, developing into a low-pressure system just east of the Lesser Antilles on August 17. Harvey briefly became a tropical cyclone as it crossed the Antillean Islands before degenerating into a tropical wave on August 18.

Exhibit 1. Hurricane Harvey Track with 7-Day Cumulative Rainfall Totals

Source: National Weather Service



After crossing the Yucatan Peninsula, Harvey regenerated into a tropical depression on Wednesday, August 23, triggering hurricane and storm surge watches for parts of the Texas coast. Early forecasts suggested the storm would strike the upper Texas coast; instead, it intensified and shifted further south.²

As Harvey approached the Texas coast, unusually warm water in the Gulf of Mexico further fueled its development, causing it to intensify substantially in the final hours before landfall, becoming a Category 4 hurricane with maximum sustained winds of around 130 mph.

Harvey made landfall just before 10 p.m. on Friday, August 25, 2017, at the northern end of San Jose Island, about four miles east of Rockport. Hurricane-force winds extended outward for about 40 miles from the storm's center. Peak wind gusts of up to 145 mph were reported near Port Aransas (**Exhibit 1, previous page**).

During the following day, Harvey continued moving inland at about 7 mph, weakening into a tropical storm.³ On August 26, Harvey made a second landfall near Copano Bay, but its center remained offshore, moving eastward toward Louisiana. The Gulf of Mexico's warm waters continued to feed the storm and its slow forward motion and high moisture content led to record-breaking rainfall across the upper Texas coast. The storm made its final landfall near Cameron, Louisiana, on August 30.

In all, Hurricane Harvey hovered above Texas for six days, making it the longest land-falling tropical storm in Texas history (**Exhibit 2**). By August 30, more than 25 inches of rain had fallen in much of southeast Texas, with isolated observations of more than 60 inches. The highest total rainfall, 60.6 inches, was recorded in Nederland near Port Arthur.⁴ In all, Harvey dumped an estimated 58 million acre-feet of water over Texas between in the last week of August, or about 700,000 gallons for every Texan.⁵

Exhibit 2. Records Set by Hurricane Harvey

- Highest tropical cyclone rainfall event ever recorded (60.58 inches).⁶
- Largest number of direct deaths (68) from a tropical cyclone in Texas since 1919.⁷
- Highest average five-day rainfall over about 1,000 square miles (records for central and eastern U.S.).⁸
- Highest average five-day rainfall over 10,000 square miles (records for entire U.S.).⁹
- Highest average five-day rainfall over 50,000 square miles (records for entire U.S.).¹⁰
- All-time-high flooding at nine of 19 official river gauges in Harris County (including the city of Houston).¹¹
- Largest disaster response in Texas history.¹²

THE COMPONENTS OF A DISASTER

Harvey's high winds and extreme flooding caused extensive damage to the Texas coast. This damage was driven by several different physical processes, including wind, storm surge, river flooding, urban flooding and reservoir-related flooding. In addition, flooding occurred at several locations due to mechanical or engineering system failures.

WIND

Tropical storm winds can damage buildings and other exposed property. In addition, storms often down power lines. Long-term outages, in turn, can affect the availability of clean drinking water and other critical resources, increasing the time needed to respond and recover.

Harvey's most severe wind damage occurred primarily in the Coastal Bend. The highest measured sustained winds on land were recorded at 110 mph near Aransas Pass, with the highest observed gust at

DEFINING TERMS

- In the Atlantic Ocean, a **tropical wave** is a band of low pressure oriented roughly north to south and moving east to west (and, for this reason, sometimes called an African easterly wave). Tropical waves are often accompanied by thunderstorms.
- A **tropical cyclone** is a low-pressure center that has developed rapid, rotating winds, typically accompanied by thunderstorms and heavy rains.
- A **tropical depression** is a tropical cyclone with winds of less than 39 mph. A tropical cyclone with winds exceeding 39 mph is a **tropical storm**; if its winds exceed 74 mph, it is called a **hurricane**.

Source: National Oceanic and Atmospheric Administration, Hurricane Research Division

145 mph near Rockport. Strong wind gusts also were measured in Corpus Christi (63 mph) and Victoria (83 mph).¹³ Many residences and businesses were damaged or destroyed, and tens of thousands of Texans remained without power for days (and in some cases, weeks).

Tropical storm winds also increase storm surge (see the following section, "Storm Surge") and produce tornadoes. During Harvey, more than 150 tornado warnings were issued and more than 50 tornadoes were reported.¹⁴ The Houston area reported 29 tornadoes, six categorized as EF1 (86 to 110 mph).¹⁵

STORM SURGE

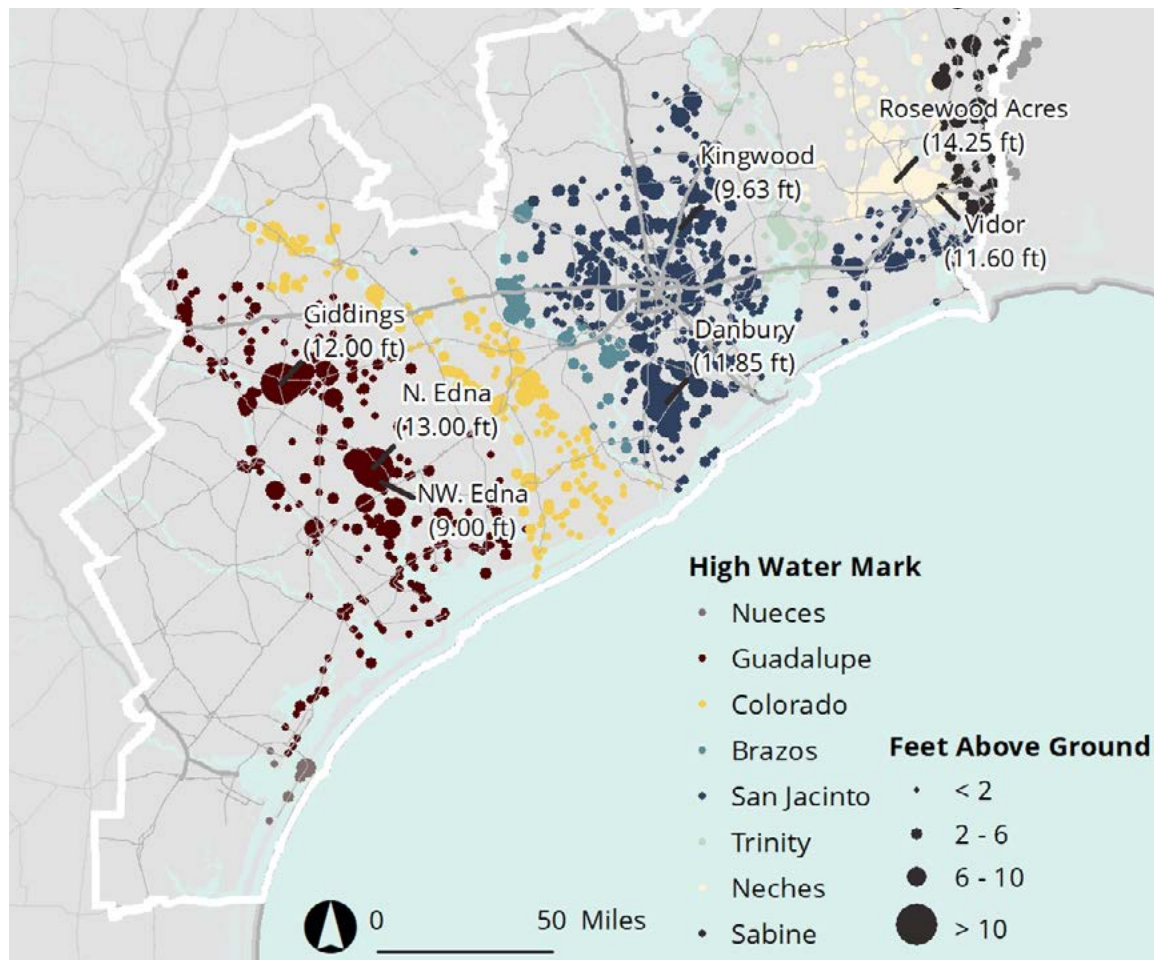
A *storm surge* is an abnormal rise in seawater level during a storm event, measured as the height of the water above the normal predicted tide.

A storm surge is caused primarily by storm winds literally pushing water onshore, but the height of the surge at any location depends on many factors, including the storm's size, forward speed, wind stress (the pressure it exerts on bodies of water), barometric pressure, water depth, the topography of on- and offshore land and the angle of approach.¹⁶ The same hurricane thus can create vastly different storm surges at different locations.

A *storm tide* is the total observed change in seawater level during a storm resulting from the combination of storm surge and the normal tide. During Harvey, the combined storm tide caused 6 to 10 feet of flooding in back bays between Port Aransas and Matagorda. The highest total rise was recorded at the Aransas Wildlife Refuge, where the storm tide may have reached 11 to 12 feet. Coastal flooding of 4 to 7 feet occurred on the barrier islands between Padre Island National Seashore

Exhibit 3. Peak Flood Gauge Readings during Hurricane Harvey

Source: Texas A&M University at Galveston based on National Weather Service data



and Port Aransas.¹⁷ Onshore winds probably produced similar flooding along the barrier islands from Port Aransas to Matagorda, but these areas lacked gauges.

High water levels also were recorded at tide gauges in Galveston Bay and Sabine Lake, but these resulted mostly from excessive runoff rather than storm surge. At these locations, maximum storm surge levels due to Harvey are estimated at two to four feet — much less than at the Coastal Bend, but still enough to cause flooding in Beaumont, Orange and Lake Charles, Louisiana, and submerge much of the Sabine National Wildlife Refuge.¹⁸

URBAN FLOODING

Urban flooding occurs when rainfall rates simply exceed the capacity of the urban drainage system. It can be accelerated by subsidence, impervious cover and undersized storm sewers. It causes ponding along streets and near homes or businesses and can cause substantial damage in areas well outside floodplain boundaries. Harvey's immense rainfall led to urban flooding in many places, but most notably in the Houston/Galveston and Beaumont areas (**Exhibit 3, previous page**).

Between August 25 and 30, 2017, the Houston/Galveston area experienced devastating urban flooding. The highest rain totals fell in the eastern part of the region, with isolated observations of as much as 51.88 inches.¹⁹ In parts of Harris County, more than 27 inches fell in less than 24 hours on August 27.²⁰ The majority of watersheds in Harris and Galveston counties flooded, with more than half reaching record levels. At one point during the storm, much of Harris County was covered by at least 2 feet of water, prompting literally thousands of high-water rescues.²¹

Between August 28 and 30, heavy rains continued over Jefferson, Orange, Hardin and Tyler counties. The Beaumont-Port Arthur area received 26 inches on August 29, doubling its previous daily record and exceeding the maximum rainfall recorded in any previous *month* in its history.²² Nederland, between Beaumont and Port Arthur, received the highest recorded rainfall total of 60.58 inches, with another report of 60.54 inches near Groves. Many nearby cities saw historic flooding, including Lumberton, Warren, Groves, Bevil Oaks, Sour Lake, Hamshire, Fannett, Chine, Silsbee, Lakeview and Mauriceville.²³

The widespread flooding made roads impassable, shut down large sections of Interstate 10 and stranded many residents in shelters for more than a week.

RIVER FLOODING

River flooding occurs when a channel can no longer accommodate the volume of water flowing through it. At the 67 River Forecast Points in Southeast Texas, 60 (90 percent) reached flood stage; of these, 46 (69 percent) reached major flood stage and 31 (46 percent) set historical records.²⁴ The Coastal Bend saw flooding along the Guadalupe River between Victoria and Gonzales. In Cuero, the river crested at 44.36 feet on August 29; in Victoria, it reached 31.25 feet on August 31.²⁵ Both observations were the second-highest levels ever recorded at those locations.

On the Colorado River, significant flooding occurred where the river crosses US-59 at Wharton and La Grange. At Wharton, the maximum water level recorded during Harvey was 50.52 feet, exceeded only by a major flood in 1913.²⁶ Along the Brazos River near Richmond, flooding exceeded that observed in April 2016, reaching its highest-ever recorded levels. On the Trinity at Liberty, flooding exceeded the previous record flood of October 1994.²⁷

In the Houston/Galveston area, most bayous and creeks exceeded their full capacities, inundating some areas never previously flooded. In some channels, water began flowing across watershed boundaries and into *other* bayou and creek systems, further increasing impacts. River flooding also pushed enormous amounts of soil to the sea; the Port of Houston reported that there was up to 10 feet of storm layer deposited in the ship channel.²⁸ Preliminary estimates suggest that local runoff, combined with inflows from the San Jacinto and Trinity rivers, pushed more than 12.2 million acre-feet of storm water into Galveston Bay, more than the usual *annual* amount.²⁹

In some areas, river flooding was compounded further by high water levels in receiving bays and estuaries. For example, the Clear Creek and Dickinson bayous remained flooded for nearly a week. These two coastal watersheds are extremely flat and have adverse channel slopes — that is, sloping toward the center of the watershed rather than outflow areas — that impede rapid drainage, especially when downstream water levels are high.

Even longer drainage times were observed in the Port Arthur/Beaumont region along Pine Island Bayou, where outflows were impeded by elevated water levels on the Neches River driven in part by releases from the Steinhagen Reservoir.

ADDICKS AND BARKER RESERVOIRS

Unlike most reservoirs in the storm region, those created by Houston's Addicks and Barker dams were specifically designed to prevent flooding in the metropolitan area. Both dams were built in the 1940s to protect downtown Houston and the Houston Ship Channel. In 2009, the U.S. Army Corps of Engineers



Rising and falling water levels at Addicks and Barker reservoirs left shorelines littered with debris.

(USACE) designated both as “high risk” due to the potential losses that could occur if they failed.³⁵ Yet in recent decades, thousands of homes have been built in and near the reservoirs.

During Harvey, unprecedented rainfall caused water inside the reservoirs to reach record levels: 109.1 feet above mean sea level inside Addicks Reservoir and 101.5 feet inside Barker Reservoir. On August 26, water began flowing around the spillway that meets natural ground at 108 feet elevation at the north end of Addicks Dam. To prevent uncontrolled releases at the spillways and reduce the potential for catastrophic failures, USACE opened the gates at both dams, releasing more than 15,000 cubic feet per second (cfs) into Buffalo Bayou — and flooding about 4,000 homes downstream. Water levels in Buffalo Bayou remained elevated for almost two weeks due to releases, leaving many structures severely damaged after water receded. In total, more than 10,000 homes in or near the reservoirs experienced some level of flooding during Harvey.^{36, 37}

RESERVOIR FLOODING

Several significant reservoirs lie within Texas' coastal region, including the Houston and Conroe lakes on the San Jacinto River, Lake Livingston on the Trinity River, Sam Rayburn and Steinhagen lakes on the Neches River, and the Toledo Bend Reservoir on the Sabine. Most provide drinking water for communities along the coast and weren't designed for flood control.

Due to Harvey's extreme nature, many reservoirs reached unprecedented levels. *Reservoir flooding* came in two basic types: *upstream flooding*, when reservoirs exceeded their capacity, flooding nearby areas; and *downstream flooding*, when water flowed over dam spillways or was intentionally released downstream to prevent uncontrolled releases or catastrophic failures.

Substantial flooding occurred at many reservoirs across the state. At Lake Conroe, officials began releasing water on August 27 at 12:30 am. The peak releases from the dam exceeded 79,100 cubic feet per second, nearly twice the previous record set in 1994.³⁰

Damaging floods occurred downstream of the dam on the West Fork of the San Jacinto River, where dam releases combined with inflows from Spring and Cypress creeks to create record-setting water levels in Lake Houston, flooding Kingwood. Downstream of Lake Houston near Sheldon, the San Jacinto River crested at 28.72 feet on August 29, more than a foot above the previous record.³¹

Similarly, flooding in the Port Arthur/Beaumont area was due in part to releases from reservoirs on the Sabine and Neches rivers. On August 29, Harvey dumped about 26 inches of rain on the area in 24 hours.³² On the following day, U.S. Army Corps of Engineers (USACE) opened the gates of Dam B at the Steinhagen Reservoir about 60 miles north of Beaumont, releasing nearly 50,000 cfs.³³ Due to the release and continued rainfall, the Neches River downstream of the dam rose to a record-setting 19.59 feet on September 1.³⁴ Several sources also suggest that releases from the dam added to river flooding along significant tributaries such as Pine Island Bayou near Sour Lake.

DEFINING TERMS

An *acre-foot* of water is the amount needed to cover one acre to a depth of one foot — 43,560 cubic feet of water or about 325,851 U.S. gallons.

At many locations near reservoirs, homeowners say they received little or no warning before water was released from the dams, although the USACE reported that they did do notification. It's important to note, however, that the reservoirs *reduced* peak flows by restricting the volume of water traveling directly downstream. It's unclear how much flood damage could have been reduced by releasing water at some reservoirs before the event.

MECHANICAL/ENGINEERING SYSTEM FAILURES

In some places, mechanical or engineering system failures contributed to the flooding. At least two problems with levees along the Brazos River in Fort Bend County were reported.

Near Pecan Grove, a new piping system required an emergency fix using a heavy crane and a dive team to close an open valve below the levee. Further downstream, near Sienna Plantation, volunteers and the National Guard fought to raise the height of the levee with plywood and two-by-fours. Because river levels weren't expected to fall, they ran temporary pumps forcing water that had seeped through the levee back into the river, and placed sandbags on top to further increase the height.³⁸ According to the Fort Bend County Office of Emergency Management, this wasn't expected to be a cause for major concern, but rumors about levees breaching near Columbia Lakes spurred widespread evacuations.³⁹

COUNTING THE LOSSES

Harvey's winds and storm surge caused significant damage, but the storm will be remembered primarily for its record-setting rainfall and floods.

As noted in **Chapter 1**, Harvey caused an estimated \$125 billion in damage, making it the second most-costly natural disaster in the nation's history.⁴⁰ In southeastern Texas, more than 203,000 structures were flooded and 12,700 were destroyed.⁴¹ In addition, an estimated 1 million vehicles may have been damaged beyond repair.⁴² Nearly 13 million people were affected, and at least 68 people died directly because of the storm and as many as 35 as an indirect result of the disaster. About 39,000 people were forced out of their homes and into shelters,⁴³ and more than 895,000 registered for FEMA assistance.⁴⁴ Its impact on Texas included both *direct losses* — the destruction of buildings, possessions, vehicles and infrastructure — and *indirect losses*, disruptions to business activity as well as environmental and health impacts.

DIRECT LOSSES

The federal, state and local governments as well as private insurers have contributed estimates of direct losses. The primary sources used in this report to estimate direct losses include:

- **National Flood Insurance Program (NFIP) claims**, which include the dollar amount paid per household for damage to buildings and contents. Households in participating NFIP communities must purchase flood insurance if they're in the 100-year floodplain and have federally backed mortgages; maximum coverage for residences is \$250,000 for the building and \$100,000 for contents.⁴⁵ As of March 2018, 682,971 NFIP policies were in force in Texas, insuring \$188 billion in assets.⁴⁶
- **Texas Wind Insurance Association (TWIA) claims.** TWIA provides windstorm and hail insurance for 14 coastal counties and certain areas in Harris County. As of December 31, 2017, 227,012 TWIA policies covered \$65 billion in assets.⁴⁷
- **Small Business Administration (SBA)** disaster loans, available to individuals and businesses in counties where a disaster has been declared. Businesses may be eligible for up to \$2 million; homeowners may be eligible for up to \$200,000 for primary residence repair or replacement; and both homeowners and renters can receive up to \$40,000 for repairs or replacement of damaged personal property.⁴⁸
- **FEMA's Individual Assistance (IA) program**, which provides funds that can be applied to basic home repairs, the replacement of essential household items and temporary housing. IA can provide up to \$33,300 (adjusted each year) to restore a home to a "safe and sanitary living or functioning condition," but claims may not account for the full extent of the home's damage.⁴⁹

While these data provide a glimpse into the amount of direct damage caused by Harvey, privacy concerns restrict their use. As a result, our analysis was conducted at the ZIP code level. Only ZIP codes within the 41 counties that qualified for FEMA individual assistance were examined, as this encompasses the primary region of direct damage to buildings, vehicles and personal property.

About \$15 billion in payments were made through the above programs due to Hurricane Harvey as of August 2018 (**Exhibit 4, next page**). As of February 28, 2018, insured flood losses accounted for the most direct

damage, at about \$8.8 billion paid for 91,661 claims. As of August 23, 2018, SBA loans accounted for \$3.4 billion, with about \$2.9 billion for home loans and \$500 million for businesses. As of August 23, 2018, FEMA's IA program received nearly 896,000 applications and disbursed \$1.6 billion in housing assistance.⁵⁰ Finally, as of October 12, 2017, TWIA had received 69,833 claims totaling just over \$1 billion in wind-related losses to commercial, residential and manufactured housing.

The 477 ZIP codes in this region sustained an average of nearly \$30 million in direct losses (**Exhibit 5**). As one would expect, the bulk of the losses occurred in cities near the coast, particularly Beaumont/Port Arthur, greater Houston and the Rockport/Fulton area.

Exhibit 6 lists the 10 ZIP codes receiving the highest shares of the payouts shown in **Exhibit 4**.

Exhibit 4. Direct Losses from Hurricane Harvey within Counties Qualifying for Individual Assistance

Sources: Federal Emergency Management Agency, U.S. Small Business Administration and Texas Windstorm Insurance Association

SOURCE	TOTAL
NFIP Payments	\$8,834,934,781
SBA Loans	\$3,397,126,700
IA Grants	\$1,633,792,194
TWIA Payments	\$1,064,229,802
Total Direct Loss	\$14,930,083,477

Exhibit 5. Total Direct Losses Due to Hurricane Harvey by ZIP Code

Sources: Federal Emergency Management Agency, U.S. Small Business Administration and Texas Windstorm Insurance Association

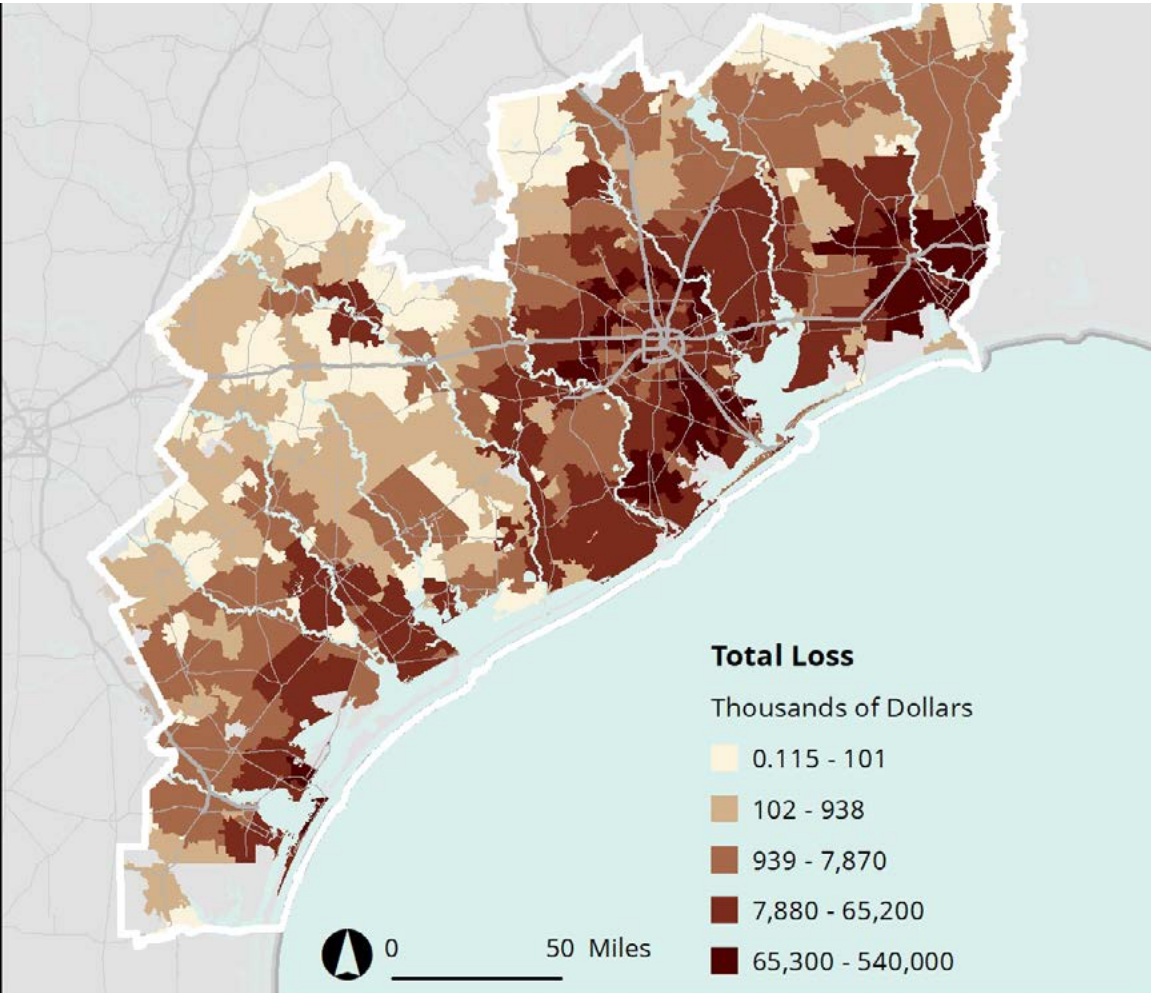


Exhibit 6. Top 10 ZIP Codes by Total Damages

Sources: Federal Emergency Management Agency, U.S. Small Business Administration and Texas Windstorm Insurance Association

ZIP CODE	CITY	DIRECT LOSS	NFIP	SBA	IA	TWIA
78382	Rockport/Fulton	\$566,807	\$40,472	\$86,793	\$22,000	\$417,542
77079	Memorial	\$489,452	\$356,506	\$107,546	\$25,400	
77096	Meyerland	\$452,767	\$387,617	\$52,850	\$12,300	
77539	Dickinson	\$440,005	\$294,845	\$96,985	\$42,100	\$6,075
77642	Port Arthur	\$391,150	\$277,044	\$52,803	\$52,000	\$9,303
78373	Port Aransas	\$383,682	\$121,328	\$26,308	\$5,963	\$230,083
77450	Mason Park	\$369,244	\$172,917	\$154,127	\$42,200	
77546	Friendswood	\$369,077	\$281,747	\$66,496	\$19,100	\$1,734
77084	Addicks	\$291,070	\$200,469	\$58,300	\$32,300	
77339	Kingwood	\$274,177	\$216,286	\$45,290	\$12,600	

Rockport/Fulton received the most direct damage, at more than \$500 million, nearly all the result of TWIA payments for wind damage; the area experienced maximum sustained winds of 130 mph. Coupled with storm surge and flooding, the winds destroyed more than a third of Rockport's homes and businesses.⁵¹ In nearby Port Aransas, the city manager said *every* building and structure had sustained some damage, with many seriously damaged.⁵² The remainder of the top 10 included communities that received most of their payments from the NFIP, including the Memorial, Meyerland and Dickinson areas.

Memorial, a neighborhood in West Houston situated along Buffalo Bayou, was severely damaged when the Corps of Engineers began releasing water from Addicks and Barker dams. Flooding continued for nearly two weeks after the storm, leaving many structures inundated for a long period. As noted above, these releases flooded about 4,000 homes downstream. Area subdivisions such as Fleetwood and Briar Hills experienced flooding yet were well beyond the 500-year floodplain.⁵³ To make matters worse, inadequate communication regarding the impact of the dam releases compromised homeowner preparation and delayed evacuation until the area was already flooded.

Meyerland, a chronically flooded community along Brays Bayou in Southwest Houston, was overwhelmed. This neighborhood has suffered repeated, severe flooding in the past two decades, including Tropical

Storm Allison and, more recently, the Memorial Day (2015) and Tax Day (2016) floods. Meyerland was still recovering from the most recent floods when Harvey hit, bringing 5 feet of water into many homes. Other communities suffering severe damage include Turkey Creek and Mason Park, upstream of Addicks and Barker reservoirs, as well as Kingwood on the banks of the San Jacinto River.⁵⁴

The city of Dickinson, in a low-lying coastal area next to Galveston Bay, experienced catastrophic damage when Dickinson Bayou backed up into surrounding neighborhoods due to the combined effect of heavy rains and storm surge, or "compound flooding." Both Dickinson Bayou and Clear Creek, where Friendswood is located, rose to record heights. Flood waters covered 80 percent of Dickinson and destroyed nearly half its homes.⁵⁵ The only other area in the top 10 to experience compound flooding, Port Arthur, received record rainfall as well as a mild storm surge. The city's mayor said nearly three-fourths of the city was underwater at some point.⁵⁶

HOUSEHOLD LOSSES

The ZIP code analysis provides a good picture of the communities and regions experiencing some of Harvey's most devastating effects. This approach, however, weights losses toward more densely populated areas with more expensive homes. Yet Harvey obviously affected rural areas as well. Calculating damages per *household* at the ZIP code level can help ameliorate this effect, providing a better picture of the hardest-hit communities.

Exhibit 7 highlights areas where damage per household was most severe, including western Beaumont, Rockport/Fulton and a few areas southwest of Houston.

Exhibit 8 shows the 10 ZIP codes with the highest payout per housing unit. Port Aransas, Rockport/Fulton and Memorial show up again; households in these areas experienced an average of \$36,000 to \$80,000 in damage. Simonton, a rural community west of Houston, stands out in particular, with nearly \$200,000 in payouts per housing unit, nearly 2.5 times the amount in Port Aransas, which came in second. Valley Lodge, Simonton's hardest-hit subdivision, saw all but a few of its 250 homes flooded by the Brazos River.⁵⁷

Sour Lake, just west of Beaumont, received an estimated 60 inches of rain. Much like Memorial, the town remained under several feet of water for more than a week as a result of releases from the Steinhagen reservoir. At one point, the only way out of Sour Lake

Exhibit 7. Hurricane Harvey Damage per Housing Unit at the ZIP Code Level

Sources: Federal Emergency Management Agency, U.S. Small Business Administration and Texas Windstorm Insurance Association

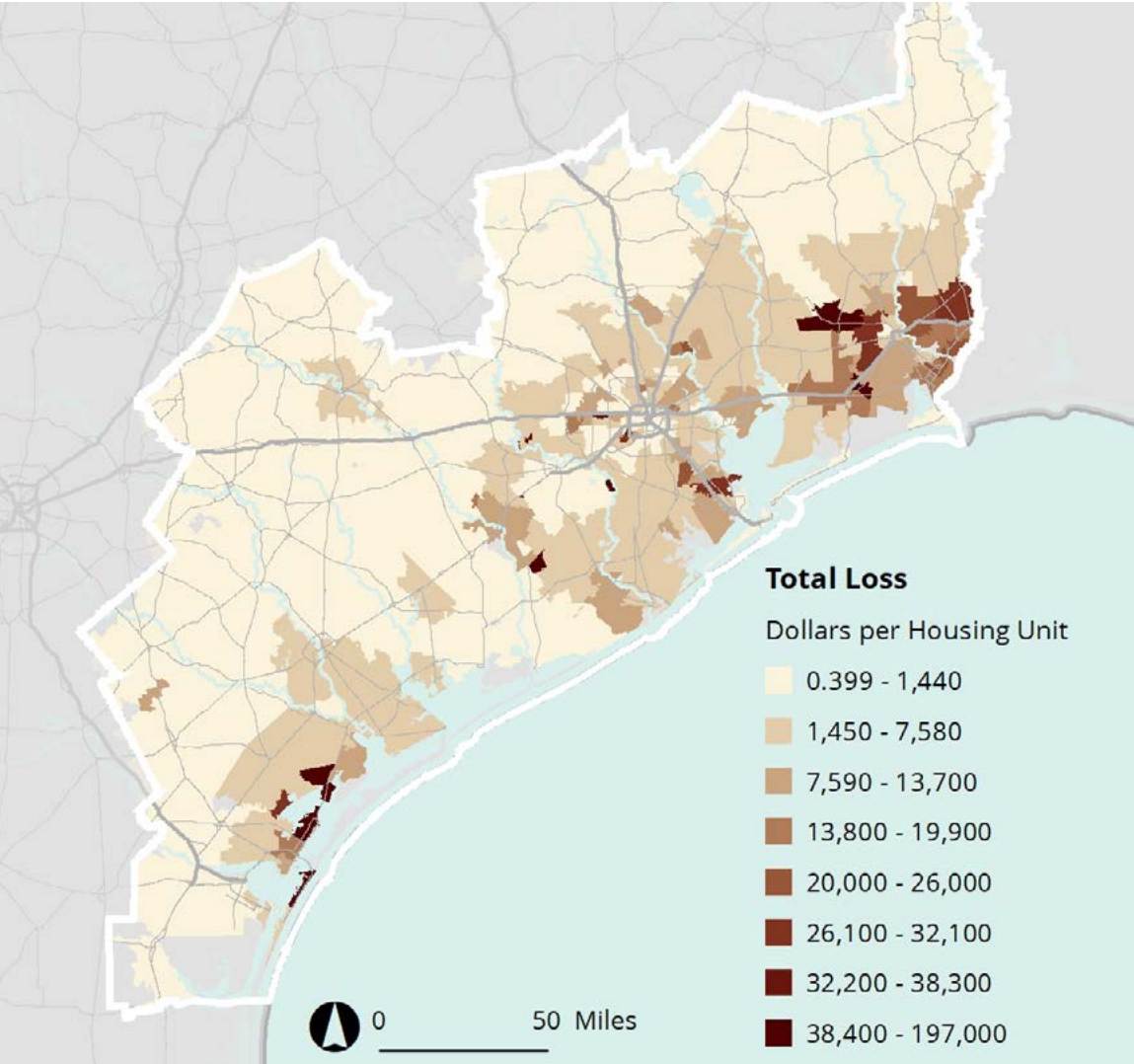


Exhibit 8. Top 10 ZIP Codes for Overall Damage per Housing Unit

Sources: Federal Emergency Management Agency, U.S. Small Business Administration and Texas Windstorm Insurance Association

ZIP CODE	CITY	LOSS PER HOUSING UNIT	NFIP	SBA	IA	TWIA
77476	Simonton	\$196,885	\$169,820	\$22,869	\$4,196	
78373	Port Aransas	\$79,668	\$25,193	\$5,463	\$1,238	\$47,775
77659	Sour Lake	\$65,453	\$41,349	\$18,963	\$5,141	
77481	Thompsons	\$53,147	\$46,923		\$6,224	
78358	Fulton	\$49,785	\$23	\$6,933	\$1,690	\$41,138
77468	Pledger	\$45,085		\$26,831	\$16,862	\$1,392
78382	Rockport/Fulton	\$41,757	\$2,982	\$6,394	\$1,621	\$30,760
77622	Hamshire	\$39,256	\$20,883	\$13,224	\$4,827	\$322
77079	Memorial	\$35,957	\$26,191	\$7,901	\$1,866	
77401	Bellaire	\$34,113	\$29,491	\$3,786	\$836	

was by boat, as all major roads were submerged up to 7 or 8 feet deep.⁵⁸

Two small farming towns south of Sour Lake, Winnie and Hamshire, saw significant flooding. Much of this area, particularly around Winnie, is outside the 100-year floodplain, but historic rainfalls flooded about 80 percent of area homes and inundated large stretches of I-10.⁵⁹ Many homes had never been flooded before and lacked flood insurance. The flooding also caused large crop and livestock losses.

CRITICAL INFRASTRUCTURE

Harvey caused major damage to the infrastructure on which communities and cities depend. At the storm's peak, 77 boil-water notices were in effect, 19 water systems went down and 31 wastewater systems were offline.⁶⁰ At least 16 hospitals closed, requiring the relocation of nearly a thousand patients.⁶¹ 15 dams suffered damage. About 336,000 customers lost power.⁶² 3 major highways were inundated (I-10, I-45 and US-59),⁶³ more than 500 roads closed and 13 bridges required repairs.⁶⁴

ROAD FATALITIES

According to the National Hurricane Center, Harvey ultimately claimed at least 103 lives, directly or indirectly. All but three of the 68 deaths directly attributable to the storm occurred due to freshwater drowning.⁶⁵ One particularly tragic example involved six members of one family, including four children, who drowned when their van was swept off a flooded road and into Greens Bayou in East Houston.⁶⁶

While these deaths were appalling, it's important to note that Harvey caused significantly fewer road casualties than in 2005's Hurricane Rita. During Rita, 73 persons died in a chaotic evacuation before the hurricane even *reached* Texas.⁶⁷ That toll accounted for more than half of the 139 deaths attributed to Rita, which veered away from Houston at the last minute and made landfall near the Texas-Louisiana border.

INDIRECT LOSSES

Indirect disaster losses include declines in economic activity, and generally arise from disruptions to the flow of goods and services due to a disaster.⁶⁸ They also include environmental damage as well as social losses ranging from lost schooldays to mental health issues.

Indirect losses haven't been measured, studied or modeled to the same extent as direct losses. Evidence to date, however, suggests that the proportion of indirect impacts increases with disaster severity, and thus may constitute a more substantial share of total losses and damage in major disasters — as Harvey certainly was.⁶⁹

ECONOMIC LOSSES

Once the danger passed, it became clear that Harvey had caused billions of dollars' worth of damage to homes, buildings, vehicles and infrastructure. According to the Texas Division of Emergency Management, as of October 12, 2018, Harvey had inflicted an estimated \$2.9 billion in damage to public property such as government buildings, roads, bridges, water facilities and electric utilities and damaged or destroyed more

than 178,400 Texas homes.⁷⁰ It has been estimated that Harvey destroyed a large number of vehicles in the Houston area alone, causing an approximate \$2.7 to \$4.9 billion in losses within the Houston market alone.⁷¹

The energy, manufacturing, retail sales and chemical production sectors suffered significant damage to structures and equipment. They also experienced losses due to power failures and employees' inability to get to work, among other problems, causing short-term disruptions to the flow of goods and services. The coastal tourism industry suffered, especially in Rockport-Fulton, where the Chamber of Commerce estimated winter tourism was down by 50 percent.

The State Comptroller's office has estimated Harvey's impacts on Texas gross state product (GSP). Its first-year estimates by sector indicate the industries most affected are memberships, telecommunication services and entertainment. Those least affected were health services, food and beverages and, for obvious reasons, rental housing, motor vehicles, furniture and clothing. Some spending categories, such as fuel, grocery, and home expenses, saw increases prior to the hurricane. In the week following landfall, however, most categories saw losses. For example, healthcare spending dropped by more than 50 percent and remained lower than average for 12 weeks after the storm.

According to the Comptroller's office, Harvey's total estimated net impact (losses plus gains) is a \$3.8 billion loss in GSP in the first year following the storm (Texas' GSP was \$1.6 trillion in 2016). Recovery will stimulate economic activity, producing an estimated \$800 million cumulative gain in GSP in three years. Texas has a resilient and diverse economy that will help sustain the state from Harvey's impact. While some industries continue to struggle, most businesses are recovering and moving ahead. In all, the analysis indicates that Hurricane Harvey will have minimal long-term effects on the Texas economy.⁷²

PORTS

Houston-area ports shut down immediately following Hurricane Harvey and remained idle for more than a week, reopening on September 1, 2017. Closing a major port such as Houston's for a week can equate to more than \$2.5 billion in economic losses due to delays and cancelled transactions. Hundreds of port employees were forced to remain inactive for several days following the hurricane.⁷³

Furthermore, the Commission of the Port of Houston Authority estimates Harvey deposited as much as 10 feet of silt along the bottom of some parts of the Houston Ship Channel, which remain heavily monitored due to inadequate depth.⁷⁴ According to the Texas Transportation Institute, a loss of one foot in depth in the Houston Ship Channel can equate to a loss of \$281 million per year due to the inability of certain vessels to navigate it.⁷⁵ Dredging of the Port of Houston and the Ship Channel continued well into 2018.

AGRICULTURE

Texas is an essential agricultural region, and Hurricane Harvey halted exports of commodity crops such as corn, wheat and soybeans. The Cotton Belt was affected as well, with some sections being devastated by the storm, ruining valuable crops just before harvest. The South Texas Cotton and Grain Association estimates Harvey caused \$150 million in crop losses.⁷⁶ Texas A&M AgriLife Extension agricultural economists estimated commodity losses due to Hurricane Harvey as follows: cotton losses, \$100 million; livestock losses, \$93 million; and combined losses to rice and soybean production, \$8 million.

ENVIRONMENTAL DAMAGE

In the aftermath of Harvey, reporters cataloged more than 266 hazardous spills and discharges on land, in water and the air.⁷⁷ Most were never publicized, as in the case of two of the most significant releases, at the Arkema chemical plant in Crosby and a Magellan Midstream Partners tank farm in Galena Park.

County, state and federal records pieced together by the Associated Press and the *Houston Chronicle* reveal a far more widespread toxic impact than authorities reported after the storm.

Some 500 chemical plants, 10 refineries and more than 6,670 miles of intertwined oil, gas and chemical pipelines line the nation's most significant energy corridor. At least 14 oil refineries accounting for 17.6 percent of the nation's gasoline refining capacity shut down during the storm. Nearly half a billion gallons of industrial wastewater mixed with storm water leaking from a single chemical plant in Baytown on the upper shores of Galveston Bay. Benzene, vinyl chloride, butadiene and other known human carcinogens were among the dozens of tons of industrial toxic substances released into neighborhoods and waterways following the torrential rains.⁷⁸

"A TON OF DEBRIS AND FLOATING STUFF."

Jaimlyn Korol

As an environmental scientist, Jaimlyn Korol knew what to look for when buying a new home. Six years ago, before she and her now husband, Brad, closed on their current house in Friendswood, she did her due diligence.

Located near Clear Creek, the brick house was on a hill above a park designed to capture floodwaters, and a drainage pond between the park and the house added an extra layer of protection. In order for the house to actually flood, the park and the pond would both have to fill to capacity.

"I remember looking at that when we first moved in, because it's so related to what I study," she said. "I took a look around and thought, this is pretty awesome."

In late August of 2017, as Hurricane Harvey approached the Gulf Coast, Jaimlyn stocked up on food. Anticipating that others might need to escape rising floodwaters, she called multiple friends to make sure they knew the best routes to her house.

"I was so confident," she said.

But not long after she fell asleep late that night, the howling of her three large dogs woke her up. As she swung her feet off the bed, about six inches before they hit the floor, she heard a splash. Water was coming into the house — and fast.

Before long, the water was reaching just below Jaimlyn's shoulder blades. It was still pitch black outside, but they couldn't wait for the sun to come up. They relocated themselves and their three dogs to the roof.

Eventually, the rain stopped. But before Jaimlyn could let out a tentative sigh of relief, she heard a sound that she said "turned her stomach." It was a tornado siren.

"We couldn't take cover," she said. "We just had to sit there."

Nearby roofs began filling with neighbors. Many of them pitched tents. They yelled words of encouragement to each other. Jaimlyn and Brad knew that they were low priority for a boat rescue, but a friend said he could get his truck within two and half miles of their house.

So, Jaimlyn and Brad wrangled their kayaks, loaded their dogs into the boats, and waded through the water towing them along.

"There was a ton of debris and floating stuff,"

Jaimlyn said. "You would push away what you thought was a garbage pile, and it would explode into hundreds of fire ants. They were everywhere."

After a harrowing journey through the water, they reached their rendezvous point. But their struggle wasn't finished.

"We were still wet when people were hounding us to start our FEMA paperwork," Jaimlyn said, recalling the unpleasantness of the process that ensued.

Through her work as a graduate student studying natural hazards and infrastructure resilience, she learned that newly updated maps that reflect changes to the local infrastructure over the last 20 years place their house right in the middle of the flood zone.

"Nobody ever told us that," she said.



Floating fire ant colony. (Texas A&M AgriLife Extension Service)

The Arkema chemical plant in Crosby attracted national attention when fires erupted there. The plant processes organic peroxide, a key component in plastics manufacturing that is thermally unstable and highly flammable. On August 31, flooding caused the plant's backup generator to fail, ending refrigeration for tons of the chemical. Some of the plant's containers ignited, causing explosions and smoke.⁷⁹ Residents within a 1.5-mile radius of the plant were urged to evacuate. On September 3, firefighters conducted a controlled burn to destroy the remaining organic peroxide. The Environmental Protection Agency (EPA) determined the air outside the plant to be safe to breathe and stated that there would be no long-term effects.

Many other chemical facilities were affected by the storm. Along the coast, oil refineries and chemical plants reported spills, leaks and emissions events to the Texas Commission on Environmental Quality (TCEQ). To date, TCEQ has approved \$239,995 in penalties for 27 violations of environmental regulations.⁸⁰

SUPERFUND SITES

Harvey's environmental impacts became an immediate public concern as the storm subsided, due to the region's high concentration of chemical and petrochemical industries. As the floodwaters receded, state and local officials, the EPA and environmental groups began to assess the impacts. The Environmental Defense Fund released an early estimate of a million pounds of pollution associated with Harvey.⁸¹

EPA conducted initial assessments at all 43 Superfund sites in the affected areas, using aerial images as well as on-site inspections and meetings with the parties responsible for ongoing cleanup activities. EPA determined that 42 didn't show damage associated with Harvey; one site, the San Jacinto River Waste Pits, required additional follow-up.

EPA collected sediment samples from 14 areas at the site. One sample confirmed its protective cap had been damaged, exposing the underlying waste.⁸³ Repairs that added armored rock to the cap were completed shortly after the sampling was conducted. EPA Administrator Scott Pruitt visited the site and promised to expedite the cleanup, and in October 2017 the agency announced a \$115 million plan to remove all contaminated material. As of April 15, 2018, the San Jacinto River Waste Pits have been removed from the EPA's special cleanup list.⁸⁴

OYSTER MORTALITY

Harvey flushed a massive amount of fresh water into Galveston Bay, causing heavy damage to the area's live oyster reefs. Oysters need a certain amount of salinity to thrive, usually around 15 parts per thousand; low salinity in many parts of Galveston and East Bay devastated their populations.

Shortly after the storm, Texas Parks and Wildlife Department biologist Christine Jensen began sampling oysters from the middle of the bay, finding a 50 to 100 percent mortality among oysters in the East and West Bay. According to Jensen,

East Bay experienced the worst of Harvey's effects with very few live oysters left. It remained too fresh for too long for most oysters to survive. Hanna's Reef had 51 percent mortality, Middle Reef had 95 percent mortality, and Frenchy's Reef had 100 percent mortality. Almost all the restoration areas in East Bay were killed.

Other reefs were damaged on the western side of the ship channel as well as the area where Dickinson Bayou drains into the bay. Several reefs in the middle of the bay survived reasonably well, however, and later showed higher numbers of live oysters than they'd had in many years. Harvesters in coastal Texas reported that the 2018 oyster season is better than expected despite the die-off; several regions that were initially closed recently reopened.⁸⁵

DEFINING TERMS

The federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 established a so-called Superfund to support cleanup efforts at contaminated industrial sites throughout the nation, including manufacturing facilities, processing plants, landfills and mining sites. The U.S. National Priorities List (NPL) includes 1,346 superfund sites, 55 of them in Texas.⁸²

HEALTH EFFECTS

The biggest Harvey-related environmental threat to citizens may come from private property damage. Hurricane Harvey flooded thousands of Texas homes as well as many other structures.⁸⁶ The floodwaters contain sewage, motor oil and various household chemicals representing an array of toxic and bacterial risks. Public health officials advised everyone to avoid direct contact with the floodwaters as much as possible.

SOCIAL EFFECTS

In the aftermath of Harvey, many students were unable to attend schools that, in some cases, wouldn't open again for months. According to the Texas Education Agency (TEA), in fall 2017 more than 10,000 students enrolled in different school districts because of Harvey, and nearly 34,700 became homeless. According to TEA, these totals may not be complete due to significant underreporting in the first round of data collection.⁸⁷ Many displaced families may not return to their original districts, which could affect per-student state funding next year. Lower enrollments also may lead to staff reductions.

Natural disasters also can have long-term harmful effects on students' mental health. The latest research indicates that schools will observe higher rates of mental health challenges among Harvey survivors, including post-traumatic stress disorder (PTSD). Such conditions will be more common among those from the areas that suffered the most destruction and those with stress factors such as the loss of homes and parental employment and closed schools.

School administrators, teachers, counselors and staff members may have experienced hurricane losses directly or may develop "compassion fatigue" or secondary traumatic stress themselves as they address their students' needs. The expected mental health impacts may be more significant for adults, including parents, caregivers and school personnel, often because they bear the brunt of emotional and financial losses. Disaster anniversaries, news of similar disasters and even heavy rain can trigger severe emotional reactions.⁸⁸

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The background is a dark, teal-toned aerial photograph of a landscape. On the left, there is a dense forest. On the right, a cluster of buildings, possibly a school or institutional complex, is visible. Overlaid on the entire image are white topographic contour lines, some solid and some dashed, indicating elevation changes. The text 'CHAPTER 3' is centered in the lower half of the image.

CHAPTER 3

3 UNDERSTANDING HARVEY'S IMPACT

Since 1953, the federal government has declared 351 disasters in Texas (as of September of 2018), a significant number of them involving severe storms or floods.¹ With its frequent and severe storms, shallow slopes and clay soils, coastal Texas is naturally prone to flooding. Changing human and environmental conditions, however, are increasing our flood risks over time.

No two storms are alike, and their impacts can be influenced by many factors. As described in **Chapter 2**, Hurricane Harvey brought four types of devastation to a broad area along the Texas Gulf coast: river floods, urban flooding, storm surge and hurricane-force winds. Future Texas flood risks are likely to involve all of these.

Harvey's impacts were shaped by meteorological factors, the human ("built") environment and dynamic interactions between the two. This chapter describes how they contribute to increasing flood risks and discusses the changing nature of flood threats in coastal Texas.

DEVELOPMENT: THE BUILT ENVIRONMENT

Development and redevelopment is inevitable and, in many cases, a sign of healthy local economies. In general, demand for housing generates new development; retail follows new populations; and often, new job opportunities emerge. This pattern is particularly common in areas with developable and relatively inexpensive land. But development affects the physical landscape, and in many cases it isn't managed or planned appropriately for flood risks.

Obviously, rising population in flood-prone areas is one of the largest contributors to increased flood losses. Coastal Texas is one of the nation's fastest-growing areas; from 1980 to 2003, about 2.5 million people moved into the region, boosting its population by 52 percent. In the same period, Harris County ranked second among all U.S. coastal counties for net population increase.²

This trend continues. From 2010 to 2016, the state's coastal population rose by nearly 900,000, due in large

part to a strong economy and affordable housing.³ This growth, however, has made it increasingly difficult for local decision-makers to guide development, resulting in a sprawling inhabited landscape in highly flood-prone areas.

COMMUNITY INFRASTRUCTURE

In addition to the *amount* of development, the *way* in which communities and supporting infrastructure are developed and maintained is critically important.

Aging infrastructure poses a significant threat to growing communities. In 2013, the National Research Council warned that the nation's existing flood control infrastructure is inadequate to protect against future flooding, and that many U.S. communities face unacceptably high risks.⁴ The majority of these structures were built in the early or mid-20th century and are approaching or already exceeding their design lives. The Association of State Floodplain Managers (ASFPM) warns we are moving into a "triage phase" that will require repeated repairs to failing infrastructure under emergency conditions.⁵

Texas has 830 miles of inland waterways and 2,027 miles of levees. Due to development near and downstream from levee systems, the risks associated with their failure have risen. In 2017, the American Society of Civil Engineers (ASCE) issued a "report card" giving Texas' dams a D grade. In all, Texas has 1,263 "high-hazard" dams (with failure entailing probable loss of life), 416 significant-hazard dams (possible loss of life) and 5,324 low-hazard dams (no loss of life expected). Of the high-hazard dams, 80 percent had emergency action plans in place, yet according to ASCE only 6 percent had

adequate maintenance and inspection programs.

Since 2012, ASCE has increased the hazard classification of 217 Texas dams. Their estimated rehabilitation cost rose from \$380 million in 2012 to \$812 million in 2017.⁶

In addition to large-scale flood control infrastructure, Harvey underlined the inadequacies of storm water infrastructure in our residential areas. Many urban and suburban areas require significant upgrades to keep up with rising runoff rates, due both to development and increasingly intense rainfall.

BUILDING CODES

Of equal importance are building requirements for new and renovated construction. A building's ability to withstand a hurricane event is largely a function of the building code it was designed to meet — standards intended to protect the health, safety and general welfare of the public, prevent deaths and reduce injuries and economic losses. Previous storms have shown that strong, well-enforced building codes reduce losses and facilitate recovery. In Florida, for instance, strong building codes adopted after 1992's Hurricane Andrew prevented wind-induced damage during Irma in 2017.

A 2018 study issued by the Insurance Institute for Business & Homes Safety (IBHS), however, reported “a concerning lack of progress” in adopting and enforcing updated residential building codes across the U.S.⁷ The IBHS evaluated states based on 47 criteria to assess the effectiveness of their residential building code programs. Eight states received scores below 70 out of 100, including Texas, which received a score of 34, a two-point decrease since 2015 (**Exhibit 1**).

It's important to note that, while Texas does not *require* mandatory adoption or enforcement of its residential building code, it does suggest that municipalities adopt the 2006 International Residential Code as a minimum standard. In addition, homes must meet minimum requirements to obtain windstorm and hail insurance from the Texas Windstorm Insurance Association (TWIA).

Notably, though, Texas building codes don't include requirements pertaining to flood risk. Instead, building standards related to flooding are codified and enforced by municipal and county governments. The only current standards pertaining to flooding are the minimum standards required for participation in the National Flood Insurance Program (NFIP).

ALTERATIONS TO THE NATURAL LANDSCAPE

While development in flood-prone areas is always vulnerable, the way in which humans build *outside* flood-prone areas also contributes to flood risk. Urbanization, with pavement, rooftops, parking lots and other impervious surfaces, is a major contributor to flood impacts.

From 1996 to 2010, for instance, coastal Texas added about 300,000 acres of new development, half of which was either low intensity or developed open space (i.e., less than 50 percent impervious cover; see **Exhibit 2**). Of these newly developed areas, about 12 percent are within the FEMA-defined 100-year floodplain. In all, this development replaced approximately 100,000 acres of forest, 84,000 acres of pasture and 32,000 acres of wetlands.

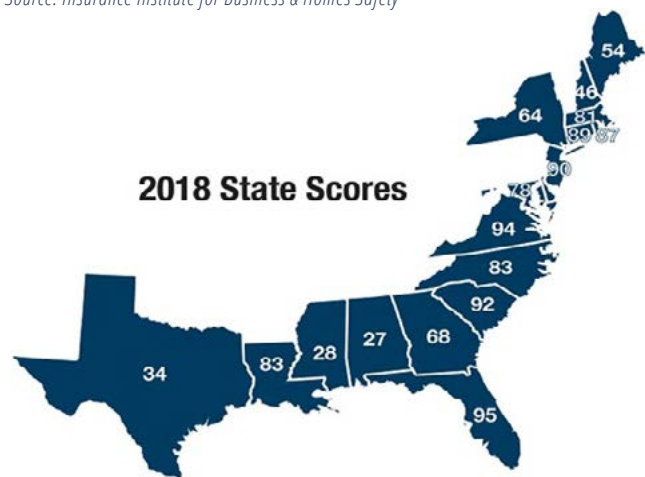
Most of the fastest-growing ZIP code areas in the Harvey-affected region were in communities around Houston, creating one of the nation's largest expanses of impervious surface. Many of these experienced significant flooding during the storm.

Urban and suburban development lead to reduced soil infiltration, increased runoff and higher peak discharge in nearby streams, raising flood risks downstream.⁸ One group of researchers studying Texas flood risks found that each additional square meter of impervious surface translated into about \$3,602 of added property damage caused by flooding.⁹

Exhibit 1 IBHS Rating for Gulf and Atlantic States (Based on a 100-Point Scale)

Note: States were evaluated on 47 factors, including whether they require residential building codes; whether states and localities enforce those codes; and whether they require licensing and education for building officials, contractors and subcontractors.

Source: Insurance Institute for Business & Homes Safety



More recent research, however, indicates that flood impacts are affected not only by the amount of impervious surface, but also by its pattern and intensity, the specific form of the built environment.¹⁰ Research indicates that, on average, areas with high-intensity development experience less property damage from floods than those with outwardly expanding, low-density development, which fragments natural hydrological systems and amplifies runoff by spreading impervious surfaces over a larger area.¹¹

WETLANDS LOSS

One of the worst consequences of coastal development is the loss of naturally occurring wetlands, which reduce flooding by storing and slowly releasing accumulated runoff.¹² Studies in coastal Texas and Florida have quantified the value of wetlands in reducing flood impacts. One 2008 study found that the loss of wetlands across 37 coastal Texas counties from 1997 to 2001 significantly increased the observed amount of property damage from floods. On average, wetland alteration permits added more than \$38,000 in property damage to each county experiencing a flood.¹³

Coastal wetlands and other natural features, such as dunes, oyster reefs and barrier islands, also reduce wave action and serve as protective buffers against erosion during storms. *Coastal erosion* occurs when the relative sea level rise exceeds the rate at which

sediment accumulates at the coast. This erosion can be further increased by local subsidence or coastal storms, which cause minor but repetitive shoreline loss.¹⁴ Ultimately, coastal erosion shrinks the distance between the sea and homes, businesses and critical infrastructure.

OUTLOOK

Texas' growth and development will continue. According to three scenarios offered by the Office of the Texas State Demographer, the state is likely to gain between 640,000 and 8 million additional residents by 2050, with growth in the middle of that range most likely. Among the fastest-growing counties in their projections are Fort Bend and Montgomery counties near Houston. Even Harris County, highly urban and highly developed, is expected to see its population rise by nearly 40 percent by 2050 in the most likely scenario.¹⁵

Understanding where and how growth is likely to occur at finer scales will be critical to increasing flood resilience. Recent computer models can predict where development is likely to occur; effective planning, employing regulatory and incentive-based policies, can and should guide new development away from vulnerable areas such as floodplains.¹⁶

A recent Texas A&M analysis of development trends estimated that nearly 750,000 additional acres are likely to be developed in the Houston-

Exhibit 2 Development Intensity in the Harvey Affected Region, 1996-2010

Source: National Oceanic and Atmospheric Administration and Texas A&M University

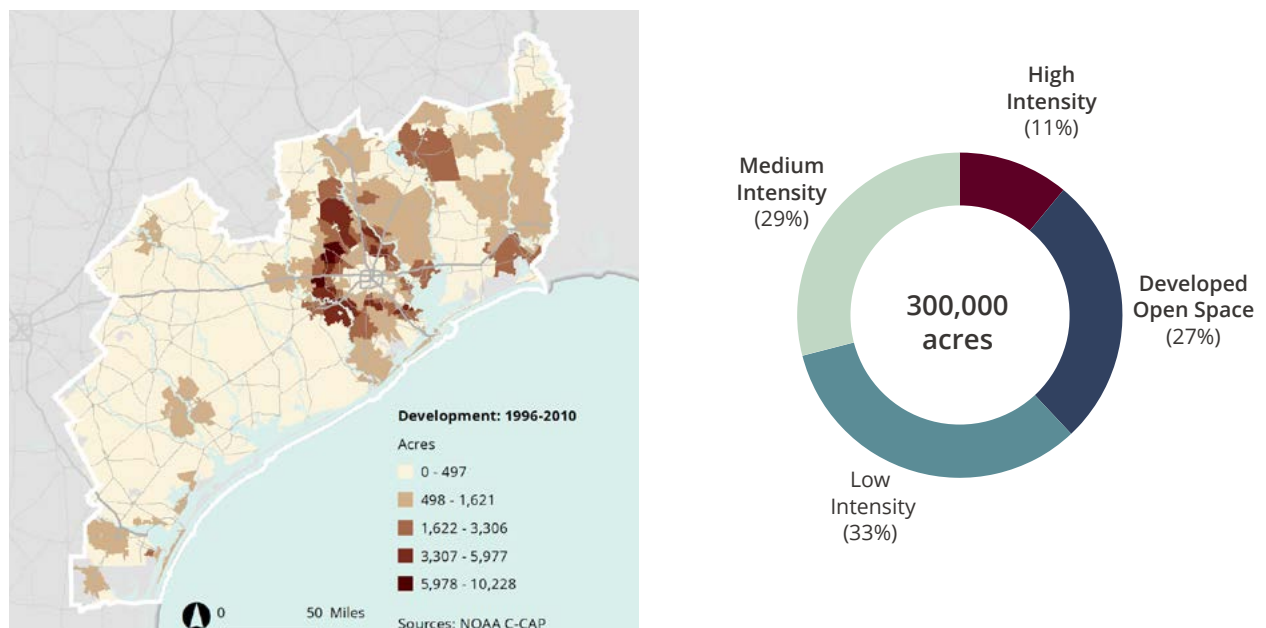
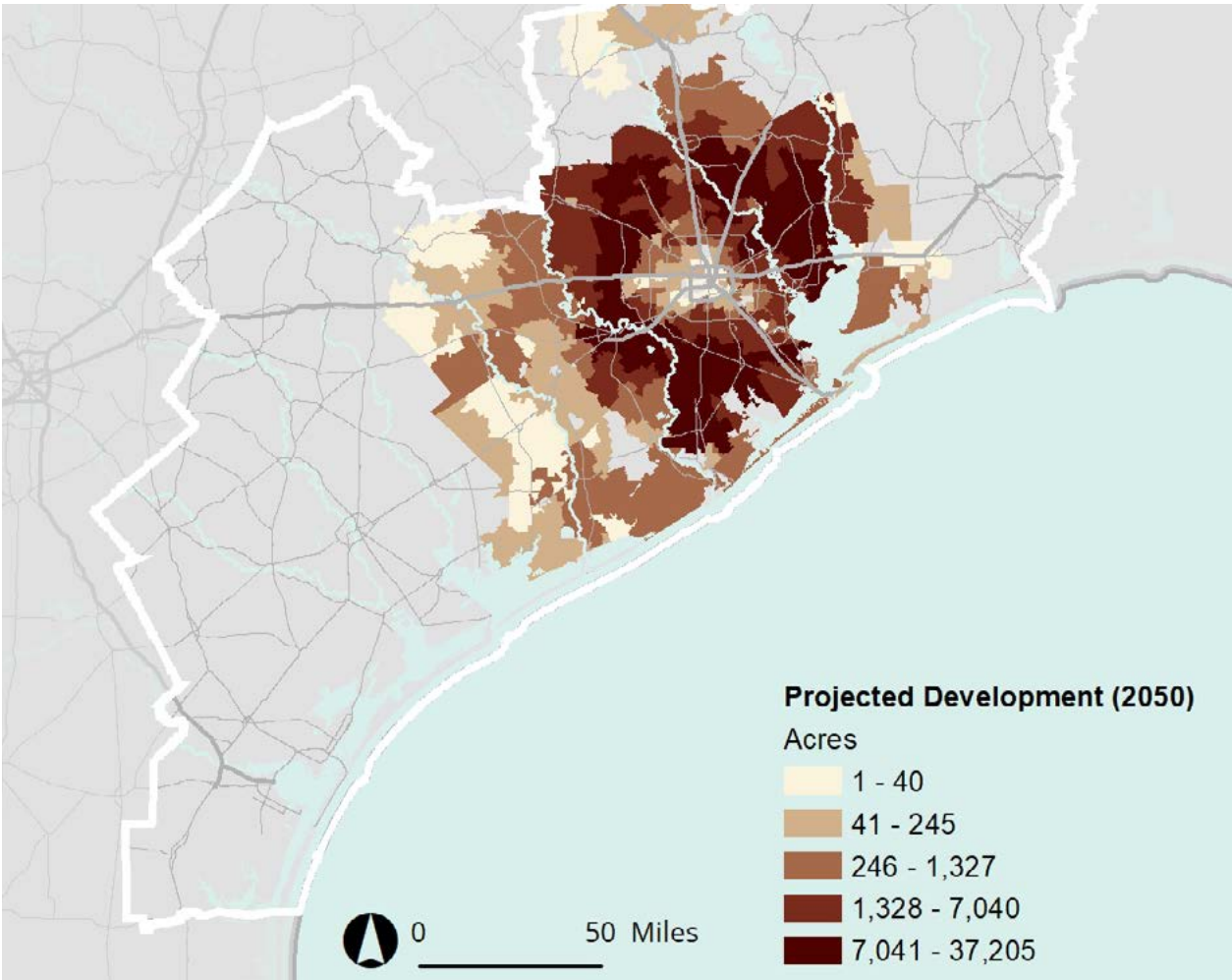


Exhibit 3. Projected Population Increases in the Harvey Disaster Declaration Area through 2050, by ZIP Code
Source: Unpublished analysis conducted by Texas A&M University at Galveston.



Galveston area by 2050. The region's fastest-growing ZIP codes include suburban and semi-rural areas outside of the Loop 8 Beltway, such as the Alvin-Hillcrest area and Barrett-Crosby-Dayton (**Exhibit 3**). They also include ZIP codes adjacent to fast-growing suburban areas including the area southwest of Sugar Land and the communities northwest of The Woodlands, such as Magnolia (**Exhibit 4**).

Without adequate planning, much of this growth is likely to occur within the current 100-year floodplain. By 2050, development in the floodplain could nearly *double* from 2001 levels — the same year in which Tropical Storm Allison struck the Houston area.

Exhibit 4. Top Projected-Growth ZIP Codes through 2050 in the Harvey Disaster Declaration Area
Source: Unpublished analysis conducted by Texas A&M University at Galveston

ZIP	CITY	PROJECTED ACREAGE DEVELOPED (2050)
77511	Alvin/Hillcrest	37,205
77532	Barrett/Crosby	32,580
77469	Southwest of Sugar Land	28,300
77535	Dayton	25,003
77354	Magnolia	23,277

FLOODPLAIN RISKS

In the hydrologic sense, a river flood is simply the point at which a river or stream has reached its capacity to convey water within its channel. To most, though, a flood involves damage to property and assets and hazards to life. In the words of the late Gilbert White, “Floods are ‘acts of God,’ but flood losses are largely acts of man.”¹⁷ Factors such as intense rainfall, altered natural landscapes and development in areas that are flood-prone — or that may become that way in time — are increasing river flood hazards.

DEVELOPMENT IN RIVER FLOODPLAINS

Floodplain “encroachment,” or development within the floodplain, is one of the major underlying causes of coastal Texas’ vulnerability to flooding. It puts property at risk while reducing the benefits associated with intact ecosystems.

Ironically, increased development within the floodplain often is due to actions designed to *reduce* flood hazards. Such measures include channelization, embankments and other physical alterations of the floodplain, intended to reduce flood risk but sometimes giving developers and buyers a false sense of security. This is known as the “safe development paradox” — development can be encouraged by the belief that the flood risk has been removed.¹⁸

Another cause of floodplain encroachment may be the National Flood Insurance Program itself. Some argue that insuring against loss encourages risky behavior. That is, by offering insurance against flood risk — and at subsidized rates — the NFIP creates indirect incentives for development within floodplains.¹⁹ Furthermore, current NFIP standards allow development within the floodplain to cause up to a one-foot rise in flood levels during a 100-year flood event, implicitly permitting encroachment if it doesn’t increase the base flood elevation by an entire foot.

This standard is particularly problematic because it doesn’t consider the influence of development *outside* the floodplain, the increasing intensity of rainfall events, future development scenarios, and residual storm water depths and velocities. The net result is that developments are likely to experience flooding exceeding NFIP standards regardless of their present design or situation.²⁰

It’s important to realize, moreover, that regulatory floodplain maps often are outdated.²¹ In Harris County, about 38 percent of flood insurance claims made between 1976 and 2014 were for properties outside the floodplain.²² Homeowners living outside designated floodplains aren’t required to buy flood insurance and may not know about their risks. A lack of such knowledge was particularly evident in the areas around Addicks and Barker reservoirs during Hurricane Harvey; many residents simply were unaware their homes were within the flood pool of the reservoirs (see inset, next page).

COMMUNICATING RISK

Risk communication has a strong influence on whether homeowners conduct mitigation activities. Most such communications are part of larger governmental and community initiatives. For example, flood insurance is required if a homeowner is located within the 100-year floodplain and has a federally backed mortgage, but some communities urge *all* their citizens to purchase flood insurance through various media avenues.

Yet understanding flood risk can be difficult. Statistically, a 100-year flood has about a 26 percent chance of occurring during a 30-year mortgage period. Few homeowners, however, truly understand this risk. Local governments can help with outreach activities that increase awareness of flood risk, including the dissemination of risk information, required hazard information disclosure during real-estate transactions, technical assistance and community flood risk-reduction workshops.

DEFINING TERMS

In a reservoir designed for flood control, the **flood pool** is any elevation of water above the reservoir’s normal maximum operating level, or more broadly, the land area that would be flooded by such an elevation. A **100-year flood pool** is the elevation of water within the reservoir (and the resulting area flooding) produced during a 100-year flood event.

URBAN FLOODING

Urban flooding is the flooding in a built environment, particularly in more densely populated areas, by rain falling on impervious surfaces that overwhelms the capacity of drainage systems. It occurs when storm water enters buildings through windows and doors, backs up through pipes and drains or seeps through walls and floors.

Population growth and urban development, coupled with aging storm water infrastructure and changing weather patterns, have given rise to the urban flood problem. These risks and impacts aren't tied to FEMA-defined floodplains or specific river or coastal areas; instead, significant flood losses can occur miles away from a floodplain, in a highly developed landscape.

PRIMARY CAUSES OF URBAN FLOODING

Aging and poorly maintained drainage systems.

Many older communities still rely on water and wastewater systems designed and built decades ago. In many cases, these systems have deteriorated significantly. In addition, storm water collection systems require continuous maintenance. Drain blockage, collapsed pipes and any restriction of channel or storage capacity can substantially reduce their effectiveness.

FOCUS ON THE ADDICKS AND BARKER RESERVOIRS

The Addicks and Barker dams were built in the 1940s to create reservoirs that could capture and hold excess rainwater during extreme rainfall, reducing flooding in downtown Houston. After Harvey made landfall on August 25, the reservoirs eventually reached record heights of 109.1 feet above mean sea level in Addicks Reservoir and 101.5 feet in Barker Reservoir. Water began flowing around the spillway on the north end of Addicks Reservoir.

To prevent further uncontrolled releases and dam failure, the U.S. Corps of Engineers (USACE) opened the floodgates on both dams on August 28, allowing water to flow at more than 15,000 cubic feet per second into Buffalo Bayou. Harris and Fort Bend counties issued evacuation orders for upstream residents on August 30, and ordered downstream evacuations on September 2. Ultimately, more than 150,000 people fled.

More than 9,000 homes and businesses built within the reservoirs' pools were flooded — about 5,000 upstream of Addicks and at least 4,000 upstream of Barker. When the reservoirs were originally constructed, USACE purchased land only within the 100-year flood pool, leaving 8,000 acres with a high potential of flooding as private land. In the 1980s, USACE acknowledged that residential subdivisions could be built within the flood pools and that it could be sued if they flooded.

Significant residential growth behind the dams began in the 1990s and 2000s. Three large, planned

communities, Cinco Ranch, Kelliwood and Grand Lakes, were built along with several smaller communities. Since 2000, nearly 30,000 structures have been built within the reservoirs' flood pools. Because these privately owned areas aren't considered to be within the 100-year floodplain, many residents were unaware of their risk prior to Harvey and did not have flood insurance.

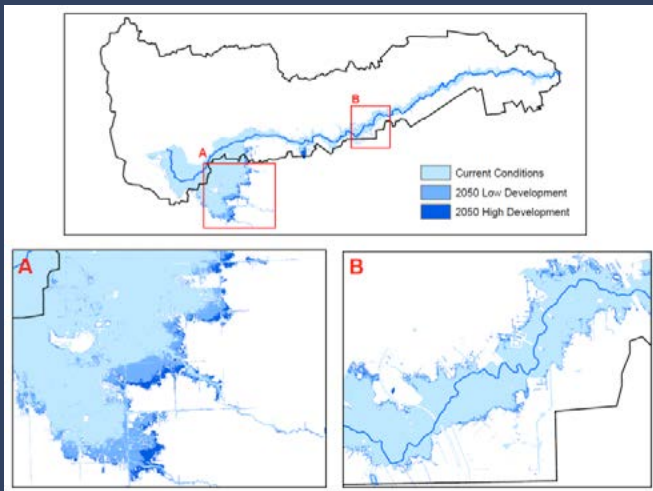
The only official disclosure that these neighborhoods were located within a flood pool is found on subdivision maps of proposed developments within Fort Bend County; Houston and Harris County never required such disclosure. Because any action that could cause private property values to fall could be considered a governmental "taking" without compensation, the legality of even these small warnings has been questioned, as illustrated in recent lawsuits against the USACE.

Because homes located in the flood pools of Addicks and Barker reservoirs are within the city of Houston's jurisdiction, the Houston Planning Commission is responsible for approving new development in the area. Multiple members of the commission during this time of residential growth also were involved in the development of these massive communities. Even after USACE rated the dams as "extremely high risk" in 2009, the planning commission never publicly discussed the risk posed within the flood pools.

THE CYPRESS CREEK FLOODPLAIN

The Cypress Creek watershed in northwest Harris County encompasses a drainage area of more than 267 square miles. In the past few years, Cypress Creek has experienced several major flooding events that damaged thousands of homes and resulted in substantial economic losses. During Hurricane Harvey, thousands of residents in the watershed experienced severe flooding for several days, leaving hundreds stranded in their homes.

Yet the area is being developed rapidly. From 2000 to 2010, the population living in the watershed rose by an average of 70 percent by ZIP code; one ZIP code in the watershed's western portion saw its population increase by 390 percent. Thus, new development is occurring in areas already vulnerable to flooding, while the accompanying increase in impervious surface is increasing the flood risk.



While new development in Cypress Creek features detention requirements, these are not sufficient to completely offset the impacts of new construction. By 2050, the amount of developed land in the watershed could rise by 54 percent, while natural land acreage could fall by 60 percent. Even with existing detention requirements, new development will increase the extent of the 100-year floodplain by up to 23 percent in some portions of the watershed. By 2050, development could bring an additional 550 residential properties into the 100-year floodplain.

Increasing local runoff. Our storm water infrastructure generally has not been improved to cope with changes in hydrology due to population growth, development and increasingly intense precipitation. As new development occurs, and redevelopment replaces smaller with larger structures, natural drainage patterns are reduced and urban flooding increases.

Changes in local physical conditions. In some cases, transportation projects and other development block historic paths for drainage. Some communities' drainage plans call for use of roadways as temporary water storage areas. During excessive rainfall, however, this strategy sometimes fails, creating unforeseen pathways for drainage with unexpected consequences.

While evidence suggests that urban flooding is an increasing problem nationwide, it can be difficult to measure. Storm surge heights and river gauges are easily measured, but such indicators aren't necessarily present during an urban flood. One useful measure, however, comes from the examination of insured flood claims occurring *outside* the floodplain. For example, an evaluation of repetitive flood losses in Harris County from 1978 to 2008 found that more than 47 percent of such losses occurred outside the 100-year floodplain.²³

In a subsequent analysis of insured flood claims in the Clear Creek watershed south of Houston, 55 percent of losses between 1999 and 2009 were located outside the 100-year floodplain. Furthermore, residents located a quarter of a mile from the floodplain boundary — the average flood claim distance — still could expect almost \$13,000 in flood damage. Significantly, *none* of the storms causing property losses during the study period were 100-year events.²⁴

OUTLOOK

Recent estimates place more than \$400 billion in Texas assets in the current 100-year floodplain, with a 50 to 75 percent increase in their value expected by 2050.²⁵

River flooding is likely to increase since it's tied directly to precipitation intensity. Increased precipitation can be expected to contribute to higher peak flows during extreme events. More intense storms will decrease the time needed to reach peak flow, causing rivers (especially bayous and smaller tributaries) to flood more readily. The impacts will be further compounded by urban development, sea-level rise and the loss of natural buffers separating developed areas from flood hazard areas.

Increased river flows have been observed across Texas, with nearly 20 percent of stream flow gauges in the state displaying upward trends. The greatest rate of

change has been seen in the greater Houston-Galveston region, followed by Dallas-Fort Worth.²⁶ Although greater peak flows won't necessarily lead to damaging floods, they can certainly cause them.

As already noted, more urban development is expected in the majority of Texas coastal watersheds. Loss of natural storage areas such as wetlands, open space and even agricultural land increases the volume and speed of runoff, particularly in coastal areas. Where floodplains are wide and shallow, small changes in peak flow can have large impacts on the extent of flooding.

Recent studies in the Houston-Galveston area have shown that urban development will increase the extent of floodplains in the future, despite investments in onsite water detention. For example, in the Cypress Creek watershed in Northeast Houston, urban development is expected to increase the size of the floodplain by 8.4 to 12.5 percent by 2050, placing an additional 361 to 550 existing structures in the Special Flood Hazard Area, where flood insurance is mandatory (see inset, previous page).

Such trends highlight the need for comprehensive flood mitigation and an increased focus on detention requirements to offset the impacts of new development, as well as policies to ensure that such development has no adverse impact on existing floodplains and nearby communities.

Periodic updates to regulatory floodplains, moreover, are likely to increase the amount of land within them. The federal regulatory process identifies

areas vulnerable to floods to define levels of risk and determine actuarial rates. The result of this analysis is the Flood Insurance Rate Map (FIRM), which draws the boundaries of the 100-year and 500-year flood plains.

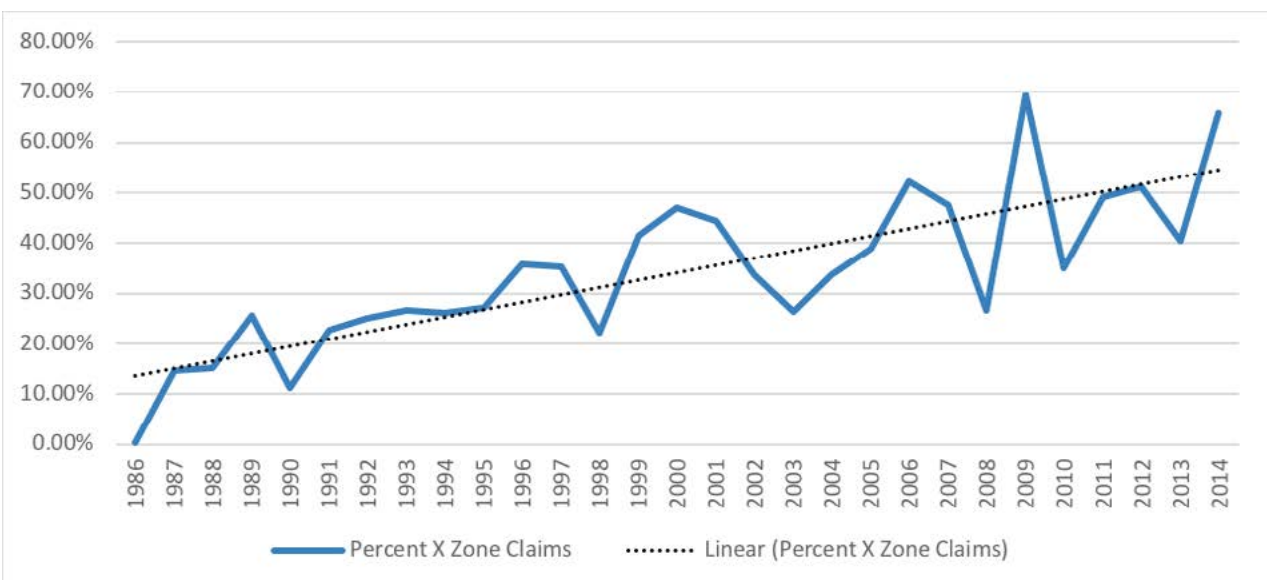
One key measure used in defining regulatory floodplains is precipitation, specifically the amount falling in a 24-hour rainfall event with a 1 percent chance of occurring in any one year. This value is provided by a rainfall frequency analysis, which for Texas is derived from a 1961 technical paper released by the National Weather Service.²⁷ NOAA updated these values for Texas, for 2018.²⁸

Early indications suggest that for the upper and middle Texas coast, along with areas throughout the Texas Hill Country, 1 percent/24 hour rainfall amounts will increase by 2 to 7 inches, which in some areas, such as southeast Harris County, represents an increase of 30 percent or more.²⁹ As these data are used to redefine flood-risk areas, identified floodplains will expand more rapidly into previously developed areas, with serious implications for insurance requirements as well as the need to communicate flood risks.

Urban flooding also appears to be increasing. Insured flood losses outside Texas floodplains rose steadily from 1986 through 2014 (**Exhibit 5**). Note that these figures include only individuals who *chose* to purchase flood insurance, because lenders and mortgage services don't require it outside the regulatory floodplain.

Exhibit 5. Share of Total Insured Flood Losses Outside Texas Floodplains, 1986–2014

Source: Created from NFIP data by Texas A&M University. X Zone claims are those that occur outside of the regulatory floodplain.



CHARACTERISTICS OF THE NATURAL ENVIRONMENT

In Texas, the primary causes of excessive rainfall are tropical cyclones and slow-moving thunderstorms.

Due to its location in the subtropics and long coastline on the Gulf of Mexico, Texas has always had a high risk of hurricane damage. The historical record shows that about one has made landfall somewhere on the Texas coast annually since 1875.³⁰ According to NOAA, eight of the 30 most significant hurricanes in U.S. history hit Texas.³¹

While almost any tropical cyclone carries the risk of 10 inches or more of rain, extreme amounts (more than 20 inches) generally are associated with tropical cyclones that stall or move very slowly. The most extreme tropical cyclone events in Texas history — Beulah in 1967, Amelia in 1978, Claudette in 1979, Allison in 2001 and Harvey in 2017 — show no correlation between total rainfall amounts and storm intensity.³²

In addition to tropical cyclones, regular annual rainfall has risen across the U.S. since 1900. Research indicates that rainfall over the central U.S. has increased in intensity as well as frequency. Texas State Climatologist Dr. John Neilson-Gammon has stated that the frequency of non-tropical extreme rain events has been increasing in recent decades and that, while droughts are becoming more common across Texas, so too are heavy downpours.³³

Since 1950, for example, parts of southern Texas have experienced a 700 percent increase in heavy rain events. Houston has seen a 167 percent rise in heavy rainfall.³⁴ Recent events across the state further highlight this trend. 2015 was Texas' wettest since record-keeping began, and May 2015 was the wettest month in the state's history, with an average of 8.81 inches of rain statewide.³⁵ In 2016, South and East Texas experienced rainfall exceeding 19 inches in 24 hours at some locations, causing devastating flooding.

STORM SURGE AND WIND

While Harvey's unprecedented flooding directed much attention to extreme rain, storm surge and wind also pose severe risks. For the vast majority of hurricanes, storm surge and wind are the largest contributors to damage; storm surge alone is responsible for 49 percent of deaths from hurricanes in the Atlantic basin from 1963 to 2012.³⁶

While wind poses a lesser threat to life than storm surge and flooding, it still can cause great damage to structures along the coast. Wind damage mainly occurs from storms approaching hurricane strength. Damage and threats to human lives increase dramatically with wind speed.



The remnants of a building in Rockport, Texas, two weeks after Hurricane Harvey.
(Texas A&M AgriLife Extension Service)

Meteorologists and wind engineers designed the Saffir-Simpson Hurricane Wind Scale to convey these exponential increases in risk with higher wind speeds. Its hurricane categories, however, are based on *maximum* wind speed, not the size of the wind field or the length of time high winds occur over a given location.³⁷ Such factors are important in determining the extent of impacts.

Harvey, for instance, had an average to slightly smaller than average-sized wind field when it made landfall. Humberto (2007), by contrast, was an extremely small hurricane with hurricane-force winds extending outward only about 20 miles from its center; its wind field was less than half of Harvey's size. Hurricane Ike (2008) was perhaps the largest storm in the historical record affecting Texas, with Carla (1961) a close second; Ike's wind field was about three times larger than Harvey's.

The American Society of Civil Engineers (ASCE) has published information for the chances of extreme winds at return intervals of 300 years (i.e. a 0.33 percent annual chance) and 700 years (a 0.14 percent annual chance) (**Exhibit 6**). The contour lines show the expected maximum wind speeds in such events. These data form the baseline for wind specifications in building code design. While such large intervals may seem to imply very low-probability events, it should be remembered that the landfall impacts of Harvey, Irma and Maria all were in the 1,000-year or greater realm.

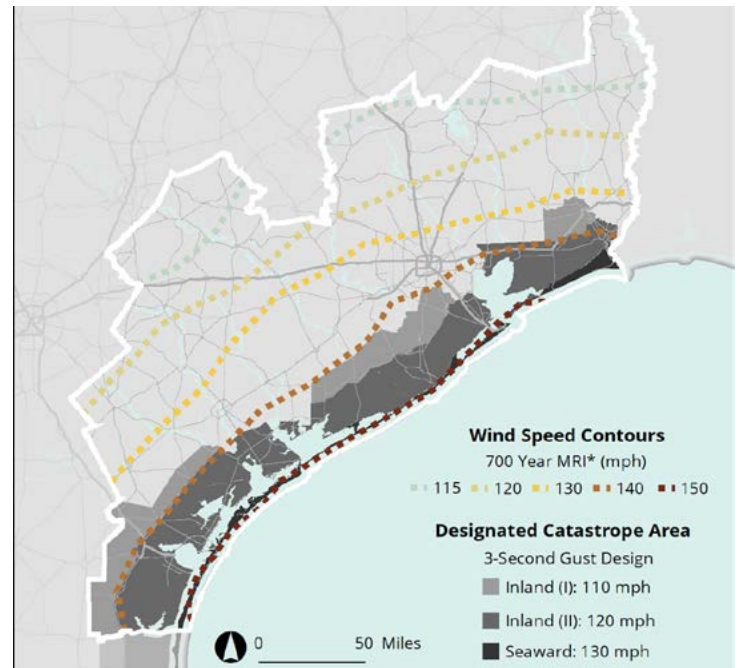
In Texas, city and county jurisdictions set and enforce building codes for wind. TWIA and the Texas Department of Insurance (TDI) have adopted guidelines for local jurisdictions to use in developing residential building codes. As with floodplain regulations, TDI's guidelines appear to closely match a 100-year return period, or 1 percent annual chance, for extreme winds. And as with flood insurance, many commercial insurance companies deem the wind risk exposure in Texas coastal counties to be too great to be actuarially acceptable, which led to creation of TWIA as an insurer of last resort.

OUTLOOK

Most of the flood-producing rains in Texas not associated with tropical storms or hurricanes are a result of intense storm systems (such as the 2015 Memorial Day weekend floods in the Hill Country and the 2016 Tax Day flood in Houston). Texas State Climatologist John Neilson-Gammon has demonstrated that the frequency of extreme rain events has increased

Exhibit 6. Wind Contours for Counties in the Harvey-Affected Area

Source: Texas A&M University analysis of Texas Windstorm Insurance and American Society of Engineering data



in recent decades.³⁸ Observations of the Gulf Coast region since 1880 show an increase of 12 to 22 percent in the intensity of extreme precipitation events lasting three days.³⁹

On other hand, the forecasting of tropical cyclones and accompanying surge and wind impacts is still evolving. There is some indication of an increased likelihood of very intense (category 4 and 5) storms, but confidence in this prediction is currently low.⁴⁰

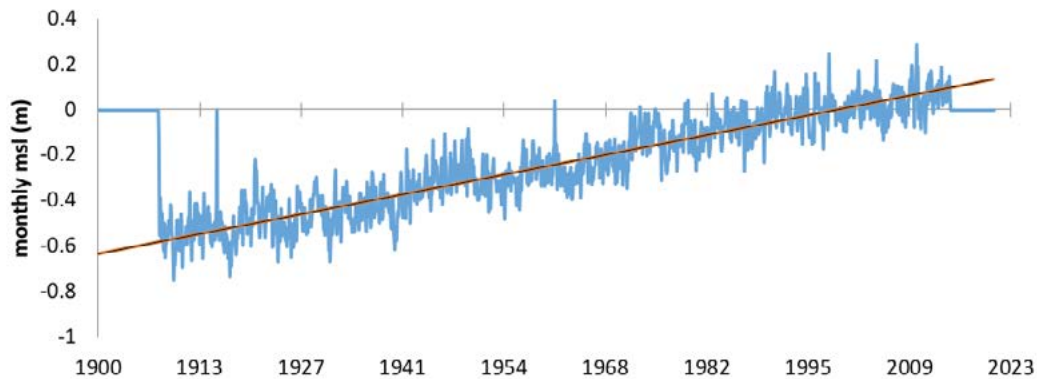
Given the very gradual change of elevation inland from the Texas coast, sea level rise would greatly increase the area at risk from storm surge and flooding. The largest sea level rise in the U.S. is anticipated in the western Gulf of Mexico, where Texas has 367 miles of coastline. Some of the highest rates of sea level rise along the Texas coast have been observed near the Bolivar Roads Inlet at the east end of Galveston Island.

Since 1904, the sea level at Galveston's Pier 21 has risen by an average 0.25 inches per year, equivalent to a 2.13 foot rise per 100 years (**Exhibit 7, next page**).¹² At Corpus Christi, sea level has risen by an average 0.18 inches per year since 1983, equivalent to a 1.5-foot rise per 100 years.

Sea level rise increases the potential for *tidal*

Exhibit 7. Observed Trend in Monthly Mean Sea Levels at Galveston Pier 21, 1904-2014

Source: Texas A&M University analysis of NOAA tides and currents data



flooding, also called recurrent or nuisance flooding. For example, Port Isabel, Texas, experienced 15 days of coastal flooding between 1955 and 1964, but 121 days between 2005 and 2014.¹³ Sea level rise also can be expected to heighten the impacts of storm surge, both by adding more land area to potential flood zones and by increasing the depth of flooding of coastal properties already at risk.

Detailed studies have been conducted to investigate the dual impact of increased development and rising sea level on the Houston-Galveston area between 2015 and 2080. The findings show that 2.4 feet of sea level rise more than doubles the chances of residential flooding in the event of a major hurricane.⁴¹

A secondary but important impact of increasing coastal water levels is the potential additive effect of storm tide to river flooding, or *compound* flooding. Recent research suggests an upward trend in compound flood events along the U.S. Gulf and East coasts. For this reason, experts expect average storm-related losses to rise by up to \$222 million annually by 2030 and up to \$650 million per year by 2050. This would increase expected annual losses to \$3.9 billion by mid-century.⁴²

CONCLUSION

Texas has been prone to flooding for millions of years. The characteristics that help shape flood impacts, however, are changing in ways that make the state more vulnerable. Flooding risks for coastal Texas, and much of the rest of the state, will continue to rise. The current scientific consensus points to increasing amounts of intense rainfall coupled with the likelihood of more intense hurricanes.

Precipitation and surge-based flood risks have always been with us, but as development creeps into flood-prone areas and floodplains expand into already developed areas, Texans are likely to become increasingly vulnerable. Urban floods will continue to pose a threat to more densely populated areas. Population growth and increasing development, if unguided, will further exacerbate the state's flood risks and vulnerabilities.

A large share of the future flood threats we face are the result of a convergence of many factors. Some of these factors can be mitigated through available techniques and proactive planning — but only if community leaders are willing to work within and across jurisdictional boundaries.

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An aerial photograph of a suburban area with a teal overlay. The image shows a residential neighborhood with a winding road, a large body of water, and a school complex. White topographic contour lines are overlaid on the map. The text 'CHAPTER 4' is centered in the middle of the image.

CHAPTER 4

4 EMERGENCY MANAGEMENT IN TEXAS

Disasters are managed at the local level.¹ They may, as in the case of Hurricane Harvey, come with several days warning, but in other cases, such as a sudden wildfire or earthquake, they may happen with little or no warning. But whatever the case, the people, local governments and voluntary agencies in the local area where the event occurs are the first to cope with the disaster.

The problem with a large or catastrophic disaster like a hurricane—and certainly in the case of a storm the magnitude of Hurricane Harvey—is that local resources needed to meet immediate needs to respond to or recover from a disaster are used quickly or even unavailable. When a local jurisdiction does not have the resources it needs, it looks to the state that might, in turn, need to look toward the federal government for resources — including financial resources—to help local governments with immediate recovery from the disaster and to help them develop plans to mitigate future disasters.

As they manage disaster situations, whether at the local, state, tribal or federal levels, emergency

management professionals often divide the emergency management cycle into 5 phases: prevention, protection, mitigation, response and recovery (**Exhibit 1**). If Texas is truly to “future-proof” the state, it must develop each of these phases with the goal of making emergency management in the state the best in the nation.

Definitions of the phases of emergency management differ depending on the source and their point of view. Here, we’ll use basic definitions from the Federal Emergency Management Agency (FEMA) to describe the five missions of the “National Preparedness Goal.” This goal, set out by the federal government, defines what it means for the nation’s public and private institutions and citizens to be prepared for all disasters and emergencies.² FEMA describes the five missions as follows:

- *Prevention* is the effort made to “prevent, avoid or stop an imminent, threatened or actual act of terrorism.”
- *Protection* is the effort to “protect our citizens, residents, visitors and assets against the greatest threats and hazards in a manner that allows our interests, aspirations and way of life to thrive.”
- *Response* is the ability to “respond quickly to save lives, protect property and the environment, and meet basic human needs in the aftermath of a catastrophic event.”
- *Recovery* is the “focus on the timely restoration, strengthening and revitalization of infrastructure, housing and a sustainable economy, as well as the health, social, cultural, historic and environmental fabric of communities affected by a catastrophic incident.”

Exhibit 1. The Emergency Management Cycle



- *Mitigation* is the effort to “reduce the loss of life and property by lessening the impact of future disasters.”³

Much has been written about response and recovery since they are the most obvious elements in managing any disaster. Unraveling the definitions above, recovery from disaster begins after response to the incident has stabilized the situation and citizens can start returning to their homes and lives, a period of several days after an event to several weeks.

Reaching the point of recovery requires an immediate emphasis on restoration of physical infrastructure such as water, sewer, electric power, natural gas, telecommunications and transportation. Some say the ultimate objective of recovery is to return the community's quality of life at least to the same level as it was before the disaster, but preferably more resilient to weather events. Attaining this level of rebuilding and renovation can take years.⁴

The dividing line between response and recovery is blurred, with transitions from one phase to the next being gradual rather than sharp. FEMA literature also views emergency management phases as interdependent and blended together in a continuum.

The Recovery Continuum highlights the reality that, for a community faced with significant and widespread disaster impacts, preparedness, response, and recovery are not and cannot be separate and sequential efforts. Laying an effective foundation for recovery outcomes is a key requirement of response activities, but planning for recovery begins before response. Community-level planning for recovery is a preparedness-phase activity that strengthens continuity and response and hastens recovery. The challenge is to ensure adequate and effective coordination between different efforts and players, as the decisions and outcomes for all phases are interconnected.⁵

Disaster mitigation is any measure that eliminates or reduces the impacts and risks of hazards through steps taken before an emergency or disaster occurs.

Mitigation covers a range of activities at the state and local level, including, in the case of hurricanes, accurately mapping flood plains, toughening building codes to make structures more resistant to wind and water, raising homes in flood prone areas, building dams or other structures such as levees to avoid flood damage, protecting electrical and water supply sources, and making sure people and businesses are adequately insured against future emergency situations. Although our focus is mainly with Hurricane Harvey and its impact, the need for mitigation extends to all sorts of

emergency management situations, from localized flooding to strengthening structures against possible tornadoes, to protection against wildfires and other potential disasters.

All five phases contribute to support of the National Preparedness Goal that provides “A secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to and recover from the threats and hazards that pose the greatest risk.”

All pieces of the emergency management cycle work together to ensure the community or state is better prepared for any future disaster. In the case of Hurricane Harvey, the widespread damage it created provided clear evidence of the areas of preparedness where Texas will be well situated to face future emergencies, but it also exposed areas where significant improvement should be made to “future-proof” the state. Much of this report is concerned with how we better prepare for future hurricanes and other disasters, through strengthening of prevention, protection, mitigation, response and recovery by incorporating lessons learned from Harvey.

THE TEXAS EMERGENCY MANAGEMENT STRUCTURE

LOCAL STRUCTURE

In Texas, the presiding officer of the governing body of an incorporated city or a county, mainly mayors and county judges are designated as emergency management directors for their jurisdictions. Emergency management directors from the affected areas serve as the governor's agents in carrying out requirements of state law in relation to emergency management.⁶ These directors often designate another person to serve as emergency management coordinators (EMCs) who manage day-to-day program activities.⁷

Under state law, each county must have an emergency management program or participate in a local or interjurisdictional program that serves the entire county or interjurisdictional area. In addition, each local and interjurisdictional emergency management agency must prepare an emergency management plan providing for disaster mitigation, preparedness, response and recovery.⁸ The state provides templates and technical assistance for development of these plans.

The presiding officer of a governing body, usually a county judge or mayor, may declare a local state of disaster. The county judges or mayor may also order evacuations within their jurisdictions.

Exhibit 2 Texas Emergency Management Council Membership¹²

American Red Cross*	Texas Department of Criminal Justice
State Procurement Division	Texas Department of Family and Protective Services
Public Utility Commission of Texas	Texas Department of Housing and Community Affairs
Railroad Commission of Texas	Texas Department of Insurance
The Salvation Army*	Texas Department of Public Safety
State Auditor's Office	Texas Department of State Health Services
Texas A&M AgriLife Extension Service	Texas Department of Transportation
Texas A&M Engineering Extension Service	Texas Division of Emergency Management
Texas A&M Forest Service	Texas Education Agency
Texas Animal Health Commission	Texas General Land Office
Texas Attorney General's Office	Texas Health and Human Services Commission
Texas Commission on Environmental Quality	Texas Military Department
Texas Commission on Fire Protection	Texas Parks and Wildlife Department
Texas Comptroller of Public Accounts	Texas Department of Information Resources
Texas Department of Agriculture	Texas Voluntary Organizations Active in Disaster*
* Note: American Red Cross, Salvation Army and Texas Voluntary Organizations Active in Disaster are not state agencies.	

STATE STRUCTURE

The governor holds the authority to declare a state-level disaster. The governor is responsible for meeting “dangers to the state and people presented by disasters; and disruptions to the state and people caused by energy emergencies.”⁹

The Texas Division of Emergency Management (TDEM), a division of the Texas Department of Public Safety (DPS), coordinates disaster response for the state. The DPS director appoints a chief to manage TDEM with the governor's approval.¹⁰

TDEM coordinates statewide emergency response with the assistance of the Texas Emergency Management Council, a body representing state agencies plus representatives of various nonprofits and other groups involved in disaster response known as “voluntary organizations active in disaster” or VOADS (**Exhibit 2**).¹¹

STATE MANAGEMENT OF DISASTERS

Members of the Emergency Management Council work together throughout the year to plan for major disasters. If needed, members of the Emergency Management Council convene at TDEM's State Operations Center in Austin. Council members coordinate the deployment of state resources and support in response to disasters.¹³

The *State of Texas Emergency Management Plan*, an extensive document managed by TDEM, guides state preparedness and response operations, detailing the structure and responsibilities involved for all Emergency Management Council members.¹⁴

The Emergency Management Council has been active in Texas, in some form, since 1973. The most recent update of the council was by executive order in 2004, the functions of some of its member agencies have changed, some agencies no longer exist, new agencies with emergency responsibilities have been created and other agencies' functions have evolved to include greater roles in emergency management. Hurricane Harvey highlighted state agencies that need a place on the council.

For example, the Texas Department of Licensing and Regulation, not represented on the council, accelerated the licensing of out-of-state workers to meet the recovery's construction demands. Similarly, the Texas Department of Motor Vehicles, created in 2009 and also unrepresented, temporarily waived permitting requirements for oversized or overweight vehicles so heavy equipment could move quickly to more secure areas; it continues to work with titling problems caused by flooded vehicles. Finally, while various private entities sit on the council, other private entities also could potentially provide valuable perspectives at this point and could be considered for membership.

STATE AND DISTRICT COORDINATORS

Seven TDEM employees serve as coordinators for each of DPS' state administrative regions, six of them geographic and one encompassing state agencies. These state coordinators provide oversight for the district coordinators in their regions. According to TDEM, its regional, state and district coordinators "have a dual role as they carry out emergency preparedness activities and also coordinate emergency response operations. In their preparedness role, they assist local officials in carrying out emergency planning, training, and exercises, and developing emergency teams and facilities. They also teach a wide variety of emergency management training courses. In their response role, they deploy to incident sites to assess damage, identify urgent needs, advise local officials regarding state assistance, and coordinate deployment of state emergency resources to assist local emergency responders."¹⁵

Texas has 24 disaster districts coinciding with the geographic boundaries of the state's 24 planning regions (**Exhibit 3**).¹⁶ These disaster districts serve as the initial point of contact for state assistance in their areas. Each is led by a Disaster District Committee (DDC) chaired by the district's senior DPS highway patrol officer, and including members of the organizations represented on the emergency management council.¹⁷

Cities and counties needing help with a disaster can request state assistance through their DDC. Each DDC chair liaises between these local governments and the State Operations Center during large-scale emergencies. TDEM's district coordinators work with local officials, nonprofits and private partners to "prevent, protect, mitigate, respond, and recover from disaster," in the words of TDEM's *Texas Emergency Management*

Executive Guide.¹⁸ **Exhibit 4 (next page)** summarizes the administrative structures involved in Texas' emergency management.

OTHER KEY RESPONSE AGENCIES

While most of the member agencies of the state's Emergency Management Council had some role in responding to Hurricane Harvey particular to their responsibility, several agencies were directly involved in aspects of the response and immediate recovery after the storm. For example, the Texas Department of Public Safety, in addition to being the administrative home of the Division of Emergency Management, also provides law enforcement, traffic control and other assistance in disaster areas.

Along with other agencies, the Texas Department of Transportation was heavily involved in debris removal and road repair. The Texas Commission on Environmental Quality was involved in debris disposal and other environmentally sensitive issues. The Texas Health and Human Services Commission operated the Disaster Supplemental Nutrition Assistance Program (D-SNAP), while the Department of State Health Services (DSHS) played a lead role in health issues, including addressing the mosquito infestation and other local health issues that arose in the days following the hurricane. DSHS also provided support through the Texas Disaster Medical System (TDMS) and the Emergency Medical Task Forces (EMTFs) which provided assistance throughout the affected areas. The Texas Water Development Board was involved in water-related issues and in October 2017, began developing the state's statewide flood plan. The Texas General Land

Exhibit 3. Texas Disaster Districts

Source: *The State of Texas*

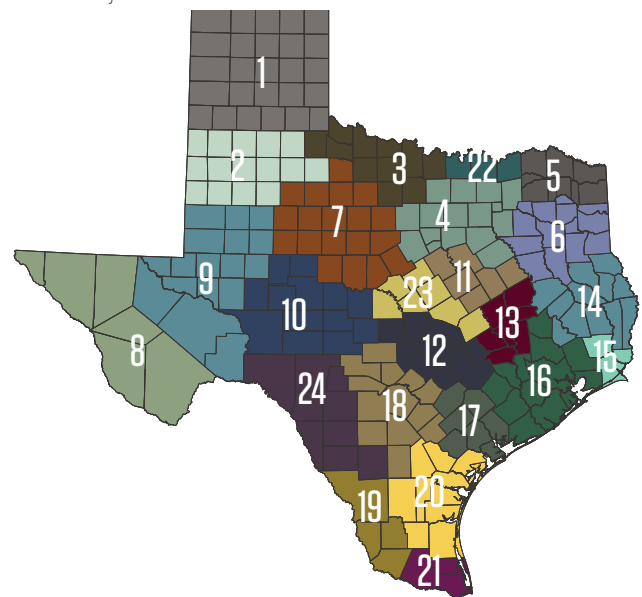
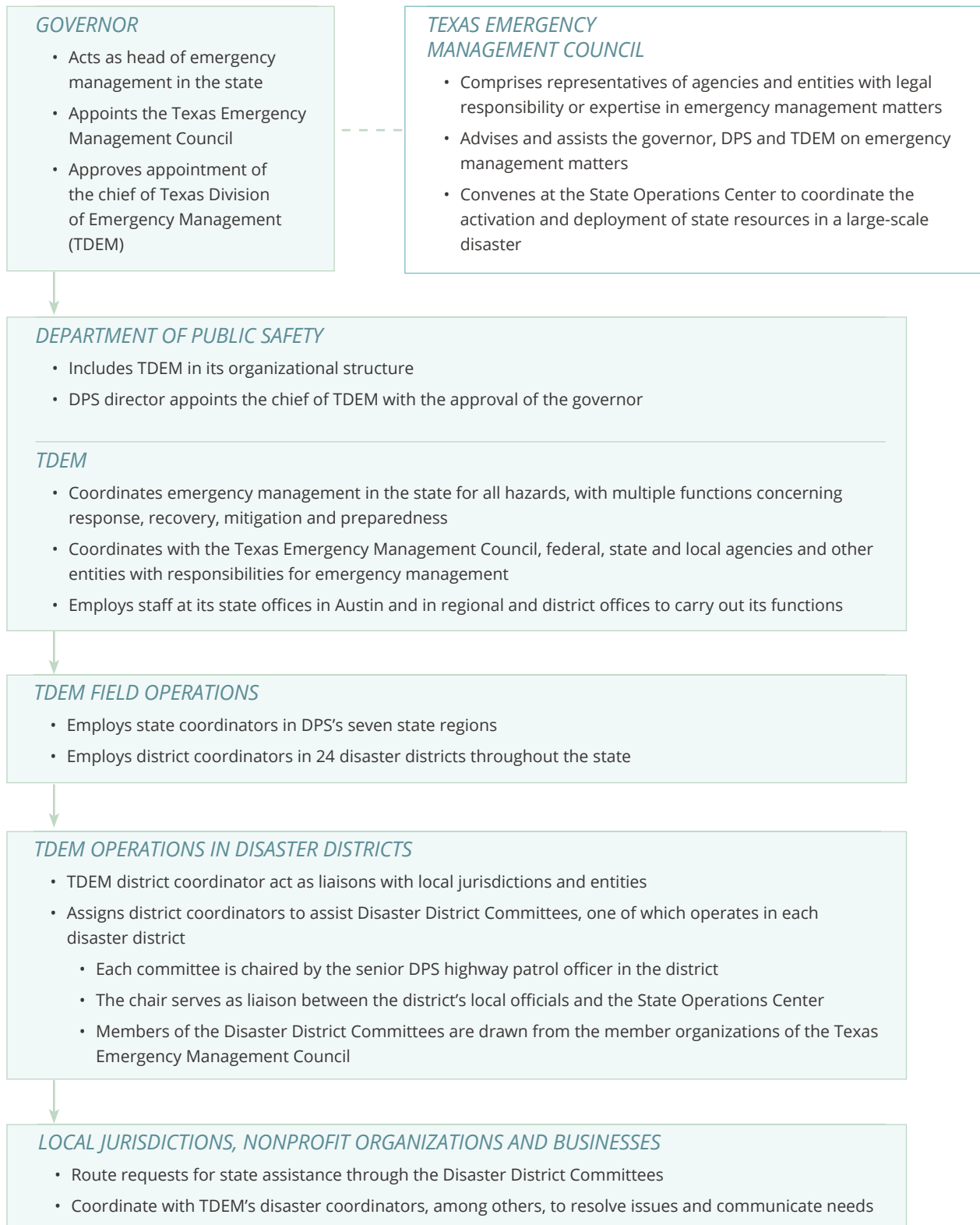


Exhibit 4. Texas Organizational Structure for State Emergency Management

Office, as is discussed below, took primary responsibility for managing federal temporary and permanent housing assistance programs for the state.

In addition, agency members of the Texas A&M University System, including the Texas A&M Engineering Extension Service, the Texas A&M Forest Service, the Texas A&M AgriLife Extension Service, the Texas Institute for Applied Environmental Research at Tarleton State and the Texas A&M College of Veterinary Medicine and Biomedical Sciences provided direct response during the hurricane, including search and rescue, agricultural relief programs and veterinary assistance for displaced and injured animals. The state climatologist, also a part of the Texas A&M University System, was directly involved as well.

FEDERAL GOVERNMENT ASSISTANCE

If needed, the governor can ask the president to issue a major disaster declaration if the damage or potential damage reaches certain dollar thresholds based on the state's population and a figure fixed by federal law. For Texas, the current threshold is \$37 million, which, of course, Harvey far exceeded. A presidential declaration releases federal funds and personnel to assist state and local officials. The president can issue this declaration if the governor has first issued a state disaster proclamation for the affected area, and if certain fiscal damage thresholds are met.¹⁹

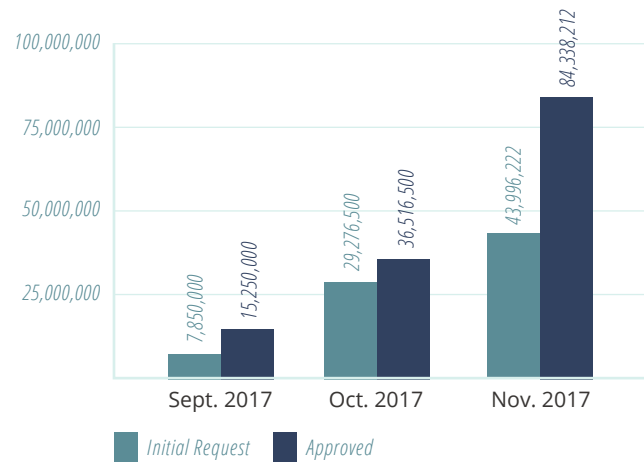
In disasters of Harvey's size and scope, the involvement of federal agencies and financial assistance are vital not only to the individuals affected but also to state and local governments, due to damage to local infrastructure such as roads, schools and other public facilities. A large number of federal agencies were directly involved in the response to Hurricane Harvey.

FEMA was the most important agency in the immediate response and recovery efforts, but the U.S. Department of Health and Human Services, Department of Housing and Urban Development, U.S. Army Corps of Engineers, the Environmental Protection Agency, the Department of Energy, the Civil Air Patrol, the Department of Agriculture and the Small Business Administration and also participated.

One aspect of the federal response that bears more discussion in context of the response and recovery from Harvey is the role of federal assistance. The commission learned in its work that federal funding is complex,

Exhibit 5. Timeline of Supplemental Congressional Appropriations Requests and Approval Responses to 2017 Disasters (\$ in Thousands)

Source: Congressional Research Service, "2017 Disaster Supplemental Appropriations: Overview," March 2018



offered by several federal agencies all with differing timing and requirements, and the actual receipt of funding can take a very long time. This situation creates problems for governments, businesses and people affected by the storm.

CONGRESSIONAL SUPPLEMENTAL DISASTER APPROPRIATIONS

Hurricane Harvey was one of 61 major disasters declared under the Robert T. Stafford Disaster Relief and Emergency Assistance Act in 2017.²⁰ Hurricanes Harvey, Irma, and Maria, alongside record wildfires in California, contributed to 2017 breaking the U.S. record for cumulative cost associated with natural disasters in a single year with \$306.2 billion in damages, dwarfing the previous inflation-adjusted record of \$214.8 billion in 2005.

In response to these challenges, Congress passed three supplemental appropriations bills in 2017 to fund emergency operations and disaster recovery. In each case, the final congressionally approved appropriation exceeded the initial request by the Administration (**Exhibit 5**).

A total of \$120 billion was appropriated in response to 2017 disasters between these three pieces of legislation and then distributed to 25 federal departments. In addition, \$16 billion in debt held by the National Flood Insurance Fund was canceled, bringing the total to just over \$136 billion. This funding was provided in addition to other disaster-related funding already previously appropriate to federal agencies like FEMA.

The supplemental appropriations were made in three parts or “tranches”:

- In September 2017, Congress approved \$7.4 billion for the FEMA Disaster Relief Fund (DRF) and \$450 million for Small Business Administration (SBA) disaster loans, and authorized FEMA to obligate DRF funds at an accelerated rate that would make up to \$6.7 billion available during the period of a possible 2018 continuing resolution. Also authorized was \$7.4 billion for disaster relief through the U.S. Department of Housing and Urban Development’s (HUD’s) Community Development Fund.
- In October 2017, Congress passed a second supplement totaling \$18.67 billion for FEMA’s Disaster Relief Fund. It also allowed some of that funding to be transferred to two other programs: \$4.9 billion to FEMA’s Disaster Assistance Direct Loan Program account, and \$10 million to the Department of Homeland Security (DHS) Office of Inspector General for oversight of disaster related activities. The measure also included \$577 million for fighting wildfire on federal lands, and authority to use \$1.27 billion of reserve funds to support nutrition assistance programs in Puerto Rico.
- Finally, in February of this year, Congress approved more than \$84 billion in supplemental appropriations for a variety of federal agencies and purposes.

The full scope of this federal disaster assistance is difficult to conceptualize and navigate; however, the largest and arguably the most important allocations go to six programs that account for more than 80 percent of the total federal outlay to date for 2017 disasters. These include:

- U.S. Department of Homeland Security - Disaster Response Fund (FEMA)
- U.S. Department of Housing and Urban Development (HUD) - Community Development Block Grants Disaster Recovery (CDBG-DR) Program

- U.S. Army Corps of Engineers - Construction Account
- U.S. Department of Agriculture - Block Grants for Agricultural Disasters
- U.S. Department of Education - Hurricane Education Recovery Grants
- Small Business Administration (SBA) - Disaster Recovery Loan Program

FEMA: The Federal Emergency Management Agency, a part of the U.S. Department of Homeland Security, is the primary federal agency for funding assistance after a disaster. Congress appropriates money annually into FEMA’s Disaster Relief Fund (DRF). After major disaster declarations, FEMA uses DRF funds to support three programs: (1) Public Assistance — used to repair and rebuild infrastructure; (2) Individual Assistance — used to help individuals with essential home repairs, temporary housing costs, and other necessary expenses; and (3) the Hazard Mitigation Grant Program — used for projects to prevent disaster losses through mitigation measures such as property buyouts and home elevations.

For severe disasters or years of multiple disasters like 2017, Congress may make supplement appropriations to FEMA. In Texas, FEMA funding is primarily managed by the Texas Division of Emergency Management with the exception of the temporary housing program, which is the responsibility of the General Land Office (GLO).

HUD: The Department of Housing and Urban Development assists in disaster recovery and mitigation through the Community Development Block Grant-Disaster Recovery (CDBG-DR) program. CDBG-DR differs from HUD’s standard Community Development Block Grant (CDBG) program, a continuous program receiving annual appropriations from Congress. CDBG-DR is funded and administered only after a disaster-related congressional appropriation. Funding must be used for disaster relief, long-term recovery, infrastructure restoration, housing and economic revitalization. Common uses are residential home buyout programs; development of multifamily rental housing, including repair and rehabilitation; homeowner assistance to restore homes; local government infrastructure repair and rebuilding; and economic revitalization. CDBG-DR funding also can be used for matching other federal funds. Grantees generally must allocate 70 percent or more of the funding to low- and moderate income

household and 80 percent to areas HUD identifies as “most impacted or distressed.” The General Land Office is the state administrator of CDBG-DR funding in Texas.

One important point is that CDBG funding usually becomes available only well after a disaster occurs. HUD Secretary Ben Carson signed the final grant agreement officially authorizing the GLO to begin spending the first \$5 billion allocated for long-term housing assistance on August 17, 2018.

Corps of Engineers: Under the federal disaster framework, the U.S. Army Corps of Engineers (USACE) is the primary agency responsible for public works and engineering after a disaster. It also supports FEMA search and rescue operations. Supplemental Congressional funding for the USACE after a disaster most typically is aimed at two areas: Flood Control and Coastal Emergencies (FCCE) and Operations and Maintenance (O&M). FCCE funding is used to pay for immediate flood fighting and repairs to non-federal flood control infrastructure. O&M funding is focused on repairs to existing USACE infrastructure. A third USACE account that often receives supplemental disaster-related funding is the Construction account.

USDA: The U.S. Department of Agriculture (USDA) offers several programs to help farmers recover financially from natural disasters, including drought, floods and hurricanes. All of the programs have permanent authorization, and only one requires a federal disaster designation (for an emergency loan program).

Most programs receive mandatory funding amounts that are “such sums as necessary” and are not subject to annual discretionary appropriations. The programs include: crop-loss insurance; noninsured crop-disaster assistance; the livestock indemnity program; the livestock forage disaster program; emergency assistance for livestock, honey bees, and farm-raised fish; tree assistance; and emergency disaster loans.

Education Grants: Local educational agencies (LEAs) in counties included in a disaster declaration may have lost equipment or facilities. Other school districts may have received evacuee students and were required to provide them with services on an emergency basis. In both cases, U.S. Department of Education Hurricane Disaster Recovery Grants may be used to offset the effects of the disaster and improve student safety.

In both cases, federal grant funds may be used to help mitigate the effects of the disaster and improve student safety. Funding was set aside in response to Harvey for a variety of purposes including allocations for restarting operations at affected elementary and secondary schools, with additional support for schools serving displaced students; affected higher education institutions; education services for homeless children; and programs for students recovering from the trauma of a natural disaster.

SBA Loans: The Small Business Association (SBA) provides direct assistance to individuals recovering from a federally declared disaster in the form of disaster recovery loans. These loans are made directly to individuals and are intended to cover expenses beyond initial FEMA assistance related to physical damage and economic injury. SBA disaster loans can be used to repair personal or business property; replace or repair machinery or equipment; replace business inventory; cover expenses due to economic loss during business downtime; and cover disaster-related active military duty expenses. Homeowners can receive loans for up to \$200,000 to repair or replace a primary residence, and homeowners or renters alike can receive loans for up to \$40,000 for repair or replacement of personal property. Businesses are eligible for up to \$2 million in loans each for any combination of damages. FEMA pushes survivors in disaster zones to apply for SBA loans, and some FEMA grants and other individual assistance requires an SBA local application for eligibility.

Appropriations. As an example of the distribution of funding among federal programs, the supplemental appropriation approved last February included the following distribution:

- \$23.5 billion for the Federal Emergency Management Agency Disaster Relief Fund, the primary funding source for immediate disaster response. This will support response and recovery efforts, including assistance to state and local governments, to cover total estimated needs for Hurricanes Harvey and Irma, and estimated fiscal 2018 needs for Hurricane Maria.
- \$17.4 billion for the U.S. Army Corps of Engineers, largely for projects to reduce the risk of future damages from flood and storm events.

- \$28 billion for the Department of Housing and Urban Development Community Development Fund to help communities rebuild damaged homes, buildings, and infrastructure.
- \$1.65 billion to the Small Business Administration to further support the disaster loan program, and \$600 million to the Department of Commerce for Economic Development Administration grants to support immediate relief efforts and long-term recovery projects in communities affected by recent disasters.
- \$2.46 billion to restart operations at elementary and secondary schools affected by the hurricanes and wildfires, and for temporary assistance for schools, including private schools outside of affected areas, serving elementary and secondary school students displaced by the disasters.
- \$434.3 million for the Department of Defense, \$720.9 million for military construction, and \$718.9 million for the U.S. Coast Guard to recover from damage caused to defense and border security facilities and equipment during the 2017 hurricane season.
- \$149.5 million to repair and strengthen damaged Customs and Border Patrol facilities.
- \$93.5 million to help the VA repair damaged hospitals and facilities.
- Small appropriations to dozens of other federal agencies, including the Department of Defense, NASA, the Department of Veterans Affairs, the Federal Highway Administration and the U.S. General Accountability Office.

The distribution of federal supplemental disaster appropriations for 2017 for all disasters is shown in **Exhibit 6**. The exhibit illustrates the complexity of federal disaster assistance funds. All of the programs have their own program requirements and impose limitations on the use of funds that state and local governments must follow.

Exhibit 6. Distribution of Federal Disaster Funding, 2017
Source: Congressional Research Service, "2017 Disaster Supplemental Appropriations: Overview," March 2018

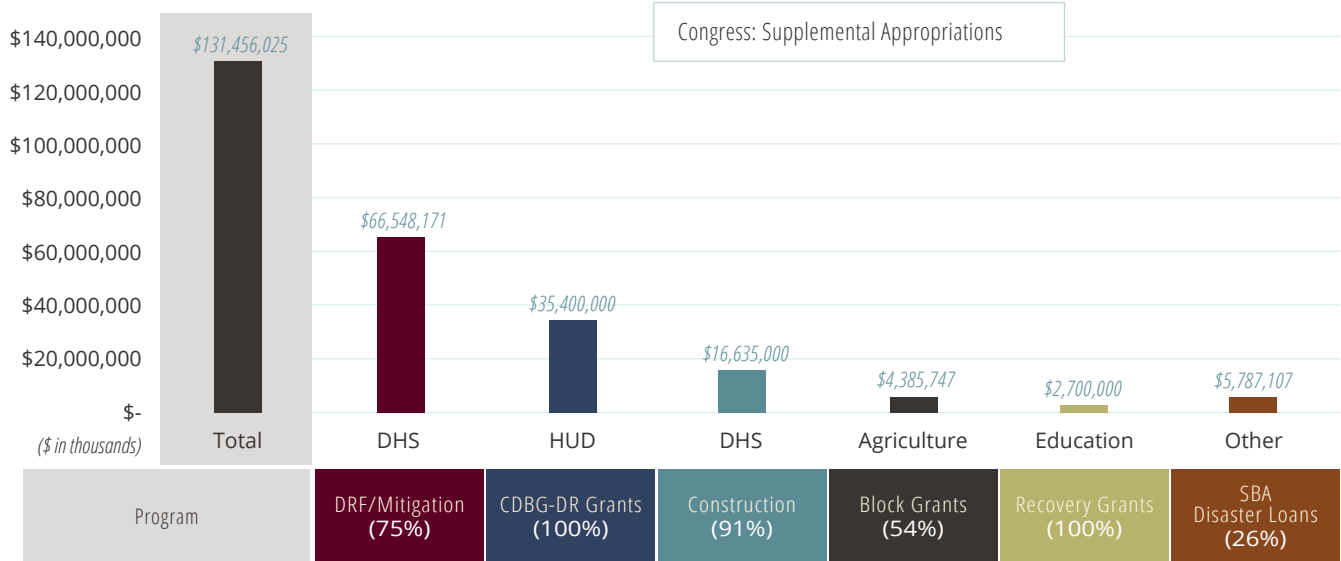


Exhibit 7. Chart of Eligible Activities Under Various Federal Disaster Funding Sources

Source: Congressional Research Service, "2017 Disaster Supplemental Appropriations: Overview," March 2018

	1	2	3	4	5	6	7	8	9	10	11	12
Acquisition					X	X	X	X				X
Rehabilitation		X	X	X	X	X	X	X	X			
Road Repair		X			X		X			X		
Housing					X	X		X				
Demolition		X	X		X	X			X			
Debris Removal			X	X	X							
Public Facilities		X	X	X	X	X	X			X		
Individual Assistance				X	X							
Business Assistance				X			X		X	X	X	X
Evacuation	X							X				
Recovery	X	X						X	X			X
Food/Medicine		X		X					X			X
Employment/Training				X	X						X	
Infrastructure					X		X	X		X		
Relocation				X								

Note: In the chart, Hazard Mitigation and Public Assistance are FEMA programs. CDBG is the Community Development Block Grant program administered by the Department of Housing and Urban Development, as is the HOME program. The 108 program refers to the HUD Section 108 program that offers state and local governments the ability to transform a small portion of their CDBG funds into federally guaranteed loans large enough to pursue physical and economic revitalization projects. USDA is the U.S. Department of Agriculture.

- | | |
|----------------------------|--|
| 1. General Federal Funding | 8. Capital Funding-PHA Only |
| 2. Essential Assistance | 9. Small Business USDA |
| 3. Hazard Mitigation | 10. Commerce Disaster Relief Opportunity Funds |
| 4. Public Assistance | 11. National Emergency Grants |
| 5. CDBG | 12. Agricultural Disaster Assistance |
| 6. HOME | |
| 7. 108 | |

For those affected by a catastrophic event, a chart like the one shown in the exhibit seems all but incomprehensible. The language used to describe their post-disaster condition is not organized by government agencies or programs, but by needs such as housing, debris removal, food, medicine, and basic post-disaster survival. **Exhibit 7 (next page)** shows a different view of federal assistance, showing the types of eligible expenditures under each category of activity.

A final point is the fact that none of the supplemental bills earmarks funds for Texas or any other state affected by the 2017 disaster season. The

state already has received more than \$2.65 billion in individual and public financial assistance from FEMA's Disaster Assistance Fund and will continue to receive funding for some time to come.

The state also learned in November 2017 that it would receive at least \$5 billion in Community Development Block Grant — Disaster Recovery funding from HUD, and Texans have received billions of dollars more in Small Business Administration loans. Finally, in July 2018, USACE announced that it would use funds provided by Congress earlier in the year to construct 60 flood and storm-damage reduction projects in 16

states and one territory. Included in this total were several long-term flood control projects in Texas already approved for USACE action but previously lacking funding. These include:

- Bray's Bayou—\$75,000,000
- Buffalo Bayou and Tributaries—\$1,454,000
- Clear Creek—\$295,165,000
- Dallas Floodway—\$222,911,000
- Dallas Floodway Extension—\$53,000,000
- Hunting Bayou—\$65,000,000
- Lewisville Dam—\$91,959,000
- Lower Colorado River—\$73,290,000
- Sabine Pass to Galveston Bay—\$3,957,134,000
- White Oak Bayou—\$45,000,000

In addition, several studies were also approved, a critical first step in securing eventual support from Congress for Corps projects. The studies included:

- Coastal Texas Protection and Restoration Study—\$1,902,000
- Buffalo Bayou and Tributaries Study—\$6,000,000
- Houston Regional Watershed Assessment—\$3,000,000
- Brazos River, Fort Bend County Erosion Management Study—\$3,000,000
- Guadalupe and San Antonio River Basins—\$2,000,000

"WE WERE DRAWING A LINE IN THE SAND..."

Scott Hall

On the afternoon of Wednesday, August 30, aside from the mechanical clatter of the sump pumps working to keep water out of the plant, and the occasional sound of rising water falling through an air vent, it was quiet – almost peaceful – outside the Neches One pumping station situated next to Pine Island Bayou.

Scott Hall, the general manager of the Lower Neches Valley Authority (LNVA), was talking to his team about what they would do once the rain stopped. Created in 1933, LNVA supplies potable water to nine municipalities in East Texas, and they did not plan on letting Hurricane Harvey stop them.

By now, their surface water and wastewater plants were offline, their saltwater barrier was compromised and they had lost two of three primary diversion points along the river. The radio tower relaying signals about the status of the LNVA canal system had stopped working. So, the authority diverted all its resources into saving the Neches pumping station.

"That's our last stand," Hall said. "We were drawing a line in the sand there."

But water has a way of erasing lines in the sand, and as it rose high enough to begin pouring through station's windows, Hall and his team began to hear weird noises. He likened it to a ship sinking. Hisses of air valves give way to gurgling and bubbling. There is splashing and banging as tool chests tip over. As the engine fills with water, he said, "There is almost the scream of a wild animal."

Witnessing the death throes of their last functional

pumping station was not easy. "It got a little emotional for some folks," Hall said. But it wasn't the end of their effort.

As soon as the rain let up, they snapped into action. Even with so much of their operations offline, if they could keep their canal system functioning, it had enough clean water stored in it to allow them to continue to serve their municipal customers.

"We worked the problem in a very methodical way," Hall said.

He was able to arrange for some team members to go up in a helicopter to do surveillance. Meanwhile, others moved about the counties manually trying to keep control of the canal system. They were able to arrange for two mobile pumps to be quickly shipped in from California and North Carolina.

After being hunkered down as Harvey dumped feet of rain on the area, Hall described the nonstop activity as invigorating. "There was such a natural high of actually doing things to improve your situation," he said.

The difference the effort made was not small. For example, LNVA was able to keep the city of Nederland supplied with fresh water. Because of this, Nederland was able to send thousands of gallons to hospitals in Beaumont — where the water system had failed — to keep them open and treating patients in the ER, performing surgeries, and even delivering babies.

"At the end of the day, we did what we set out to do," Hall said. "We did not fail any of our customers."

In announcing the USACE projects and studies, Governor Abbott underscored their value in the long-term goal of future-proofing the state against future disasters. “The billions allocated to Texas today is welcome news as we continue to rebuild in the aftermath of Hurricane Harvey,” he said. “This funding will go a long way toward future-proofing Texas against another hurricane and strengthening our infrastructure to withstand dangerous flooding. I thank the U.S. Army Corps of Engineers, the Texas Congressional Delegation and the Office of Management and Budget for their work in helping rebuild Texas stronger than before.”²¹

In terms of other federal assistance, Texans learned what experts in the field of emergency management already knew — there can be a significant and frustrating gap between the time when funds are approved by Congress and when they actually become available for use at the local level (as will be discussed in a later chapter).

FRAGMENTATION OF EMERGENCY MANAGEMENT

Given the number of organizations and levels of government involved, the coordination of Texas’ various emergency management functions is challenging at best.

At present, the state relies on TDEM to integrate the emergency functions of multiple state and federal entities including FEMA, the U.S. Department of Housing and Urban Development, the Small Business Administration, the U.S. Army Corps of Engineers and the U.S. Department of Agriculture.

These entities operate many different programs, follow differing policies and procedures and use funding from multiple sources. This complexity inevitably leads to inefficiency and duplicated effort. For example, various state agencies with emergency functions have their own, separately managed planning, training, exercise and response programs. TDEM works to coordinate the various players at the state level, but there is a real need for closer coordination of the process in the future, which means working in advance of emergencies with federal, state and local entities.

Given Texas’ size and the division of emergency responsibilities among local, state and federal agencies, a unified emergency management system for the state is probably impractical. Even so, it would be valuable for the state to investigate the consolidation of some operations to simplify coordination and provide a more focused and consistent approach to emergency management. More importantly, a more coordinated

approach could allow the state to improve the parts of the emergency management cycle — particularly mitigation and recovery where Texas, like most states, has considerable room for improvement.

One logical opportunity for such consolidation would be TDEM and the Texas A&M University System. TDEM’s core mission is the coordination of emergency management throughout the state, including response and recovery, disaster preparation, and training, planning, exercises and grant management and technical assistance. The Texas A&M System, through its member agencies and the Texas A&M University, has a number of emergency management functions that dovetail with those of TDEM, Texas Task Forces 1 and 2, the Texas A&M Forest Service, the Texas A&M Engineering Extension Service, the Texas A&M AgriLife Extension Service (agriculture disaster response and assistance in local recovery efforts), the Texas A&M College of Veterinary Medicine and Life Sciences Veterinary Emergency Team and various academic units with research expertise in coastal flooding, mosquito control and other related issues.

Integrating or co-locating such programs and activities could help reduce the problems associated with fragmentation among emergency programs.

Chapters 5 and 6 address response and recovery in greater detail. They will address this fragmentation and how it can be reduced or eliminated.



A truck of donated hay and other supplies from New Jersey is unloaded in Sour Lake, Texas, September 14, 2017. (Texas A&M AgriLife Extension Service/Blair Fannin)

EMERGENCY MANAGEMENT IN TEXAS RECOMMENDATIONS

1. Reorganize emergency management functions to unify the most critical emergency response and recovery functions.

Emergency management in Texas is fragmented among federal, state, and local agencies and jurisdictions. At the state level, the emergency management system relies on the Texas Division of Emergency Management to integrate the emergency functions of many state agencies and entities and multiple federal agencies, mostly through voluntary coordination and gubernatorial directive. These entities can have different priorities and operate many different programs, have many funding streams, and function under different policies and procedures.

This fragmentation presents ample opportunity for inefficient use of resources, overlap and duplicated programs. For example, various state agencies have their own planning, training, exercise, and response programs, all managed and funded separately.

Setting up a highly unified emergency management system at the state level probably is not practical given Texas' size and division of emergency responsibilities among so many entities. Even so, it would be valuable for the state to consider unifying major portions of state emergency management operations to simplify coordination and provide a more focused and consistent approach to emergency management. More importantly, a coordinated approach would allow the state to improve the parts of the emergency management cycle — particularly mitigation and recovery — where Texas, like most states, has considerable room for improvement.

One potential option is to unify the Texas Division of Emergency Management, currently organized within the Texas Department of Public Safety, with and as part of the extensive emergency management functions currently performed by the Texas A&M University System. The state agency components of the Texas A&M System have the capacity and resources to integrate major state emergency management functions with TDEM with a resulting improvement in functions such as local government disaster assistance, emergency management training, mitigation and preparedness planning, and emergency first response.

2. Update and expand the Texas Emergency Management Council

The Governor's Office would be responsible for implementing this recommendation.

The Governor's Office has the authority to appoint members to the Texas Emergency Management Council. The Governor should consider updating and expanding the membership of the Council. This list of state agency and non-profit organizations has not been changed since Governor Rick Perry's Executive Order establishing the current official membership in 2004. Since that time, various organizational and name changes have occurred in member agencies, and additional agencies and groups also have taken on expanded roles in emergency management, warranting their consideration for formal membership.

Two such state agencies, for example, are the Texas Department of Licensing and Regulation (TDLR) and the Texas Department of Motor Vehicles (TxDMV). Due to the expanded role of TDLR during the response to Hurricane Harvey and the extent of its regulatory authority, the state would benefit from having a more formal relationship with TDLR in all phases of emergency management, including planning, response, and recovery. TxDMV has an important role in the waivers needed for use of the roadways, such as motor carrier permits, and supports county offices affected by disaster events. TxDMV also has a robust communications capability.

In addition to these state agencies, the Texas Emergency Management Council may benefit from the presence of additional non-profit organizations such as the Michael and Susan Dell Foundation.

Implementing this recommendation would not result in cost to the state.

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An aerial photograph of a flooded landscape, likely a residential or commercial area, with a teal overlay. White contour lines are drawn over the image, indicating elevation changes. The text "CHAPTER 5" is prominently displayed in the center-right.

CHAPTER 5

5 RESPONSE

In the days leading up to Hurricane Harvey's landfall, the Texas Division of Emergency Management (TDEM) worked closely with state leaders and agencies, the federal government, local officials and other groups to prepare for Hurricane Harvey's arrival. TDEM had to respond quickly in uncertain circumstances; forecasts couldn't conclusively predict where the storm, rapidly intensifying as it approached the coast, would make landfall.

The state's emergency management plan suggests a 120-hour time frame for mobilizing equipment, supplies and personnel for a hurricane — but Harvey was following its own schedule, and wouldn't wait.¹

MOBILIZATION

TDEM was monitoring Harvey's progress a week before it made landfall, but full mobilization began on August 23, when Governor Abbott ordered the State Operations Center (SOC) to elevate its readiness level. The SOC, operated by TDEM and representing a number of state agencies and voluntary organizations, serves as the nerve center for state response in disasters.

Governor Abbott announced that, as of that morning, the SOC had increased its readiness from level IV (normal conditions) to level III (increased readiness) and would further elevate to level II (escalated response conditions) on the morning of August 24.² Later that day, the Governor also issued a declaration designating a state of disaster for the 30 Texas counties most likely to be directly affected by the coming storm.³ (The Governor's disaster proclamation eventually would be expanded to 60 of the state's 254 counties.)

As part of the heightened state of readiness, TDEM activated Texas Task Forces 1 and 2, groups deployed by the Texas A&M Engineering Extension Service (TEEX), to provide urban search and rescue, water rescue and helicopter rescue services in cooperation with the Texas Military Department.⁴

FEMA also prepositioned supplies and personnel in preparation for the storm. According to FEMA, "Within days, the number of FEMA employees, other federal agencies, and the National Guard deployed topped 31,000, all focused on helping Texans respond to Harvey."⁵

On August 25, as the storm neared the coast, the Texas A&M Forest Service issued its first call to Texas local fire departments for personnel and equipment to meet fire, rescue, medical and humanitarian needs created by Harvey under a statewide agreement, the Texas Intrastate Fire Mutual Aid System (TIFMAS). These volunteers initially were deployed to resource staging areas in San Antonio and College Station along with food, water and other supplies that could be moved quickly in the areas affected by the storm.

San Antonio serves as the state's primary staging hub for coastal disasters. During Harvey, about 2,000 responders and their equipment moved through San Antonio into the disaster areas.⁶ TDEM relies on San Antonio to make space available for large responses, and San Antonio complied, allowing the state essentially to take over large venues such as the Henry B. Gonzales Convention Center.

THE RESPONSE BEGINS

On August 25, Governor Abbott asked President Trump to declare a federal state of disaster for the Texas coast. The president quickly complied. (The federal disaster declaration eventually would cover 53 counties.)

Harvey made landfall that evening and the state response began in earnest, starting with pre-positioned search-and-rescue teams, Texas Task Forces 1 and 2, and other responders staged in a shelter in Robstown. Subsequently, Initial Reentry Assessment Teams (IRATs) led by TDEM were deployed. IRATs include teams with approximately 50 vehicles of various types and staffed by experts able to determine whether conditions were safe enough for responders to enter disaster areas and begin providing assistance. Use of IRATs was a "first" in Harvey, allowing a precise assessment of conditions

and assets needed to meet local needs. Once extreme storm conditions subsided, first responders moved into affected areas to work with local governments in responding to the disaster.

In any disaster, it can be difficult to mark the point at which response ends and recovery commences; for a time, they go on simultaneously. During Harvey, the state's response began on August 24, before landfall, when state responders were mobilized and began to move in to place. Its effective end was September 15, when the last of the first responders from Texas Task Forces 1 and 2 stood down. But even during the active response, local, state and federal agencies as well as private and nonprofit groups were already working on recovery, providing temporary shelter, feeding survivors and assessing the extent of the local damage.

In all, more than 21,400 personnel were deployed to the hurricane area or to support areas including San Antonio and Austin. Texas Task Forces 1 and 2, provided 2,278 responders from 103 organizations across Texas as well as other states. These responders eventually were joined by personnel from federal agencies as well as uncounted scores of volunteers from across Texas and from other states.

State response personnel task forces eventually accounted for 841 rescues by air, 35,424 rescues by ground or water, 37,758 evacuations, 4,354 welfare checks, and 2,084 animal rescues.⁷

FEMA deployed all 28 Urban Search and Rescue teams from across the nation to assist state and local agencies; they used boats and high-water trucks to rescue 6,453 people and 237 animals. The National Park Service, U.S. Fish and Wildlife Service, U.S. Customs and Border Protection and the U.S. Department of Defense also contributed to search and rescue. In addition, the U.S. Coast Guard deployed 2,060 personnel, 50 aircraft, 75 boats and 29 cutters, rescuing 11,022 people and 1,384 pets.⁸

With state logistical support, FEMA supplied 3 million meals, 3 million liters of water, 9,900 blankets, 8,840 cots and 10,300 hygiene kits to the state for distribution to survivors, and quickly provided \$186 million in public assistance funding to reimburse local and state agencies for the cost of emergency protective measures and debris removal. FEMA also deployed teams of specialists to neighborhoods and disaster recovery centers to help Texans with registration and questions about disaster assistance.

The U.S. Health and Human Services Department, U.S. Department of Housing and Urban Development, U.S. Army Corps of Engineers, Environmental Protection

Agency, U.S. Department of Energy, Civil Air Patrol, U.S. Department of Agriculture and Small Business Administration also contributed to the response effort.

More than 300 voluntary organizations also supported Harvey survivors, "working to remove muck from homes, support shelters, feed people, distribute supplies, provide emotional and spiritual care, clean up debris, repair and rebuild housing and provide crisis support," as FEMA reported. Nearly 4,500 Salvation Army volunteers joined the effort, as did 109 members of AmeriCorps Disaster Response Teams.⁹

SPECIAL CHALLENGES

Harvey's high winds and flood waters made response efforts difficult, creating mountains of debris. About 300,000 electrical utility customers in Texas experienced electrical outages on August 26, the day after landfall.¹⁰ These outages magnified the discomfort of late August and early September temperatures, as did hordes of mosquitoes breeding in flood waters and debris fields.

LOCAL PREPAREDNESS

One problem that became apparent almost immediately was the variation among counties and local communities in their level of preparedness for an emergency of this magnitude. The state's emergency management structure relies heavily on local decision making, but not all local governments have trained emergency managers and some have no one in this role.

Too often, local officials were forced to make decisions without the input of trained emergency staff. This was primarily a problem in smaller communities and areas that hadn't experienced challenges of Harvey's magnitude in recent history. Larger cities and counties, and communities with recent experience of hurricanes, were much better prepared.

One question Harvey raised, then, is what state and local governments can do to develop the expertise needed to respond to future hurricanes, a critical first step to overall emergency management preparedness.

COMMUNICATIONS PROBLEMS

Effective communication among responder groups and citizens during a crisis greatly increases the success of response. One important element is the ability of different teams of responders to share information through radio or other communication systems, an

ability called “interoperability.”

Widespread interoperability of communications is a well-known problem in Texas and most states. A fully interoperable system, connecting federal, state, local and nonprofit responders, would require funding for compatible equipment as well as collaboration among *many emergency response groups — more than 5,300 in Texas alone.*¹¹ According to a 2011 House Research Organization report, the Department of Public Safety has estimated the total cost of an interoperable communications system for Texas at \$813 million, including federal contributions of \$393 million and \$420 million in state funds.¹² Obviously, such a project represents a daunting commitment during a time of significant fiscal strain on the state budget.

In its 2015 *Report on Interoperable Communications to the Texas Legislature*, DPS said it had joined with the 24 state councils of governments and other state agencies that use public radios to adopt a “system-of-systems” approach that would join multiple regional communications systems when needed. This approach allows independent entities to connect to a broader range of resources for emergency operations. Today, state partners continue to work toward this goal, building off the current radio backbone. In the 2015 report, DPS reported an average statewide “interoperability maturity level”—meaning how far along they are in connecting various communications systems—of 3.85 out of five for 2014-2015 (**Exhibit 1**).

Texas has made progress toward full-scale interoperability. DPS’ 2015 report, however, noted that the “maturity level” failed to increase between 2013 and 2015. In addition, the department pointed out several critical issues:

- Some state agencies don’t even have radios to communicate with their own responders or those of neighboring jurisdictions.
- Some lack the resources needed to train responders on the proper use of the equipment they do have.
- A few areas of the state have no radio coverage.

Federal, state and local governments all spend money for communication inoperability in Texas. No one appears to know the total amount spent, however, given that local revenues and federal money going directly to local governments are hard to track.

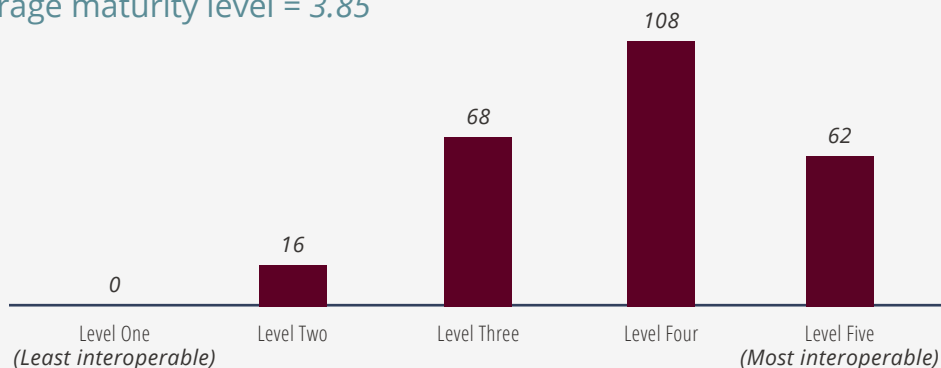
At the state level, the Governor’s Office is a major fiscal supporter of interoperability, providing local jurisdictions with grants of about \$40 million for interoperable communications technology in the 2014-2015 biennium. The Governor’s Office also distributed about \$279.2 million in federal funds to local jurisdictions between 2007 and 2015.

In addition to these funds, the Legislature has taken steps to create a permanent funding stream for interoperability. House Bill 442, enacted in 2011, established the Emergency Radio Infrastructure Account in Texas’ General Revenue Fund, funded with a portion of court cost fees. The Texas Legislative Budget Board expected the infrastructure account to accrue about \$10.6 million annually. In fiscal 2017, the fund received net revenues of about \$8.7 million, but none of the funds have been appropriated. In a self-evaluation report to the Sunset Commission, DPS pointed out that “this recurring funding mechanism is in place but appropriations from this account have not been appropriated for radio infrastructure.”¹³

Exhibit 1. Number of Countries at Each Maturity Level of Communications Interoperability, 2014–15

Source: Texas Department of Public Safety, 2015 *Report on Interoperable Communications*

Average maturity level = 3.85





Governor Greg Abbott, Texas A&M System Chancellor John Sharp and FEMA Regional Administrator Tony Robinson at one of many regional meetings with local officials. (Governor's Commission to Rebuild Texas)

In short, full system interoperability carries a heavy price tag, and its absence was a challenge to responders during Hurricane Harvey. This disaster reminds us once again of the importance of widespread radio interoperability during major storms. And the need for such a system isn't unique to the coast; the state has to plan for its *next disaster, which could occur anywhere in the state. The Legislature should consider appropriating funds for the state's interoperable communications systems as it writes its next budget.*

LOCAL NEEDS

Another communications problem was highlighted by Hurricane Harvey — in this case, communication between the affected communities and the state and federal governments. Many cities and counties had numerous questions about accessing federal and state assistance, particularly the complexities of federal disaster funding requirements, and various other problems related to response and recovery.

The State Operations Center and subsequent Joint Field Office were able to respond to many of these questions; the Governor's Commission to Rebuild Texas supplemented their efforts with personnel from the Texas A&M AgriLife Extension Service and the Texas A&M Engineering Extension Service. Many of the Extension agents already lived and worked in the affected counties (see below). This model was another "first," created as part of the response to Hurricane Harvey. It greatly improved communications among jurisdictions, although there are significant opportunities for further improvement through advanced training and the development of improved technology.

THE GOVERNOR'S COMMISSION TO REBUILD TEXAS

Harvey's unprecedented destructive power presented opportunities for innovation, and one of those was the creation of the Governor's Commission to Rebuild Texas, created by Governor Abbott on September 7, 2017 (**Appendix**).¹⁴

The Governor appointed Chancellor John Sharp of the Texas A&M University System to lead the Commission and gave him broad authority to, as the Governor put it, "advocate for our communities, and make sure things get done without delay."¹⁵ In his mission statement, Chancellor, and now also Commissioner, Sharp identified his responsibility in this way:

*The Commissioner's responsibility is to assist local areas with their unique needs, to coordinate the state recovery response and to recommend policies that serve the best interests of the people of Texas while maintaining Texas' economic preeminence, specifically along the Gulf Coast.*¹⁶

The Governor also assigned the Texas A&M University System to support Commissioner Sharp:

*The Texas A&M University System, its member agencies and universities, and its employees, are authorized to participate in and support the work of the Commission in the recovery and rebuilding mission.*¹⁷

This enlisted valuable A&M assets such as Texas Task Force 1 and 2, the Texas A&M Forest Service and the Texas A&M Veterinary Emergency Team (VET), which have been involved in hurricane response since their creation.

CARING FOR PETS AND OTHER ANIMALS DURING HURRICANE HARVEY

In a disaster like Harvey, beloved pets and valuable livestock also are in harm's way. The evacuation, sheltering and care of animals are outlined in the State of Texas Emergency Management Plan, in Emergency Support Function #11, *Animals, Agriculture & Food and Feed Safety*.

Previous disasters such as Hurricanes Rita and Ike taught first responders that people often are reluctant to evacuate without their animals. Such lessons led to the development of an integrated, statewide approach to provide the best possible care of pets and livestock during a disaster. The Texas Animal Health Commission, Texas A&M AgriLife Extension Service and the Texas A&M Veterinary Emergency Team (A&M VET) teamed with Texas Department of Agriculture (TDA), the U.S. Department of Agriculture (USDA) and industry partners to provide for the welfare of animals evacuated from or displaced by Harvey.

The effort centered around three major functions: the establishment and management of animal shelters; creation of animal supply points; and recovery of displaced livestock. At the request of local and state officials, animal shelters were established in Brazoria, Chambers, Fort Bend, Jefferson, Walker and Wharton counties and other locations to receive and care for thousands of pets and livestock. To support volunteer veterinarians and veterinary technicians serving in these shelters, A&M VET staff provided triage and care.

Elsewhere, the Texas A&M AgriLife Extension Service led the establishment of 13 animal supply points in the early days of the response. These sites distributed 3,331 round bales of hay, 1,769 square bales of hay, 1,413 tons of livestock feed and 235 tons of pet food during the emergency.¹⁸ Much of these resources were donated from across Texas and the U.S. through a hotline manned by AgriLife staff and TDA's hay hotline. In addition to distributing feed and hay directly to pet and livestock owners, they were delivered to displaced and stranded livestock via volunteers and Texas military forces. Using aircraft including two AgriLife and USDA



A member of TX-TF1 holds a recently rescued puppy from the Fort Bend County area while members of the Texas A&M Veterinary Emergency Team (VET) conduct a medical check during Hurricane Harvey.

Wildlife Service helicopters, responders surveyed 2,200 miles of the Texas coast to locate displaced or stranded livestock. Once located, feed and hay were delivered to the animals via truck, airboat and helicopter to enhance their chances of survival until flood waters could recede.

While people come first during disasters, animals also require an organized and integrated emergency response. The Texas A&M University System worked with state and federal agencies and private stakeholders to protect thousands of animals, thus protecting the economic and emotional security of many Texas families and rural communities.

The commission’s major innovation, however, was adding the resources of the Texas A&M AgriLife Extension Service as a “force extender” as the response unfolded. AgriLife maintains offices in 250 of Texas’ 254 counties, with local agents partly funded by and working with county government. The Commission, working with AgriLife, created a network of about 180 extension agents and other Texas A&M System staff members in the affected counties and tied them together with a digital reporting tool.

The agents worked with local officials on a daily basis, relaying requests for assistance, questions, comments and complaints to a response center at the system offices in College Station. Experts there fielded comments coming in the field and worked to get answers within 72 hours whenever possible, contacting experts at TDEM, FEMA or other state or federal agencies as necessary. Questions and comments were logged electronically and could be analyzed by geographic area (Exhibit 2).

This communications link proved valuable during the response phase, but became even more important during recovery, as cities and counties began to deal with a maze of federal and state regulations.

“AN EXTRAORDINARY EFFORT”

In any disaster, the first few days of response are critical to saving lives. The response mounted to Hurricane Harvey was largest in Texas history and one of the largest in American history, involving thousands of responders from local, state and federal governments as well as businesses, nonprofits and individuals, all of them pitching in get the affected counties through the storm.

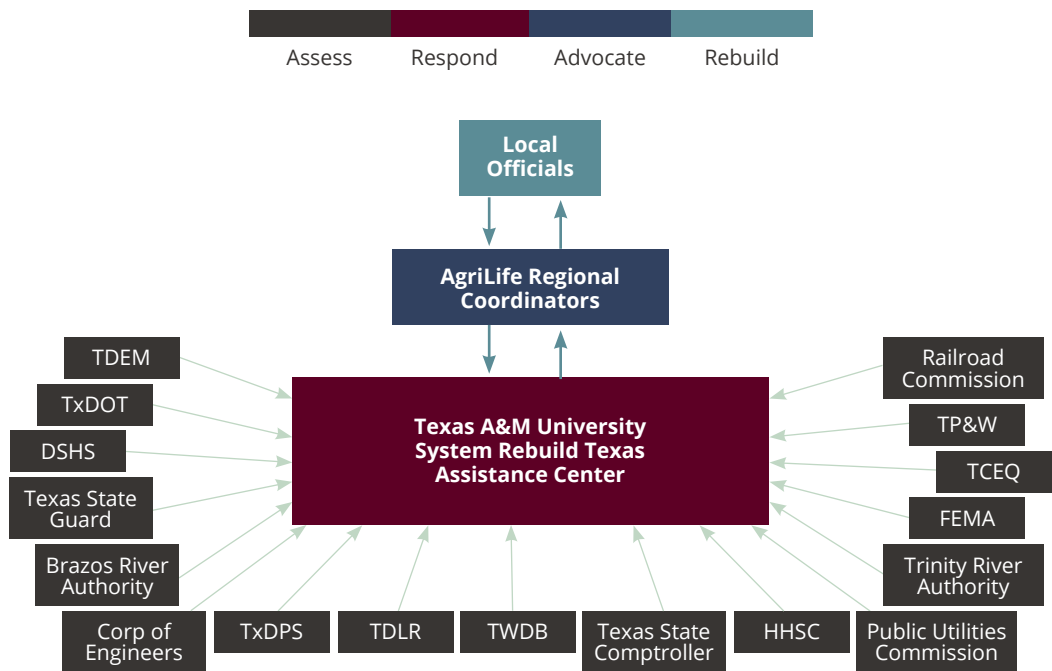
As FEMA described the state’s response:

Neighbors, strangers, nonprofit organizations and governments at all levels joined together to mount an extraordinary effort to save lives and meet the needs of thousands of people who suffered from the storm and subsequent flooding. It was Texans helping Texans, aided by people who came to Texas from all parts of the nation.¹⁹

Given the scope of the disaster and the thousands of people involved, the response went remarkably well. When asked about the state’s preparation for and response to Harvey, FEMA Administrator Brock Long called Texas a “model” for the rest of the nation, while pointing out that the Texas experience pointed to a

Exhibit 2. Structure of Rebuild Texas Assistance Network During Hurricane Harvey

Source: The Governor’s Commission to Rebuild Texas



national need to invest in planning and preparedness, calling it “a wake-up call for this country.”²⁰

But the response was only the first step toward restoring the counties affected by Hurricane Harvey. The next phase, recovery, would be crucial — and much longer, more complicated and in many ways more frustrating.

RESPONSE: RECOMMENDATIONS

1. Consider appropriating additional funds from the existing Emergency Radio Infrastructure Account to fund radio infrastructure.

Widespread interoperability of communications systems among responder groups is vital to successful response and recovery. The Legislature established the Emergency Radio Infrastructure Account in general revenue in 2011 to speed development and operation of an interoperable statewide emergency radio infrastructure, among other purposes.

The Texas Department of Public Safety indicates that, to date, funds have not been appropriated from this fund for radio infrastructure. In addition, the state has not completed building out its proposed emergency interoperable communications network, and pockets of the state, such as some border regions, still experience poor connectivity.

Given the frequency of disasters and emergencies in Texas, not only on the coast but throughout the state, Texas citizens would benefit from a system with enhanced interoperability. The Legislature should consider appropriating funds from the Emergency Radio Infrastructure Account to achieve this purpose.

2. Strengthen the role of the Texas A&M Veterinary Emergency Team by giving it a more appropriate designation in the State of Texas Emergency Management Plan and consider additional appropriations.

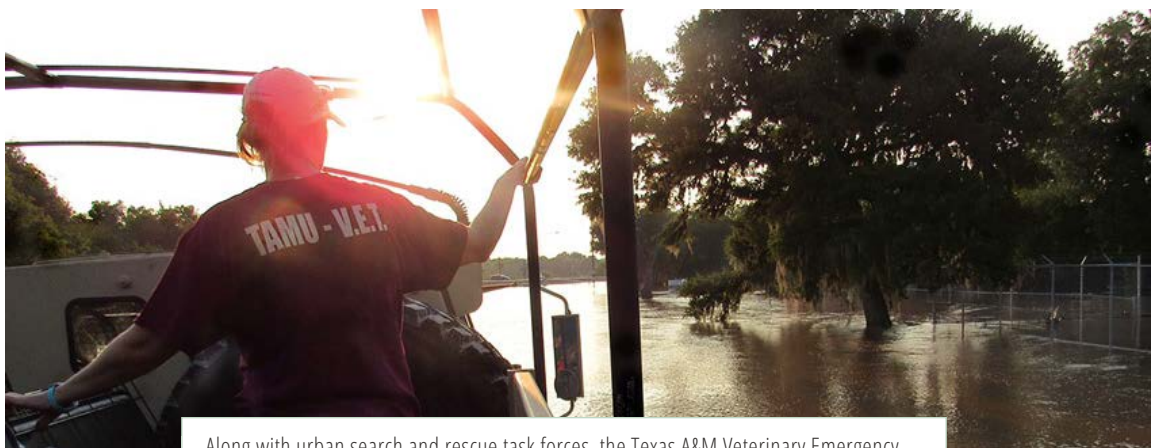
TDEM should implement this recommendation.

Texas A&M VET has developed into an important emergency veterinary response component for animals and pets. The state’s emergency management plan places the team in a supporting role, primarily to the Texas Animal Health Commission, in an emergency support function (ESF) detailing disaster response for “Animals, Agriculture & Food & Feed Safety,” known as “ESF 11.” Texas A&M VET has evolved into a broader role, serving as a veterinary medical response unit across multiple support functions. Given its evolution, TDEM could move Texas A&M VET to a more visible and appropriate assignment in the “Public Health and Medical Services” emergency service function (ESF 8), a reassignment that could increase its effectiveness.

In addition, Texas A&M VET has no recurring legislative appropriation and has had to piece together necessary equipment to support its response function. The Legislature should consider state support for the Texas A&M VET mission apart from normal appropriations for the Texas A&M University Veterinary Medical Program.

No cost would be associated with changing the ESF designation for Texas A&M VET. Funding to enhance the response capabilities of the agency would depend on decisions of the Legislature.

For recommended changes in the structure of state emergency management, see **Chapter 4**.



Along with urban search and rescue task forces, the Texas A&M Veterinary Emergency Team (VET) stepped in to offer emergency support to the Texas Animal Health Commission and medical support to impacted pets and animals.

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An aerial photograph of a suburban area, including a residential neighborhood with winding streets, a commercial area with a shopping center, and a multi-lane highway at the bottom. The image is overlaid with a semi-transparent teal color and white topographic contour lines.

CHAPTER 6

6 THE ROAD TO RECOVERY

In a September 1 news conference, as Harvey continued its path of destruction, Governor Abbott warned Texans that some places in the state still were “deadly dangerous.”¹ But in areas the storm had passed, the first efforts at recovery had already begun.

On the same day, the federal Office of Management and Budget sent a letter to Congress requesting \$7.85 billion in funding to deal with Harvey-related destruction.² This included \$7.4 billion for FEMA’s Disaster Relief Fund and \$450 million to support the Small Business Administration’s disaster loan program. President Trump signed this funding into law on September 8, along with an additional \$7.4 billion in Community Development Block Grants to help the affected areas rebuild. The bill also included a three-month extension of the National Flood Insurance Program, which was set to expire on September 30.³

As discussed in **Chapter 4**, FEMA funding included two parts — the *Individual Assistance program* providing survivors with financial help and direct services ranging from medical care to housing assistance; and the *Public Assistance program* to help local governments and certain nonprofits defray costs for removing debris, providing emergency protective measures and fixing or replacing damaged facilities.

The Public Assistance program generally requires recipients to provide 25 percent of the total cost of assistance or repair. On September 2, however, President Trump directed FEMA to authorize a 90 percent federal cost share for debris removal and a 100 percent federal cost share for emergency protective measures for 30 days, and a 90 percent share thereafter, thus providing major assistance for financially strapped local governments.⁴ Subsequently, the state also provided additional grants to local governments to help them pay their 10 percent cost share.

In the early days of September, Governor Abbott made two critical decisions concerning the recovery effort. On September 7, he announced the creation of the Governor’s Commission to Rebuild Texas to help assist with the state’s recovery. On September 14, he announced that Texas Land Commissioner George P. Bush and the General Land Office (GLO) would lead the

state’s short- and long-term housing recovery efforts in response to Harvey, managing programs funded by FEMA and the U.S. Department of Housing and Urban Development (HUD).

In early September, the governor also began holding meetings in communities affected by the disaster to learn about their problems and needs. Also attending the meetings with the Governor were representatives of FEMA, state agencies involved in the response, and the newly created Governor’s Commission. These efforts continue today, through the work of TDEM, GLO, the commission and other agencies.

While the pieces of the state’s long-term recovery strategy were falling into place, the difficult, early work of recovery began with providing temporary shelter, clearing debris, addressing health and safety concerns and beginning the rebuilding and repairs needed to get affected areas of the state back on their feet as quickly as possible.

“MOSQUITOES, MEDICINE AND MOLD”

After Hurricane Harvey’s immediate threat receded, Texans faced a series of potential health problems caused by contaminants, infections and insect infestations. Also to be considered were the physical, emotional and financial stresses caused by the disaster, and, for some, the trauma of losing not only their homes but family members.

At the state level, the primary responsibility for health matters in Texas lies with the Department of State Health Services (DSHS), which became heavily involved in the response to Harvey and its aftermath. County health authorities addressed issues such as mosquitoes, water purification and vaccinations. Clinics and local doctors provide other important services.

Harvey presented health authorities with a series of significant challenges. Flood waters often are contaminated with sewage and chemicals and can hide

sharp objects made of metal or glass. Pollutants can cause many health problems, including rashes and burning of the skin and eyes after exposure. Flood water also can carry disease, although this danger typically recedes with the waters. And there's also the matter of rumors and misinformation. In early September, for example, Harris County had to squelch a rumor that Harvey's flood waters carried plague.⁵

Other health threats arose. Survivors suddenly couldn't escape September's heat and humidity. Some were unable to obtain necessary medicines such as insulin or blood-pressure medications. And some were coping with post-traumatic stress from their experiences during the storm. Many local hospitals and clinics were either too damaged to operate or were overwhelmed with patients. Doctors and nurses dealt with the problems as best they could, their efforts sometimes supplemented by volunteers.

Many of the affected counties also were plagued by clouds of mosquitoes. "As the floodwaters recede, mosquito numbers are going to start going up," said Dr. Peter Hotez, dean for the National School of Tropical Medicine at Houston's Baylor College of Medicine.⁶ The problem was compounded by standing water, power outages and the need to work outside. "We are seeing people who have just been eaten up by mosquito bites," said Lara Hamilton, executive director of the Christ Clinic in Katy, west of Houston.

Mosquitoes are both a nuisance and a well-known health threat. Flood waters and water-catching debris immensely increased the mosquito population all along the coast. Medical personnel noted that stagnating floodwaters and hot, humid weather could create an ideal environment for the *Aedes aegypti* mosquito that

carries viruses such as dengue fever and the Zika virus. "There's just debris everywhere," said Baylor Medical Schools' Peter Hotez. "It's like *Aedes aegypti* heaven."⁷ In this case, Texas was lucky; no known cases of Zika or other exotic diseases associated with Harvey occurred.

Mosquitoes presented significant risks early on in the recovery, however. In some locations, mosquito populations were so high that they threatened to suffocate wildlife and livestock. One type, the "container-breeding mosquito," breeds where water collects, such as old tires, irrigation ditches and sewers, and presents a risk of disease well after the flooding has passed.

Local, state, and federal agencies all became involved in the fight against mosquitoes. On September 6, DSHS, supported by federal partners, announced that aerial spraying for mosquitoes would begin the next day in Aransas, Bee, Nueces, Refugio and San Patricio counties, using several aircraft including specially equipped C-130H cargo planes from an air base in Ohio.⁸

The spraying campaign faced problems including a shortage of properly equipped aircraft. Organic growers and beekeepers, moreover, voiced concerns that they could lose organic certification as a result of the spraying, an issue at least partially resolved through the efforts of federal and state agencies by showing that the spray wouldn't endanger organic certification.

It's unclear whether the mosquito plague following Harvey did in fact spread disease. The *potential* of disease for hurricane survivors and responders underlined the need to be prepared with local mosquito suppression plans *before* the next hurricane.



Flood waters and water-catching debris immensely increased the mosquito population all along the coast.

DEBRIS

Massive quantities of debris lay in Hurricane Harvey's wake. Its disposal presented one of the most difficult problems state and local jurisdictions faced in the recovery process. In some areas, debris disposal continued a full year after the storm.

While some local jurisdictions had debris management plans in place prior to Harvey, their plans often proved inadequate in the face of the devastation. At the end of July 2018, FEMA estimated that Harvey piled up more than 13 million cubic yards of debris, enough to fill Texas A&M's Kyle Field stadium more than 60 times.⁹

In many neighborhoods, debris piled up in front of houses for block after block as homeowners began clearing their damaged homes of ruined sheetrock, sodden furniture and many other items ruined by rising water and mud. Debris removal after Harvey proceeded more rapidly than in previous hurricanes; even so, snakes and rodents posed risks, as did the threat of mosquito-borne disease. The presence of the debris fields, moreover, certainly contributed to mental health issues some survivors faced.¹⁰

TDEM helps local jurisdictions establish debris management plans and offers technical advice and assistance. These plans aren't required for federal reimbursement but allow for a quicker and more organized response when disaster occurs. Plan requirements cover topics such as contracts with debris haulers, requirements for independent monitoring, disposal equipment and temporary storage.

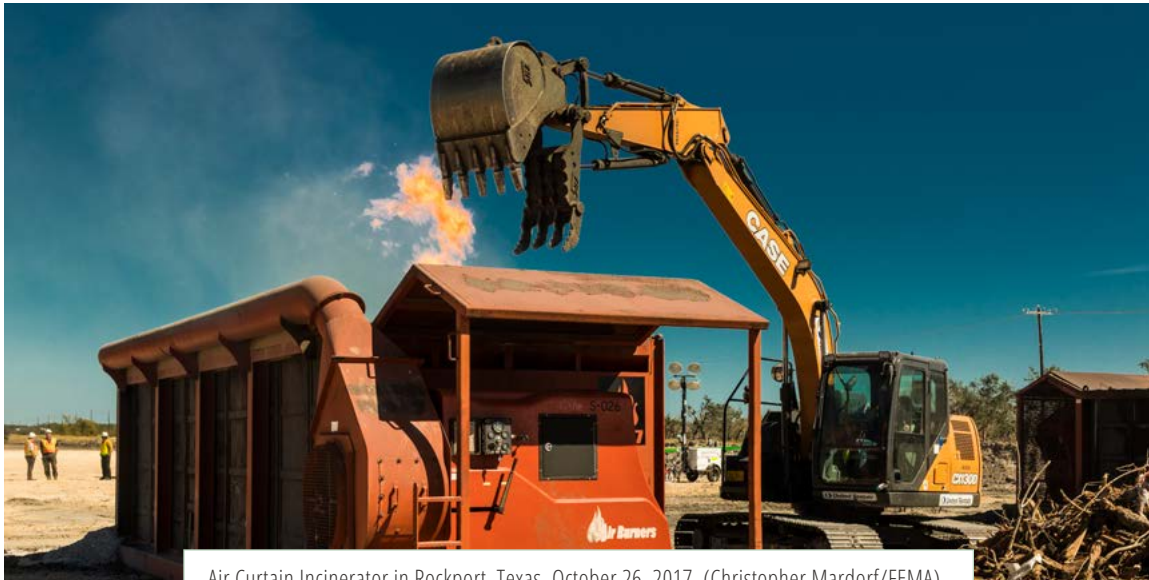
TDEM and local jurisdictions began mobilizing to deal with the debris problem early in the Harvey response. After initial search and rescue concluded and flood waters receded, the state's Debris Task Force was activated at the Joint Field Office operated by FEMA and TDEM. The task force comprises federal and state partners including TDEM, FEMA, GLO, the National Oceanic and Atmospheric Administration, the U.S. Army Corps of Engineers, the Texas Commission on Environmental Quality and the Texas Historical Commission. The Texas Department of Transportation (TxDOT) also joined the effort. The task force had daily calls with local jurisdictions, answering questions, providing assistance and coordinating deployment of staff and equipment to assist with debris removal.

FEMA issued a "greensheet" for Harvey, as it does for all disasters, which established guidelines for environmental review and determination of whether the site had historical relevance; funding and reimbursement requirements; and compliance with all applicable environmental laws, regulations and executive orders.¹¹ These guidelines included protocols and requirements for debris removal (**Exhibit 1**). Ordinarily, FEMA requires a 25 percent match for debris removal from the grant recipient, typically a state, which then determines how this percentage will be split among "subrecipients," usually cities and counties. In this case, FEMA lowered the match to 10 percent due to Harvey's catastrophic nature and the magnitude of the financial burdens involved. FEMA also provided some funds to assist with the match.

Exhibit 1. FEMA "Greensheet" Debris Removal Protocol

Source: Federal Emergency Management Agency

- Debris cleanup must be documented from removal to final disposition.
- The location and permit number for the landfill should be included in the project worksheet.
- Temporary emergency staging and disposal sites for the stockpiling, reduction, burning and/or burial of disaster debris must be approved by the Texas Commission on Environmental Quality (TCEQ) and the Texas Historical Commission (THC).
- Applicants must complete the "Request for Approval of Temporary Debris Management Site" form and send it to TCEQ and the "Disposal Site Evaluation and Registry Form" and send it to THC.
- Applicant must provide FEMA with the approved forms.
- Hazardous materials must be disposed of in a manner consistent with all state and federal laws.
- Debris should not be staged [stored] within the floodplain and should never be staged in a wetland area, even temporarily.
- Debris removal from wetlands should be coordinated with the US Army Corps of Engineers and may require FEMA consultation with the US Fish and Wildlife Service.



Air Curtain Incinerator in Rockport, Texas, October 26, 2017. (Christopher Mardorf/FEMA)

Contracting with haulers for debris removal was another major problem for some local jurisdictions where pre-existing debris removal contracts had expired, were insufficient or didn't exist. Some contractors didn't honor contracts and went to other counties, towns and even other states, such as Florida, where they could get higher rates. Some contractors wouldn't honor contract rates and persuaded jurisdictions to renegotiate at higher rates.

Securing temporary storage (or "staging") sites was a key initial aspect of the disposal process, made difficult by the sheer volume of debris. The Texas Commission on Environmental Quality (TCEQ), the state's chief environmental oversight agency, approved 228 temporary debris management sites to help expedite debris removal. These sites are used for temporary storage, separation and volume reduction before final disposition. TxDOT assisted by providing state highways and rights of way for collection points and helped haul off debris with its own equipment or with contract haulers. TxDOT also entered into agreements with some local jurisdictions that allowed it to pick up debris on non-state roads. Local jurisdictions and other local entities, such as homeowner associations, used contractors to get debris to roadways for pickup. An estimated 98,021 cubic yards of debris had been or still were being processed at the temporary sites as of July 10, 2018.¹²

The amount of vegetative debris caused by Harvey required disposal using "air curtain incinerators," specialized equipment that forcefully projects a curtain

of air over burning material, raising the temperature in the incinerator and greatly reducing the amount of smoke and particulates. TCEQ approved temporary burn authorizations using these incinerators. The Texas A&M Forest Service and Texas A&M Engineering Extension Service burned vegetative debris in Aransas and Refugio counties, where this type of debris was most extensive. TxDOT helped collect the debris and hauled it to sites where it could be incinerated. In all, 80,940 cubic yards of debris — about 24,000 pickup loads — were burned.¹³

The availability of landfills was important for non-vegetative debris such as cement and metal. TCEQ issued temporary authorizations to 25 landfills and four transfer stations (sites for temporary storage) that allowed them to exceed their permit limits to handle the tremendous volume of debris. TCEQ also granted temporary authorizations to three landfills that requested to stage waste above their permitted height for up to 360 days.¹⁴ Many landfills, designed to operate for years before reaching capacity, began to fill up in only a few weeks.

Debris removal from certain bodies of water and streams has proven to be particularly complex and exasperating for a range of local jurisdictions and state and federal agencies. Responsibility for this debris depends on its location, whether in tidal waters, rivers or other bodies of water. Multiple agencies and jurisdictions have responsibilities for these waters, which makes identifying the responsible party and applicable law difficult.

THE D-SNAP PROGRAM

The Texas Health and Human Services Commission (HHSC) implemented the Disaster Supplemental Nutrition Assistance Program (D-SNAP) in the aftermath of Hurricane Harvey. Governor Abbott announced the availability of the program to Harvey survivors on September 11, 2017.¹⁵

D-SNAP, a U.S. Department of Agriculture (USDA) program administered in Texas by HHSC, provides food assistance to low-income households suffering losses caused by a natural disaster.¹⁶ In previous disasters, state officials had administered a modified Supplemental Nutrition Assistance Program (SNAP), a successor to the food-stamp program.

Eligibility criteria for D-SNAP and SNAP differ. An individual who would not usually qualify for SNAP may qualify for D-SNAP if he or she has had one of these disaster-related expenses:

- home or business repairs
- temporary shelter expenses
- evacuation or relocation expenses
- home or business protection
- disaster-related personal injury, including funeral expenses
- loss of or no access to income due to the disaster, including reduced, terminated or delayed receipt of income, for a large part of the benefit period
- food loss from flooding or power outage after a disaster¹⁷

D-SNAP is not intended for use immediately after a disaster. Instead, it's designed to help people moving back into their homes who need to restock pantries and have access to electricity and grocery stores.¹⁸

D-SNAP benefits typically are approved for one month of eligibility. After Harvey, HHSC requested and received USDA approval for a two-month eligibility period.

Current SNAP recipients may request a supplement to their benefits when D-SNAP is active, if their benefits are less than the possible monthly maximum benefit based on household size. The recipient also must have had losses from the disaster. The "supplement" brings benefits up to the monthly maximum for a limited period. HHSC also can provide replacement benefits for current SNAP recipients who lost food from refrigerators and pantries during the disaster.

HHSC submitted a waiver to USDA to request both D-SNAP benefits and supplemental SNAP benefits before Hurricane Harvey came ashore; the waiver was

granted after the federal disaster declaration. HHSC asked local officials to specify dates to open eligibility centers in their jurisdictions and HHSC was able to meet those requests with few exceptions. HHSC opened the first D-SNAP eligibility centers on September 13, 2017, and closed the last ones on October 20, 2017. According to HHSC, this is the longest period ever in which D-SNAP applications have been accepted after a disaster.

BENEFITS ISSUED

In the five weeks during which HHSC accepted applications, it issued D-SNAP benefits to more than 1.6 million Texans, paying more than \$532 million in benefits. More than a million current SNAP recipients received supplemental benefits totaling more than \$145 million. Another 1.6 million current recipients received replacement benefits of more than \$91 million. In all, HHSC issued more than \$769 million in SNAP and D-SNAP benefits as a result of Hurricane Harvey.

The federal government pays the full bill for D-SNAP benefits; the state and federal government share the administrative costs equally. HHSC incurred an estimated \$16.7 million in D-SNAP administrative costs, of which \$8.3 million will come from state general revenue.¹⁹

ELIGIBILITY SITE PROBLEMS

The USDA requires applications for D-SNAP benefits to be submitted in person, which presented a considerable challenge since many survivors were unable to travel to D-SNAP locations. In this regard, the most challenging aspect of administering D-SNAP in Texas was selecting sites to accept applications that met federal requirements while being sufficiently close to likely applicants.

The federal government requires these sites to be able to safely secure D-SNAP electronic benefit cards, with adequate parking. HHSC coordinated with county judges and mayors to identify large, relatively undamaged buildings with suitable features for the expected number of applicants. USDA approval for each site took from 24 to 48 hours.

Some people waited outdoors in the heat for seven to eight hours before entering a center. HHSC provided water to those in line, but the wait was excruciating for many. D-SNAP eligibility determinations went quickly, however, typically lasting about 10 minutes — once each applicant reached the front of the line. HHSC mobilized thousands of eligibility staff from across the

state to fly or drive into the area to assist.

During stakeholder meetings in the months after Hurricane Harvey, many criticized the rollout of D-SNAP, expressing frustration with the scramble to find sufficiently large locations for application centers in a very short period of time.

FEDERAL DISASTER CASE MANAGEMENT

Many state and local officials mentioned the need for better case management services to help survivors navigate the requirements for private and governmental recovery assistance. Federal law authorizes FEMA to “provide case management services, including financial assistance, to State or local government agencies or qualified private organizations to provide such services to victims of major disasters to identify and address unmet needs.”²⁰

FEMA offers case management services in partnership with the U.S. Department of Health and Human Services' (HHS') Administration for Children and Families (ACF). FEMA's case management services are limited in time and available in the aftermath of a federally declared disaster that involves FEMA's Individual Assistance (IA) program.²¹

The services feature a partnership between a case manager and disaster survivors, generally called clients. This partnership gives the client a single point of contact to help him or her access a range of available services and to advocate on the client's behalf.²² The goal of case management services is to return the individual to self-sufficiency as quickly as possible.²³

A state's governor can request disaster case management services through direct services or a federal grant. In fact, the process is viewed as potentially comprising two stages: an Immediate

Disaster Case Management (IDCM) program and a long-term Disaster Case Management Program (DCM) grant program. Both have been part of the recovery effort after Harvey.

The *IDCM program* is time-limited to 90 days with possible 45-day extensions. The Harvey IDCM program opened on September 12, 2017, closed on March 13, 2018, and served 16,506 individuals.²⁴ The program featured a hotline for survivors and offered assistance in English and Spanish; callers could leave a message and receive a response from a case manager within 24 hours. The case managers in the program worked in shelters in operation during and after the storm and in disaster recovery centers set up in the disaster area to assist survivors.

The IDCM program provided services through a contracted vendor. The Governor's Commission received stakeholder feedback indicating that federal contract requirements limited the effectiveness of the IDCM contractor. Staff for the contracted vendor focused primarily on referrals to programs and appeals of FEMA decisions, but survivors needed more extensive case management.

The IDCM program, begun quickly after a disaster, may not be sufficient to meet the longer term needs of many survivors. States may apply for a DCM grant to fund the longer-term *DCM program* within 60 days of a presidential disaster declaration. The program can't run longer than 24 months from the date of a major disaster declaration unless the state receives an extension.

In the aftermath of Hurricane Harvey, two organizations submitted applications to FEMA for DCM: the Texas Health and Human Services Commission (HHSC) and the National Voluntary Organizations Active in Disaster (NVOAD), a coalition of charitable nonprofits.



Texas A&M System staff worked to resolve recovery issues submitted to the Assistance Center by AgriLife Extension personnel in affected counties, regions and communities.

Exhibit 2. Disaster Case Management Vendors

HHSC Contractors	Family Endeavors
	BCFS
NVOAD Contractors	Baker Ripley
	Catholic Charities Corpus Christi
	Catholic Charities Galveston Houston
	Catholic Charities Southeast Texas
	Catholic Charities USA
	Disaster Humanitarian Services
	Hope Disaster Recovery Network
	Humble Area Ministries
	Islamic Circle of North America Relief
	Jewish Family Services
	Lutheran Disaster Response
	Lutheran Social Services/Upbring
	Rio Texas Conference UMC
	Society of St. Vincent de Paul
	The Alliance
	United Methodist Committee on Relief

Although submitted in late October 2017, FEMA didn't fund the program until February 2018. Ultimately, though, FEMA authorized a total of \$100 million for DCM in Texas. Of that amount, HHSC received authorization for \$45 million for 287 case managers and NVOAD received authorization for \$55 million and 345 case managers. FEMA calculated that 21,000 people in Texas needed these case management services and that each case manager could have a maximum caseload of 35 individuals. HHSC will serve a minimum of 8,380 survivors and NVOAD will serve another 12,000 survivors.

Once awarded, both HHSC and NVOAD began contracting immediately with local non-profit, charitable, and faith-based organizations to hire case managers and start serving survivors. The official roll-out of the DCM program was on June 15, 2018, and will be available through August 24, 2019, according to a FEMA announcement.²⁵

HHSC had contracts in place before that date, having issued a request for proposals in May 2016 and awarded contracts to three vendors. Only two of the three vendors currently offer DCM services.

NVOAD was finalizing their contracts with charitable

organizations during the time this report was being written. Several of these organizations had begun hiring case managers and working with clients. Both HHSC and NVOAD vendors are enrolling individuals in DCM who have signed up to participate through multiple agencies. **Exhibit 2** lists the organizations contracting with HHSC and NVOAD to administer the DCM program, provide case management services, or both.

Of note, FEMA allows reimbursement for direct expenditures on case management, including case managers' salaries and other direct expenses; FEMA doesn't pay indirect or administrative costs. The charitable organizations with which HHSC and NVOAD have contracted to deliver case management services must expend funds before being reimbursed.

The intent of the DCM program in Texas was for HHSC and NVOAD to coordinate their applications to ensure their roles were well defined and did not overlap or duplicate. In subsequent feedback on the program, however, several stakeholders expressed concern about this split allocation of resources and believed it slowed down case management.

LONG-TERM RECOVERY COMMITTEES IN CASE MANAGEMENT

Local communities can form *long-term recovery committees* (LTRCs) after a disaster to serve individuals in need. The structure and composition of LTRCs vary widely, but generally they include local nonprofit or governmental organizations within the community. Both FEMA and TDEM encourage and support their formation. LTRCs typically lead case management activities in a community, often coordinating repair and rebuilding work, the provision of mental health providers and the purchase of new or used home furnishings.

CASE MANAGEMENT CHALLENGES

Case managers face several significant challenges in helping survivors navigate the confusing array of organizations involved in response and recovery.

Delays: After a disaster, people need assistance *immediately*. Funding for DCM didn't arrive until February 2018 and the program didn't begin operation until June 2018, more than nine months after Hurricane Harvey made landfall. Nine months is simply too long to wait. This delay prolonged survivors' frustration, delayed their receipt of needed services and slowed economic recovery.

"IT WAS TEXANS TAKING CARE OF TEXAS..."

Ken Larson

For many search and rescue workers, Hurricane Harvey was undoubtedly a once-in-a-lifetime deployment. But for Ken Larson, who has participated in search and rescue missions with Texas Task Force 1 since its inception in 1997, it was all too familiar.

"From the air, it looked very much like a repeat of what we saw with Hurricane Katrina in New Orleans," he said of Houston. "You had large areas of urban flooding, and a population that wasn't prepared for that type of storm event."

Larson, a seasoned helicopter rescue swimmer, viewed these scenes out of a UH-72 Lakota. Despite his experience, he described the process of being lowered out in the midst of a storm as "hectic."

After a reconnaissance mission is flown to determine the location and number of victims in need of assistance, the rescuer is suspended from the helicopter on a small metal cable as it moves forward. The rotors of the aircraft accelerate the already heavy rainfall, making it very difficult to see the hazards and obstacles that must be navigated.

"For the most part, you're on the end of the line, and you'll get to the bottom when the hoist operator gets you there," Larson said.

During Harvey, Larson made about 15 hoist rescues. When asked which was the most memorable, he recalled the rescue of a family that included a husband, wife, a toddler, an infant, teenagers and a dog. Once a rescue swimmer makes contact with victims, they must determine the priority in which they will be rescued.

"That was probably one of the more difficult operations, in that it entailed getting the mother to let me take her newborn," he said. "She was not at all keen on this idea."

Ultimately, Larson took the infant and toddler up together to minimize the amount of time the pilot would have to maintain its difficult hovering position. The mother followed shortly thereafter, followed by one of the teenage daughters. After they were flown to a rescue center, and the helicopter refueled, Larson and his team returned for the rest of the family and the dog.

"As far as coordination with the aircraft went, that one was actually a really smooth operation," he said.

But rescue swimmers often encounter victims in conditions that present difficulties. "It can be difficult

when you get victims who are having a panic response and are not following commands," Larson said.

"Generally, if they can listen to the directions about what to do and – more importantly – what not to do, that goes a long way to making the rescue swimmer's job easier."

While Houston's flooding resembled what he saw in Hurricane Katrina, Larson said that the size, scope, and effectiveness of the rescue operations represented a starkly different approach to a similar problem.

He was also struck by the friendliness he encountered as he flew around the city.

"Everywhere you went, you kept seeing the same thing," he said. "It was Texans taking care of Texas."



Watch Texas Task Force 1 Helicopter SAR Technicians and aircrews from the Texas Army National Guard conduct hoist rescue operations of a family in the LUH72 Lakota during Hurricane Harvey:

<https://youtu.be/NXrS32NKeiA>

Need for comprehensive case management:

While extensive, FEMA's DCM program is supposed to *supplement* existing case management efforts; but no Texas state agencies offer disaster case management or, so far as is known, compile data on the case management activities of nonprofit organizations.

Many organizations use the term "case management" when referring to activities such as helping people fill out forms, handle appeals and other tasks. The term as used here, however, is more comprehensive and ongoing. It would include completing a recovery plan — defined by FEMA as including "resources, services, decision-making priorities, progress reports and the goals needed to achieve case closure" — and working with clients over time to complete the plan's steps.²⁶ Comprehensive case management needs a specialized framework with best-practice protocols. DCM specifies such a protocol, but the actual practices used by other organizations working with disaster survivors are largely unknown.

CHALLENGES FOR PROPERTY OWNERS

Hurricane Harvey damaged or destroyed more than 200,000 structures. As the process of recovery began, many owners faced daunting challenges to rebuilding.

FINANCING

Homeowners with wind or flood insurance had an easier task, moving forward relatively quickly with repairs. For those without insurance, seeking funding from FEMA was a lengthy, more arduous process, requiring proof of rejection by a property insurer and an application for a loan from the Small Business Administration.

FEMA data illustrate the importance of flood insurance in helping homeowners recover. The agency's National Flood Insurance Program provides flood insurance to homeowners, renters, and business owners. From 1996 to 2016, the average Texas claim was \$40,800. These claims can be made at any point and without the need for a disaster declaration. By contrast, FEMA's Individuals and Households Program (IHP) helps people in a presidentially declared disaster, funding necessary housing-related expenses and other serious needs that can't be met through other means. The average FEMA IA disaster grant is \$5,000 per household. If a state receives a FEMA Direct Housing Mission, which is extremely rare, that average number rises to \$7,300 per household. Texas has had only one small Direct Housing Mission besides Harvey in the last 10 years.

WORKER SHORTAGES

Many homeowners found themselves managing a construction project they didn't want with little experience in how to proceed. Finding and vetting builders, construction managers and tradespeople is challenging at any time, but after Hurricane Harvey the availability of these professionals was severely limited.

Harvey exacerbated an existing shortage of some building trades, particularly plumbers and electricians. In response, the Texas Department of Licensing and Regulation (TDLR) expedited the licensing of out-of-state tradespeople with a simple, inexpensive registration process. TDLR also had reciprocal licensing agreements with other states already in place.

The Texas Association of Builders launched a Builders to Trades website that matches workers with builders in Texas; the site already has 15,000 tradespeople registered. Longer-term efforts are under way by trade associations, the Governor's Office, the Texas Education Agency and the Texas Higher Education Coordinating Board to increase the building trades workforce in Texas.

Another challenge that hampered rebuilding was a lack of sufficient housing for workers, due to damaged structures and the need to shelter survivors. Some workers were driving into the disaster area each day from as far away as San Antonio.

Getting workers back to work in their own communities quickly is important; if they can't return to work soon after a storm, they may feel forced to move elsewhere.

PRICE GOUGING

Price gouging proved to be such a significant problem early in the response phase to Harvey that Governor Abbott issued a proclamation on September 1, 2017, emphasizing that "Texas law prohibits price gouging and gives the attorney general the authority to prosecute anyone throughout Texas who takes advantage of a declared disaster by charging an exorbitant or excessive price for fuel, food, medicine, or any other necessity." The proclamation noted that such violations can be investigated and prosecuted by the Attorney General anywhere throughout the state.

SCAMS

Property owners also faced the risk of fraud by people posing as skilled professionals to take advantage of their desperation. One common scam involved demanding pay in advance and then not showing up to do the work. Imposters sometimes posed as skilled professionals. Homeowners often were rushed into contracts, tempted by special offers or discounts for signing a contract quickly.

Many organizations conduct outreach to homeowners after a disaster to provide information on avoiding scams and fraud during rebuilding. For example, the General Land Office publishes a *Texas Homeowner's Handbook to Prepare for Coastal Natural Hazards* that provides guidance about selecting skilled professionals to do repair and rebuilding.²⁷ In addition, the Texas Association of Builders and the Texas Builders Foundation publish a guide, *Rebuilding Following a Disaster*, to help homeowners make informed decisions.²⁸

CODE REQUIREMENTS

One difficult and costly issue for persons with older homes is that new construction must meet at least the International Building Council code, as specified in state law, or even more stringent codes adopted by their communities. For owners of older properties, this requirement significantly increases the cost of construction *and* their homes' assessed value, consequently resulting in higher property taxes. For severely damaged properties in a flood plain, FEMA's rules require the structure to be brought into compliance with local floodplain management regulations — which may require it to be elevated or demolished.²⁹ Additional flood plain regulations can make rebuilding even more expensive.

Increasing the value of homes in a community, moreover, makes future homeownership more challenging. According to a study by the Texas A&M Real Estate Center, every \$1,000 increase in the average cost of a home means an average 22,000 households can no longer afford homeownership.³⁰ Even so, as many stakeholders have noted, "building codes work." According to one trade association, of 75,000 homes built in unincorporated areas of Harris County according to the latest updated codes, only 460 flooded.³¹

REGULATIONS

Permitting varies from jurisdiction to jurisdiction, and stakeholders reported that many homeowners were confused about the permitting process. For example, while some jurisdictions waived permitting fees, some residents thought this meant they didn't have to obtain permits at all.

Another troublesome regulation was the prohibition by some homeowners' associations against travel trailers or mobile homes on property located within the association. Allowing trailers would have resulted in faster recovery. In some cases, FEMA was forced to pay for hotel stays simply because the survivors couldn't put a trailer on their property.

FEDERAL HOUSING ASSISTANCE PROGRAMS

One of the most critical concerns following a disaster like Hurricane Harvey is to provide shelter and, where possible, housing assistance for survivors. This assistance can be broadly divided into two categories—temporary housing assistance to provide immediate, short-term shelter for people unable to return to their homes after the storm and longer-term assistance to help people repair or replace their homes, particularly when they do not have private insurance.

The Governor's Commission to Rebuild Texas was not given the responsibility of working in the temporary housing area, but it is difficult to be involved in the Harvey relief effort without considering the effects of the housing programs on Texans affected by the storm. GLO, which had state responsibility for temporary and permanent housing assistance has commented extensively on improvements to the program in a report released in August 2017.³²

At the federal level, these programs are divided between FEMA, which provides temporary housing assistance, and the U.S. Department of Housing and Urban Development (HUD) which provides housing assistance through the Community Development Block Grant Program (CDBG-DR) and other programs such as the Section 108 loan guarantee program.



Local resident Mark Richard plays with his dog Lucy outside of his new temporary home which is part of the Hurricane Harvey housing mission coordinated by the state, local and federal government in Sour Lake, Texas, December 16, 2017. Photo by Jocelyn Augustino/FEMA.

TEMPORARY HOUSING ASSISTANCE

On August 30, FEMA announced that 230 shelters were operating across the affected area and in other nearby locations.³³ These facilities provided immediate shelter and emergency supplies. Within a few days after landfall, FEMA granted the Transitional Sheltering Assistance (TSA) program which provided hotels as shelter for Texans in the disaster areas. In the meantime, the state and FEMA were working on two more significant programs, Direct Assistance for Limited Home Repair (DALHR) and Partial Repair and Essential Power for Sheltering (PREPS).

On September 7, the State requested a direct housing mission as part of the recovery. On September 13, GLO was assigned to be the first Texas state agency to partner with FEMA on short-term direct housing assistance, a task that included everything from lining up contractors for minor repairs to securing trailers for displaced families. The program represented the first time in Texas history that any form of repair was offered as part of the short-term disaster housing assistance mission.

One lesson from past disasters that was underscored by Hurricane Harvey is the sometimes cumbersome and slow nature of federal assistance programs. Once the GLO had been given the responsibility, the agency had to go through a process of working out an Inter-Governmental Service Agreement with FEMA to detail how the program would work. That agreement wasn't put into place until September 22, 2017. A week later, on September 29, the U.S. Department of Homeland Security's Inspector

General issued a management alert that the agreement lacked basic controls to ensure that the program was secure against waste, fraud and abuse.³⁴

GLO noted the nature of the problems with the program in its overall report on Hurricane Harvey in August 2018:

Because this was the first time the GLO administered these programs, no pre-event contracting was in place which could quickly be used to implement these temporary housing programs. The very complex Federal Acquisition Regulation (FAR) had to be followed to bid out these contracts. This is a process-heavy and very bureaucratic set of rules. Regardless whether the FAR is adequate to the task of guiding federal contracting, it is not designed for nor does it function for crisis.³⁵

Reed Clay, the Chief Operating Officer for Governor Abbott testified to the federal House Committee on Homeland Security on March 15, 2018. He criticized what he called the "tangle of federal regulations" that hamper FEMA's emergency response system. He reported that "some jurisdictions encountered challenges in quickly procuring needed support services, while many others discovered that the contracts they had in advance of the storm did not include all of the contract provisions required under the governing federal laws and/or rules."³⁶

He said that for federal-state cooperation to work, "states must truly be relieved of complying with the tangle of federal regulations governing the temporary housing program," although he said that the state must also do a better job of "removing regulatory obstacles

from the successful delivery of temporary housing solutions,” such as local ordinances that prevented the installation of trailers or manufactured housing as temporary housing in some cities.

One of the main regulations to which Clay was referring is the Federal Acquisition Regulation (FAR), which governs most federal procurements, including those of FEMA. FEMA has no control over FAR or any ability to wave its requirements which can be quite stringent.

The problem with the temporary assistance housing, probably also was related, in part, to the fact that FEMA was at that point responding not only to Hurricane Harvey but also Hurricanes Irma and Maria. To its credit, FEMA officials later acknowledged difficulties and delays in the process because of high demand and the complex requirements of federal law. In 2018, FEMA Administrator Brock Long said the system needs to be reevaluated: “We’ve got to streamline a very fragmented recovery process,” he said at a congressional hearing on April 11. “Recovery funding comes from 17 different federal government agencies and it’s too difficult to understand what you’re entitled to and how to put it to work.”³⁷

The lack of information also was a recurring theme in meetings with local officials in the aftermath of Hurricane Harvey, which accounts for multiple state and federal meetings being held in the affected areas in the weeks and months after the disaster — and in other venues. “The problem is no one really understands how FEMA works,” Rockport Mayor C.J. Wax said at a *Texas Tribune* event in October. “When you don’t understand how they work, then how can they understand what our needs are?”³⁸ The comment also underscores the need for better preparation for future disasters at both the state and local level in Texas.

The GLO report also highlighted this “information gap” as the report calls it, in its report: “The GLO’s conversations with mayors, city councilors, the county court, county judges, city managers, police and fire chiefs, and the directors of municipal planning all uncovered a serious gap between what they and the public believe about federal disaster assistance, and the reality of what the Stafford Act, which governs federal disaster management programs, actually says.... a large gap exists between the damage hurricanes do, and the financial resources available for housing recovery in particular, and the public’s knowledge of what they can expect from the federal and state government.”

The point the report makes, with which the

commission agrees, is that federal programs are slower and less beneficial for survivors than many imagine, leaving major economic hardships for Texans and many others affected by disasters like Harvey.

The GLO report also discusses the lack of information about the risks of flooding along the Texas Gulf coast, a point documented earlier in this report: “In Harris County (one of the largest counties in the United States at 4.2 million people) alone, 55% of the homes which flooded were outside the flood plain. Flood plain maps are not an accurate predictor of flooding risk as many people have discovered to their detriment.” The GLO suggests a public information campaign to, in effect, educate Texans on what public assistance programs can do but also “what they will not do under federal and state law.”

Since the hurricane, representatives of the state government agencies involved in the hurricane recovery have met with FEMA officials in an effort to streamline procedures and operations. One idea the GLO report is to consolidate FEMA housing programs into a single block grant to states with high risk of disasters. In general, FEMA has been open to the possibility of examining options, although many of the restrictions and limitations are a result of federal law designed to promote fiscal accountability, an important factor in providing such large amounts of federal dollars to an area affected by a disaster but of small comfort to the people who need help getting their lives back to normal.

Nonetheless, many Texans did receive FEMA Individual Assistance. As of October 2018, a total of 373,540 individual assistance applications had been approved by FEMA totaling \$1.6 billion in assistance. Of this total, \$1.2 billion was channeled through the housing assistance programs and \$400.8 million was paid for other assistance needs.³⁹ This was in addition to about \$1 billion approved in Public Assistance grants to Texas governments and eligible non-profits.

PERMANENT HOUSING ASSISTANCE

In addition to the FEMA housing programs, the General Land Office also had responsibility for working with HUD on a variety of more permanent assistance programs, including Community Development Block Grants-Disaster Recovery (CDBG-DR) and mortgage foreclosure relief for homeowners struggling to make payments following Hurricane Harvey.

Among these programs is the CDBG-DR grant program, which is intended to provide grants to help

cities, counties, and states recover from federally declared disasters, especially in low-income areas. Funding for the program is subject to the availability of federal supplemental appropriations.

On November 17, 2017, HUD awarded a total of \$5.024 billion to help Texas recover from Hurricane Harvey.⁴⁰ The funding was contained in a supplemental appropriation signed by President Trump on September 8. CDBG-DR grants support a wide variety of activities including housing redevelopment, business assistance, infrastructure repair and economic development, as was discussed in **Chapter 4**. State and local governments are required to spend the majority of these recovery funds in “most impacted” areas as identified by HUD. When the announcement of the award was made, HUD also announced it would shortly issue administrative guidelines for use of the funds that will increase grantees’ flexibility in addressing their long-term recovery needs.

Rather than make the funds immediately available, though, the announcement actually marked the beginning of a multi-month planning process involving the General Land Office and HUD. GLO was required to develop and submit for approval a State Action Plan. HUD issued its guidance for the administration of the funding on February 7, 2018. GLO’s plan was completed and submitted to HUD on April 10, 2018, eight months after the storm. The plan was made up of two parts: \$2.7 billion in funding for disaster areas other than Houston and Harris County that GLO will administer and the remaining \$2.3 billion for direct allocation by the remaining two entities. Local governments would be required to submit individual plans for the funding as an amendment to the state plan.

The overall state plan was finally approved by HUD on June 25, 2018, with the final grant agreement signed by HUD Secretary Ben Carson on August 17, 2018. In effect, GLO was given authority to help Texans through the program just short of a year after Hurricane Harvey.

Both GLO and HUD believe this was the most rapid implementation possible under federal law and regulation. In June 2018, when the GLO plan was approved, Land Commissioner George P. Bush said in a written statement: “The GLO is committed to its mission to expedite federal housing recovery assistance as quickly as possible to help those affected by Hurricane Harvey. Due to the GLO’s pre-planning and preparation, these federal recovery funds will be in the hands of Texans faster than in previous disasters.”⁴¹

Under the plan, GLO will allocate the \$5 billion total among eight different assistance programs. These include:

- Single Family Homeowner Assistance (\$1.048 billion): Provides funding for rehabilitation and reconstruction of owner-occupied single-family homes damaged by Hurricane Harvey.
- Buyouts and Acquisitions (\$275 million): Eligible homeowners may sell their home to a local government at a pre- or post-storm fair market value and move out of harm’s way by relocating outside of a floodplain to a lower-risk area.
- Homeowner Reimbursement (\$100 million): Allows homeowners to be reimbursed for certain out-of-pocket expenses incurred for repairs to their home including reconstruction, rehabilitation or mitigation up to \$50,000.
- Affordable Rental (\$250 million): Provides funding for rehabilitation, reconstruction and new construction of affordable multi-family housing projects in areas affected by Hurricane Harvey.
- Local Infrastructure (\$413 million): Repairs, enhances and restores infrastructure for local communities affected by Hurricane Harvey as part of a comprehensive long-term recovery program.
- Economic Revitalization (\$100 million): Offers interim assistance to small businesses impacted by Hurricane Harvey through deferred forgivable loans and loans in exchange for job creation or retention.
- Local, Regional and State Planning (\$137 million): GLO will conduct planning studies focused on disaster mitigation in the impacted areas with the purpose of promoting sound long-term recovery.
- Homelessness Prevention (\$50 million): Provides assistance such as short-term mortgage, utility payment and tenant-based rental assistance.

HUD also required 80 percent of the money to be allocated to 11 of the most distressed areas, including Harris, Galveston and Aransas counties. Houston is the only city to be awarded a portion of the money: just over \$1 billion, which the city will use for recovery programs with GLO’s oversight.

Another common criticism of the CDBG-DR program by local officials, according to GLO’s report, was that the provisions of HUD regulations requiring that 70 percent of HUD funding under CDBG-DR be directed to moderate to low-income families. According to GLO:

Some counties received limited or no funds because they did not meet with threshold requirements of income levels. While it is certainly understandable why HUD policies federal funding be focused on low and moderate income people, the way in which this rule operates in practice excludes aid to lower income people who happen to live less populated counties with some higher income families.⁴²

The GLO recommends that HUD rewrite the formula for the allocation of CDBG-DR funding to local governments so that all people in these categories are assisted, a potentially controversial recommendation given the low- and moderate-income nature of the Community Development Block Grant program generally.

Also, noting that the “federal disaster management system has been designed with no one in charge,” GLO recommends that Congress enact legislation consolidating the various housing programs provided by the federal government:

Any restructuring of federal disaster recovery (as opposed to emergency response) should also include the consolidation of HUD disaster recovery programs through the CDBG-DR (Community Development Block Grants–Disaster Recovery), the Small Business Administration disaster loans, and the FEMA temporary housing programs described above into one organizational location in the federal government to further simplify the system and reduce overlapping programs, eliminating conflicting missions and business systems.⁴³

These changes might, indeed, improve the federal programs, although it is difficult to imagine the effort that would be required to execute such a consolidation at the federal level. As in other cases, the state should pursue a continuing dialog with the relevant federal agencies to find common agreements in improvements in all of these programs to better assist the survivors of future disasters in Texas and in other states.

From the standpoint of the individuals and local government officials that commented at various forums held after Hurricane Harvey, the problem with both the temporary and permanent housing programs was the length of time required to access federal assistance. In the case of the CDBG-DR program, it is significant, that even with GLO and HUD administrators working to speed up the program, funding was not available until a year after the storm.

It is also important to note that while the \$1.2 billion granted under the FEMA temporary housing

program and the \$5 billion awarded under CDBG-DR are significant amounts of funding, they represent only a fraction of the total needed in the affected areas that will have to be met through other sources, including insurance payments and out-of-pocket expenditures by survivors.

LOCAL GOVERNMENT NEEDS

During the course of its work, the Governor’s Commission was struck by the wide variation in local jurisdictions’ ability to deal with Harvey (an issue also discussed in **Chapter 5**). Populous areas such as Houston and Harris County have well-trained staff and resources to undertake response and recovery, but many smaller communities were nowhere close to being ready for a storm of Harvey’s magnitude. This wide divergence argues for a *scalable* recovery system that can offer more help to these communities during a large-scale emergency.

The lack of knowledge and expertise at the local level made it a priority for the state to provide information and technical assistance on an ongoing basis. Every day brought new needs and the best — and often only — help came from the state agencies involved in the response. For example, TDEM provided information and training to staff from the Texas A&M AgriLife Extension Service and the Texas A&M Engineering Extension Service in the completion of FEMA paperwork. These individuals in turn worked with local officials to help them complete the required federal forms correctly and in a timely manner.

INFORMATION AND TECHNICAL ASSISTANCE

Governor Abbott was aggressive in his response to and involvement in the recovery after Harvey. In the weeks following the storm, the governor conducted 60 visits, organized listening sessions and press conferences, briefings, meetings and tours, often with representatives of TDEM, FEMA, the Governor’s Commission to Rebuild Texas and other state agencies involved in the response.⁴⁴

State legislators from the affected areas also became involved in assisting their communities. Many local issues were addressed in these meetings, but far more extensive assistance was needed as the recovery progressed.

As part of this effort, the governor and the state agencies under his direction sought federal support for the recovery, so that local communities would have

of the meetings were to provide a current overview of the Rebuild Texas Needs Survey results, presentations by and access to subject matter experts, and to dialogue with local officials to determine needs and recovery issues.

Subject-matter experts provided information in: public finance issues; flood control, mitigation, and land development; debris management; housing standards, codes and benchmarking; structural standards; and work force issues. Information from these meetings was used to assist local entities with addressing mitigation and recovery issues, as well as determining the size, scope and priorities of the Texas recovery.

In addition, HUD, FEMA and GLO also held a series of “Hurricane Harvey Federal/State Housing Strike Team” meetings in San Patricio County on January 23, in Wharton County on February 2, in Montgomery County on February 5, in Galveston County on February 7, in Jefferson County/City of Beaumont on February 13, in Jefferson County/City of Port Arthur on February 14, and in Newton County on February 15. These meetings continued the ongoing discussions among local, state and federal partners, providing up-to-date information and assistance and to help state and local officials identify unmet needs and potential resources as part of the overall recovery effort.

TDEM FORUMS

In addition to the informational meetings, TDEM sponsored three Hurricane Harvey Mitigation Workshops entitled “Future-Proofing Texas Through Mitigation” during March, April and May 2018 in College Station. These workshops were supported by the Governor’s Commission and other components of the Texas A&M University System. The purpose of the workshops was “to focus on how best to restore, redevelop and revitalize the health, social, economic, natural and environmental fabric of the communities and build a more resilient Texas.” The workshop participants included officials from county and city government, plus other local officials and representatives from local, state, and federal agencies, including FEMA.

The three workshops were designed to take a progressive approach toward identifying corrective actions that should be taken to future-proof Texas. The first workshop provided an open discussion format that invited all feedback without debate or defense from state or federal agencies. Between the first and second workshops, the state and federal agencies responded

to the comments, questions and feedback that resulted from the first session. The methodology for the second workshop was to provide local representatives the opportunity to discuss the responses, ask additional questions and make recommendations for the actions needed on issues identified as “needing improvement.” The results of the second session were prioritized and a select list of items to be addressed was created for review and discussion during the third session. During the third and final workshop, the local community representatives worked with the state and federal agencies to identify specific changes needed and regional projects that aligned with the priority areas. Those specific changes and projects were organized in the form of 11 recommendations put forward by workshop participants.

This document, in conjunction with the information from the five Rebuild Texas regional meetings, will serve as a living document to guide activities as we move forward in the state’s efforts to recover and prepare for future disasters.

LOCAL FINANCES

A continuing problem for many smaller communities in the affected areas is the hurricane’s impact on their finances. Texas local governments are funded in large part by property taxes — which may be heavily affected by the storm’s damage. As the *Texas Tribune* reported in October 2017:

Thousands of property owners along the coast could see their property values—and their taxes — decrease because of wind and flood damage. How much values drop depends on the amount of damage and where owners are in the rebuilding process when their property is assigned a new value.⁴⁵

While this situation benefits hard-hit survivors, it created a major problem for some local jurisdictions, which faced the prospect of seeing their main source of tax revenue dropping at double-digit rates just as they need all available resources to meet the heavy cost of debris removal, repairs to public infrastructure and restoration of basic public services. “The impact next year is going to be severe,” Rockport Mayor C.J. Wax said at a *Texas Tribune* event last October.⁴⁶

School districts affected by Harvey have been promised help by legislative budget writers in next year’s legislative session if they experience “a significant reduction” in property tax collections due to Harvey.⁴⁷

School districts rely on the property tax and state aid as their main sources of funding, and school finance is a major component of the state budget. Under the Texas Education Code, the state is required to reimburse certain costs school districts incurred from the hurricane, while other assistance is at the Legislature's discretion.

At a joint hearing of the House Public Education Committee and Senate Finance Committee in May of this year, Education Commissioner Mike Morath discussed these actual and potential costs. For fiscal 2019, the Texas Education Agency estimates the cost of required reimbursements for enrollment and value losses from reappraisals could total \$426 million. Other costs, particularly for the repair of facilities damaged or destroyed by the hurricane, are not required under state law but could, if funded by the Legislature, range from \$860 million to \$1.36 billion. Some or all of these costs could be considered by the Legislature next year as part of a supplemental appropriations bill — if the money is available.⁴⁸

Cities, counties and special-purpose districts receive virtually no state aid and have few ties to the state budget — and so have no protections similar to those of school districts. The Legislature could address this issue during the 2019 legislative session, but state finances for normal state spending needs, including public schools, will be tight. For many local governments, there's no easy solution other than increasing taxes on the remaining property tax base, relying on limited federal funds, cutting spending where possible — and hoping for state assistance.

FEMA does provide a Community Disaster Loan Program that provides limited loans for operational funds to help local governments that have incurred significant losses due to a major disaster. While this may be helpful to some communities, more needs to be done to help smaller communities in particular, resume full operation as quickly after a disaster as possible.

ASSESSING LOCAL NEEDS

One of the first and most important steps in the recovery involved working with federal lawmakers and agencies such as FEMA and HUD to ensure that the affected areas received the maximum possible amount of federal disaster assistance. Governor Abbott, Commissioner Sharp and disaster experts from TDEM were in constant communication with decision-makers in Washington, and traveled there several times to make the state's case.

One of the early activities of the Governor's Commission to Rebuild Texas was to reach out to all affected counties, cities, school districts and other jurisdictions to construct a detailed picture of the damage and the estimated funding needed to restore the Gulf Coast. This list of needs exceeded \$100 billion, but the state pared the list to \$61 billion in priority projects based on an assessment structure developed by Texas A&M University at Galveston.

Governor Abbott personally delivered this list to members of Congress, the Trump Administration and relevant federal agencies on October 31, 2017. Commissioner Sharp said the report would evolve as new issues were identified or as projects were reprioritized. "We wanted to illustrate the size of the assistance we need and the type of projects," he said. "Just because a project is on the list does not mean it will be funded and just because a project is not on the list doesn't mean it can't be funded if a mayor or county judge brings it to us."⁴⁹

Much of the list focused on projects that would help mitigate future events, including flood control, dredging of silted rivers and bays and the restoration of public infrastructure such as roads and bridges destroyed by the storm. The list was, to the degree possible, diverse and geographically balanced in proportion to the storm's damage and the level of need. The projects ranged from a few million dollars to repair public buildings in small communities to \$12 billion for a "coastal spine," an innovative sea barrier that would help protect a large portion of the coast from the storm surge of future hurricanes.

Making the state's case and providing ideas for its recovery were vital because of the unusual number of disasters in 2017, when the nation experienced three landfalling hurricanes as well as some of the costliest wildfires in California's history.

In general, Texas' advocacy was successful. While not earmarked specifically for Texas, Congress eventually passed two supplemental spending bills in September and October 2017 appropriating \$34.5 billion in post-disaster funds and forgiving \$16 billion of debt for the National Flood Insurance Program. In February 2018, Congress approved a two-year budget that included an additional \$90 billion for disaster-related rebuilding. This brought total spending on the 2017 events to more than \$130 billion, a U.S. record according to the Wharton School Risk Management and Decision Processes Center.⁵⁰

(See **Chapter 4** for more details on federal funding appropriated for disasters in 2017, including Hurricanes Harvey, Irma and Maria, the California wildfires and other disasters.)

OPEN MEETINGS ACT ISSUES

Texas state and local government operate under the Open Meetings Act.⁵¹ The statute's intent is to promote open and transparent deliberations of public bodies, including state executive agencies, city councils and county commissioners' courts.

Various local officials indicated to the Governor's Commission and TDEM that the requirements of the Open Meetings Act were difficult to meet during Harvey.

For example, according to a TDEM document summarizing comments from the first forum,

*Attendees expressed concern regarding having to follow the Texas Open Meetings Law during disasters such as Hurricane Harvey when jurisdictional leaders had to meet to discuss immediately needed actions or decisions regarding public safety and there was not time to publish agendas, announce the meeting or follow the provisions of the Open Meetings Law due to the exigent circumstances.*⁵²

One participant suggested that the state should:

*Explore changes to Open Meetings Act rules during disasters. Our county felt that quorum rules made it difficult to share information to elected leadership during Harvey.*⁵³

Some of these issues arose when elected members of local jurisdictions were grouped together by necessity, seeking shelter from the storm. These groupings constituted a quorum. During these periods, decisions had to be made quickly about disaster-related issues such as road closures and rescue operations, but their discussions were not occurring in a properly posted open meeting; in fact, some posting locations specified in law no longer existed.

In most situations, the Open Meetings Act requires public bodies to conduct meetings with a quorum present, typically defined as a majority of the body.⁵⁴ County governments must post notice "on a bulletin board at a place convenient to the public in the county courthouse," while cities must post "on a physical or electronic bulletin board at a place convenient to the public in the city hall."⁵⁵

State law provides exceptions to some of these requirements. The Open Meetings Act specifies that, when an emergency or an urgent public necessity arises, the governmental body must post its meeting at least two hours, rather than 72 hours, before it convenes.⁵⁶

Notice also must be given to the news media not later than one hour before the meeting by telephone, fax or email.⁵⁷

Although not part of the Open Meetings Act, the state's emergency management statutes allow local governmental entities to meet without a quorum if the jurisdiction is in a disaster area declared by the governor or president and a majority of members can't convene due to the disaster.⁵⁸ These statutes also appoint the county judge, mayor or the chief administrative officer of a local joint board as the political subdivision's "emergency management director." The law gives that individual "the powers granted to the governor under this chapter on an appropriate local scale."⁵⁹

The Texas governor has broad authority during a disaster, including the following passage in Section 418.016(a) of the Texas Government Code:

*The governor may suspend the provisions of any regulatory statute prescribing the procedures for conduct of state business or the orders or rules of a state agency if strict compliance with the provisions, orders or rules would in any way prevent, hinder or delay necessary action in coping with a disaster.*⁶⁰

Whether a judge or mayor could suspend the Open Meetings Act using these powers is unclear, due in part to the question of whether such a suspension would be a use of the governor's powers "on an appropriate local scale."

The various requirements of the Open Meetings Act and related laws can be difficult to interpret, as reflected by many Texas Attorney General opinions rendered over the years. The Attorney General's website shows about 280 opinions concerning open meetings, suggesting the need to work with the Attorney General's Office to clarify whether existing law covers some of the situations that arose during Harvey.⁶¹ This information could be shared with local jurisdictions through training or other means.

The reference above to Section 418.016(a) of the Government Code opens a possible way to address emergency circumstances. Under this provision, the governor might be able to issue a proclamation that suspends the Open Meetings Act temporarily if it hinders "necessary action in coping with a disaster." Governor Abbott's disaster proclamations for Hurricane Harvey suspended certain laws or regulations, but not the Open Meetings Act.

Former Governor Rick Perry took a broader approach in addressing the circumstances of Hurricane Ike in 2008. Governor Perry's disaster proclamations simply stated that "As provided in section 418.016, all rules and regulations that may inhibit or prevent prompt response to this threat are suspended for the duration of the state of disaster."⁶² How this provision may have affected open meetings concerns is unclear, but similar measures could be considered in future disaster events.

OTHER RECOVERY ISSUES

In addition to the issues discussed above, the commission heard about several other issues related to the widespread damage caused by Harvey. Two worth noting involve the titling of vehicles destroyed by flooding and problems some consumers experienced with utility billing on damaged or destroyed homes.

VEHICLE TITLING AND "BRANDING"

The Texas Department of Motor Vehicles (TxDMV) has many responsibilities concerning vehicles in the state, including issuing vehicle titles and registrations, granting various permits and collecting fees to support these functions. TxDMV also plays a role in emergency response as it is responsible for waivers related to vehicles, such as issuing motor carrier permits and permits for oversize or overweight vehicles. These permits allowed rescue, response and transport vehicles, as well as vehicles moving heavy equipment out of harms' way, to use roadways outside normal load limits.

Even before Harvey made landfall, TxDMV was taking steps to be ready for a surge of vehicle-related issues. One of the first actions the agency took in the storm's aftermath was to begin the waiver process for counties included in the disaster proclamation. These waivers temporarily exempted vehicle owners from a fee for duplicate registration receipts, registration renewals and permits, and from the time requirements for completing title transfers.

TxDmv engaged in numerous communication efforts to inform vehicle owners, vehicle dealerships and related businesses about titling issues. The agency set up a temporary worksite in its Austin headquarters to meet the increase in salvage and non-repairable title applications.

In early October 2017, TxDMV became aware of an issue concerning a FEMA assistance program for owners of vehicles flooded or damaged by Hurricane Harvey. Individuals apply for this assistance directly from FEMA. If the owner qualifies, HHSC is responsible for disbursing funds. To determine eligibility, FEMA must confirm that all vehicles owned by the applicant were rendered inoperable and that the vehicle(s) had liability coverage only. An owner with a repairable vehicle can receive assistance of \$550 up to \$9,000, depending on damage; owners of destroyed vehicles receive \$9,000 regardless of value.

By law, flooded vehicles that are sold or salvaged must have title notations to that effect, called "branding." TxDMV brands flood-damaged vehicles and reports its issuance of titles and brands to the U.S. Department of Justice through the National Motor Vehicle Title Information System; the process creates a record indicating flood damage for the next owner, if the vehicle is sold. When FEMA processed paperwork for reimbursing flooded vehicle owners, however, it didn't capture vehicle identification numbers or license plate information. Without these records, TxDMV couldn't track the vehicles or require owners to apply for a properly flood-branded title. Working with FEMA, TxDMV determined that TDEM had information that could be used to locate some of these vehicles. TxDMV requested access to these data but, in the crush of activity and multiple demands on TDEM immediately after Harvey, was unable to gain access to them.

TxDmv also encountered issues related to trailers deployed as temporary housing after Harvey. FEMA designated GLO to administer its temporary housing program. FEMA purchased trailers directly from retail dealers. As such, the trailers were technically exempt from titling requirements and thus had no owner of record. When FEMA transferred the trailers to GLO, the trailers then needed titling, as state agencies are not exempt from titling requirements. Proper titling is also necessary so the state can issue the trailers exempt license plates not subject to fees. TxDMV discussed this issue with FEMA and GLO but was unsuccessful in resolving the issue.

SUSPENSION OF REGULATIONS

As noted earlier, state law allows the governor to suspend provisions of any statute or orders or rules of a state agency if strict compliance would prevent or hinder needed action in coping with a disaster.⁶³ State law also provides that:

A person who holds a license, certificate or other permit issued by a state or political subdivision of any state evidencing the meeting of qualifications for professional, mechanical or other skills may render aid involving the skill in this state to meet an emergency or disaster. This state shall give due consideration to the license, certificate or other permit.⁶⁴

Governor Abbott invoked this authority to help expedite recovery. These provisions proved essential in expediting response and recovery efforts in the early phases of Hurricane Harvey. Statutes and regulations waived included those dealing with air and water quality and fuel regulations; various licensing-related statutes; and certain taxes administered by the State Comptroller's office.

The Governor's Office has maintained a list of these various suspensions. The list should continue to be maintained and reviewed for completeness by state agencies to help expedite suspensions in any future event.

UTILITY BILLING

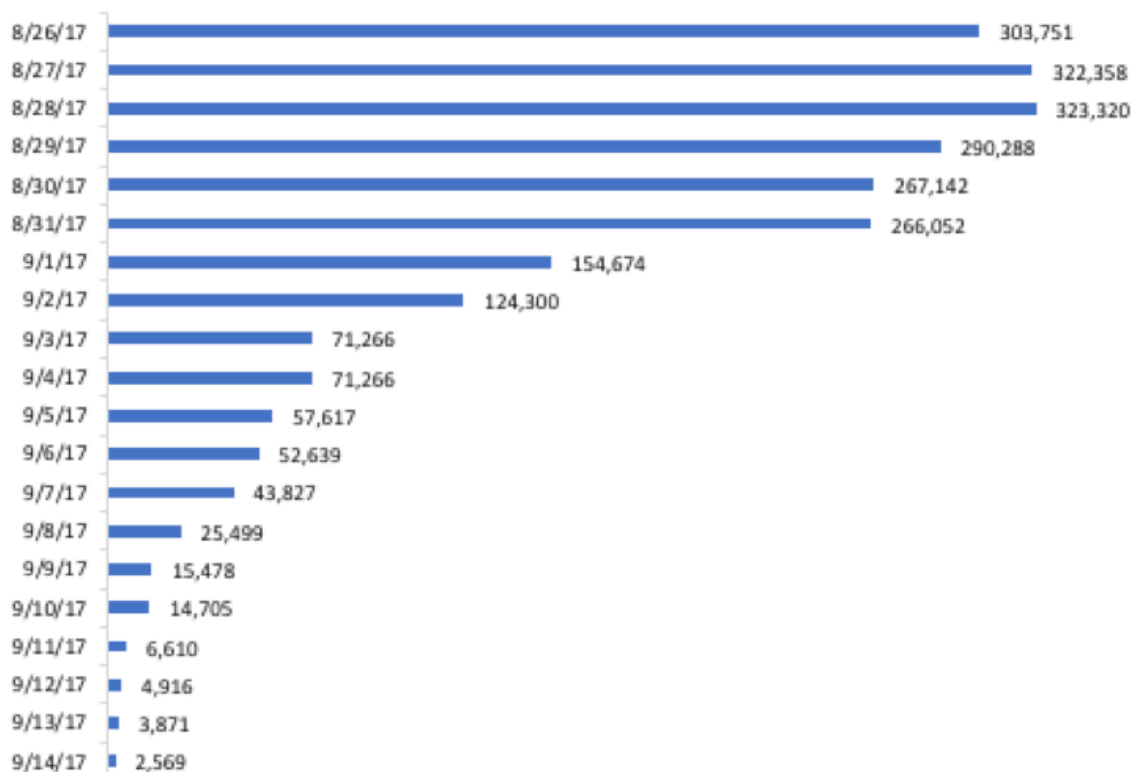
Hurricane Harvey created a number of utility billing problems for survivors and utility companies alike. The Public Utility Commission of Texas (PUC) has various responsibilities related to electric, water and sewer utilities; the Railroad Commission of Texas has similar responsibilities for gas utilities.

Many customers experienced service outages from the storm (**Exhibit 4**), and these needed to be accounted for in their billings.

Furthermore, many homes in the affected areas were uninhabitable and some residents who evacuated or lost their jobs were unable to pay utility bills. At one stakeholder meeting, residents of San Patricio County said they were accruing debt for services they were not using because they were unable to return to and occupy their homes.

Exhibit 4. Number of Customers Experiencing Electric Outages by Date

Source: Public Utility Commission of Texas



ELECTRIC, WATER AND SEWER

On August 31, 2017, shortly after Harvey's landfall, PUC issued an order addressing these billing issues.⁶⁵ The order directed electric and water utilities to use "smart" meter readings, if available, to avoid issuing bills based on estimated usage. The use of estimates can result in overbilling customers during a disaster when they are not living in the home.

PUC's order required electric, water and wastewater utilities to identify reductions in consumption resulting from hurricane damage and evacuation. The utilities were further ordered to "use their best efforts, without delaying restoration of service, to identify premises that are not capable of receiving service [and] to discontinue billing these premises ... without assessing a disconnection charge."⁶⁶

PUC has indicated that most utility companies offer payment assistance to customers such as deferred payment plans, waivers of reconnection fees and late charges and assistance to low-income families. PUC's order required retail electric providers to "offer deferred payment plans upon a customer's request in an area covered by a disaster declaration" until September 29, 2017. The order also directed regulated electric, telecommunications, water and sewer utilities to notify customers of regulations that had been suspended by the Governor's Office as a result of the storm.

PUC received 13 customer complaints about water utility bills as a result of Hurricane Harvey; the number of complaints about electric service is not available. Utility customers may not have been aware of the options available to them to request a suspension of service or other forms of payment relief.

PUC's order also didn't address a billing option for some utility customers allowing them to average their utility usage over a 12-month period and pay "leveled" payments each month. When a house on this type of payment plan is destroyed, the utility company can't simply stop billing because they must recoup costs for utilities they already may have provided.

Electric utilities have indicated that the payment relief programs offered to customers during Hurricane Harvey resulted in material revenue losses for them. These data are not available, however.

PUC plans to release recommendations for addressing these issues in future disasters.

"THIS IS NOT GOING TO BE A SHORT-TERM PROJECT"

Emergency managers across the nation recognize that recovery is far more difficult and complex than the initial response to disaster. Recovery doesn't involve the high tension and drama of response, and garners less attention. Mucking out flooded houses is hard, messy work and doesn't involve heroics; the same could be said about rebuilding communities. And as the urgency of response passes and the long business of recovery proceeds, fewer volunteers and donations arrive to help survivors.

Nevertheless, an effective recovery process is critical to helping individuals and communities return to normal after a disaster, and it's a process that cannot be completed on a short-term time schedule, a point Governor Abbott made in a September 1 interview, days after Harvey struck: "This is going to be a massive, massive cleanup process," he said. "People need to understand this is not going to be a short-term project. This is going to be a multi-year project for Texas to be able to dig out of this catastrophe."

Texas is perhaps best in the nation in responding to disasters; it's in the area of recovery where the most room for improvement lies. Some of these issues only became more apparent as the recovery phase moved beyond the initial problem of debris and mosquitoes and moved on to the longer process of getting people help in repairing their homes and securing funding for the improvements that truly would, as Governor Abbott said in his directions to the commission, "future-proof Texas" against future hurricanes.



Power utility personnel repair electrical transmission lines outside the town of Rockport in response to Hurricane Harvey in Rockport, Texas, August 28, 2017. (Christopher Mardorf / FEMA.)

**THE ROAD TO RECOVERY:
RECOMMENDATIONS**

DEBRIS**1. Create a catastrophic debris management plan and model guide for local use.**

The Texas Division of Emergency Management should implement this recommendation.

Considering lessons learned from Harvey, TDEM should develop a catastrophic debris management plan and protocols and procedures to incorporate changes as needed. For example, TDEM should work with extension agents from the Texas A&M AgriLife Extension Service (AgriLife) to increase its emphasis on encouraging local jurisdictions to adopt debris management plans. TDEM currently provides guidance and technical assistance to jurisdictions seeking FEMA plan approval, and AgriLife has strong relationships at the county level that enhances its ability to assist local jurisdictions. Having an approved plan positions a jurisdiction to respond quicker and simplifies the FEMA reimbursement process.

TDEM should document for future events the vegetative debris burning process created after Harvey, including TxDOT's role in debris removal. In addition, TDEM should ask the Texas A&M Engineering Extension Service to establish a training program for trench burning that state and local personnel could use to improve the use of the trench burners acquired after Harvey.

In a debris management plan, TDEM also should create a section that focuses on preparing for the massive amount of debris that comes with a catastrophic event the size of Harvey. This type of event complicates the logistics of pickup and disposal, the availability of necessary equipment and interactions among local jurisdictions and other state and federal agencies. The successful approaches TDEM used should be documented for future reference.

The plan also should include provisions for the future use of trench burning and air curtain incineration of vegetative debris, including identifying sources of equipment to bring into action in the immediate stages of recovery.

Implementing this recommendation would not result in cost to the state.

2. Improve contracting for debris removal.

The Texas Division of Emergency Management should work with FEMA to implement this recommendation.

These agencies should identify common contracting issues after Harvey and use the lessons learned to establish a template incorporating essential contract requirements. One such contract standard, for example, would require haulers to make several "passes" to pick up debris, starting first with large, easy to remove debris and ending with smaller and more tedious and time-consuming debris some haulers might prefer to neglect. Not all contracts spelled out such a standard, leaving some jurisdictions with little recourse when haulers threatened or failed to complete all passes. A model contract would help solve such problems.

TDEM should consult with the Comptroller's office procurement staff to establish appropriate contractor requirements. For example, jurisdictions could use preferred debris haulers' qualifications as contracting criteria, including expertise, geographic location, fleet size and number of employees. Bonding requirements and provisions for failure to perform also should be considered as contract requirements. Once determined, the requirements would be added to the contract template.

TDEM also should consult with the Comptroller's office regarding the inclusion of debris contracts as a category in one of the Comptroller's blanket contract instruments for the purchase of goods and services. If appropriate, debris contractors could be pre-vetted and included in the blanket contract, after which local jurisdictions could use the list to identify potential contractors.

Implementing this recommendation would not result in cost to the state.

"WHATEVER NEEDED TO BE DONE THAT NIGHT GOT DONE..."

Brent Call

As rising floodwaters from Hurricane Harvey forced first responders to move their staging area further away from Houston, they found high ground in Katy in the parking lot of an unopened Buc-ees, a popular Texas-based convenience store chain.

The location's grand opening had been set for that Monday, August 28, but was postponed due to the approaching storm. But as the parking lot began filling up with responders from the FEMA, the Texas National Guard, local police and other organizations, someone managed to get on the phone with the owner, starting a phone chain that worked its way down to Brent Call, one of the store's managers.

Call was told to get a team together and get to work. Along with some fellow managers, he wrangled a group of about 15 volunteer workers, well short of a full crew for a typical shift.

As they made their way to what, by that point,

people were calling "Buc-ee's Island," he said they saw some cars nearly submerged in water. "You start driving through the streets and you see people on their cars, on their homes, you see boats, and you start to understand that it's a pretty serious situation, and you have to help out," he said.

When they pulled up, every one of the roughly 120 fueling pumps had an emergency response vehicle stationed at it. Call and his team unlocked the store and got the gas flowing to vehicles that needed it. It was an opening unlike any other in Buc-ee's history.

Lights in one section of the store were shut off to allow people to sleep. Cots were set up along the candy aisles in case people needed to sleep. Hammocks were hung underneath the gas canopy. At one point, Call was asked if a mobile health unit could be staged in the car wash.

Because the store was not yet officially opened, nothing could be sold. But Call said his team was determined to provide the hundreds of first responders with something hot to eat and cold to drink. They kept all of their beverage dispensers running and prepared fresh food in their delicatessen.

Despite the crowd, Call said everything proceeded in a very orderly fashion.

"It was all very organized," he said. "They were all in groups. They knew their directives and were all doing their thing. Everyone did what they could to take advantage of the time, and when they were called away, they left."

Call and his colleagues continued to serve the responders for over 24 hours, until conditions allowed them to move the staging area. He later referred to it as "a nice little stress test" for their official grand opening, and said it reminded him that there were a variety of ways to be helpful in a crisis situation.

"Whatever needed to be done that night got done," he said. "It didn't matter what uniform a person was wearing or what division they were with, everybody just helped out, and then the responders went out and did the real work."



The Katy Buc-ee's served as an unofficial staging area as Hurricane Harvey pushed first responders further away from Houston.

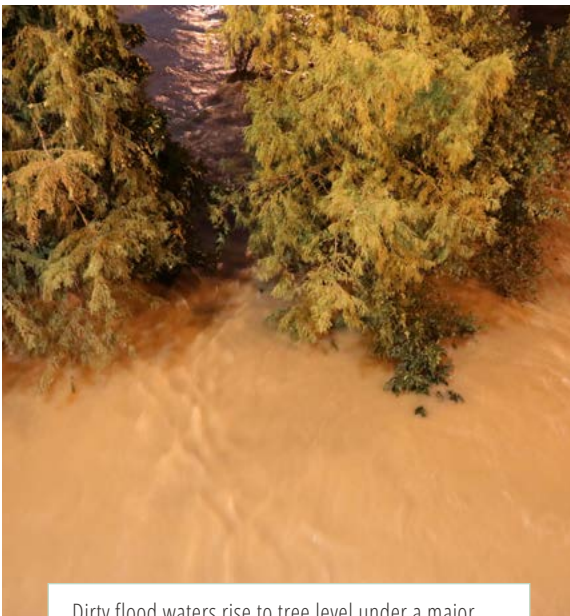
3. Study the issues surrounding the removal of “wet” debris.

The Legislature should appoint a study group to examine solutions to this issue.

Wet debris removal in certain bodies of water and streams proved to be a difficult and complex issue for many local jurisdictions and state and federal agencies. Responsibility for the removal of wet debris depends on its location, whether nearly tidal influenced waters, rivers and waterways, or other bodies of water. Multiple state and federal agencies and regional and local jurisdictions have roles and responsibilities over these waters, which makes sorting out the responsible party and the applicable law very difficult.

The complexity of this issue requires additional study to resolve. The Speaker of the House and the Lieutenant Governor would make a yet-to-be determined number of appointments to a study committee. The study group should include representatives from relevant local, state and federal jurisdictions. The group would make its recommendations by November 1, 2020, in time for any necessary changes to be considered by the 87th Legislature in 2021. The group would sunset on January 1, 2021.

Implementing this recommendation would not result in cost to the state.



Dirty flood waters rise to tree level under a major highway bridge in Houston, Texas, August 30, 2017. (Dominick Del Vecchio/FEMA)

IMPROVE SERVICES TO DISASTER SURVIVORS

4. Improve the process for applying for D-SNAP benefits during a major disaster.

The Texas Health and Human Services Commission (HHSC) would be responsible for implementing this recommendation.

HHSC implemented the Disaster Supplemental Nutrition Assistance Program (D-SNAP) for the first time in Texas in the aftermath of Hurricane Harvey. Operated by the U.S. Department of Agriculture (USDA) and administered in Texas by HHSC, the D-SNAP program assists low-income households to replace food lost or damaged in a storm.

In the aftermath of Hurricane Harvey, HHSC had difficulty finding a sufficient number of sites large enough to accommodate the thousands of anticipated applicants that met specific USDA requirements for accessibility, security, and parking. The solution, already underway at HHSC, is for HHSC staff to review potential D-SNAP sites with county judges on an annual basis. This advanced planning would ease the last-minute scramble to identify and secure locations in the event of a future disaster.

Furthermore, USDA currently mandates that D-SNAP applicants appear *in person* at designated centers to apply for benefits, contributing to the difficulty in finding sites meeting the size and parking requirements mentioned above. The ability to accept applications online would reduce these logistical difficulties and the administrative costs involved in finding and setting up secure, accessible on-site application centers. An online system, however, would require staffing a high-volume call center for phone and electronic applications would be needed.

HHSC is working with national peer organizations to ask the federal government to reconsider the requirement for people to apply for D-SNAP benefits in person. Texas' elected and appointed state officials should work with the Texas Congressional delegation and the leadership at USDA to discuss this issue.

This recommendation would not result in any additional costs, provided that the reduction of the number of centers offsets the costs of the call center.

5. Investigate the possibility of creating a state case management program administered by the Health and Human Services Commission.

HHSC and the TDEM should work with FEMA and other appropriate federal partners to implement this recommendation.

While many organizations indicate that they offer case management services after disasters in Texas, the level of service varies considerably. By contrast, the federal government offers a structured case management program based on a specialized framework using best-practice protocols. The roll out of these services after a major disaster, however, often is frustratingly slow and poses a serious obstacle to survivors who need help navigating the morass of disaster assistance programs and accompanying paperwork. In the case of Hurricane Harvey, services offered through the federal disaster case management program were unavailable until about nine months after Hurricane Harvey's landfall.

HHSC could operate a case management program similar to the FEMA's, but without serious delays. HHSC could contract with non-profit vendors to hire caseworkers and provide case management services as needed. HHSC already has this contracting process in place for use with federal disaster case management. Being able to address individual needs in the days and weeks immediately after a disaster would speed recovery efforts.

Eight months is the maximum length of time FEMA estimates a person should need disaster case management services, and thus the maximum time period that should be considered for a Texas program. FEMA estimated that 21,000 Texans needed case management help after Harvey. Based on FEMA agreements for the Harvey disaster, case management services for 10,000 people would cost about \$45 million.

Together, HHSC, TDEM and FEMA and other appropriate federal partners should determine whether the cost of a state-administered case management program could be reimbursed by the federal government and the level of any such reimbursement. The cost and advisability of implementing this recommendation depends on the reimbursement determination.

6. Determine the feasibility of developing a single intake form for disaster victims to complete to determine their eligibility for disaster programs.

HHSC and TDEM should work with FEMA and other appropriate federal partners to implement this recommendation.

Disaster survivors currently fill out many different forms to apply for services such as case management and financial assistance. HHSC should work with TDEM and the state's federal partners to determine the feasibility of developing a single intake form and an automated intake system.

HHSC and TDEM would need to ensure FEMA and any other involved entities would accept such a form. In addition, the cost of development would have to be determined. At that point, the decision to go forward with the form should be made by HHSC and TDEM.

Implementing this recommendation would not result in cost to the state.



Disaster survivor Joan Upton (center right) gets a FEMA hug from Bridgette Fiumedora (center left), FEMA Corps Eagle 1, after she receives FEMA disaster survivor registration information in Austwell, Texas, September 11, 2017. (Christopher Mardorf/FEMA)

*CHALLENGES FOR PROPERTY OWNERS***7. Improve oversight, accountability, and availability of individuals in the building trades offering services to disaster survivors.**

The Texas Division of Emergency Management, with the cooperation of appropriate agencies, jurisdictions, and trade associations, should implement this recommendation.

Property owners struggled to find legitimate, skilled tradespeople to help them rebuild after Hurricane Harvey. Shortages in some building trades, particularly plumbers and electricians, have been an ongoing problem in some areas of the state for some time, and especially high demand for these tradespeople after the disaster made acquiring their services even more difficult.

During Harvey, the lack of qualified plumbers, electricians and other tradespeople, created a fertile environment for scams. Many contractors didn't have performance bonds, a common contracting provision still not required in many jurisdictions. To make matters worse, smaller communities often didn't have the resources to investigate and prosecute alleged instances of fraud.

These issues deserve attention by entities that have the interest and expertise to tackle such concerns. These entities could include, for example, TDEM, AgriLife, the Texas Department of Licensing and Regulation, representatives of local jurisdictions, trade associations, and law enforcement groups.

TDEM should organize this effort. With the assistance of participating entities, TDEM should spearhead a report delivered to the Legislature by November 1, 2020, in time for consideration by the 87th Legislature in 2021. At minimum, the report should address:

- strategies to increase the availability of tradespeople, particularly plumbers and electricians, following a disaster;
- approaches to increase prosecution of alleged fraud; and
- ways to encourage communities to require performance bonds from contractors in case of non-performance.

Implementing this recommendation would not result in cost to the state.

*MEETING LOCAL GOVERNMENT ASSISTANCE NEEDS***8. Institutionalize the use of extension agents from the Texas A&M AgriLife Extension Service as a “force extender” in support of the Texas Division of Emergency Management.**

The immensity and destructive power of Hurricane Harvey severely stretched the response and recovery resources of local, state and federal governments as well as nonprofit organizations involved in disaster operations. Governor Abbott created the Governor's Commission to Rebuild Texas and appointed Chancellor John Sharp of the Texas A&M University System to head the Commission. This action brought the considerable academic, disaster-related, and community-based resources of the Texas A&M System directly into response and recovery from Hurricane Harvey.

The Commission's innovation in this role was adding the resources of the Texas A&M AgriLife Extension Service as a “force extender” for TDEM. AgriLife maintains local extension agents in 250 of Texas' 254 counties and, working with the Commission, created a network of 130 agents in the affected counties, tying them together with a digital reporting tool. The agents relayed questions, comments and complaints to Texas A&M University System offices in College Station, where knowledgeable staff experts either responded themselves or contacted experts in TDEM, FEMA or other state or federal agencies as necessary, and sent answers back to local jurisdictions. AgriLife Extension agents and other Texas A&M personnel also helped local officials navigate the bureaucratic tangle of paperwork needed to request financial assistance from FEMA or other sources and provided other help as needed.

AgriLife, in consultation with other Texas A&M System entities, should take steps to further plan and develop its role in support of TDEM. The Texas A&M System should ensure that extension agents receive appropriate training for this new disaster-related role, including training on disaster-related assistance programs and other duties local jurisdictions must face in the aftermath of an event.

To further this overall role expansion, the Texas A&M AgriLife Extension Service has included an initiative in its 2020-2021 Legislative Appropriations Request that addresses and complements this recommendation.

- 9. Use available state resources, such as staff from AgriLife Extension, TEEX and other state agencies, to create a recovery task force to provide specialized assistance for communities and individuals in areas like financial issues, federal assistance programs, and recovery and resiliency planning to speed recovery at the local level.**

The commission believes that AgriLife's support of TDEM, as recommended above, is an important though limited first step in enhancing the state's emergency management functions.

We have been told repeatedly that recovery is the weakest phase of the emergency management cycle. Recognizing this, the commission believes that the state should build on the concept to create a *recovery task force* that could be scaled to an appropriate size in future events. If this recommendation were accepted, AgriLife's new function would be folded into the recovery task force as one of its functional areas.

TDEM should be given authority to develop this task force using AgriLife and other resources of the Texas A&M University System, including the Texas A&M Engineering Extension Service, Texas A&M Forest Service and other appropriate state agencies as well as nonprofit organizations if appropriate. TDEM would develop this task force as time and resources permit.

The task force would be active from the beginning of a disaster throughout long-term recovery. TDEM should organize the resources and expertise available to the recovery task force to fit the changing needs of response and recovery over time.

The commission sees establishment of a recovery task force as a major step toward helping communities recover more quickly. This effort would be particularly helpful for smaller communities that lack the resources available to undertake the hard and challenging work of both short-and long-term recovery.

To achieve the recovery task force objective, the Texas A&M Engineering Extension Service has included an initiative in its 2020-2021 Legislative Appropriations Request that addresses and supports this recommendation.

- 10. Set up a response team at the state level to respond to questions and other inquiries from local emergency management officials.**

The Texas Division of Emergency Management, in cooperation with the Governor's Office and the Texas A&M University System, should implement this recommendation.

During the response and early recovery from Hurricane Harvey, extension agents from AgriLife worked with local officials and communities, sending their questions and inquiries to a response center located in College Station. Experts at the response center answered these inquiries or found the answers and returned the information to local jurisdictions, usually within 24 hours. Many questions dealt with federal funding assistance, the location of sites for obtaining assistance and other basic issues.

The Governor's Commission developed this mechanism quickly as a response to the pressing needs caused by Hurricane Harvey. A lack of state and federal agency experts to answer questions identified ahead of the hurricane complicated and contributed to the chaotic nature of this effort.

The ad hoc process for relaying information to and from the field worked surprisingly well, however. A more efficient and less stressful approach would be for TDEM, in cooperation with the Governor's Office and the Texas A&M University System, to designate and keep current a standing pool of experts with the depth of knowledge and contacts needed to answer urgent questions whenever a major disaster strikes. TDEM could decide whether the experts should function from a fixed or "virtual" call center location within their own agencies or if some other approach might be preferable.

A predesignated group of experts ready to assemble immediately for large-scale disasters would help the response and early recovery efforts function more efficiently and less stressfully. The state could implement this best practice at little or no additional cost.



US Representative John Carter (R-TX) picks up some debris in Friendswood, Texas, September 17, 2017. (Steve Zumwalt/FEMA)

11. Organize ongoing briefings at least quarterly or as needed to inform legislators, their staffs, and appropriate agency personnel on hazard threats and disasters.

The Texas Division of Emergency Management, the Texas A&M University System, and the Governor's Office should coordinate to implement this recommendation.

The Texas A&M System often served as a clearinghouse of general information and news among state, federal, and local agencies and elected officials who wanted to be kept informed on unfolding events in the response and recovery efforts on Hurricane Harvey. These communications tended to be reactive in nature because, as a first-time occurrence, A&M system offices had not developed an ongoing procedure to communicate disaster-related information.

TDEM, the Texas A&M University System, and the Governor's Office should develop a more rounded plan to communicate about disasters and hazard threats. The approach could include predetermined briefings at least quarterly, not only during disasters but in "blue sky" periods, defined as times when the state is not actively engaged in response and short-term recovery operations. During these blue-sky periods, elected officials and their staffs, state agencies, and other appropriate parties could be briefed on the possibilities of upcoming hazards and how the state addresses those hazards. During actual disasters, topics would naturally focus on the unfolding event.

Implementing this recommendation would not result in cost to the state.

ASSESSING LOCAL NEEDS

12. Ensure the state is prepared to quickly develop and present a well-reasoned report to the federal government listing projects requiring federal funding after large-scale disasters.

The Governor's Office would have primary responsibility for ensuring the development of this report, a best practice learned from Hurricane Harvey.

At Governor Abbott's direction, the Governor's Commission to Rebuild Texas assembled a report identifying projects needing federal funding to restore infrastructure destroyed by Hurricane Harvey shortly after its landfall. The project package, which identified key projects totaling \$61 billion in requested federal aid, counts as one of the most significant innovations of the Governor's Commission.

The report was timed to arrive other anticipated state requests to the federal government resulting from Hurricanes Irma and Maria. This helped keep Congress focused on the needs of Texas. In addition, expert reviewers screened submitted projects with clearly defined selection criteria included in the publication, thus providing a carefully reasoned basis for a large funding request. The report helped satisfy local jurisdictions that the state was taking reasonable project requests seriously and also pointed donors to priority projects. Nothing close to the \$61 billion has materialized at this point, more than one year later. Even so, the report will provide a basis for ongoing efforts to pursue more federal funding in the future.

Implementing this recommendation would not result in cost to the state.

*OPEN MEETINGS ACT ISSUES***13. Clarify the requirements local officials must meet to communicate in emergency situations under the state's Open Meetings Act.**

The Texas Division of Emergency Management should work with local officials and the Office of Attorney General to implement this recommendation.

Various local officials told the Governor's Commission and TDEM that Open Meetings Act requirements were difficult or impossible to meet during the extreme circumstances of Hurricane Harvey. These difficulties occurred even though the Open Meetings Act recognizes that emergency situations can arise and relaxes various provisions to accommodate these circumstances.

Some officials commented that sufficient time was not available to publish agendas or post meetings properly. Others explained that, of necessity, they could be sheltered together in numbers constituting a quorum while decisions had to be made, with no ability to make those decisions in a properly posted open meeting. In fact, some posting locations specified in law no longer existed.

Provisions of the Open Meetings Act can be hard to interpret, especially in the extraordinary and stressful situations that Hurricane Harvey presented. TDEM should work with local officials and the Office of Attorney General to examine provisions of the Open Meetings Act that local officials found difficult and suggest ways to address those issues. Clarification could include giving local officials and their staffs written guidance or training on the act, for provisions that may not be fully understood, or changes to accommodate unusual circumstances such as a major disaster.

Implementing this recommendation would not result in cost to the state.

*VEHICLE TITLING AND "BRANDING"***14. Develop a process to capture vehicle identification information in FEMA's vehicle assistance program.**

The Texas Motor Vehicle Department, assisted by the Texas Division of Emergency Management, should work with FEMA to implement this recommendation.

FEMA offers an assistance program for owners of vehicles flooded or damaged by Hurricane Harvey. If an owner qualifies, FEMA can assist that person in varying amounts depending on the degree of damage. TxDMV must be able to identify the vehicles that are repaired or salvaged through FEMA's assistance program to carry out its legal responsibility; TxDMV needs to see that these vehicles' titles are properly "branded" to show they were flooded. During Harvey, however, FEMA failed to capture vehicle identification numbers or license plates that TxDMV could use to track down these vehicles so their titles could be branded properly.

FEMA could resolve this issue by adding fields for a vehicle's VIN, make, model and license plate to its vehicle assistance program database. Because of its relationship with FEMA, TDEM should help TxDMV resolve this issue. Implementing this recommendation would not result in cost to the state.

15. Explore ways to solve the issue of titling trailers in the FEMA temporary housing program.

FEMA, the Texas General Land Office, and the Texas Department of Motor Vehicles should work together to implement this recommendation.

At this writing, the trailers purchased by FEMA and transferred to GLO for its short-term housing program have not been properly titled under Texas law. FEMA purchased these trailers directly from retail dealers and, as such, they were technically exempt from titling requirements and have no owner of record. Texas law, however, does not exempt state agencies from titling requirements, but GLO cannot comply with state law because the trailers have no owner of record.

So far, this issue has not been resolved. One option is for GLO, the state's program administrator of the short-term housing program, to register the trailers in its name, exempting them from titling fees. At the end of the program, GLO could offer the occupant first right of refusal to buy the trailer. If the occupant declines, GLO could transfer the trailer to the state's surplus property program for disposal.

Implementing this recommendation would not result in cost to the state.

SUSPENSION OF REGULATIONS

16. Compile and maintain a comprehensive list of all the regulatory waivers needed during a disaster to expedite suspensions in any future event.

The Governor's Office would implement this recommendation.

The Governor has broad authority to suspend statutes and rules that prevent, hinder or delay response efforts to a disaster. Even as Harvey was approaching, the Governor's Office was asking agencies for, and many agencies were requesting, waivers to allow response and recovery to proceed as quickly as possible.

The Governor's Office compiled a comprehensive list of the waivers requested and granted. The Governor's Office should ask appropriate state agencies to review this list for accuracy and completeness. The resulting list should be maintained for use when future disaster events require its activation.

Implementing this recommendation would not result in cost to the state.

UTILITY CUSTOMER BILLING

17. Increase utility customers' awareness of utility payment relief programs.

The Texas Division of Emergency Management and the Public Utility Commission (PUC) of Texas should implement this recommendation.

Hurricane Harvey created a number of utility billing issues for survivors and utility companies alike. The PUC has various responsibilities related to electric, water and sewer utilities.

Many customers experienced electric, water or wastewater outages from the storm, and these outages needed to be accounted for in the utility bills they received. Also, many homes in the affected areas were uninhabitable and some residents who evacuated or lost their jobs were unable to pay utility bills.

PUC has indicated that most utility companies have various programs that offer payment assistance to customers. In addition, PUC ordered electric providers to offer deferred payment plans upon request after Harvey. Relief for consumers on level billing plans may not be available in the same manner as for other utility plans, however. Level billing plans allow consumers to pay a level monthly charge to avoid big fluctuations in their bills. These consumers may be required to pay their monthly charge even if they were unable to occupy their residence for extended periods during the year.

Residents may not understand the disaster-related relief available and issues they might face if seeking relief while under a level billing plan. TDEM and PUC should take steps to help ensure utility customers are clearly informed about these programs during a disaster. Information on these programs should be part of emergency preparedness or consumer awareness campaigns. Clearly communicated information could help disaster survivors take advantage of these benefits and ease their financial situation.

A cost could be associated with this recommendation depending on the means used to increase the public's awareness of utility assistance programs.



A TX-TF1 Helicopter Search & Rescue Technician working aboard a Texas Military Department UH-60 Blackhawk conducts a hoist-rescue over Houston, Texas during Hurricane Harvey.

PURCHASING AUTHORITY OF THE TEXAS DEPARTMENT OF TRANSPORTATION

18. Grant the Texas Department of Transportation (TxDOT) authority to pre-purchase food and water and stockpile these essentials for each hurricane season.

Currently, TxDOT has no authority to purchase food and water before a formal disaster declaration from the Governor. In a case like Hurricane Harvey, however, the agency must begin mobilizing staff and other resources to the disaster area *before* the issuance of a disaster declaration.

To support mobilized staff as well as local district staff deployed in the disaster area, the agency should be able to purchase supplies before the Governor issues a disaster declaration. To achieve this end, TxDOT needs specific authority to pre-purchase essentials, primarily meals ready to eat (MREs) and water, and stockpiling these supplies in strategic locations in advance of each hurricane season.

TxDOT doesn't anticipate stockpiling large quantities of MREs or water because these supplies would be needed only during a storm and for a few days after it passes. TxDOT has indicated it would donate the leftover supplies at the end of hurricane season.

This recommendation would not have a significant fiscal impact. Once a disaster declaration is issued, TxDOT expenses are eligible for federal reimbursement.

LOCAL IMPEDIMENTS

19. Study and recommend ways to resolve restrictions of homeowner associations or local jurisdictions impeding debris removal or trailer placement for short-term housing during disasters.

The Legislature would be responsible for implementing this recommendation.

Debris removal received a great deal of attention after Harvey. Some homeowners covered by home owner associations (HOAs) found it difficult to get rid of debris because debris removal contractors working for local jurisdictions had no clear authority to enter areas considered private property.

The regulations and ordinances of some HOAs and local jurisdictions also played a role in the placement of trailer homes. As recovery began, HOA requirements and city ordinances sometimes prevented FEMA and its state partner, the General Land Office, from locating trailers in otherwise appropriate spots.

The Legislature should establish a study group to assess how local restrictions impede state and federal disaster recovery efforts. The Speaker and the Lieutenant Governor would appoint representatives from local, state and federal entities, as well as private groups and associations to identify solutions. The group would make its recommendations by November 1, 2020, in time for any necessary changes to be considered by the 87th Legislature in 2021. The group would sunset on January 1, 2021.

One solution for the study group to consider would be granting the Governor authority to suspend certain local requirements after a disaster to allow for debris removal and placement of temporary living quarters such as trailers in otherwise restricted areas for a limited, clearly defined time. The study group should seek broad input from local, state and federal entities and private groups and associations, to help identify appropriate solutions.

Implementing this recommendation would not result in cost to the state.



FEMA teams managing the distribution of water, and meals for hundreds of semi-trucks at an incident Support Base in Seguin, Texas, August 29, 2017. (Dominick Del Vecchio/FEMA)

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CHAPTER 7

7 BUILDING A MORE RESILIENT TEXAS

When he asked the Governor's Commission to Rebuild Texas to survey all local jurisdictions following Hurricane Harvey to develop an inventory of local needs to submit to Congress, Governor Abbott said that the commission should "identify the strategies, policies, practices and types of projects that would help 'future-proof' the entire Gulf Coast, protecting our cities, our rural areas, our industrial assets, and the homes of our fellow Texans."¹

In short, the commission's goal was to identify ways not only to repair the hurricane's damage but to make our state more resilient against future disasters.

To accomplish this task, the commission contacted cities, counties, school districts and other institutions affected by Harvey to develop a preliminary list of projects needed to help with the recovery and to build resilience. These projects were assessed by experts at the Texas A&M System along with representatives of the Governor's Office and the Texas Division of Emergency Management based on a set of criteria shown in **Exhibit 1 (next page)**.

This survey became the basis of a report Governor Abbott took to Congress in October 2017 as part of a request for federal financial assistance.

The commission views this list of projects as a conservative estimate, representative of the type and scope of damages known in September and October 2017, shortly after Harvey's landfall. Since the list was compiled, the commission has worked to develop a more rigorous approach to defining our needs for coastal mitigation, working with the Texas Division of Emergency Management (TDEM) to further refine the original list based on continuing discussions with local officials.

In the intervening months, as well, Congress acted to provide recovery funding, but the amount is nowhere near enough to meet Texas' actual needs. This is disappointing but not unexpected, given that Congress also was called on to provide recovery assistance for hurricanes-stricken Florida and Puerto Rico as well as wildfire areas in California. Nevertheless, the promised funding is a starting point and, combined with the

commission's comprehensive list, it points toward what can be accomplished now and what will need to be done in the future to better withstand the impact of future storms.

Commission researchers, led by experts at the Texas A&M University at Galveston Center for Texas Beaches and Shores, have studied various strategies for identifying projects and approaches to mitigate the impact of future storms on coastal Texas. This chapter discusses key strategies for building a more resilient state and an organizational structure for executing these strategies.

Of course, it is important to recognize that other parts of the state, at times, face a variety of emergencies including flash floods, tornadoes and wildfires. While the commission's work focused on the Gulf Coast and the impact of future hurricanes, the model presented here can easily be adapted to the entire state and the entire range of emergencies.

A COMPREHENSIVE FRAMEWORK FOR "FUTURE-PROOFING" TEXAS

As work continues on rebuilding the Texas Gulf Coast communities affected by Harvey, Texas' top priorities should be restoring the homes, businesses and infrastructure destroyed by Harvey, preferably in ways that make new construction more resilient than what was replaced.

The ultimate goal is to ensure that future development along the coast considers the potential impact of future disasters. Another priority is interjurisdictional coordination, to make sure fixing a

Exhibit 1. Project Selection Framework Post-Hurricane Harvey Needs Assessment, September-October 2017

Source: Texas A&M University at Galveston and the Governor's Commission to Rebuild Texas

1. Degree of Flood Impacts Avoided

- The project completely or substantially solves the problem.
- The project provides a permanent or long-term solution.
- Measures that, if not taken, will have a detrimental impact on the applicant, such as potential loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.
- Measures that have the greatest potential impact on reducing future disaster losses relative to a community's population.
- High level of urgency, where action needs to be taken quickly in order to prevent a risk from growing worse.

2. Economically Justifiable

- The project is likely to be cost effective based on physical damages prevented.
- Long-term economic benefits of losses avoided exceed up-front costs.
- The project shall not cost more than the anticipated value of the reduction in both direct damages and subsequent negative impacts to the area if future floods were to occur.

3. Technically Feasible

- The project is consistent with other plans, projects, initiatives, and state agency priorities.
- Project problem/issue is clearly defined and understood.
- The project is "shovel ready" in that it has been thoroughly evaluated, adheres to existing regulatory standards, and has demonstrated local support.
- The applicant community is a member, in good standing, of the NFIP.
- The project uses design and construction methods and materials that are approved, codified, recognized, fall under standard or accepted level of practice, or otherwise are determined to be generally acceptable by the design and construction industry.

4. Equitable and Fair

- The project is nondiscriminatory in its implementation.
- A range of income levels and population sizes are protected.
- The project provides equitable distribution of benefits geographically across impacted areas.
- The project is critically needed or otherwise significantly maximizes public benefits, enhances public safety, and reduces state liability.
- The project adheres to community development housing goals

5. Environmentally Sound

- The project will not create significant adverse environmental impacts.
- The project, when implemented, does not increase storm-water runoff or peak flows in surrounding areas.
- The project includes the protection or restoration of natural resources that provide critical ecosystem services (e.g. wetlands, riparian areas, dune systems, and so on).
- The project considers cumulative impacts at a watershed level and does not adversely impact "down-stream" communities.

problem for one jurisdiction doesn't create a problem for its neighbor.

In this sense, the framework used in the post-Hurricane Harvey evaluation can be briefly summarized into the set of guiding principles shown in **Exhibit 2**. These principles largely can be extended to all parts of the state that experience periodic problems with disasters that not only include hurricanes, but also tornadoes, flooding, windstorms and other emergency situations.

"Future-proofing" Texas should involve a mix of mitigation activities, ranging from improved drainage infrastructure and land acquisition to risk communication programs. The specific portfolio of techniques will depend on the characteristics of each local jurisdiction, but should draw from a common set of approaches.

This framework rests on four basic mitigation approaches based on the concepts of *avoid*, *resist*, *accommodate* and *communicate* (**Exhibit 3, next page**). Avoidance requires moving development away from vulnerable areas; resistance means holding back wind

or flood waters; accommodation entails allowing flooding or disaster impacts to occur in specific areas; and communication is about making sure residents understand risk and how to reduce its potential impacts. The following discusses these techniques and some of strategies that can be used to implement them.

AVOIDANCE

An *avoidance* approach to reducing flood risk involves removing development or steering it away from the most vulnerable areas, such as the 100-year floodplain or flood surge zones. While complete retreat may not be possible, the idea of avoiding specific flood-prone areas is gaining widespread acceptance.

Avoidance can be *vertical*, elevating structures and people above anticipated flood levels; or *horizontal*, pulling back from or banning construction in the most flood-prone areas. Some key avoidance strategies include the following:

1. Establish state standards or best practices to elevate structures above the base flood elevation in flood-prone areas.

In low-lying areas such as the Texas coast, the elevation of a structure is a significant factor in determining its risk of flood damage. Inches quite literally can make the difference in a home's survival.

One critical avoidance technique is the adoption of freeboard standards in local floodplain ordinances. Communities participating in the National Flood Insurance Program (NFIP) already must elevate new residential buildings in a 100-year flood plain up to or above the base flood elevation (BFE), the level flood waters are expected to reach in a 100-year flood. Many communities, however, have decided that elevation to the BFE does not provide sufficient protection from floods, since:

- the BFE does not account for the impacts of future development, increasing rainfall, subsidence or sea level rise;
- flooding above the BFE already occurs on a regular basis;
- most flood studies do not account for debris or obstructions that can damage homes built to the BFE standard; and,
- in non-coastal areas, BFE elevation is measured at the top *surface* of the lowest floor, leaving the flooring, subfloor and floor joists vulnerable to the base flood.

Exhibit 2. Guiding Principles for "Future-Proofing" Texas

Source: Texas A&M University at Galveston and the Governor's Commission to Rebuild Texas

- **Support future growth and development** while reducing the potential for losses in the event of disaster.
- **Prioritize the rebuilding of damaged structures** or the **permanent relocation** of those destroyed, while planning for future population growth and development.
- **Protect socially vulnerable communities.**
- **Protect and enhance critical ecological systems** that contribute to resilience in case of flooding or other disasters.
- **Consider the cumulative impacts** of development and flood mitigation activities, particularly on neighborhoods and downstream communities.
- **Collaborate across jurisdictional and organizational boundaries** to develop a regional approach to flood mitigation.
- **Foster the development of hazard mitigation** methods that use a mix of strategies to reduce the impact of disasters on the state, its communities and rural Texas over time.

Exhibit 3. Basic Mitigation Strategies for Future Hurricanes

Source: Texas A&M University at Galveston and the Governor’s Commission to Rebuild Texas

AVOID	RESIST	ACCOMMODATE	COMMUNICATE
• Elevate (fill or piers) • Open space protection • Buy-outs/land acquisition • Relocation • Buffers/setbacks • Incentivize development • Transfer dev rights • Density bonuses • Tax incentives • Spatially-targeted development	• Reservoirs • Dikes/barriers • Hardening/channels • Dams • Construction of natural features • Household flood-proofing	• Detention/retention • Storm drainage • Wetland protection/restoration • Break-away walls	• Disclosure • Web tools/apps • Street drain sweep program • University Center for Flood Risk Reduction

To achieve an extra margin of safety, homes can be raised to an even higher level. This additional height usually is expressed as *freeboard*, the number of feet the first floor of a building is raised above the base flood elevation. A freeboard requirement provides an extra margin of protection that accounts for waves, debris, changing future weather conditions and new development, as well as a general lack of accurate data. For example, a freeboard requirement of one foot means that the lowest floor (or lowest horizontal structural member) is one foot above the base flood elevation. Freeboard requirements can be adopted by entire states or individual communities.

Before adopting freeboard standards, the costs and consequences of building higher must be considered. According to a study conducted by the Association of State Floodplain Managers (ASFPM), for example, the approximate cost of elevating a 2,000-square-foot house higher than the BFE is between \$890 and \$4,470 per foot (**Exhibit 4**). Costs vary by foundation type and some approaches, such as using fill, can adversely affect surrounding residences by changing drainage patterns.

Freeboard requirements can be costly if the structure is a “slab on grade” design (that is, a concrete slab poured over excavated soil). The upfront costs, however, usually are offset by avoided flood losses over time. For example, a national study by Wes Highfield and Sam Brody of Texas A&M University at Galveston showed localities adopting freeboard standards each saved about \$800,000 in flood losses annually.² In all, the study found freeboard requirements to be the most effective of all mitigation strategies in terms of avoiding

flood damage to residential structures.

Another study examining the effectiveness of mitigation techniques in the Clear Creek watershed southeast of Houston also validated the use of freeboard standards.³ The authors found that, when communities within the watershed adopted higher standards such as freeboard to protect residential structures, property owners avoided an average of more than \$21,000 in property damage per parcel. A more recent analysis conducted by the city of Houston found that, if the city had had a two-foot freeboard standard in place for its 500-year floodplain, 84 percent of the homes flooded by Harvey would have remained dry.⁴

Freeboard standards also can lower homeowner insurance costs. Elevating structures so that they are considered outside the base flood area significantly lowers required federal flood insurance rates.

A recent ASFPM analysis, for example, found that

Exhibit 4. Cost of Freeboard Elevation

Source: Association of State Floodplain Managers

FOUNDATION TYPE	COST PER FOOT
Concrete block piers	\$890
Crawlspace with concrete block walls	\$1,850
Crawlspace with poured concrete walls	\$2,155
Stem wall with fill	\$2,345
Fill only	\$4,470

building a 2,000-square foot home two feet above the BFE (with fill underneath) would reduce annual flood insurance premiums by an average of more than \$1,400. The cost of the elevation would be offset by just 3.3 years of premium savings, and would yield \$37,300 in savings during a 30-year mortgage.⁵ Similarly, a 2011 analysis by FEMA calculated that spending an additional \$12,000 to elevate a structure three feet above the BFE would save a homeowner more than \$151,000 in insurance premiums during a 30-year mortgage.⁶

Homeowners can enjoy further premium reductions if their jurisdiction participates in FEMA's Community Rating System (CRS), which offers discounted flood insurance premium rates for freeboard requirements. Structure elevation has become such a cornerstone for flood mitigation programs that a one-foot freeboard standard soon will be a prerequisite for communities that want to participate in the CRS program.

Freeboard requirements also offer several benefits. For example, a home built or retrofitted to freeboard standards may become more valuable at the time of sale due to lower risk and lower insurance costs, particularly when surrounding structures have flooded before. And while elevating structures may be expensive in the short term, it's generally far less expensive than demolition and relocation — and the property continues to generate taxable revenue.

As of 2015 (most recent available data), 21 states and the District of Columbia had adopted freeboard requirements; Texas is not among these. In addition, 596 local communities, 51 of them in Texas, had adopted freeboard standards of between one and three feet through building codes and floodplain ordinances. In all, more than 61 percent of the U.S. population was covered by some freeboard requirement to reduce the adverse impacts of floods in 2015.

Exhibit 5 (next page) shows the residential freeboard requirements in cities and counties within the greater Houston area as of 2017. Harris County has the strictest regulation, requiring two feet of freeboard above the 500-year floodplain, recently changed from 18 inches above the 100-year floodplain. The cities of Pasadena, Baytown, and Brazoria County require properties to be two feet above the 100-year floodplain.

2. Avoid the use of fill dirt to elevate structures for development in high-risk areas, and develop best practices for its use when necessary.

Another vertical avoidance strategy is the use of fill dirt to raise individual or multiple lots in a new subdivision above the BFE. It's particularly common in sprawling urban areas facing significant pressure to build in floodplains. A major advantage of fill is that it can be combined with additional avoidance measures, such as crawlspace foundations on compacted fill material, to provide a higher level of flood protection.

Fill has been widely used in the U.S. for this purpose since the 1980s; about half of all development in U.S. floodplains is either filled or elevated. In the Houston metropolitan area, almost 7,000 parcels were filled or approved for fill between 1999 and 2014 alone.

Despite its advantages, however, FEMA does not permit the use of fill in developments near river channels or in areas prone to high-velocity storm surge due to the risk of foundation failure. The use of fill in floodplains, moreover, increases the flood risk in adjacent or downstream areas that *haven't* been filled by altering flow patterns and restricting natural flow pathways.

For these reasons, the use of fill generally should be avoided. When necessary, however, its impacts should be minimized by making provisions for compensatory water storage in detention ponds near filled subdivisions. Several cities and counties along the coast have fill requirements in place that could serve as models for other jurisdictions. Harris County, for example, requires developers to offset fill by creating an equivalent amount of water storage, typically through on-site detention. Such rules reduce adverse impacts but do not eliminate them. Developers sometimes use fill to raise a structure to or above the BFE to reduce required insurance premium costs. Yet Texas has seen a great deal of flooding above 100-year levels, and the 100-year predicted flood is only an estimate.

Exhibit 5. Freeboard Requirements for Cities and Counties in the Greater Houston Area, 2017

Source: Greater Houston Flood Mitigation Consortium

CITY/COUNTY	FLOODWAY	INSIDE 100-YEAR FLOODPLAIN	OUTSIDE 100-YEAR FLOODPLAIN
City of Houston	1.5 ft above 100-year flood	1 ft above 100-year flood	1 ft above nearest sanitary sewer or 4 in above crown of street
City of Pasadena	Prohibited	2 ft above 100-year flood. No critical facilities	1 ft above nearest sanitary sewer or 4 in above crown of street
City of Baytown	2 ft above 100-year flood	2 ft above 100-year flood	1 ft above nearest sanitary sewer or 4 in above crown of street
City of Sugarland	1 ft above 100-year flood	1 ft above 100-year flood	1 ft above nearest sanitary sewer or 4 in above crown of street
Missouri City	1 ft above 100-year flood	1 ft above 100-year flood	1 ft above nearest sanitary sewer or 4 in above crown of street
League City	1.5 ft above 100-year flood	1.5 ft above 100-year flood	1.5 ft above crown of street or adjacent grade
Harris County (new)	2 ft above 500-year flood	2 ft above 500-year flood	1 ft above adjacent grade
Fort Bend County	1.5 ft above 100-year flood	2 ft above natural ground or 1.5 ft above 100-year flood	
Montgomery County	1 ft above 100-year flood	1 ft above 100-year flood	
San Jacinto County	1 ft above 100-year flood	1 ft above 100-year flood	
Liberty County	1 ft above 100-year flood	1 ft above 100-year flood	
Galveston County	0 ft above 100-year flood	0 ft above 100-year flood	
Brazoria County	2 ft above 100-year flood or natural ground	2 ft above 100-year flood or natural ground	
Grimes County	0 ft above 100-year flood	0 ft above 100-year flood	
Waller County	1.5 ft above 100-year flood	1.5 ft above 100-year flood	
Walker County	1 ft above 100-year flood	1 ft above 100-year flood	



Highest Regulation

Least/No Regulation

Note: A “floodway” means the channel of a river or stream plus the adjacent land needed to carry floodwaters. Communities may regulate development in floodways to ensure that there are no increases in the height of flooding upstream of the floodway after a major rainfall as floodwaters accumulate behind structures in or near the floodway.

3. Identify properties in high flood-risk areas for city and county voluntary purchase and relocation programs.

Public purchases of flood-prone properties, to remove residents from harm's way while compensating them financially, usually are called "buy-outs." Buy-outs can return the land to its natural flood function while creating open-space amenities for nearby residents. It's important to note homeowners would have to request or volunteer for a buy-out, and only the most chronically and severely damaged properties should be considered.

The largest and most comprehensive program for such buy-outs is FEMA's Hazard Mitigation Grant Program (HMGP). Under this program, FEMA provides 75 percent of the funds needed for a buy-out and requires a 25 percent match from a local government containing the land being acquired. (HMGP funding also can be used to elevate structures rather than purchase them outright.) Land acquired through an HMGP buyout can't be developed again, but instead must be used for one of several purposes specified by FEMA, such as wetland restoration, wildlife refuges, gardens and campgrounds.⁷

Every property slated for HMPG funding must undergo a cost-benefit analysis showing that the estimated cost of future flood damage surpasses the cost of purchasing and demolishing the structure. In 2013, these analyses were changed to include a more comprehensive understanding of flood risk and the benefits of open green space. FEMA estimates the benefits communities gain from open space preservation — including flood hazard reduction, erosion control, habitat preservation, recreation and other advantages — at \$2.57 per square foot annually for open green space and \$12.29 annually for land near waterways.⁸

Between 2004 and 2016, more than 10,000 voluntary property acquisitions were completed nationwide under the HMGP program.⁹ The process is relatively straightforward. A local government affected by natural disaster submits an application for land acquisition to FEMA, which determines whether or not the land is eligible.¹⁰ In the aftermath of Hurricane Sandy, for example, homeowners received the value of the home before it was damaged and an additional 10 percent if the home is in a high-risk area; 5 percent more if the owner stays in the same county when they relocate; and 10 percent more if the purchase is part of a group buyout.¹¹ Group buyouts are preferable because they prevent a checkerboard pattern of empty lots.

Since its inception, the program has invested about \$555 million in Texas to acquire or elevate 4,386 properties. Of that total, 1,618 are located in the Harvey impact area, with FEMA-funded project costs estimated at \$205 million. According to FEMA, this investment prevented \$330 million in potential losses during Hurricane Harvey, a return of \$1.61 for every federal dollar spent on these projects.¹²

In response to 2008's Hurricane Ike, Galveston County has acquired 561 coastal properties through the HMGP program. In 2014, Friendswood used \$16.2 million in HMGP funds to purchase 114 single-family homes. Between 2014 and 2015, the city of Pearland used \$9.3 million in HGMP funding to acquire 82 single-family homes. Jefferson County has used HGMP to purchase 106 properties in Beaumont for flood mitigation.¹³

Harris County, however, leads the nation both for property buyouts for flood mitigation and dollars spent, receiving nearly 14 percent of the nation's HMGP acquisition and demolition funding since 2004. Since 1997, the Harris County Flood Control District (HCFCD) has spent nearly \$340 million, mostly in federal funds, to acquire more than 2,500 properties. Since Harvey, HCFCD has identified 200 more buyout-eligible homes that flooded during the storm.¹⁴

Returning chronically flooded properties to a more natural state can help maintain their water storage capacity.¹⁵ And of course, open-space protection can prevent homes from being built in flood-vulnerable locations in the first place. This approach also has significant potential to enhance ecological, recreational and aesthetic values.

Regulations that prevent development along waterways and wetlands are particularly useful for creating areas that collect storm water runoff while promoting public access. One national study found that communities that protect open spaces avoid an average of about \$200,000 annually in insured flood losses.¹⁶

Multiple studies have found that preventing development near river systems also protects natural wetlands that absorb and store flood waters.¹⁷ An analysis in coastal Texas counties, by contrast, showed that wetland alteration added more than \$38,000 in property damage per flood.¹⁸

Buy-outs and open-space protection in vulnerable areas will be an important component of any effective flood risk reduction strategy in Texas. A bond issue approved by Harris County voters in August 2018, which when coupled with outside funding, could allow the purchases as many as 3,600 buildings in flood-prone areas.¹⁹ The total

would be more than the Harris County Flood Control District has purchased in its 33-year history.

It's important to recognize, however, that buy-out programs aren't without their problems. Buy-outs remove property from the tax rolls, often meaning a permanent loss of taxable value — and therefore local revenue — since most buyout programs require the land to remain as green space and not be put to other (taxable) uses. Moreover, since buy-out programs often are voluntary, programs may not encompass all of the land in an area, leaving the “checkboard” pattern mentioned above.

4. Establish regulations to ensure new development does not cause flood damage in adjacent or downstream properties.

The Texas coast is one of the nation's fastest-growing regions. Greater Houston alone added about 159,000 people between 2014 and 2015.²⁰ Rapid population growth brings roadways, rooftops, parking lots and other impervious surfaces that lead to greater flood losses downstream through increased flood peaks, higher flood volumes and velocities and increased erosion and sedimentation.²¹

The proliferation of impervious surfaces in watersheds has long been considered a major contributor to flood damage.²² It leads to reduced soil infiltration and increased surface runoff and peak discharge in nearby streams.²³ Storm water runoff within a drainage basin can nearly double with only a 10 to 20 percent increase in impervious surfaces.²⁴ Because paved surfaces reduce the lag time between the center of precipitation volume and runoff volume, floods peak more rapidly.²⁵ For example, peak discharge increases by about 80 percent in urbanized water catchments.²⁶

In all, a host of studies suggest that increased surface runoff and resulting peak discharges due to impervious surfaces can increase the frequency and severity of flooding. One Texas A&M study found that an increase in impervious surfaces coincided with a significant increase in stream flow during a 12-year period across 85 coastal watersheds in Texas and Florida.²⁷ Another study of 37 coastal counties in Texas found that each square meter of impervious surface added to the landscape translated into about \$3,602 of additional property damage due to floods annually from 1997 to 2001.²⁸

For these reasons, development regulation in areas near flood and storm-surge zones should *require* a consideration of impacts on downstream communities, even if they lie outside the community's regulatory jurisdiction.

For example

The Houston neighborhood of Meyerland is one of the state's most chronically flooded areas. Meyerland was built largely in the 1970s. Upstream development since has contributed to an expanding floodplain boundary as more runoff enters the local drainage system of Brays Bayou. In the 1980s, the mapped 100-year floodplain was confined to bankside areas; today, the floodplain encompasses the *entire* neighborhood, making it highly vulnerable to flooding during heavy rainfall.

5. Establish collaborative efforts to promote watershed-wide planning and risk management.

Storm runoff and drainage usually occur within areas called watersheds, areas separated by ridges or other elevations that divide waters flowing to different rivers or basins. Watersheds vary in scale and generally are nested within one another. The U.S. Geological Survey has delineated watersheds across the entire U.S. at different scales, ranging from small lakes to areas encompassing thousands of square miles.

Small to medium-sized watersheds make ideal planning units for addressing flood problems; unfortunately, they don't follow jurisdictional or administrative boundaries. Local regulation, then, often is uncoordinated and disconnected, creating a patchwork of flood mitigation strategies.

Effective flood risk reduction thus requires *collaboration at the watershed level*. Improved coordination within and among governments can help minimize duplicative and conflicting regulation, make better use of taxpayer dollars and improve actual outcomes. Such coordination should include communication, data sharing, the establishment of informal networks and joint project management.²⁹ Through collaboration, decision-makers from multiple jurisdictions can ensure their actions don't increase flood risks for those living downstream.

Several Texas entities already focus on watershed units, although not specifically for flood or storm risk reduction. Existing broad-based state-local initiatives provide important models for how the state could

establish a watershed-based flood management program featuring collaboration across multiple local jurisdictions. Effective flood planning ultimately will require a *heavy* emphasis on collaboration.

For example

Montgomery County, the San Jacinto River Authority, the city of Houston and the Harris County Flood Control District have proposed a \$2.5 million collaborative watershed study for the San Jacinto River basin. Its goal will be to integrate flood-warning information into a shared system; coordinate with flood responders to develop a consistent communications protocol and action plan; recommend strategies to reduce flood risk; and develop programs that educate decision-makers and the public on conditions within the basin.³⁰

6. Use regulation and incentives to steer development away from high flood-risk areas.

Many disaster-avoidance strategies attempt to guide development away from flood and tidal surge zones and other vulnerable locations. Such strategies include both regulatory (“push”) and incentive-based (“pull”) policies. In many cases, local management plans already use these tools to protect critical natural habitat; they can be expanded or modified to cover flood mitigation as well.

Regulatory techniques include strategies such as development restrictions or buffers around critical areas where development should be avoided due to extreme flood risk. Buffer distances can range 50 to more than 1,000 feet depending on the specific location.³¹

Incentive-based mitigation policies “pull” development toward less vulnerable areas in exchange for less development on chronically flooded parcels. “Clustering” provisions, for instance, concentrate homes in a specific portion of a land parcel. Density or building height bonuses in less-sensitive areas also can help focus new development in a flood-resilient manner, as can transferring development rights from the floodplain to areas in higher elevations. Finally, placing public infrastructure such as sewer and water lines in the least flood-prone areas within a community will encourage safer development over time.

For example

In October 2013, the Austin City Council passed a watershed protection ordinance focusing on environmental concerns and floodplain management. A core part of the ordinance was the adoption of more than 400 miles of stream buffers to maintain natural drainage systems and block development from floodways. Similarly, Cameron County has created a Coastal High Hazard Zone with a 200-foot buffer landward of the FEMA defined V-zone (FEMA defines V-zones as coastal areas subject to inundation by a 100-year flood and storm-induced waves).

RESISTANCE

A second major part of disaster-proofing is to resist, whenever possible, the intrusion of flood waters into human settlements. Resistance strategies usually involve large-scale construction projects that actively protect communities in vulnerable areas, such as levees, sea walls and channels that control river flows. Such structures are most appropriate in areas that already have high-intensity development or critical facilities such as oil and gas production or power plants.

The most significant drawback of these structures is that they can be expected to fail when the flood exceeds their design limitations. This “stand and fight” approach, moreover, often requires large investments to ensure effective operation and maintenance in the long term.

Key resistance strategies include the following

1. Develop a strategic plan for flood control infrastructure that includes *long-term* investments in maintenance and replacement.

The American Society of Civil Engineers’ (ASCE’s) 2017 *Infrastructure Report Card* for Texas highlighted growing needs for flood control infrastructure to combat both rain- and surge-based flooding. The state’s existing dams and flood control infrastructure received a grade of “D: Poor, at Risk.” ASCE stated that many elements of this infrastructure are approaching the end of their design lives, with large numbers exhibiting significant deterioration and increasingly high risks of failure.

Dam failures can cause catastrophic impacts. According to ASCE, Texas has 1,263 “high-hazard dams” that could cause deaths if they fail; more than 75 percent of these were built before 1975 and many

have no maintenance or inspection programs.³² A changing climate, with its increased river runoff, more severe precipitation events and sea level rise, will make it crucial to strengthen these dams and related infrastructure such as levees, reservoirs, floodgates and storm drains.

The Harvey-affected region in particular is in dire need of a strategic plan for flood control infrastructure, including investments in long-term maintenance and repair as well as new infrastructure.

2. Build flood defenses to protect key economic assets and major population centers from storm surge and major floods.

Surge-based events such as Hurricane Ike (2008) highlight the need for systematic coastal protection to sustain Texas' barrier islands and reduce the vulnerability of critical communities and industrial facilities further inland.

Mobile floodgates and storm surge barriers represent an increasingly common resistance strategy worldwide. These consist of adjustable gates designed to prevent a storm surge or high tide from flooding a protected area behind the barrier. At the mouths of estuaries or river outflows, they allow water to pass through under normal conditions but can be closed in the event of an impending storm. Such barriers usually are integrated into a larger flood-protection system comprising dikes, levees and other mitigation strategies.

Floodgates have been in use in coastal areas around the globe for decades, and storm surge barriers have been used to areas such as New Orleans, the Netherlands, Saint Petersburg, Russia, parts of England and, in the near future, Venice, Italy.³³ These structures can eliminate the threat of storm-surge flooding without significant environmental impacts, but they're expensive and difficult to build. Once in place, they require long-term investment in maintenance.

THE "COASTAL SPINE"

Texas A&M University at Galveston has proposed a comprehensive storm-surge barrier, or "coastal spine," at the entrance of Galveston Bay, to protect key residential areas and industrial assets in the Houston-Galveston region (**Exhibit 6**).

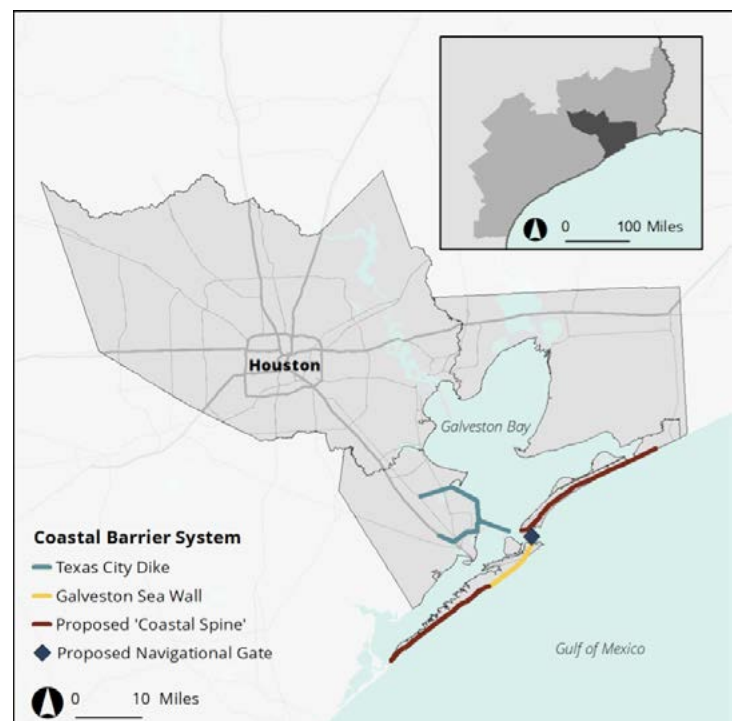
Creating the coastal spine would involve extending the existing seawall on Galveston Island northeast to High Island and southwest to San Luis Pass, and

building a movable gate system, similar to those used in the Netherlands, to prevent rising waters and storm surge from entering Galveston Bay and the Houston Ship Channel. The entire system would include a 57-mile-long land barrier at 17 feet above sea level and two 22-foot-high movable gates stretching across the mouth of Galveston Bay for about 2.5 miles. The coastal spine would dampen hurricane storm surge and associated wave action and could prevent storm surge events in the event of a future sea level rise.

Recent economic studies evaluated the effectiveness of a coastal spine system against a range of different storm intensities in reducing potential losses in the Houston-Galveston area. One examined the impact of the proposed system against data from four different historical storms and found a 70 to 95 percent reduction in losses in the three counties surrounding Galveston Bay.³⁴ Depending on the strength of the modeled storm, these reductions imply \$400 million to \$7 billion in savings per storm. Avoided losses were most pronounced in the case of a hurricane similar to Ike. In such a case, coastal protection could prevent more than 95 percent of residential damage from storm surge (\$2.8 billion).

Exhibit 6. Galveston Island and the "Coastal Spine": Proposed Components

Source: Texas A&M University



Another study that factored in industrial and indirect impacts showed similar benefits. The authors found that, on average, the coastal spine could:

- prevent 86 to 91 percent of total economic losses, both direct and indirect, induced by storm surge in a 500-year storm;
- 79 to 84 percent in a 100-year storm; and
- 100 percent of losses in a 10-year storm.³⁵

The coastal spine's estimated engineering cost is significantly lower than other federally funded flood control structures, including the levee system in New Orleans, but the investment is still sizeable. It's important, then, to understand the *benefits* of such an investment.

The cost of the coastal spine has been estimated at about \$8 billion (with lower and upper estimates of \$4.7 billion and \$11.4 billion).³⁶ These are one-time construction costs for a coastal system with an estimated lifespan of 100 years. Under all cost scenarios, the study found that annual costs were lower than the average annual *benefits* of damage avoidance, indicating a sound economic case.

Changing environmental and human conditions are creating a situation in which the economic impact of storms hitting Texas will rise exponentially. One study considered the effectiveness of the proposed coastal spine system under conditions predicted for 2080.³⁷ The predicted conditions included a conservative estimate of a 2.4-foot sea level rise in Galveston Bay and projected development patterns in the Houston region based on current trends. Through 2080, the authors expect:

- a 148 percent increase in the number of residential structures;
- a 125 percent rise in flood exposure for 100-year events and a 143 percent rise for 500-year events;
- a 262 percent increase in residential flooding exposure for 100-year events and 271 percent for 500-year events;
- and, with the presence of a coastal spine, an 80 percent reduction in residential damage (from \$18.8 billion to \$3.7 billion) for a 100-year storm and 81 percent (from \$31.8 billion to \$6 billion) for a 500-year event.

While the study indicates a protective coastal surge barrier would significantly reduce losses well into its 100-year life, the cost of doing nothing escalates with each passing year. For example, if Hurricane Ike were to strike the upper Texas coast in 2080 with no protection

in place, the estimated residential losses would be 200 percent higher than those of 2008.

A coastal spine would have done little to stem the severe flooding and associated losses from Hurricane Harvey, since the storm was primarily a rainfall event for the Houston and Beaumont areas. But any systematic and comprehensive attempt to future-proof Texas against storms should consider *all* types of flood events, from the sky *and* the sea.

3. Establish “resilient” building codes for all new structures on the Texas coast.

Outdated building codes and local ordinances contribute to wind and flood damage. Updating and improving these regulations would make the Texas coast more resilient.

In Texas, the responsibility for managing flood risk lies primarily with local governments. In 1999, the Texas Legislature amended the Texas Water Code to allow the governing body of each city and county to adopt ordinances necessary for participation in the NFIP.³⁸ Once a community adopts a flood damage prevention ordinance as required by the NFIP, it assumes responsibility for floodplain management within its corporate limits.

Communities may adopt the model ordinance that best fits their flood risks, and can choose to adopt higher standards than those required to increase their protection. As a consequence of this flexibility, local building and development regulations on first-floor elevation, fill and foundation type vary across the Harvey-affected area. Texas does not have a model or best-practice ordinance for use by coastal communities; such an instrument could serve as a common standard for increasing local resiliency to future floods.

Regulations that reduce the adverse effects of wind on structures are found primarily in codes maintained by the International Code Council (ICC). Rather than create and maintain their own codes, most states and local jurisdictions adopt the model building codes maintained by the ICC and amend them as needed prior to adoption. Several types of ICC codes are available to communities, with the International Residential Code (IRC) containing most of the provisions concerning family dwellings.

Texas has adopted the 2006 edition of the IRC as its minimum standard for residential construction, although local jurisdictions may choose to adopt and enforce more recent editions. Texas has no state mechanism for enforcing any version of the IRC.³⁹

The Insurance Institute for Business & Home Safety's (IBHS') 2018 *Rating the States Report* ranks Texas 15th out of 18 coastal hurricane-prone states for code enforcement and contractor licensing.⁴⁰ To obtain insurance coverage through the Texas Windstorm Insurance Association (TWIA), however, homes must comply with the building code in force at the time of their construction.

Florida, by contrast, has adopted the 2015 IRC and ranked first in the 2018 IBHS report. Florida *requires* the use and enforcement of this code throughout the state, as well as the certification and training of code enforcement officials and licensing and continuing education for building contractors. As a result, code enforcement in Florida tends to be consistent.

For example

In 2009, Beaumont updated its city building code to make its future building stock more wind-resistant. Under the new code, structures must be able to withstand wind gusts of up to 110 mph for three seconds. Builders must use metal plates called "hurricane straps" to fasten the roof to the frame and anchor bolts to secure the frame to the concrete slab. The code also requires roofing nails of sufficient length to attach shingles to the roof. In Port Arthur, the code stipulates resistance to 120 mph gusts, while homes on the Bolivar Peninsula must meet a 130-mph standard.⁴¹

4. Identify critical facilities facing high storm risks and plan to ensure their protection.

Critical facilities such as water treatment plants, hospitals, fire stations and power plants should be built or retrofitted to ensure these "lifeline" services continue to function in the face of disaster. Systematically assessing storm risks and identifying protection strategies for each location will be major steps toward increasing disaster resilience.

For example

Houston's Texas Medical Center (TMC) is the world's largest medical complex. During Tropical Storm Allison in 2001, severe flooding caused more than \$1.5 billion in damages to TMC, as well as the loss of decades of medical research. In response, the center developed a hazard mitigation plan (HMP) to minimize the impact of future floods by protecting facilities to the 500-year flood level. The HMP

included improving, elevating or relocating electrical and mechanical equipment; improving local storm water infrastructure, which included enlarging a nearby detention pond; and installing more than 50 floodgates and submarine doors (large watertight doors to prevent flood waters from entering buildings). The system successfully protected the TMC from flooding during Hurricane Harvey and allowed it to remain operational.

5. Encourage communities and their residents to adopt the most advanced household flood-proofing techniques for residential structures.

Large-scale structural interventions should be coupled with flood-proofing measures in individual buildings. Flood mitigation at the household level has become more common in the last few decades due to government regulations, incentives, outreach programs and, perhaps, an increasing sense of personal responsibility. These options provide a useful complement to larger-scale mitigation measures and offer another layer of protection.

Household adjustments include a broad spectrum of activities, ranging from expensive structural modifications to simply disseminating information on the nature of flood risk within particular neighborhoods. In terms of the expense, time and effort involved, residential mitigation techniques can be placed in three categories: major structural changes; behavioral changes with minor structural modifications; and information gathering and exchange (**Exhibit 7, next page**).

Structural techniques include elevating the structure (usually above the BFE), constructing earthen berms, installing movable floodwalls and dry flood-proofing a home to prevent water from entering (by using sealants or impermeable barriers). *Behavioral changes with minor modifications* involve "wet flood-proofing," allowing flood water to enter a home but relocating critical features and valuables out of harm's way, with features such as breakaway walls, garage vents, anchoring mechanisms and mold-resistant insulation. Finally, adjustments relying purely on *information gathering and exchange* include attending meetings, communicating with government agencies and other activities that increase residents' awareness of their flood risk. The latter activities require little or no cost but can help reduce flood losses over the long term.

Exhibit 7. Household Adjustment Techniques for Flood Risk

Source: Federal Emergency Management Agency

MITIGATION TECHNIQUES		DESCRIPTION
Structural techniques		
Elevation		Elevating the entire house or building a new, elevated floor within the house
Earthen berms		Constructing a small barrier around a house to keep waters from reaching it
Flood-proofing (dry)		Adding a waterproof veneer to exterior walls; sealing doors to prevent water entering
Behavioral changes with minor modifications		
Flood-proofing (wet)		Intentionally allowing flood waters to enter to protect the building from major structural damage, through the use of breakaway walls and other features
Second-floor storage		Moving valuables and service equipment to a second floor to minimize flood damage
Information gathering and exchange		
Contacting government agencies		Seeking information about flood hazards
Attending meetings		Learning about flood hazards

ACCOMMODATION

A third category of the future-proofing framework for Texas involves *accommodating* flood waters, allowing or even encouraging flooding in specific areas or under certain conditions. Such strategies can allow communities to coexist with periodic flooding by providing a “safety valve” for excessive runoff.

1. Enhance natural storm water drainage and storage across flood-prone landscapes.

Natural landscape features such as wetlands, river areas and forests collect, store and slowly release storm water. They can significantly reduce losses during small to moderate flood events caused by rainfall. According to the U.S. Environmental Protection Agency, one acre of wetlands can hold from 1 to 1.5 million gallons of water.⁴²

Multiple studies in Texas have shown the value of naturally occurring wetlands in reducing property loss during flooding.⁴³ As noted above, wetland alteration permits have been shown to add an average of more than \$38,000 in property damage per flood to a jurisdiction.

For example

The Gulf-Houston Regional Conservation Plan, a collaborative effort of environmental, business and governmental entities, is working to preserve and protect undeveloped land in the eight-county Houston-Galveston area. Its primary focus is on nature-based infrastructure, including wetlands and river areas that can reduce runoff and slow floodwaters, and marshes and dunes that can reduce storm surge and resist sea-level rise. The plan’s goal is to preserve nearly 1.2 million acres of nature-based infrastructure in the area.⁴⁴

2. Improve and enhance existing storm water drainage and storage facilities.

Retention and detention facilities that collect storm water can significantly reduce flood impacts, particularly in developed areas. *Detention areas* usually are vegetated depressions hidden behind houses, possibly used as playing fields in dry periods. They hold water for a short time during flood events and usually remain dry at other times. *Retention ponds* always contain water and store floodwaters by allowing them to infiltrate slowly. They're often placed in full view as amenities, essentially artificial lakes. While retention ponds can add more value to a community, greater attention must be paid to maintaining proper water levels in them during heavy rains. Retention ponds and detention areas are most effective in well-planned communities that place them for maximum effect.

In Texas, each county and city can establish its own detention requirements for new development. The volume of storage required differs by jurisdiction and depends on the area's soils as well as its existing floodwater storage system. In Harris County, developers are required to provide detention storage for 0.55 acre-feet per acre of developed land for developments of between two and 640 acres, and 0.45 acre-feet per acre for larger developments.⁴⁵ Fort Bend County has stricter regulations, requiring 0.62 to 0.98 acre-feet per acre of development depending on the amount of impervious cover.⁴⁶

Most counties also stipulate maximum release rates from on-site detention ponds. These vary based on storm frequency and typically are regulated for 10- or 25-year and 100-year storms. The purpose of maximum release-rate regulations is to ensure that on-site

detention ponds slow down overland drainage during storms, and that new development doesn't overwhelm the capacity of the receiving body of water. Although most Texas counties require maximum release rates from on-site detention ponds to be less than or equal to pre-development flows, these rates differ (**Exhibit 8**). For example, Harris County's maximum 100-year storm release rate is 2 cubic feet per second (cfs/acre), versus only 0.125 cfs/acre in Fort Bend County.⁴⁷

In theory, such differences are due to differing topography and watershed conditions, but also may be attributable in part to local preference.

Several studies across the U.S. have documented the effectiveness of on-site detention in mitigating the impacts of urbanization. For example, a study across 31 watersheds in North Carolina and Virginia found that detention systems could partially mitigate peak-flow increases caused by urbanization.⁵¹ A Georgia study reached similar conclusions.⁵²

Even so, on-site detention may not completely mitigate increasing flood risks associated with urbanization. A recent study in the Houston region found that, even when assuming compliance, existing detention requirements were not sufficient to fully offset the impact of new development.⁵³

For example

Even before Hurricane Harvey, plans were in place to convert the Inwood Forest Golf Course, a 226-acre site north of Houston, into a series of 10 connected detention basins to reduce flood impacts on the White Oak Bayou watershed. Once complete, the new basins should be able to hold 391 million gallons of storm water.⁵⁴

Exhibit 8. On-site Detention Requirements for Small Developments* in Selected Texas Counties

Source: Governor's Commission to Rebuild Texas survey of individual county government documents

COUNTY	REQUIRED STORAGE (ACRE-FT/ACRE)	MAXIMUM 100-YEAR STORM RELEASE RATE (CFS/ACRE)
Harris	0.55	2.0
Fort Bend	0.62-0.98**	0.125
Galveston ⁴⁸	0.65	Less than/equal to pre-development flows
Montgomery ⁴⁹	0.45	Less than/equal to pre-development flows
Brazoria ⁵⁰	0.45-0.92**	0.735

*Less than 50 acres.

**Based on different levels of impervious cover on the development site.

RISK COMMUNICATION

The fourth category of the Texas framework is *risk communication*. Effective, ongoing communication of flood or storm risk to residents is an essential component of any future-proofing initiative.

When citizens know what to expect during a storm event and how to reduce its impacts, they can minimize property losses and disruptions to their daily activities. Outreach projects that educate citizens about the probability of flooding in and around floodplains will help them make more informed decisions when purchasing homes. Information about various mitigation options, from insurance to flood-proofing, can help them protect their investments. And an understanding of how various activities, sometimes many miles away, can affect one's home will build support for cooperative agreements among jurisdictions.

Such information can be communicated through written materials, signage, web content and local television. In-person workshops and training sessions empower residents and lead to more long-lasting behavioral changes. Both general and targeted outreach projects at the local level increase awareness and help residents make better decisions on protecting themselves from the impacts of future storms.

For instance, residents often are unaware that their streets are *designed* to flood during heavy rains, and that vehicles should be moved out of harm's way. Similarly, homeowners should understand that clogged street drains nullify the effectiveness of storm water infrastructure, and that regular sweeping and maintenance can mean the difference between being flooded or staying dry.

1. Develop web-based analytical and visualization tools to communicate flood risk and promote risk reduction strategies.

Web-based mapping and analytical tools offer a prime opportunity to facilitate risk communication. Online assets such as the FEMA RiskMap, Harris County's Flood Education Mapping Tool, the *Texas Coastal Bay Atlas* and Texas A&M's *Buyers Be Where* web tool can help anyone with an internet connection understand risks from the watershed level all the way down to specific lots. Expanding these and other web tools to include

larger regions of Texas would provide an effective, interactive venue for communicating with those most at risk of various hazards. Crowd-sourced web platforms also can be used to communicate risk and household needs, particularly for response efforts and short-term recovery.

Tools that could be developed based on this strategy include:

- a comprehensive, easily accessible internet database of information on flood risk reduction, including vulnerable structures, critical facilities, previous loss estimates, inundation models and existing mitigation strategies.
- a web-based mapping and visualization system for communities and stakeholders to use in analyzing vulnerabilities and reducing future impacts.
- open-source tools for post-flood damage estimation to better inform mitigation strategies.
- web-based crowd-sourcing initiatives for short- and long-term recovery.
- web tools with scenario planning abilities to explore policy options for guiding development and strengthening mitigation efforts in areas of greatest risk.
- improvements to the state's geographical information systems (GIS) and information systems to enhance real-time decision-making and response during and after emergencies, and to help communities make effective development and management decisions in advance of the next storm.

For example

A home is usually the largest investment any individual or family makes. Research shows, however, that homeowners generally are unaware of potential flood risks to properties *before* buying. One system that can help is Texas A&M's *Buyers Be Where* (buyersbewhere.com), which shows prospective home buyers and sellers the flood risks facing any residential address in Harris and Galveston counties. Users simply enter a street address to receive a graphic and statistical risk assessment for the property. Comprehensive, easy-to-understand information of this kind offers a critical resource for anyone interested in making sound investment decisions.

2. Use state extension agencies to provide cities and counties with training and outreach on reducing future storm hazards.

Some cities and counties and other groups, including the Texas A&M AgriLife Extension Service, already offer community outreach projects through written materials, web content, workshops and training sessions, but they're generally constrained by resource limitations that make it difficult for them to work with more than a handful of local governments in any year.

Such efforts could be expanded to explain hazard risk and reduction techniques to stakeholders and the general public. State extension agents can provide an important link between those with important technical knowledge and the groups and individuals who need it. Hazard risk communication converts knowledge to action — but it must be a two-way proposition, allowing residents and community leaders to provide their own knowledge and feedback.

For example

Pasadena, a suburb of Houston, has developed a Program for Public Information (PPI) to educate, prepare and aid residents on flood and storm water protection. The PPI is led by a committee of floodplain managers and community leaders that assesses the community's flood risks, receives comments and advice from stakeholders and distributes information regarding flood risk to area residents.

Through an in-depth analysis of historic flood loss data, the committee was able to craft specific messages for target audiences such as those living in repetitive-loss areas, Spanish speakers, landscapers and real estate agents. It then used existing public information opportunities (such as festivals, press releases, community service activities, commercials and radio programs) to bring attention to flood protection. The PPI has enhanced awareness of flood risk and motivated action to reduce flood damage.

3. Encourage or require information disclosures that communicate flood risks to current and future property owners.

One way to increase awareness of flood risks is to offer information on potential hazards during the development and real-estate transaction processes. In Texas, sellers are required only to disclose whether

a property is located in a 100-year floodplain due to federal mortgage requirements. Additional information would be a major benefit to those buying homes and businesses. Disclosure of *past* flooding, for instance, would help prospective buyers understand the risks involved before purchasing a particular property (see the *Buyers Be Where* system above).

A particularly important time to communicate storm risk is during real-estate transactions. Disclosing hazards to potential buyers can reduce the chance that someone is caught by surprise when their home is flooded or damaged.

Most prospective buyers don't take the time to investigate whether a property is subject to flooding, and may not be aware of information that could help them. Federal regulations enacted pursuant to the Flood Disaster Protection Act of 1973 (as amended by the National Flood Insurance Reform Act of 1994) require only that a lender advise a buyer of flood hazards before closing on the loan. This point of communication may come well after the buyer has put down earnest money or otherwise committed to purchasing the property.⁵⁵

For example

Through the state's Natural Hazards Disclosure Act, California requires real estate sellers or brokers to disclose whether a property being sold lies within one or more state or locally mapped hazard areas, including FEMA 100-year floodplains and dam inundation areas. These must be disclosed on a form called the Natural Hazard Disclosure Statement that must be signed by both parties before closing.⁵⁶ The law is meant to ensure that real estate buyers are aware of risks and are protected in cases where hazards are not properly disclosed.

4. Launch public information campaigns to encourage the purchase of flood and wind insurance policies in Texas.

Flood and wind insurance is one of the most affordable ways in which homeowners can mitigate the adverse impacts of storm events. According to FEMA, promoting insurance should be as much a community responsibility as flood control projects or the regulation of new development.⁵⁷

Federal flood insurance penetration rates (number of policies divided by the number of structures) are especially low in Texas and the U.S., hovering around

50 percent. For example, there were 462,000 active NFIP policies in the Hurricane Harvey affected area. Penetration rates were only 42 percent within the FEMA-designated flood hazard area and 22 percent for the entire region, according to an analysis by researchers at Texas A&M at Galveston. Homeowners that *do* purchase insurance, moreover, often let policies lapse over time if no storm occurs.

For example

Harris County is planning a billboard campaign to encourage residents to buy flood insurance. When Hurricane Harvey hit Texas, 83 percent of Harris County's 1.4 million buildings lacked flood insurance. The county is seeking \$75,000 in federal grant funds to put up these billboards.⁵⁸

5. Improve the reach and quality of Texas' early warning systems and communicate the dangers of low-water crossings more effectively.

Detailed weather forecasts and accurate predictions of river flows and water depths allow government officials and emergency managers to determine how and when to warn the public about impending floods. Early warning systems collect, analyze and disseminate hydrologic information to provide advance warning during impending floods, prompting residents to reduce their vulnerability and thus helping to reduce damage to property and loss of life.

Early warning systems can work with existing flood management practices to help predict the performance of flood infrastructure and foster public awareness of flooding. Recent advances in flood warning techniques include radar rainfall maps and results from LiDAR (a laser-based surveying system), extensive networks of real-time streamflow and precipitation gauges and large amounts of high-quality historical data.

For example

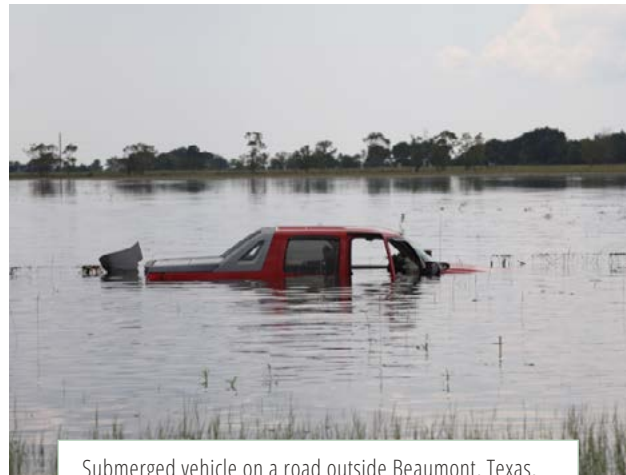
Texas already has several effective, community-based flood warning systems. Austin created its ATX floods system in 1985, in part to monitor flooded roadways in Austin's surrounding nine-county area.⁵⁹ The system uses 130 gauges and cameras to monitor water levels in creeks and at low-water crossings. It can provide alerts via email, text message or phone call. In addition, the city has placed flashing lights and automated barricades at 15 low-water crossings to prevent motorists from driving into high water.

6. Establish a Texas Institute for Disaster Resilience that integrates research and data analytics with training, education and local outreach to lead Texas and the nation in becoming more resilient to future hurricanes, floods and other disaster events.

The regular occurrence of billion-dollar disaster events has placed Texas at the center of a national debate on the need to foster the development of more hazard-resilient communities. Texas has a critical need for an institute that uses data analytics and technological innovations to produce specific policy recommendations. No existing entity in Texas can leverage cutting-edge research capabilities, expertise across multiple disciplines and a comprehensive, local extension-based network with experience in education and community engagement.

A *Texas Institute for Disaster Resilience* could leverage expertise within the Texas A&M University System and other state institutions to develop evidence-based solutions for evolving storm and disaster-related problems. It would provide a venue for scientists, policymakers and entrepreneurs from around the world to collaborate and learn about coastal and inland flood issues, storm-related wind impacts and other issues of vital concern. Institute personnel and partners would use the Harvey-affected area as a "living laboratory" to study and test new ideas and technologies.

As one of its missions, the institute could create a repository for hazard-related data that could be used to address queries from state agencies, regional entities and local governments. It also could pursue collaborative national and state-level research grants and contracts on disaster risk reduction.



Submerged vehicle on a road outside Beaumont, Texas, September 2, 2017. (Dominick Del Vecchio/FEMA)

Exhibit 9. Categories of Critical Facilities

- **Governmental Facilities** — facilities essential for the delivery of critical services and crisis management, including data and communication centers, key government complexes, etc.
- **Essential Facilities** — facilities vital to health and welfare of entire populations, including hospitals and other medical facilities, retirement homes, police and fire departments, emergency operations centers, prisons, evacuation shelters and schools.
- **Transportation Systems** — systems and infrastructure necessary for moving people and resources during major disasters, including airports, highways, railways and waterways.
- **Lifeline Utility Systems** — systems vital to public health and safety, including potable water, wastewater, oil, natural gas, electric power and communication systems.
- **High-Potential-Loss Facilities** — facilities whose failure or disruption of operations may have significant physical, social, environmental and/or economic impacts to neighboring communities, including nuclear power plants, high-hazard dams, urban levees and military installations.
- **Hazardous Material Facilities** — facilities involved in the production, storage and/or transport of corrosives, explosives, flammable materials, radioactive materials and toxins.

HARDENING PUBLIC INFRASTRUCTURE

Our society requires critical facilities such as water treatment plants, hospitals, fire stations and power plants (**Exhibit 9**). Their protection and effective operation during and after a storm are critical to preventing catastrophic impacts. Systematically assessing the storm risk and identifying protection strategies to “harden” facilities against damage for each location would be a major step toward increasing disaster resilience in Texas.

Ideally, critical facilities should never be located in flood hazard areas. If no practical alternatives exist outside a floodplain, however, federal guidelines suggest measures be taken to protect the facility against anything less than a 500-year flood event, meaning a flood that has a 0.2 percent chance of occurring in any given year.⁶⁰

Harvey’s impacts were particularly severe on water systems and the chemical, oil and transportation industries. At its peak, 77 boil-water notices were in effect, 19 water systems went down, and 31 wastewater systems were offline.⁶¹ At least 16 hospitals closed, requiring the relocation of nearly a thousand patients.⁶² Fifteen dams suffered some type of damage. About 336,000 customers lost power. Three major highways (I-10, I-45 and US-59) were inundated, more than 500 roads closed and 13 bridges required repairs.⁶³

Major economic disruptions occurred due to flooded roadways and damaged infrastructure, suspended rail service and closures of regional shipping terminals and ports. Companies including Valero Energy, ExxonMobil, Motiva and Royal Dutch Shell shut down operations in southern Texas; in all, nearly a third of U.S. refineries were affected.⁶⁴

Many techniques can be used to harden critical facilities, ranging from relatively simple retrofits to major construction projects. Usually, a combination of several techniques offers the most protection; the massive mitigation efforts conducted at the Texas Medical Center after Tropical Storm Allison, discussed above, provide an excellent example.

A PORTFOLIO OF HAZARD MITIGATION STRATEGIES

A summary framework for future-proofing Texas based on the principles of avoid, resist, accommodate and communicate is shown in **Exhibit 10**. While each strategy can have a positive effect, communities seeking flood resilience must consider employing *multiple* techniques.

Each community must decide on its optimal portfolio of flood mitigation strategies, based on specific local characteristics and their ability to pursue them. For example, a community afflicted by storm-surge events may build a levee system, behind which new home construction requires a freeboard of several feet. Another, prone to heavy rainfall, may choose buffer development along critical river areas, focusing development on a nearby urban core while protecting naturally occurring wetlands. Both communities could use risk communication and awareness programs to inform residents about residual flood risks. Furthermore, each community must consider the effects of its actions on its neighbors. Interventions upstream should *never* hurt downstream neighbors.

Exhibit 10. Possible Flood Risk Reduction Strategies

Source: S.D. Brody and K. Atoba, *Institutional Resilience: Vulnerability and Resilience to Natural Hazards*, S. Fuchs and T. Thaler, eds., Cambridge University Press

MITIGATION STRATEGY	DESCRIPTION
Dikes/Levees	Solid walls that prevent elevated water from flooding interior lowlands.
Dams	Artificial barriers usually constructed across a stream to impound or store water.
Flood Gates/Barriers	Adjustable gates that prevent storm surge from flooding coastal areas.
Breakwaters	Detached structures built parallel to the coast.
Groins/Jetties	Typically, short structures attached perpendicularly to the shoreline, extending across at least part of the beach into the surf zone.
Bulkheads	Vertical retaining walls to hold or prevent soil from sliding seaward.
Revetments	Armoring materials placed on an existing slope, embankment or seawall to protect the backside area from storm-driven waves.
Artificial Reefs	Construction in near-shore areas to reduce the impacts of storm surge and waves.
Constructed Dunes	Construction or replacement of dunes to protect communities from storm surge and wave action.
Freeboard/Building Elevation	Elevation of structures above base flood elevation to protect from inundation.
Fill	Elevation of landscapes with compacted soil or dirt before construction of buildings to prevent inundation.
Buffers/Setbacks	A specific distance from which structures must be set back.
Clustering	Increased permissible development density in the least vulnerable areas within a specific property.
Density Bonuses	Increased development density and height requirements for specified parcels.
TDRs	Transfer of development rights from a vulnerable area to a less vulnerable or sensitive area.
Targeted Public Infrastructure	Investment in public utilities and other infrastructure in the least vulnerable areas.
Acquisition	Purchase of some or all property rights to create open-space protection.
Relocation	Removal of structures from a vulnerable location to a less vulnerable location.
Drainage Maintenance	Maintenance of drainage devices (canals, ditches, storm drains, etc.) to ensure they operate effectively during a flood event.
Protected Areas	Designation of lands as protected open space for flood mitigation.
Local Plans	Adoption of local planning instruments (e.g. floodplain plans, comprehensive plans, local mitigation strategies, etc.) that set forth coordinated policies aimed at mitigating flood impacts.
Low Impact Development	Development of standards and techniques designed to work with ecological functions to manage storm water as close to its source as possible (e.g. swales, rain gardens, permeable pavement).
Retention/Detention	Dry or wet holding areas/ponds that collect storm water.

Continued on next page

(Exhibit 10 Continued)

MITIGATION STRATEGY	DESCRIPTION
Underground Cisterns	Large storm water holding areas underground.
Breakaway Walls	First-story walls on elevated homes designed to break away during storm surges.
Garage Vents	Openings at the base of a garage that allow water to pass through the structure.
Protected Open Space	Designation of protected open spaces or passive recreation sites for flood detention.
Constructed Wetlands	Creation of wetlands around structures or on vacant parcels.
Flood Risk Information	Information about flood risks communicated through multiple media outlets.
Education/Training	Training through classes, workshops, certifications, etc.
Hazard Disclosure	Disclosure of a property's potential flood hazard to prospective buyers before the lender notifies them of the need for flood insurance.

Regardless of the strategies employed, decision-makers *must* think beyond normal jurisdictional lines and consider changing physical, socioeconomic and human conditions over time. Mitigation strategies should be evaluated from the watershed all the way down to the parcel level. Most importantly, these activities must be *collaborative*, involving the participation of multiple actors across political boundaries.

The value of these interventions should be measured against long-range hurricane and flooding probabilities. Effective risk management on the Gulf Coast must remain nimble enough to adjust in the face of changes in population, development or natural systems.

A STATE-LOCAL MODEL FOR INTERREGIONAL PLANNING

The entire Texas coast needs mitigation. As this chapter illustrates, many approaches are available, and models in Texas and elsewhere show how to apply them successfully. One last innovation needed, though, is a formal process by which the state and local jurisdictions can work together to identify and prioritize projects that will contribute to the overall goal of future-proofing the state.

Such cooperation could lead to the more effective distribution of federal disaster assistance, a targeted state program of local assistance, interlocal cooperation on large-scale projects and — at the very least — an awareness of how decisions in one jurisdiction affect others.

The state’s regional water planning process, administered by the Texas Water Development Board (TWDB), offers a model for a state-local partnership in Texas. Planning for water shortages has been partly a state responsibility since the 1950s, when the Legislature created TWDB in response to the severe droughts of that decade. Lawmakers overhauled the program in 1997 to better reflect regional needs through a “bottom-up,” consensus-driven approach.⁶⁵

Of course, water planning and flood control are different things. But regional water planning represents a successful state-local partnership and should inform the development of any similar partnership for flood control and disaster recovery (**Exhibit 11, next page**).⁶⁶

A BOTTOM-UP APPROACH

Mitigation projects should be planned and developed from the “bottom up” — local governments know their needs best and are invested in meeting them.

The state and local jurisdictions together should consider adopting a collaborative flood planning process based on watersheds. Watersheds determine how water moves across the landscape, making them ideal planning units for addressing flood problems. Unfortunately, they don’t follow jurisdictional or administrative boundaries; local decision-making within a watershed often is uncoordinated, creating a patchwork of flood mitigation strategies.

Effective flood risk reduction requires *collaboration at the watershed level*. Improved coordination among the watershed’s jurisdictions would help minimize duplication and conflicting regulation, make better use

Exhibit 11. Texas Regional Water Planning*Source: Texas Water Development Board***Regional Structure**

- The state is divided into 16 regional water planning areas.
- Sixteen planning groups, one for each area, coordinate the water planning process. These groups, each comprising about 20 members, represent a variety of public and private interests.
- Each planning group adopts bylaws to govern its business.
- The planning groups each adopt a regional water plan. The plans summarize the planning efforts of the groups and their technical experts, with input from the public and participation of several state agencies, over a five-year planning cycle.

State Responsibility

- Planning groups send their regional water plans to TWDB for approval.
- TWDB compiles the information from the approved regional plans and other sources to develop the state water plan.

Financing

- TWDB offers financial assistance for implementing water-related projects through several state and federally funded programs. The programs provide funding through loans or grants.
- TWDB can provide financial assistance for water supply projects only if the needs addressed are consistent with the regional water plans and state water plan.

of taxpayer dollars and improve outcomes.

Collaborative activities could include data and information sharing, the establishment of informal decision-making networks and joint project management. Through this approach, local leaders could ensure that their decisions don't adversely affect those living downstream. Watershed-level management also would promote the development of more consistent and efficient policies to replace the ad hoc patchwork largely in place today.

Several Texas management entities already focus on watershed units. For example, the Houston-Galveston Area Council and North Central Texas Council of Governments collaborate in watershed protection planning focused on water quality.⁶⁷ Similarly, following historic floods in 1998 and 2002, government leaders in Bexar County established the Bexar Regional Watershed Management partnership to improve flood control and storm water management. This partnership consists of Bexar County, the city of San Antonio, the San Antonio River Authority and 20 suburban cities within the county.⁶⁸ As a "virtual" flood control district, it provides tax revenue for projects within five watersheds crossing multiple jurisdictions.⁶⁹

Watershed management initiatives can be informal. For example, Montgomery County, the San Jacinto River Authority, the city of Houston and the Harris County Flood Control District have proposed a collaborative, watershed-based effort for the San Jacinto River to improve regional flood management. Its goals will include coordinating with flood responders to develop a consistent communications protocol and action plan; recommending strategies to reduce flood risk; and developing programs that educate decision-makers and the public.⁷⁰

Effective flood planning ultimately will require a heavy emphasis on collaboration across property lines, organizations and jurisdictions. These and other initiatives provide important examples of how the state could achieve this.

DATA AND WEB-BASED MAPPING

Effective mitigation of future hazards will require a thorough understanding of the natural forces at work, which in turn will require reliable data. Achieving this will require systematic evaluations of data both in "blue sky" periods and during times of crisis. The results

should be shared actively and continually among state and local decision-makers, response and recovery personnel and residents living in vulnerable areas.

One effective way to do this is through web-based mapping and analytical tools, emerging technologies that offer an excellent way to communicate with decision-makers and the public about flood risks and other hazards. At present, however, Texas has no state-level system assembling multiple data sources to offer users a comprehensive picture of disaster risk and risk reduction techniques. Web-based mapping tools currently available typically are more geographically confined and limited in purpose.

For example, FEMA's RiskMap and Harris County's flood warning system and interactive map both focus primarily on telling users whether they reside in a floodplain for insurance rating purposes.⁷¹ The Texas Coastal Bay Atlas developed at Texas A&M University at Galveston offers a more comprehensive picture of risk and its consequences, but is limited to communities surrounding Galveston Bay.⁷² The Buyers Be-Where system (buyersbewhere.com) helps users understand the risks facing specific properties, but is limited to a few counties.⁷³

The rapid expansion of technology and data availability, however, creates the possibility of a *statewide* mapping tool that can offer "what-if" disaster scenarios and other customized and interactive experiences.

Currently, no state entity exists to perform these data collection, mapping and communication functions to meet the challenges ahead. The proposed Texas Institute for Disaster Resilience could be an ideal vehicle for filling this void. Effectively displayed risk information would promote decision-making *before a disaster* that could save lives and prevent or curtail economic damage to local economies along the coast.

CONCLUSION: THINKING ABOUT THE NEXT ONE

In the past year, most communities affected by Hurricane Harvey have returned to something approaching normal. They've erased the mark if not the memory of the storm. The journey hasn't been easy, and while much has been accomplished, much remains to be done.

But even as basic rebuilding continues, it's important that the state and its local governments begin to consider the strategies discussed in this chapter and how they can be applied systematically to the Texas Gulf Coast. The state government in particular should

begin thinking not only about the last hurricane but the next one — and the many other emergencies, large and small, the state may face in coming decades.

The tools are available. The need is obvious. What's needed now is an investment of time and resources to begin the long process of truly future-proofing Texas, not just for tomorrow or next year, but for generations to come.

BUILDING A MORE RESILIENT TEXAS: RECOMMENDATIONS

STATE-LOCAL MITIGATION PARTNERSHIP

1. Establish a special study committee to evaluate and propose options for a state-local partnership to help future-proof Texas against flood events on a watershed basis.

Future-proofing the entire Texas Gulf Coast from flood events is a difficult and expensive proposition. Because of these difficulties, we have put it off, even after seeing the costly and wrenching destruction of past hurricanes, and most recently Harvey.

We should wait no longer to move forward with planning for and constructing mitigation projects on a coordinated and collaborative basis. The Governor's Commission believes that to accomplish this end, a state-local partnership of some sort is necessary. We believe primary responsibility for designing and implementing projects rests with local jurisdictions. They are the ones closest to the problem, and they are the ones who have to live with the consequences of flooding. But state government also has a role as a representative of state interests that cross jurisdictional lines and as a source of assistance.

The structure of a state-local partnership is one that needs to be well planned and widely accepted by stakeholders. We have learned over time, such as in water planning, that a broad and challenging process won't work well without widespread support. To accomplish this end, the Governor's Commission proposes a study committee to examine the need for and possible structure of a state-local partnership and to make resulting recommendations to the Legislature. To inform the creation of such a committee, the Governor's Commission relied as appropriate on the successful efforts of the Water Conservation Implementation Task Force, which was created by the Legislature in 2003 to develop recommendations

promoting water conservation across the state. The task force presented its report to the Texas Legislature in November 2004, and legislation was subsequently adopted in future legislatures implementing various task force recommendations.

Structure. The study committee should be appointed by the Governor with the advice of appropriate agencies, such as the Texas Water Development Board, which has various responsibilities related to flood issues, one being the state agency responsible for coordinating the National Flood Insurance Program within the state. The committee should be composed from applicants and interest groups recommended by a broad array of stakeholder groups including state agencies, federal agencies, cities, water districts of various kinds, and private nonprofit entities.

Duties. The committee should examine, among its duties, a state-local partnership that emphasizes the following characteristics:

- State agency partner(s). What state agency or agencies would make an appropriate partner? One possibility could be the Texas Water Development Board, given its current duties related to flooding and familiarity with the topic.
- Watershed planning. How could watershed planning be promoted? Floods don't recognize political boundaries, and the steps one jurisdiction takes to protect against flooding affects its neighbors. Planning based on watershed hydraulics acknowledges and addresses the nature of flooding.
- Nature of participation. Should local planning groups form on a voluntary or required basis? If required, how should regional groupings be developed and structured?
- Incentives for formation of planning groups. To support watershed planning, local entities must see the benefit of organizing to collaborate on a watershed basis. Funding, technical assistance or other incentives to formation need to be considered, including a possible state funding source for local mitigation projects.
- Roles and duties. What would be the appropriate roles for the state partner and local partners in a state-local partnership?

Implementation. What would be appropriate timing for rollout of a state-local partnership? It may not be appropriate to go too far too soon, starting from the beginning position we currently are in.

Best practices. What best practices should a state-local partnership incorporate? These best practices could cover a variety of subjects, such as how best to form collaborative organizations, what types of projects a partnership should promote, and other appropriate subjects.

Data. Mitigation on a watershed basis should rest on good data. What can be done to help ensure this data is available?

Reporting. The committee should prepare a report with recommendations to be submitted to the Legislature and Governor by November 1, 2020, before the start of the 87th Legislature in 2021. The committee should sunset on January 1, 2021.

Staffing and Cost. A committee of this nature would require staff. Possibilities include the Texas Water Development Board and the Texas A&M University System. The Legislature should consider funding for staff. Members of the committee would participate at no cost to the state.

2. Establish and fund a new Institute for a Disaster Resilient Texas to be established within The Texas A&M University System.

The increasing impacts of storms has created a need to better understand risks to local communities, which, in turn, relies on the systematic collection and evaluation of data in both “blue sky” periods and times of disaster. Information gained from this analysis should then be communicated to the public and decision makers to improve decision making. No entity currently exists to provide this information to the extent needed.

The state should fund a new institute within the Texas A&M University System dedicated to collecting, displaying, and communicating comprehensive flood-related information for use by decision makers and the public. The new organization, called the Institute for a Disaster Resilient Texas, could leverage the many research assets of the Texas A&M system to advance future-proofing goals. These resources include, but are not limited to, the Center for Texas Beaches and Shores at TAMUG, the Hazard Reduction and Recovery Center in Architecture at Texas A&M University, and the Harte Research Institute at Texas A&M University-Corpus Christi.

In addition, the Institute could link these research-based entities with extension and training-focused agencies within the A&M system such as the Texas A&M AgriLife Extension Service, Texas A&M Engineering

Extension Service, Texas A&M Forest Service, and Sea Grant. This linkage provides the means to bring useful information and research done in academic settings to the field.

The Institute also could continue the work begun at the Center for Texas Beaches and Shores at TAMUG to create and maintain web-based analytical and visual tools to communicate disaster risk and ways to reduce them. No comprehensive state-level system of this nature currently exists. Its design would allow users to assess risk and mitigation issues from the regional level down to individual parcels. Such a system would be useful in relaying information in a visual and understandable manner to local decision makers and the public.

Of note, the institute could be one source of useful data provided to help entities participating in any future state-local partnership to plan for and develop mitigation projects, as proposed in an earlier recommendation.

The Institute would require an appropriation to fund its operation. The amount of funding provided would depend on the decisions of the Legislature and are unknown at this time.



Texas A&M University System Chancellor John Sharp and Governor Greg Abbott arriving to meet with local officials on recovery efforts.

HARDENING OF FACILITIES

3. Investigate ways to improve the hardening of utilities and facilities.

The Texas Division of Emergency Management should have primary responsibility for implementing this recommendation.

Protection of critical infrastructure, such as hospitals, fire stations, power plants, and water treatment plants, is essential during and after a disaster so that essential services remain operational. Developing strategies to “harden” facilities would be a major step toward future-proofing the state against the impact of future disasters.

For public facilities, TDEM and Texas A&M System entities such as AgriLife, could encourage local governments to collaborate on steps to take to harden local facilities. TDEM and other agencies should work with local jurisdictions and facilities to conduct assessments and identify where critical infrastructure facilities are located and which techniques might be most effective to reduce risk and associated impacts.

For private facilities, TDEM should convene representatives from PUC, TCEQ, and the Railroad Commission, given that these state agencies have various levels of responsibility over utility sectors. The agencies could discuss how to encourage private sector hardening using this forum.

Implementing this recommendation would not result in cost to the state.

4. Create a comprehensive inventory of needed mitigation and resiliency projects statewide and develop a prioritization methodology to guide local, state and federal decision makers.

This task has already begun in a comprehensive list for the Gulf Coast areas affected by Harvey developed by the Governor's Commission to Rebuild Texas and TDEM. This work should continue and be refined.

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An aerial photograph of a landscape, possibly a golf course or park, with a road running horizontally across the middle. The image is overlaid with white topographic contour lines. The right side of the image has a teal gradient overlay.

CHAPTER 8

8 PREPARING FOR THE FUTURE

The five mission areas of emergency management include prevention, protection, mitigation, response and recovery. These five areas serve as an aid in best organizing and coordinating preparedness for all disasters. All of the mission areas are extensively interrelated and support FEMA's National Preparedness Goal. Preparedness in all of the mission areas is required for a strong and effective emergency management program.

Course material at FEMA's Emergency Management Institute defines preparedness as "... pre-impact activities that establish a state of readiness to respond to extreme events that could affect the community." The description goes on to say that "... emergency preparedness is achieved by planning, training, equipping, and exercising the emergency response organization."¹ These activities should be maintained in each of the five mission areas.

In keeping with this definition, this section looks first at the state's efforts to train emergency management personnel. It also examines other steps in effective preparedness for future disasters, such as having critical emergency management agreements in place *before* the onset of a disaster, and the importance of establishing a smoothly functioning partnership with the federal government. Recognizing the significance of technology to the future of disaster management, the chapter also reviews some ways to improve this aspect of emergency preparedness. The chapter ends with a discussion of the importance of a well-informed public to escape the destructive power of future disasters like Harvey.

TRAINING

Texas' local jurisdictions responded very differently to Hurricane Harvey. Some communities, primarily larger ones, displayed sophistication in their response and recovery functions and were staffed with full-time and trained emergency personnel. Many smaller communities were not as well prepared due to insufficient planning, resources, training, or experience managing an event of Harvey's magnitude. To improve emergency response

and recovery, the state needs to do everything it can to raise the overall level of preparation by city and county officials and personnel who will deal with future emergencies.

Ideally, given the serious nature of emergency management, an emergency management training framework would include some sort of tiered scheme. Those tiers would be based on different levels of management responsibility, the critical nature of facilities in a manager's jurisdiction, or other criteria. This structure is already in place for law enforcement and fire personnel. The Texas Commission on Law Enforcement administers state-required licensing and certification for peace officers, corrections officers, jailers, and other law enforcement personnel, and regulates training. Likewise, the Commission on Fire Protection sets standards for certifying and equipping paid fire service personnel, tests to those standards, and regulates training provided.

In comparison, Texas law sets up a skeletal framework for emergency management training. The law only requires three hours of training for certain personnel approved by the Texas Division of Emergency Management (TDEM). Among these individuals are an "elected law enforcement officer or county judge, or an appointed public officer of the state or of a political subdivision" who has emergency management responsibilities. The law contains no enforcement mechanism or penalty for jurisdictions that do not comply with these provisions. Noncompliance does not affect the validity of actions the state or local jurisdictions may have taken.²

Although the law is not prescriptive, local officials and emergency personnel have a variety of emergency management training opportunities available to them. State and federal entities such as TDEM, the Texas A&M Engineering Extension Service (TEEX) and FEMA offer training, as do private associations and other groups at the state and national level. Course offerings cover many aspects of emergency preparedness such as incident management and response, first response, rescue, communications, crisis preparedness, mitigation, recovery, and community resilience.

Emergency management personnel have pointed out gaps in Texas' emergency management course offerings. Training is almost exclusively focused on response, with less concentration on recovery. Earlier chapters of the report highlighted weaknesses in recovery compared to response. Better training and preparation are important for local jurisdictions to more effectively engage with recovery programs. Recovery related training currently available does not train or educate to the degree needed to carry out some required actions or duties, such as disaster finance or debris management.

During forums with local officials held by TDEM in the wake of Hurricane Harvey, local communities' elected leaders, public officials, and their staffs frequently voiced a desire for more training in emergency management and, more specifically, the recovery process. One suggestion discussed was establishing a credentialing program for emergency management professionals. A program of this type could set up requirements and job descriptions for various levels of emergency personnel.

This review did not canvass each state's laws to determine requirements for certification. In general, and from information gathered from Texas professionals and other sources, few, if any state's law mandates a range of licensing or certification requirements for specific emergency management positions. However, national, state, and local associations or state agency departments do offer certification programs of various types and levels, and entities hiring emergency management personnel may require specific certifications.³

In Texas, the Emergency Management Association of Texas administers a certification program, available to members of the Association.⁴ In addition, some academic institutions offer emergency management degrees. While these courses are worthwhile and useful, they vary widely in location and content and do not offer the comprehensive, targeted approach that is needed

to address the training concerns raised after Harvey.

Given the storm-prone nature of Texas and the varying skill levels of emergency managers noted during Harvey, it is clear that the state needs to think through a coordinated approach to emergency management training available to a widespread audience. This training should result in demonstrated proficiency for emergency management professionals with different levels of responsibility and different duties, whether by certification or licensing tiers or some other means.

DATA SHARING, CONTRACTING, AND AGREEMENTS

Emergency managers know the importance of preparedness in the many aspects of disaster management. The Governor's Commission listened to feedback from various sources and heard the message that several of the administrative underpinnings of emergency management operations needed more consideration. While not the only concerns, some of the more pressing topics were quality of data available, lack of agreements and partnerships with key partners, and issues of contracting for resources.

The discussion that follows presents examples of the importance of preparedness in all these areas to fortify these building blocks of many emergency management programs before an actual event. The examples presented are not isolated cases, but some of the more striking examples showing what can happen when circumstances align to eliminate or reduce time to prepare, even when management is not at fault.

DATA AND AGREEMENTS: THE CASE OF SHORT-TERM HOUSING

The devastation from Harvey left many people in need of housing or other assistance. Estimates show, in fact, that nearly 900,000 survivors applied for some form of assistance from the Federal Emergency Management Agency (FEMA).⁵

One of the programs that FEMA made available to the state to meet a part of this need was a temporary housing program offered directly to qualifying survivors. This initiative was challenging in several ways.

First, FEMA has rarely made direct housing programs available for disasters in Texas, Harvey being one of the rare cases because of its extreme devastation. Second, when offering this type of program, FEMA leads program delivery. This time, the federal government and the state agreed that the

General Land Office (GLO) and FEMA would administer the program jointly. *Third*, GLO had not participated in managing this type of program before. *Finally*, the urgency of Harvey required that the program be “stood up” quickly, with the Governor designating GLO as the state lead for the program on September 14, 2017, some 19 days after Harvey made landfall near Rockport.⁶

All of these situations gave GLO and FEMA little opportunity to prepare for this short-term housing partnership, which would require both sharing of data about survivors and sharing of programmatic responsibilities, with each agency fielding agents to assist survivors in receiving assistance. These mutual responsibilities, quickly assigned, could present administrative difficulties under the best of circumstances, least of all the chaotic environment of the Harvey event. At least some of those difficulties appear to have materialized.⁷

Data Sharing. One close observer in this process judged data integrity and database management as the most serious issue the program faced. FEMA stored applicant data in various databases, with no assurance that data would be consistent across these sources. Meshing of data between FEMA and GLO was poor, requiring manual “data scrubs” to ensure survivor information was up to date and accurate.

GLO personnel initially did not have proper clearance to access elements of FEMA data considered to be personal, even addresses, making it difficult to send contractors or field staff to find the survivor who needed assistance. FEMA finally resolved this situation, but at the loss of efficiency in the process.

Programming Coordination. The joint nature of the housing operation between FEMA and GLO required expedited development of interagency agreements and operating procedures to start putting survivors in temporary housing quickly. The procedures did not always work smoothly. The arrangement of both agencies having agents working cases in the field, for example, sometimes resulted in confusion because of unclear division of case responsibilities, probably aggravated by multiple databases that information was being pulled from.

The result. These issues resulted in a variety of problems. Most critically, the placement of individuals in temporary housing moved too slowly, a matter of frustration to staff, the public, and elected leaders. Survivors found themselves visited several times by different agents, each unaware of the others,

another point of irritation for survivors. Survivors also complained of inconsistent information from GLO or FEMA staff.

Many of these issues have already been corrected, but not without considerable difficulty and interagency collaboration. Attention needs to be given to developing a reliable, secure data infrastructure and data sharing protocols among state agencies and their federal or local partners, many of which have extensive data resources. Harvey exposed the need for more advance work to create partnerships, where possible, to better weather extreme events when they occur.

CONTRACTING: THE EXAMPLE OF DEBRIS

Hurricane Harvey generated massive amounts of debris. As explained in Chapter 6, accumulated piles of debris greatly hinders response and a timely start to recovery, and is a very visible and disturbing reminder to survivors of the devastation they have endured.

The sheer amount of debris set up a situation where there was too much debris for too few debris haulers. This circumstance, in turn, added a nightmare scenario for some local officials without well designed contracts, or no contracts at all, with haulers. In such cases, haulers easily could find other clients for their services if a local jurisdiction failed to meet its terms.

Debris is an extreme case made extraordinary by an imbalance in supply and demand, but it underscores the issue of having the assurance of services available ahead of an event. Part of the issue discouraging such



Texas A&M Forest Service Saw Crews worked to open roads and clear debris in Aransas and Victoria Counties. (Texas A&M Forest Service)

preparedness is simply the amount of time it takes smaller communities to find and have prearranged services in place, particularly if a locality has the mindset that highly destructive storms are rare.

The state could consider developing other contracting mechanisms to help ensure supply meets demand without local jurisdictions constantly having to look for and update existing agreements. The state has developed one similar program for certain types of services in which the Comptroller's office prequalifies and signs up vendors for certain kinds of goods and services. State agencies and local governments can select vendors or services from this list without having to go through an onerous bidding and search process themselves. Basic services and products that emergency management agencies typically need, such as debris removal, barricades, portable toilets, and meals ready to eat (MREs) could possibly be appropriate for this type of contracting procedure.

PARTNERSHIPS WITH THE FEDERAL GOVERNMENT

Assorted federal laws and policies have hindered Texas' response to and recovery from Hurricane Harvey. The list of these issues below is an extensive but not exhaustive presentation of the issues that proved most problematic and that should be addressed.

The Texas congressional delegation and state leaders should work with Congress and key federal agencies, including, among others, the Federal Emergency Management Agency (FEMA) and the U.S. Department of Housing and Urban Development (HUD), to address these issues. These efforts would require collaboration between the federal government and state agencies to actively improve policies for emergency management. In the wake of Hurricane Harvey, some of these needed discussions have already begun and our federal partners have been open to making improvements where they are possible under federal law. However, further efforts in the following areas are needed.

A critical step in this process is for state emergency managers to work closely with our federal agency partners to promote the continuous improvement of the processes involved in federal programs during major disasters. In this regard, FEMA has released a detailed strategic plan in March 2018 that outlines three national strategic goals. These include:

- Build a culture of preparedness
- Ready the nation for catastrophic disasters
- Reduce the complexity of FEMA⁸

These goals closely align with the goals that the state of Texas should pursue as we work to rebuild from Hurricane Harvey and look to make the state better able to withstand future disasters. TDEM and other agencies of the state responsible for emergency management should engage with and work closely with FEMA, HUD and other federal agencies to share lessons learned and, where possible, to make Texas a laboratory for future improvements that streamline processes and improve the effectiveness of federal and state response and recovery efforts.

PROCUREMENT

Within limits, it would be useful to have select federal procurement rules suspended for cause during a disaster, including, for example, rules related to sole source contracting. Obviously, this would have to be done in a way that doesn't compromise the integrity of the procurements made under a streamlined program.

Currently, federal regulations allow for procurement by noncompetitive proposals if the need for the procurement is too urgent for competitive solicitation.⁹ The state must provide documentation of the emergency and specify why there was no time for competitive bidding. Easier suspension of procurement rules would speed response and recovery.

HOUSING ISSUES (FEMA AND HUD)

Another area where improvements could be made in the state-federal relationship is by addressing conflicting federal policies that are not cost effective. The critical federal disaster housing programs provide a good example of this issue.

Program Qualifications. For example, an individual currently may not qualify for \$17,000 to fix a home, but a person can qualify for a temporary trailer that costs \$100,000. As a second example, Texas was working with two new housing programs after Hurricane Harvey (Partial Repair and Essential Power for Sheltering, or "PREPS"; and Direct Assistance for Limited Home Repair, or "DAHLR"). Federal policy focused on each program independently and not on how the two programs could work together.

During a disaster, the federal government implements many programs independently and they rarely are well coordinated, resulting in conflicting and nonsensical outcomes. The federal government should not wait until the next disaster to begin coordinating programs but should start now, before the next disaster hits, to mesh programs so they work together.

Transition to Long-Term Housing. Under current programs, disaster housing, such as shelter assistance, must be temporary. Transition to long-term housing, such as leased housing, is often made difficult when that housing inventory is destroyed by the storm. Advances in technology and building materials allow creation of housing in the short term that also could serve as long-term housing. These options should be explored with federal counterparts.



Texas A&M Forest Service and Texas A&M Engineering Extension teams burned 80,940 cubic yards of vegetative debris in Aransas and Refugio Counties in support of TxDOT debris removal operations. (Texas A&M Forest Service)

FEMA Trailers—Alternatives. FEMA requirements for manufactured housing don't reflect industry standards and manufacturers find such housing more difficult to produce quickly. Modernizing requirements and considering a wider range of temporary housing options would allow survivors to be housed more quickly. The innovations achieved with the Katrina Cottages and Rapido housing design process exemplify possible new approaches for temporary housing of the future.¹⁰

OTHER ISSUES

Data Sharing. Sharing of FEMA's critical survivor information, such as addresses and phone numbers, with the General Land Office, local communities, and other partners was problematic and a complicating issue in addressing survivor needs quickly and effectively. Data sharing protocols fashioned to protect privacy and data security should be developed to allow appropriate sharing of this information.

Intake Forms. The state of Texas could design a simplified, single intake form for disaster survivors with FEMA's approval. A Turbo-Tax-like electronic interface for filling out required information for use by all state and federal agencies would simplify paperwork processes so disaster survivors could more easily fill out requests for assistance and avoid delays in receiving assistance.

Debris Removal Contracts. The state should work with FEMA to speed up contracts for quick debris removal after a disaster and fast-track funds for debris clearing. Also, reimburse states for cleaning up "wet debris" (debris in waterways). (See Chapter 6 for more information about debris removal.)

Creation of Improved Flood Insurance Rate Maps. FEMA creates Flood Insurance Rate Maps, or "FIRMs," with the assistance of "cooperating technical partners" such as cities, river authorities, state agencies, and other water-related entities or programs.¹¹ Insuring entities use these maps to set flood insurance rates, and many communities in Texas rely on FIRMs to help in their decision making and to communicate flood risk.

Many of these maps are now outdated and do not show more current flooding patterns, which change with development and other factors. In addition, local jurisdictions may challenge new maps and use previous versions. Maps communicating out-of-date information are confusing and could lead to poor development or purchasing decision for businesses and homeowners.

The state should work with FEMA and local jurisdictions to explore ways to speed the development and adoption of more recent flood insurance rate maps to improve the basis for flood-related decision making for communities and property owners alike.

Eligibility for Reimbursement. Staff of the state and FEMA should be adequately trained to ensure that all staff have a shared understanding of eligibility guidelines and requirements for expenses at both the state and federal levels.

50-Week Rule. The state should work, to the degree possible, to have the FEMA 50-week rule reassessed.

Currently, FEMA reservists, who are “intermittently employed professionals,” may only be deployed away from their home state for a maximum duration of 50 consecutive weeks. This requirement results in constant staff turnover, which in turn hurts consistency in communication of information and hinders recovery efforts. This dynamic is particularly troublesome in disasters with long-running recovery periods such as Harvey. In addition, these temporary staff are not always well-informed about FEMA programs and procedures. Another drawback to the rule is that FEMA is hiring for positions in the Texas Recovery Office that require a year of experience, but the 50-week rule prevents prospective candidates from meeting the one-year requirement.

Public Facilities. The state should work with FEMA to change existing rules to allow public facilities operated by the same entity to be grouped together as one project to simplify reimbursement under FEMA’s Public Assistance program.

Currently, FEMA counts each facility as a separate project. This design requires the applying organization to isolate time keeping and expenses by facility, which is difficult and time-consuming. Employees may work at multiple facilities on response activities and one purchase order may be used to procure materials for repairs at multiple facilities. Tracking this level of detail during a disaster response is challenging and jeopardizes FEMA reimbursement for eligible activities.

Batched Applications. The state should encourage FEMA to batch applications by location rather than on a first-come, first-serve basis. If FEMA and GLO were to evaluate total need and batch these cases together by location or need, they would be able to address many needs at one time. Also, FEMA and GLO should focus on closing out counties or areas with low numbers of applicant needs so resources could shift to counties or areas with greater needs.

Eligibility for Individual Assistance. FEMA funding limits as well as eligibility requirements for individual assistance should be reviewed for potential change.

The limit for Individual Assistance currently is \$34,900, but the average grant averages \$4,000 to \$6,000 per applicant, suggesting that eligibility requirements are preventing survivors from receiving the funding they need to recover from a disaster.

Consolidation of Public Infrastructure Projects. The state should work with federal partners to encourage a change in federal policy to make FEMA the lead agency for all public infrastructure projects.

Currently, FEMA requires that the USDA Natural Resources Conservation Service (NRCS) deny an applicant under its jurisdiction assistance before that entity can apply for FEMA Public Assistance funding. This requirement particularly impedes the efforts of the Harris County Flood Control District where about 90 percent of the infrastructure is “natural channels” under the jurisdiction of NRCS, not FEMA. NRCS may grant approval for projects under its purview, but if funding is not appropriated, the project will stall. An approved but unfunded NRCS project cannot be funded by FEMA.

More Flexible Timeframes. The Natural Resources Conservation Service currently requires a project be completed 220 days from approval of the contract, which stakeholders indicate is impossible for a \$90 million repair. The state should work with NRCS to allow more flexibility in completion time frames.

DISASTER TECHNOLOGY

During stakeholder meetings across the region impacted by Hurricane Harvey over the last few months, technology, especially as a means of communication and information sharing, emerged as a frequent topic of discussion. Technology used during and after Hurricane Harvey included unmanned aerial vehicles, commonly referred to as UAVs, unmanned aircraft systems (UASs), or drones; websites; social media; and software applications. The use of technology can accelerate and expand response and recovery efforts.

DRONES

Drones played an important role in the immediate aftermath to Hurricane Harvey. Many different groups, both public and private, flew drones over affected areas for a variety of reasons. Emergency responders as well as insurance companies, NASA, railway operators, private industry, and state government agencies were all among drone users during Harvey.

This hurricane helped secure a future and growingly important spot in disaster operations. As reported by the *Wall Street Journal* a few days after Harvey's Landfall,

For drone users, Hurricane Harvey is likely to be the event that propelled unmanned aircraft to become integral parts of government and corporate disaster-recovery efforts. In the first six days after the storm hit, the Federal Aviation Administration issued more than 40 separate authorizations for emergency drone activities above flood-ravaged Houston and surrounding areas. They ranged from inspecting roadways to checking railroad tracks to assessing the condition of water plants, oil refineries and power lines.¹²

The Texas A&M University System is no stranger to drone-related activities, either in disaster work or other pursuits. For example, drones support the air wing of Texas Task Force 1, a disaster response team operated by the Texas A&M Engineering Extension Service (TEEX). Texas A&M AgriLife Extension Service borrowed drones to locate displaced cattle during Harvey. The Texas A&M Forest Service deploys drones for fire response.

Various entities within the Texas A&M System are directly involved in drone research, deployment of drones in emergency situations, and other drone-related functions. The Lone Star UAS Center of Excellence and Innovation at Texas A&M University-Corpus Christi is one such organization. The Center is engaged in drone research and supports Texas Task Force 1 in its response functions. TEEX and the Center also operate a national credentialing program for U.S. commercial service providers and public safety organizations using small unmanned aircraft systems.¹³ In addition, the Center for Robot-Assisted Search and Rescue, another organization affiliated with the Texas A&M University System, participates in drone research and deploys them in disaster functions.

Both federal and state laws affect the use of drones, with the Federal Aviation Administration (FAA) taking the lead in regulating their use. The Texas Legislature also has enacted laws dealing with the use of drones in such situations as, for example, the lawfulness of capturing certain kinds of images.¹⁴

One amendment to these statutes, enacted in 2017, has relevance to disaster operations. The amendment allowed employees of insurance companies to take pictures "in connection with the underwriting of an insurance policy, or the rating or adjusting of an insurance claim, regarding real property or a structure on real property."¹⁵ The effective date for this bill was



The Lone Star UAS Center of Excellence at Texas A&M University-Corpus Christi used unmanned aerial systems, or drones, to conduct inspections in Aransas and Fort Bend counties after Hurricane Harvey. (LSUASC photo)

September 1, 2017, just in time for insurance companies to use drones to help assess property damage in the aftermath of Hurricane Harvey.

The wide use of drones is a significant and encouraging development toward saving lives and property in disasters. However, attention needs to be given to this evolving field to ensure laws and regulations match disaster needs.

For example, some feel that not everyone needing access to drones in emergency situations has that authority or gets that authority quickly enough when sought. Stakeholders have said that federal "line of sight" rules require a drone operator to be able to see the drone at all times, reducing the effectiveness of drone use.¹⁶ And stakeholders discussing their Harvey experience also have reported cases of volunteers flying drones in violation of FAA rules, and have complained that drone flights could be better coordinated. The importance of this technology to the future of disaster operations argues for focused attention on resolving such issues.

COMPREHENSIVE WEBSITE

Texas currently has several websites devoted to informing the public about recovery from Hurricane Harvey. These include, among others:

- “Rebuild Texas,” the website of the Governor’s Commission to Rebuild Texas;¹⁷
- “Rebuild Texas Fund,” a collaborative project of the Michael & Susan Dell Foundation and the OneStar Foundation;¹⁸
- “Texas Rebuilds,” a website of the General Land Office;¹⁹ and
- “Recovery.Texas.gov,” another website of the General Land Office.²⁰

These multiple websites, while containing vital information, are confusing and difficult for survivors and the public to navigate. The names of the websites are very similar, so viewers could be confused immediately as to which site to access. The information also varies on all the sites, causing viewers to search around for information they’re looking for. The last thing a survivor requiring assistance needs is to spend time trying to navigate among sites to find funding and services available to help with recovery.

In addition, the sites don’t contain comprehensive and digestible information on the amounts of money federal and state governments make available and distribute to local jurisdictions. Transparency in government always resonates with the public, but transparency in disaster expenditures is particularly important, given the large sums involved, the urgency in proper disbursement of disaster funding, and the state’s interest in knowing how these sums are being allocated and spent.

Several websites also offer general advice on how to prepare for disasters and hurricanes. These include, for example:

- “Texas Hurricane Center,” a web resource found on the website of the Governor’s Office;²¹
- “Hurricane Awareness,” a web resource found on the website of the Texas Department of Public Safety;²² and
- “Texas Prepares,” a website developed by the Texas Department of State Health Services.²³

Safety information communicated on these sites could at some point be vitally important to all of us. The public’s awareness of the existence or location of this information is diminished when scattered in this fashion.

Providing access to disaster and safety information that’s easily navigable, comprehensive, and well publicized is no easy task. State government may not be able to achieve this goal completely, but could certainly move toward it.

SOCIAL MEDIA

Social media has changed disaster response and developed into a method of communication that benefits people during and after natural disasters. Hurricane Harvey is a case in point; survivors and emergency responders made frequent use of the technology.

Harvey victims used social media during the hurricane as a 911 service, posting requests for assistance to family, friends, and neighbors. Communicating via social media often resulted in quicker attention of responders and created a means for collecting and distributing vital information in real time.

Survivors used Facebook, Twitter, Nextdoor, and other platforms or sites, to send emergency responders locations where they or friends and family members could be found. Victims kept their communities, families, and loved ones — indeed, the world — updated through posts, many of which included pictures.

Local, state, and federal jurisdictions also leveraged their reach with social media. Local officials used texts and social media to communicate with constituents and increase access to press conferences. Many organizations, including the Coast Guard and local emergency management offices, employed social media for incoming communications from victims and those that needed assistance. AgriLife Extension agents used social media to request donations of feed, hay, water, and other items for delivery to supply points. These supplies were then distributed to affected producers and local citizens until the local feed infrastructure could recover.

The use of social media during Harvey had disadvantages as well as advantages. Some of these drawbacks included:

- Overwhelming community organizations by generating unsolicited donations;
- Creating an influx of volunteers lacking appropriate training and working independently of official response operations;
- Spreading unsubstantiated information, including erroneous claims about the operational status of utilities;

- Propagating hoaxes, including insurance scams; and
- Pouring emergency posts onto social media employees who, while trying to help, simply didn't have the training to deal with the volume and critical nature of the information.

Social media is a net benefit to disaster operations and certainly is not going away. We need to work on reducing the problems associated with using the technology and take full advantage of the benefits social media brings to disaster response and recovery.

COMMON OPERATING PICTURE

Communication is key to coordinating the efforts of first responders in the field. High quality communication capabilities increases the efficiency with which responders search for survivors, rescue those injured or trapped, and identify those sheltering in place. Safety of the teams in the field also depends on communication.

Traditionally, regardless of the type of disaster, responders in base camps tracked squads in the field with paper maps that were updated with notes whenever new GPS-based reports were radioed in or brought back to the base of operations. Some teams still use this approach today. However, advances in technology have dramatically improved the opportunity for keeping track of teams and digitally sharing that information among squads.

Today, technology exists for teams to digitally collect spatial location and other information from the field and display that information on a screen back at base camp. Team members can load that information on return to base camp or, with the right technology, automatically transmit it back to base camp in real time. Since May 2015, Texas Task Force 1 has equipped its personnel in the field with the type of technology that transmits data back to base camp in real time.

Whether the digital information is shared real time or loaded into the system on return to base camp, first responders can create a picture of the operating area quickly, without spending many precious search and rescue hours digesting, translating, and transferring data. As important as the time savings, another advantage of this technology is that, properly implemented, teams can share the digitally collected information and create a "common operating picture" of the operating area. The more data shared, the better and broader the picture. The common operating picture then allows teams to operate with a shared understanding of the area they are working

in, enhancing their efficiency and the opportunity to remove victims from harm's way.

But here's the catch. The data shared to create a common operating picture *needs to be in a standard format* so different equipment and systems can interpret and understand it. Cell phone technology reflects this same concept. Cell phone manufacturers and service providers may differ, but customers can communicate without problem because the phones recognize the same communication protocols.

Currently, no authority in the state requires the use of a standard protocol to enable responding teams to share digital information widely. These teams, which could arrive at a large-scale disaster from around or outside the state, bring the technology on which their jurisdictions or they themselves decide.

Of note, adoption of a standard for a common operating picture doesn't require purchase of a specific brand of equipment. Rather, equipment used would recognize the common standard, just as cell phones of different types communicate with shared protocols.

The state should examine the costs and benefits of promoting widespread use of a common operating picture. If ultimately deemed desirable, the state could consider steps to enable that outcome, with the bottom line being the saving of lives.

SOFTWARE APPLICATIONS

Software applications, commonly called "apps," have become familiar to all of us. The apps now available for all common platforms offer a variety of functions to make our lives easier or more enjoyable.

Apps for mobile devices have a particularly promising future in emergency operations. Designers can tailor apps to specific needs of responders and survivors and offer them for free or at reasonable prices. Users can typically download and install apps conveniently on their mobile devices and carry them on their phones or tablets wherever they go. The presence of mobile devices also is widespread; many people have smart phones, for example, and if they don't, a friend close by is likely to own one.

Hurricane Harvey demonstrated the usefulness of various apps in emergency operations, both before and after landfall. Some of the apps stakeholders reported using follow.

- *Rebuild Texas app.* The Texas A&M Forest Service modified one of its software applications to create the Rebuild Texas app for use in Harvey. The Texas A&M University System supplied AgriLife agents and other System responders with the app, who used it

to collect questions, needs, and other information from local jurisdictions and relay that information in real time to headquarters for processing. Viewers in College Station could create detailed reports and dashboard summaries from data submitted. Answers to questions or other information could be relayed back to agents in the field and passed on to local officials. The app proved very successful as a way to quickly resolve issues and keep track of the situation unfolding in the disaster area and is an innovation that should be improved and continued.

- *Commodity distribution app.* The Texas A&M Forest Service also developed software to assist in the distribution of food and to help manage damage assessments of fire departments.
- *Red Cross app.* This free app offered by the Red Cross passed on alerts from the National Oceanic and Atmospheric Administration (NOAA), and provided a means to connect friends and family.
- *Zello.* This app converts a smartphone into a walkie-talkie. Survivors used the app to communicate with other people also using the app when mobile networks were overloaded.
- *Are you OK?* Employers used this app to send messages to their employees, who then could respond with one button to indicate they were okay or needed help. GPS tracking would be engaged for employees needing help. Employers also could use the app to send employees information about work conditions and a number to call if they had questions or needed help.
- *Weather apps.* Other apps like The Weather Channel and NOAA Radar US are free to the public. Harvey victims used them to view real time animated radar images, interactive maps, weather forecasts, alerts, radar, live video feeds, and information about first aid.

Feedback from stakeholders suggested that the state should develop a disaster-related app for the public similar to the DriveTime app of the Texas Department of Transportation. This app features real-time information about road conditions. A similar app for disasters could forward information about weather conditions, safety issues, assistance locations, numbers to call, and other useful information to disaster victims.

The use of apps is not going away. The technology should be supported and extended to improve emergency management.

ACCESS TO TECHNOLOGY DURING A DISASTER

Communications links are among the most critical functions to restore first in the immediate aftermath of a storm. Effective response efforts cannot be conducted without these links, whether they be private sector cellular phone service, internet, or cable service.

Communications providers offering these services often have portable equipment that can be used to help re-establish data communications after a disaster. Examples include portable DISH satellites and portable cell phone towers.

These providers can be “force extenders” for official responders in times of critical need. Appropriate state agencies such as the Texas Division of Emergency Management and AgriLife Extension agents as well as local jurisdictions should cultivate relationships with these providers before a storm hits to make maximum benefit of all resources available.

DATA, TECHNOLOGY, AND ANALYTICS

From tornadoes to hurricanes, to man-made emergencies such as wildfires, Texas’ diverse geography and large number of cities brings with it various disaster-related challenges. There is no shortage of ways to leverage technology to support and inform government’s decision-making process throughout the disaster cycle.

Data and technology can mitigate damage and loss leading up to a disaster, can assist rescue and response during the disaster itself, and can inform and help monitor rebuilding and recovery efforts after a disaster occurs. By integrating data sources from federal, state, local, and non-governmental organizations into one platform and applying analytics, the state can develop a more complete understanding of the disaster and the people it’s impacting.

Texas should examine ways that it can apply integrated data analytics to assist with disaster response and recovery management. The state already employs this approach in other areas of government management, and the time is right for its application in this area.

PUBLIC INFORMATION AND EDUCATION

We have discussed ways to improve government preparedness for disasters. Citizen preparedness also is an essential first line of defense in coping with disasters.

Residents in Texas often are unaware of storm risk and how to prepare for, mitigate, and respond to severe events. When citizens know what to expect during a storm event and how to reduce its impacts, they can reduce property losses and disruptions in their lives. For example, outreach projects that educate citizens about the possibility of flooding in and around floodplains help them make more informed decisions when purchasing homes. Information about various mitigation options, from insurance purchases to flood-proofing, help residents protect existing investments.

Federal, state, and local governments all have accepted a level of responsibility to educate their citizens on how to cope with disasters, including flood and storm risk communication. Educational efforts can take many forms, including basic written information and public service announcements. For example:

- The National Weather Service has used its trademarked flood safety slogan, “Turn Around, Don’t Drown,” in a variety of ways for 15 years to educate the nation about the dangers of driving through flooded roadways. The National Weather Service also produces public service announcements using this slogan.²⁴
- The Texas Division of Emergency Management has a webpage devoted to a variety of safety topics for the public, including flood safety awareness, hurricane awareness, hurricane and post-storm preparedness, and much more.²⁵
- The Texas Water Development Board (TWDB) displays information on its website about what to do before, during, and after a storm and links the reader to other web resources.²⁶
- The Harris County Flood Control District has several tools on their website, including a flood education mapping tool that shows a user if they live in a FEMA-defined floodplain.²⁷

All these efforts are worthwhile, but more still needs to be done to improve safety messaging to the public. Some of the concerns with our current approach include the following.

Scattered efforts. Efforts to educate the public about flood and hurricane risks are divided among federal, state, and local governmental bodies. This situation is

understandable, considering the different interests and missions of entities such as TDEM and TWDB as well as local partners. However, little or no coordination weakens focus on important messages and reduces the impact of funds for public information. Also, the division of information broadly among different entities complicates the public’s ability to find the information they may need urgently.

Limited messaging topics. Currently, most messaging concentrates on personal safety *during* a disaster. Public information much less frequently informs about longer-term measures residents could take *between disasters* to reduce the impacts of severe weather. As a result, homeowners have less opportunity to be aware of the wide range of actions available to them to mitigate these impacts, including buying flood insurance, exercising reasonable diligence to discover water-related or other hazards before purchasing a house, and preparing in advance for emergency situations.

Scarce local resources. Occasionally, a smaller community may find itself without the resources or experience to produce essential public service announcements during urgent events. This circumstance leaves a community in a dangerous position.

The state needs to develop a more coordinated and visible means of distributing public safety information to the public. The report addresses the issue in the chapter on recommendations.

CONCLUSION

The Governor’s Commission fully recognizes that future-proofing the Gulf Coast through mitigation and other efforts is far from a simple task. As stated in the Commission’s October request to the federal government for financial assistance, future-proofing the Gulf Coast

*... is not a simple or inexpensive process. It will require the work of years, not weeks or months. It is, however, a process that, if completed successfully, will save the nation, the state, and individual Texans billions of dollars in losses and damages from future natural disasters, and save lives in the process.*²⁸

Recognizing the difficulty of the task, the commission presents the ideas here not as final solutions, but as concepts decision makers and the state’s citizens can consider and debate. Ultimately, the solution lies in the collective wisdom all of us bring to the table.

PREPARING FOR THE FUTURE: RECOMMENDATIONS

TRAINING

1. Develop for the Legislature a proposal for training and credentialing emergency management personnel.

Statute should direct the Texas Division of Emergency Management to convene a work group of qualified individuals to develop a consensus driven proposal to enhance the training and qualifications of emergency management coordinators and directors. TDEM already has convened a group to work on ways to improve emergency management training.

The work group should develop a proposal that could act as a basis for change. The proposal should be submitted to the Legislature and Governor by November 1, 2020, before the start of the 87th Legislature in 2021. The work group would sunset on January 1, 2021.

In its deliberations, the work group should consider the training and credentials needed to ensure that elected and appointed officials charged with overseeing response and recovery efforts in a community have the requisite training and credentials to do so effectively. In making this assessment, the working group should consider the following:

- Variations in levels of training resulting from different levels of responsibility such as community size, vulnerability of critical facilities, or other factors;

- Appropriateness of requiring in statute training and credentialing as a prerequisite to assuming emergency management responsibilities;
- Incentives to encourage emergency management personnel to seek training and continuing education; and
- Ways to pay for a more rigorous training regimen, whether through user fees or funded in whole or part by state or local jurisdictions.

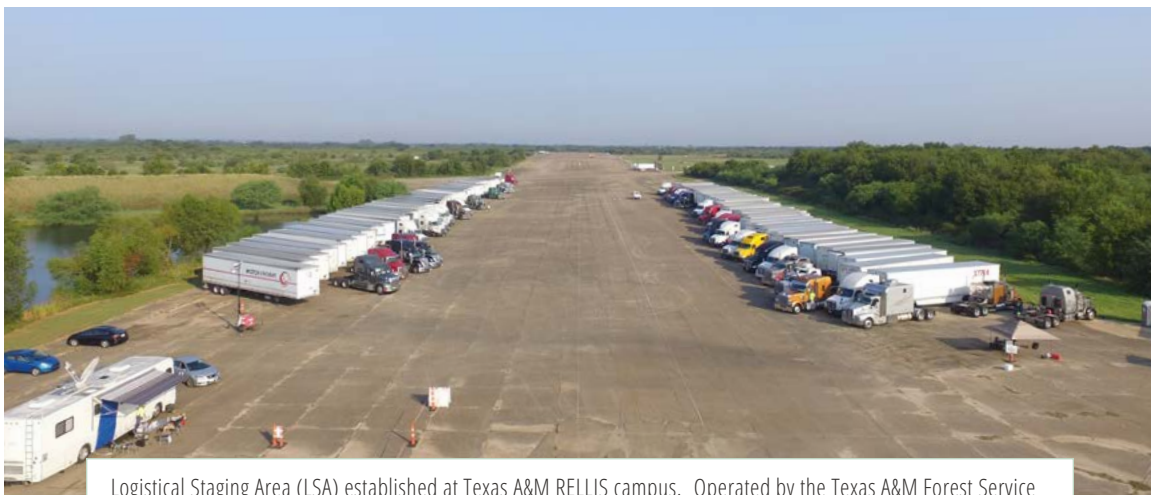
Implementing this recommendation would not result in cost to the state.

2. Review current training courses with the goal of strengthening training for recovery operations for state and local personnel in emergency management.

The Texas Division of Emergency Management should collaborate with the Texas Engineering Extension Service to carry out this recommendation.

Experience with Harvey has highlighted the need to strengthen training for personnel involved in recovery operations. The effectiveness of the recovery phase would benefit from emergency management personnel well trained in recovery operations. Important topics for training would include disaster finance, damage assessment, disaster contracting, debris management, and skills needed to participate in federal emergency management programs. This training would help ensure that local jurisdictions have personnel adequately trained to perform response and recovery duties.

This recommendation could result in cost for the development of such programs.



Logistical Staging Area (LSA) established at Texas A&M RELLIS campus. Operated by the Texas A&M Forest Service and the Texas Division of Emergency Management, 1,921 truckloads of food, water and ice flowed through RELLIS and other LSAs in response to Hurricane Harvey. (Texas A&M Forest Service)

3. Explore possible expansion of current degree programs in emergency management.

TDEM should work on this recommendation with Texas A&M University and other Texas universities.

The increasing complexity of the issues related to response and recovery supports establishing increased training and credentialing of emergency management personnel. This same need justifies a discussion about the potential benefits of adding more focused course offerings and potentially other degree programs.

The recommendation would not have an immediate fiscal impact. Long-term costs would be dependent on whether the Legislature establishes a mandatory training and credentialing program and whether that program is based on user fees or funded in whole or part by the state or local governments.

DATA SHARING, AGREEMENTS, AND CONTRACTS

4. Examine and report on ways to strengthen the quality and sharing of data used in emergency management operations.

The Texas Division of Emergency Management, assisted by an interagency work group, should implement this recommendation.

A major issue in emergency management is the quality of data available to support housing and other disaster-related programs, and the ability of agencies at the federal and state levels to share that information. These problems can stem from incompatible data sets, privacy issues, and other matters. For example, at least one observer judged the data integrity of FEMA's databases supporting short-term housing and inconsistency of that data with data maintained by its state partner, the General Land Office, was one of the most serious issue faced in administering the short-term housing program.

These kinds of issues need to be identified and addressed. The Governor's Commission recommends that major agencies involved in disaster management convene to examine issues of data quality and sharing. Major agencies could include, for example, the Health and Human Services Commission, Department of State Health Services, General Land Office, Texas Department

of Transportation, the Comptroller's office, and units of the Texas A&M University System involved in emergency management. Federal agencies such as FEMA could be invited to participate in the discussions. The work group should report each biennium to the Office of the Governor on the status of its work.

Establishing such a group would create a formal venue, currently lacking, in which data issues for emergency management could be examined cooperatively by agencies with principal data sources.

Implementing this recommendation would not result in cost to the state.

5. Emphasize to emergency management personnel the importance of working out partnership agreements and contracted services before a disaster strikes.

The Texas Division of Emergency Management, assisted by extension agents from the Texas A&M AgriLife Extension Service, should implement this recommendation.

TDEM should encourage agreements and partnerships in its training. AgriLife Extension agents should help local jurisdictions search out and seek agreements and contracted services as necessary to be prepared for future events. Raising the importance of agreements and partnerships for services in the consciousness of emergency management personnel would result in communities better prepared for disasters.

Implementing this recommendation would not result in cost to the state.

6. Explore whether the purchasing programs of the Texas Comptroller's office could be tailored to help local jurisdictions with their emergency management needs.

The Texas Division of Emergency Management should carry out this recommendation.

Local jurisdictions need to have assurance of access to needed goods and services when disaster strikes. The problems many jurisdictions faced with contracting for essential debris removal services, as explained in the report, demonstrates the importance of having pre-arranged and reliable access to essential goods and services in emergency situations. However, contracting for all necessary services ahead of time is a time-consuming and difficult process, especially for smaller jurisdictions.

The Texas Division of Emergency Management has pointed out to the Governor's Commission that the Texas Comptroller's office operates purchasing programs that possibly could help local jurisdictions obtain necessary items when needed. One such program, the Texas SmartBuy Membership Program, offers local jurisdictions such as cities, counties, and school districts, the opportunity to purchase from a wide variety of products from vendors with whom the Comptroller's office has contracted. The program saves local jurisdictions the trouble of negotiating contracts on their own and leverages the purchasing power of the state to obtain low prices. Goods or services that could be considered for emergency management could include, for example, debris hauling, purchase of barriers, portable toilets, and other items needed in a disaster.

TDEM has initiated discussions with the Comptroller's office about whether this type of program could benefit emergency managers. The Division should continue these conversations.

Implementing this recommendation would not result in cost to the state.

PARTNERSHIP WITH THE FEDERAL GOVERNMENT

7. Collaborate with Congress and the federal government to improve emergency management laws and policies.

The Texas congressional delegation and state leaders should work together to collaborate with Congress and the federal government on these issues.

The goal of this federal-state partnership would be to improve and streamline federal laws and policies related to procurement, housing assistance, sharing of data, staffing issues, and navigation through the maze of federal disaster assistance programs.

The recommendation could be implemented without cost, being included in on-going state efforts to collaborate with federal officials on emergency management policy issues.

8. Embrace the basic tenets of FEMA's Strategic Plan with its emphasis on cooperation among federal emergency management agencies, state government, local government, non-governmental organizations, the private sector and individual citizens to meet the critical basic goals of making the Nation better prepared for and better able to deal with future disasters.

FEMA's strategic plan stresses cooperation among the federal emergency management agencies, state government, local government, non-governmental organizations, the private sector and individual citizens. The aim of this cooperative posture is to meet the critical basic goals of making the nation better prepared for and better able to deal with future disasters. Capitalizing on this cooperative attitude, the Texas emergency management agencies should actively engage the agencies of the federal government like FEMA and HUD that provide assistance in times of major disaster to streamline and improve processes and develop more effective cooperative arrangements that can be applied in future disasters. Federal, state and local agencies should share lessons learned during major disasters and use the collective resources of all levels of government to improve and simplify processes and to apply the best practices in disaster response and recovery.

DISASTER TECHNOLOGY

9. Review laws and practices affecting the use of drones during emergency events and recommend changes in statutes or operations to promote their use.

The Texas Division of Emergency Management, in coordination with the Texas A&M University System agencies and other stakeholders, should implement this recommendation.

Drones played an important role in the immediate aftermath of Hurricane Harvey. Emergency responders, insurance companies, NASA, railway operators, private industry, and state government agencies all were among drone users during Harvey.

Harvey showed that drones are becoming increasingly important during disasters. However, laws and regulations need to match disaster needs. For example, not everyone that may need access to drones in emergency situations has that authority or obtains it quickly enough. Also, federal “line of sight” rules require a drone operator to keep visual contact with the drone at all times, thereby reducing the range and effectiveness of drone use.

In this recommended study, TDEM and cooperating entities should examine appropriate uses for drones in disasters, how to coordinate and promote that use, and what rule and law changes are needed to make drones more effective.

Implementing this recommendation would not result in cost to the state.

10. Establish a single, well publicized state website at the Texas A&M University System that is easy to use and presents important post-disaster information about response and recovery activities.

The Texas A&M University System should work with the Governor’s Office and the Texas Division of Emergency Management to realize this recommendation. The Texas A&M University System is a logical choice for spearheading the development of this website because of the key roles various system entities carry out in disaster response and recovery.

Texas does not have one central website posting comprehensive information about disasters. Several state and federal agencies have websites with disaster-related information and links, but they do not provide “one-stop shopping” for comprehensive information

about programs and services, response and recovery efforts, and funding and expenditures for assistance programs. A comprehensive site would make it easy for disaster survivors, policy makers, government agencies, first responders, and service providers to find information important to them.

For example, this single website could be a “Window on Disaster” portal that would contain pages specific to each declared disaster in Texas. Information pertinent in any disaster, such as a single intake form recommended elsewhere in this report, would be easily accessible from the main page. In addition to status reports and other critical advice and information for those impacted by a disaster, the website also could present financial information from FEMA, the state, and philanthropical organizations to increase transparency about how response and recovery efforts are funded.

The cost of developing and maintaining a comprehensive website would be negligible.

11. Consider ways to make better use of 911 and social media during disaster response.

The Texas Division of Emergency Management, with the cooperation of the Texas Engineering Extension Service, Texas A&M AgriLife Extension Service, and other appropriate entities should work together to implement this recommendation.

During forums held by TDEM after Harvey, responders, local officials, and state and federal agency representatives all agreed that the state needs a better approach for communicating during and after a disaster event. Two of the options discussed centered on the use of social media, such as Facebook and Twitter; and texting to 911, the country’s emergency access number.

Social media has become an important form of communication during disasters. Disaster victims used social media extensively to request assistance during Hurricane Harvey, and government entities found social media a useful means of communicating with the public.

Although already an important component of emergency response, the use of social media in disaster situations needs to mature further to realize its full potential. TDEM, TEEX, and other appropriate public or private entities, should explore ways to improve and standardize the use of social media as a communication tool.

Victims of a disaster need clear instructions on how to request emergency rescue or assistance so

that they are not posting identical information on multiple platforms. Government agencies, responders, and volunteers need instruction on how to use social media effectively to optimize the effectiveness of social media, such as using consistent hashtags for tracking information. Also, limiting access on some platforms to credible sources of information during a disaster would help improve the effectiveness of social media. TEEX already is exploring training for the use of social media in disasters.

The 911 emergency number presents another maturing avenue of communication to improve disaster. Currently, residents in more than 250 jurisdictions in Texas may not only call but also send a text to 911. TDEM and AgriLife should work with other jurisdictions to encourage them to develop the capability to receive texts. Providing an alternative way of communicating with 911 across the state may ease survivor victims' use of multiple and overextended social media platforms and help streamline emergency response.

The cost of implementing these initiatives is unknown. The state would not incur any costs to coordinate with local jurisdictions on the use of 911; however local governments could incur costs to acquire technology to receive texts through their 911 call centers.

12. Explore expansion of the capabilities of the Rebuild Texas application or development of a new mobile app to deliver important information to responders and disaster victims alike.

The Texas Division of Emergency Management and the Texas A&M Forest Service should collaborate to carry out this recommendation.

In the immediate aftermath of Harvey, administrators and responders in the Texas A&M University System working with the Governor's Commission to Rebuild Texas quickly realized that effective response and recovery depends on real-time information from the disaster area. The Texas A&M Forest Service hurriedly modified one of its existing applications to produce a "Rebuild Texas app" to exchange and summarize information primarily between AgriLife responders and state experts. The app proved to be a highly successful innovation that greatly facilitated the rapid exchange of important information.

The successful use of this app to communicate critical information has raised the question as to whether the Rebuild Texas app could be modified or another app developed to deliver critical information

directly to disaster victims and responders. Having a publicized government-sponsored "disaster app" that could, for example, accurately inform about current road and weather conditions or response activities, would be an invaluable source of information for responders and victims alike.

This recommendation could result in some development costs if the idea proved feasible.

13. Examine the costs and benefits of promoting a technology standard enabling a wider video representation of a disaster area for first responders.

The Texas Division of Emergency Management and the Texas A&M Engineering Extension Service should collaborate to implement this recommendation.

Today, technology exists for first responder teams to digitally collect spatial location and other information from the field and display that information on a screen back at base camp. Team members load that information on return to base camp or, with the right technology, automatically transmit it to base camp in real time. This data creates what first responders call a "common operating picture," enabling first responder teams to all see the same field situation and better coordinate their response. The more teams that can share this data, the bigger the common operating picture and the better the response.

The problem with the system today is that, to share this digital data, responder groups need to use a standard communications format so different equipment and systems can interconnect. No such standard currently exists. Today, teams arriving at a large-scale disaster from around or outside the state bring the technology on which their jurisdictions or they themselves decide. Thus, lack of a standard digital protocol limits the range of the common operating picture.

Adoption of a standard communication format for a common operating picture doesn't require purchase of a specific brand of equipment. Rather, equipment used would recognize the common standard, just as cell phones from different makers communicate with shared protocols.

TDEM and the Texas A&M Engineering Extension Service should examine the costs and benefits of promoting use of a standard communications format to create a larger common operating picture. The analysis should include identification of any equipment costs that first responder groups might have to incur in acquiring gear that recognizes the standard format. If

ultimately deemed desirable, the state could consider steps to enable adoption of a standard communication format, with the bottom line being the saving of lives.

Implementing this recommendation would not result in cost to the state.

14. Continue to cultivate relationships with private technology providers to coordinate their assistance in the early days of a disaster when communications systems are damaged or destroyed.

The Texas Division of Emergency Management, with the collaboration of the Texas A&M AgriLife Extension Service and other appropriate entities, should implement this recommendation.

Private sector cellular phone, internet, and cable services have portable equipment that could be used to help re-establish data and communication connections immediately after a disaster. This equipment includes portable satellite communications equipment and portable cell phone towers. TDEM and AgriLife should promote relationships with these service providers as part of their preparedness activities and develop plans outlining how these providers could be included to assist with response and recovery after disasters. No cost is associated with establishing and maintaining these relationships.

Implementing this recommendation would not result in cost to the state.

15. Examine ways for the state to apply data analytics to improve disaster management through more effective and timely information.

Extensive software applications are currently available allowing the integration of large amounts of data from federal, state, local and non-governmental sources. This wealth of information can be analyzed and used to more effectively manage the disaster cycle. Such technology has been effectively used in other areas of state government.

PUBLIC INFORMATION

16. Examine ways to better inform the public about how to prepare for and survive a disaster.

Implementation of this recommendation should occur through the Governor's appointment of a committee, as

discussed below.

The first line of defense in future-proofing the state lies with each of us, the members of the public. We can do much on our own to protect our families and property, given the initiative and knowledge.

One of the lessons of Hurricane Harvey is that members of our communities often are unaware of the steps they can take on their own, or the dangers they might face if they don't take those steps. The unfortunate examples of motorists drowning trying to cross flooded roadways or families unaware of their homes' locations close to or in reservoirs in Houston come to mind.

Federal, state, and local entities with resources all have conducted public information campaigns to help educate citizens, but these efforts are scattered and messaging is not coordinated or focused for maximum benefit across the state. Messaging typically centers more on immediate dangers during a storm event than steps homeowners can take to protect their homes and lives before an event. In addition, some very small communities can find themselves in situations in which personnel are not available to notify their communities about imminent danger using public media or other means.

The Governor's Office should convene an advisory committee well versed in media communications and public information campaigns to address and make recommendations on these concerns. The Governor should consider appointing representatives to this group from appropriate sources, such as state, federal, or local governments and private sector entities. The Governor would appoint a chair from among state agency representatives. The Texas Division of Emergency Management and other state agencies represented on the committee would provide staff to assist the committee in its work.

Although not limited to this list, the committee would consider and make recommendations on the following issues related to public information campaigns.

- How to better focus and integrate federal, state, or local resources on selected topics for public information campaigns.
- The most important mix of topics for public information campaigns. Topics for consideration could include:
 - Encouraging homeowners to purchase flood insurance in localities within designated flood plains;

- Encouraging homebuyers to do their due diligence to uncover any water-related or other hazards associated with the purchase;
- Emphasizing individual family preparedness for storm events;
- Communicating the dangers of driving through low water crossings; and
- Promoting unclogging and maintenance of street drains.
- Types or mix of media to use to communicate the information.
- Likely cost to run an effective public information campaign on any one topic for a statewide audience, or for audiences in smaller geographic regions.

In addition, the committee would consider ways that state or larger local governments could provide a communications safety net for small communities during times of urgent need. This need could occur, for example, if the community lost critical personnel typically in charge of media communications.

The committee would report its findings and recommendations to the Governor by November 1, 2020, who could then decide how or whether to proceed. This schedule also would give the Governor the opportunity to recommend any necessary changes for consideration by the 87th Legislature, which convenes in January 2021.

No additional cost to the state would be associated with convening this group other than out-of-pocket expenses of members for attending meetings in person.

MEDICAL PREPAREDNESS

17. Consider appropriating additional funds to expand and improve the state's trauma care network to be better prepared for future disasters.

The state's network of trauma centers saves lives and is a critical component of disaster response. Some areas of the state don't have enough of these centers, particularly the Level I Comprehensive Trauma Centers.

The Legislature should consider investing the trauma network to ensure the infrastructure and personnel are in place before another disaster like Hurricane Harvey strikes the state. This will require significant capital investment, although there are no current estimates of the statewide need.

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An aerial photograph of a river valley, likely the Amazon, with a river winding through a dense forest. Overlaid on the image are white topographic contour lines, some solid and some dashed, indicating elevation changes. The overall color palette is a mix of dark blues, greys, and greens, with a teal gradient overlay on the right side.

CHAPTER 9

9 FUTURE-PROOFING TEXAS

During a news conference announcing the formation of the Governor's Commission to Rebuild Texas, Commissioner Sharp said: "One of the guiding principles will be to 'future-proof' what is being rebuilt so as to mitigate future risks as much as possible."¹ Since its creation, Governor Abbott and Chancellor Sharp have returned to that idea again and again, driving home an important point to Texans.

The concept of future-proofing may seem unfamiliar, but its core meaning in emergency management isn't: It means to plan ahead and prepare for the inevitable emergencies of the future. In this sense, future-proofing is the process of anticipating future storm events and developing ways to minimize their effects on lives and property — strategies that can mitigate the impact of future disasters and make the state more resilient.

As such, the concept rests on two assumptions: First, that Texas will face future disasters, and second, that since we know that future disasters will come, we should not wait for them unprepared. The report of an earlier commission, the Governor's Commission for Disaster Recovery and Renewal, put it this way in 2009: "Where possible, the state of Texas should take measures to protect against catastrophic damage. But catastrophes will still happen, so the state of Texas needs to pursue processes that will help prevent one major loss from triggering additional losses."²

As we applied the concept of future proofing in the course of the Commission's work and in detail in Chapter 8 of this report, it means putting a premium on strategies that can help avoid, resist and accommodate the worst nature can throw at our state. It also means we do our best to prepare our citizens and our institutions to deal with emergencies by communicating information that will allow them to make good decisions about mitigating risks.

No one working on the state's recovery from Hurricane Harvey has ever been under the illusion that future-proofing Texas in the most comprehensive sense of the word would be easy or inexpensive. If it was easy and inexpensive, it would have been accomplished long ago. It would have been accomplished in 2008 after Texas suffered through three hurricanes — Dolly, Gustav, and Ike. It would have been accomplished in 2005 after Katrina devastated Southern Louisiana and Mississippi

and Rita tore through South East Texas on its way to creating more destruction in Louisiana. It would have been accomplished after the deadly and destructive 2011 fire season. Periodic disasters are not a new story in Texas. Because of its sheer size, environmental diversity and location on the Gulf of Mexico, the state must deal with these threats on a regular basis. Texas, after all, has had more declared disasters than any other state in the nation.³

"NOTHING GOOD COMES OUT OF A SLOWING STORM"

That unwanted distinction is unlikely to change in the future. Recent scientific studies have found that tropical cyclones, which includes hurricanes, are moving more slowly than they did in past decades, intensifying their potential effects when they reach land.⁴ "Nothing good comes out of a slowing storm," said James Kossin, with the National Oceanic and Atmospheric Administration's Center for Weather and Climate in Madison, Wisconsin, and author of one recent analysis published in *Nature*. "It can increase storm surge. It can increase the amount of time that structures are subjected to strong wind. And it increases rainfall."⁵ The recent destruction in the Carolinas caused by Hurricane Florence offers yet another demonstration of the trend.

Ethan Gutmann of the National Center for Atmospheric Research who led another study of recent hurricane trends brought the issue closer to home: "Our research suggests that future hurricanes could drop significantly more rain. Hurricane Harvey demonstrated last year just how dangerous that can be."⁶ In the same vein, a study released last year found that rainfall events along the Texas coast as intense as that produced by Hurricane Harvey, had about a 1 percent annual

likelihood in the 1990s. That likelihood increased to about 6 percent annually in 2017, and by 2090, it could be about 18 percent.⁷

The commission's work focused on hurricanes and coastal Texas, but the state's challenges with disasters, natural and otherwise, goes beyond hurricanes. The 351 declared disasters in Texas since 1953 that FEMA tracks include hurricanes, tornadoes, severe storms and floods, fires and more than one explosion, including the West fertilizer explosion in April 2013. Texans remember the Bastrop fires of 2011 that burned more than 34,000 acres and destroyed 1,660 homes in Central Texas, one of the most damaging wildfires the state has ever seen. Some will remember April 10, 1979, when a series of about 30 deadly tornadoes tore through communities on the Texas-Oklahoma border and the Red River Valley, killing 58 people, 54 of them Texans, on a day that became known as "Terrible Tuesday." The list, in fact, includes more fires and floods than hurricanes and the effects of these other disasters, though smaller than Harvey, are no less devastating to the communities and individuals affected.

So, we should recognize that Texas, along with its many benefits, will face a future that contains more challenges, and the question we have tried to answer in this report is: What should we do to prepare? The answers we found after months of work on hurricane recovery and days of discussion with state and local officials, business, nonprofit and individuals encompasses many recommendations for improvements in our current emergency management process contained in this report. As we look to the future, six conclusions stand out as vital in determining whether Hurricane Harvey has really taught us our lesson or if we will simply wait for the next hurricane or tornado or wildfire to arrive without taking the steps needed to better protect our citizens, their homes and businesses and the public infrastructure that is critical to the state's economic success.

First, we found that Texas is the best in the nation in its ability respond to disasters, whether natural or man-made, but we also identified ways that we can improve the current system through more efficient organization, more effective coordination, better information and the application of emerging technologies. Texas must not only remain a leader in emergency response. It must also be an innovator.

Second, we need to apply the lessons of Hurricane Harvey to the strategies we use to begin the recovery in the critical days and weeks following a future disaster. That means better organizing

assistance for survivors of the disaster, better coordination of recovery efforts at the state and local level, stronger partnerships with the federal agencies who provide funding and assistance for major disasters, and more quickly and effectively bringing state and federal resources to bear on the problem.

Third, we need to greatly streamline and improve our longer-term approach to recovery, providing more effective and organized assistance to communities affected by disaster, working with our federal partners to streamline and speed up assistance programs for local governments, individuals and businesses, and build on what we have learned from Harvey as we prepare for the next inevitable challenge. The recovery has not worked well for all Texans. There have been delays, particularly in federal housing programs, and many Texans have spent the year battling through the thicket of federal and state bureaucracy in order to get back on their feet. Some of this is inevitable given the magnitude of the problem, but we should make a commitment to making real improvements in the process before the next large storm.

Fourth, we need to be better prepared. Harvey was a tragedy for many Texans, but it also exposed areas where the state can better equip itself for the future. We should not allow the opportunity for improvement to pass by without action. We need to have better trained local officials and emergency managers. We need to ensure that state capabilities for emergency response are organized, trained and equipped for future Harveys. We need to stop making the old mistakes in local development that expose homes and businesses to flood events like Harvey.

Fifth, we need to provide local governments, Texas businesses and individual Texans with better and more accessible information about future risks in their area, and we need to develop our communities in ways that don't expose homeowners and businesses to risks that only become apparent when disaster strikes. In a 2016 study of public perceptions of hurricane-related risks along the Gulf Coast and how they influence public support for flood management policies, researchers found that residents had low motivation to take voluntary steps to reduce their risks before a storm unless they have timely, up-to-date information from trusted sources about how serious those risks are. Their perceptions were also affected by past experience with storms.⁸ "In the case of Harvey, we believe that many victims did not correctly perceive

the risks they faced, and failed to anticipate or prepare adequately for this unprecedented catastrophe,” the study’s author said.⁹ We need to make sure that doesn’t happen again. Only when people have good information can they make good decisions.

Finally, we need to begin the vital work of future-proofing Texas, and we need to develop a more organized method of approaching this imposing task. As part of the work of the commission, we have worked with the Texas Division of Emergency Management to compile a comprehensive list of hazard mitigation projects in the counties affected by Hurricane Harvey. The list totals more than 4,000 potential projects costing billions of dollars. Many of these projects are important to protecting the state as a whole from future hurricane and flooding disasters; all are critical to the local communities where they are needed — and needed now, not in the future.

This list, which continues to grow, is only a start. Ultimately, the state needs to compile a comprehensive list of mitigation strategies for the entire state, an effort that will require much more time and cooperation at the local level. Then we need to prioritize the projects based on the best available scientific and economic analyses and begin work on attacking the problem. There is no need to wait for a perfect list. It will be ever-changing. The time to begin work is now while resources are available from the federal government and the state to address as much as is feasible.

PREPARING ON AN EXTENDED TIME SCALE

Texas already has a model for this sort of approach — the Texas Water Plan. Born in the 1950s during the state’s drought of record, it was designed to forecast the state’s future water needs over decades, rather than a few years and prioritize water projects, working from the local level up to the overall plan, an approach that ensures that local concerns are addressed along with statewide concerns. As one article put it: “Texas officials, with the pain of ‘50s drought fresh in their minds, funded the first water plan in 1961 in a way that hasn’t been done since.”¹⁰

Texas needs water, but it also needs to protect its citizens and public infrastructure from future disasters like Harvey. Is it not appropriate that with the hurricane fresh on our minds that we make the changes we need to make now and not in some theoretical future? Chapter 8 of this report lays out a path to improvement.

Commissioner Sharp, who oversaw the state’s

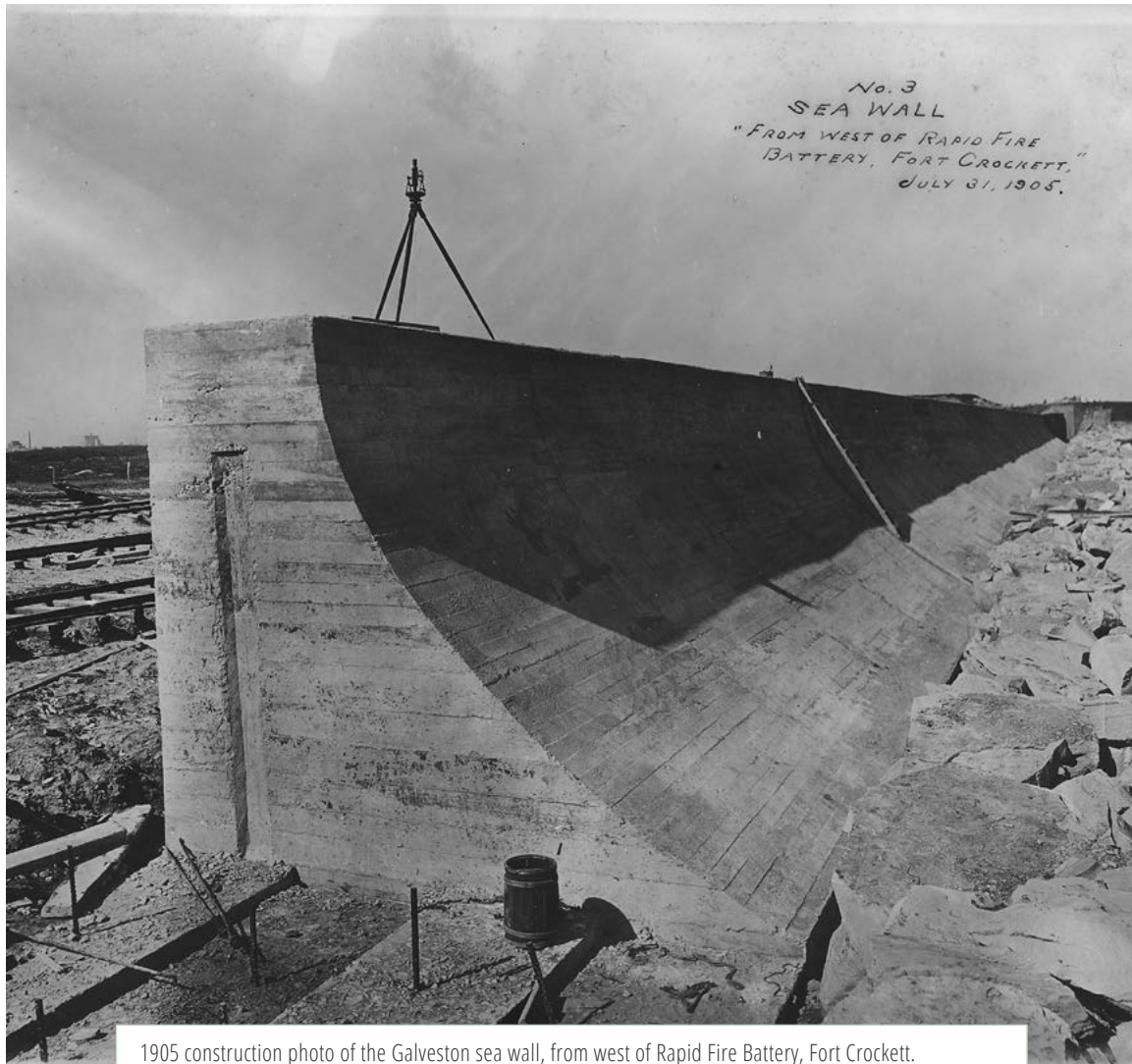
finances for eight years as Texas Comptroller of Public Accounts, recognizes as well as anyone that this process cannot be completed immediately. He recognizes as we all should that we are talking about thinking in generational terms, to making a commitment that we will start now to build an infrastructure that will last for decades and survive the worst that is thrown at it. This requires a vision for what needs to be done and a willingness to think long term. As MIT Professor Kerry Emanuel, who authored the paper on hurricanes along the Gulf Coast, put it: “It would be nice to see cities in general plan on a 50-year time scale, at least, versus a one- or two- or 10-year time scale.”

The list TDEM and the commission have compiled is the beginning of such a plan. It contains projects totaling an estimated 108 billion, including the \$61 billion in priority projects that Governor Abbott submitted to Congress in October of last year. The total funding requirement, assuming it is accurate, is far larger than the funding provided by Congress in the wake of Hurricane Harvey. It is far more than the Legislature can possibly provide in any legislative session or succession of legislative sessions. It is, in fact, about the same as the entire annual budget of the state of Texas in fiscal 2019. That is why we need a plan, a set of priorities, and a commitment to addressing the plan over time as funding becomes available.

In short, we need to know what we will do when we are able to do it — and to be effective, we need the participation both of local governments and the federal government, which has a compelling national interest in protecting the vital infrastructure of the Texas Gulf Coast along with its millions of inhabitants. As Commissioner Sharp put it last year: “Future-proofing the state’s coastal areas requires a long-term commitment and investment to improve the resiliency of our communities and institutions. To succeed, the task needs both the continued partnership and financial support of the federal government.”¹¹ And that is before we even before we consider the very real needs of the rest of the state.

The future risks to the Texas Gulf Coast are real and will only grow as the coastal counties continue to develop. The reality is that there will never be a better time to begin working on a future-proof Texas than right now.

Isaac Cline, the chief of the U.S. Weather Bureau in Galveston at the time of the 1900 hurricane — and the Isaac in Erik Larson’s book about the 1900 hurricane, *Isaac’s Storm* — once dismissed the probability of a hurricane striking the island: “Galveston should take



1905 construction photo of the Galveston sea wall, from west of Rapid Fire Battery, Fort Crockett.
(U.S. National Archives and Records Administration)

heart as the chances are that not once in a thousand years would she be so terribly stricken," he wrote. His comments helped persuade local officials to save money and postpone improvements, including building a seawall, which would have given the island some measure of protection. Eventually Cline saw the error of his ways. As the 1900 storm bore down on Galveston, he violated Weather Bureau policy and unilaterally warned the island's residents. Tragically, the warning came too late to allow residents to evacuate and thousands died.

It wouldn't be the last hurricane to threaten the Texas Gulf Coast and Galveston. Another large hurricane struck the island in 1915. There were many

others in succeeding years as Larson wrote: "Other hurricanes struck or came very near in 1919, 1932, 1941, 1943, 1949, 1957, 1961, and 1983," Larson wrote in *Isaac's Storm*. That list has expanded over the last 20 years and now includes not only Hurricane Harvey but also the devastating Hurricane Ike in 2008. But while many storms have lashed the island since 1900, many fewer people have suffered and much less damage has been done. The reason for this can be attributed to two lessons learned in that tragic year. First, the people of Galveston were better prepared and took approaching storms more seriously. And second, they elevated an entire island and built a seawall.

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An aerial photograph of a landscape featuring a river, dense forests, and some buildings. The image is overlaid with a teal-to-blue gradient and white topographic contour lines. The text 'REPORT CONTRIBUTORS' is centered in a white, bold, sans-serif font, with a thin white horizontal line underneath it.

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An aerial photograph of a flooded landscape, likely a wetland or marsh, with a teal overlay and white contour lines. The water is a dark, mottled blue-grey, and the surrounding land is a lighter, textured blue-grey. The contour lines are white and follow the topography of the land, with some solid lines and some dashed lines. The word "APPENDIX" is written in white, bold, sans-serif capital letters, centered horizontally and slightly below the vertical center. A thin white horizontal line is positioned directly below the text.

APPENDIX

HARVEY TIMELINE

2017

AUGUST

23 Disaster Proclamation Issued For 30 Texas Counties in Anticipation Of Tropical Depression Harvey Making Landfall.

25 Harvey makes first landfall

Governor Abbott sent a letter to President Donald J. Trump requesting a Presidential Disaster Declaration as Hurricane Harvey is set to make landfall. President approves major disaster declaration for Texas.

The Federal Emergency Management Agency (FEMA) announced that federal disaster assistance has been made available to the state of Texas to supplement state and local recovery efforts in the areas affected by Hurricane Harvey from August 23, 2017 and continuing.

26 Harvey makes second landfall

28 Harvey's center moves into Gulf of Mexico with winds of 45 mph. Catastrophic flooding in southeastern Texas continues. Tropical storm and storm surge warnings extend to Louisiana. Governor Abbott visits Coastal Bend and activates entire Texas National Guard; deployed guard members number 17,000

Governor Abbott amended disaster proclamation to include an additional 28 counties.

29 Rain, catastrophic flooding continues in southeastern Texas and extends into southwestern Louisiana. Harvey remains just offshore of middle and upper Texas coast.

Governor Abbott and President Donald Trump visit Corpus Christi, receive detailed briefing.

30 Harvey makes third landfall

Governor Abbott requests 14 additional counties be added to presidential disaster declaration

SEPTEMBER

1 Harvey moved northeastward over the southern United States while producing heavy rainfall, and it transformed into an extratropical cyclone by 0600 UTC 1 September over the Tennessee Valley.

6 The House approved an initial \$7.9 billion package of disaster relief funds in the wake of Hurricane Harvey

7 Governor Abbott signs proclamation creating the Governor's Commission to Rebuild Texas to be led by Texas A&M University System Chancellor John Sharp.

Governor Abbott agrees to waivers to help with debris removal

8 Governor Abbott on Friday distributed more than \$135 million in advances from the federal government to Harris County and the city of Houston,

9 Multi-agency warehouse (MAW) opened in San Antonio to collect and sort donated goods.

13 First Disaster Supplemental Nutrition Assistance Program (DSNAP) offices open

Governor Abbott announces Governor's Commission to Rebuild Texas Website

14 Texas General Land Office (GLO) Commissioner George P Bush named to head state's housing recovery efforts after Hurricane Harvey.

Governor Abbott issues declaration extending the disaster proclamation to include Milam and San Augustine counties.

20 Governor Abbott Extends Disaster Declaration For Texas Counties Impacted By Hurricane Harvey

21 Governor Abbott Extends Proclamation Suspending Hotel And Motel Taxes During Hurricane Harvey

26 Chancellor Sharp explains that municipalities must submit paperwork outlining their needs to potentially get financial aid by September 29.

OCTOBER

- 2** Houston area officials tell lawmakers of Harvey costs and funding needs
- 5** Abbott and Texans in Congress request \$18.7 billion more in Harvey aid
- 11** Texas Education Commissioner announces establishment of Hurricane Harvey Task Force on School Mental Health Supports to deliver needed attention to schools and higher education institutions impacted by storm.
- 16** Governor Greg Abbott today extended the temporary waiver suspending rules relating to vehicle registration, titling, and inspection for victims of Hurricane Harvey.

Agriculture, Water and Rural Affairs Hearing regarding Harvey
- 20** Last day Disaster Supplemental Nutrition Assistance Program offices are open
Governor Greg Abbott renews state disaster declaration for 60 Texas counties.
- 24** Chancellor Sharp testifies at Senate Finance Committee
- 25** State Affairs Hearing (Harvey)

NOVEMBER

- 1** Intergovernmental Relations Hearing (Harvey)
- 6** Education Hearing (Harvey)
- 8** Health and Human Services Hearing (Harvey)
- 9** Texas dedicates \$90 million to supplement federal aid for debris cleanup
- 10** Texas lobbies federal government for \$61 billion for infrastructure improvements after Hurricane Harvey's destruction.
- 15** Transportation Hearing (Harvey)
- 17** Multi-agency warehouse (MAW) closed.
- 20** Governor Abbott Extends Disaster Proclamation for 60 Texas Counties

\$90 million
to supplement federal
aid for debris cleanup

DECEMBER

- 5** Finance Hearing (Harvey)
- 7** Housing and Urban Development meeting in Rockport
- 14** South East Texas Regional Planning Meeting held
- 15** Housing meeting held in Beaumont, TX
- 18** Abbott extends disaster declaration for Harvey hit areas
- 20** Gov Abbott delivers checks for Harvey debris removal

Land and Resources Management Committee holds hearing to discuss Harvey

Abbott announces 100k donation in flooring and funds for Aransas Pass Middle School
- 21** Texas A&M engineering students begin work with FEMA in assessing Harvey damage

US House approves \$81 billion more for Harvey relief
- 28** GLO Offers additional temporary housing program for Harvey survivors: PREPS

US House approves
\$81 billion more
for Harvey relief

2018

JANUARY

- 18 Public Hearing of the Texas House of Representatives General Investigating and Ethics Committee
- 23 Business and Commerce Hearing (Harvey)
- 29 TX Senate Committee on Ag, rural affairs and water hearing

FEBRUARY

- 1 Property Tax Reform hearing (Harvey)
- 8 Deal met between House and Senate that would include \$89.3 billion to respond to the effects of hurricanes in Texas, Florida, Puerto Rico and the Virgin Islands and wildfires and mudslides in California, up from \$81 billion in earlier legislation.
- 13 Gov Abbott announces more than \$1.1 billion in new funding coming to Harvey impacted areas for hazard mitigation
- 16 Governor Greg Abbott today extended the State Disaster Declaration for Texas counties affected by Hurricane Harvey.
- 20 Finance Committee Hearing (Harvey)
- 26 Governor's Commission to Rebuild Texas announces launch of new recovery tracker to allow public to see how funds related to the state's recovery from Hurricane Harvey are being used.

MARCH

- 16 Governor Greg Abbott extended the State Disaster Declaration for Texas counties affected by Hurricane Harvey.
- 20 Finance Hearing (Harvey)
- 27 Federal government declares fishery disaster following Hurricane Harvey.
Intergovernmental Relations Hearing (Harvey)

APRIL

- 10 Texas GLO published State of Texas Action Plan for \$5.024 billion in Community Development Block -Disaster Recovery Grant (CDBG-DR)
- 13 Governor Greg Abbott today extended the State Disaster Declaration for Texas counties affected by Hurricane Harvey.

MAY

- 8 Commissioner George P Bush announced the State Action Plan has been sent to the US Department of Housing and Urban Development. Plan details distribution and eligible use of \$2.7 billion in CDBG-DR funds.
- 13 HUD approval of State action Plan for \$57.8 million in CDBG-DR funds

AUGUST

- 7 Governor Abbott extends Hurricane Harvey Disaster Declaration

PROCLAMATION



GOVERNOR GREG ABBOTT

September 7, 2017

FILED IN THE OFFICE OF THE
SECRETARY OF STATE
9:55 AM 'CLOCK

The Honorable Rolando B. Pablos
Secretary of State
State Capitol Room 1E.8
Austin, Texas 78701

SEP 07 2017
A handwritten signature in blue ink, appearing to read "RBP", written over a horizontal line.
Secretary of State

Dear Mr. Secretary:

Pursuant to his powers as Governor of the State of Texas, Greg Abbott has issued the following:

A proclamation relating to the creation of the Governor's Commission to Rebuild Texas following the disaster created by Hurricane Harvey.

The original proclamation is attached to this letter of transmittal.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read "GSD", written over a horizontal line.
Gregory S. Davidson
Executive Clerk to the Governor

GSD/gsd

Attachment

PROCLAMATION
BY THE
Governor of the State of Texas

TO ALL TO WHOM THESE PRESENTS SHALL COME:

WHEREAS, Hurricane Harvey hit the Texas coast on Friday, August 25, 2017, causing massive destruction along the Coastal Bend before moving up the Texas coast into Central and Southeast Texas resulting in unprecedented flooding and tragic loss of life; and

WHEREAS, the enormity of Harvey's destruction in small coastal communities, in the Houston area, and in the Beaumont area and beyond has caused unprecedented damage in many parts of the state to the public infrastructure upon which Texans and the Texas economy depend; and

WHEREAS, many communities affected by this disaster are in immediate need of aid from the state and federal governments for the restoration of public infrastructure such as roads, bridges, schools, government buildings, and other public facilities; and

WHEREAS, the swift and effective restoration of damaged public infrastructure throughout the disaster area is of paramount importance to the Texas economy and to the people of Texas who live and work in the communities affected by Hurricane Harvey; and

WHEREAS, the State of Texas must provide coordinated leadership to assist local governments and citizens with the resources they need to facilitate the recovery and rebuilding effort;

THEREFORE, I, GREG ABBOTT, Governor of the State of Texas, by the authority vested in me by the Texas Constitution and Sections 418.011, 418.016, and 418.017 of the Texas Government Code, do hereby proclaim the following:

1. The Governor's Commission to Rebuild Texas is hereby established.
2. The Commissioner of the Governor's Commission to Rebuild Texas shall be John Sharp, Chancellor of The Texas A&M University System, an agency of the State of Texas, who shall have the executive power to act on behalf of the Commission.
3. The Commission, under the leadership of Chancellor Sharp, shall exercise executive authority, delegated by the Governor, to marshal state agency resources in order to coordinate the statewide effort to rebuild public infrastructure damaged by Hurricane Harvey including roads, bridges, schools, government buildings, and other public facilities.
4. The Commission shall have any authority necessary and proper to effectively coordinate the State's effort to recover and rebuild public infrastructure damaged by Hurricane Harvey, subject to oversight by the Governor.
5. The duties of the Commission shall include: assisting local governmental entities and nonprofit organizations to assess and identify rebuilding needs and to navigate state and federal resources available for the rebuilding effort; advocating for the interests of state and local government on matters related to disaster response; and providing expertise and assistance to local governmental entities and nonprofit organizations throughout the rebuilding process.
6. The Commission shall establish and operate a one-stop support center for local officials and other community leaders seeking information and assistance regarding efforts to rebuild public infrastructure.

FILED IN THE OFFICE OF THE
SECRETARY OF STATE
9:55 AM O'CLOCK
SEP 07 2017

Governor Greg Abbott
September 7, 2017

Proclamation
Page 2

7. The Texas A&M University System, its member agencies and universities, and its employees, are authorized to participate in and support the work of the Commission in the recovery and rebuilding effort.
8. The Commission is authorized to seek the participation and support of other state agencies and state university systems in this effort, and such agencies and university systems and their employees are authorized to participate in and support the recovery and rebuilding effort.
9. Pursuant to Section 418.016 of the Texas Government Code, any statute or administrative rule regarding the procedures for staffing, travel, or procurement by The Texas A&M University System is hereby suspended to the extent it would interfere with or delay the swift establishment of the Commission's capacity to perform the duties assigned herein. Notwithstanding this suspension, The Texas A&M University System should take reasonable steps to ensure it receives good value for any expenditure of public funds.

The Commission and the terms of this proclamation shall remain in effect until modified, amended, rescinded, or superseded by me or by a succeeding governor.



IN TESTIMONY WHEREOF, I
have hereunto signed my name and
have officially caused the Seal of
State to be affixed at my office in the
City of Austin, Texas, this the 7th
day of September, 2017.


GREG ABBOTT
Governor

ATTESTED BY:


ROLANDO B. PABLOS
Secretary of State

FILED IN THE OFFICE OF THE
SECRETARY OF STATE
9:55 AM O'CLOCK
SEP 07 2017

