

Sources:

Big Storms Leave Small Marks on the U.S. Economy - Studies show business slows during and after hurricanes hit, but rebuilding leads to a boost in economic activity.

We Looked Into The Effects Of Hurricane Harvey And Here's What We Found - The Effects Of Hurricane Harvey.

Hurricane Harvey could be the costliest natural disaster in US history: here's how we'll know the true cost. – Cost of Harvey.

Hurricane Harvey Facts, Damage and Costs What Made Harvey So Devastating – Facts and damages that made Harvey devastating.

What Harvey taught us: lessons from the energy industry – Harvey's effect on energy industry.

House Committee on Energy and Commerce: The 2017 Hurricane Season: A Review of Emergency Response and Energy Infrastructure Recovery Efforts.

American Oil Chemist Society: Lessons Learned from Hurricane Harvey.

Eye of the Storm: Rebuild Texas.

Houston and Hurricane Harvey: A call to Action.

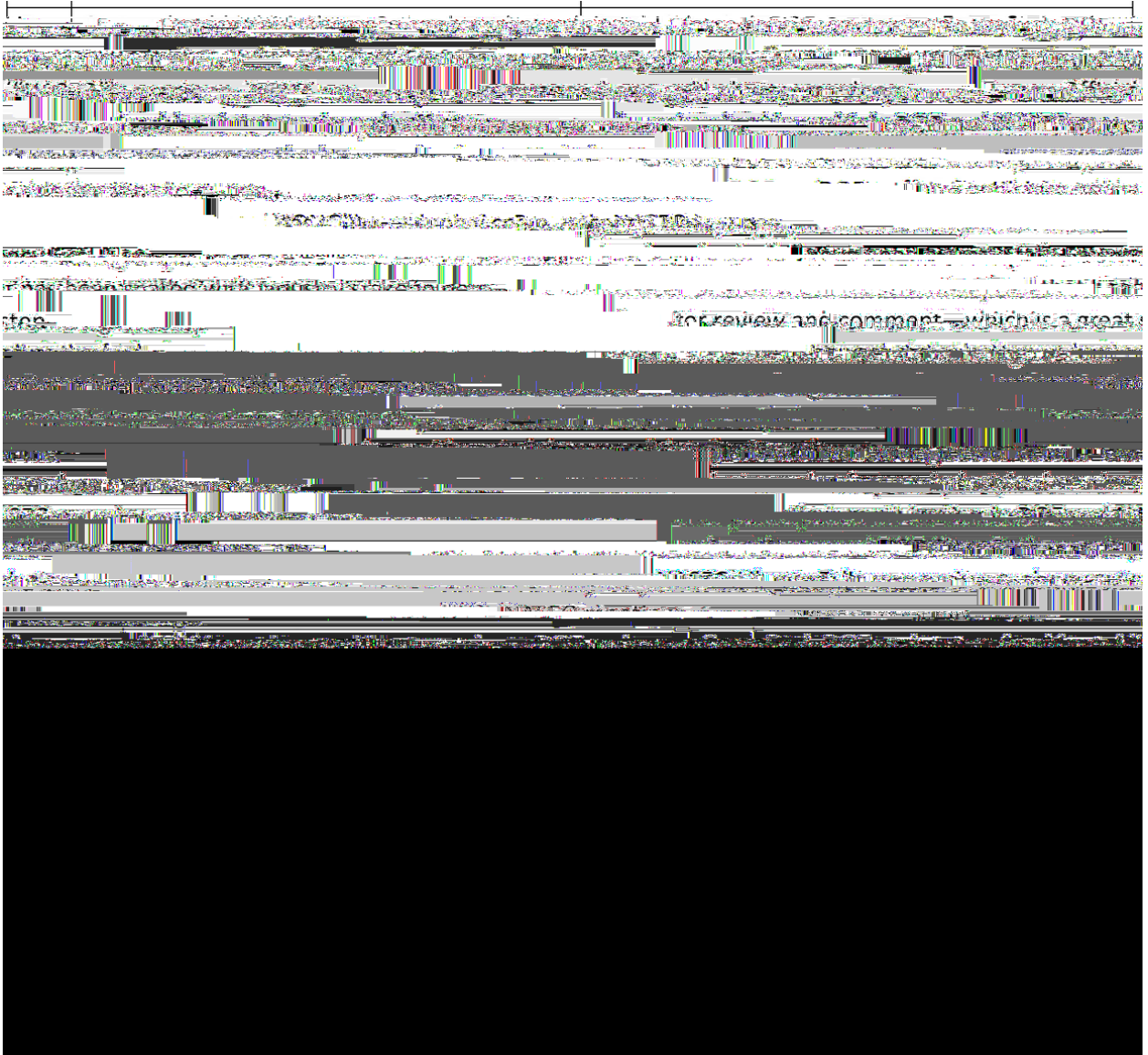
Hurricane Harvey Event Recap Report.

North American Electric Reliability Corporation: Hurricane Harvey Event Analysis Report.

Texas Comptroller of Public Accounts: Hurricane Harvey and the Texas Economy.

In the wake of Hurricanes Katrina and Rita in 2005, the industries took steps to mitigate the impact of natural disasters. For example, many Gulf Coast refineries built and elevated refinery control rooms to avoid flooding and hardened to withstand Category 5 storm wind speed. Refineries and chemical plants installed redundant power supplies and elevated generators and electrical systems to avoid flooding. (p. 5)

In the w



members were particularly pleased with the communication and coordination between federal authorities and industries. The Department of Energy, Department of Transportation, Department of Homeland Security, and Federal Emergency Management Agency held daily joint calls with trade associations and companies representing critical infrastructure. These calls served to provide updates on issues like site access, port closures, curfews, and the status of infrastructure, but also allowed industries to make officials aware of problems or questions. (p. 7)

Federal and state authorities took many actions to support an efficient and effective recovery effort, including expeditiously processing waiver requests:

Fuels: On August 30th, the Environmental Protection granted a multi-state waiver for requirements of low-Reid Vapor

provided companies with a larger pool of skilled workers to aid in recovery. This relief aided in the recovery efforts and ensured

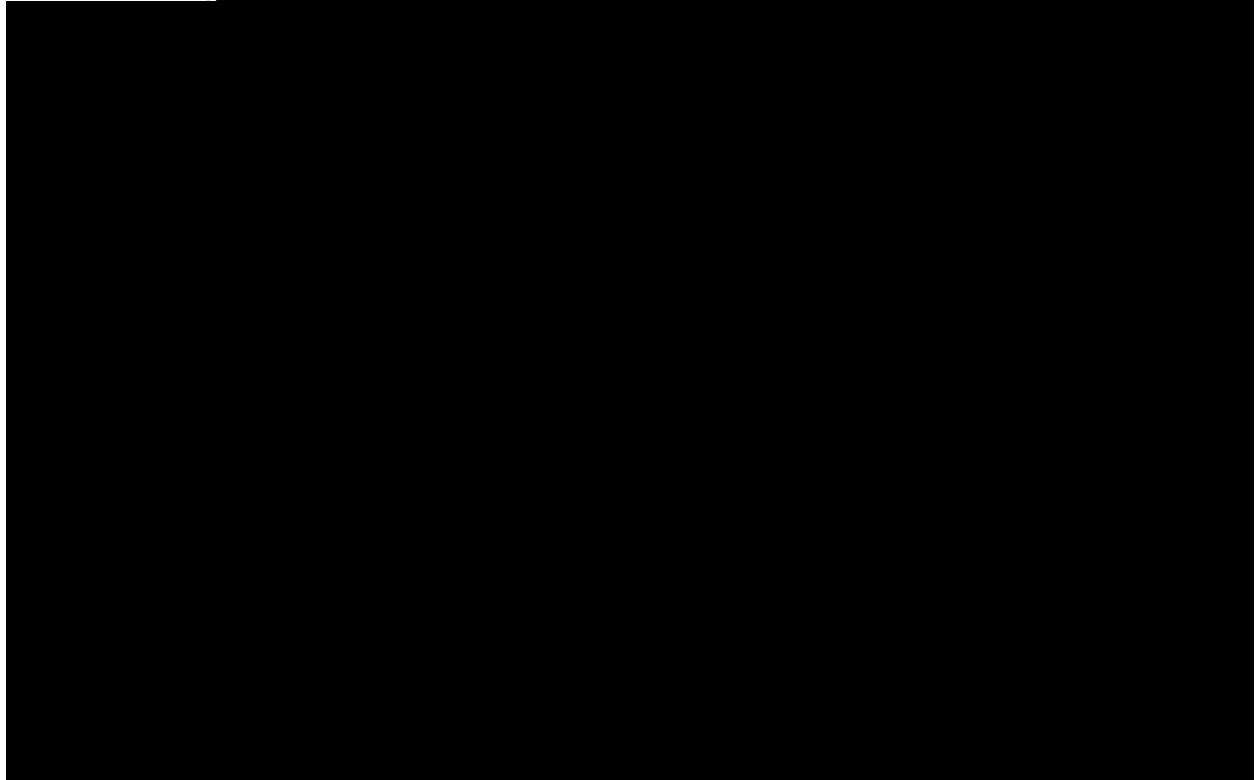
Companies have assets today that can help facilitate better information, but in some cases were unclear on whether/how they might be used. The best example is the use of commercial drones to help facilitate information needed for reentry procedures. AFPM urges the Federal Aviation Administration to establish guidelines on commercial drone use to facilitate emergency response operations- particularly relating to utility and energy infrastructure restoration efforts- following a natural disaster. (p. 10)

It is critical to review public communications about available fuel supplies. As with previous emergencies, retail fuel supplies were exhausted before landfall. This is not a new problem, but is a repeat problem for all significant storms. Within 24-48 hours prior to landfall

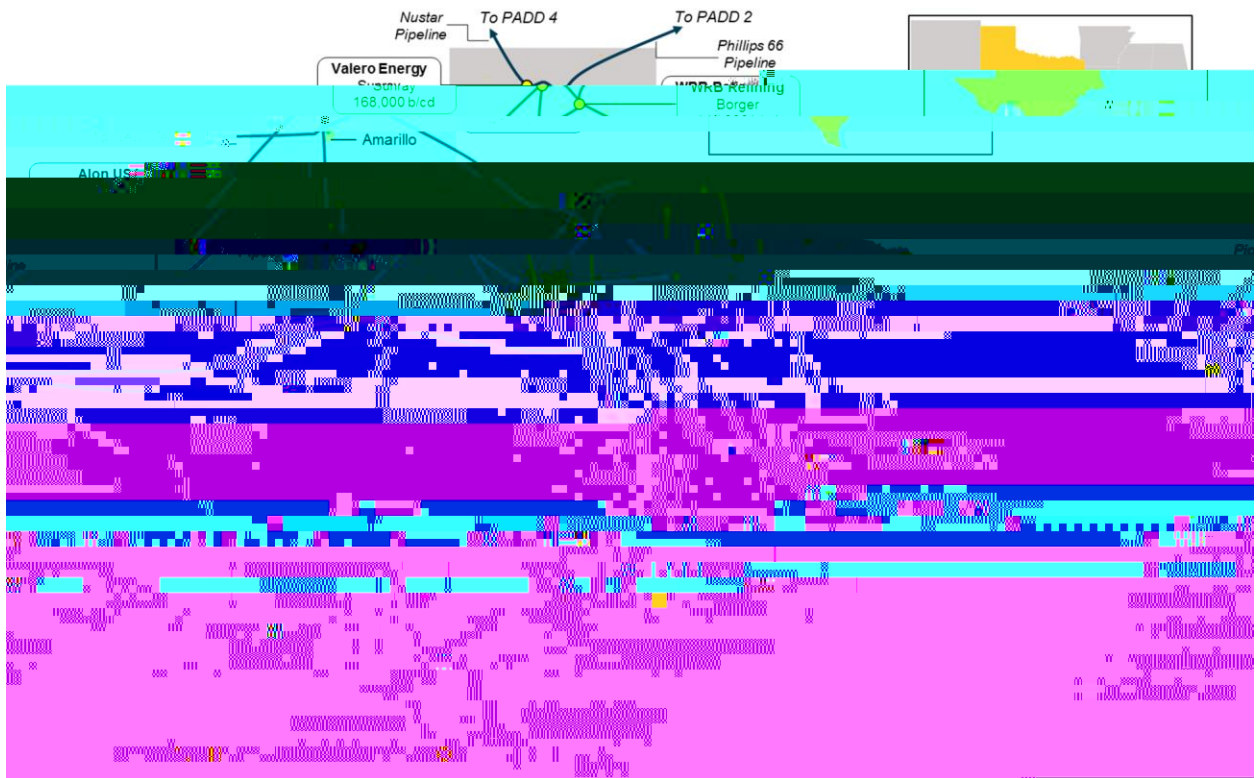
APPENDIX A

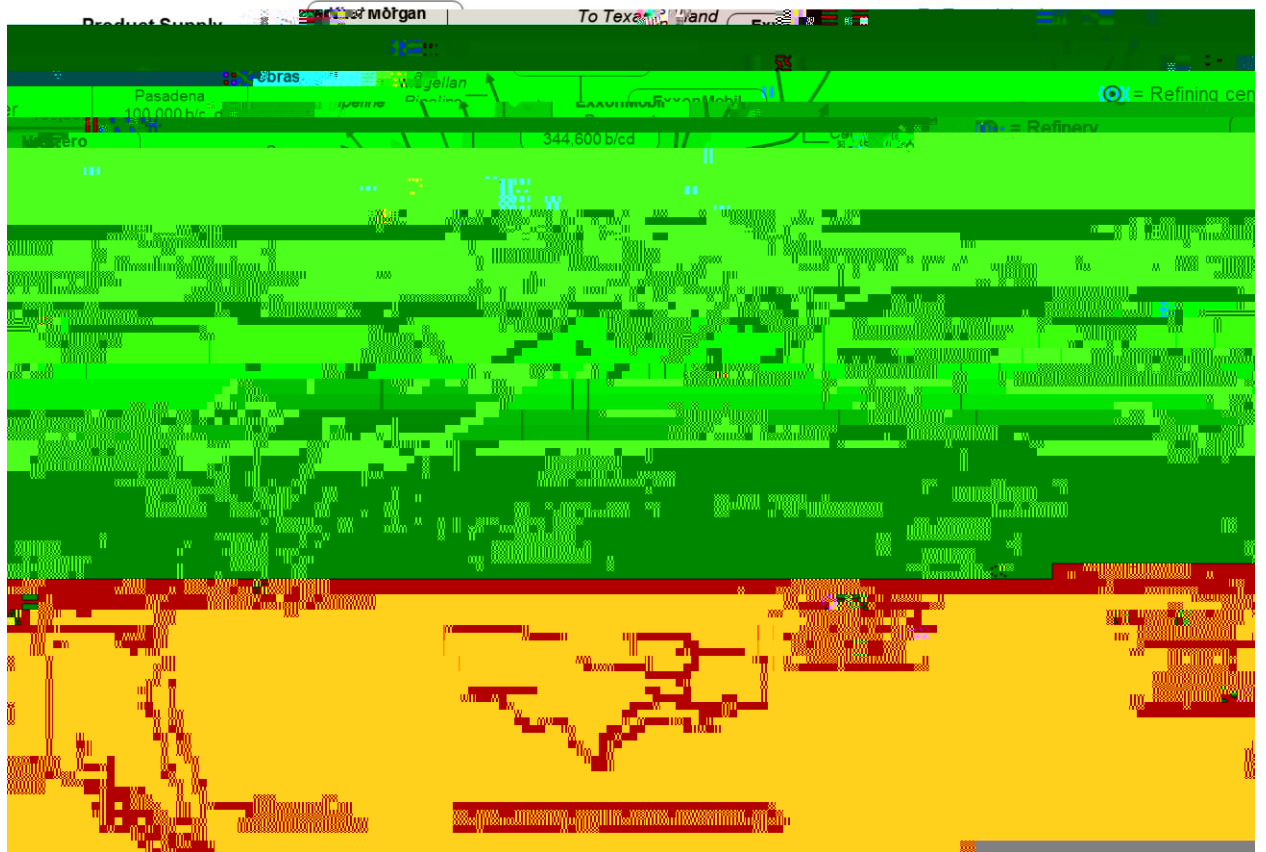
Refineries Impacted by Harvey

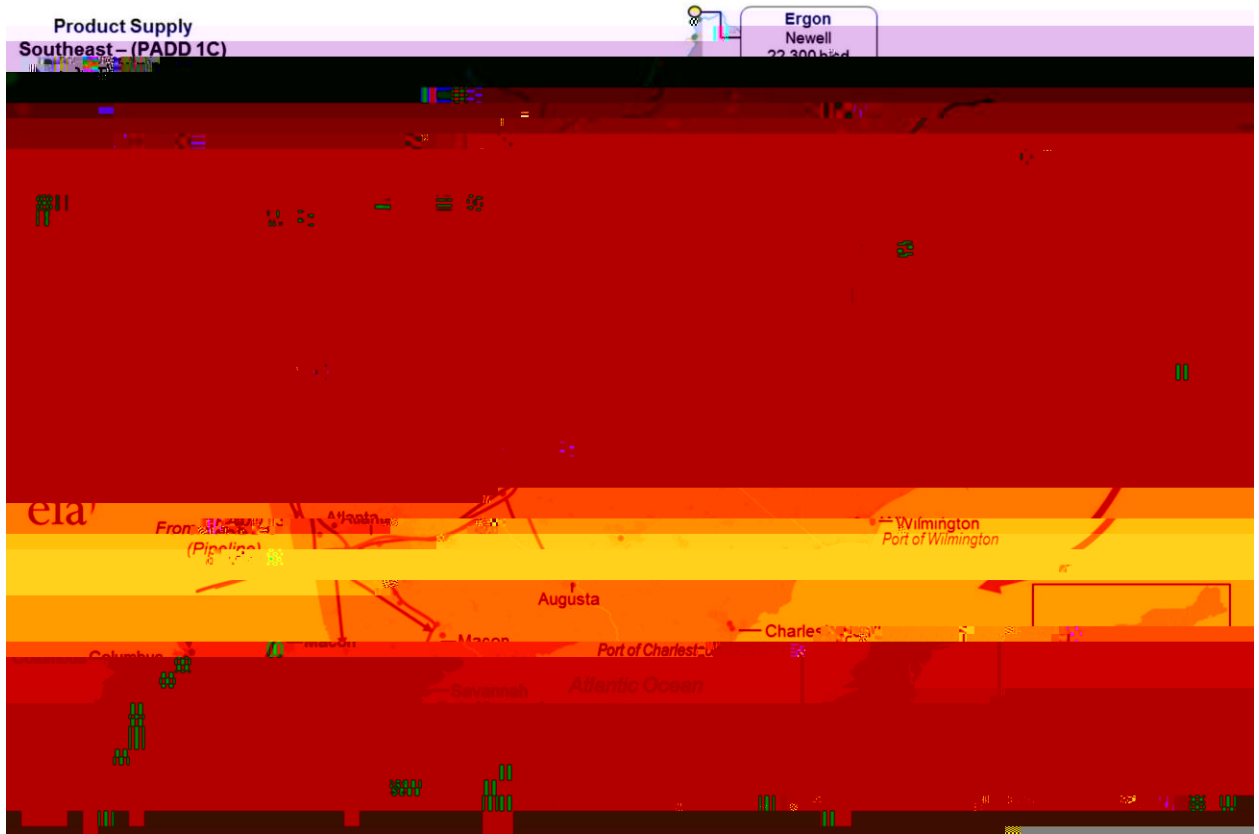
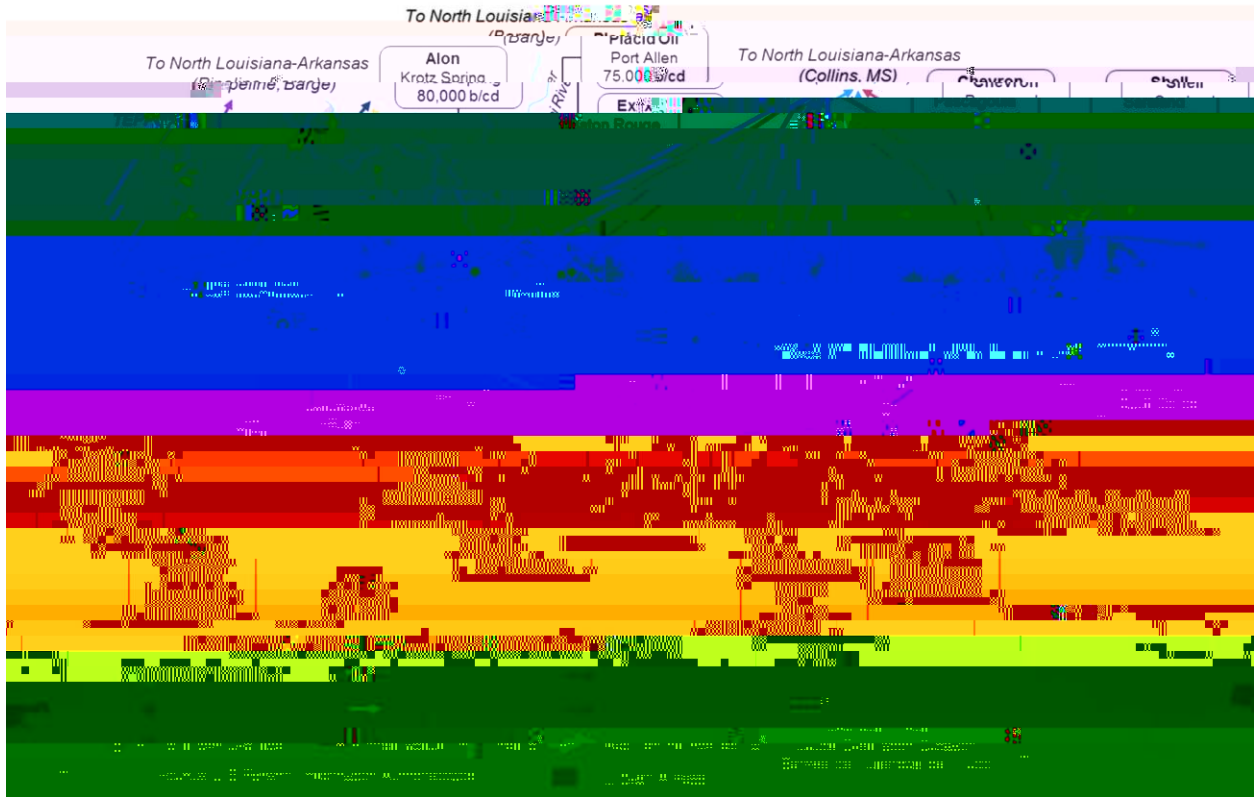




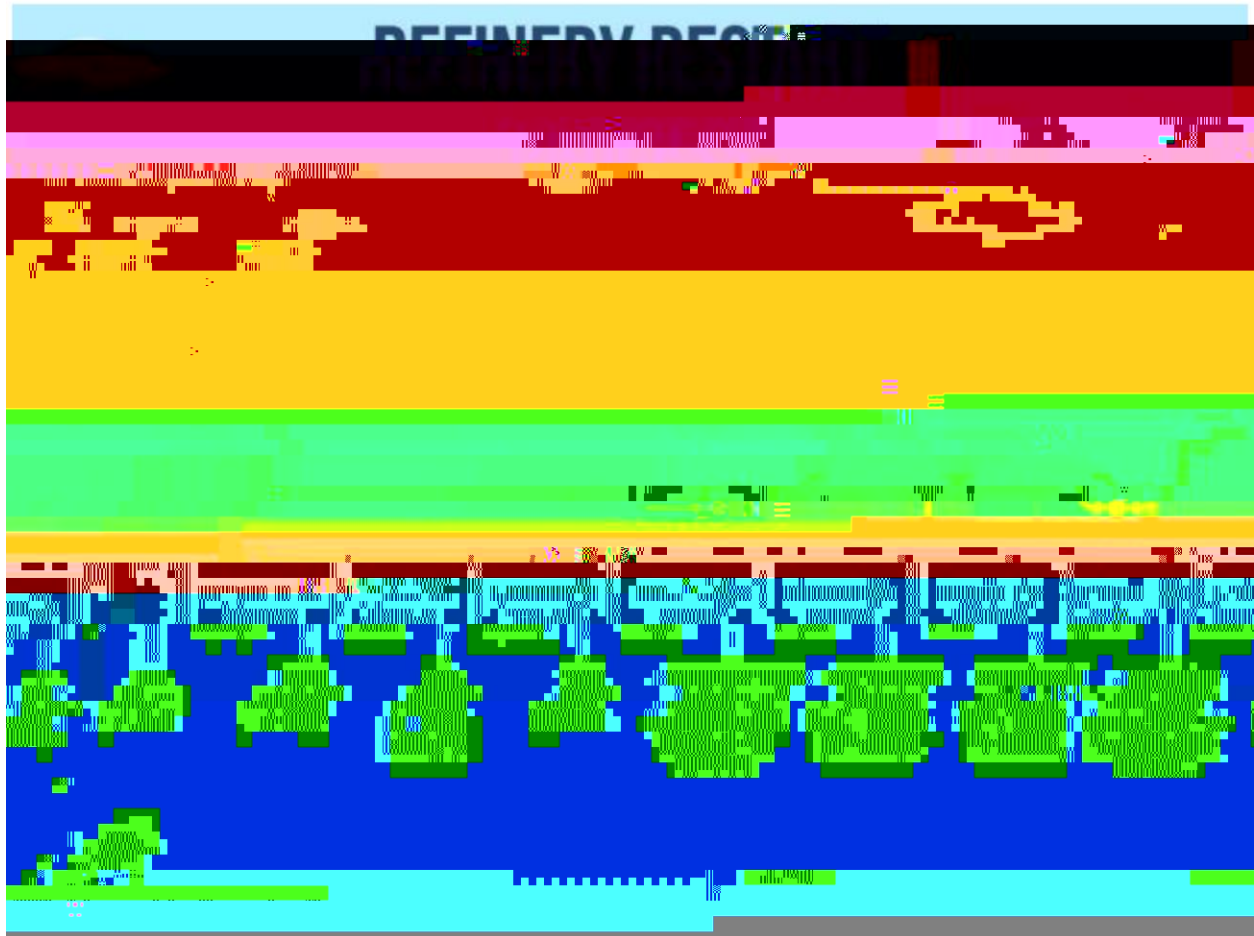
APPENDIX B- Energy Information Administration Supply Chain Maps







APPENDIX C- The Refinery Restart Process



Title: Hurricane Harvey Facts, Damage and Costs What Made Harvey So Devastating

Author: Kimberly Amadeo, The Balance

Significant Report Findings (include page number):

Harvey flooded 800 wastewater treatment facilities and 13 Superfund sites. That spread sewage and toxic chemicals into the flooded areas. (p. 3)

Title: Lessons Learned from Hurricane Harvey

Significant Report Findings (include page number):

production. In particular, Texas is the largest chemical-producing state in the U.S., with \$129 billion in shipments annually. (p. 2)

Texas produces nearly 75% of the US supply and 15% of the world supply of ethylene, a basic chemical building block used to make everything from plastic containers to automobile parts to disposable diapers. Processing

common plastic, and many other products such as ethylene oxide (used to produce surfactants and detergents), ethylene glycol (antifreeze), polyvinyl chloride (PVC; used in pipe, windows, and bottles), and polystyrene (used for packaging and insulation). Ethylene and its derivatives comprise about 40% of global chemical sales. (p.3)

Emergency plans vary with storm severity but may include complete shutdown of the facility, evacuation of personnel, activation of generators, filling of tanks, physically securing equipment, and removal of unnecessary

Responsible Care Program, all members must have established emergency plans that are activated in coordination with local, state, and national authorities, as well as with other businesses and transportation systems in the path of the storm. (p. 3)

On September 1, 2017: More than 20% of US refining capacity was offline due to storm-related shutdowns. More than 50% of total US ethylene production remained offline. (p. 4)

On September 15, 2017: Most refineries and chemical plants had restarted. Transportation backlogs remained. (p. 5)

Small -site to maintain the facility, monitor conditions, and make repairs. (p. 5)

With estimated damages and losses totaling more than \$190 billion, Hurricane Harvey is the costliest hurricane on record. (p. 6)

Most oil and petrochemical plants were spared from extensive structural damage and flooding due to facility design, including the strategic placement of dikes and levees. (p. 6)

Because transportation by truck, railway, and barge was severely disrupted until at least September 5, refineries and chemical plants were unable to receive shipments of raw materials. Even if companies did not shut down, they were unable to transport shipments. On least t m0. 4(yl(t)oW*n(t)osthey were e t1

Lingering transportation issues delayed the restart of many refineries and chemical plants. (p. 6)

Ultimately, Harvey disrupted more than one third of U.S. chemical production. On August 31, Bloomberg and other sources reported even higher numbers: 61% of the US production of ethylene, 50% of polyethylene, and 60% of polypropylene was shut down. Shortages of petrochemicals

Title: A Storm to Remember: Hurricane Harvey and the Texas Economy

Author: Glenn Hegar, Texas Comptroller of Public Accounts

Significant Report Findings (include page number):

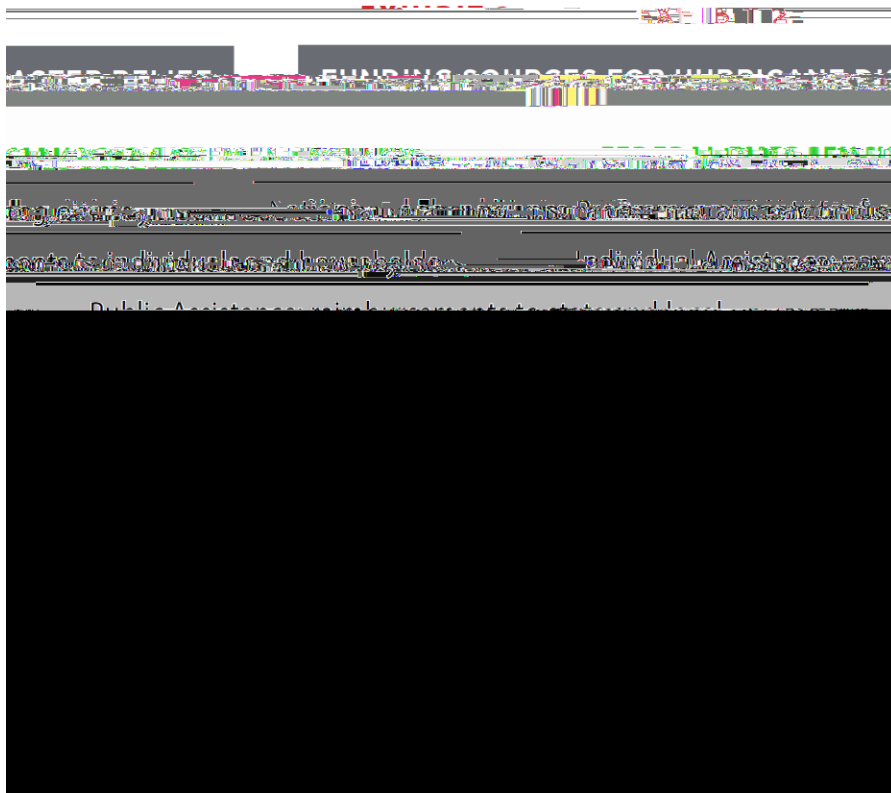
Our analysis takes a wide-ranging view of the consequences, using a dynamic input-output model to measure the storm's economic impacts, both negative and positive, on our state. We estimate lost business productivity from the storm

differently depending on the amount of time they were estimated to be offline, their level of competition and their place in the supply chain: manufacturing and mining were assumed to be offline or experiencing reduced revenue for 15.4 days; hospitals were assumed to be offline or experiencing reduced revenue for four days; firm-level competition is assumed for all industries except those with a high location quotient ($LQ > 4$) such as oil and gas extraction, which are considered exogenous; retail and wholesale trade are further discounted to account only for the markup of cost of goods sold, to avoid double-

The model available divides Texas into COG regions and depicts dynamic relationships between industries and market forces; future studies may benefit from a more granular model to show county-level damage to housing stock, which would eliminate the need for the population discount. (p. 14)

For additional reference, see Federal Reserve Bank of Dallas Releases on Hurricane Harvey.

Charts/Figures/Tables to be included in website (include page number and chart title/description or copy and paste table here):



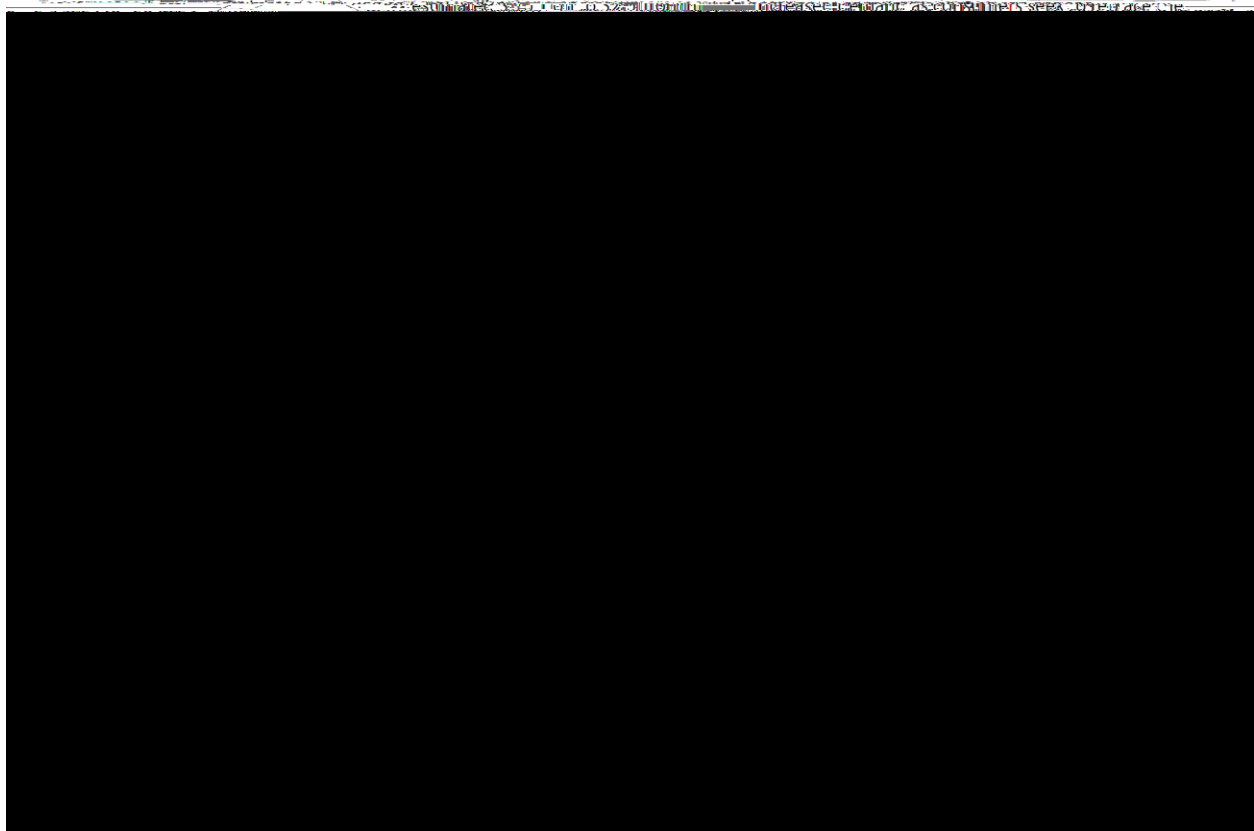


EXHIBIT 3



EXHIBIT 6

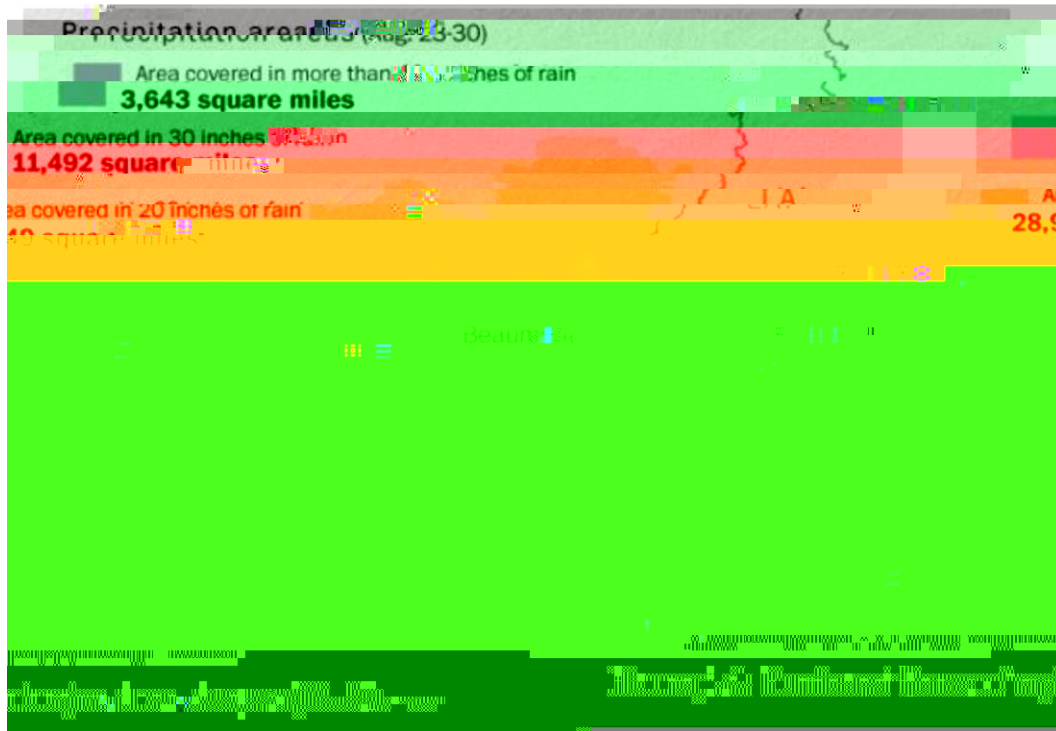
TOP 15 COSTLIEST STORMS IN THE U.S. SINCE 1980

	DAMAGE*	CATEGORY AT
[REDACTED]		

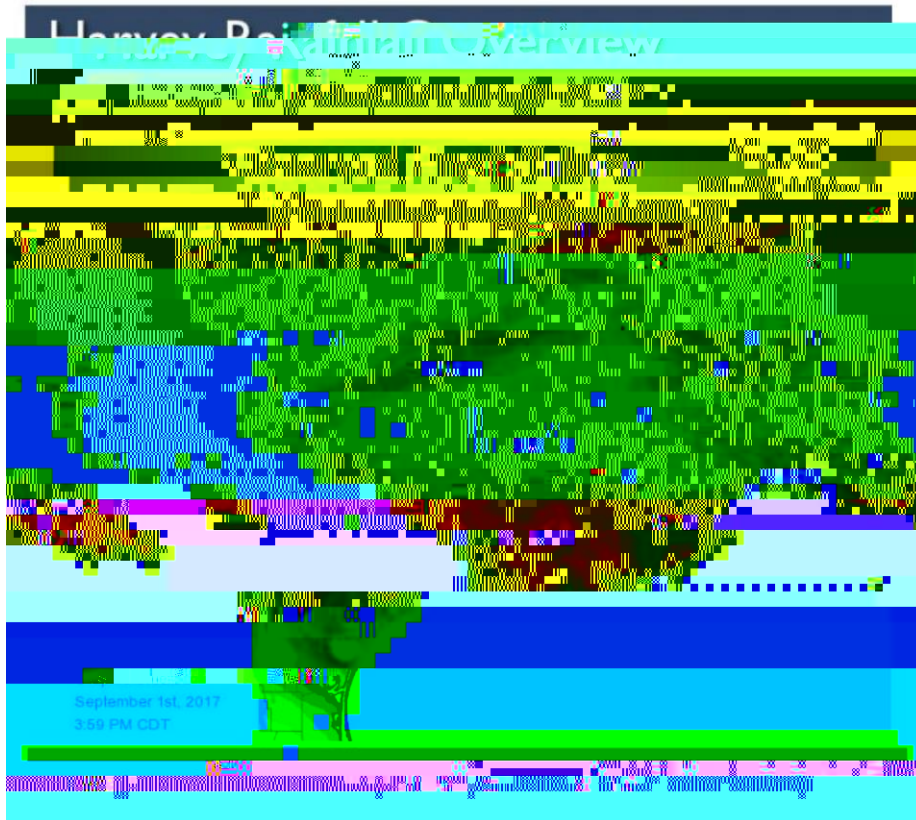
Title: Hurricane Harvey Event Analysis Report

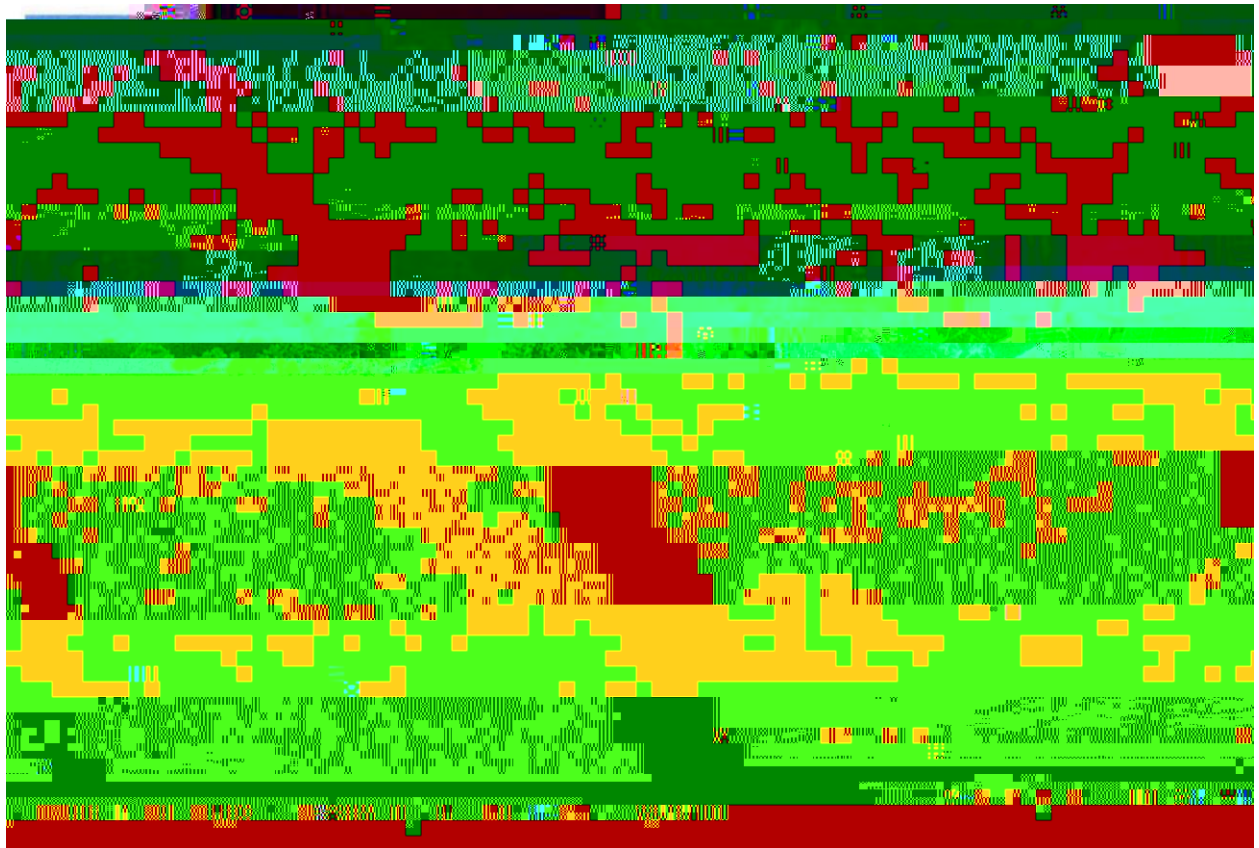
hurricane drills and blackstart drills and training for response to loss of station dc supplies.

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Title: What Harvey taught us: lessons from the energy industry

Author: Dr. Latha Ramchand, Dr. Ramanan Krishnamoorti. University of Houston Energy Fellows

Significant Report Findings (include page number):

Dumping more than 51 inches of rain in some areas, Harvey gave new meaning to flooding. Damaging more than 148,000 single family homes, 163,000 apartments and more than 500,000 vehicles, Harvey also is responsible for 88 fatalities. (p. 2)

Airports, roads and freight were affected, including about 10% of the nation's trucking business. (p. 2)

The storm's impact on the energy supply chain was significant, too. Harvey shut down 22% of nation's refining capacity, 25% of oil production in the Gulf of Mexico and half of both the production of organic chemical and plastics resin and of natural gas in the Eagle Ford. Fuel shortages hit Houston, Austin and Dallas. (p. 2)

Energy industry insight:

This wasn't the industry's first test, although past emergency management plans mostly addressed hurricane-force winds and storm surge. Massive rain and inland flooding on the scale witnessed during Harvey was unprecedented. In addition to facilities and operations, approximately 10% of industry personnel were impacted, as was access to offices, and industrial sites. (p. 2)

After Superstorm Sandy, the Department of Energy (DOE) requested the National Petroleum Council (NPC) to study emergency preparedness, which led to a series of recommen

management teams), and covering the spectrum of preparedness from the strategic to the tactical. (p. 3)

Experience with prior hurricanes helped fine-tune their plans. Working with regulators helped reduce supply-chain bottlenecks. (p. 3)

Most respondents said having a designated individual (not the CEO) who could direct resources and manage the emergency response team ensured efficiency and safety. Organizationally, the process worked via decentralized teams that reported to senior leadership. (p. 3)

All executives we spoke with described efforts to provide accommodation, transportation and emergency financial assistance, including interest-free loans to affected employees. (p. 4)

In many cases, company ride-out and volunteer teams wound up helping both their own employees and other residents. This was perhaps the most commonly cited “learning” from the disaster. They also deployed relief efforts to aid the community. That included donations of gasoline and diesel, air lifting people from stranded areas, providing food and water to residents where the firms had operations and direct financial assistance to charity organizations that operated in the community. (p. 4)

What went better than expected (p. 4-5):

- Communications - The variety of platforms used to communicate with employees and customers was critical. Emails, phone trees, daily summary text messages, call in numbers, emergency alerts, text blasting, intranet communications and social media channels all helped management stay in touch with employees. Social media platforms connected employees who wanted to volunteer with those who needed assistance.
- Technology – Modern technology clearly helped, from using drones to monitor facilities and operations to services like the Power Alert Service, which sent customers notifications of power outages on a timely basis. Agile deployment of technologies such as remote coQq0.000009.-.024 295.13 Tm0 g0 GteM(d)-3(pe)4(d)-3((u)-3(ta)-5(g)6atio)5id g2nl ass,

agencies during times of natural disasters – as Houstonians. Moving energy facilities away from the Gulf Coast is not a consideration, Harvey or not. (p. 6)

Charts/Figures/Tables to be included in website (include page number and chart title/description or copy and paste table here):

Title: Big Storms Leave Small Marks on the U.S. Economy

Author: Harriet Torry, Sarah Chaney. The Wall Street Journal

Significant Report Findings (include page number):

(pages 1-3)

Business slows during and after hurricanes hit, but rebuilding leads to a boost in economic activity.

- Hurricane Harvey last year flooded the nation's fourth-largest city by population, Houston, destroying \$125 billion worth of property, according to estimates by Moody's Analytics Inc. But lost economic output was just \$8.5 billion, a barely perceptible sliver of more than \$19 trillion of national economic output, according to Moody's.

- For the U.S. economy as a whole, output grew at a healthy 2.8% rate in the quarter when Harvey hit Texas. Payroll employment growth slowed in the weeks after Harvey, rising just 14,000 in September, and then bounced back with growth of 271,000 the following month. Individual claims for unemployment benefits briefly climbed, and then resumed a trend of shrinking to historic lows.

- Studies show that business might slow down during and immediately after storms hit. However, before long, rebuilding and restocking starts, leading to car purchases and construction that boost economic activity to replace property that was wiped out. Houston saw sectors like retail, restaurants and trade recover quickly.

- Some local economies can be devastated by a storm and bear long-running scars, especially ones plagued by poverty or poor infrastructure. Employment in Puerto Rico dropped 35,000 after Hurricane Maria last year and still hasn't recovered. In New Orleans, shocked in 2005 by Hurricane Katrina, employment and economic output still haven't returned to pre-Katrina levels. But even in those cases, local devastation typically doesn't hit the national economy. When Katrina hit New Orleans, the broader economy grew at a robust 3.6% annual rate, one of the best quarters in the last expansion. Property damage from Katrina—at \$161 billion—far outnumbered lost economic output—at \$31 billion—according to Moody's.

- At the Fed's late-January policy meeting, nearly five months after Harvey, policy makers were still trying to sort through the statistical noise. "It was noted that spending on durable goods to replace those damaged during the 5(re)7(30.00000912 0 ofe)-5(s)13(s i6(n)-3(d)

reduces consumer spending nationally by \$1 billion over the course of a year, estimates economist at Moody's Analytics. East Coast storms don't bear the same risk.

Charts/Figures/Tables to be included in website (include page number and chart title/description or copy and paste table here):

p. 3.

Title: The economic impact of hurricanes

Author: Fiona Greig, Chris Wheat and Bill Fulton, Houston Chronicle

Significant Report Findings (include page number):

(pages 1-3)

Hurricanes can lead to wide-ranging financial impacts. Need to change the way we think about hurricane preparedness.

Storms are increasingly powerful and increasingly expensive. Families and small businesses need to prepare for both the physical impact and the financial impact of these storms, or face the potential for long-term financial damage that could last long after the flood waters have receded.

The Impact Of Hurricane Harvey:

- The 2017 hurricane season was the most expensive on record, surpassing 2005, when Hurricane Katrina made landfall.
- Private insurance and the National Flood Insurance Program are crucial safety nets to property owners, renters and businesses.
- Businesses and families alike showed admirable resilience in the face of Hurricanes Harvey. Cash balances for the typical small business dropped by more than 7.4 percent after landfall, but recovered within two weeks. Few small businesses neighborhoods had significant revenue loss for more than four weeks.
- During the week of landfall, checking account deposits for consumers were more than 20 percent (\$400) lower and expenditures were more than 30 percent (\$500) lower than the baseline in the week of Harvey. And loss of income during a large storm can force families to make difficult financial trade-offs.

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hurricane? Health care issues don't age well, and especially for individuals with chronic conditions, it's important to maintain health care even throughout these major storms.

To mitigate the financial shock created by hurricanes, small businesses and families alike should maintain an emergency cash fund to help them get through the immediate

Title: Hurricane Harvey could be the costliest natural disaster in US history

Title: Hurricane Harvey Event Recap Report

Author: Aon Benfield

Significant Report Findings (include page number):

than 4,300 bridges had been inspected following Harvey of which 13 required repairs. The federal government diverted USD25 million of funds to the Department of Transport to aid with the response to Hurricane Harvey. The Department of Transport additionally carried out extensive debris removal work across multiple counties and cities. Collected

A federal disaster proclamation was signed on August 25. This came in addition to the 58 counties declared by the state as disaster areas. (p. 20)

Harvey was responsible for severe erosion all along the central and northern Texas coastline. Impacts from storm surge and prolonged elevated water levels led to major dune overwash, breaching, and erosion. (p. 30)

Harvey caused damage of USD104 million to the University of Texas' Marine Science Institute at Port Aransas and killed hundreds of study animals. (p. 30)

Given the extensive volume of new construction and concrete throughout Houston metro, the current infrastructure was not prepared to handle more than 60 inches of rainfall. This led to major flash flooding and inundation. The dominant soil type (clay) and excessive amount of concrete additionally provided further risk for flash flooding. (p. 27)

The Sea, Lake and Overland S000091g

that “insurable losses” does not indicate the total economic loss estimate, nor the insured loss estimate. This only includes the value of properties (homes, businesses, vehicles) that are potentially insured by the private market. It does not include additional damage to such things as infrastructure. (p. 39)

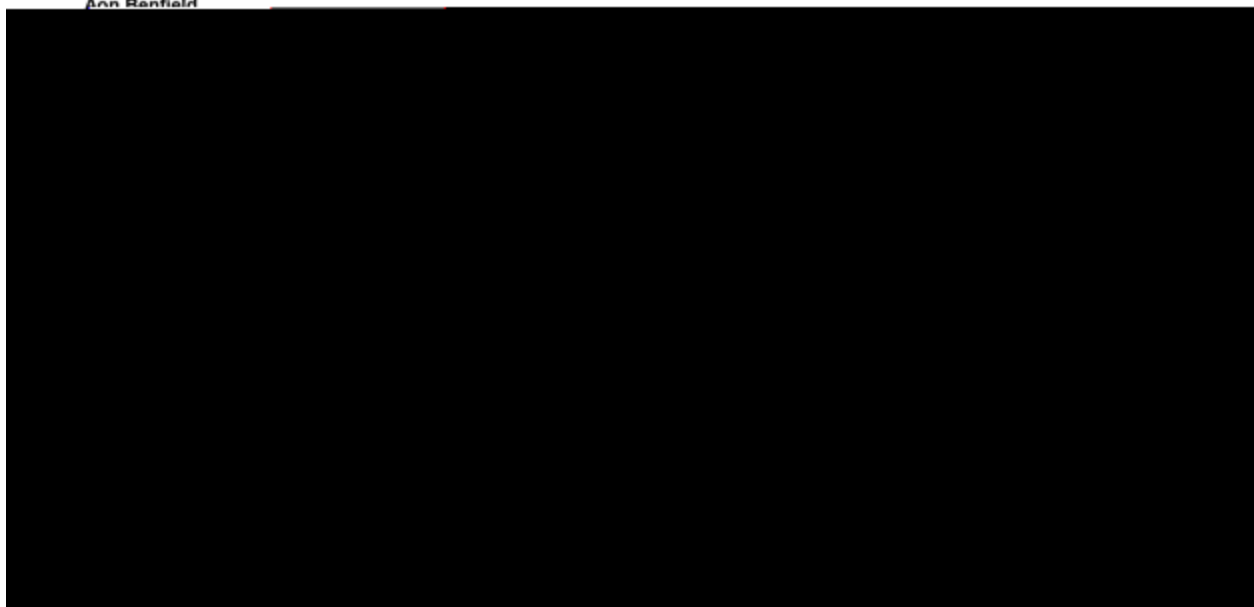
The specific breakout is as follows:

- Wind & Storm Surge: USD2 to 4 billion,
- Inland Flood: USD50 to 65 billion.

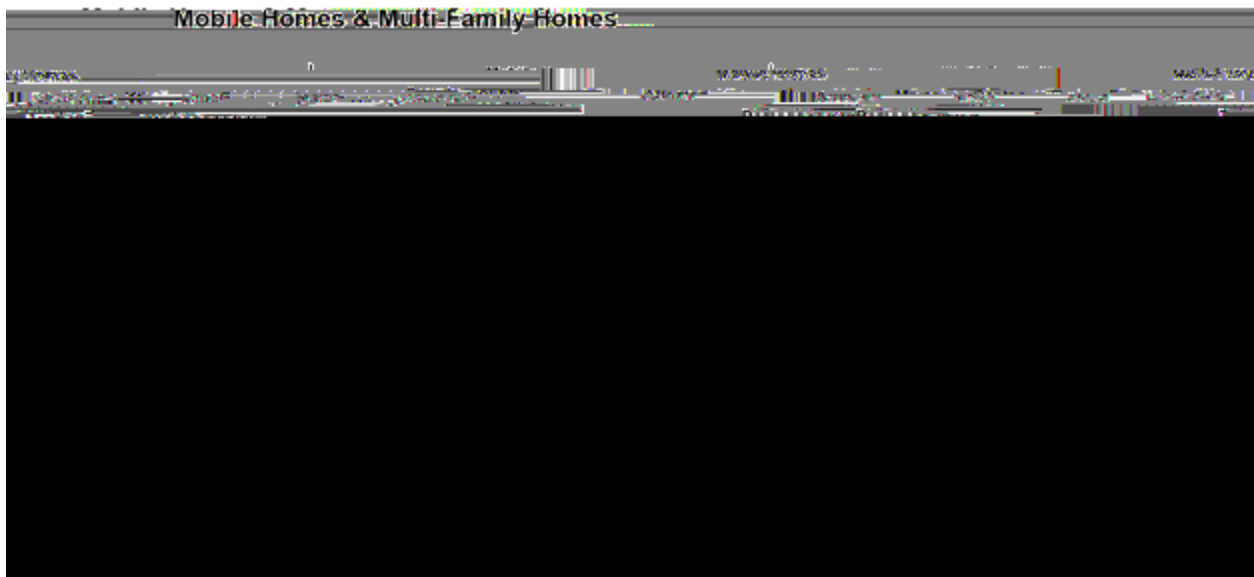
Financial Impact. Hurricane Harvey left a catastrophic path of devastation across a wide swath of southeast Texas and portions of extreme southwest Louisiana and is

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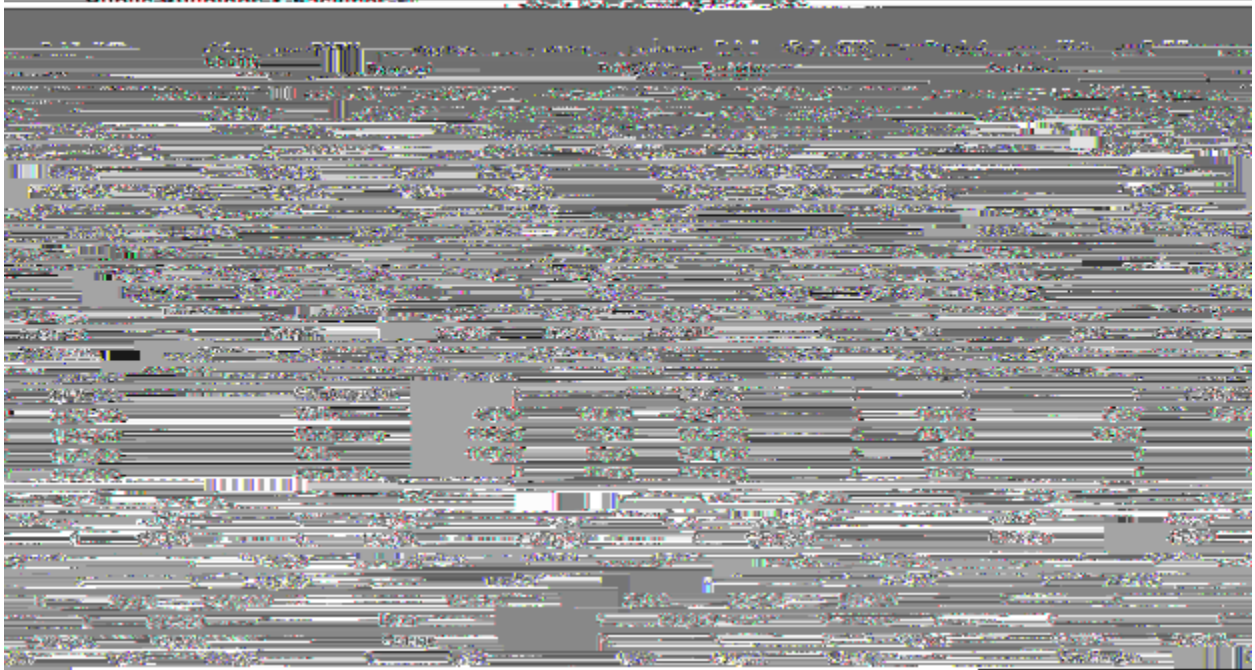
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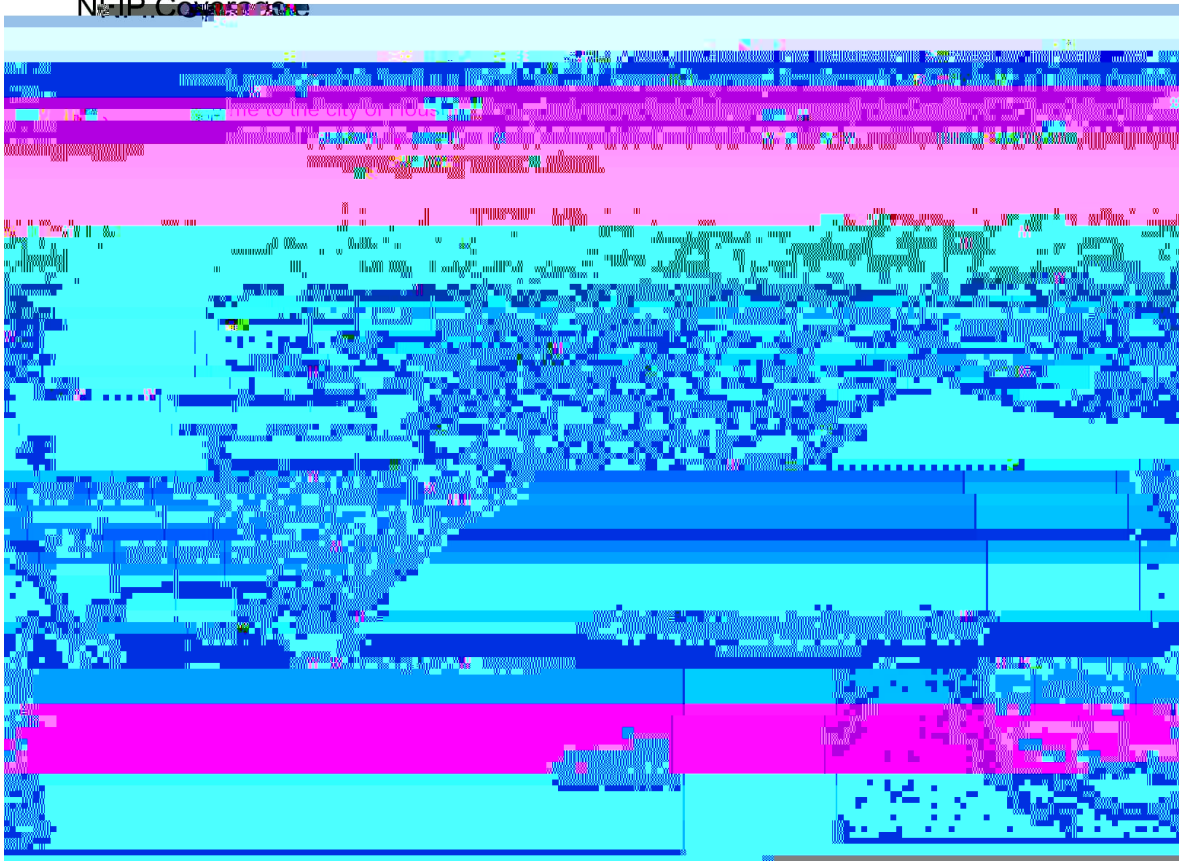
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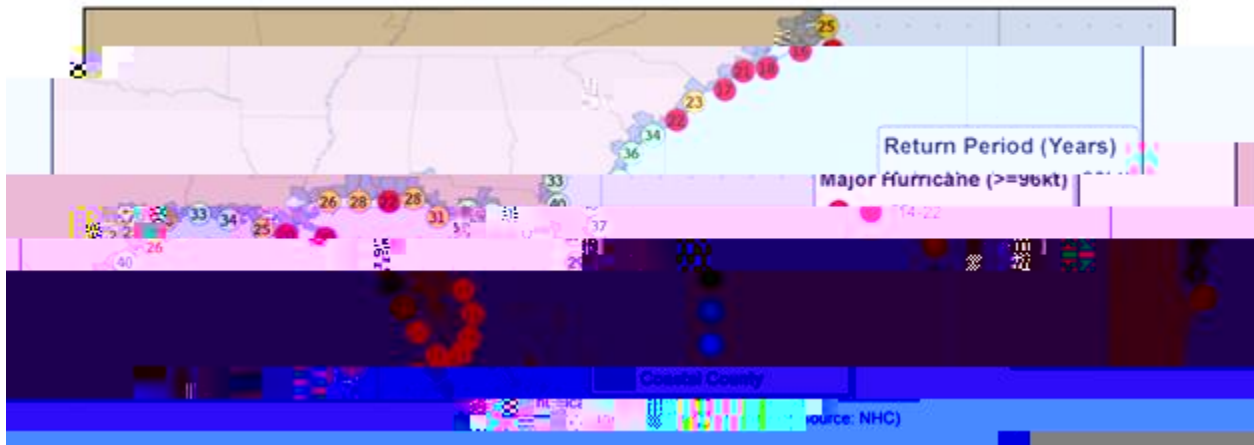
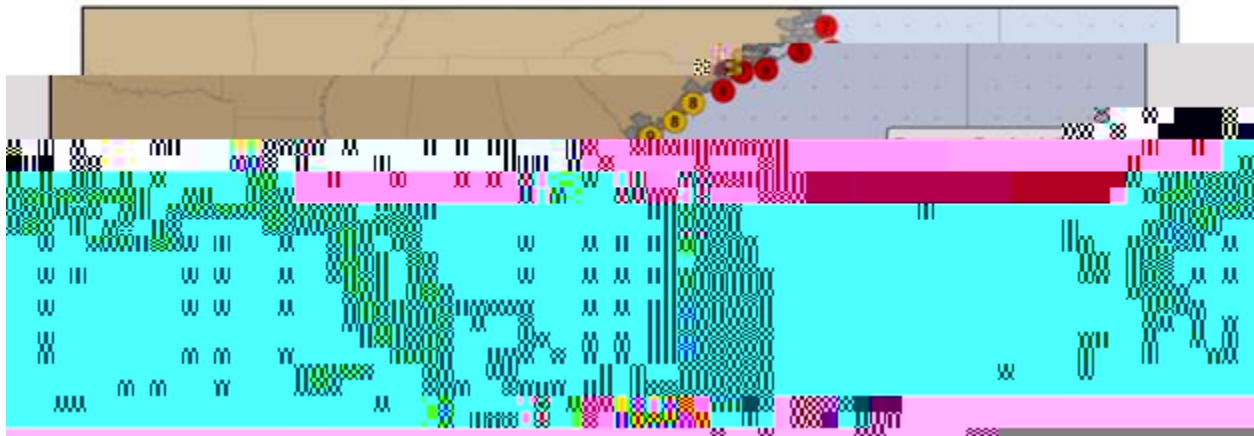
p. 23



p. 32



United States Hurricane Landfall Return Periods. Below are maps from the National Hurricane Center (NHC) that provide tropical cyclone return periods for areas along the United States coastline located south of the North Carolina border.



In terms of tropical cyclone development, the official Atlantic Hurricane season runs from June 1 to November 30 – though tropical cyclones have been known to develop during any month. As seen in the graphics below, the most likely months for cyclogenesis are during the peak months of August, September, and October. During these months, atmospheric and oceanic conditions are climatologically the most conducive for cyclones being influenced and/or steered by a strong Atlantic ridge of high pressure and/or by the advancement of strong troughs that dig into the central and eastern United States. (p. 43)

