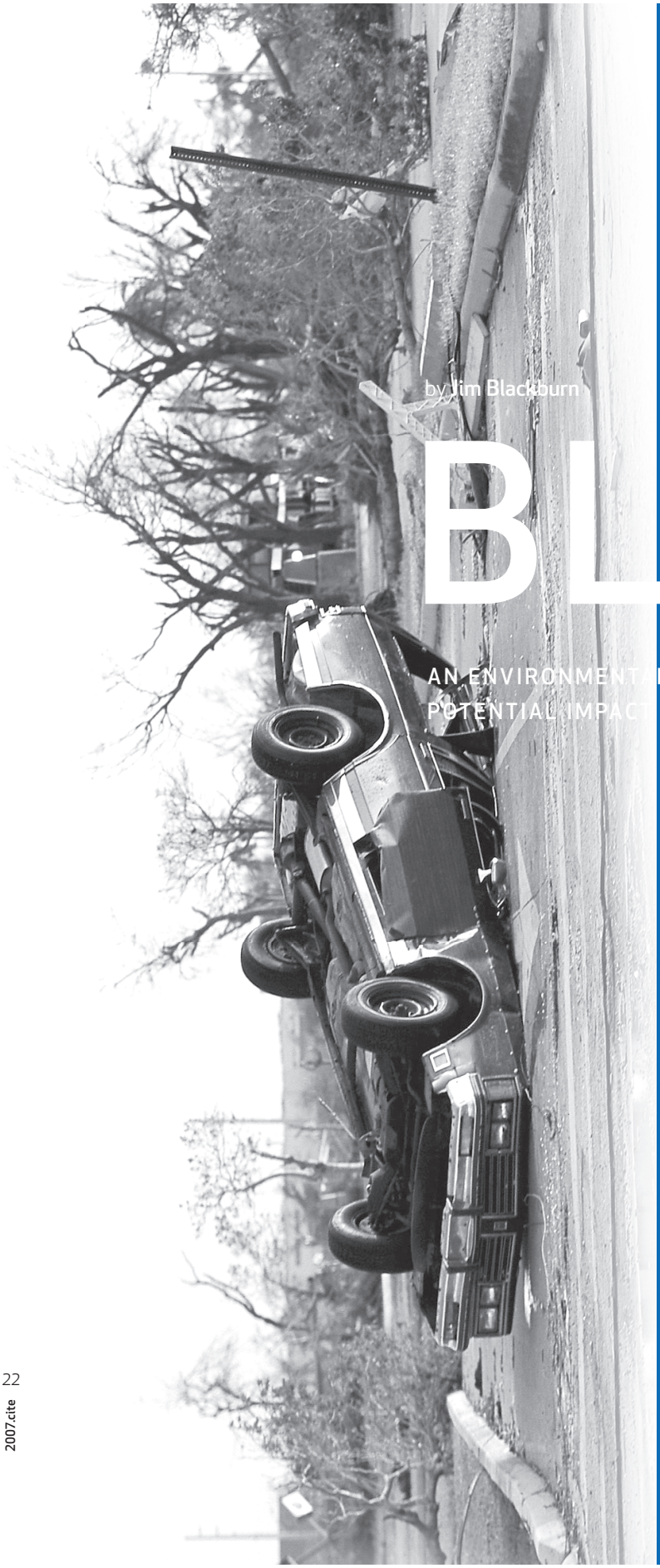

by Jim Blackburn

BLOW-BY

AN ENVIRONMENTAL ATTORNEY DETAILS A MAJOR HURRICANE'S POTENTIAL IMPACT ON HOUSTON

-BtW

FOR MOST OF US, IT IS DIFFICULT TO ENVISION THE POWER OF A HURRICANE. IN OUR MODERN INFORMATION-DENSE SOCIETY, PERHAPS ONE MEASURE OF AN EVENT'S POWER IS THE ABILITY TO FOCUS US ON THE MOMENT. FOR EXAMPLE, YOU REMEMBER WHERE YOU WERE WHEN HURRICANE RITA WAS HEADING FOR THE HOUSTON REGION—IN ALL LIKELIHOOD, EITHER STUCK IN TRAFFIC LEAVING TOWN OR HUNKERED DOWN AT HOME WAITING TO GET POUNDED. EITHER WAY, RITA IS INGRAINED IN OUR COMMUNITY MEMORY, AND SHE DIDN'T EVEN HIT US. THAT'S POWER.

ANOTHER TESTIMENT OF A HURRICANE'S POWER IS THE FACT that we name it, giving these events a metaphysical element. Carla hit 150 miles down the Texas coast in 1961 and is remembered by old-timers 40 years later; Beulah hit South Texas in 1967; Celia hit Corpus Christi in 1971; Alicia hit Galveston Island in 1983; and more recently there was Andrew in Florida and Katrina in New Orleans. We name these storms and fear them, like ancient angry spirits.

As residents of New Orleans and the Mississippi coast can attest, life will not be as it was once a hurricane strikes. Luckily, we in Houston have missed a direct hit from a large Category 4 or Category 5 hurricane. Although many of us have evacuated, we have always returned to relatively good conditions. But we should not delude ourselves that we are not going to be hit; it is simply a matter of time.

Have you ever considered what would happen if a large hurricane came ashore in the Houston-Galveston area? I know that many of you have been flooded and have had to live with the horror of the loss of your primary investment, the loss of security, and the feeling of invasion. But how about a storm roaring in from the Gulf with a 20-plus-foot surge tide, sustained winds of over 150 miles per hour, and perhaps 12 or more inches of rain. What happens then?

The storm of most concern to the Houston region is one that makes landfall just south of Galveston Bay. Hurricanes are large low-pressure systems with counterclockwise rotation in the northern hemisphere. As they come ashore, the more severe storm surge, wind, and rain will be on the side of the storm with the circulation moving in from water rather than from land. In our area, the dirty side is the east side.

As these circular storms make their way across the Gulf of Mexico, I pay particular attention to any that move westward in the Caribbean toward the Yucatan straits. Once a major storm enters the Gulf of Mexico, we should be ready to act, particularly those living on Galveston Island and adjacent to Galveston Bay. Time is of the essence. Those who don't get out early may not get out at all.

The modern storm of record on the Texas coast is the Category 4 Hurricane Carla. In 1961, Carla hit the Port O'Connor area on Matagorda Bay with a 22.5-foot surge tide, sustained winds of 150 miles per hour with gusts to 175, and over 16 inches of rain. In Galveston Bay, 150 miles to the north, the surge tide reached almost 15 feet in the Houston Ship Channel.

In order to better understand the impact of such a storm on the Houston region, Dr. Gordon Wells of the University of Texas Space Research Center simulated Hurricane Carla striking the Houston region. Dr. Wells named his mockup Carly and modeled it making landfall near Freeport. The following description documents the fictional storm's powerful potential as it intersects our lives.

Carly makes landfall in the early morning. By 8 a.m., her forward edge—the storm will cover hundreds of square miles—has moved ashore and the tide has risen to almost five feet above sea level. At this early stage, the damage is minimal. The major flooding is of low-lying marshlands, primarily in Galveston, Brazoria, and Chambers counties, our natural flood buffer. Large coastal streams and bayous such as Clear Creek, Oyster Creek, Double Bayou, and Dickinson Bayou are at or near flood stage as water moves upstream from the bay. Travel along Interstate 45 and State Highway 146 is disrupted at this point.

As the storm continues to move ashore, the surge tide moves farther inland. By noon it has reached an elevation of 10.6 feet. Damage is increasing and becoming widespread. All of Bolivar Peninsula and most of the West End of Galveston Island are under three or more feet of water. The southern half of Chambers County has disappeared into East Bay and much of southern Brazoria and Galveston counties are one with West Bay. Water levels are becoming a major problem in the Clear Lake area as well as in Dickinson Bayou and along the Houston Ship Channel. Areas of Galveston Island such as the Strand are not yet inundated due to the protection of the 16-foot-high seawall, although water is coming into downtown Galveston from the bay side.

By 5 p.m., the tide has reached 17.8 feet, and the eye of the hurricane has not yet moved ashore. With three-to-five-foot waves atop the surge tide, the seawall has been overtopped, and the Strand is now under water. The western shoreline of Galveston Bay—San Leon, Kemah, Seabrook, La Porte—is submerged, as is much of the Clear Lake area. Water surrounds and has moved into the Johnson Space Center. Depths of from six to seven feet are common over the southern mainland areas from Brazoria to

Chambers County. Coastal bayou flooding is now a major problem because rainfall amounts of four to six inches have already fallen and the storm surge is pushing up bayou levels, preventing runoff, and extending the flooded area well inland.

At 8 p.m., the eye has moved ashore and the surge tide has peaked at 22.4 feet. Water is several feet deep over the seawall on Galveston Island. Virtually all of the western shoreline of Galveston Bay east of IH 45 is under water. The Clear Lake–NASA area is submerged, with the tidal water extending from League City and Webster across the south side of Ellington Field to Deer Park and La Porte. The flooding extends up Dickinson Bayou and Clear Creek well beyond IH 45. The Houston Ship Channel has topped its banks on both sides, inundating portions of refineries and chemical plants all the way to Loop 610.

Now, this flooding is no bayou simply rising out of its banks due to too much water. This is a storm surge, water driven by hurricane winds. As the storm approaches, the winds build. Gale forces of 40 to 50 miles per hour start 24 hours before the eye hits. Hurricane-force winds of 75 miles per hour are felt by midmorning. For about 12 hours, the wind continues to increase, reaching a peak of sustained winds of about 150 miles per hour in a Category 4 storm and even higher in a Category 5.

The picture on the coast is ugly, and nowhere is worse than West Galveston Island. The rising tide inundates the West End, where the highest elevation is 10 to 12 feet above sea level. The beach is literally ripped up and the dunes flattened. The storm waters cut channels through the island, aided by the presence of human-made canals and excavations, many of which have been built in the last two decades. Few structures survive without serious damage on the island's West End.

Along the bay, tree limbs start popping, and shingles are blown from roofs. Anything loose becomes airborne. The sound of the wind is frightening. It just keeps on and on without stopping, only getting stronger, sounding more like machinery than nature. The water rises into and then above the coastal marshes. It comes over the docks at the edge of the bay and then extends into the yards as it also snakes its way up the coastal bayous, preempting their capacity to handle the runoff from the rainfall that started hours ago.

As the water rises, the wind blows whitecaps into and onto the mainland, blasting the first level of homes on the shoreline. The windblown waves are three to five feet higher than the tide itself, and they strike with relentless power. Homeowners who elevated their foundations are grateful at this time. Any structure built at ground level is subjected to hours of pounding waves. The minutes seem like hours. Crashing wave after crashing wave weakens every structure, and then, as the water and winds rise higher and higher, buildings collapse.

The first floors of most structures immediately

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MARTHA CLAIRE TOMPKINS

UNDER

THE CURRENT EVACUATION PLAN, THOSE OF US LIVING INSIDE THE LOOP AND FARTHER NORTH AND WEST ARE TOLD TO REMAIN HOME AND "SHELTER IN PLACE," A FEARSOME PROSPECT AT BEST. ELECTRICITY IS LOST SOON AFTER THE STORM MOVES ASHORE ON THE COAST. CELL PHONE TOWERS BLOW DOWN. LANDLINES ARE CUT. WE MAY BE ISOLATED FOR DAYS.

adjacent to the bay are built to an elevation of 16 feet. However, as little as a hundred feet inland, the FEMA flood elevation requirements drop to 10 or 11 feet throughout the Clear Lake, Kemah, and Seabrook areas. Unlike the regulatory map, this incoming wall of water does not differentiate. It simply rises and occupies space.

As the unrelenting surge continues, the damage mounts. Smaller structures go first—the storage room or extra bedroom built at ground level, often in violation of the coastal building standards. The debris flying off one damaged building rams into an adjacent one. Rooftops blown off their roosts fly with the fury, only to be added to the floating mass atop the waves. This is not just wind-blown water but a slurry of water and demolished buildings, with an occasional boat and a few cars battering inland with the storm. As the mass moves, it stacks up against any structure in its way. The former wall of the storage room turns into a battering ram, smashing windows, piling up against foundations, adding its weight to the weight of the water that piles up with it, slamming with the next wave, ever rising, ever moving inland. Slowly but surely, a house is uprooted like a tree, ripped from its mooring in the soil and hurled into the next home inland, adding its weight to the mass of moving debris.

Along the Houston Ship Channel, industries have shut down, leaving only skeleton crews to ride out the storm. Industrial waste storage and waste disposal areas there are protected by levees built to the elevation stated on the FEMA floodplain maps. Along the Houston Ship Channel, the 100-year floodplain lies below approximately 11 or 12 feet in elevation. Dikes and levees are built to those levels.

As the storm surge goes higher than 12 feet, the levees are overtopped, and the water churns up the soil and waste, floating barrels and other materials. Although land disposal of hazardous waste is no longer allowed in the United States, a substantial volume of waste is still stored along the ship channel, awaiting incineration or transport, and there is on-site disposal of many so-called nonhazardous industrial wastes. There is also commercial product waiting to be shipped away by barge, rail, and truck, and there are no flood protection rules for its storage.

Perhaps more importantly, the refineries and petrochemical plants themselves are not required to be protected by levees. These structures are inundated as the water level rises to over 20 feet. The potential for contamination is significant, particularly if any of the storage vessels collapse from the pounding of waves and debris. The Houston-Galveston industrial complex is one of the largest in the world and includes over 2.5 percent of the world's refining capacity, as well as significant percentages of the world's production of ethylene, propylene, butadiene, and many other building blocks of the petrochemical industry. None of these facilities are required to be flood-protected.

Similar issues are associated with dredge spoil disposal sites. Galveston Bay is relatively shallow, with an average depth of ten feet or less. Industrial navigation channels such as the Houston Ship Channel require dredging, and the dredged material must be deposited in sites contained by levees, which are only to minimum flood elevations, if that. Among other things, these spoil disposal areas contain sediments contaminated with dioxin, a highly dangerous pollutant. Virtually all of the spoil disposal sites in the ship channel are ripped apart by the storm, and their sediment spread inland and then back into the bay.

The damage from the storm is not limited to the coastal areas but extends far inland, generated by both wind and flooding from rainfall. Gusts in excess of 175 miles per hour are common on the coastline and diminish slowly as the storm moves inland. Tornadoes are common. Downtown Houston is subjected to sustained winds greater than 125 miles per hour with gusts to 150. Our skyscrapers are tested as debris of all sorts flies full speed into their glass walls.

Under the current evacuation plan, those of us living inside the Loop and farther north and west are told to remain home and "shelter in place," a fearsome prospect. Electricity is lost soon after the storm moves ashore on the coast. Cell phone towers blow down. Landlines are cut. We may be isolated for days.

Inland, trees are uprooted and roofs are stressed if not ripped off. Most homes are built to withstand winds of less than 100 miles per hour, a number exceeded over much of our region, at least during gusts. Rita caused significant damage in Beaumont from trees being uprooted and falling into houses. Given the number of trees in the greater Houston area, significant wind damage can be expected.

And then there is flooding. Houston floods often; we don't need a hurricane to have a flood. Over the last 40 years we have not experienced a major hurricane with a high storm surge and high rainfall amounts. Often our flooding is limited to one portion of the region or another. Seldom do all our bayous flood during a single storm event, as they are likely to during a Category 4 hurricane. The amount of rainfall associated with a hurricane is determined by the forward speed of the system. A formula used by meteorologists divides the forward speed of the storm into 100 to determine the inches of rain during the storm. If a storm is moving forward at 15 miles per hour, then six to seven inches of rain are expected; if the storm is moving at 10 miles per hour, then 10 inches. Carla, a slow-moving storm, dumped over 16 inches of rain on Galveston.

Flooding associated with hurricane-generated rain is worsened by the storm surge. The tide moves up the streams and bayous that drain into the bay, raising the water's elevation to as much as 20 feet above sea level as it surges inland. As much as ten inches of rain may fall as the storm closes in. There is a high likelihood that the lower ends of our coastal streams and bayous such as Buffalo, Brays, Greens, Clear Creek, Dickinson, Armand, Hunting, and countless others will fill up and be unable to drain adjacent urban areas. Rainfall will pond within urban areas, unable to drain until the coastal tide falls.

FEMA, the federal agency responsible for flood mapping, assumes that a larger hurricane event with a significant surge tide will not coincide with a very large rainfall event. Therefore our flooding maps do not predict the dual circumstance. Those looking at a floodplain map should recognize that it is a minimalist representation of the reality of flooding from a strong hurricane.

The results of a hit by a Category 4 hurricane are beyond belief. Areas near the coast will look as if a bomb had leveled everything. Pictures of Kemah after Carla hit over a hundred miles down the coast shows a landscape where all of the buildings are gone. Virtually nothing was left standing on the Mississippi coast after Katrina. Holly Beach, in Louisiana, was removed from the face of the earth by Rita. Damage estimates prepared by the Governor's Division of Emergency Management indicate that the wind and storm surge damage will exceed $73 billion. Of the approximately 300,000 homes in the coastal evacuation zone, over 100,000 will have been destroyed and virtually all damaged, either by winds or floodwaters or both. The governor's office estimates that nearly two million households in the region will have been negatively impacted by the storm. One hundred twenty-four million tons of debris will be generated.

Think about it: 100,000 homes destroyed. Wiped out. No home to come back to. In the coastal evacuation zone, over 500,000 people will likely be without a home for several months. It may take that long for some of these areas to get basic electrical and water and wastewater service repaired. These people will need to be housed and fed. Where will they go? Who will care for them? For those of us living outside the evacuation zone, the prospect may not be much better. Electricity and water will likely be lost for days, if not weeks. Trees will have smashed many houses, opening them to the weather, making them uninhabitable. However, we will have "sheltered in place" because we're not encouraged or able to evacuate: There are simply too many of us for all to leave.

The bottom line is that we are not prepared to deal with the impact and aftermath of a large hurricane. The loss will be staggering. And at the time our worst fears are realized, we will be hit with the hardest question of all: What to do now? The absolute worst time to make these types of decisions is the week after a hurricane hits, yet that is what we face if we do not recognize the danger and plan for living afterward. Many of us made derisive comments about the lack of organization and planning in New Orleans. Houston, you haven't seen anything yet.