Kingdom of Causeways: New Orleans

Paul Abu-Taleb

With its international airport named after what many consider to be one of the greatest horn players of all time—Louis Armstrong—it can be easy to give way to the convenient temptation of flying into the magical city of New Orleans with music on your mind. We all have distinct images of that charismatic trumpeter etched into our memory. Most of them, however, include some combination of puffed up cheeks, bulging eyes, a blaring trumpet, or a snazzy-dressed Armstrong singing "Mac the Knife" into an old-school Crooner microphone with that scratchy, bubbly, yet remarkably razor-sharp voice. But don't let Louis Armstrong's charm trick you into flying into the Big Easy—the drive in is a speeder's paradise.

Barring the presence of any police cars within a two-mile vicinity before ascending onto the Manchac Swamp Bridge on Interstate 55 South, lead-footed drivers get the chance of a lifetime to let their hair hang down, open up their V-8's, and howl down thirty-four miles of beautifully paved concrete causeway on their way in to New Orleans. Yet, it isn't open road and the absence of police that astounds first-time drivers of the Manchac and the Bonnet Carrè Spillway Bridge, the Lake Pontchartrain Causeway or the five-mile Twin Span Bridge (see figures 1.1—1.3). The fact that once you drive eight miles on the Lake Pontchartrain Causeway, the naked eye sees nothing but water will make your jaw drop and your foot ease off the accelerator in utter amazement. A similar phenomenon occurs on the Twin Span—while land remains in sight, it is far in the distance at the construction's halfway point. Likewise, in the case of the Manchac Swamp Bridge and the first ten miles of the I-10 corridor, the fact that you are driving above marshlands for nearly thirty-five miles grabs too much attention to even drive like a wild man in the first place. Indeed, attempting to take in the remarkable engineering feat of these bridges and the beauty that surrounds you is reason enough to ride shotgun while the adrenaline junkies get their fix.

And then the inevitable questions begin to percolate through your mind as you drift back toward reality: why in the world have people *chosen* to live where miles upon miles of causeway are needed for that place to be accessible in the first place? If natural disasters are growing increasingly common and progressively stronger, why do people keep coming back to New Orleans after catastrophic storms like Hurricane Katrina? Ultimately, these questions, and many more, can only be answered by a lengthy visit to the Bayou. If it must be articulated, however, suffice it to say that while science and rationale point toward the inevitable occurrence of another Katrina, while melting ice caps, warming oceans, rising seas and subsiding land levels

will persist in years to come and only exacerbate the impact of that catastrophic storm when it does arrive, New Orleans, the people of New Orleans, and the culture of New Orleans will remain until the day that city slips into the sea itself. Resilience is the defining characteristic of the Big Easy—its tragic and heroic flaw—and over the next several decades that resiliency will be tested in an unprecedented and historic fashion. But New Orleans will always return. For this fact and this fact alone, the Lake Pontchartrain Causeway and the Twin Span Bridge, the Bonnet Carrè Spillway Bridge and her sister over the Manchac Swamp, will all remain intact—renovated when needed, rebuilt if necessary—not so that the people of New Orleans can get home on a cool summer evening when no danger is in sight, but so they can escape their city to the safety of higher ground when the next Katrina makes landfall—and then return.

In 1708, Jean Baptiste Le Moyne de Bienville made an expedition up the Mississippi near the site that New Orleans now rests upon. After examining the landscape, Bienville remarked that he "did not find any [lands in the vicinity of this river] that are not flooded in the spring. I do not see how settlers can be placed on this river."[1] Nevertheless, French frontiersmen arrived in increasing numbers over the next decade and proved that the Lake Pontchartrain basin was in fact habitable. After further consideration, Bienville concluded that the land adjacent to the bend in the Mississippi River—particularly the elevated ground around Bayou St. John—was high enough to remain safe from inundation. After communicating this message to his superiors, Bieville's plans for the city were approved and La Nouvelle Orléans, named after Phillipe d'Orléans, was founded in 1718.[2]

To Bienville's credit, the city's geographic positioning was ideal: it lay at the mouth of the Mississippi Delta and proved to be a tremendously profitable port city, possessing a virtual monopoly on shipping and a stranglehold on all imports and exports coming through the continent's largest artery. New Orleans's topography, on the other hand, was not so advantageous. Most of the crescent city is at or below sea level, with the highest natural levee elevated a mere twelve feet and large swaths of land depressed four to twelve feet below sea level. Two ridges in the immediate area—the Gentilly and Metairie—provide additional high ground, but both are small in size and remain susceptible to the Mississippi's inundations as well as hurricane surge waters. What is worse, the two ridges produce a concavity in the landscape, which captures both the torrential rains characteristic of the region in addition to floodwaters (see figure 2.3).[3] Moreover, the

construction of levees that has accompanied the settlement of these areas prevents the sediment rejuvenation typically provided by flooding, which further depresses the landscape. Indeed, according to Craig E. Colton, author of *An Unnatural Metropolis: Wresting New Orleans from Nature* and a geographer at Louisiana State University, "none of New Orleans's site was above the level of river floods, and much of it barely deserved to be called land."[4] Many other geographers and scientists agree. Wilson Shaffer, a hurricane modeler at the National Weather Service, asserts that "there are no high areas near the city that wouldn't flood in extreme cases.... High ground is several tens of miles away."[5] Nonetheless, Bienville predicted that astronomical profits would be made at New Orleans and considered the natural challenges of the landscape surmountable. Thus, the city was platted in 1721, beginning with the high ground of the French Quarter.

Curtailing the course of nature and minimizing flooding proved far more challenging than was expected, however, especially as the city's burgeoning population spilled off of the high ground and onto the subsiding, flood-prone lower territories in the early twentieth century.[6] Massive water pumps, intricate levee systems, and damming of the Mississippi all emerged as methods of preserving New Orleans. But, unsurprisingly, there have been many occasions in which nature has trumped man. Thus, part of the solution to the problems posed by natural disasters has always been vacating the city, and in the mid to late twentieth century, construction began of highways that also served as evacuation routes toward the elevated interior. Coupled with social and economic incentives to create such routes, evacuation provided a strong incentive to build bridges and causeways out of New Orleans.

The Lake Pontchartrain Causeway, which spans nearly twenty-four miles north-northeast across Louisiana's largest inland lake, is the most notable of these constructions. The idea of the causeway surfaced in many forms during the early twentieth century, but technology did not permit its construction for several decades after its conceptual birth.[*] Finally, in 1955, engineering and technology were sophisticated enough to build the structure that stands today and the Greater New Orleans Expressway Commission gave the bid for the causeway to the Louisiana Bridge Company (LBC). The causeway's rapid completion and remarkable stability stem from the innovative approach that the LBC used during construction. Of critical import was the CENVIRO Process, which produced the cylindrical concrete pilings that support the bridge. This process uses centrifugal force to push the concrete outward, violent vibrations to eliminate air pockets and compact

the concrete, and rollers to harden the concrete.* The end result was a pile nearly twice as thick, substantially stronger, and significantly longer than was previously possible. The LBC also pre-fabricated and pre-stressed the concrete slabs on land prior to barge-assembly on the lake, which reduced construction time, ensured uniformity throughout the bridge, and limited the environmental impact by pouring the concrete on land. The Lake Pontchartrain Causeway was completed well ahead of schedule and opened 30 August 1956 (see figures 1.3—1.5).[7]

A similar process was used to construct the second longest causeway in Louisiana—the Manchac Swamp Bridge on Interstate 55, which has served as a northwestern evacuation route toward Ponchatoula since its completion in 1979. The Manchac Swamp Bridge is one mile shorter than the causeway, stretching 22.8 miles through beautiful Louisiana swamplands before reaching dry land to the north or merging with I-10's Bonnet Carrè Spillway Bridge to the south. Construction of the bridge was far more costly than her predecessor at seven million dollars per mile, with each of the several thousand concrete pilings driven 250 feet into the ground.[8] Southbound travelers on the Manchac Swamp Bridge connect with I-10's Bonnet Carrè Spillway Bridge just over ten miles outside of New Orleans's city limits in a seamless merge. Thus, while the causeway technically changes bridge-names three times, vehicles remain on the same strip of elevated highway for nearly thirty-four miles (see figures 1.2, 1.6, and 1.7).[9]

Then there is the Twin Span Bridge, which connects New Orleans to the city of Slidell, north and east of the city center. The original Twin Span Bridge was completed in 1965, but the surge waters of Hurricane Katrina submerged the majority of the bridge and permanently damaged the 1965 construction. Of the more than 500 segments that comprised the old Twin Spans, Katrina dislodged or destroyed fifty-eight and severely misaligned another 437 (see figure 1.8).[10] Immediately after the hurricane, the Boh Brothers Construction Company restored what could be salvaged of the old bridge and reopened the eastbound span within 45 days to ease the flow of traffic. Following this immediate solution, the Boh Brothers teamed up with the Louisiana Department of Transportation and Development and other private contractors to complete a new Twin Span, which opened its northbound segment on 15 August 2011. The new spans are elevated thirty feet above water for the normal stretch—as opposed to an elevation of eight and one-half feet above water on the old Twin Span—and eighty feet above water at the Bridge's apex, rather than the sixty-five

foot crests on the previous spans. The increased height of the bridge is expected to withstand substantially stronger and higher storm surges than were experienced during Katrina, as is seen in figures 1.9 a and 1.9 b.[11]

None of these causeways or bridges were constructed simply to serve as evacuation routes for New Orleans. Indeed, this is most definitely an ancillary function of the infrastructures, as they are seldom used in evacuative capacities. For the most part, these bridges and causeways function as any other strip of highway would, connecting New Orleans to the surrounding areas. Because they provide shorter, more convenient routes to the city center, these constructions facilitate travel, reduce shipping costs and times, and extend the metropolitan area to include cities like Slidell, Mandeville, Ponchatoula, and Hammond in the New Orleans community and economy. In fact, in the past half-century, New Orleans has only been devastated by hurricanes on two occasions—Betsy in 1965 and Katrina in 2005—a remarkable rate for its location on the Gulf. But it is in these times that the constructions earn their praise, prove their utility, and justify their expense. It is as they save human lives that the 803 million dollar price tag on the better, safer Twin Span becomes worth it (see figure 2.1 for all evacuation routes and contraflow patterns out of New Orleans).

Despite the overwhelmingly beneficial role that the New Orleans area causeways have played in serving the New Orleans community, however, there have also been negative impacts from these roadways. This is particularly true during their construction, when the ecosystem bears the brunt of human interference and many local inhabitants are displaced. Such was especially the case with the construction of the Manchac Swamp Bridge, as it traverses for nearly twenty-three miles through swamplands occupied by people and wildlife alike. Indeed, the construction of the I-55 causeway through the swamp village of Manchac "shoved aside nearly all of this village and nearly half its people," according to one article in *The Tuscaloosa News*. "About 30 families," the article continued, "had no choice except to take the money offered them and leave."[12]

The impact on the local ecosystems and wildlife is no less abrasive. Environmental Impact Studies (EIS) and other reports on all of the mentioned constructions are hard to come by or do not exist because they were built before the federal government mandated that states conduct these studies for every new project. Still, it is reasonable to conclude that environmental studies on other causeways have a degree of applicability to the New Orleans area causeways. According to Peter G. Wells, author of a 1999

Environmental impact report on the Bay of Fundy, some of the adverse effects of causeways constructed over water, generally speaking, include: disrupting "the natural flow and accumulation of sediments… [preventing] the flow of estuarine waters and the dilution of industrial discharges… or the natural distribution of critical life stages of commercial fish species."[13] While the construction of causeways over the Bay of Fundy had dramatically different impacts than did similar projects in the New Orleans area, this study is still important as it provides information on the *general* impacts causeways have upon the local environment. Certainly, these bridges have impacted the flow of water in Lake Pontchartrain, the Joyce Wildlife Management Area, and the Manchac and Maurepas Swamps. Similarly, although there may not be commercial fish species in these bodies of water, they are still abound with wildlife and fish that are inevitably affected by the construction of major highways through their environs. Even the introduction of shade, which results from the construction of the new bridges, can impact shrimp populations in the New Orleans area. Habitat connectivity, drainage concerns, sheet flow hydrology, stream impact, and shade effects are therefore considered heavily before construction begins.[14] In some cases—and this is growing increasingly common—bridges are constructed in an "end-on" fashion if the ecosystem in concern is particularly sensitive, which means that the bridge is built from one end of the structure onward without equipment in the water. Ideally, this eliminates or significantly reduces human interference at ground level.[15] Destruction of the infrastructure is also inimical to the marine environment. Hurricane Katrina damaged the majority of the old Twin Span, for example, and left several 600,000-pound concrete slabs broken apart at the bottom of Lake Pontchartrain. Lastly, the existence of interstates that funnel millions of vehicles through swamplands each year has deleterious impacts on the plant habitat that roadway traverses through, which must absorb the jarring increase of carbon emissions.

But, by and large, the benefits of the causeways far outweigh the environmental harm done. Justifying their existence, however, does not answer the question as to why people have chosen to live in one of the most flood-prone, hurricane-susceptible areas in the world. The causeways are valuable because they help people get to safety and facilitate travel around the city. But the only reason the causeways exist in New Orleans is because New Orleans exists in a place where it probably should not. Why, then, do people live where they must vacate at some point or another? Hurricane Katrina bluntly posed this question to the

residents of New Orleans in the early morning hours of 29 August 2005 (see figure 2.2 for a NASA photo of Katrina and figure 1.5 for a photo of the flooding).

Thankfully, Katrina relented in her final approach to New Orleans, subsiding from a Category 5 to a Category 3 as the eye wall deteriorated just hours before making landfall. Thus, instead of hurdling into Louisiana with wind speeds in excess of 175 miles per hour, Katrina approached New Orleans as a 125 mile-an-hour Category 3.[16] Still, she exacted a heavy toll. Hurricane Katrina is the costliest natural disaster in American history: the storm claimed the lives of nearly two thousand people and left more than 100 billion dollars in damages in her wake.[17] The environmental impact was also significant. Between Hurricanes Katrina and Rita alone—the Category 5 hurricane that followed three weeks behind Katrina—Louisiana lost 217 square miles of wetlands to the Gulf of Mexico, well above the annual average of twelve square miles.[18] The storm also resulted in a concoction of sewage, backswamp, lake water, and seawater throughout the city, which reached in some areas more than twenty feet high. Survivors of Katrina suffered immensely. The tempest destroyed thousands of homes and hundreds of thousands of lives, leaving people reeling in agony as she dissipated north into the country's interior.

Storms of equal or greater size in the future are not only inevitable; they are also growing increasingly likely—both in frequency and severity—as a result of recent climate change. Perhaps that is the most daunting outcome of Katrina: that it is only one in a series of unavoidable natural disasters bound for New Orleans. And if 2005 was any indication, grave predictions about the future of the city will likely prove true.[19] '05 was a good year for Atlantic hurricanes. Hurricanes Katrina, Rita, and Wilma—the most severe of the 2005 hurricane season—were only three of the twenty-seven tropical storms named that year, fifteen of which developed into full-fledged Atlantic hurricanes.[20] Certainly, the year was an anomaly, but it did not deviate far from the spiraling trend that began in 1995, when oceans began to warm more rapidly.[21] Hurricanes derive their energy from heat, so warmer oceans means more frequent and more lethal hurricanes. According to a study conducted by Peter Webster at the Georgia Institute of Technology, these tropical storms have increased in severity over the last thirty-five years, with Category 4 and 5 hurricanes twice as likely today.[22] Further exacerbating the situation is that damage control is virtually impossible, natural coastal fortifications are decreasing, and coastal populations are increasing, with a fifty percent rise in

populations living in hurricane-prone areas of the United States between 1980 and 2003.[23] To a degree, this is due to the so-called "levee effect," a theory originally coined by Gilbert F. White of the University of Chicago. In essence, White asserted that man-made barriers that seek to tame nature in areas susceptible to hurricanes and inundation encourages settlement of that area, which makes natural disasters all the more calamitous when they eventually—and unavoidably—overwhelm the synthetic creations.[24] So why, after twenty-seven floods in its history, do people live in New Orleans and return after she is decimated by tropical storms?

Many people return—or don't even leave in the first place—because science is not entirely accurate or reliable at this point. All of us have experienced faulty meteorology in our lifetime. Instead of the predicted thunderstorms, blue skies and sun arrive; rather than partly cloudy, a torrential downpour passes through. Just as an abrupt change in anticipated weather may make or break a day in the outdoors here in the Midwest, then, so too can an abrupt change in a hurricane prediction make or break lives in the Southeast. Thus, the same thought process about whether to ignore forecasts in the country's interior pervades the thinking of coastal populations—only their decision is of far greater consequence. To them, getting up and evacuating for every hurricane warning would be unfathomable in a season that spans six months and averages five to six hurricanes per year. Importantly, this attitude is prevalent because hurricanes are far more volatile and predictions far less accurate than typical storm systems. Indeed, three-day forecasts of hurricane positions are still off by an average of 173 miles, while one-day predictions vary an average of seventy miles from where the storm actually makes landfall. The severity of the storm is also difficult to predict, with wind speed forecasts still twenty miles above or below the recorded speeds. The hurricane's categorization is no more reliable. As was seen with Katrina, a Category 5 can become a Category 3 in six hours, and vice versa.[25]

Combined, this sounds like all the more reason not to take the chance, and, if you choose to live New Orleans, to be ready to pack up and go five or six times per year. But the unreliability of storm forecasts also sounds like all the more reason not to place much credence in evacuation notices in the first place, which are of course liberal in their estimations, inclining toward public safety rather than realistic appraisals of any given storm. Yet, this does not take away from the fact that catastrophic storms *will inevitably and repeatedly devastate* New Orleans in the future, just as they have throughout the city's history. So why, *why*,

have people chosen to live in this city—a city that, combined, needs nearly seventy miles of causeway to access and evacuate it?

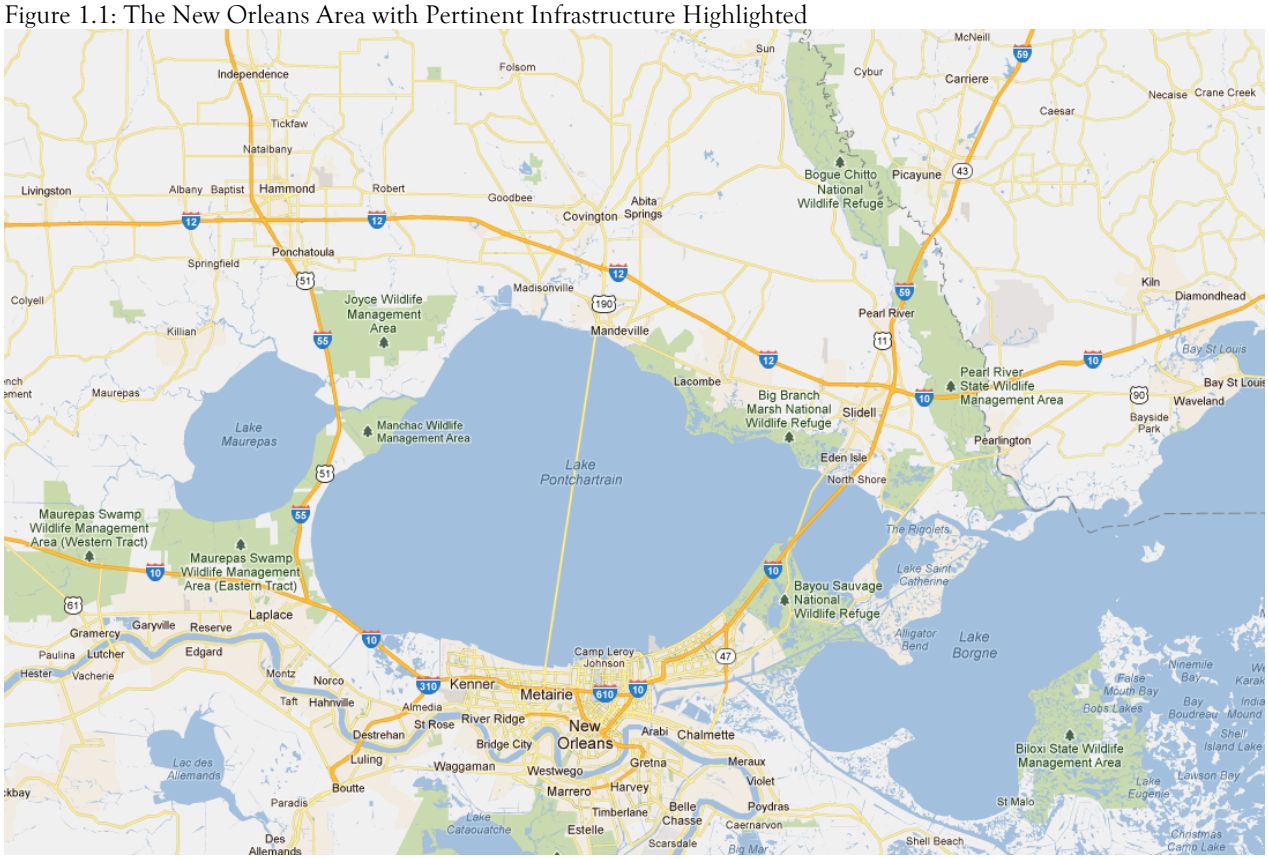
As alluded to in the introductory paragraphs, this question can only be answered by a visit to New Orleans, preferably a visit in which one has no reservations, no sense of time, and no real need of sleep. A walk down Bourbon Street will be necessary, if for no other reason than to be utterly overwhelmed by the epic weirdness that is the Big Easy. But don't settle on Bourbon for too long—N'awlins has so much more to offer than booze and bead throwing tourists. It is a haven for artists and musicians. It is the birthplace of jazz and a cradle for rhythm and blues. It is an international nucleus of culture, love, and, above all else, life. It is vibrant, funky, and upbeat. But the pace of life is positively slow. The shrimp po' boy you chow down on a street corner may have been made fast, although that is unlikely. In any event, it is consumed in a meticulous and protracted manner, each bite selected to have just the right combination of remoulade, lettuce, tomato, fried shrimp, and French bread, spaced out with a sip here and there of a cold beverage of your choice. According to Dan Baum, author of *Nine Lives: Death and Life in New Orleans*, the people of New Orleans are "masters of living in the moment. If we're doing okay this minute, goes the logic—enjoying one another's company, keeping cool, and maybe having something good to eat—of what earthly importance is tomorrow or next week? Given the fragility of life, why even count on getting there?"[26]

It is the New Orleaniens and their refusal to do anything but live in the now, their undying love for music, pleasant company, and Cajun cookin', their sole passion for soul, and their zealous embrace of life that make this city what it is. In Baum's analysis, despite the abject poverty that plagues much of the city, the abhorrent crime rates, and the incessant political corruption, "more New Orleanians—regardless of age, race, or wealth—were 'extremely satisfied' with their lives than residents of any other American city," before Katrina struck.[27] While I have not found any similar poll conducted since that catastrophe, it is unlikely that it would be any different today—those that returned embody the spirit of New Orleans best. And so, despite all of the scientific, logical rationale that points toward the inevitable occurrence of another Katrina and the ungodly sum of money required to maintain and preserve the crescent city; despite the pains that await the Big Easy in both the near and distant future and the exorbitant amount of life that will be lost, the homes,

businesses, and infrastructure destroyed; despite the likely event that New Orleans will, in the end, be captured by the sea, New Orleans will always return. New Orleans will always return.

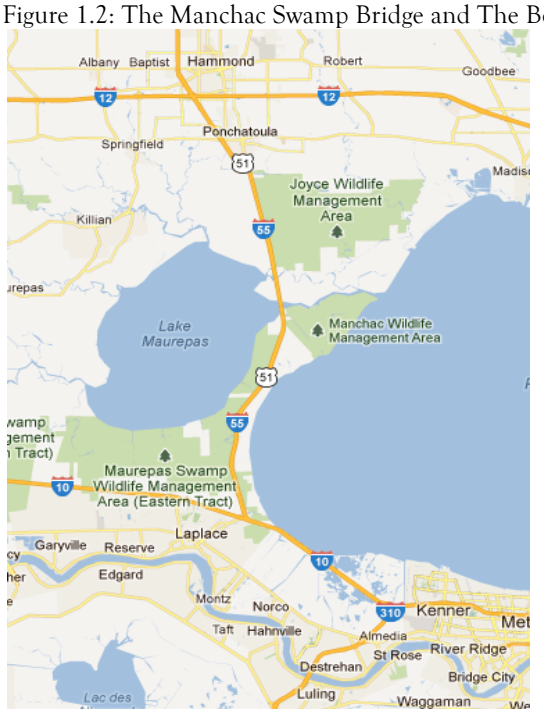
Hence the causeways and the bridges. True, they serve many other functions, and, in actuality, their ability to evacuate the city is not the main reason for their existence—or the most important. In fact, the evacuative role of the Bonnet Carrè Spillway Bridge, the Manchac Swamp Bridge, the Lake Pontchartrain Causeway and the Twin Span Bridge is most certainly secondary in importance. Indeed, the principal purpose of these structures has not been so that people can pack up their belongings, pack into their vehicles, and leave the Big Easy. Instead, the most valuable function of the causeways is that they allow people to return—time and time again—to the beautiful, magical city of New Orleans, that metropolis on the river that is, concisely put, *desitively bonnaroo*.[28]

Figure 1.1: The New Orleans Area with Pertinent Infrastructure Highlighted



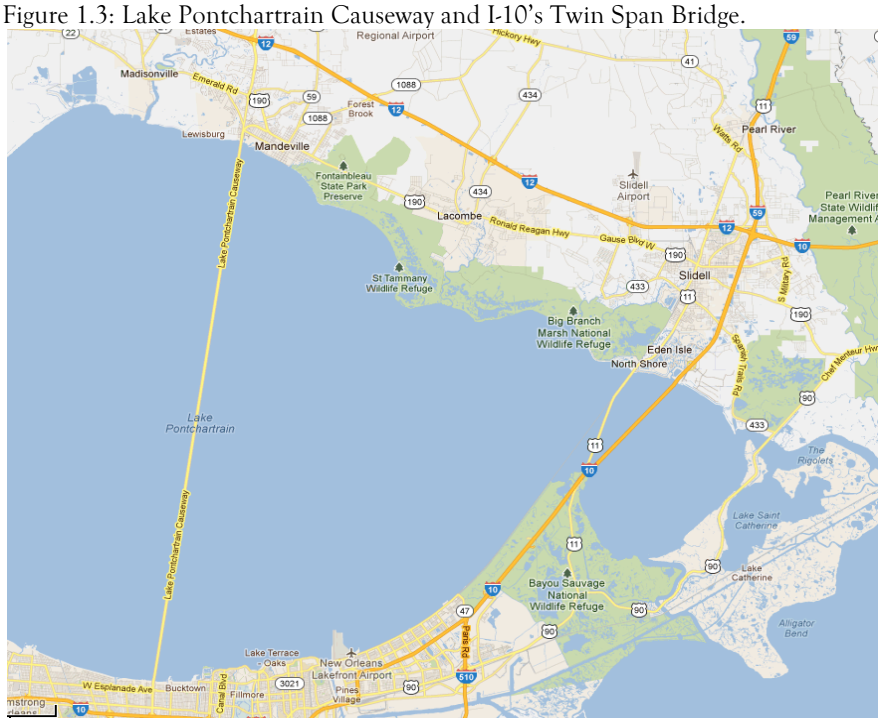
Source: Google Maps

Figure 1.2: The Manchac Swamp Bridge and The Bonnet Carrè Spillway Bridge.



Source: Google Maps

Figure 1.3: Lake Pontchartrain Causeway and I-10's Twin Span Bridge.



Source: Google Maps

Figure 1.4: Aerial view of the Lake Pontchartrain Causeway.

Source: David Frazier, *Lake Pontchartrain Causeway* (New Orleans: Corbis Images, no date cited), accessed April 18, 2012, http://www.corbisimages.com/stock-photo/royalty-free/CB021993/lake-pontchartrain-causeway.

Figure 1.5: Aerial View of New Orleans after Katrina, with the Lake Pontchartrain Causeway in the Background.

Source: Jocelyn Augustino *Aerial View of a Flooded New Orleans Neighborhood with Lake Ponchartrain in the Background*, Federal Emergency Management Agency, August 30, 2005, accessed April 18, 2012, http://www.fema.gov/photolibrary/photo_details.do?id=18166.

Figure 1.6: I-55 between the causeways.

Source: Kevin J. Dufresne, *Interstate 55 Twin Span*, photograph, unpublished, uploaded November 21, 2010, accessed 15 April 2012, http://www.panoramio.com/photo/44003349

Figure 1.7: Aerial View of The Bonnet Carrè Spillway Bridge.

Source: *I-10 Bonnet Carrè Spillway Bridge and Lake Pontchartrain*, accessed April 16, 2012, http://a3.ec-images.myspacecdn.com/images02/36/4b592959f863449f93228091c7abbd66/l.jpg. No photographer or publish date provided.

Figure 1.8: I-10 Twin Span, Post Katrina.

Source: http://www.twinspanbridge.com/Hurricane_Damage.htm. No publish date, photographer, or title provided, accessed April 18, 2012.

Figure 1.9a, Animation of the Old Twin Span Bridge.

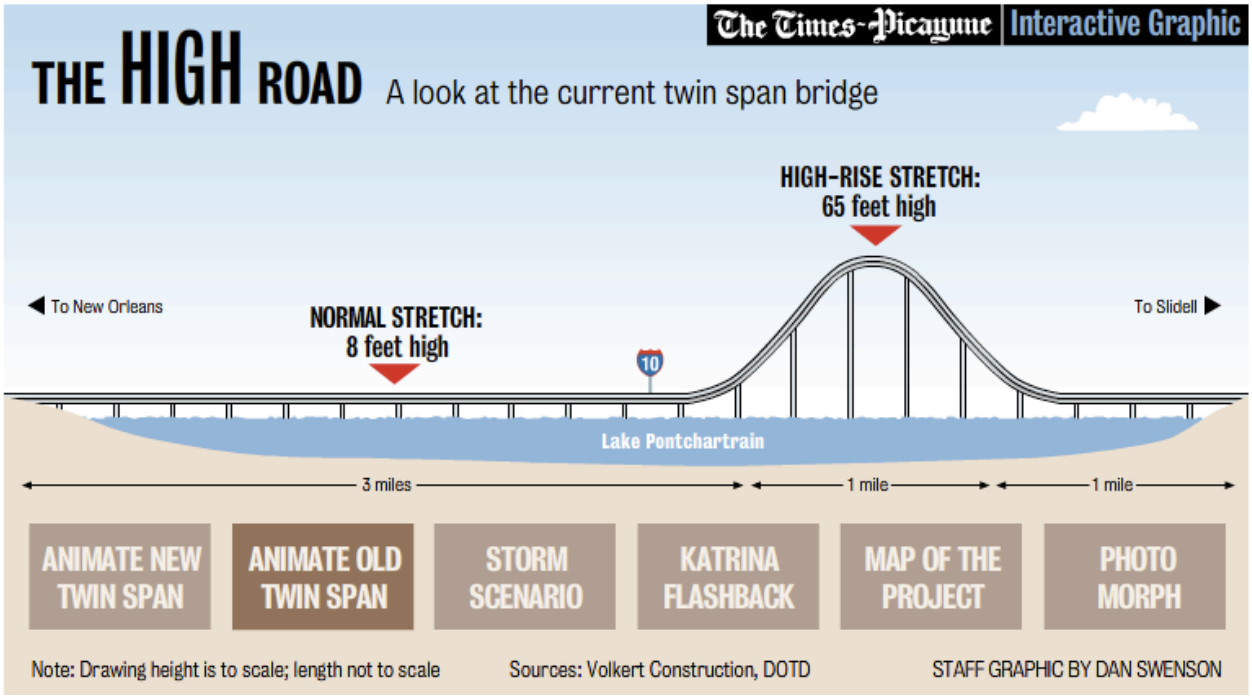
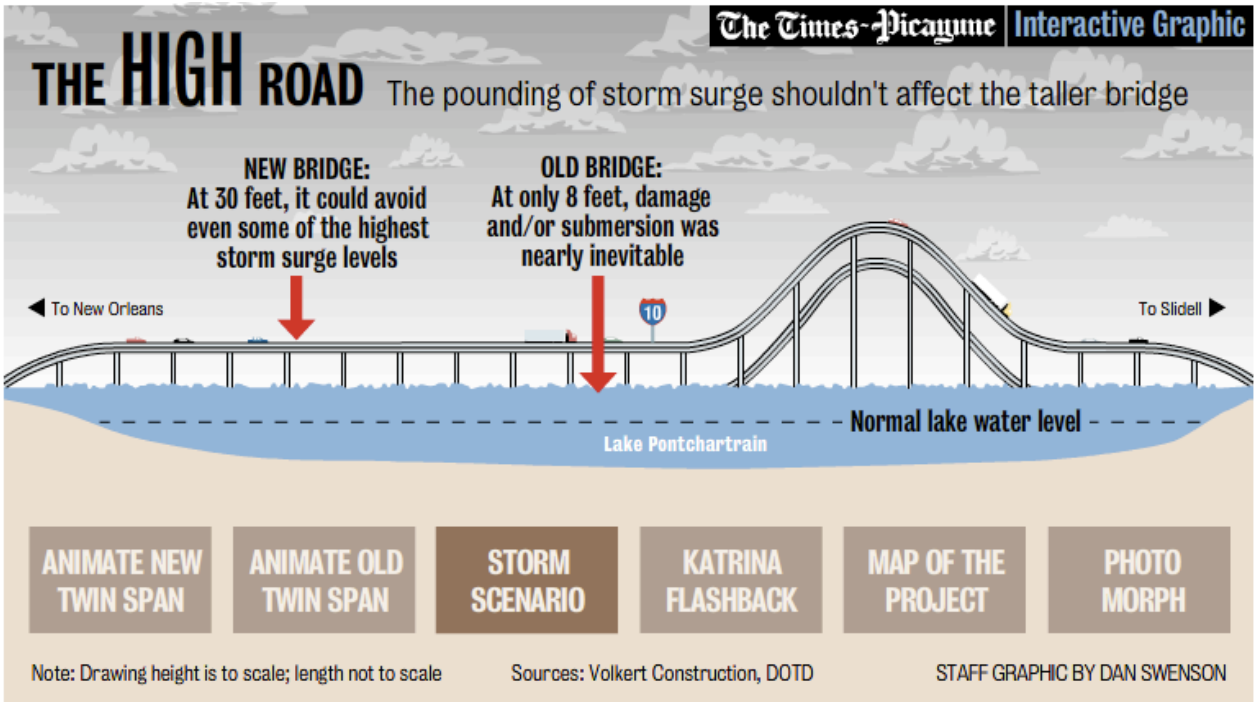
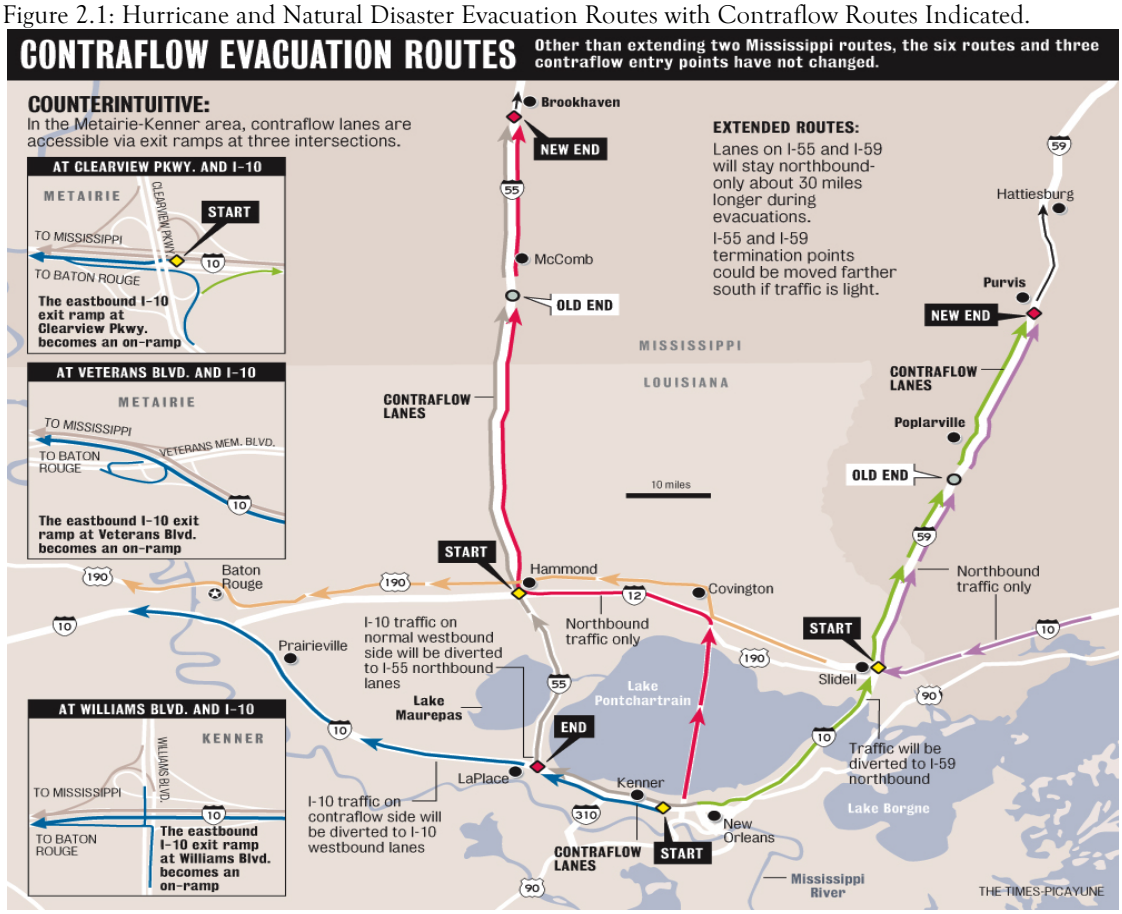


Figure 1.9b: Animation of the New Twin Span Bridge with Storm Surge Waters Equivalent to Katrina Below.



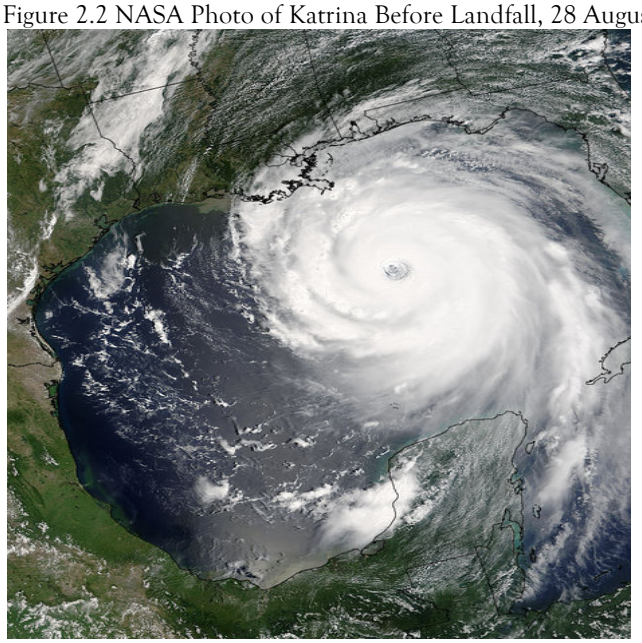
Both animations from: *The Times Picayune*, 2012, accessed April 16, 2012, http://www.nola.com/photos/t-p/index.ssf?/twinspans/newtwinspan.swf

Figure 2.1: Hurricane and Natural Disaster Evacuation Routes with Contraflow Routes Indicated.



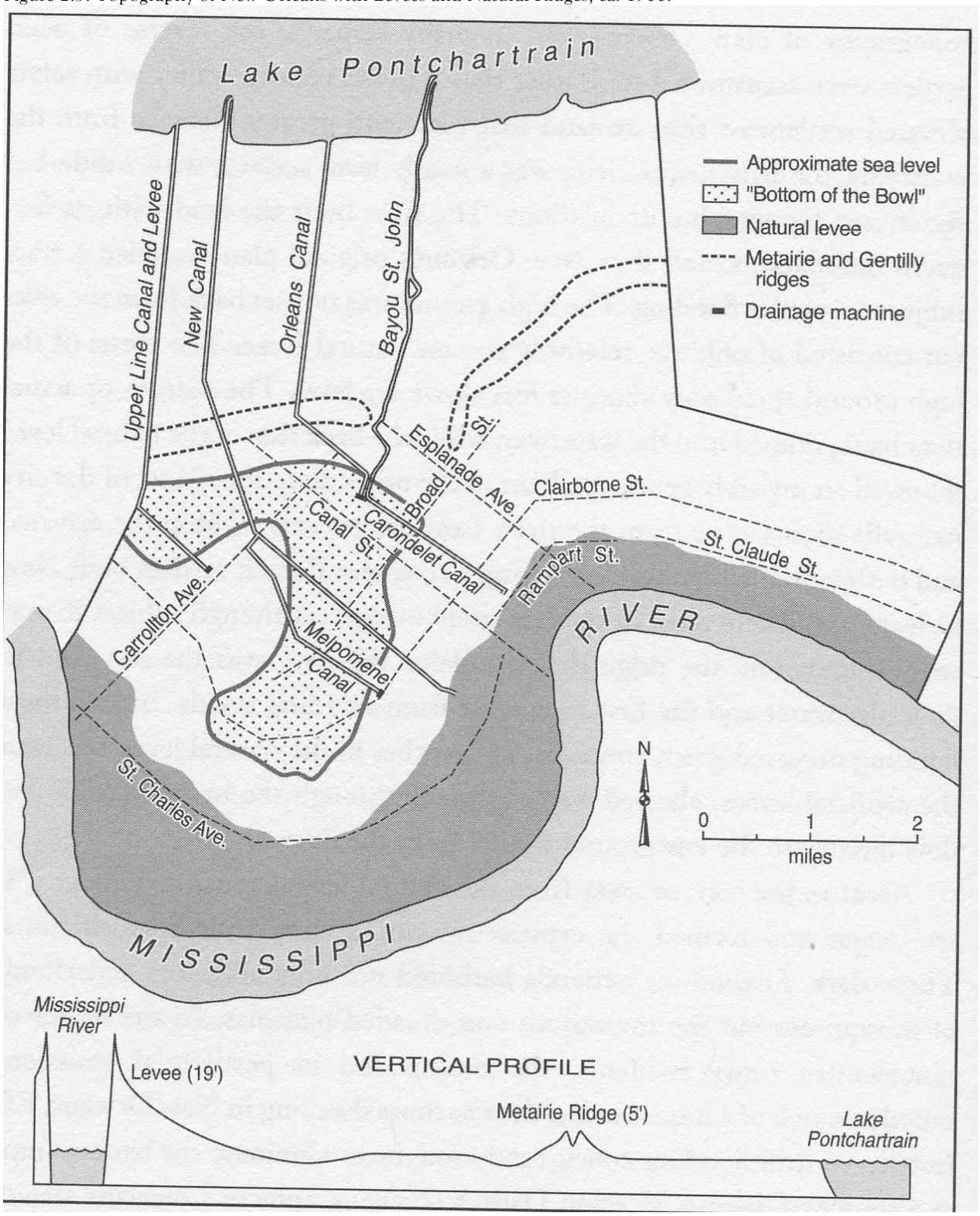
Source: "Contraflow Evacuation Routes," *The Times Picayune*, May 16, 2006, accessed April 16, 2012, http://www.nola.com/katrina/index.ssf/2006/05/contraflow_evacuation_routes.html

Figure 2.2 NASA Photo of Katrina Before Landfall, 28 August 2005



Source: *Katrina, August 28, 2005 (NASA Photo)*, accessed April 18, 2012, http://www.williamcronon.net/handouts/katrina/465px-hurricane_katrina_august_28_2005_nasa.jpg.

Figure 2.3: Topography of New Orleans with Levees and Natural Ridges, ca. 1900.



Source: Craig E. Colton, *An Unnatural Metropolis: Wresting New Orleans from Nature* (Baton Rouge: Louisiana State University Press, 2005), 18.

[1] Quoted in Christopher Morris, "Impenetrable but Easy: The French Transformation of the Lower Mississippi Valley and the Founding of New Orleans," in Craig E. Colton, ed., *Transforming New Orleans and Its Environs: Centuries of Change* (Pittsburgh: University of Pittsburgh Press), 26.
[2] Ibid., 30. It is unclear whether Bienville's brother, Pierre Le Moyne d'Iberville, should be considered a cofounder of New Orleans. The two discovered the area surrounding New Orleans in 1699 while traveling down the Mississippi, but even this is vague, with scholars like Colton and Morris hinting at the location, but not explicitly stating the area the two brothers were standing upon. In any event, it was not until 1717 that Bienville—acting without his brother—recommended the city be built. For a reference on the two brothers navigating the Mississippi in 1699, see both Morris's essay in *Transforming New Orleans* and Craig E. Colton, *An Unnatural Metropolis: Wresting New Orleans from Nature* (Baton Rouge: Louisiana State University Press, 2005), 2.
[3] Colton, *Unnatural Metropolis,* 4. Colton asserts that, "artificial levees built on the crest of the river's natural levee beginning in the eighteenth century and, much later, along the lakefront have secured the city against regular flooding but accentuated the bowl-like features and make drainage a bigger challenge today than in the past. Intense thunderstorms and hurricane-spawned rain have replaced the river as the greatest threats to the city in a saucer."
[4] Ibid., 5.
[5] Joel Bourne, Jr., "New Orleans: A Perilous Future," *National Geographic*, August 2007, 43.
[6] Colton, *Unnatural Metropolis*, 4-5. "Initial settlement avoided these zones in favor of the more solid natural levees and the Metairie and Gentilly ridges. As the city grew, developers using massive drainage schemes and levees transformed these wetlands into suburbs... Much of New Orleans that was drained for residential development is now below sea level and continues to subside."
[*] One idea was to dot the lake with small islands, then bridge the islands together. The project would then be paid for by the sale of real estate on the islands.
[*] The abbreviation CENVIRO is born from the CEN in centrifugal, the VI in violent vibrations, and the RO in rolling.
[7] For an excellent summary of the making of the Lake Pontchartrain Causeway—the impetus behind its construction, the engineering involved in the production process, and a general history of the causeway, from the idea's conception to the present day—see *Modern Marvels*, Season 10, Episode 60, "The Lake Pontchartrain Causeway," first broadcast 15 October, 2003 by The History Channel, accessed April 10, 2012, http://www.youtube.com/watch?v=VVge2uCmOtk. This documentary was used for all of the information on the Lake Pontchartrain Causeway and the construction process contained in this paragraph.
[8] Jules Loh, "Louisiana 'Oasis' is a Cypress-Paneled," *The Tuscaloosa News*, June 7, 1977. The second stretch of the Lake Pontchartrain Causeway, which was built to meet the high demand generated by the fist causeway, fetched a total of $26 million upon its completion in 1969, compared to the nearly $150 million tab run up by the Manchac Swamp Bridge.
[9] Wikipedia's page on the Lake Pontchartrain Causeway is actually one of the best and most thorough available on the internet. For information on the length and continuity of the bridges for travelers of the I-55 N/S Manchac Swamp Bridge and the I-10 E/W Bonnet Carrè Spillway Bridge, see http://en.wikipedia.org/wiki/Lake_Pontchartrain_Causeway, accessed 13 April 2012.
[10] Information on the Twin Span Bridge can be found on the Twin Span Bridge website. For the damage done by Hurricane Katrina, see http://www.twinspanbridge.com/Hurricane_Damage.htm, accessed 12 April 2012.
[11] See the Project News tab on http://www.twinspanbridge.com/. For a virtual comparison of the old span versus the recent construction, see http://www.nola.com/photos/t-p/index.ssf?/twinspans/newtwinspan.swf.
[12] Loh, "Louisiana 'Oasis' is a Cypress-Paneled."
[13] Peter G. Wells, "Environmental Impact of Barriers on Rivers Entering the Bay of Fundy: Report of an *ad hoc* Environment Canada Working Group," Technical Report Series No. 334 (Ottawa: Minister of Supply and Services Canada, 1999), 4, accessed April 16, 2011, http://www.bofep.org/Publications/barrier.pdf.
[14] In a conversation with LADOTD Environmental Engineer Administrator, Noel Ardoin, these areas and considerations were stressed as the most important that the DOTD considers when embarking on a new project.

[15] I-310 toward Louis Armstrong International Airport was constructed in this way.
[16] Thomas Hayden, "Super Storms: No End in Sight," *National Geographic*, August 2006, 75.
[17] Bourne, "New Orleans," 41.
[18] Ibid., 57. This is only a fraction of the 1,900 square miles of these precious coastal fortifications that the state has ceded to its southern border between storms, development, erosion, and rising sea levels since 1930. For information on this, see ibid., 41. A portion of Ted Steinberg's piece in the *Chronicle of Higher Education* also addresses how the destruction of Louisiana's marshlands contributed to the calamity. For his piece, see Ted Steinberg, "Opinion: A Natural Disaster, a Man-Made Catastrophe, and a Human Tragedy," *Chronicle of Higher Education*, September 9, 2005, accessed April 16, 2012, http://www.williamcronon.net/handouts/katrina/steinberg_disaster_catastrophe_tragedy_chronicle_9-9-05.htm.
[19] Bourne, "New Orleans," 60. Ivor van Heerden, head of the Louisiana-state investigation team tasked with analyzing Hurricane Katrina, gave such a prediction in the storms aftermath: "'The future of New Orleans looks bleak,' he said. 'We have to recognize that global warming is part of our future, sea level rise is part of our future, more storms are part of our future.'" As quoted in Bourne.
[20] Hayden, "Super Storms," 68.
[21] Ibid., 70. "One thing was clear in 2005: Conditions were ideal for making hurricanes... Yet 2005 was just a continuation of the upward trend that began in 1995. Because of a tropical climate shift that brought warmer waters and reduced wind shear, the Atlantic has spawned unusual numbers of hurricanes for nine of the past eleven seasons. 'We're 11 years into the cycle of high activity and landfall,' NOAA meteorologist Gerry Bell says, 'but I can't tell you if it will last another ten years, or thirty.'"
[22] Study discussed in Hayden, "Super Storms," 76.
[23] Ibid., 68.
[24] Levee effect discussed in Bourne, Jr., "New Orleans," 43. For a similar argument, see Craig E. Colton, "Rebuilding New Orleans," *Louisiana State University (blog)*, November 6, 2008, accessed April 18, 2012, http://www.williamcronon.net/handouts/katrina/colten_rebuilding_new_orleans.htm. Colton says that, "in particular, a devotion to structural devices to prevent flooding has contributed to the current vulnerability of the city. So in one sense, human artifice has contributed to risk... Ultimately, the levees have given the residents of the lower valley a false sense of security—as they do elsewhere."
[25] All statistics and averages in the previous four sentences taken from Hayden, "Super Storms," 71.
[26] Dan Baum, *Nine Lives: Death and Life in New Orleans* (New York: Spiegel and Grau, 2009), xi.
[27] Ibid.
[28] Desitively Bonnaroo is the title of funk, R&B pioneer or Dr. John's (Malcolm John "Mac" Rebbennack Jr.) 1974 Album. The phrase is slang for, "a real good time," and is the namesake of the annual music and arts festival in Manchester, Tennessee.