GEOPOLITICAL NEW ORLEANS

New Orleans, one of the nation's cities, lies at the youngest sizable earthen surface of North America. This Crescent City has stood for almost 600 years, its age dwarfed by the life span of its physical terrain, one of the youngest sizable earthen surfaces of North America. New Orleans' land base is only ten years older than its oldest living biota (livestock). Twenty times as old, yet still the most aged buildings, and fifty times the age of its million or so citizens. So young is the region that geologists can collaborate with archeologists in investigating their respective disciplines: geology and human history practically share the same timeline, and recent human artifacts often lie beneath thick strata deposited by natural forces. “This alluvial country is truly curious,” wrote Edouard de Montulé in 1817.

When they dug a basin behind New Orleans, they found everywhere several layers of tree trunks, in one of them, fifteen feet below the present level, an iron axe, evidently of European form. It had probably been dropped with a tree trunk from the vicinity of Pittsburgh, on the Ohio, a region inhabited by the French a long time before Louisiana.

New Orleans' perch upon the deltaic plain of the Mississippi River makes the city a one-of-a-kind metropolitan experiment with geography.

ADrift Across the Planet

A sense of geographic destiny underscores New Orleans' location. What better place for a city than near the mouth of the continent's greatest river, where waterborne access to a fertile basin may be controlled from a single point? Even New Orleans' newly compiled geodetic coordinates—30° North, 90° West—suggest a sense of order in the world, a need for this city to exist. But the geographical situation seized in the early 1700s to become the New Orleans we know today was a long time in the making, and even longer just to arrive at its eventual location, a sixth-of-a-planet above the Equator and a quarter-planet west of Greenwich.

A half billion years ago, continents practically unrecognizable today were distributed mostly across the southern hemisphere. During the next 250 million years, underlying tectonic plates drifted together to form the supercontinent Pangaea. Named by the German scientist Alfred Wegener (1880-1930) who first proposed the radical hypothesis of continental drift, Pangaea spanned from present-day Europe (1880-1930) who first proposed the radical hypothesis of continental drift, Pangaea spanned from present-day Europe to Antarctica, roughly straddling the Greenwich Meridian. Within the supercontinent were the nascent landmasses whose shapes would come to recognize continents' contours. The general footprint of ancestral North America, called Laurentia, put the relative situation of future New Orleans in the middle of the Atlantic Ocean along the Equator. But this locale, in the Permian Period, was landlocked by the future continents of South America and Africa, fitted snugly around what would become the southeastern United States.

Over the next one hundred million years, during the Jurassic Period, the tectonic plates underlying North America and Eurasia drifted away from the nascent mass of South America, Africa, India, Australia, and Antarctica, thus creating a present Atlantic Ocean and the beginnings of a Gulf of Mexico. Future New Orleans was much roughly at 10° North, 60° West—near present-day Trinidad—drifting northward and westward. New Orleans' Gulf juxtaposition, however, was not even embryonic at this time; the southern edge of North America was well inland of its present-day coast.

A sense of destiny underscores New Orleans' geographical situation, astride North America's greatest river, gateway to a vast and fertile basin. Its location was a long time in the making. Shown here, from the bottom up, are the theorized positions of the drifting continents from the Jurassic Period to the present, with future New Orleans' relative position shown as a black point, and its eventual absolute location (30° North, 90° West) as a yellow diamond by author based on C.R. Scotese and other sources.

1 Southeastern Louisiana, once thought to be 5,000 years old, is now estimated to be roughly 200,000 years old. The land-building delta of the Mississippi River that formed New Orleans proper commenced 4,000-5,000 years ago. Allusion to the age of the New Orleans land base in this discussion gives an approximate 500-year range.

2 Edouard de Montulé, Travels in America 1816-1817, trans. Edward D. Seiber (Bloomington, IN, 191), 91.

3 Data for this section were interpreted from a number of source materials, among them Brian F. Winslow, Philip Keary, Seiya Uyeda and Charles Schuchert. Maps were adapted from Christopher R. Scotese’s “Paleomap Project: Global Plate Tectonic Model,” www.scotese.com.
line, and neither the Mississippi Valley nor a river was yet formed. Then, as the continent drifted, it also rifted apart internally, forming an expansive trough along the middle of North America.

A very different planet emerged by the Cretaceous Period, about one hundred million years ago, as the components of former Pangaea separated into distinct continents, and sea level rose to levels higher than the Earth has seen in the past three hundred million years. The rising waters, about North America in half with a vast continental seaway spanning from the present-day Rockies to the Appalachians, and from the Arctic Ocean to the Gulf of Mexico. This is during that period that central North America's crust warped downward along the path of the present-day lower Mississippi River. This important feature, the father of the Mississippi Valley, is called the Mississippi Embayment, described by geologist Roger T. Saucier as "a northward synclinal projection of the Coastal Plain that lies between the Southern Appalachians and the Ouachita Mountains of Arkansas. New Orleans' relative situation, if one were to project it upon this alien Cretaceous geography, was located roughly at 24° North, 77° West, a position east of present-day Miami, Florida, and still far offshore.

By the time of the disappearance of the dinosaurs—sixty-five million years ago—the continent's bifurcating seaway had retreated in the north, but still flooded most of the central-southern portions of North America, making New Orleans' situation still a watery spot hundreds of miles offshore. This position, if mapped upon today's globe, would be located off the coast of Jacksonville, Florida, around 30° North, 80° West.

By the Eocene Epoch, the Mississippi Embayment—once 1,000 feet deep and intruding upon the present-day Mississippi Valley to southern Illinois—had been drained of retreating seawater and mostly sedimented, rendering the shape of the continent we recognize today (sans Florida). The continent's southern coast was now (about fifty million years ago) sufficiently developed so that we can identify future New Orleans' situation relative to it, though it remained hundreds of miles from the city's modern-day geodetic position. Over the next tens of millions of years, the sea repeatedly transgressed and regressed into the Mississippi Embayment, depositing after each cycle. The overall effect was a single major regressive sedimentary cycle continuing (up to two to three million years ago), in consequence, the edge of the continental shelf progressed southward about two hundred miles to its present location. With the Gulf Coast now more or less "in place", the relative and absolute positions of the future city of New Orleans would finally coincide by the Miocene Epoch, around fifteen million years ago. This did not mark the end of continental drift, only another stage of it. Nor did the formation of North America's modern coast with the Gulf of Mexico mean that a Mississippi Valley yet adjoined it, a Mississippi River yet discharged into it, or a river-dominated delta yet formed upon it.

**Formation of the Mississippi Valley**

It is now the Pleistocene Epoch, about two million years ago. The Gulf Coast at this time traced a smooth arc from the present-day Florida panhandle through Mobile, Baton Rouge, Lake Charles, Houston, Corpus Christi, and into coastal Mexico. Running five hundred miles northward into the North American interior was the now-drained, now-sedimented Mississippi Embayment, which still exhibited its downwarped configuration, a valley formed not by adjacent mountains but by an indentation in the Earth's crust, a syncline formed from the surrounding landscape collected in this valley to form a primordial Mississippi River. Had these conditions persisted, a river of regional importance—perhaps the size of the Tennessee or the Ohio—might have developed with a small delta near present-day Lafayette or Baton Rouge. It was the Missouri, not the Mississippi, that drained the eastern Rock-
The Pleistocene Epoch also saw the beginning of a relatively rare event in the history of the planet—one to date: an Ice Age. As temperatures dropped, ice sheets expanded and advanced southward across North America, taking up water at the expense of the sea, whose level thus declined. Then temperatures increased, the ice sheets retreated, and sea level rose. This cycle repeated about five times over the past two million years, reaching the coldest point about eighteen thousand years ago (glacial maximum), when the ice sheets reached their southmost extent. With each glacial advance, the dropping sea level rendered 30° North, 90° West a landscape instead of a seascape. Sea level may have reached as low as 150 feet below the current level, placing the coastline well south (near the Continental Shelf) of its current position. An earlier New Orleans site might have exhibited a climate like that of the present-day upper South or Midwest, with a gently sloping topography of small clay hills, perhaps like that of Arkansas or Mississippi. The 18,000-year-old Ice Age also dramatically transformed the waterway we now call the Mississippi River.

Formation of the Mississippi River

At glacial maximum, the edge of the northern ice sheet sprouted westward along what is now the Missouri River and extended along the east. The relationship between the border of this glacier and the channels of these rivers was causative. As the ice sheet—called the Illinoian Advance at this stage—pushed southward, it forced the rivers’ drainage patterns to conform to its southernmost point. That point was located at the northernmost point (present-day Cairo, Illinois) of the Mississippi Embayment. Glaciers thus redirected waters running off vast expanses of North America into what was previously a relatively small valley winding broadly in a wide meander belt, transforming it into the greatest drainage system on the continent. The Mississippi River was born, the Mississippi Basin was established, and the Mississippi delta was about to develop.

The glacial maximum was now delivering increasing quantities of both water and sediment to the Gulf of Mexico and began to attain the magnitude and path we know today. The exact paths of the lower Mississippi’s historical meander belts—that is, the levees, broad expanses, bordered by bluffs, within which the actual channel shifted—is not known for certain. Roger Saucier, foremost expert on this subject, wrote in 1974 that it is difficult if not even embarrassing for geologists to admit that during the past fifty years, we have taken a giant step backward rather than forward in understanding “the chronology of Holocene Mississippi River meander belts.” Once the meandering river exited its alluvial valley and entered the Gulf of Mexico, it slowed its velocity and dropped its sediments, forming a delta—a body of sediment laid down by dynamic sedimentary processes...where a river enters a deeper and less turbulent body of water.” This delta would, in time, form a plain that is now southeastern Louisiana, and host the site for New Orleans. Only when the changing level of the sea would allow it to accumulate.

At the Sangamon Stage (125,000 years ago), the delta comprised a small discharge zone—between present-day Lafayette and Baton Rouge, while a much smaller delta developed at the mouth of the Pearl River, on the present-day Louisiana/Mississippi state line. Here, gulf currents carried the Pearl’s sand deposits westward to what is now eastern New Orleans, where they formed a sandy beach known as the Pine Island Trend. By 70,000 years ago (Ewicosion Stage), the Mississippi delta forked near Old River, one branch flowing into the modern-day Mississippi channel, the other in the Atchafalaya River channel. Over the next 60,000 years, the lower river jumped channels and generally meandered within the area known today as the Atchafalaya Swamp, while its...
Southeastern Louisiana formed over the past 7,200 years, as the lowermost two hundred to three hundred miles of the Mississippi River jumped channels and deposited sediment throughout 20,000 square miles along the Gulf Coast. Scientific research has shed light on the locations, dates, and shapes of these delta complexes. The top map shows the Russel/Fisk and Kolb/Van Lopik interpretation from the 1940s and 1950s; the bottom map shows Frazier's 1967 refinement using radiocarbon dating and other methods. (Shades of red indicate the delta complex's age.) The New Orleans area is mostly a product of the St. Bernard and Plaquemines deltas, starting roughly 5,000 years ago. Nine

9 Ibid., 2: Plate 28, Sheets 1-3.

flooding. Yet, despite all this deposition, no substantial, lasting deltaic plain developed, and no southeastern Louisiana formed. Why? Sea level during these times fell, rose, fell, and rose again, interrupting the land-building process and scattering the sediments offshore rather than allowing them to

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accumulate in a plain. In the latter stages of the Holocene, "the rate of postglacial sea level rise was so rapid that it is unlikely that a deltaic plain analogous to that of today was able to form."10 Starting around 12,000 to 10,000 years ago, the sea at which sea level rose started to diminish. Gulf currents still carried off sediment, but to a lesser degree and at a slower pace. Now a new environment awaited sediments bound for the sea via the Mississippi River.

FORMATION OF THE MISSISSIPPI DELTAIC-PLAIN AND NEW ORLEANS REGION

Starting about 7,200 years ago, river-borne sediments were decreasingly overwhelmed by the rising sea, and thus started to accumulate on the river's mouth. The Mississippi's repeated seizing, and then releasing of the steepest gradient toward the sea resulted in no one accumulation at one mouth, but a series of widely divergent sources. These deltaic complexes, containing numerous sub-deltaic lobes, roamed an area two hundred miles west-to-east and one hundred miles north-to-south over the course of millennia. Places far as coastal Vermilion Parish and as far east as the waters off Biloxi, Mississippi, were influenced by the outflow of vast quantities of fresh, muddy water. It is from these recent geological events that we mark geological time in southeastern Louisiana. Even though the underlying Pleistocene and Holocene formations are much older, the topographic surface, arable soils, and coastline came about only as this recent alluvium began to amass.

To the French geographer Elisée Reclus (1855), the deltaic portion of the lower Mississippi River resembled "a gigantic hand projecting into the sea as it spreading its fingers on the surface of the water."11 American geographer John McPhee described the lowmost river as jumping "here and there within an arc about two hundred miles wide, like a pianist playing with one hand—frequently and radically changing course, surging over the left or the right bank to pop off in utterly new directions."12 Geologists have, since the 1930s, generally agreed upon where this "hand" landed over the millennia, though its exact extent, movements, eras, and "fingers" (lobes) have been debated and refined. In the 1950s, geologists R.J. Russell and H.N. Fisk identified six deltaic complexes and subdivided them into a number of sub-deltas. In 1958, C.R. Kolb and J.R. Van Lopik updated these findings with seven deltaic complexes of the Mississippi River, assigning the new names, and mapped them as distinctive lopolith-like lobes. The general consensus at this point was that the complex-and the stage of southeastern Louisiana-spanned roughly the last 5,000 years.

According to the 1958 study, New Orleans proper was first directly coasted by Mississippi sediments by the Cocodrie Delta, starting about 5,000 years ago, then by the St. Bernard Delta. Sediments also layered the future New Orleans area during the years of the Plaquemines and Balize deltas, not because the Mississippi deposited there but because, during high water, it overflowed levee banks and deposited sediments upon it.

The influential research of Kolb and Van Lopik is still widely accepted today. In 1967, the understanding of delta complexes was further modified by David E. Frazier, based on radiocarbon dating and other new technologies. Frazier identified five delta complexes of the Mississippi River, subdividing them into sixteen deltaic lobes, determined that many functioned contemporaneously, and estimated that the entire land-building event transpired over 7,200 years. Other researchers have since added to the body of knowledge on the origins of southeastern Louisiana, but according to Saucier, "Frazier's work remains the most definitive to date."13

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*a* Ibid., 1:277. See also graph of historic sea level variations on page 49.


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**For the early Holocene period, the three principal delta complexes were: (1) the Plaquemines Delta, the oldest, extending from the Atchafalaya River, north to the mouth of the Mississippi River; (2) the Balize Delta, extending from the Plaquemines Delta north to the Gulf of Mexico; and (3) the Atchafalaya Delta, extending from the mouth of the Mississippi River, north to the mouth of the Atchafalaya River.**

**For the Middle Holocene period, the four principal delta complexes were: (1) the Plaquemines Delta; (2) the Balize Delta; (3) the Atchafalaya Delta; and (4) the Lower Plaquemines Delta, extending from the mouth of the Mississippi River to the Gulf of Mexico.**

**For the Late Holocene period, the five principal delta complexes were: (1) the Plaquemines Delta; (2) the Balize Delta; (3) the Atchafalaya Delta; (4) the Lower Plaquemines Delta; and (5) the Upper Plaquemines Delta.**

**Geological New Orleans**

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**Deltas of the Mississippi River,**

**According to Kolb and Van Lopik (1958)**

<table>
<thead>
<tr>
<th>Name of Delta Complexes</th>
<th>Years Ago</th>
<th>General Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salé-Cypremort Delta</td>
<td>5,000-4,500</td>
<td>Atchafalaya Bay, around Franklin</td>
</tr>
<tr>
<td>Cocodrie Delta</td>
<td>4,500-3,500</td>
<td>St. John, St. Charles, Jefferson, and Orleans parishes</td>
</tr>
<tr>
<td>Teche Delta</td>
<td>3,500-2,500</td>
<td>Terrebonne Parish, around Houma</td>
</tr>
<tr>
<td>St. Bernard Delta</td>
<td>2,600-1,500</td>
<td>Orleans and St. Bernard parishes</td>
</tr>
<tr>
<td>Lafitte Delta</td>
<td>1,500-700</td>
<td>Terrebonne and Lafourche parishes</td>
</tr>
<tr>
<td>Plaquemines Delta</td>
<td>1,200-500</td>
<td>Upper Plaquemines Parish, from English Cove to Empire</td>
</tr>
<tr>
<td>St. John the Baptist</td>
<td>500-300</td>
<td>Lower Plaquemines Parish, below Venice</td>
</tr>
</tbody>
</table>

---

**Deltas of the Mississippi River,**

**According to Frazier (1967) and Others**

<table>
<thead>
<tr>
<th>Name of Delta Complexes</th>
<th>Years Ago</th>
<th>General Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Shoal Complex</td>
<td>Possibly 9,000-8,000</td>
<td>Deltaic shoreline now submerged in Gulf of Mexico south of Terrebonne Parish</td>
</tr>
<tr>
<td>Maringouin Complex*</td>
<td>7,300-6,200</td>
<td>Expansive delta reaching fifty miles off present-day coast of south central Louisiana</td>
</tr>
<tr>
<td>Teche Complex*</td>
<td>500-300</td>
<td>Smaller complex in the Vermilion Bay-Morgan City area</td>
</tr>
</tbody>
</table>

---

**Saucier, Geology and Quaternary Geology, 1:276.**
According to Frazier’s assessment, the New Orleans region is primarily a product of the St. Bernard and Plaquemines deltaic complexes, starting at least 4,300 years ago—a time frame which agrees with earlier research. The soil, topographical, and hydrological features formed by these complexes would profoundly affect the historical geography of New Orleans, and are discussed in detail in the following chapters and referenced throughout this book.

New Orleans, then, stands not on ancient, solid North America but on a thin, soft alluvial “doormat” cast recently out upon the continent’s margin. Not only is New Orleans’ underlying terrain the youngest of any major American city, but southeastern Louisiana is the youngest region of its size in the nation, and the entire lower Mississippi Valley, from Cairo to the sea, comprises the continent’s youngest surface soils. By the time of French exploration, around 1700, most of the landscape of southeast Louisiana and New Orleans had reached a stage recognizable today. The passes, bays, bayous, lakes, natural levees and backswamps which currently grace our maps, with colonial-era names, were in place and known well by the Native Americans, and later, greatly valued by the likes of Iberville and Bienville. These features, at the dawn of the colonial era, were still geologically alive and shifting, still obeying no law but gravity, still controlled only by the forces of nature. The Mississippi River periodically spilled over its banks and redistributed the backswamp with new sediments; enough river flow still flowed toward the old Lafourche Delta to inspire Iberville to name it “the fork”; and the Bayou Manchac distributary still injected fresh muddy river water into the region once similarly nourished by the old St. Bernard Delta. Over the next 300 years, man would seize this malleable geology and re-form it to improve the safety and circumstances for the time frame in which he lives: the moment and the immediate future. Artificial levees ensure that the river no longer overflows; the distributaries are sealed off; a similar reason the backswamps are drained and scored with canals; and the Mississippi is controlled by the Old River Control Structure from seizing the steeper grade to the sea via the Atchafalaya River. Here, like few other places in the world, man has intervened in geological processes and wrested control of them, allowing New Orleanians to grow and prosper with far fewer natural disasters than an uncontrolled nature might have wrought. The long-term consequences of this intervention, however, are perfectly bleak. But more on this later. For now, suffice it to say that the major natural geological processes which formed the New Orleans region are on hiatus, currently controlled by the hands of man. Their resumption is not a question of if, but when, and we can only ponder what 30° North, 90° West will look like then.
Surficial geology of southeastern Louisiana, compared to satellite image of same area. Map by author based on data prepared by Louisiana Geological Survey and LSU Geography and Anthropology/CADGIS Lab.
**Pedological New Orleans**

*Gentilly muck. Westwego Clay. Sticky gumbo.* Terms like these are used by pedologists to describe the soils of New Orleans, which, like many phenomena here, are exceptional to the national norm and influential, as a sort of stealth factor, to the development of the city. New Orleans’ soils are salient for a number of reasons. First, like the human population, every particle here is an “immigrant” to this deltaic plain, arriving episodically over five millennia and as recently as the mid-nineteenth century, not to mention those imported artificially today. Second, given the wide range of soil types and classes found across North America, these soils are drawn entirely from one extreme: only the very finest sediments settle here. Third, considering the many human uses of soil, from agriculture to urbanization, New Orleans’ soils again occupy the extremes. This (rather than, say, another half) are outstanding for cultivation, but outstandingly poor for urban development (especially the other half). Fourth, soils here do not adequately fit the narrow definition of soil—gathered materials at the Earth’s surface—in favor of a broader interpretation: “a natural body composed of minerals, organic compounds, living organisms, air and water in interactive combinations produced by physical, chemical, and biological processes.” Finally, humans in New Orleans have both adapted to and altered the soils of this region—deltaic soils are much more vulnerable to transformation with even minor intervention—such that Crescent City soils today are a product of both nature and man.

**Soil Formation**

Every natural soil particle on or near New Orleans’ land surface is a recent import to the region, originating anywhere from New York to New Mexico, from Alberta to Alabama, delivered to the Crescent City by the Mississippi River and its tributaries within the past few thousand years. The particles, as they start their journey, erode from parent material by water, ice, wind, or chemical reaction, and vary greatly in composition and size. A few exceed 75 mm in diameter (stones) and tumble with the current in the uppermost tributaries of the Mississippi, such as the Yellowstone River in the Wyoming Rockies or the Mississippi headwaters in the forests of Minnesota. Other particles measure 75 mm to 0.05 mm in size, called gravel and fine sand, respectively. Further still, the finest particles, less than 0.002 mm in diameter, dominate the sediments borne by the lower stretches of the Mississippi, and spill out upon gulf waters and the Continental Shelf in vast quantities. Only the finest, lightest sediment particles survive the pull of gravity and make it to the New Orleans region, which stands 96 percent of the way down the 2,340-mile Mississippi River. Any particle in southeastern Louisiana coarser than a few millimeters was imported by humans. “An alluvial soil cannot be supposed to abound in rock,” wrote Maj. Amos

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15 Derived from the Greek *pedon* (meaning ground, soil, earth), the term pedology can mean both the study of child development and education, or the scientific study of soils.
Physical Geographies

Stoddard in his 1812 description of Louisiana. "Neither on the island of Orleans, nor along the immense flat country on the west side of the Mississippi...is even a single pebble to be found."17 So devoid is the city of stones that the New Orleans Geological Society's walking tour of downtown is devoted entirely to the building stones used in prominent edifices, quarried "from scores of places...of the world" and bearing "interesting stories to tell anyone willing to listen."18 The sediment particles beneath those edifices testify to the sheer magnitude of the Mississippi River system, and New Orleans' position at its extreme terminus. They too have interesting stories to tell.

When, historically, the Mississippi seasonally overflowed its banks, the crested water carried only the finest, lighter portion of that already well-sieved selection of sediments into the land surface. These particles did not settle quickly but were sorted by gravity according to their size. The coarsest particles settled first, immediately after the river spilled beyond its channel and suddenly slowed its speed upon the banks. First in line for sediment deposition from floods of any size, these “natural levees” built up fastest and are now the highest and best-drained features in the deltaic plain. Natural levees in New Orleans comprise varying amounts of sand, lots of silt, and some clay, while they are not predominantly sand, they are sandier than most other regional soils. As floodwaters flowed backward off the natural levee, finer particles traveled with them until they too settled, anywhere from a few score to a few thousand feet from the river. Their deposition formed the backslope of the natural levee, comprising almost no sand, a fair portion of clay, and large quantities of silt. Most clay particles, finest in diameter and lightest in weight, generally settled when the floodwaters had run their course and accumulated in lowest spots farthest from the river: the backswamp.

Soil Transformation

Gravity, then, determines which particles reach the deltaic plain, which spill over the riverbank during floods, and how they sort topographically once deposited on the land surface. These assorted sediments then undergo processes of formation and transformation, making them truly local and unique to the region. Five factors guide these ongoing processes:19

Climate — New Orleans' brief, mild winters and long, hot summers accelerate soil transformation primarily by speeding the decomposition of vegetation. The region's semitropical levels of humidity and rainfall saturate its soils, though not all areas are affected equally (see Topography, below) nor react the same (see Organisms, below).

Organisms — Living organisms alter soils by changing their structure, porosity, and ultimate composition. Plants cycle nutrients from lower layers to the surface, while their roots stir and rearrange layers. Most significantly, when they die, their organic matter is decomposed by other organisms—bacteria, fungi, animals—integrating it back into the soil to be mixed and cycled by other plants. So thick is organic matter predominately where water accumulates (see Topography) and saturates (see Particles). Organic matter buried in New Orleans soils may range from dead leaves and grasses to enormous cypress trunks and stumps—some mysterically cut, as if by a saw, lying twenty to forty feet below street level.20 So thick were

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17 Major Amos Stoddard, Sketches, Historical and Descriptive of Louisiana (Philadelphia, PA, 1812), 175.
20 Works Progress Administration, Some Data in Regard to Foundations in New Orleans and Vicinity, 3.
layers of buried trees when the foundations for the gas works were excavated in the 1830s and 1840s, contractors had to replace their Irish ditch-diggers with 150 “well-practised axe-men from Kentucky” to chop through what they calculated to be eight centuries’ worth of cypress timber.

**Particles** — The parent material from which sediments eroded affects the mineralogy, chemistry, color, and other aspects of local soils. Equally significant is the soil’s “texture,” that is, its varying percentage of gradations of sand, silt, and clay. In general, the coarser the texture of soils (mostly sand, some silt, little clay), the more air spaces among the particles allowing water to filter through, which in turn allows organic matter to decompose faster. The finer the texture (mostly clay, some silt, little sand), the fewer air pockets, forcing water to accumulate on top and slowly (if at all) percolate through. Puddled water prevents “the complete oxidation and decomposition of the plant residue,” making clayey soils rich in both water and organic matter.

**Topography** — The lay and shape of the land directs the flow of rainfall and floodwater from the higher, coarser-grained soils of the natural levee toward the lower, finer-grained soils of the backswamp, where they accumulate as swamps or back bays. In doing so, topography sorts particle sizes and plays a role in its own destiny. Explained Major Stoddard in 1812,

> That the banks of the river are much more elevated than the circumjacent country... is occasioned by a more copious deposition along the margin of the river, a distance from them. These are thickly covered with grass, and a vast variety of ligneous plants, which serve to filter the waters in their progress to the low grounds and swamps... Hence the lands along the banks...are excellent for tillage; while the whole surface in the rear of them, extending to the sea, is alternately covered by lakes and impassable swamps.23

**Time** — The temporal factor in soil formation allows the above factors to take effect, eventually producing soil “horizons,” or layers, of distinct characteristics. Enough time has elapsed in deltaic New Orleans for distinct horizons to develop, with the exception of the natural levees, which have weakly developed “A” and “B” horizons. But this is not to say that the soils of New Orleans are not stratified: dozens of strata, ranging from clays of various colors to sands of different mixtures to water, humus, and stumps, comprise profiles one hundred to two hundred feet deep throughout the city.24 Additionally, nearly three hundred years of human occupation have added artificial fill to the data, creating a historical-geological profile dramatically visible to pedestrians whenever French Quarter streets are opened up for sewer work. There, beneath the asphalt, lies a layer or two of recent concrete, followed by one of early twentieth-century paving stones; then by increasingly fascinating layers of massive old bricks and ancient orange-colored brick fragments, dating to the nineteenth and eighteenth centuries. When the foundation for Charity Hospital was excavated in the 1930s, the underlying strata limned a timeline of local human and geological history:

> The light upper stratum is artificial filling, such as earth, cinders, brick, etc., that extends to a depth of about 4 feet. The second stratum is about 6 feet thick and is almost pure river silt, evidently deposited many years ago by overflow from the Mississippi River... the third stratum is about 8 or 10 feet thick and can be distinguished by its dark color... composed almost entirely of lake, roots, and humus... Below this is river...
The Pine Island Trend, a buried barrier island, may have influenced the routes of distributaries of the Mississippi (and perhaps the river itself) as they first flowed through the area. Its compacted sands offer a stable foundation for large engineering projects such as Interstate 10, which follows the trend in eastern New Orleans. In certain low-lying lakeside neighborhoods, the relict feature comes close to the topographic surface, and sometimes even breaks it. One extraordinary example, arguably the only part of New Orleans’ natural land surface formed by the Mississippi River (but rather by the Pearl), is part of a series of oak-covered “islands” (inset) with a long history of original use. Map and GIS processing by author based on data from the University of New Orleans, Louisiana State University, and Natural Resource Conservation Service.

The Pine Island Trend Beneath Modern New Orleans

- 0 feet below surface
- 30 feet below surface
- Scale of Main Image

Site analysis and at about 18 to 20 feet below ground surface…

...ground water or permanent line of saturation is reached. 

NEW SOILS ENVIRONMENT

Consider, then, how man has altered New Orleans’ soils. First and foremost, he has artificially augmented the natural levees of the Mississippi River and severed the river’s distributaries, depriving the landscape of replenishing sediments in exchange for protection from floods. New Orleans has not been significantly doused by new riverine sediments since the days of the last levee crevasses, well over a century ago. Man has also altered the hydrology of the region by draining the backswamp soils of their water content and clearing their forest and marsh, which eliminated organic matter from the surface and from soil-transformation processes, leaving soils to compact and subside. To counter the shrinkage, man has imported foreign soils, fill, shells, riprap, gravel, and rocks to the land’s surface, building up some areas and excavating others for canals and drainage. He has also dredged material from Lake Pontchartrain and appended it to the lakefront and man-made navigational canals. Europeans introduced, accidentally and intentionally, biota not native to these environments, from fire ants to Formosan termites to water hyacinth to banana trees—all of which ultimately affected soils. Finally, he has paved over the natural soil surfaces, severing them from the atmosphere while concentrating runoff into man-made drainage systems. As a result, the soil composition of Orleans Parish’s 127,360 terrestrial acres has been significantly altered by anthropogenic activity, primarily through flood control, drainage, reforestation, and paving. Man has created a new soils environment in New Orleans, a massive transformation often overlooked for its more visible impacts on the skyline, the river, and the coast. The alteration of the natural environment is, of course, existentially integral to any city. Deleterious affects of these actions (primarily subsidence and erosion), and the challenges of eliminating or at least minimizing them, are the expected societal costs that necessarily accompany the benefits of urbanization.

Europeans started altering soil processes with the clearing of the Bayou St. John area (1708), French Quarter site (1718), erection of the first levees (1719), and continuing thenceforth. But aboriginal populations also played an earlier role in transforming soils, albeit on a drastically smaller scale. One example involves a series of Tchefuncte Indian sites in the marshes of Eastern Orleans Parish, known as Little Woods,  

Ibid., 10 of 1939 addendum.
Little Oak, and Big Oak Island. Structurally, these sites are mounds of *Rangia* clams, bone, and other debris; functionally, they probably served as ceremonial centers, living spaces, or mounds (refuse heaps), dating from roughly 500 B.C. to 200 A.D., when they were much closer to the Lake Pontchartrain shore. The relationship between these archeological sites and the underlying Pine Island Tend is unclear; perhaps they were modifications of the crest of this ancient barrier island. Geologic maps depict the subterranean Pine Island Tend as just barely breaking the surface of the earth near the archeological sites, like the ridged back of an alligator emerging from the swampwater. As high as fifteen feet above the marshes and hundreds of feet long, the “islands” have been anthropically occupied by Natives, hunters, and trappers, practically in modern times. These midden deposits accumulated over different time spans, some short, some long; all had one common result—vertical buildup of sites above sea level,” wrote archeologist T. R. Kidder. As a result, these early man-influenced soils were better drained and fostered the growth of vegetation normally associated with natural levees, such as oaks, cypress, hackberry, and willow. “The planned and unplanned shell accumulation formed an entirely new ecozone in the marsh,” which, coupled with a new hydrology, further transformed these soils. Today, these sites, currently under study by the University of New Orleans, form pedological aberrations in the sea-level muck, saline grasses, and brackish water of eastern Orleans Parish. A 1989 soil survey by the Department of Agriculture designated Big Oak Island as a Commerce silty clay loam, a natural levee soil as out-of-place in the eastern marshes as an iceberg in the Gulf of Mexico.

**Soils of New Orleans**

One early effort to map the soils of the New Orleans region was conducted in 1903 by Thomas D. Rice and Lewis Griswold of the Department of Agriculture’s now-defunct Bureau of Soils. The map, produced at a scale of one inch to one mile (1:62,500), shows highly generalized soil patterns. Of course, soils form no such clear-cut units that their characteristics change gradually, and their components vary slightly in their relative proportions, as one moves across the landscape. Pedologists extract soil samples in a systematic fashion, analyze them, and judge where one soil class transitions to another, a process that involves some subjective judgment and may be better depicted cartographically as a “fuzzy” border rather than a hard line. The following descriptions of New Orleans soils are actual scientific data (river’s natural levees), Yazoo loam (distributaries’ natural levees), Yazoo clay (back slopes of natural levees), Sharkey clay (backslopes), and St. John (lakeside marshes). Much more detailed efforts were made by the department’s Soil Conservation Service, cataloging with a 1:20,000 survey and analysis, the *Soil Survey of Orleans Parish, Louisiana* researched in 1986 and published in 1989. Like most soils maps, the 1989 survey depicts soil pods within the urbanized area as discrete polygons with hard edges in precise locations. Of course, soils form no such clear-cut spatial units; their characteristics are better described cartographically as a “fuzzy” border rather than a hard line. The following descriptions of New Orleans soils are actual scientific data...
soil types, listed in order of historical influence, are drawn from this 1989 survey.29

**Commerce Silt Loam** (4,560 acres; 3.6 percent of terrestrial Orleans Parish)

**Characteristics**: A relatively well-drained soil comprising roughly equal parts of sand, silt, and clay, with little organic content. This dark, fertile soil is found exclusively on high natural levees.

**Range**: Historic neighborhoods on the crest of natural levees of Mississippi River and distributaries, including riverside portions of uptown to Bywater to French Quarter to Holy Cross; Algiers Point to Lower Coast; City Park Avenue to Bayou St. John/Fairgrounds; Gentilly Boulevard and portions of Esplanade Ridge.

**Historical Influences**: Highest historical influence: excellent for plantation agriculture and pasture; best locally available soil for urban development. Historic New Orleans and its adjacent plantations were largely based upon these soils.

**Anthropogenic Change**: Originally forested, these soils have been mostly cleared since the early eighteenth century and fully urbanized since the late nineteenth century. Lower Coast of Algiers and live oak grove in lower City Park represent last forested portions of this valuable soil.

**Commerce Silty Clay Loam** (2,153 acres; 1.7 percent)

**Characteristics**: This dark, fertile soil is a slightly finer-textured variation of Commerce silt loam, found on the backslope of the natural levees of the river and the old Metairie/Gentilly distributaries.

**Range**: Carrollton, lower City Park, parts of Gentilly and Esplanade Ridge, rear of French Quarter, Holy Cross, Algiers and Lower Coast, plus Big Oak Island and other archeological sites in eastern marshes.

**Historical Influences**: High historical influence: very good for agriculture, relatively sound for urban development, compared to alternatives.

**Anthropogenic Change**: Cleared of their original forest and mostly urbanized.

**Sharkey Silty Clay Loam** (1,006 acres; 0.8 percent)

**Characteristics**: Finer in texture than the Commerce series, this dark, fertile soil is found on the backslope of some river natural levees, and on the crest of meager natural levees on small waterways.

**Range**: Portions of French Quarter, through St. Roch and Bywater to Lower Ninth Ward; minor natural levees following Bayou Sauvage and Trace Bayou in eastern marshes.

**Historical Influences**: Historically significant: these soils lined the former “back-of-town,” where the city interfaced with swamps. Good for agriculture and fair for urban development (relatively speaking), though less so on both accounts than Commerce series.

**Anthropogenic Change**: Pods in downtown are fully urbanized, but small pods in the eastern marshes remain close to their original state.

**Sharkey Clay** (22,549 acres; 17.7 percent)

**Characteristics**: This soil is a slightly finer-textured variation of Sharkey silt clay loam, found in a much more expansive distribution.

**Range**: Covers extreme rear of natural levees and into former backswamp throughout heart of city; extends through Gentilly Boulevard to Bayou Sauvage as well as Lower Coast of Algiers.

**Historical Influences**: Historically influential, forming middle and rear sections of most antebellum sugar planta-
Pedological New Orleans

Anthropogenic Change: Almost all zones, with the exception of Bayou Sauvage, have been deforested, drained, and developed most, experience varying levels of subsidence.

**Frequently Flooded Commerce and Sharkey Soils** (602 acres; 0.5 percent)

Characteristics: Mix of sediments deposited by wind on the batture, sometimes comprising significant amounts of coarse sand particles as well as driftwood and debris. Frequently flooded depending on stage of river.

Range: Battures along riverside of Carrollton, Audubon Park, McDonogh, Algiers Point, and along Lower Coast of Algiers to Twelve Mile Point (I-55 South Turn).

Historical Influences: Historically important, but for unusual reasons: the batture is a large area of non-urbanized land, sometimes comprising such large areas that it is difficult to incorporate them into the urbanized area. Today, this soil type is limited to narrow areas surrounded by large, immediate riverbanks.

**Anthropogenic Change:** These soils are among the last examples of natural sediments deposition in New Orleans, due to the rapid urban development. They are often forested with willow trees. Older pods have since been developed into urban development (example: Warehouse District).

**HARAHAN CLAY** (13,347 acres; 10.5 percent)

Characteristics: A gray-to-black colored clay found in formerly forested backswamps, where backswamps of natural levees fall below sea level. This clay is finer in texture, higher in organic matter, poorly drained, and less adequate for agriculture and development than all Commerce and Sharkey soils.

Range: Sections of Lakeview and City Park, Hollygrove to Broadmoor, Central City and rear of CBD, Tremé through Irish Channel to Lower Ninth Ward; East Forest East and other eastern subdivisions; parts of Algiers.

Historical Influences: Less historical influence: this backswamp soil made up areas at or beyond the rear edge of longlot plantations, and were not urbanized until the early twentieth century, after the drainage system was installed.

**Anthropogenic Change:** Mostly cleared of forest, drained, filled in, and paved over. Some Harahan clays are still forested, particularly along Mississippi River-Gulf Outlet Canal.

**DRAINED KENNER MUCK** (4,446 acres; 3.5 percent)

Characteristics: Similar to Harahan Clay, but associated with freshwater marshes rather than dense forested wetlands and even less suitable for agriculture and urban development.

Range: Lyceum, Lakeview and City Park, and in the expansive, forested areas east and north of Michoud.

Historical Influences: Little historical significance. These soils comprised the Lake Pontchartrain shore prior to the 1920s Lakefront land reclamation project.

**Anthropogenic Change:** Developed areas are highly altered by drainage. Lakefront areas, fill, and residential urbanization; undeveloped areas are close to their natural state.

**CLOVELLY MUCC** (16,175 acres; 20.6 percent)

Characteristics: Very fluid, mucky clay soil with high quantities of organic material and saline water, found in thousands of acres of not-undeveloped brackish marsh.

Range: Eastern marshes along the Intracoastal Waterway, Chef Menteur, Pass and Rigolets, on Point aux Herbes peninsula, along Lake Borgne shore near Bayou Bienvenue outlet.

Historical Influences: Little historical influence.

**Anthropogenic Change:** Still bear their natural vegetation cover, but often subject to erosion, increasing salinity, and non-native plants.

**LAFITTE MUCK** (19,222 acres; 15.1 percent)

Characteristics: Similar to Kenner and Clovelly mucks; generally associated with saline marshes.

Range: Eastern marshes, particularly Point aux Herbes peninsula; Chef Menteur, Pass, Bayou Bienvenue area, and Lake Borgne shore.

Historical Influences: Little historical significance.

**Anthropogenic Change:** Mostly in their natural state, but highly prone to erosion and increasing salinity.

**DREDGED AQUENTS** (7,114 acres; 5.9 percent)

Characteristics: Dredged material from adjacent lakes and waterways, deposited to hard land or excavating navigation canals. Some areas are developed with residential neighborhoods, others are undeveloped.

Range: Found all along the front, from West End, Carriageway Boulevard; Jourdan Road Terminal and along MR-GO; Irish Channel, Point aux Herbes; Michoud area; Venetian Isles, Bayou Sauvage area, and Rigolets.

**Historical Influences:** No historical influence, beyond that of specific engineering projects.

**Anthropogenic Change:** Entirely a product of anthropogenic activity.

**FREQUENTLY FLOODDOM DREDGED AQUENTS** (8,148 acres; 6.6 percent)

Characteristics: Same as dredged aquents, except more flood-prone for their proximity to waterbodies. Often strewn with clam and oyster shells.

Range: Found at the interface of man-made lands with adjoining water bodies: West End Park, Lakeshore Drive along lakefront, former Pontchartrain Beach, land paralleling Industrial Canal, MR-GO, and Intracoastal Waterway; also Michoud, Venetian Isles and Point aux Herbes.

**Historical Influences:** No historical influence.

**Anthropogenic Change:** Entirely a product of anthropogenic activity.
Drained Allemands Muck (5,885 acres; 4.6 percent)

Characteristics: A clay soil with high organic and water content, found in low-lying former freshwater marshes located on the Metairie/Gentilly Ridge.

Range: Lakeside neighborhoods and eastern marshes near Harri son Avenue corridor through West End and Lakeshore across central City Park, through Film Row, St. Anthony Village, Pontchartrain Park, Lake Kenilworth, and Lake Forest East; and in eastern marshes near Michoud.

Historical Influences: Little historical influence; too wet and fine-grained for plantation agriculture, too flood-prone for urban development, until the twentieth century.

Anthropogenic Change: A municipal drainage system opened up these soils to urbanization; drained areas now often covered with one to two feet of artifical fill. Urbanized soils are susceptible to subsidence; undeveloped pods in eastern marshes are prone to salt-water intrusion and erosion.

Westwego Clay (4,930 acres; 3.9 percent)

Characteristics: Dark gray clay found in former and present-day swamps, with a fair amount of organic matter.

Range: South Point area of Point aux Herbes peninsula; Beauman, St. Estel, and St. Mildred Aurora neighborhoods on the west bank.

Historical Influences: Historically unimportant.

Anthropogenic Change: Cleared, drained, and urbanized on the West Bank; still in natural state in eastern marshes.

Gentilly Muck (4,148 acres; 3.3 percent)

Characteristics: A dark fluid, mucky clay found in brackish marshes, almost continuously flooded.

Range: Throughout eastern marshes, particularly paralleling slow-moving bayous, inlets, and lake shores.

Historical Influences: No historical significance.

Anthropogenic Change: Still bears natural vegetative cover, but often subject to erosion and increasing salinity.

From the above soil classes, the following "superlatives" may be identified for New Orleans soils:

Best Soil to Build Upon: Commerce soils (superior only when compared to the other alternatives).

Best Soil to Farm: Commerce and Sharkey series: fertile, well drained, and well textured.

Worst Soils to Farm or Build Upon: Gentilly, Clovelly, and Lafitte mucks: very ill-drained, clayey, and saline.

Youngest Soils: Frequently flooded Commerce/Sharkey soil with deposits of the river along the batture.

Highest Soils: Commerce silty loam, on the crest of the natural levee.

Lowest Soils: Harahan clay, in the drained and subsiding marshes near the Lake Pontchartrain inlet.

Coarsest Soils: Frequently flooded Commerce/Sharkey soils, in batture areas, containing the most sand.

Finest Soils: Gentilly, Clovelly, and Lafitte mucks, farthest from the river and containing the most clay.

Most Saline Soils: Lafitte muck, near the brackish water lakes.

Most Organic Soils: Allemands muck, in the backswamp.

Most Vulnerable to Subsidence: Kenner and Lafitte muck in theory; actually according to field data (average of 5.9 millimeters per year subsidence).

Highest Water Table: Gentilly, Clovelly, and Lafitte mucks.

Most Common Soil in Orleans Parish: Allemands muck.

Rarest Natural Soil in Orleans Parish: Frequently flooded Commerce/Sharkey soils (batture soil).

Soils Currently Closest to Prehistoric State: Gentilly, Clovelly, and Lafitte mucks.

Altered Soils: Aquets dredged from the bottom of the Pontchartrain for the Lakefront project.

Most Extraordinary Soil Pod: Two small pods of Commerce silty clay loam located in the eastern marshes, far from all other Commerce soils of the natural levee.

Soils and History in New Orleans

Two general rules relate the soils of New Orleans to the city's historical geography. The closer the soil pod is to the river (or its distributaries), the closer the soil texture, the higher the elevation (the lower the organic matter and water table), the less salty in the soil, the less likely the soil was drained after the installation of the drainage system around 1900. The more likely it is that the area once hosted plantations, the more likely it was urbanized after the installation of the drainage system around 1900. The more likely it has subsided significantly, the more vulnerable it is to flooding, and the more likely it exhibits twentieth-century suburban architecture. Most of what people perceive as "classic New Orleans" stands on these soils.

The farther the soil pod is from the river (or its distributaries), the farther the soil texture, the lower the elevation, the higher the elevation of the soil, the more distant the area once hosted plantations, the more likely it was urbanized after the installation of the drainage system around 1900, the more likely it has subsided significantly, the more vulnerable it is to flooding, and the more likely it exhibits twentieth-century suburban architecture. Most modern suburban-style neighborhoods stand on these soils.

New Orleans' physical geography were compared to a painting, the river would serve as artist, gravity as inspiration, water as brush, and soil as paint. Man has since assumed the role of artist, tinkering with the textures, depths, water content, color, and other attributes of this most fundamental environmental element. Beneath that recently altered surface lies soils laid out naturally over millennia by the Mississippi, which remain deeply essential to the history and engineering of the city. Soils played an unwritten role in the siting of

the city, its spread and development, the adjacent agricultural enterprises upon which it depended, and the natural threats it combated. Soils have also indirectly influenced the architectural character of New Orleans’ neighborhoods (a function of age, in turn a function of soils), the radiating layout of its street network (based on delineation of longlot plantations, also related to soil patterns), and the location of present-day infrastructure, from interstates to skyscrapers to tourism. These idiosyncratic deltaic soils—covered over and trod upon unrecognized; excavated, rearranged, and accumulated; drained by canals and penetrated by pilings—are a stealth factor in the historical geography of New Orleans.

Epilogue: Soils played a stealth factor in the Hurricane Katrina catastrophe as well. The New Orleans area was not below sea level in colonial times; rather, it traced a gradual slope from about ten feet above sea level near the river to zero to one foot at the lake. That New Orleans today is bowl-shaped and half below sea level is a result of soil subsidence induced by levee construction on the Mississippi and drainage of the backswamp. Soils also played a direct role in the failure of the levees: while initial assessments held that overtopping of the floodwalls caused the breaches, engineers later determined that heavy water pressure on a porous layer beneath the sheet piles allowed seepage to undermine the levees from below. Alarmingly, other soil pods of peat may compromise sections of levees system-wide. The good news is that subsurface soil features such as the Pine Island Trend and the suballuvial surface may offer certain flood-control solutions: one-hundred-foot-long concrete pilings used for skyscrapers may be driven into these sturdy features to support massive new flood-control structures, such as the sort of floodgates and seawalls in the Netherlands.
**Topographic New Orleans**

Topographic elevation is both father and son—producer and reflector, cause and effect—of the geology, pedology, hydrology, and biology of the New Orleans region. As such, it is one of the most influential physical substances underlying the nature and development of Crescent City. Some may find this surprising: New Orleans is as everybody knows, famously, comically, and absolutely flat. It is a city in which most people are taught that a manmade mound named Monkey Hill, built in Audubon Zoo for children to play on, is the highest point in the city. And this is, after all, a city in which that notion is not far off from the truth.31 But such impressions of utter flatness derive from countless comparisons to distant places: be it the bluffs of Baton Rouge or the ramparts of the Rockies, the problem is, if the subject is New Orleans, then the distant places with all their undulation, may as well be on Mars. No one would dismiss an oasis in a desert solely because deserts lack the water of a rain forest; likewise, topographic elevation is relevant in a deltaic urban environment like New Orleans because it is desperately needed and exceedingly scarce, and thus is as valuable for protection against the accumulation of water. New Orleans is not flat, not in an absolute sense and especially not in a relative sense. Its topographic surface saddles the level of the sea, with twenty-five to forty vertical feet separating highest and lowest areas. Not much, one may say, but enough to guide whether urban development would take place in the Age of Napoleon or in the Age of Jazz, around the Civil War or around the Cold War—and this between neighborhoods barely a mile apart. Topography in New Orleans underscores the presence of an elegant 1850s townhouse with a central staircase and gallery, versus a 1950s suburban ranch house with a deck and a two-car garage. Topography helps explain why most older streets follow the ancient pattern of the arpent land surveying system, and most recent streets form planned, orthogonal grids. Topography, in short, reflects the difference between old New Orleans—built when humans had to adapt their needs to the environment—and new New Orleans, constructed when humans gained the technology to adapt the environment to their needs. In a deltaic plain, where water threatens human settlement, even as it gains them, a few feet or even inches of topographic elevation may spell the difference between the livable and the uninhabitable, between city and wilderness, between life and death. Technology, in the form of modern drainage systems, has muted topographic elevation as a premier factor behind urbanization patterns, but not before New Orleans abided by this “first-tier rule,” building where New Orleanians built New Orleans32 for most two centuries, 1718 to the early 1900s.

**Measuring Elevation in Low Places**

Elevation is simply the vertical distance of the land surface above an agreed-upon zero, or vertical datum (usually, but not always, associated with the mean level of the sea). Topography is not quite as straightforward. Years ago, the word carried its literal meaning (“description of a place”), a concept that is more correctly addressed by the word *geography* (“description of the earth”). For example, population data...
published in *A Geographical Description of the United States* (1826) were entitled “Topographical Tables,” a use that makes no reference to the physical terrain so day, topography is usually used to describe the lay and shape of the land surface—not just elevation, but relief, curvature, slope, aspect, drainage patterns, and other effects. Loosely speaking, elevation is to topography what temperature is to weather. That a particular point is thirty-seven feet above sea level is elevation; that this point is mid-way up a northern-facing, 12° slope, shedding water into a particular basin and out a certain stream, is topography. In general centuries, however, the terms are often used interchangeably.

Elevations in New Orleans have been described qualitatively since the founding of the city and quantitatively since the 1870s (earlier for certain sites), using the traditional land-surveying techniques of traverse, lines, leveling, and triangulation. Field methods were supplemented with the use of stereo aerial photography and photogrammetry starting in the 1920s, enabling topographic mapping of cities and rural areas without deploying survey laws. These techniques generally measured (with increasing accuracy) the relative elevation of the New Orleans surface: how high is Coliseum Square compared to Claiborne Avenue; how much lower is Lakeview than the Garden District. Absolute elevation—that is, the height of these features above sea level, has proven more challenging. Vertical datums used in mapping the Mississippi Valley did not even refer to sea level until the 1880s, earlier surveys were in feet based on local standards such as the level of the Memphis-area flood of 1858, or the Cairo City Datum of 1871. Newly formed Mississippi River Commission (1879) tried to merge various vertical datums together to form the New Mississippian Datum of 1880; the following year, the Commission began associating this standard with the level of the Gulf of Mexico at Biloxi, forming, by 1899, a Mean Geodetic Vertical Datum (NGVD) that has been superceded by the satellite-measured North American Vertical Datum of 1988, but both systems may be encountered today, and are duly cited in the corner of most standard topographic maps. Geodesists working on engineering and military applications also base elevation/height measurements on the “ellipsoid” (a mathematical model describing the slightly oblate shape of the Earth) and on the “geoid” (a construct that accounts for gravitational pull). The height or elevation of any particular location may vary widely based on which of it is measured from the topographical, ellipsoidal, or geoidal surface.

These different standards may sound like arcane matters of concern only to mapping scientists, but they are relevant to New Orleans for a number of reasons. For one, New Orleans’ elevational range is minute that only inch counts. The land surface is also dangerously shifting, and we really do not know by how much. Sea level, meanwhile, is rising at rates faster than it has been for the past 28,000 years (measured recently at a pace of 0.24 mm/year), making New Orleans’ elevation relative to the sea—and its vulnerability to hurricane-induced storm surge—so much more of an unknown. Because some benchmarks throughout the region appear to have subsided, elevations throughout southeastern Louisiana may be inches, perhaps even feet, lower than presumed, and because relationships between antiquated vertical datums and modern ones are difficult to establish, it is difficult to determine exactly how much lands have subsided in the past century, and by much they may have. For purposes here, relative elevations are sufficient to appreciate the role of topography in the history of New Orleans, but an accurate understanding of absolute elevation—how much protection can the levees truly afford? by how much will New Orleans flood if struck by a Category 5 hurricane?—is needed to foresee the city’s future.

**Elevation Mapping in New Orleans**

Despite the dearth of lofty features, the general topographic patterns of the New Orleans area are immediately apparent to the earliest inhabitants of the region. One either traversed fairly well-drained forests on small ridges paralleling waterways, poorly drained forested wetlands (swamps), or marshes of varying degrees of salinity, and thus traveled from highest to lowest areas. Early maps depicted elevation patterns through generalized hattures or cartoonish drawings of dense canopy or murky mazes. Numerous cartographic products were published in the early to mid-nineteenth century with names such as “Topographic Map of New Orleans,” but these

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The information is a bit dated when the committee entered upon its duties, was too large, extent meagre, crude, and unprofitable. It was deemed too large a base upon it the design of so large a project as the board under consideration. Therefore another preliminary plan, a complete survey was recommended.

In addition, survey lines were laid along canals at both surface-water level and canal bottoms, and profiles were measured for about 270 street segments through the urbanized area and rural outskirts. From these traverses and triangulations, W.C. Kirkland compiled one-foot contours and plotted them upon a detail street network at a scale of one inch to six hundred feet, producing ten large linen maps under the title Topographical Map of New Orleans (1895). Because the contours are based on the Cairo Datum, which was calculated at the time as 21.26 feet above sea level, the Kirkland-Brown-D.A.B map shows elevations ranging from

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39 Ibid., 33.
thirty-seven feet (16.74 above sea level) at the foot of Canal Street to twenty feet (-1.26 below sea level) in present-day Mid-City. The cartographic information of the linen maps was used extensively in the Drainage Advisory Board's engineering design of the complex drainage systems, and was adapted as a supplement for its 1895 report to the city. This important document, representing American engineering at its best as conducted by native New Orleanians, would guide the development of one of the world's greatest urban drainage systems, still functioning today, a system which would radically augment the urban development of New Orleans. In the decades that followed, the Kirkland/Brown/D.A.B. elevation maps from 1895 were cited, copied, adapted, and modified for numerous engineering projects, by groups ranging from the Sewerage and Water Board to the Works Progress Administration, into the mid-twentieth century. The scarcity of topographic data was not peculiar to New Orleans: according to one geologist, south Louisiana in general "was one of the last major areas within the continental United States to experience detailed geological investigations," due in large part to inaccessibility. It was not until the advent of aerial photography that "accurate topographic maps of the region" were finally made.42

The advent of photogrammetry (the science of extracting measurements from stereo pairs of aerial photographs), increasingly demanding engineering requirements, and a changing urban surface antiquated the 1895 elevation map. Countless site-specific surveys have since been conducted throughout New Orleans for various projects, but detailed, comprehensive (and very costly) surveys of the entire city are few and far between. U.S. Army Engineers conducted one such survey in 1935, and contours derived from stereo aerial photographs and plotted on standard 1:24,000 USGS quadrangles provided topographic information on the city for many years, into the past decades. In 1994, the City Planning Commission contracted Vernon F. Meyer and Associates (now 3001, Inc., Louisiana-based mapping and surveying firm) to conduct a Global Positioning Systems (GPS) survey of the urbanization portion of the parish, based on second-order, class-1 survey standards using the North American Horizontal Datum of 1983-1986 and the National Geodetic Vertical Datum of 1929. Contours were compiled from these data points at the same interval as the 1895 map (one foot), but because the GPS data were much denser and far more accurate than the old manually surveyed data, the 1994 contours are extremely detailed, showing precisely every curb and bound of every block. In 2000-2003, the same company, funded by the Federal Emergency Management Agency and the state, acquired LIDAR (Light Detection and Ranging) data for the most flood-prone parishes of Louisiana, including Orleans, to produce topographic maps with unprecedented accuracy. This particular LIDAR sensor, mounted on an aircraft flying at 8,000 feet altitude, emits 15,000-30,000 laser pulses per second aimed at the target site. The exact time and direction of each pulse is recorded as it leaves the sensor and as it returns after reflecting off surface features. Because the speed of light is constant, the system is able to compute the distance to and from the target, and because a Global Positioning System (GPS) is integrated with the sensor, exact geodetic coordinates are associated with each pulse. From these raw data, analysts are later able to compute the precise longitude, latitude, and elevation of millions of points scattered irregularly upon the target area. Not just the earth’s surface but buildings, cars, vegetation, and other features are also captured, and must be removed through a post-processing algorithm to create the underlying topographic elevation. A continuous surface is then interpolated from these points,
Elevation map of New Orleans metropolitan area, measured by airborne LiDAR for terrestrial areas and waterborne SONAR instruments for water depth. Posted figures indicate feet above and below mean sea level at those points. Brown areas are below sea level. Map and GIS processing by author based on FEMA/Army Corps/Louisiana/3001Data/LSU-CADGIS data for terrestrial areas and Army Corps/USGS data for river and lake.
from which are extracted contours at intervals as detailed as six inches, or digital elevation models with five-meter-resolution pixels. The FEMA LIDAR data, shown in this chapter both with and without surface features, represents the most detailed and comprehensive elevation maps ever conducted in this region, and for the city of New Orleans. Surveying crews are capable of capturing even more detailed topographic data than remote sensing devices such as aerial cameras and LIDAR, but they are usually deployed to limited areas relevant to specific engineering projects. The LIDAR data are currently being used to update the city’s circa-1984 flood insurance maps, which in turn will affect the premiums of thousands of homeowners.

**MAJOR FEATURES OF TOPOGRAPHY IN NEW ORLEANS**

What comprises a topographic feature in the New Orleans region? If cypress trees had their say, they may bestow the status of feature upon deadly swamps, eschewing other areas as uninhabitable. If the grasses of the saline marsh were to speak, they might select their boggy sea-level terrain, relegating the uplands and inland swamps to the status of wasteland. Humans in a deltaic or alluvial environment favor the wetlands unaltered that support their physical and cultural lives, while dismissing the swamps and marshes of the inter-basin as dangerous “backsplams.” Because this was the world of the historic New Orleans—and an unchangeable one—the “topographic features” identified in this section are those that rose above the lowlands, providing passage and human space and thus influencing the development of New Orleans.

**Natural Levees of the Mississippi River** — Those lands paralleling the Mississippi River rise higher than all other natural surfaces in the delta region. They are to the New Orleans area what the Rocky Mountains are to North America: the major watershed and division of drainage basins, the regional spinal column. The French described these riverside ridges as levee (“raised up”); the adjective natural distinguishes them from the manmade embankments (artificial levees) built upon them starting in the colonial era. Natural levees form, because, as the Louisiana Geological Survey explained in 1892, with every flood, the river…overflows its flood plain and deposits much of its sediment from its head waters, with a slight increase in velocity, the transporting power [of sediment] is vastly increased. So with a slight checking of velocity occurs over the flood plain outside of the channel, but takes place in the greatest decrease in velocity takes place near the channel where the heaviest and coarsest sediments are deposited.

and in greatest quantity. The river banks are thus built higher by each flood and a system of natural levees are produced.

Natural levees in the New Orleans area usually stand about eight to fifteen feet above sea level, and slope backward from their crest at declivity of about one vertical foot for every five hundred horizontal feet, forming the backslope of the natural levee. Beyond the backslope, which typically spans around 1.5 to two miles, lies the backswarded or below the level of the sea, where the smallest amounts of the finest clay particles are deposited. Where the river is straight, natural levees tend to be more narrow, not as high, and less likely to break. In meandering sections, particularly in and below the Faubourg Marigny, the river is divided by natural levees and eliminated some swamps or isolated in the late 1800s. In others, the river has deposited sediment between the levee and the water forming a low, river side sandbar called a batture (“barren ground” by the Dutch—the opposite of levée). The best example is the batture in the area riverside of Tchoupitoulas in the Central Business District, built up by a combination of natural and manmade forces from the late 1700s to the 1840s. The “St. John Batture” has long since been incorporated into the street network and forms the Warehouse District today, an area that was in the river 280 years ago.

Artificial levees were built between or near the crest of the natural levee starting in 1796 and expanded piecemeal until after the Civil War, when river control became a federal responsibility, and particularly after the Great Flood of 1927, when levees and other flood control devices were augmented significantly. Topographically, artificial levees add fifteen to twenty-five feet to the crest of the natural levee. Paradoxically, they constrict the river to its channel and prevent it from meandering, flooding the adjacent lands. Artificial levees are further reinforced by flood walls, concrete boxes, and gates, their engineering success at keeping water out of New Orleans unintentionally deprived the land of new sediments.

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43 FEMA LIDAR, “Flood Insurance Rate Maps.”
45 Louisiana Geological Survey, Geology and Agriculture of Louisiana (Baton Rouge, 1892), 2.
ments; ironically, then, the highest topographical features in the region serve to diminish the height of the entire landscape.

Despite its significance, the natural levee is almost always imperceptible to the eye, except during heavy rainstorms, when runoff in gutters flows readily away from the river. Tchoupitoulas Street marks the crest of the natural levee through most of uptown, while North Peters, St. Sarah, and Chartres streets ride it from the French Quarter to the lower Ninth Ward, and Patterson Road marks the feature in Algiers. The natural levees and their backslopes are home to almost all of historic New Orleans, simply because these were the only drained lands available for urban development during the city's first two centuries. With two important exceptions—Bayou St. John and the Bayou Road/Esplanade Ridge—New Orleans' essentially Creole cottages and townhouses, Greek Revival houses and mansions, and monumental nineteenth-century public buildings all stand upon the natural levee of the Mississippi River. Shotgun houses, too, occur on the natural levee but prevail on the rear backslope, because the turn-of-the-century popularity occurred when drainage projects began to clean up the lowlands. The California cottages and ranch houses of the early to mid-twentieth century are more widely found well beyond the river's natural levee, because these styles post-date the circa-1900 drainage system. Architecture is correlated to topography in New Orleans almost as strongly as vegetation is to natural ecosystems. Topography also imbued New Orleans with a distinct sense of orientation. “There is...a marked difference in the 'front lands' and the 'back lands' along the river,” observed the Louisiana Geological Survey, topographically rooting notions of the “front of town” and “back of town,” still alive in the local lexicon, have deeply informed patterns of urban growth, class, race, architectural culture, and myriad other geographies.

A satellite image of the region shows the preponderance of human existence upon these few river-parallel lands in the deltaic region of Louisiana. It can almost be said that at least in terms of human geography, southeastern Louisiana is the natural levee of the lower Mississippi River area's distributaries, in the same manner that Egypt is a river and Australia a coast. The only exceptions are the drained backswamps of the New Orleans metropolitan area and its sparse infrastructure (ports, petroleum, transportation, etc.), actually built in southeastern Louisiana's swamps and marshes.

**Metairie/Gentilly Ridge** — If the natural levees of the Mississippi are the “Rocky Mountains” of New Orleans, then the Metairie/Gentilly (also called the Metairie/Sauvage) Ridge equals the Appalachians. Though only about the height and half the width of the river levees, this ridge system is significant because it is a convenient west-to-east passageway through the levees, uniting what is today the entire metropolitan area (present-day Kenner to Chef Menteur Pass). It is also the city’s most conspicuous example of an abandoned distributary, formed during the days of the St. Bernard Delta (4,300-1,000 years ago), when, unusually, the Mississippi itself followed this path, building up present-day Metairie Road, City Park Avenue, and Gentilly Boulevard before emptying into the Gulf of Mexico due east. The Pine Island Trend, a sandy shoal pushed westward by gulf currents and now buried beneath the New Orleans land surface, helped guide the path of the river and thus the formation of this ridge. Topographic uprising of this now-abandoned main channel included secure features like the Metairie Ridge (which now hosts the eponymous Metairie Business Park), “Unknown Bayou” through New Orleans and into the West Bank, and Turtle Bayou, Bayou Pecoin, Stump Bayou, Bayou de Lassaire, and Bayou Alligator in the eastern marshes, among others. Most of these features would barely influence New Orleans’ urban geography, but two, as we shall see, would play a critical role in the city’s siting.

After the Mississippi attained its present channel, it continued to feed the earlier channel through an opening in the natural levee in present-day Kenner. This distributary bore a sediment load, fed its banks, and formed its own natural levees—the same depositional processes of the Mississippi, in

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46 Ibid.

miniature. It was still a functioning distributary during New Orleans' first century and a half, when it was known as Bayou Metairie in its western stretch, Bayou Gentilly and Bayou Sauvage to the east, and Bayou Laureal connecting the two, possibly originating as a cutoff of a meander in the distributary.49 These bayous were closed off by sedimentation by the late nineteenth century; the only surviving portions include a series of ornamental lagoons in City Park (remnants of Bayou Metairie) and Bayou Sauvage in eastern New Orleans. But they had their impact on the landscape; the Metairie/Gentilly Ridge today rises two to four feet above sea level and six to ten feet above the adjacent lowlands. Its natural levees are highest and widest near the origin, Kenner by the river, and progressively thin and narrow eastward "to the levees of these two features. The connection became a portage from river to lake, and later the main transportation route (Bayou St. John, a waterway communicating with Lake Pontchartrain and thence with the Gulf of Mexico, with the Mississippi River. All other areas between Lake Pontchartrain and the Mississippi River presented impassible swamp. This meager ridge served as a critical link in the least-cost route between river and Gulf used by indigenous people and shown, then, to the early Europeans. Bienville's decision to site New Orleans next to the present-day French Quarter was largely based on the river/lake accessibility enabled by this ridge.

The Esplanade Ridge probably developed during the days of the aforementioned St. Bernard Delta, when the Mississippi River wended from present-day Kenner, through Metairie Road, Gentilly Boulevard, and Chef Menteur Highway to the highway 30 embedded in the orthogonal street network of the Metairie/Gentilly Ridge and marked by facilities such as cemeteries, race tracks, parks, and fair grounds, located because, when built in the 1800s, they shared proximity to the population but not too much space to be located in the city center. Once rail, they were now enveloped by the city, well situated on the upraised ridge, to the envy of homeowners living in adjacent, low-lying subdivisions. Though quite apparent in the cityscape, the actual topography of the Metairie/Gentilly Ridge is, again, all but imperceptible to the eye. Only from the Industrial Canal, which was cut through the Ninth Ward in 1918-1921, can one see the full vertical range of the Gentilly Ridge; seven to ten feet of white, sandy sediment, sloping in a manner slightly reminiscent of the Badlands or features of the southwestern desert. It is a rare sight in New Orleans.

**Esplanade Ridge** — Between City Park and the French Quarter lies a slight ridge rising two to four feet above sea level and three to five above adjacent lowlands. Called the

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Saucier, Recent Geomorphic History, 19.
of the roads to the city reads practically as a topographical report:

The road [Bayou Road, following the Esplanade Ridge] leading from the back part of the city [today's French Quarter], forks two miles from the Mississippi. The one on the right [Gentilly Boulevard] runs north east on a tongue of land, about half a mile in width, generally known by the name of Chantilly [Gentilly Ridge], and terminates in barrens and swamp [Chef Menteur Pass area] at the distance of about twenty miles. The one on the left [which becomes City Park Avenue, following the Metairie Ridge] extends about west, crosses Bayou St. John, over a drawbridge, and connects the river road [following the natural levee of the Mississippi] of about fifteen miles above the city [in Kenner, where Bayou Metairie once diverted from the river channel].

As would a road through the wilderness, Bayou Road curved gently through the swamps to exploit the Esplanade Ridge, and to this day, the slight bend of Bayou Road remains in the streetscape beneath that graceful arc is one of New Orleans' most significant topographic serendipities, without which New Orleans would be a very different today, for Bien-ville presumably would have located the city elsewhere.

Bayou St. John — This minor waterway is not a topographic feature in the sense of an upraised terrestrial ridge. But Bayou St. John spawned from such a feature, and played so an important a role in the early history of New Orleans that it warrants inclusion here.

Bayou St. John is a sibling of the Esplanade Ridge, offspring of the same former channel of the Mississippi River that once flowed along the Metairie/Gentilly Ridge. As described earlier, it is theorized that this channel formed a sharp meander at the present-day entrance to City Park, before continuing eastward. At one point in the meander, a distributary was released southward to form the Esplanade Ridge. At another, a smaller distributary broke northward, becoming Bayou St. John. Alternately, or perhaps additionally, after the Mississippi abandoned this channel and the much lesser Bayou Metairie and Bayou Gentilly continued to trickle through it, a crevasse or perhaps a fault in this waterway continued to send water out Bayou St. John to the lake. Because of its short distance, its isolation from the new channel of the Mississippi, its minute sediment load, and the tidal effect at the lake, Bayou St. John never formed natural levees. Rather, it was a narrow, clogged, slack-water inlet through which tidally influenced brackish lake water intruded into the marshes. This was the portage most likely shown to Iberville on March 9, 1699, who recorded,

the Indian who accompanied me revealed a terminus of the portage [Bayou St. John] from the southern shore of the bay [Lake Pontchartrain], where the Indian boats were in order to descend to this [Mississippi] river. They dragged their canoes along the path [Bayou Road], where we found the baggage of people who are either leaving or returning by way of this portage. This Indian, our guide, took a good time. He remarked

51 Major Amos Stoddard, Sketches, Historical and Descriptive, of Louisiana (Philadelphia, PA, 1812), 162.
that the distance between one end of the trail and the other is indeed inconsiderable.53

Bayou St. John's era of historical significance lasted from that moment in 1699 to the 1830s, when the Pontchartrain Railroad and New Basin Canal succeeded the bayou (and the adjoining Carondelet Canal) as the most efficient route to the lake. The bayou we see today is a sanitized, mostly ornamental descendant of the original waterway, having been dredged, drained, straightened, channelled, pumped, and altered in every way imaginable. But the general channel and path remain.

**Carrollton Spur** — A recent upland underlies the uptown neighborhood of Carrollton, running along South Carrollton Avenue from the Mississippi River to a point near Earhart Boulevard. This is the natural levee of the Mississippi, but here it rises slightly higher and extends farther inland than elsewhere uptown. The formation of this “Carrollton Spur” can probably be traced to crevasses that opened periodically along present-day Lake Avenue, most notably in 1816 and in 1832, when a 150-foot break in the levee near present-day Leonidas Street flooded New Orleans from the recently coated Carrollton with valuable fresh sediments.54 This area is located on the cutbank side of a sharp river meander where the trajectory and the topography of the current make it more likely to undermine the natural levee and flood the land. Carrollton was thus subjected to slightly more sediment deposition and rose slightly higher than adjacent natural levees, by roughly one to two feet.

There is an interesting “non-consequence,” and one important historical consequence, of the Carrollton Spur. Because this feature falls short of adjoining the Metairie/Gentilly Ridge, as the Esplanade Ridge does on the opposite side of the crescent, Indians and early explorers did not have easy access to the Carrollton area from Bayou St. John. Carrollton was therefore isolated from the main corridor of development activity during New Orleans’ first century. Had the Carrollton Spur adjoined the Metairie/Gentilly Ridge, early inhabitants would have had two routes to the river shaped like the legs of a trident (one with Bayou St. John, the other with the trunk), perhaps fostering the development of a separate city or settlement at Carrollton in the eighteenth century. But a 1,000-foot gap between these two ridges, located just south of the present-day Carrollton I-10 interchange, prevented this. It was not until 1833, that this area, previously operating as the Macarty sugar plantation, was finally developed as the city of Carrollton. The town’s main avenue and subdivided streets existed to accommodate the Carrollton Spur by extending deep into the middle of the crescent, considerably beyond other subdivided former plantations. Carrollton is divided in two areas in 1874, today exhibits architectural styles, trees, and an overall look-and-feel that are a generation older than other areas equally distant from the river. This cityscape is a consequence of the area’s topography.

**Lakefront** — The Lake Pontchartrain area is known for nearly nine centuries, New Orleans being located by the resorts of Milneburg, Spanish Fort, and West End.55 In 1810, the lakefront terminus of three important city streets: the Pontchartrain Railroad on Elysian Fields Avenue, Bayou St. John, and the New Basin Canal, respectively. The rest of the lakeshore and its adjoining marshes were, from the perspective of most city dwellers, a marshy wasteland useful only for fishing and crabbing.56 But once the installation of the municipal drainage system (1893-1911) dried the lakeside marshes, New Orleans expanded off its 180-year confinement to the natural levee and cast its eyes to the once-useless lakefront marshes. With urban development rapidly expanding toward the lake starting in the 1910s, the prospect of a hurricane-induced lake surge—to many residents a serious threat to the growing city—was averted, with the high quantity of water and organic matter in the fine clay sediments deteriorating them. Then, in the 1920s, public support mounted for a plan envisioned as early as 1873 and finally executed sixty years later.

The Lakefront project, a highly successful flood-protection and land-reclamation effort envisioned as early as 1873 and finally executed sixty years later.

6 Carl A. Brasseaux, trans. and ed., *A Cantonais View of French Louisiana, 1699 and 1762:* *The Journals of Pierre Le Moyne d’Iberville and Jean-Jacques Blaise d’Abbadié*, 2nd ed. (Lafayette, LA, 1981), 44. I paraphrase that Iberville was describing a portage located farther upriver, such as Bayou St. Eugene.

The French tradition of surveying riverine lands into “longlot” plantations measured by the old French unit, the arpent (192 feet) transformed the natural levees of the deltaic plain into agricultural landscapes. Arpent-system plantations may be seen today as elongated parcels extending off the Mississippi river and its distributaries from the natural levee to the backswamp, a distance of usually forty or eighty arpents (1.5 to three miles, shown on the above River Road satellite image as red and yellow lines). Old arpent-system lots in present-day uptown New Orleans, formerly sugar plantations, were urbanized throughout the 1900s, leaving their imprint in the radiating street network of the modern city. The term “arpent” is long since replaced by English acres and feet, but the word is still occasionally referenced in the landscape. This real estate sign near Lockport, for example, demonstrates continued popular usage of arpent, “Eighty Arpent Road” in Jefferson Parish marks the rear edge of old West Bank plantations. Photograph of real estate sign by Mark Fox and Kevin A. Caillouet, 2004; map and street sign photograph by the author, 2003.

Though the knuckle and thumb of a partially clenched fist. The project was a success—“one of the very few places where twentieth century city planning has truly improved a large area of an American city”—and remains so today, by almost everyone’s measure.

**A Dynamic Topography: Soil Subsidence and Coastal Erosion**

River-deposited sediments occupy a volume bloated by water content. As the water drains away, the soil volume contracts; particles settle under their own weight and fill in air pockets; and organic matter disintegrates, opening up space for compaction. Crustal sinking and tectonic activity also sometimes occur in result: subsidence, “the lowering of the elevation of an area in relation to sea level.”55 A natural process in a deltaic plain, subsidence is normally counterbalanced by incoming deposits of sediment-laden floodwaters, maintained roughly the same pace. Deltaic regions maintain topographical equilibrium so long as the sustaining river does not meander, or the level of the sea does not change.

Or so long as man does not construct levees, embankments, and embankments, which prevent inundation of cities and farms but simultaneously restrict riverine sedimentary deposits to the deltaic bank account. Thus what has happened in southeastern Louisiana, New Orleans’ topographic elevation is presently diminishing. Absolute terms and particularities in relation to sea level aside, in a conspiracy of factors, especially of man’s own doing, happens to be rising at increasing rates. Subsidence is an arcane scientific preoccupation in New Orleans; it is a topic of everyday conversation, inspiration for the sort of doomsday humor that binds the residents of New Orleans with those of other colossal urban-engineering challenges, such as Mexico City and Venice. It is also nothing new. A rumor says that New Orleans is slowly sinking,” reported the Harper’s Weekly in 1871, in one locality a bathtub was sunk seven feet below the ordinary level.57 Subsidence became a household word during the oil-boom years of the 1970s, when rapid urbanization of the recently drained marshes of Jefferson Parish landed the issue on the front page of local newspapers. That five suburban houses on Jefferson Parish’s high-peat soils literally exploded because of subsidence-related breaks in gas lines only added to the city-wide preoccupation.58 A survey of headlines from 1972 to 1979, culled from a bibliography on soil subsidence by Christine Moe, sheds light on how the public learns of an unintended

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58 J.O. Snowden, W. Ward, and J.R. Studlick, Geology of Greater New Orleans: In Relationship to Subsidence and Flooding (New Orleans, 1980), 17. The five houses, which existed between 1972 and 1976, were located within one mile of the Veterans Hospital/David Drive intersection.
environmental consequence, struggles with it and eventually tries to resolve it.

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<table>
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<tr>
<th>Headline</th>
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<tr>
<td>“Marshlands in Trouble – Homeowners Are Too”</td>
<td>11/9/77</td>
<td>Times-Picayune</td>
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<td>“Wetlands in Trouble; Drained Marshland Poses Hazards”</td>
<td>11/10/77</td>
<td>States-Isem</td>
<td>East Bank Guide</td>
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<td>“Rats, Nutria, Snakes, and Mosquitoes—Not to Mention Sinking Backyards”</td>
<td>11/16/77</td>
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<td>“Gas Explosion Destroys House”</td>
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<td>“How Can You Cope With Sinking Soil?”</td>
<td>2/2/77</td>
<td>Jefferson Parish Times</td>
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<td>“Soil Sinkage News Not Good for Kenner”</td>
<td>2/7/77</td>
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<td>“Soil Testing Starts in East Jeff”</td>
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<td>3/28/77</td>
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<td>“Gas Firm Halts Service Due to Sinking, Kenner May Fight”</td>
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<td>“Developer Urged to Prevent 'Gas Blasts’”</td>
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<td>“Louisiana Gas Sues Jeff, Says Parish Partly at Fault for Subsidence”</td>
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<td>“Soil Survey Finds Muck in Metairie”</td>
<td>7/15/77</td>
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<td>“Soil Sinkage Study Needed for Urban Use”</td>
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<td>10/25/77</td>
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<td>Times-Picayune</td>
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New Orleans is located in the heart of the world’s largest subsiding coastal region, stretching from Mexico to New York, far larger than the world’s other forty-two coastal areas experiencing significant subsidence. The city itself is one of seventeen subsidence zones in the nation, and while certain Western valleys and cities (which have over-tapped their ground water) are subsiding, New Orleans’ situation is surely the most dire because of the city’s proximity to an eroding coast and a rising sea. Although its affected blackened areas, buckled streets, cracked and leaning buildings—are visible to the eye, subsidence is difficult to measure precisely over an extensive area. Researchers have quantified these subtle changes through the use of historical maps, structural observations, tidal gauges, geodetic surveys of benchmarks, gravity meters, radiocarbon dating of buried organic matter extracted...”

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**Physical Geographies**

“West Bank Couple to File ‘Sinkage’ Suit” 11/9/77 States-Isem

“Smile: Your House Is Sinking” 11/10/77 States-Isem

“Soil Study Requirements Are Proposed” 11/16/77 East Bank Guide

“Halt Marsh Development for Soil Study, Parish Urges” 12/10/77 States-Isem

“Builders Seek Help, Must Need Soil Test Prior to Permit” 12/21/77 Bank Guide

“Some Subsidence Blamed on Builders” 1978 Times-Picayune

“Jeff Requites Report for New Subsidence Zones” 2/16/78 Times-Picayune

“Warning: House May Sink” 8/16/78 States-Isem

“Homes North of Jeff Line Pay for Gas Hoses” 9/1/77 States-Isem


“Jeff Soil Sinkage: Seller Can Be Mum” 11/10/78 States-Isem

“West Bank Is on Shaky Ground” 12/11/78 Times-Picayune

“Soil Sinkage Plagues 84% of West Jeff” 12/12/78 States-Isem

“They’re Losing It, Dad” 2/16/78 States-Isem

“Sinkage Has Plagued for W. Jeff Homeowner” 2/12/78 States-Isem


“Building Code Is Top of New Jeff Panel” 1/25/79 States-Isem

“Jeff to Consider Requiring Pilings Over Sinking Soil” 3/7/79 Times-Picayune

“Law Requires Pilings” 3/8/79 Times-Picayune

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through basis in the subsidence story but also in the present-day through borehole and—today—through the sub-centimeter accuracy of integrated networks of Global Positioning Systems. Still, results often vary widely among points within a single study, and average rates vary almost as much between studies. Literature on subsidence rates is replete with phrases like “as high as,” “up to,” or “in some areas,” which reflect high variability and the fallacy of a single, “official” mean rate. Such is the case in New Orleans, where factors such as “geology, soils, hydrology, well locations and water withdrawal…levee locations, drainage pumping strategies…the history of drainage and settlement, application of fill and overburden, the bulk density of buildings, and land use”—drive the rate of subsidence at any given spot. The influence of even these factors, such as elevation, is not clear. The conventional wisdom holds that subsidence is more severe in low-lying flood-levee basins than in higher areas of the city based on natural levees, because the loss of higher water and organic content, once drained, allows greater settlement of finer-grained deposits. Actual field data often refute this generality. For example, benchmarks measured between 1951 and 1995 by the National Geodetic Survey show that, for the most part, the range in higher ground sunk by more than five millimeters per year, and many of those on lower ground subsided by less than that amount. Indeed, in some cases, natural levees and barrier sands, due to their higher bulk density, may actually subside faster than surrounding clay and organic sediment. Nevertheless, most researchers agree that the low-lying peat deposits of former saline marshes, such as the lakeside and eastern New Orleans neighborhoods, subside the fastest when drained and developed for the first time.

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<tr>
<td>As much as 1 cm per year</td>
<td>Leved area of metropolitan Orleans, averaged five times between 1951 and 1995</td>
<td>National Geodetic Survey, as cited by Burtett, Zilkoski, and Hart (2003)</td>
</tr>
<tr>
<td>Average of 20.7 cm/century, with a range from 5.5 to 123.7 cm/century</td>
<td>Average of hundreds of test points, mostly on natural levees, measured between 1981 and 1991.</td>
<td>National Geodetic Survey, as cited by Hart and Zilkoski (1999)</td>
</tr>
<tr>
<td>Averages of 0.52 feet per century</td>
<td>Central Louisiana coastal plain</td>
<td>Roberts (1985)</td>
</tr>
<tr>
<td>Range from 0.40-0.7 feet/century</td>
<td>Barataria Basin</td>
<td>Kosters (1985)</td>
</tr>
<tr>
<td>Average of 1.05 feet/century</td>
<td>Generalized rate for deltaic plain</td>
<td>Perlman and Boyles (1983)</td>
</tr>
<tr>
<td>As much as 6-7 feet in several decades</td>
<td>Average maximum rate in parts of New Orleans metropolitan area</td>
<td>K. A. Saucier, as cited in Saucier, Geomorphology and Quaternary Geologic History, 1:54.</td>
</tr>
<tr>
<td>Average of 0.36 foot per century</td>
<td>Generalized rate for deltaic plain</td>
<td>Cugliano and Van Beek (1975)</td>
</tr>
<tr>
<td>Average of 0.39 foot per century for 1850-1940 years</td>
<td>Generalized for Pontchartrain Basin, based on radiocarbon dating of peat deposits</td>
<td>Saucier, Recent Geomorphologic History (1963), 1:3.</td>
</tr>
<tr>
<td>Average of 0.78 feet/century</td>
<td>South Louisiana deltaic plain, accounting for sea level rise of 1.2 feet/century</td>
<td>Kolb and Van Lopik (1958), as cited in Saucier, Geomorphology and Quaternary Geologic History, 1:53.</td>
</tr>
</tbody>
</table>


* Snowden, W. and Small, Geology of Greater New Orleans, 14.*
“The query is—What went done?”64 The Harper’s Weekly about subsidence in New Orleans in 1871.65 To date, no satisfactory “master formula” has been developed to characterize fully the phenomenon of subsidence, a challenge like “trying to map a bowl of vibrating jello,” according to two mapping scientists.66 The mandated use of pilings under new house construction in certain areas, the recommended use of flexible utility connections, and artificial fill by the truckload counter the worse effects of subsidence in the metropolitan area, but the problem itself may be unsolvable. Homeowners respond by shoring up their raised houses with jacks and pilings, or, more desperately, watering the underlying soil with a garden hose during dry spells. Greater New Orleans is home to more shoring specialists per-capita than any other major American city; one, Abry Brothers, has been in business since the 1840s.

Subsidence is relevant to a discussion on New Orleans topography for the obvious reason that it alters the elevation of the land surface. The recent topographic surveys discussed in this chapter will probably be as obsolete in the twenty-first century as the Hardee and Kirkland-Brown-D.A.B maps of the nineteenth century are today. “Considering the rate of subsidence and sea level rise,” wrote the authors of a topographic survey based on LIDAR data.

As much as 3-6 feet over 40 years

Maximum observed subsidence in certain areas, starting after installation of drainage system (1897), to 1937

World War II, Adm. of War (1937), 3.

Subsidence is also pertinent to this discussion because it is the ironic consequence of topographic engineering, and not the only one. The sediment-starved delta region is now not only subsiding vertically, but eroding horizontally. Southern Louisiana has lost over 1,500 square miles of coastal lands since the 1930s and currently loses an additional twenty-five to thirty-five square miles per year, or an acre every twenty-four minutes; swamps that once were verdant are now being killed by intruding salt water. While most researchers generally agree that flood-control levees on the river are the root cause of this catastrophic decline in topography, other factors exacerbate the problem. Saltwater intrusion, dikes built for navigation, oil and gas exploration, and compacting soils for the construction of a modern city have created erosion-prone land/water interfaces; protective grasses are destroyed by invasive marsh and muddy salinity levels and droughts; and compacting soils lower the relative height and weight in relation to rising Gulf waters. New Orleans proper suffers its share of the loss, in the marshes of eastern Orleans Parish. Coastal erosion in neighboring parishes is an even greater threat to the city, not to mention those parishes themselves, because it brings the potentially tempestuous Gulf of Mexico ever closer to the low-lying metropolis. Every 2.7 miles of wetlands that disappear allow an additional foot of gulf water to surge inland. Every 2.7 miles of wetlands that disappear allow an additional foot of gulf water to surge inland in front of an oncoming hurricane and put the ratio at one house to one foot. “The city will lose the wetland buffer that now protects it from many effects of flooding. As a result, severe floods will occur more frequently, and the strain on the area’s already overtaxed drainage system will increase.”70 The diminishing verticality of the land has added a new elevation.


2 Ibid., viii-ix.
tion-based dimension to hurricane preparedness: when those with means flee the city as a hurricane approaches (“horizontal evacuation”), public officials devote their resources to the “vertical evacuation” of those without means—that is, moving the infirm and the poor into high buildings. Hurricane season brings annual awareness to over one million people of the topographic precariousness of their home, and of its eroding coastal buffer. If current trends continue, New Orleans may occupy the tip of a narrow peninsula protruding into the Gulf of Mexico by the early twenty-second century, possibly sooner. With this nightmare scenario in mind, and with the disheartening prospect of a world without southern Louisiana, massive engineering attempts to slow and reverse the pace of coastal land loss have been proposed and enacted. Most call upon the Mississippi River, creator of this land and topic of the next chapter, to restore the topography of the deltaic coastal. As topography has played a profoundly consequential role in New Orleans’ first three centuries, it will make or break the city in the next century.

Epilogue: The once-arcane topic of New Orleans topography received worldwide publicity, complete with detailed maps and three-dimensional diagrams, in the aftermath of Hurricane Katrina. As the Pontchartrain’s waters invaded the metropolis via multiple levee breaches, the few feet of elevation that differentiated the landscape imperceptibly to the naked eye dramatically spelled the difference between survival or destruction of entire neighborhoods. Those areas above sea level, developed in the 1700s and 1800s and home to sturdy historical housing, mostly evaded damage and persistent flooding. The areas below sea level, developed largely in the 1900s with slab-based housing, suffered inundation to a degree precisely commensurate to their elevation, or lack thereof. Satellite images captured after the deluge showed only the natural ridges of the Mississippi, Marigny, Gentilly, Esplanade, and Carrollton in their normal dry tones, amid a sea of dark floodwaters.

Topography served as the first-tier rule guiding where New Orleanians built New Orleans in the eighteenth and nineteenth centuries, only to be trumped by drainage technologies in the twentieth century. With Katrina, in the early twenty-first century, topography would drive where New Orleanians demolish New Orleans, and, it is hoped, inform how they should reconstruct it.
**Riverine New Orleans**

To state that New Orleans is inextricably linked to the Mississippi River—physically, historically, culturally, economically—is axiomatic. The river, shaped its unrelenting terrain, drew indigenous and colonial settlement to its site, connected the city to the world, shaped its crops and industries, sustained it, threatened it with floods and silences, diffused internal traits, and conveyed cargo handled here to and from points worldwide. New Orleanians imbue the waters of the Mississippi even more—riverscapes of earthy-grave: the river is literally part of their lives. That it is a Crescent City is the first and last major city on the Mississippi, intentionally positioned at the point of a peninsula between the southern seas and the North American interior, renders it that much more an urban scion of the Father of Waters. New Orleans “has strong advantages ... from its situation,” wrote Thomas Ashe in 1806. “It stands on the very bank of the most perfect course of a water navigable in the world...one hundred miles from the sea,” accessible to all the rest of the maritime world. This characteristic magnitude and significance of this continental drainage, and describes selected “rules” it plays upon New Orleans. The discussion emphasizes riverine influences upon the physical environment, including natural resources and infrastructure, rather than upon New Orleans’ political, cultural, and economic experiences. It concludes by addressing the modern city’s disturbing conundrum: is as august and invaluable as the Mississippi, why is New Orleans declining economically?

**Magnitude**

Gauging the influence of the Mississippi River on New Orleans starts with a snapshot of the river’s sheer magnitude. All the Mississippi’s very dynamics assures its exact measurements, and even its “true” course. Because the flowing water constantly erodes banks, builds battures, shifts sandbars, creates and cuts off meanders, it extends its delta (often with the help of man, intentional and otherwise), measurements of the river’s length vary from under 2,322 to over 2,775 miles. Signs posted at the Lake Itasca headwaters of Minnesota claim that the river runs 2,552 miles to the coast of Mexico. This chapter uses 2,340 miles as the length, based on a published U.S. Geological Survey source. Width, too, of water passing a line in one second. This volume will expand on one point and by the time it reaches New Orleans “about ninety days hence.” After passing the Twin Cities where the river measures 11,786 CFS, the river augmentations from the confluences of the rivers St. Croix, Wisconsin, Rock, Des Moines, and Illinois, plus scores of smaller tributaries. As the river separates the states of Minnesota, Iowa, and Missouri from Wisconsin and Illinois, it carries some of the widest spans—over two miles wide at natural Lake Pepin and four miles at manmade Lake Onalaska—but otherwise maintains a fairly consistent character. Now averaging 105,812 CFS, the river undergoes its first major transformation at its confluence with the 2,565-mile-long Missouri River, which drains 312,414 square miles toward the Missouri, but as Red Rock Creek in the Montana Rockies, accounts for nearly half of the entire Mississippi River Basin in terms of extent, and actually outranks the Father of Waters in length by two hundred miles, though it contributes only 1 percent of the Mississippi’s annual maximum flow. The Missouri brings to the system the lion’s share of its sediment load, eroded from 2,565-mile-long Missouri, which is the Mississippi passes St. Louis, immediately below the confluence, it has transformed to a muddy and turbulent river of 191,136 CFS.

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The 1,243,700-square-mile Mississippi River Basin drains 41 percent of the continental United States and 15 percent of the North American continent. Thirty-one states and two Canadian provinces partially or fully drain into the Mississippi. The outflow discharges entirely along coastal southeastern Louisiana, 70 percent via the Mississippi, 30 percent via the Atchafalaya. Maps by author; data from USGS and ESRI.
An even greater transformation occurs at Cairo, Illinois—“the vortex of the United States,”\(^73\) where the Ohio River joins the Mississippi. The ecological and hydrological significance of this locale cannot be overstated: it marked both the southern margin of glacial maximum during the Ice Age, and the northern tip of the Mississippi Embayment, the great rift in the earth’s crust which formed the Mississippi Valley. Encroaching ice sheets sculpted the channels of the Missouri and Ohio to flow into the hitherto meager Mississippi, dramatically increasing its flow and essentially creating the lower river channel from its deltaic plains. The glaciers have long since retreated and the Mississippi Embayment has filled with sediments, but the Ohio River continues to transform the Mississippi into a completely different river—so much so that scientists and engineers almost universally refer to distinct segments of the river. Scientists typically refer to the river as the “upper” Mississippi, with its headwaters in the Colorado Rockies. By the time it flows through Cairo, the river has more than doubled to 484,609 CFS with the addition of the Arkansas River, with a present-day flow of 30,797 CFS. Once flowing into the Mississippi at the tip of a meander loop (Turnbull’s Bend), while a distributary, the Atchafalaya followed out and through south-central Louisiana to the Gulf of Mexico. Two events in the 1830s altered the course of history here—and very nearly altered the course of the Mississippi. In 1831, Capt. Henry Shreve severed Turnbull’s Bend, in the interest of shortening travel time for riverboatmen, by digging “Shreve’s Cutoff” across the narrow neck. Almost immediately, the Mississippi lunged into the cutoff and made it its main channel. Meanwhile, the ever-present, dubiously named Old River, stepped up in one vision, while in the other portion, continued on its way. By 1833, the Old River escaped the Atchafalaya River distributary because a massive natural logjam clogged the channel. Eight years later, activities natural logjam clogged the channel. Eight years later, activities

The charming upper river is unmistakably feminine[] the big brute of a lower river is just as certainly masculine.\(^74\)

Despite its updated stature, the lower Mississippi still acts as a water collector, with the addition of the Arkansas River’s 39,743 CFS and accompanying sediment load from its headwaters in the Colorado Rockies. By the time it flows beneath the low bluffs of Vicksburg and New Orleans, the Mississippi River reaches its peak single-channel volume, averaging 602,724 CFS, though it easily surpasses 1,000,000 CFS in high-water years—a theoretical foot-thick wall of water 1,000 feet wide and 1,000 feet high passed every second. About fifty river miles south of Natchez, the Mississippi changes character for a third time. At this climatic point, the “tunnel” formed by the Red River Valley to the north and the Mississippi Valley to the southeast is broken. The river, with a present-day flow of 30,797 CFS, once flowed into the Mississippi at the tip of a meander loop (Turnbull’s Bend), while a distributary, the Atchafalaya, followed out and through south-central Louisiana to the Gulf of Mexico. Two events in the 1830s altered the course of history here—and very nearly altered the course of the Mississippi. In 1831, Capt. Henry Shreve severed Turnbull’s Bend, in the interest of shortening travel time for riverboatmen, by digging “Shreve’s Cutoff” across the narrow neck. Almost immediately, the Mississippi lunged into the cutoff and made it its main channel. Meanwhile, the ever-present, dubiously named Old River, stepped up in one vision, while in the other portion, continued on its way. By 1833, the Old River escaped the Atchafalaya River distributary because a massive natural logjam clogged the channel. Eight years later, actors...
In the interest of navigation and development, the state of Louisiana started clearing the thirty-mile-long blockage of the Atchafalaya, unknowingly providing the Mississippi two characteristics that physics dictates it will seize: a shorter path and steeper gradient to the sea. The cleared logjam allowed increasing quantities of both the Red and the Mississippi to flow down the 142 relatively steep miles of the Atchafalaya, rather than the 315 relatively flat miles of the Mississippi. By the mid-twentieth century, the Atchafalaya had tripled its share of Mississippi water and seized all of the Red's. Scientists by that time recognized that the Father of Waters would eventually jump channels—substantially, possibly entirely, around 1975—abandoning New Orleans and converting Louisiana's invaluable river corridor to an elongated and increasingly brackish bay. To prevent this catastrophe, the Old River Control Structure was built in 1954-1962 to regulate the flow of the Mississippi into the Atchafalaya at a government-approved seventy-to-thirty ratio, which may be adjusted to alter the stage of either river for flooding or navigation reasons. Thus, while the Mississippi peaks in the Vicksburg-Natchez section at about 602,724 CFS, it runs an average of 465,206 CFS by Baton Rouge, having distributed 30 percent into the Atchafalaya distributary (but gaining back 7-8 percent courtesy of runoff from the Tunica Hills region north of Baton Rouge). The Old River Control Structure represents one of the most Herculean engineering projects in history.

Uptown New Orleans sits on a point bar—the concave side of a river meander where the current slows and deposits sediment. Across the river is the cutbank, where the river runs faster and deeper (thalweg), and erodes the bank more aggressively. Past the French Quarter, the thalweg swings across the channel, eroding the east bank and accreting on the west. GIS processing by author based on data from FEMA, State of Louisiana, and Army Corps of Engineers.
emblematic of both the brilliance and folly of man’s alteration of the environment to suit his needs.77

Below Baton Rouge, the Mississippi River departs the broad floodplain at the bottom of a alluvial valley and enters its upper deltaic plain.78 As the river proceeds down the Mississippi,” New Orleans Mayor Martin Behrman once observed, “the river seems to grow higher as he descends.”79 It is no illusion: near the West Baton Rouge-East Baton Rouge parishes line, the Mississippi River leaves behind the valley “walled” by the meager Pleistocene uplands of East Baton Rouge and west of Lafayette, and then flows above the landscape, buttressed by natural levees rising fifteen feet above the swamps. With manmade levees adding another fifteen to twenty feet of elevation, the river’s immediate flanks make up the most prominent topographical feature in the upper deltaic plain. In its final two hundred miles, the Mississippi River ranges 2,000–3,000 feet wide, runs fifty-four to two hundred feet deep at its deepest point per river mile,79 and rises at slightly below the rate gauged at Baton Rouge. There are no more tributaries in this deltaic region (the last one joins the river in north Baton Rouge); this varved estuary cordilera is a shedder of water, not a collector. Feeder distributaries such as Bayou Manchac and Bayou Lafourche have been lost, but some manmade levees, while the broad Bonne Carré crevasse zone between the river and Lake Pontchartrain was wisely engineered into an emergency spillway for flood control—but only after the Great Flood of 1927 exposed the danger of failing solely on levees for flood control.

At River Mile 115, the Mississippi River enters the New Orleans metropolitan area and twists through for the next twenty-seven miles. Thirteen of those urban river miles actually bisect Orleans Parish, and for only 4 miles does Orleans Parish encompass both banks of the river. The metropolitan section of the river is especially wending its way forming two promontories that bars on the east bank and three on the West Bank, placing the river meanders of about 15 degrees which have challenged navigators for three hundred years. Ninety-five miles above the mouth sits the original city of New Orleans, where confluently, lies the deepest point of the entire river, almost two hundred feet deep depending on river stage and bankfull conditions. The rate of flow through New Orleans riverine reaches ranges from 450,000 to 535,000 CFS at normal river stage, but can triple that rate during high water: it swelling to a frightening 1,557,000 CFS during the Great Flood of 1927. Since consistent measurements have been kept, river stage in New Orleans has ranged as low as 0.71 feet above sea level (February 11, 1977) and as high as 19.98 feet (February 10, 1950), averaging about 10 feet above the sea.79 This means that the river surface is almost always higher than 56 percent of greater New Orleans, usually higher than 95 percent, and occasionally higher than 99.5 percent of the land surface (everything except the artificial levees).80 Such is the sheer physical dominance of the Mississippi River over the cityscape of New Orleans.

Once past greater New Orleans, the river makes one last great meander at English Turn beforestraightening out and speeding up through Plaquemines Parish to the Gulf of Mexico. A mild frontier-like ambiance is both the physical and human environment prevails in this subdued region. The delta is the culmination of a great natural process and the proximity to the ragged edge of a continent. At Head of Passes—River Mile 0—the channel trifurcates into a birdfoot-shaped embayment known as the Atchafalaya or Plaquemines Complex. In terms of spatial extent, the modern Mississippi River delta is not the largest on earth; the Ganges and Mekong span about triple the size and the Amazon delta is sixteen times larger. But it is probably the most outstanding example of an elongated, river-dominated delta, as opposed to those dominated by waves, tides, or combinations of the three factors. Deltaic dominance by rivers when the flow of fresh water and sediment is substantial and the receiving sea is slow-moving and placid as in the Gulf of Mexico. The resulting formation is a well-developed delta plain with several distributaries projecting seaward in a digitate, “pincushion” configuration.81 The Mississippi’s birdfoot formation comprises six sub-deltas, numerous spurs and lobes, and three major passes, the lowest (Pass 50 percent). And

* The line of the Mississippi’s alluvial valley and the plain may be traced as far north as the Ohio River, where the Archafalaya becomes a tributary of the Mississippi, then re emerges as a distributary, to as far south as the Lefayette-to-Baton Rouge delta, where the Louisiana levees disappear and the river is free to meander widely.

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This photograph, taken from an aircraft near the mouth of the Mississippi, illustrates the stark interface between sediment-laden river water and the clear, saline Gulf of Mexico. From this interaction emerged the terrain of New Orleans over the past 5,000 years. Photograph by author, 2004; aircraft courtesy SouthWings, The Nature Conservancy, and CBR.
the route of most navigation activity), South Pass (20 percent), and Pass à Loutre (30 percent), which branches into North and Northeast Pass. It is the seventh delta complex to have roamed across southern Louisiana in the many millennia of flooding, depositing, jumping channels, and building new land as earlier sediments sink and erode to the sea. The sediment load, discharged to the continental shelf, extends the lower deltaic plain into a subaqueous delta amid a sediment plume visible from space. In this great estuary, the telltale waters of the Mississippi, which reflect with unrelenting accuracy myriad environmental alterations in the North American interior, intermix with the sea. “The line of demarcation between the yellowish-brown water of the river, and the clear green water of the sea,” wrote Joseph Holt Ingraham in 1835, “is so distinctly defined, that a cane could be laid along it.”82

**Nomenclature**

Measurements of the Mississippi River understate the true magnitude of the natural phenomenon flowing through New Orleans, for what we designate as that indigenous appellation is really a subset of a much larger system. The Mississippi River basin drains an area spanning 1,750 miles, at its widest point and 4,540 miles north to south, fully 15 percent of the entire North American continent and 41 percent of the continental United States. Thirty-one states and two Canadian provinces partially or fully drain into the Mississippi. Above basin, covering 1,243,700 square miles is surpassed only by those of the Amazon and Congo. Within this watershed are countless stream sub-basins feeding into hundreds of river sub-basins, then into scores of larger river sub-basins, and eventually into three major river sub-basins: one from the west (the Missouri), one from the north (the upper Mississippi), and one from the east (the Ohio). These three major sub-systems merge within a two-hundred-mile stretch of river between St. Louis and Cairo. There is no dispute that the great river flowing below Cairo to the Gulf of Mexico is the *bona fide* father of Waters. Above Cairo, however, where the three tributaries unify waters draining from a vast dendritic network, we rather arbitrarily divide the north branch, originating in Minnesota, to be the *bona fide* Mississippi River. Why? Perhaps its centrally located peninsula and orderly, meridional orientation convinced mapmakers that it constitutes a single hydrological entity with the lower Mississippi.

By this day, a popular but highly erroneous notion holds that rivers flow in a north-to-south direction.**83** Perhaps topography played a role: the lower Mississippi retains the same relatively flat forested terrain that also characterizes the lower Missouri—together forming “the great longitudinal trough of North America”84—whereas the Illinois and Ohio tributaries are born in hilly, mountainous environments off to the east and west. But the real reason is historical. Because early French explorers—Jacques de Buade, Joseph Buade, and Louis Joliet in 1673 and René Robert Cavelier de La Salle in 1682—first encountered the river system from the Great Lakes region downriver toward the Gulf of Mexico, that route struck them as a single, cohesive hydrological unit. Historian Timothy Severin noted that early French traders heard the Algonkian words *Mississippi*, loosely translated as “Big Water” or “Father of Waters” from Illinois/Michigan tribesmen in the northern territory and “carried it downstream with them,”85 implying that the defining element of the river’s route was the Frenchmen’s own exploration down it. This impression was passed on to cartographers, who depicted it in turn-of-the-eighteenth-century maps under every conceivable orthography of “Mississippi.” Le Page du Pratz in his 1774 *History of Louisiana*. The first discoverers of this river by the way of Canada, called it “Mississippi”—in honour of that great navigator [Jean Baptiste Colbert, financial minister for Louis XIV]. By some of the savages of the north it is called Meact-Chassipi, which literally denotes “the Ancient Father of Rivers, of which the French have, by corruption, formed Mississipi, other Indians, especially those lower down the river, called it *Bachamba*; and at last the French have given it the name of *Louis*.**86**

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82. See Edward Fontaine, “Investigation on the Peculiarities of the Physical Geography of the Mississippi River and Delta” (Washington, D.C., 1874), 5, for a novel circa-1874 explanation of the Mississippi’s north-south orientation, involving the centrifugal force of the rotating Earth.


By the 1710s-1720s, French maps and geologic derivations identified the source of the Mississippi as a series of small hypotetical lakes west of the Great Lakes and the route of the Mississippi as the channel flowing from them southward to the Gulf of Mexico.\(^\text{67}\) All other channels, no matter how significant, were perceived as tributaries.\(^\text{68}\) Had early explorers sailed down the Ohio to the Gulf of Mexico, or from the mississippi to the gulf, we may well describe either of those routes as the continent’s greatest river (though it would not have carried the name Mississippi, since this infamous word came from the northern region). There is no compelling hydrological or geological explanation justifying the designation of the Minnesota-to-Cairo river as the main trunk of the Mississippi. If sheer length, distance from mouth, or sediment load were the criteria, the Missouri River-to-gulf route would form the Mississippi River. Even as conventionally defined, the Mississippi is longer than the Mississippi by two hundred miles. If water volume were the criterion, then the Ohio River-Mississippi route would be bestowed with that name.\(^\text{69}\) The Ohio discharges 28,000 cubic feet per second into the mississippi, while the mississippi might be three times the volume of the Ohio, and roughly half that of the Ohio at its mouth.\(^\text{70}\) If hydrology or geology were the criteria, then the mississippi River, in fact, almost uniquely describe solely the river-to-gulf channel—that is, what is generally called the “lower Mississipi River” today.

This is not just an interesting (and, to some, heretical) question of name, nature.\(^\text{71}\) Considering the Mississipi River as the culture of a vast watershed puts New Orleans astride nothing less than a 2,340-mile river, buttressed by a 5,500-mile network of interconnected navigable waterways, and a much larger web of smaller tributaries. Those rivers carry commerce and culture as well as sediment, but with chemicals to New Orleans, and avail to the city its equally large area to which it can export its attributes, and convey those originating elsewhere. If rivers are “regional bonds,”\(^\text{72}\) then New Orleans is uniquely bonded to the heart of the entire continent. The roles of the river that flowed in the next section should be considered as not just the influences upon New Orleans of the single channel christened “Mississippi,” but of this much grander system.

Standing on the extreme points of the longest river in the world, New Orleans commands all commerce of the immense territory...traversing a million square miles. You may travel on board a steam-boat of three hundred tons [for] 1,000 miles from New Orleans up the river; 1,500 miles up the Arkansas—2,000 miles up the Missouri and its branches; 1,700 miles up the Mississippi to the falls of St. Anthony; the same distance from New Orleans up the Illinois; 2,000 miles up the Wabash; 2,300 miles on the Cumberland; and 2,500 miles on the Ohio up to Pittsburgh. Thus New Orleans rules in its rear this immense territory; [plus] the east of Mexico, the West India islands, and the half of America to the south, the half of America on its left, and the continent of Europe beyond the Atlantic. New Orleans is beyond a doubt the most important commercial point on the face of the earth.\(^\text{73}\)

Roles of the Mississipi River in New Orleans

The Mississipi River plays roles of provider, creator, and to some, the physical landscape of New Orleans.

River as Provider — Sundry resources arrive to New Orleans via the Mississipi River, as they have for centuries. Breeses coming off its 2,000 foot-wide surface provided New Orleanians of the eighteenth and early nineteenth century the sole refuge from the stagnant heat of a summer eve. Fuel arrived on its surface, with a visitor observed in 1826 “much driftwood afloat on the river, even large tree trunks, [which] Ne-

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\(^{69}\) Others have made the observation: see Severin, Explorers of the Mississipi, 5-6, and Norah Deakin The River as Region: A Mississipi River Chronicle (San Francisco, 1982), 1-2.


\(^{71}\) Charles Sealsfield American As They Are; Described in A Tour Through the Valley of the Mississipi (London, 1828), 163-66 (emphasis added).
groes in canoes were engaged in bringing… fore, where it serves the people on the levée as firewood. Maj. Amos
Stoddard commented in 1812 on its fish resources:

The Mississippi is not remarkable for good fish. The deltaic
part of it, however, furnishes plenty of eels, shad, trout,
and a species of small sturgeon [as well as a kind of freshwater
sheep-head, and likewise the carp or buffalo fish…. Canoes
are abundantly in the two, some of them as high as
one hundred and seventy pounds. Some [alligator] for the
Mississippi are fifteen feet long [and] extend that river into
Arkansas.92

To this day, local fishermen haul enormous sturgeon from
the river within sight of St. Louis Cathedral; yet, despite
the contaminants bio-concentrated in their aged flesh, take home
the great bottom-dwellers as the frying pan.

In terms of critical resources imparted by colossal quantities,
the Mississippi River is the exclusive provider to New
Orleans of two: fresh water and sediment. The two most basic
elements of the planet, water and rock, are extracted en masse
from a million square miles of hinterland and routed through
New Orleans to the sea. During normal stage, roughly the
hundred billion gallons of flow past Jackson Square every
day, accompanied by 140,000 pounds of sediment. The Mississippi ranks as the seventh largest river in the
world in terms of both discharges.44 The first is tapped liberally and easily by the city to satisfy its everyday needs; the second a bit more challenging to extract and not needed as regularly, but ultimately just as critical to the survival of the region.

So abundant and reliable is the supply of fresh water in
New Orleans that residents may not appreciate its scarcity in
urban areas across the nation and globally. Water surplus
in the Crescent City and a shortage in cities as close as Florida,95
and as far as the Mideast, have led some to ponder the eco-
nomics of exporting Mississippi River water as a commodity.

The water is here, the shipping lanes and port facilities are
established, and the technology available; the only obstacle
is cost, and if present trends continue, willing buyers may
come by. Until then, New Orleans will happily satisfy its
water needs courtesy of the Mississippi, as it has since
the earliest days of human habitation of the area.

For most of its first century, New Orleanians obtained
their potable water by drawing it from the river themselves
or purchasing it from street vendors at one picayune [four
buckets]. Homemakers would then store the water in earth-

4 Duke of Saxe-Weimar-Eisenach Bernhard, Travels by His Ducal Escort in Southeastern Europe, South America in the Years 1825 and 1826 (London: William

5 Major Amos Stoddard, Sketches, Historical and Descriptive, sec. 1 (Philadel-
phia, PA, 1830).

6 In terms of water discharge, the Amazon ranks first, followed by the Zaire, Orinoco in Venezuela, Nile, Yangtze, and Yenisey in Russia. In terms of sea
 discharge, the Amazon is first, followed by the Yellow River, Yangtze, and
in Burma/Myanmar, and Magdalena in Columbia. Benjamin B.A. McKee
MAR: The Transport, Transformation and Energy of Carbon in River-Dominated
Ocean Margins,” Report of the RiOMAR Workshop, Tulane University, New

7 While New Orleans watches a half-million curvet of freshwater pass by
every second, the Gulf Coast city of Tampa, Florida, just a few hundred miles away, struggles with a costly and problematic desalinization plant to satisfy its water needs.

8 Duke of Saxe-Weimar-Eisenach Bernhard, Travels by His Ducal Escort in Southeastern Europe, South America in the Years 1825 and 1826 (London: William

9 Major Amos Stoddard, Sketches, Historical and Descriptive, sec. 1 (Philadel-
phia, PA, 1830).

10 In terms of water discharge, the Amazon ranks first, followed by the Zaire, Orinoco in Venezuela, Nile, Yangtze, and Yenisey in Russia. In terms of sea
 discharge, the Amazon is first, followed by the Yellow River, Yangtze, and
in Burma/Myanmar, and Magdalena in Columbia. Benjamin B.A. McKee
MAR: The Transport, Transformation and Energy of Carbon in River-Dominated
Ocean Margins,” Report of the RiOMAR Workshop, Tulane University, New

11 While New Orleans watches a half-million curvet of freshwater pass by
every second, the Gulf Coast city of Tampa, Florida, just a few hundred miles away, struggles with a costly and problematic desalinization plant to satisfy its water needs.

en jars and remove the sediment by means of stone, alum,
or charcoal filters. “When filtrated, it is transparent, light,
soft, pleasant, and wholesome,” reported Stoddard in 1812.

“The salubrious quality of its water is attributed to the nitre
and sulphur [in the river’s] deep and rapid current…. As
it is precipitated from the cold regions, it tempers the fer-
vid atmosphere of the lower Mississippi, and renders it more
healthful.”45 Unlike for other domestic uses, indeed in greater
quantity but not in high quality, came from shallow, muddy
wells dug in courtyards. Beyond the bayou, the great river
flowing, but one block from the city went practically unutil-
ized for lack of a mechanized system to pump it over the levee
and distribute it throughout its city. In 1819 a system
warranted of Biblical times was attempted on the levee at
the corner of Ursulines Street, in which river water was pumped
initially by slaves into a reservoir and distributed through
hollow cypress logs to subscribers. That primitive system was
vastly improved by the design of famed architect Benjamin
H.B. Latrobe, consisting of a steam mill mounted in a
three-story pumphouse, which drew water from the Missis-
ippi, stored it in raisers, and distributed it through a superior network of cypress pipes to residential households.

Over a decade in construction and fraught with legal and other
problems, Latrobe’s waterworks were finally completed three
years after the architect’s death from yellow fever, and served the
city well. In 1823 to 1825, the growth and spread of the
antebellum boomtown soon challenged the capacity of the
system, helping spawn a number of private water companies
overshadowing the city. The Commercial Bank of New
Orleans operated the system from 1836 to 1869, after which the city took it over until 1878, when the city deeded the system over
to the New Orleans Water Works Company. Its monopoly
in many cases stymied court, precluded the rise of competing
systems. By the 1880s, about 8,000,000 gallons per day were
pumped through seventy-one miles of cast-iron pipe, creating
a small domestic water supply for those few who were
connected to the system. The lack of a modern purification
processes, cost management and unreliability, rendered the
treatment inadequate and forced residents to satisfy their
potable water needs through what the local-color writer
described in 1893 as “one of the strictest and most distinctive
features of New Orleans[,][i]t…converts the rain-water in
almost every dooryard.”

Rising above the palms, the grape arbor, and the stately magnolias are these huge, hooped, green cylinders of wood. They
suggest enormous watersheds, and with the tops cut
off…. Nine-tenths of the water used for cooking and drinking
is this cistern water.46

Into the 1890s, practically the whole city depended on rain water caught on its roofs and stored in cisterns as the source of drinking water.47 This meant that, during
dry spells, many residents of this riverine city, usually suffered from water famines, particularly the poor living in the back-of-town. During droughts, water was sometimes “delivered” to residents simply by pumping it through the open gates. This tactic, in 1883, serendipitously provided another Mississippi River resource to New Orleans. Many of these waters are alive with small fish and river shrimp, and they furnish a harvest to the boys who catch them.

It was the Progressive municipal improvement era of the turn-of-the-century that finally brought a full-scale modern municipal water system (as well as a drainage and sewerage system) to New Orleans. Research conducted at Audubon Park in the 1890s helped determine optimal methods for purifying the sediment-laden waters of the Mississippi, debunking those who claimed that only clean wells or Lake Pontchartrain could produce potable water. The New Orleans Sewerage and Water Board, established in 1899, sited the new waterworks plant in the extreme upriver neighborhood of Carrollton. The location was selected for a number of reasons: it was, at the time, the rural edge of the city, upstream from sources of urban pollution, and above the salt-water intrusions occasioned by extremely low river stages or hurricane-induced gulf surges. The site also provided the maximum amount of head, or distribution to homes, because it tapped the river at a slightly higher stage that in other parts of the city. (The river gains about 1.5 inches of stage per mile heading upriver in the metro area; as the river reached Carrollton, it made average only a foot higher than its stage at the French Quarter.) Locating the plant 3,000-4,000 feet from the river kept it out of the way of shipping activity, wharves, and railroads, while siting it just within the Orleans Parish line kept it within local government control, even if it did contain some residential blocks.

The Carrollton Water Works Plant, started in 1905 and opened in 1908, drew water from the Mississippi by an intake pipeline and pumped it into a “head race,” the controlling node at the center of a series of reinforced-concrete reservoirs. The water then passed slowly over the “grit reservoir,” where its coarsest particles settled out, then returned to the head house to be pumped into the “lime mixing reservoir,” where lime and sulfate of iron were added for softening. Next, the water was returned to the head house to be sent to the “coagulating reservoir,” where fine particles of suspended sediment were precipitated out. Finally, the water was again sent back to the head house, strained through sand filters, poured into equalizing reservoirs,” purified further with a small dosage of chloride gas, and stored in a clean water well to await delivery. Eight pumps then delivered the purified water through distribution mains to city residents everywhere except Algiers, which was served through a similar, smaller system on the West Bank. In this manner, modern engineer-technology delivered a tiny fraction of the runoff of the South American interior—33,000,000 gallons per day in the 1910s, or 0.01 percent of normal river volume—in the kitchens and courtyards of New Orleanians.

Today, a greatly enlarged Carrollton Plant operates on the 1899-century-old site, drawing water from the Mississippi immediately below the parish line of the Oak Tree River Section, and pumping it down to the Ogden Street to the East Bank Water Treatment Plant. The purification process is far more thorough than a century ago but still fundamentally the same, involving coagulants to congeal sediment particles, time to adjust pH and soften the water, settling basins to remove the sediment, chlorine to disinfect, and sand filtration as the final purification step. The Carrollton Plant and Algiers Plant now yield the distribution of millions of gallons of river water per day, through 1,610 miles of water mains to 160,000 service connections and, typically the entire population (plus thousands of visitors, who are usually unaware that they are drinking the Mississippi River). This means that one water molecule in every 2,400 flowing past New Orleans is captured for the domestic, municipal, and commercial use of New Orleanians. It is one of the city’s greatest and most valuable blessings, cheap, at about $0.03 per gallon, and surprisingly high in quality, especially vis-à-vis popular perceptions of the rest of the Mississippi River. Overall, the Natural Resource Defense Council, which grades municipal tap water on rigorous environmental standards, rated the city’s water quality the “environmental compliant” good” for the past few years. The river may soon also satisfy a more rigorous environmental standards. The river may soon also satisfy a more

“Water Famine which Suffering in the City for Want of Water is a Household Purposes,” Orleanian, October 3, 1883, p. 2, col. 4.

“When drought, a low and tides high, great water some are carried 100 miles up the river and into the city’s intake pipes, allowing water in the range of a hundred parts per million to be pumped into homes. It all happens, producing ‘a funny taste in the water’ and, according to a journalist, producing houseswives to ask, ‘I do wish this water wasn’t there. I can’t get a decent shampoo lately [and] I don’t know what I’m going to do with my under things.’ A sand sill installed recently at River Mile 64 now holds large water wedges (which sink, due to their heavier weight) from moving upriver, and Sand Woolley, ‘Orleanians and Algerians Drink Salt Water For First Time in History,” The Morning Times, September 11, 1930, 1.

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The process of sediment transport is as complex as the river itself, as any change in water velocity (which varies within the column from mile to mile, and from day to day) affects the river’s ability to move or drop its load. The faster the velocity, the more sediment is stirred up and mobilized. When velocity slows, some suspended load drops to a bed load, which slows even more. The suspended load streaming past New Orleans typically comprises very little, and, significant quantities of silt and even more of clay, with the bed load the opposite: mostly sand, some silt, and small amounts of clay.

Before the development of the western frontier, the Missouri River delivered the vast majority of sediment into the Mississippi, with smaller quantities contributed by the two other Rocky Mountain tributaries, the Arkansas and the Red. The forested drainages of the upper Mississippi and Ohio, other Rocky Mountain tributaries, the Arkansas and the Red, deltaic lands created by the lower Mississippi. The environmental damage caused by the loss of this precious topsoil was compounded by the fact that Louisiana could no longer benefit from the Mississippi’s increasingly sediment-laden waters because the river by this time was constrained by artificial levees. Then, in the mid-twentieth century, dams constructed on the sediment-bearing Missouri and Arkansas slowed their waters dramatically and caused them to drop most of their load into reservoirs. Another twenty sets of locks and dams were constructed on the upper Mississippi, at times on other tributaries, with similar effect trapping roughly 15 percent of the system’s sediment load. Worse yet, it was the high-quality sediment—sand, the coarsest and best particles for land-building—that was most likely to end up trapped upstream. Additionally, the increased diversion of Mississippi water into the Arkansas, now channeled to a stable 30 percent by the Ohio River Control structure) routed even more sediment away from New Orleans. As a result, the Mississippi today carries past New Orleans as well under one-third the sediment it deposited in historical times. The change is visible to the naked eye: water that were once an opaque, rusty brown are now a translucent, cloudy gray. The 890 milligrams of particles measured in 1846 now typically weigh in around 125 milligrams, precisely, if one were to repeat Ingraham’s drinking glass experiment, would deposit a thin, impossibly thin layer on the glass.

A precipitous reduction of the Mississippi River’s system have made river sediment a bit like fire; beneficial in some circumstances, a nuisance or menace in others. It is beneficial when, forays in place in Midwestern prairies and Appalachian hillsides, producing crops, grasses and trees. Once river-borne, it—or rather, was—beneficial in centuries ago, it replenished the Louisiana deltaic plain with new deposits of sediment. To navigation, it has always been a nuisance, requiring costly dredging to lift particles mobilized and shifting routes obstacle-free. As dams were installed, even mobilized particles became invisible, silting up reservoirs and necessitating costly maintenance, a problem that still afflicts flood-control structures and other infrastructure on the river. But no New Orleanians complained in the early 1800s when the river formed a batture adjacent to the Faubourg St. Mary, by fortuitously depositing sediment precisely at the right time and place where new land could be thoroughly utilized for urban and port development. (The entire Warehouse District and riverside portions of the French Quarter, CBD, and Lower Garden District now occupy this average of 890 milligrams per liter. Agricultural development of the Midwest and West in the nineteenth and early twentieth centuries included vast forests and grasslands, leaving them vulnerable to erosion and increasing sediment in all Mississippi River tributaries. The environmental damage caused by the loss of this precious topsoil was compounded by the fact that Louisiana could no longer benefit from the Mississippi’s increasingly sediment-laden waters because the river by this time was constrained by artificial levees. Then, in the mid-twentieth century, dams constructed on the sediment-bearing Missouri and Arkansas slowed their waters dramatically and caused them to drop most of their load into reservoirs. Another twenty sets of locks and dams were constructed on the upper Mississippi, at times on other tributaries, with similar effect trapping roughly 15 percent of the system’s sediment load. Worse yet, it was the high-quality sediment—sand, the coarsest and best particles for land-building—that was most likely to end up trapped upstream. Additionally, the increased diversion of Mississippi water into the Arkansas, now channeled to a stable 30 percent by the Ohio River Control structure) routed even more sediment away from New Orleans. As a result, the Mississippi today carries past New Orleans as well under one-third the sediment it deposited in historical times. The change is visible to the naked eye: water that were once an opaque, rusty brown are now a translucent, cloudy gray. The 890 milligrams of particles measured in 1846 now typically weigh in around 125 milligrams, precisely, if one were to repeat Ingraham’s drinking glass experiment, would deposit a thin, impossibly thin layer on the glass.

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105 Generalized from data presented in Sherwood M. Ingraham, “Mississippi River Sediment as a Resource,” Continental Monthly: Devoted to Literature, Science and National Policy 5 (June 1864): 635. This source, published in 1864, tabulates twenty measurements of sediment taken at New Orleans from May through August, with an average of 6.5 “grains” per pint. One grain equals 64.8 milligrams.
feature.) Even fewer complained about the size of riverborne sediment on agriculture: most of the sugar production that enriched New Orleans in the nineteenth century arose from alluvial deposits, as did much of the cotton. On the other hand, sediment discharged into the Gulf of Mexico in the late nineteenth century impeded shipping activity into the Mississippi, costing New Orleans critical economic activity as it struggled to recover from the Civil War. Capt. James Eads solved this problem in 1879 by building jetties to speed up the flow and clear out sediment building up at the mouth, but this infrastructure too requires maintenance and dredging, to this day. Sediment in the Mississippi River also influences the delivery of pollutants and trace metals, which bind to particles and may enter in New Orleans’ water supply, as well as those of security to so other cities and towns.108 The challenge presented by this sometimes avoided, sometimes disdained natural feature to residents of the Mississippi basin is, how do we keep sediment from ending from the land and accumulating the Mississippi in which the answer is soil conservation. The sediment challenge to those in the Mississippi delta is how we extract sediment from the Mississippi and put it to use on the land. The answer to this problem segues to the Mississippi River’s role as creator of land.

River as creator — riverine influence is as fundamental to society as the creation of its underlying terrain. This role is described in soil, from geological, pedological, and topographical angles in preceding chapters. To recapitulate, the Mississippi River formed New Orleans’s terrain, and that terrain, at the mouth of Louisiana, as it emerged from its alluvial valley, slowed its velocity, and deposited its sediment load at the brink of the Gulf of Mexico. As it built this deltaic plain, its banks tended to occasionally develop levees, through which sediment was carried toward a new delta to the gulf. If this plain became steeper and closer to the sea, it would eventually erode nearly all flow and form a new channel. In other cases, enough sediment accumulated at the mouth to block the river’s final passage to the gulf, nudging it into a new, adjacent delta. This process repeated for seven millennia, with each channel building upon alluvium in new areas and the young deltaic plain rose above the level of the sea. As seasonal overbank floods of the Mississippi and its distributaries continued to coat the surroundings with new layers of sediment. These soils, rich in water content and organic matter, naturally subsided into the sea, while the sea’s receded, eroding their periphery through wave action and oceanic storms. Under natural conditions, however, the Mississippi’s deposited alluvium roughly matched the rate at which the sea withdrew it.

Environment, and circumstances changed. Louisiana society understood could not tolerate river floods and proceeded with the available engineering technology of the day to prevent the springtime deluges. Manmade barriers arose along the Mississippi River’s front as early as 1719, and lined the river from English Turn to present-day Reserve by 1735, to the Old River region by 1872, and beyond Greenville, Mississippi, by 1844.109 Though levees remained a dangerous threat to the human population, the river’s seasonal overbank flooding was significantly reduced by the mid-nineteenth century and all but eliminated in the lower river by the mid-twentieth century, when the levee system, dramatically reinforced after the 1927 flood, splashed 1,600 miles along the lower river.

As the levees constrained the river, Louisianians increasingly began to notice disturbing trends throughout the coastal region. Coastlines and shorelines receded visibly within a few years. Small inlets interspersed between marshes expanded into sizable bays. Salt water intruded on interior lands for the first time, turning freshwater swamps into saline marshes, then eroding the saline marshes. Cypress trees were being land everywhere was subsiding, predictably in New Orleans. Percy Bosca, Jr., director of Fisheries for the state’s Department of Conservation, sounded an early warning in his 1927 paper, “Flood Control in the Mississippi Valley in Its Relation to Louisiana Fisheries,” which made the connection between levee construction and ecological degradation. Other scientists later confirmed the trends: sediment “withdrawals” were exceeding the “deposits,” and coastal Louisiana was eroding into the Gulf of Mexico. Factors such as canal networks excavated for oil and gas exploration, navigation, fishing, and trapping increased erosion at land/water interfaces and further exacerbated the situation. Additionally, marsh grasses died back during dry years, or were devoured by invasive nutria; petroleum extraction created collapsible voids in the earth’s volume; and sea level rose at increasing rates. As a result, coastal Louisiana lost 1,200,000 acres of wetlands (1,875 square miles, nearly the size of Delaware) during the twentieth century, and continues to lose land at a rate of twenty-five to thirty-five square miles per year, or forty-five to sixty acres per day. Another 330,000 to 430,000 acres are expected to disappear between 2000-2050.112 Headline newspaper stories about Louisiana’s coastal erosion crisis appearing about six times per year in the 1990s more than tripled the pace of twenty-one articles per year in the early 2000s. What was once an obscure environmental concern known only to scientists is now the primary public concern of coastal zone residents, for whose situation is dire: departures of commercial and residential populations, threats to oil and gas infrastructure, damage to the $1 billion/year seafood


110 I thank Daniel Etheridge for bringing this paper to my attention.


113 Lexis-Nexis online search conducted on Times-Picayune articles with “coastal erosion” in the headline and “Louisiana” in the text, published between January 1993 and January 2004.
industry and the $220 million sport hunting business, diminishing wildlife habitat, a literal loss of real estate, and an end to a centuries-old way of life, particularly among Acadian and Creole peoples. Coastal erosion also threatens New Orleans: the parish lost at least 14,500 acres of land since 1932, mostly in the eastern marshes and much due to ill-advised canal excavation.114 The eroding shores of lakes St. Catherine and Pontchartrain, and of connecting waterways such as Sawmill Pass, threaten the raised camps of the Rigolets—a New Orleans neighborhood, albeit a very unusual one—as well as Highway 90, an evacuation route from the city to rural Mississippi.115 More significantly, the diminishing buffer of coastal wetlands renders the city increasingly vulnerable to hurricanes: every 2.7 miles of wetland loss allows an extra foot of gulf water to surge inland ahead of a hurricane. New Orleans’ future is in jeopardy if coastal erosion continues.

Levee construction on the Mississippi River, plus canal excavation, rising sea level, and other factors, have conspired to erode 1,875 square miles of Louisiana’s coastal wetlands during the twentieth century. Another twenty-five to thirty-five square miles disappear annually. The diminishing buffer of coastal wetlands renders the city increasingly vulnerable to hurricanes: every 2.7 miles of wetland loss allows an extra foot of gulf water to surge inland ahead of a storm, and in a bowl-shaped city half below sea level, storm surges present a far greater danger than wind and rain. In effect, the levee system transferred the source of the flood threat to southeastern Louisiana from the Mississippi River to the Gulf of Mexico. The freshwater and sediment needed to reverse this gradual catastrophe remain trapped in the levee-constrained Mississippi River, emptying out uselessly into the Gulf of Mexico. Returning the river to its role of land creator requires addressing the question posed earlier: how do we extract sediment from the Mississippi river and put it to use on the land in a financially conservative program? The simplest and most radical solution is to simply “let it go”: cease maintenance of the levees, allow crevasses to develop, open up Old River and let the Atchafalaya and Mississippi fight it out naturally, and let the system heal itself. Most human residents would find the resultant floods and brackish drinking water to be utterly intolerable, and the impact on the local economy and society
Riverine New Orleans

So the question must be amended with two pragmatic conditions: in a cost-effective manner—see the historical precedent that minimally impairs human activity. The optimal solution appears to be river diversion—that is, the controlled re-creation of crevasses and overbank flooding by means of specially engineered breaks in the levee at carefully selected locations. River water has been intentionally diverted or siphoned at least since the 1830s to stimulate oyster, fish, and muskrat productivity, and at least since the 1750s for irrigation and mill power. Diversions were even made for land-building in antebellum times: A. Oakey Hall in 1846 or 1847 was “shown some six hundred acres of land on a plantation below New Orleans that some ten or twelve years ago was manufactured on worthless swamp land by a season’s irrigation” [diversion].116 Modern controlled diversions, crevasses, and siphons are planned for the near future. Map by author based on Army Corps information.

The most practical large-scale solution to coastal erosion is the diversion of Mississippi River waters into the wetlands through control structures or crevasses in the levees. The freshwater pushes back the encroaching saltwater wedge and coats the subsiding wetlands with new sediments. The impact areas of the first two major river diversions, Caernarvon and Davis Pond, are shown on this map. Others diversions, crevasses, and siphons are planned for the near future. Map by author based on Army Corps information.

A. Oakey Hall, The Manhattaner in New Orleans; or Phases of “Crescent City” Life (New York, 1851), 130.
and wildlife populations, and stabilized the marshes.\textsuperscript{117} Plaquemines and St. Bernard parishes. In 2002, the Davis Pond Freshwater Diversion Structure opened near Luling, twenty-two miles above New Orleans, designed to release a maximum capacity of 10,650 CFS into 777,000 acres of Barataria Basin marshes. It is the largest coastal restoration project of its type in the world, and together with Caernarvon and other currently on-line structures, can divert up to 6 percent of Mississippi River flow when operating at full capacity. Where gated diversions are not practical, pipelines are used to pump high river water over the levee to specific locations in the low-lying backswamp. Too costly to install, but difficult to maintain suction, siphons are proposed to rebuild wetlands in eastern Orleans Parish, the only planned marsh creation that falls within New Orleans’ limits. Where circumstances allow for a more natural approach, an old-fashioned manmade crevasse is opened in the levee, allowing the water to spill through unimpeded. One such manmade crevasse is the West Bay Project, a twenty-five-foot deep cut in the levee about five miles downriver from Venice, through which up to 20,000-50,000 CFS of river water will pass. Currently under construction, West Bay promises significant land-building because of its large and unimpeded flow, and because it taps into a larger quantity of high-quality suspended sediments, not just the surface-level particles that controlled diversions use.\textsuperscript{118} Many more openings, part of the Delta-wide Crevasses Project, are planned for lower Plaquemines Parish, near the mouth of the Mississippi. In all, as of August 2003, the Army Corps of Engineers, the state of Louisiana, and other federal agencies oversee twenty-five gated diversions, siphons, crevasses, and auxiliary projects in various phases of planning, construction, or operational phases throughout southeastern Louisiana.

Perhaps the most ambitious proposed diversion is known as the Third Delta Conveyance Channel, conceived by geologist Sherwood Gagliano. This idea essentially seeks to re-establish Bayou Lafourche, a natural distributary of the Mississippi until it was mostly sealed off in 1904, as an active fork of the river. Because literally re-opening the levee would threaten cities and agricultural communities of Bayou Lafourche, Gagliano proposes to create a conveyance channel east of the natural levee to carry sediment-laden river water into the marshlands. While the initial capacity would be 20,000 CFS, its eventual staging would augment flow to 150,000 CFS—indeed a “third delta,” equal to the Atchafalaya, and nearly a third the size of the Mississippi. A project of this magnitude may take decades to realize; diversions of any size are expensive and politically charged, and they are not without short-term detrimental side affects to the shellfish and fisheries industries, navigation, and the control of floods and pollution. Some geologists even question diversions ability to build land, arguing that not enough of the right sediments (sand, rather than silt or clay) flow to the right place in the right amount to result in significant land-building.


the river (along the bank near the surface, where stakes are located) to accomplish that objective. It has been estimated that only 15 percent of the river’s sediment load is available for land-building, the rest being trapped in a river dump directed to the gulf by navigation channels. Minimizing sand from the riverbed and pumping it to where it is needed may prove to be more effective, providing that it can be done inexpensively at enormous volumes. Biologists and engineers agree that well-engineered river diversions—big ones, and lots of them—represent the last, best, and most realistic hope to save coastal Louisiana and New Orleans. After a century-long absence, the Mississippi River’s role as a creator of land has begun to resume.115

River as Threat — The Mississippi River threatens New Orleans with hazard even as it benefits it with resources. Chief among the river’s threats to the eighteenth- and nineteenth-century city was its uncontrollability, manifested occasionally through bank erosion, occasionally through channel jumps, and seasonally through a threat of spring flooding. Hernando de Soto’s expedition bore first European witness to this annual phenomenon, when the river flooded both sides of the channel for about fifty miles in March and April 1543. Under natural conditions, the Mississippi River inundated its deltaic plain two manners. Annual springtime high waters sometimes surpass the crest of the natural levee and flow over it as sheet of water (overbank flooding) flowing slowly over the land and toward the backswamp. Alternatively, river water surges through a specific break in the natural levee (overuse flooding), filling up the backswamp via a focused and sometimes torrential flow rather than a thin, slow-moving sheet. Overbank flooding inundates the deltaic plain from the riverfront, while overuse flooding does so from the backswamp. Sometimes both types of flooding occur simultaneously, since waters that are high enough to spate over the bank may also be strong enough to penetrate a weak spot in the levee. Additionally, many local flood events are entirely attributable to Lake Pontchartrain, whose waters may be pushed upon adjacent marshes by storm surges from the Gulf of Mexico. One of the reasons the future New Orleans site appealed to Bienville during his explorations of 1699 and 1700 was that the riverfront land stood above the waterlogged backswamp at the time, which may have been flooded either by a spring river crevasse or by the lake. Those seasons turned out to be low-water years on the river; had Bienville first surveyed the area under overbank-flood conditions, he might have relented to pressures to locate New Orleans at Bayou Manchac or elsewhere.121

During the clearing of 1861, when in the spring of 1718, the Mississippi River threatened the nascent outpost with overbank flooding, interrupting the men’s work and forcing them to erect a make-shift dyke to keep river water from breaching the crest of the natural levee. Water higher than even the natives had ever seen arrived in April 1719, smothering the settlement with a half-foot of water and forcing the men to transform the temporary embankment into a permanent levee. Commencing the era of levee construction on the Mississippi River. A complete chronology and characterization of New Orleans floods in the century that followed exists, although because no single standard was applied to judging exactly what constituted a flood event, and no agency of historical times kept consistent records of location, duration, severity, or cause. According to one circa-1882 public health report, “partial inundations by the river” afflicted New Orleans in 1730, 1735, 1780, 1791, 1799, 1816, 1840, and 1862, while “partial inundations by Lake Pontchartrain or by ground water aided by the river”122 occurred in 1725, 1837, 1846, possibly in 1853 and 1854–1855, 1856, 1861, 1868, 1870, 1871, and 1881. Data on lake-direction floods prior to 1800 were either lost or never recorded, but the source notes that such floods were “much more numerous” than direct overbank flooding from the river, which became increasingly rare with improved levees.123 Gould’s “On the Mississippi adds 1780 to the list of colonial water crevasse floods. Kendall’s History of New Orleans (1901) adds 1813 to the record of crevasse flooding and 1844 as a lake flood; and a recent Army Corps of Engineers source adds 1850, 1858, 1861, 1867, and 1874 to the list of flood years.” In 1890, a river crevasse raised the level of the lake, which was pushed inland by winds, flooding the city up to the Metairie ridge. Another study found that New Orleans reached flood stage at least at New Orleans (but did not necessarily in the city) on an interval of once every 40 years, from 1854 to the 1920s.

“Crevasse,” the name given to a fissure or breaking of the levee, was first used by John Adams Paxton in 1823, “are occasioned by the causes: first, the yielding of the Levee; and secondly, the sinking of the bank of the river; the former kind could happen in instances, be prevented by prudently retiring the Levee from the immediate margin of the river; the latter is not so frequent, and is almost uniformly produced by neglect.” Their unpredictability and difficulty to repair made crevasse floods accountable for the city’s worst deluges—and the French term crevasses (“crack”) a dreaded word in the nineteenth-century Louisiana lexicon. On May 6, 1816,

117 E.W. Gould, Fifty Years on the Mississippi; Or, Gould’s History of River Navigation (St. Louis, MO, 1889), 223.
120 Under natural conditions, the Mississippi River inundated its deltaic plain in two manners. Annual springtime high waters sometimes surpass the crest of the natural levee and flow over it as sheet of water (overbank flooding) flowing slowly over the land and toward the backswamp. Alternatively, river water surges through a specific break in the natural levee (overuse flooding), filling up the backswamp via a focused and sometimes torrential flow rather than a thin, slow-moving sheet. Overbank flooding inundates the deltaic plain from the riverfront, while overuse flooding does so from the backswamp. Sometimes both types of flooding occur simultaneously, since waters that are high enough to spate over the bank may also be strong enough to penetrate a weak spot in the levee. Additionally, many local flood events are entirely attributable to Lake Pontchartrain, whose waters may be pushed upon adjacent marshes by storm surges from the Gulf of Mexico. One of the reasons the future New Orleans site appealed to Bienville during his explorations of 1699 and 1700 was that the riverfront land stood above the waterlogged backswamp at the time, which may have been flooded either by a spring river crevasse or by the lake. Those seasons turned out to be low-water years on the river; had Bienville first surveyed the area under overbank-flood conditions, he might have relented to pressures to locate New Orleans at Bayou Manchac or elsewhere.121 During the clearing of 1861, when in the spring of 1718, the Mississippi River threatened the nascent outpost with overbank flooding, interrupting the men’s work and forcing them to erect a make-shift dyke to keep river water from breaching the crest of the natural levee. Water higher than even the natives had ever seen arrived in April 1719, smothering the settlement with a half-foot of water and forcing the men to transform the temporary embankment into a permanent levee. Commencing the era of levee construction on the Mississippi River. A complete chronology and characterization of New Orleans floods in the century that followed exists, although because no single standard was applied to judging exactly what constituted a flood event, and no agency of historical times kept consistent records of location, duration, severity, or cause. According to one circa-1882 public health report, “partial inundations by the river” afflicted New Orleans in 1730, 1735, 1780, 1791, 1799, 1816, 1840, and 1862, while “partial inundations by Lake Pontchartrain or by ground water aided by the river”122 occurred in 1725, 1837, 1846, possibly in 1853 and 1854–1855, 1856, 1861, 1868, 1870, 1871, and 1881. Data on lake-direction floods prior to 1800 were either lost or never recorded, but the source notes that such floods were “much more numerous” than direct overbank flooding from the river, which became increasingly rare with improved levees.123 Gould’s “On the Mississippi adds 1780 to the list of colonial water crevasse floods. Kendall’s History of New Orleans (1901) adds 1813 to the record of crevasse flooding and 1844 as a lake flood; and a recent Army Corps of Engineers source adds 1850, 1858, 1861, 1867, and 1874 to the list of flood years.” In 1890, a river crevasse raised the level of the lake, which was pushed inland by winds, flooding the city up to the Metairie ridge. Another study found that New Orleans reached flood stage at least at New Orleans (but did not necessarily in the city) on an interval of once every 40 years, from 1854 to the 1920s.

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a weak spot in the levee on Barthélémy Macarty’s plantation in present-day Carrollton opened into a crevasse. Meeting river water fill up the backswamp and ascend the steep slope of the natural levee to the very heart of the city. One could see in a skiff from the corner of Chartres and Canal streets to Dauphin, down Dauphin to Bienville, down Bienville to Burgundy, thus to St. Louis Street from St. Louis to Rampart, and so throughout the rear suburbs.”127 But even with this destructive river-caused hazard came a valued river-borne resource: “the receding water,” noted one historian, “filled the low terrain with alluvial deposits, enriching the soil as well as elevating the swamp sections.”128 (This help position helped form the high ground along south Carrollton Avenue.) That summer also proved to be unusually healthy for the population—there were only 651 deaths in New Orleans in 1816, compared to 2,225 in 1816, 1877, and 3,078 in 1877—possibly due to the mass unplanned string cleaning of the filthy port city.129 Thirty-three years later, a one riverbed above the Macarty crevasse, the levee breach on Pierre Sauvé’s plantation in present-day western Metairie, between Harahan and Kenner. The river, May 3. 1849, river water poured through the breach that would later reach to 150 feet long and six feet deep, accumulating in the backswamp between the natural leveer of the Mississippi and the Metairie Ridge. It breached the New Basin Canal and its upraised Shell Road. On May 8, a few days, Rampart Street on May 15, and finally the St. Charles Avenu Streetcar Line) of up to ten inches.130 A few weeks later, a daily Picayune journalist climbed the cupola of the St. Charles Hotel and described the view from the 185-foot-high perch:

The whole of the streets in the Second Municipality…are now so many vast water courses, or aquatic highways, issuing as it were from the bosom of the swamp…. Indeed, there is no place within which we can compare New Orleans…. that would give the absent traveller so correct an idea of its topographical features, as the city of Venice.131

The crevasse was formally declared on June 25. A total of before 220 city blocks, with 2,000 structures and 12,000 residents were flooded by a single leak in the levee and seventeen miles away a levee settlement, gutters, wharves, and city structures were damaged that a special tax levied the next year to levy the bills.132 It was the worst crevasse flood ever to affect New Orleans, though by no means the last: a crevasse developed near the Garden District in 1862 and four reoccurred at Bonnet Carré between 1849 and 1882.133 Beneath layers of coarse and artificial fill in the area between Sauvé Road in Vernon Parish and the rear of the French Quarter lies a thin layer of 1849 river sediment, one of the last major flood-deposits made upon the cityscape created by them.

“May Heaven avert from us such another catastrophe! May our citizens, in their foresight and sagacity, devise some means of raising an insuperable barrier to another inundation from the Mississippi River.”134 So implored the Daily Picayune journalist on June 4, 1849, concluding his report on the historic magnitude of the Sauvé flood. His prayer was answered within a few decades: increasing sophistication and an extensive levee construction following the establishment of the Mississippi River Commission and the Federalization of flood control (1879) greatly reduced the threat of Mississippi River flooding to New Orleans. The increasing height and length of levees reduced the risk of overbank flooding in the region, while the increased quantity of levees diminished the chance of crevasse flooding. When the Great Mississippi River Flood of 1927 inundated most of the lower Mississippi Valley, from Cairo to the delta of the Atchafalaya River, New Orleans was saved by its levees even what would have been a catastrophic disaster. That crevasse was dynamited in the Caernarvon levee below New Orleans, to ensure further the safety of the prosperous city at the expense of poor, rural St. Bernard and Plaquemines parishes, remains one of the most controversial and bitter incidents in local history. The 1927 flood revealed the inadequacy of the long-standing “levees only” policy for Mississippi River flood control, and demon- strated the need for measures that accommodate the will of the river, in addition to the levees that constrain it. After the disaster, spillways at Bonnet Carré and Morganza—which are essentially controlled crevasses—were installed as a complement to the manmade levees that had been the only line of defense against the threat of the Mississippi from 1719 to 1927.

For the word “crevasse” is not heard today beyond historical and geological circles as a replication of the success of the Army Corps of Engineers’ flood control policies. Today the Mississippi River still periodically threatens New Orleans—the Bonnet Carré Spillway has been used in 1937, 1945, 1950, 1973, 1975, 1979, 1983, and 1997—but not in over a century has Mississippi River water significantly impinged directly upon Orleans Parish. Yet the legacy of the old threat lingers in the city’s memory. River flooding caused massive property damage and public-health problems from the early 1700s to the late 1800s, forcing private citizens and governments to spend and invest immeasurable resources.


133 See “The City” in Daily Picayune of May-June 1862 for accounts of this little-known port of disaster, which occurred as the city surrendered to Union forces during the Civil War.

into flood-control projects. This diversion of water resources surely has come at the expense of the economic well-being of the city. The flood threat is also manifested in the city’s historical geography, vis-à-vis its physical expansion, its architecture, and the cultural adaptation, its real estate values, even its racial patterns: poorer blacks lived closer to the flood-prone riverfront and backswamp, while wealthier whites lived in the safer areas between. Today, manmade levees and floodwalls for a single most significant landscape feature of the region, rising high above all surrounding deltaic terrain, orienting residents to the local layout of the land, securing them against what was once a dreaded annual threat. Worries were now look to Lake Pontchartrain and the adjoining Gulf of Mexico as the premier flood threat to the city, whose fate would rise with the force of a perfectly situated hurricane and pour into the New Orleans topographic bowl.

With the flood threat in check, a remaining threat posed by the Mississippi River is its role as a pathway of pollutants gathered from its 1,243,700 square-mile watershed and ushered past New Orleans. A pollutant, or contaminant, is all foreign (or overwhelming) substance that registers deleterious effects upon the ecosystem economics, or human health, of the river-influenced region, including its estuary. As the major water conduit north of the river, New Orleans bears the effects of much that is dumped, dug, eroded, spilled, sprayed, flushed, stored, manufactured, and passed through it. “Living downstream” is a fact of all port cities, but the burden upon New Orleans is multiplied by the sheer size of its hinterland, its dependency on the Mississippi, and by position 96 percent of the way down the river. Whatever the source of the problem—a huge Midwestern agricultural runoff to morning cups of coffee—if it ends up in the Mississippi, it will eventually be New Orleans’ problem.

Pollutants may be grouped into two overlapping categories that can cause health problems and those that disrupt ecosystem functions. Among those affecting the health of humans and other species: organic chemicals such as pesticides and petroleum products; inorganic chemicals in drinking metals and acids; ferrous agents such as bacteria and viruses; and radioactive materials like uranium. Pollutants potentially alter ecosystem functions include materials such as nitrates, ammonium, and phosphates; sediments; biota nonnative to the ecosystem; and temperature changes. Regardless of their sources, pollutants are released into the Mississippi watershed in two ways. Those released from point sources, such as sewers, oil refineries, and wastewater outfalls, generally flow directly into water bodies (treated or otherwise) and toward the Mississippi New Orleans. Others, in much greater quantities, discharge from non-point sources, such as farms, where pesticides and herbicides are sprayed, cities where polluted rainwater runs off, fields and forest where acid rain falls, and take the slow road toward their fate. A pesticide sprayed on a cropland, for example, may (1) run off the surface and into streams and rivers; (2) evaporize and return with rainfall; (3) absorb into vegetation for consumption by animals or humans; (4) leach into the soil and enter the aquifer; or (5) chemically break down into other compounds. Depending on a multitude of factors, most molecules would degrade over time, but at some time will eventually find their way into the Mississippi. Once riverborne, pollutants are by binding to sediments, articles either suspended or dissolved in the water column or in the bedload. For thousands of river miles from its entry into the system to the banks of the New Orleans metropolitan area, a pollutant molecule is at the mercy of the larger sediment flux, chemistry, and flow dynamics of the Mississippi River.

New Orleans’ potable water quality was notoriously bad until the early twentieth century. So foul was the piped water in 1854 that a German newspaper urged its readers to “drink no water—drink beer.” Most people tackled the problem alongside by resorting to cistern-collected rainwater, until the municipal system was finally opened in 1908 and the Mississippi River became the exclusive source of the city’s potable water. Judging from city newspapers, New Orleans awoke slowly to threat of Mississippi River water pollution: articles about water pollution numbered four in the 1930s, sixteen in the 1940s, nearly a hundred in the 1950s, then exploded in the early 1960s, when river and lake pollution hit the front pages consistently. One entered fifty-two articles about local water pollution annually in city papers in 1960 alone, including reports on “a sea of black crude oil flowing down Mississippi River toward New Orleans,” a nauseating experience to drink this water” after Esso Standard Oil spilled phenol in the river in Baton Rouge, and the on-again, off-again closure of Pontchartrain Beach due to lake pollution. Most of the river pollution in the early 1960s came from chemical and oil spills from river vessels, exacerbated by particularly cold winters (which diminished biological breakdown of the compounds) and slow river stages (which minimized dilution). News reports, editorials, and political cartoons both reflected and produced increasing public concern about the threat of water pollution. Over the next decade, similar sentiments nationwide led to the formation of environmental protection agencies at the federal and state levels, passage of the Clean Water Act, and countless other legislation and regulations aimed at reducing water and soil pollution. So great was the change in public opinion and legislation in the latter twentieth century that one tome divided...
the history of water quality management into two eras: from ancient times to Earth Day 1970, and after that symbolic day afterwards. Whatever one’s judgement of Mississippi River water quality at New Orleans today—municipal authorities assure its safety even as environmentalists sound alarms—all would agree that it is far better than it was a generation ago.

According to the Natural Resources Defense Council, the so-called “key contaminants” remain cause for concern in New Orleans’ tap of Mississippi River waters:

- Atrazine, an organic pollutant used as a weedkiller, was detected locally at the national standard in 1999, but has since declined. Sprayed on croplands (including local sugarcane) at levels of 35,000 tons per year, atrazine can damage organs and possibly cause cancer. Recent research indicates that this herbicide, produced entirely in nearby St. Gabriel and used internationally as one of the world’s most popular agricultural applications, may also disrupt species’ endocrine systems, resulting in the mis-transmission of hormonal signals and possibly sex reversal and other reproductive problems.141
- Fecal coliform bacteria have been found locally in small quantities in 1999-2001. While this microbial contaminant itself is not a concern at the levels detected, its presence “may indicate some regrowth of bacteria in the water mains after the water leaves the treatment plant, [which] may allow disease-causing pathogens to subsist in pipes.”142
- Turbidity (cloudiness) levels, another potential indicator of pathogen levels, nearly reached the EPA limit in 2000-2001. Turbide water may be contaminated with the waterborne microbial disease Cryptosporidium, which can pose a threat to people with weakened immune systems and was detected in small amounts in local tap water in 1998.
- Arsenic, an inorganic pollutant associated with industry, mining, and now-banned pesticides, as well as natural geological processes, has been detected at average levels of under one part per billion, below EPA standards but still possibly posing a cancer risk.
- Lead, a heavy metal with serious adverse affects on the health and development of young children, leaches into tap water through pipe or faucet corrosion. Levels of lead in the Mississippi River at New Orleans are lower than those of most major cities but because the “hardness” of local waters

139 Vladimir Novotny, Water Quality: Diffuse Pollution and Watershed Management (New York, NY, 2003), 1-10.
fortuitously tends to prevent pipe corrosion. New Orleans is generally in good shape in this regard. Lead-based paint on old houses, however, is a major health concern as it is on old bridges: when the Algiers-bound Crescent City Connection was repainted in 2002, paint chips falling into the Mississippi caused a spike in tests for lead at polio testing stations.

Hundreds of other pollutants flow in the Mississippi River past New Orleans at levels usually low enough to pose minimal threat to humans—but not necessarily to other living things or to the ecosystem. Consider the excessive nutrients in the river, derived mostly from manure and phosphorous used on Midwestern farms, as well as urban runoff, sewage, and animal waste. While this massive application of fertilizer helps make the Mississippi River basin the world’s most productive agricultural region, the nutrients eventually flow out to the Gulf of Mexico, where they stimulate algae growth in the upper layers of the water, deplete oxygen. When oxygen falls below two parts per million, most marine life is driven away or killed, creating a hypoxic (“low oxygen”) zone in what was once a rich fisheries resource. Silt directly benefiting Louisiana’s billion-dollar fishing industry. In a typical summer, a so-called “dead zone” spans 5,000 square miles along the inner- and mid-continental shelf, from the Mississippi birdfoot delta westward to the Texas coast. Sometimes hypoxia reaches into Lake Pontchartrain by means of the Mississippi River-Gulf Outlet (MR-GO), a navigation channel excavated between 1958 and 1968, which has since had a myriad environmental problems.

Consider also a more unconventional form of pollution: the invasion of species not native to the region by means of the Mississippi River. In the 20th century, four species of Asian carp escaped to control vegetation in Arkansas and Mississippi rivers and escaped and made their way into the Mississippi River system. As they spread upstream, causing concern for their competition with native commercial fisheries and for their hazardous tendency to leap out of the water, they struck surface ships, such as unsuspecting boaters. They also spread south: in 2006, a local fisherman within forty-five miles of the mouth of the river, when a U-boat sank the Robert E. Lee passenger freighter and later itself was destroyed. During the War in the early 2000s, authorities identified New Orleans as a “hot spot” for terrorist infiltration, for both its target-rich environment and its river accessibility. The sophisticated security devices now being installed on shipping containers and port facilities are the modern-day equivalents of the nineteenth-century masonry forts standing vigil along the river and adjacent marshes: bastions against those who seek to exploit the riverine access to the American interior, by means of New Orleans. It is no coincidence that, prior to September 11, 2001,

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the last major foreign attack on an American city occurred on the plains of Chalmette on January 8, 1815, the Battle of New Orleans.

Other Roles

Roles played by the Mississippi were political, economic, engineering, and culture underpins much of the history and geography of New Orleans. Politically, the river was an initial interest in the region from colonial and later American powers, each seeking to control the sole access route to the North American interior. The river served as a divider in the political subdivision of the region among competing powers and, later, as an American possession, as a boundary among states, counties and parishes, a principal distributable lands, and a litany of smaller political, geographic entities. No greater geo-political role has ever been played by the Mississippi River than the Louisiana Purchase in 1803, even New Orleans' street network pays indirect homage to the river: the French arpent system, used to delineate plantations perpendicularly to the river, passed the contours of the Mississippi on to the geometry of large properties, in which the urbanization process is conformable as New Orleans expanded upriver. The 1990 census counted by 99 percent of the population 99 percent of the time, and the river nevertheless exerts a formidable impact on local culture, as an orienting feature ("riverside," "upriver," "downriver") embedded in the local lexicon, as an influence in countless songs and stories, and as a "geographic and psychological barrier" separating the more prosperous and famous East Bank from the oft-sunken West Bank.

The Mississippi River's most important role to the city is as its economic one, as a conduit through which pass 6,000 ocean-vessels per year, with 2,000 docking or loading nearly 90 million tons of cargo at the Port of New Orleans. It is the single busiest port in the nation and easily ranks first when combined with the nearby Rail Road-Port of South Louisiana. The Port of New Orleans alone supports over 107,000 jobs, spends $13 billion per year, earns an additional $2 billion, and contributes $231 million to state tax coffers annually.149 Relative importance of the river and port to New Orleans was even greater in the past: most, if not close to all, of the city's spectacular wealth and meteoric rise between Americanization in 1803 and the Civil War in 1861 can be traced to river-related activity, as a cotton, rice, and sugar port and later a hub of coffee, tobacco, and bulk cargo. So long as New Orleans enjoys its present advantages by location on the Mississippi river, "to be a New Orleans Beaux Arts, "so long will her commerce continue to be augmented, and her property ensured. The townships of the French Quarter, the mansions of the Garden District, and most other vestiges of an opulent past derive from the "superiority of nature advantages,"150 and it is these historical attributes that the city’s million-plus visitors come to see. Perhaps in the future the Mississippi will serve as a conduit not just for cargo but data, as it offers a convenient distribution system for optical fibers and other circuity of the information age.

Volumes may also be written on the cultural influences of the Mississippi River upon New Orleans. The river served as a cultural conduit, drawing immigrants, women, and travelers into the Mississippi Valley and to New Orleans, and as a pipeline that injected a cosmopolitan, open-minded atmosphere into the port city. It also brought rural American farmers from Kentuckyian riverboatmen in the early 1800s to emancipated slaves later in the century, downriver to the city, and many of their descendents remain. That "round-the-clock, city-of-strangers" characteristic, coupled with the sense of physical isolation, helped form the city's reputation for the raffish and the rowdy, another pillar in today’s tourism industry. Bourbon Street is a direct descendant of this reputation.

At least for its first two centuries, the Mississippi River also diffused New Orleans culture outwardly, sending its merchants with their money and culture along with their worldview—and their language, music, and food—to ports upriver. The nature of that diffusion awaits serious scholarly investigation. Transmission of jazz spreading "up the river from New Orleans," for example, is oversimplified. Railroads, interstates, and air links to major hubs (not to mention telecommunications) diffuse immeasurably more culture, in all its manifestations, than does the river. Likewise, the Mississippi, as important as it remains to the national shipping system, has long since relinquished its monopoly on access to the Mississippi Basin. A century

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150 New Orleans Bee, April 10, 1836, p. 2, col. 2.
and a half ago, a Mississippi cotton grower or Louisiana sugar planter had little choice but to ship his harvest on the river through New Orleans to reach its buyers, thus enriching the city in the handling, marketing, and accessing of a commodity. He probably also used the river to get New Orleans to conduct business, meet with financiers, and send his children to school, socialize and entertain, and buy supplies for his estate. Today, a cotton or sugar producer has numerous shipping and handling options to get his commodity to market, few of which involve either the Mississippi or the Crescent City, and might even need to come to New Orleans for a trade show or convention—by New Orleans’ Mississippi monopoly began to falter as early as 1825, when the Erie Canal gave the Eastern Seaboard waterborne access to the western frontier. More canals followed. By the 1830s, “an increasing percentage of western produce traveled on the nearly dry river” to go to a market directly to the East. New Orleans’ share of the total freight, from 200,000 tons in 1800, eroded to 9,000 miles of railroad track in 1850, to 193,000 miles in 1900, further eroded the city’s once-exalted destiny. Whereas waterborne transportation moved nearly all freight in early nineteenth-century America, only about 15 percent of interstate commercial freight moves on inland waterways today; the rest is handled by railroads, trucks, pipelines, and aircraft. Many factors explain New Orleans’ decline from the heady visions of the early nineteenth century, when pamphlet and pontificators predicted that the city would someday rival Europe’s richest and most important cities on earth. Chief among them is the simple fact that its riverine raison d’être—despite its magnitude and majesty—has been much less critical to the nation than it once was. New Orleans today may be viewed as a grand and splendid vestige of an economic geography that no longer exists.

The bonds that link New Orleans to the Mississippi River are fewer and weaker than in the day when America depended heavily on waterborne transportation. Yet a survey of the great river from the levee at Jackson Square only fails to convey a sense of awe and reverence, like that held by an essayist in 1866:

In the river lies the majestic river—lies that hold of power, wealth, and the highest beauty, for it reaches back 13,000 years. An earthwork of omnipotence and eternity, it lies as it did ages ago in the unknown past, and it will roll on in the same grandeur until time shall be no more.133

Epilogue: Katrina’s assault on the coastal wetlands will force managers to reevaluate earlier plans for river diversions and siphoning, a new situation may render infeasible radical strategies such as large-scale crevasses and levee openings, allowing for more and cheap wetlands restoration and perhaps some protection from the next storm. But this would come at the cost of navigation needs and the hundreds of communities that have the heart of the lower-river landscape since colonial times.136

Mississippi River played a long, ground role during the dramatic Hurricanes Katrina and Rita. The storm surge from the Gulf of Mexico arrived almost exclusively via lake Pontchartrain and Bourg and manmade drainage and navigation canals, not Mississippi. But the river would swell from its typically low late-summer stage of about four feet to nearly sixty feet above normal sea level—practically flood stage—and inundated over laterally in parts of lower Plaquemines Parish. In New Orleans proper, the Mississippi River came to be seen as a sort of refuge, a destination for those wading out of the delta to head toward to reach dry land, a place for rescuers to dock their vessels for a safe night’s sleep, a source of water that needn’t be piped, and a possible route for future evolutions. After one hundred years of sprawling outwardly toward the lake and drowned marshes, New Orleans may look back to a river, reconstituting the crescent-shaped city and giving its historical moniker renewed meaning.

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