

# Above-Sea-Level New Orleans

## The Residential Capacity of Orleans Parish's Higher Ground



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### Executive Summary

- Contrary to popular perceptions, half of New Orleans is *at* or *above* sea level. Elevated areas, while not immune to flooding, constitute a valuable natural resource for which residential use, whenever practical, should be prioritized.
- It is well known that New Orleans' population declined by 143,000 during 1960-2000, as residents departed for suburban parishes. Few realize that, within the remaining population, 121,000 New Orleanians migrated internally from higher historic neighborhoods to low-lying subdivisions, many of which flooded after Katrina.
- If New Orleanians lived today at circa-1960 population densities and distributions, over 300,000 people could reside above sea level—far more than the 223,000 people living throughout the entire city today.<sup>1</sup>
- Despite its value, above-sea-level New Orleans is replete with open parcels and other underutilized space. Nearly 2,000 such lots have been identified in this study, covering 1.21 square miles (three times the size of the French Quarter). If blighted and adjudicated properties were included, this figure would be even higher.
- If these open parcels were residentially developed at earlier population densities, between 9,000 and 20,000 additional people could be settled on high ground, possibly many more. This effort would help put people out of harm's way while “mending tears” in the historical urban fabric.
- **Policies aimed at fully utilizing above-sea-level New Orleans for residential living are recommended.**

### Introduction

Innumerable media reports following Hurricane Katrina described the topography of New Orleans as unconditionally “below sea level.” This oversimplification is inaccurate by half, and its frequent repetition does a great disservice to the city. In fact, both New Orleans proper and the metropolitan region *straddle* sea level.

Since Katrina, a great deal of attention has been rightfully paid to the future of lower-lying neighborhoods, which flooded heavily. Meanwhile, higher areas have been largely under studied.

The purpose of this investigation is to bring attention to above-sea-level New Orleans, measure and map it, and estimate how many people could theoretically reside there, based on historical and recent census data. These estimates are calculated for the entire elevated zone, as well as for specifically identified open parcels which could be developed into higher, safer residential housing with minimal impact on adjacent areas.

### Topographic New Orleans

Historically, when the Mississippi River flooded during most springs, it deposited the largest quantities of the coarsest sediments immediately upon the banks of the river, with lesser amounts of finer-grained sediment settling away from the river (the “backswamp”). Areas closer to the river thus built up the highest, over the course of centuries. These areas are called “natural levees.”

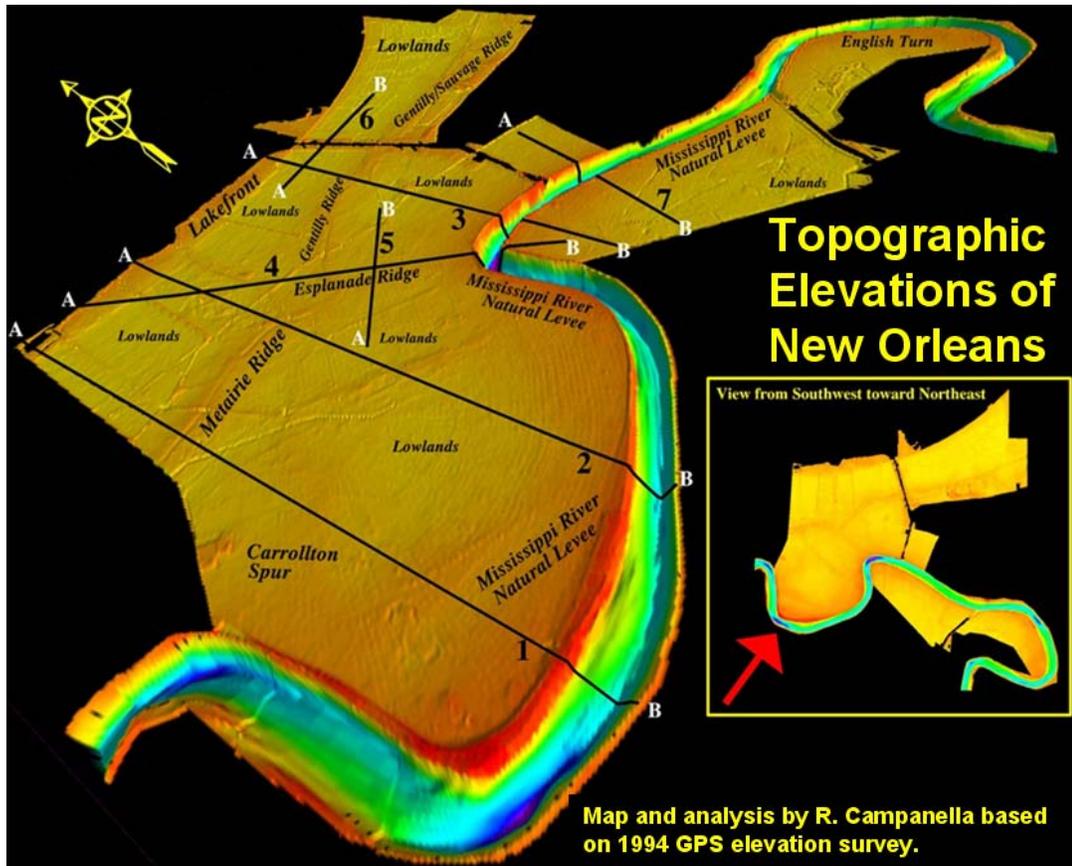
Occasionally, a break (“crevasse”) would develop in the natural levee, allowing a “distributary” to flow into the backswamp. These waterways would form their own natural levees, though much smaller ones than those of the main channel. One such distributary flowed out of the river in present-day Kenner and wended its way eastward, creating a slight upland known today as the Metairie-Gentilly Ridge (now traversed by Metairie Road, City Park Avenue, and Gentilly Boulevard). Earlier, the river itself flowed along this trajectory; one of its forks formed the Esplanade Ridge, a slight upland beneath today's Esplanade Avenue. These natural topographic crests—the natural levee of the Mississippi, Metairie-Gentilly Ridge, and Esplanade Ridge—hydrologically subdivided New Orleans into four sub-basins, plus another on the West Bank in Algiers.

Starting in the early 1700s, when the local land surface lay entirely at or above sea level, humans radically altered the topography of New Orleans. They shored up the Mississippi's natural levees with earthen

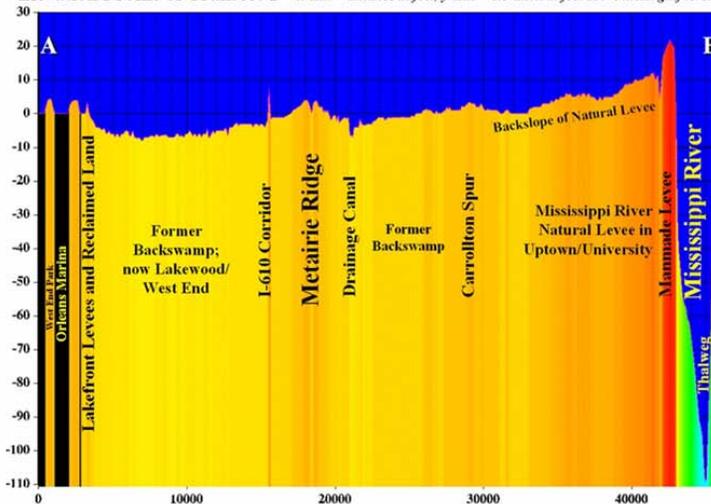
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<sup>1</sup> Matt Scallan, “N.O. at 223,000 in Census Estimate; Jeff Pegged as La.'s Most Populous Parish,” *Times-Picayune*, March 22, 2007, page 2.

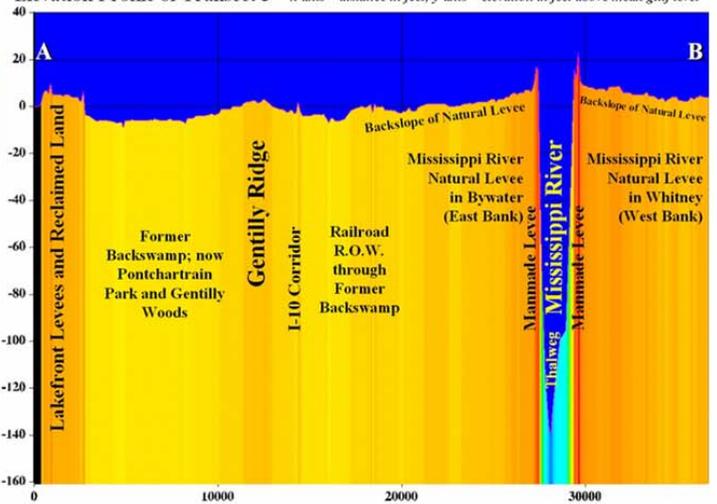
embankments (“artificial levees”) to prevent springtime overbank flooding, then did the same along Lake Pontchartrain shore and around the marshy periphery (“hurricane protection levees”) to keep out coastal surges. These levees, plus the sophisticated municipal drainage system installed around 1900, allowed the city to spread onto former marshes but also starved the land of replenishing sediment and removed the water component from the alluvial soil body. As a result, former marshes sunk as much as 8-12 feet, while unleveed wetlands eroded at a pace of 10-35 square miles per year between the 1930s and early 2000s. Land that once sloped gradually from 10-12 feet above sea level to sea level in 1700 today forms a series of topographic bowls both above and below sea level, with the artificial levees forming the highest earthen surfaces.<sup>2</sup>



**Elevation Profile of Transect 1** x-axis = distance in feet; y-axis = elevation in feet above mean gulf level



**Elevation Profile of Transect 3** x-axis = distance in feet; y-axis = elevation in feet above mean gulf level



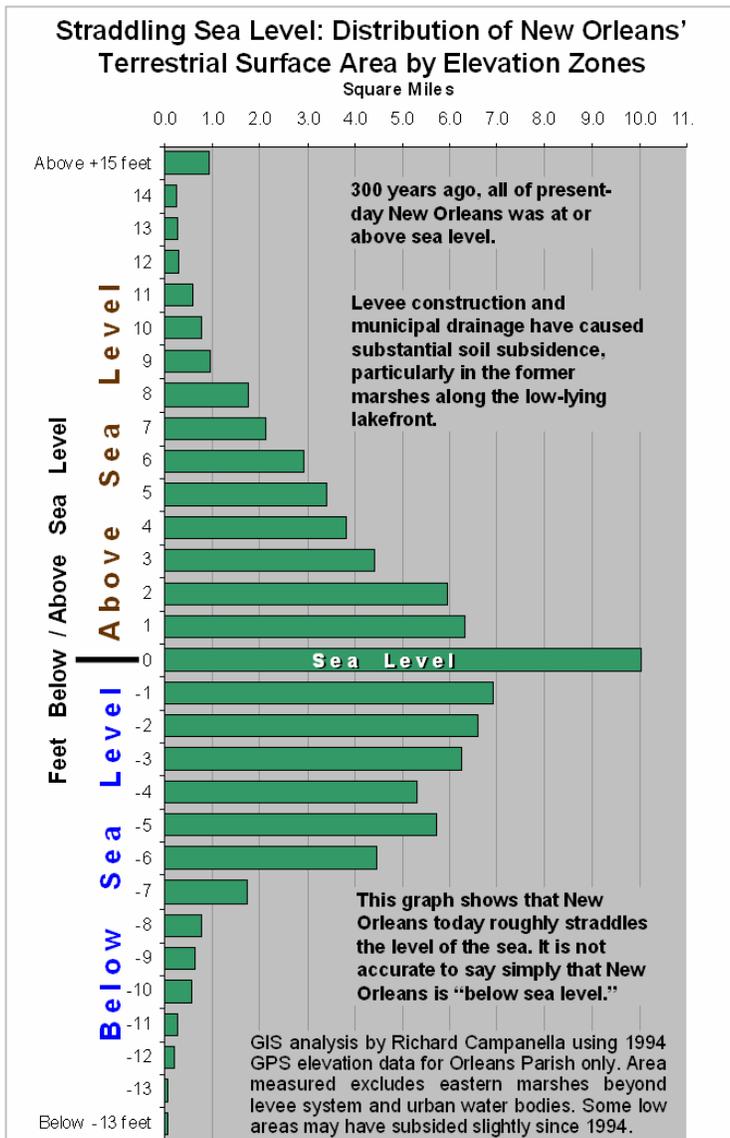
<sup>2</sup> Campanella, Richard, *Geographies of New Orleans: Urban Fabrics Before the Storm*, Lafayette, Louisiana: Center for Louisiana Studies, 2006, and Campanella, Richard, *Time and Place in New Orleans: Past Geographies in the Present Day*, Gretna, Louisiana: Pelican Publishing Company, 2002.

It is important to note that topographic elevation is by no means the sole factor determining flooding potential. Various human manipulations of the topographic surface (levees, drainage canals, navigation canals, transportation corridors) have subdivided the city's natural hydrological basins into about a dozen sub-basins. A levee or floodwall breach, pump failure, or clogged canal in one basin may or may not flood adjoining basins, depending on location and severity. Above-sea-level parcels in an affected sub-basin may flood even as below-sea-level parcels in a nearby unaffected basin remain dry. This happened during Katrina: higher-elevation parcels in Holy Cross flooded because of the severity of the levee failures east of the Industrial Canal, while lower-elevation areas west of the canal were spared because those levees mostly held.<sup>3</sup>

Nevertheless, because we cannot currently forecast where levees or pumps might fail and which basins might inundate, we must acknowledge that, as a general principle, higher ground is always less flood-prone to lower ground. Elevation is a scarce, precious resource in an inhabited deltaic environment. It should be fully utilized for residential living.

### Above-Sea-Level New Orleans

Both New Orleans proper and the metropolitan region *straddle* the level of the sea, almost precisely (see graph below). An analysis of GPS elevation data indicates that the levee-protected terrestrial surfaces of Orleans Parish, from the Jefferson Parish line to the eastern hurricane-protection levees plus Algiers, are 53% at or above sea level, and 47% below.



The unprotected eastern marshes are mostly at or slightly above sea level.) Results are similar for the metropolitan area: LIDAR elevation data show that 51 percent of the terrestrial surface of the contiguous urbanized portions of Orleans, Jefferson, and St. Bernard parishes lie at or above sea level (with the highest neighborhoods at 10-12 feet above mean sea level), while 49 percent lies below sea level, in places to equivalent depths.<sup>4</sup>

Above-sea-level New Orleans hosts most of the city's significant architecture and famous historical neighborhoods. As recently as the early 20<sup>th</sup> century, nearly all of the city's 300,000 residents as well as those in neighboring parishes resided above sea level. The reason is obvious: only in these elevated areas could neighborhoods be built prior to the circa-1900 installation of the municipal drainage system. All other areas comprised swamp or marsh.

Above-sea-level New Orleans is also home to two of the city's most important industries—the tourism and convention trade and the port—as well as the entire Central Business District and most of the medical district. New Orleans' signature neighborhood, the French Quarter, is entirely above sea level, in areas by over 10 feet.

Above-sea-level New Orleans fared relatively well during Hurricane Katrina. Sturdy old homes generally withstood the winds, and more importantly, evaded most of the severe and long-lasting flooding. Residents were able to return to these higher areas within weeks of the disaster. Businesses on higher ground reopened faster than those on lower ground.

<sup>3</sup> Grisett, Sheila, "Uneven Flood Risks Dot Local Terrain," *Times-Picayune*, December 24, 2006, page 1.

<sup>4</sup> Percentages computed from LIDAR digital elevation models covering from 90° 15' West, 29° 53' North to 89° 56' West, 30° 03' North (roughly from Westwego to Little Woods).

According to one study, 96% of unflooded businesses on higher ground had reopened within the year after Katrina, while 57% of those that flooded moderately and only 37% of those that flooded deeply, had reopened.<sup>5</sup>

Given the relative safety and appealing attributes of above-sea-level New Orleans, one might expect these higher environs to be fully utilized. In fact, residentially developed areas on the natural levee now host less than half the population density seen in the recent past. Furthermore, nearly two thousand open and apparently underutilized parcels lie scattered throughout this higher area. Determining the residential capacity of these areas is described below.

## **Methodology to Measure Residential Capacity of Above-Sea-Level New Orleans**

Two methods are used to determine how many people could live in above-sea-level sections of New Orleans: (1) through historical censuses, and (2) through mapping and measuring open parcels. The first method looks at how many people once lived in those areas. The year 1960 is ideal for this approach, since that year witnessed New Orleans' population peak at 627,585 people, and is recent enough to embody social and domestic circumstances similar to those that exist today. Census 2000 was also processed for comparative purposes.

The second method is more conservative. It assumes that modern-day residents would not or could not change their residential densities to match those of earlier times. So increasing population capacities would have to be accomplished by residentially developing open and apparently underutilized parcels at densities at least commensurate with adjacent areas. Such an effort would have the added benefit of "mending tears" in the historical "urban fabric" of the city.

### **Method 1: Historical Censuses**

The following procedures explain how 1960 and 2000 Census data were processed:

1. Population data at the census tract level were acquired in hard-copy format (no digital versions existed) from Special Collections archives at Tulane University and the University of New Orleans.<sup>6</sup>
2. Census tract codes and their respective populations were entered into a Geographic Information Systems (GIS) attribute table.
3. Census tracts were digitized as polygons into the GIS and tagged with tract codes.
4. The census tracts were then edited and reshaped to reflect the developed, inhabited areas that existed in 1960. This was done by finding reliable maps from that era, scanning and georeferencing them, underlaying them beneath the census tract polygons, and "shrinking" the census tracts to the extent of the developed regions. This time-consuming step is extremely important because it dramatically increases the accuracy of population density measurements. For example, census tracts almost always include parks, water bodies, uninhabited marshes, and other unpopulated areas; if they are not edited to eliminate these areas, the resultant density measurement would be lower than that actually experienced by residents.
5. Recent LIDAR elevation data, measuring topographic elevations at the five-meter pixel level, were acquired, mosaicked, and processed into vector-based elevation zones, so that spatial queries may be performed.<sup>7</sup> No adjustments were made for the amount of topographic subsidence that has occurred between 1960 and the date of the LIDAR data (1999-2001), because such estimates are difficult to validate, and natural levees tend to subside less than former marshes.
6. Population data were then spatially queried as their centroids fell within elevation zones. For census tracts that straddled above- and below-sea-level areas, the polygon was edited down to the above-sea-level area and the population was proportionally decreased under the assumption of even population distribution.
7. These procedures were repeated for the 2000 Census, using population data at the block level. Because block-level data are about ten times more detailed than census tract data, no editing was required.

### **Results of Method 1**

This analysis determined that approximately 306,000 New Orleanians, or roughly 48%, lived above sea level in 1960.<sup>8</sup> Because this year represented Orleans Parish's peak population and because most of the existing housing stock remains in place today, the number 306,000 may be viewed as a reasonable (perhaps even conservative) estimated population capacity of above-sea-level New Orleans.

Over the next forty years, 143,000 New Orleanians departed for suburban parishes, and many thousands more migrated within Orleans Parish from higher to lower ground—even after Hurricane Betsy

<sup>5</sup> Campanella, Richard. "Street Survey of Business Reopenings in Post-Katrina New Orleans," CBR Whitepaper available at [www.kernn.org/pdf/campanella2.pdf](http://www.kernn.org/pdf/campanella2.pdf), National Science Foundation SGER Award 0554937, January 2007.

<sup>6</sup> U.S. Department of Commerce Bureau of the Census, *U.S. Census of Housing: 1960, City Blocks-New Orleans, La.*, 1961, pp. 1-79, and Chamber of Commerce of the New Orleans Area, *Metropolitan New Orleans Population & Housing by Census Tracts*, 1963, pp. 1-19.

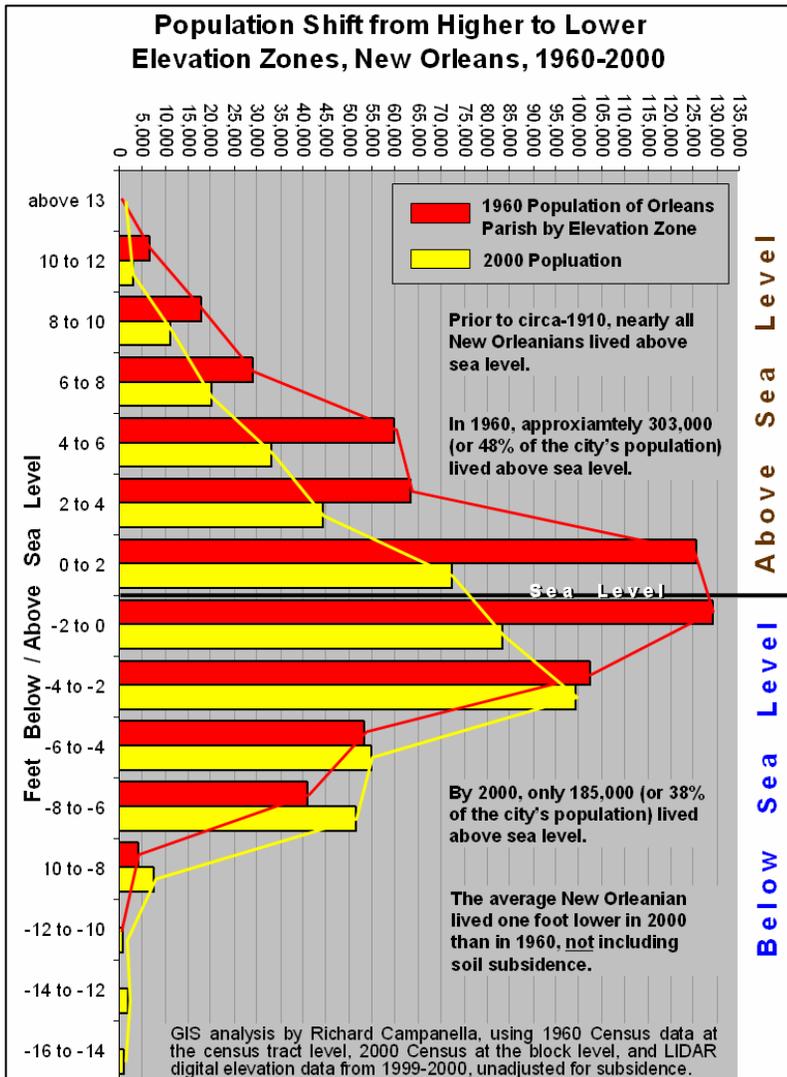
<sup>7</sup> Cunningham, Robert, David Gisclair, and John Craig. "The Louisiana Statewide LIDAR Project." Unpublished technical paper distributed at [www.atlas.lsu.edu](http://www.atlas.lsu.edu).

<sup>8</sup> The actual number is probably slightly higher, because elevations have since subsided and this study uses modern-day elevation measurements.

flooded some of these areas in 1965. The 2000 Census analyzed in the same manner shows that only 185,000 New Orleanians, or 38%, lived above sea level at the beginning of the 21<sup>st</sup> century. This compares to 48% (of a much larger total population) 40 years earlier, and over 90% (of a comparable total population) a century ago.

| <b>Population Capacity of Above-Sea-Level New Orleans, according to Historical Census Data</b> |  |   |   |  |  |
|--|--|---|---|--|--|
| <b>In this year:</b>   | <b>New Orleanians lived above sea level...</b> | <b>...representing _____ percent...</b> | <b>...of _____ total parish population.</b> | <b>This above-sea-level population represents...</b> | <b>Above-sea-level New Orleans was...</b>  |
| 1910   | ~300,000 (estimated)                           | ~90% (estimated)                        | 339,075                                     | 77,000 more than the total 2006 city population.     | ... <b>well-utilized</b> in 1910, and <b>spacious enough</b> to accommodate most of the population.  |
| 1960   | 306,000  | 48%                                     | 627,585                                     | 80,000 more than the total 2006 city population.     | ... <b>well-utilized</b> in 1960, but could not accommodate all New Orleanians. City had to occupy lower areas—and did, mostly west of Industrial Canal. |
| 2000   | 185,000  | 38%                                     | 484,674                                     | 38,000 fewer than the total 2006 city population.    | ... <b>poorly utilized by 2000</b> . It is <b>spacious enough</b> to accommodate entire 2006 population with room for 80,000 more.                       |

Sources: US Census 1910, 1960, and 2000, analyzed topographically using 2000 LIDAR digital elevation models from FEMA and state.

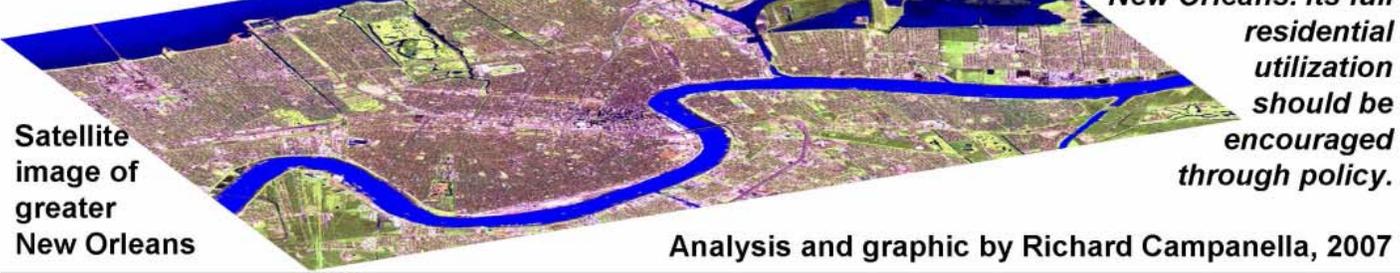


### Citywide Population Density

Disregarding elevation, New Orleans' actual population density (that is, population divided by occupied area, excluding parks, fields, forests, marshes, water bodies, etc.) dropped by over half in forty years. In 1960, 627,535 people lived mostly on 36.8 square miles, equating to 17,053 per square mile. By 2000, only 484,674 lived on 66.7 square miles, for a density of 7,266 per square mile.<sup>9</sup> This dramatic decline was caused by simultaneous suburban exodus and urban sprawl.

The graph at left illustrates how the New Orleans population shifted from higher to lower elevations during the late 20<sup>th</sup> century, even as the total population declined by 23%. Meanwhile, coastal wetlands eroded, soils subsided, and low-lying urban areas became increasingly vulnerable.

<sup>9</sup> 1960 data were processed at the coarser census tract level, while 2000 were analyzed at the more detailed census block level.



Analysis and graphic by Richard Campanella, 2007

## Method 2: Mending the Urban Fabric

If reconstituting 1960 population densities is not feasible, opportunities still exist for increasing the modern-day population of above-sea-level New Orleans. A drive along the highest corridors in the city, such as Tchoupitoulas Street uptown and Chartres Street in Bywater, reveals a large number of undeveloped parcels that are either completely vacant or, at best, used for temporary storage, parking, or other light purposes. This section inventories these open parcels, computes the adjacent mean and maximum population density from both 1960 and 2000, and calculates how many additional residents may be theoretically settled in these parcels if they were to be rezoned and developed for residential living. The following protocols were followed:

1. Color-composite DigitalGlobe post-Katrina satellite imagery was acquired at 0.6m spatial resolution.
2. LIDAR elevation models were processed to identify above-sea-level areas within Orleans Parish, on both banks of the Mississippi and on both sides of the Industrial Canal, but excluding the rural marshes east of the hurricane-protection levee and the rural Lower Coast of Algiers (below the Algiers Canal).
3. GIS data, Internet maps, and other ancillary data sources were acquired and georeferenced.
4. The various data source were consulted to identify open parcels with the following characteristics:
  - That they were above sea level;
  - That they were not parks, cemeteries, levees, neutral grounds, landscaped green space, campuses, military bases, school yards, canal rights-of-way, rail yards, or other undevelopable lots;
  - That they were not parking lots which were dedicated to specific entities such as hospitals or schools (a typical public-access commercial parking in the CBD was included in the inventory);
  - That they were not within a half-block of a railroad corridor;
  - That they were largely unoccupied by structures such as open sheds and stored objects.

Blighted or adjudicated properties were not included in this study, nor were unoccupied structures or housing projects. Certain exceptions were made for large multi-family complexes specifically known to be empty at the time.
5. Parcels that conformed to these protocols were field-checked for accuracy and mapped into a GIS.
6. A script was written in Arc Macro Language (AML) to loop through all parcels and (1) compute its area, (2) buffer it by 200 meters, (3) intersect it with the adjacent area's mean and maximum population density from 1960 and from 2000, (4) compute how many people could theoretically reside on that parcel at those densities, and (5) determine the lot's current zoning. A buffer of 200 meters was selected because this distance (about two city blocks) represented a reasonable radius within which the adjacent population density may be calculated.

It is fully recognized that most of these open parcels are under private ownership. Identification of a privately owned parcel in this study should not be viewed as an imposition on the rights of private land owners. It is intended only to measure the impact that residential development of said parcels would have on the population capacity of higher ground.

### Results of Method 2

- 1,972 open parcels conforming to the above protocols were inventoried.
- Together, these parcels measured 1.21 square miles, an area triple the size of the French Quarter.
- Of those parcels, 65% are already zoned for residential use, while 23% occupy a mix of land-use zones and the remaining 12% are mostly zoned for uses other than residential.

The follow table computes how many residents could theoretically settle these areas at various densities.

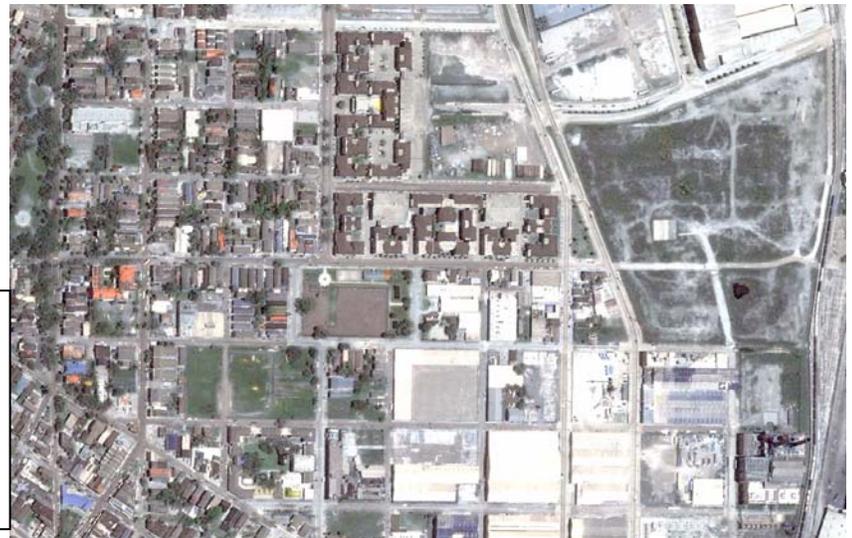
| <b>If 1,972 above-sea-level parcels (1.21 sq mi) in Orleans Parish were residentially developed to accommodate...</b> |  |   |   |   |  |
|---|--|---|---|---|--|
| <b>...the mean local population density from 1960 (within 200m), then...</b>  | <b>...the mean citywide population density from 1960 (17,053/sq mi), then...</b> | <b>...the maximum local population density from 1960 (within 200m), then...</b> | <b>...the mean local population density from 2000 (within 200m), then ...</b> | <b>...the mean citywide population density from 2000 (7,266/sq mi), then...</b> | <b>...the maximum local population density from 2000 (within 200m), then ...</b> |
| <b>18,900</b>   | <b>20,630</b>  | <b>67,200</b>   | <b>8,900</b>  | <b>8,790</b>  | <b>44,300</b>  |
| <b>...people could be settled in those areas.</b>   |  |   |   |   |  |
| <i>Sources: US Census, 1960 and 2000, and LIDAR digital elevation models from FEMA and state.</i>                     |  |   |   |   |  |



Oblique satellite image showing open or under-utilized parcels that lie above sea level in red.



These Bywater blocks at left, which range from 4 feet above sea level at the top to 8 feet along Chartres Street at the bottom, host about a dozen open parcels of varying sizes. This high land could become home to hundreds of New Orleanians.



The Lower Garden District riverfront (right), once slated for Convention Center expansion, is replete with open high land. Extending the urban fabric of the historic Coliseum Square neighborhood (at left edge) into those areas would broaden the tax base, energize local retail economies, and put people out of harm's way.

**Policy Recommendations**

For many decades during the 20<sup>th</sup> century, over 300,000 New Orleanians lived above sea level. By century's end, however, New Orleanians depopulated the very areas that afford the greatest natural protection from flooding. Only 185,000 remained above sea level by 2000, and fewer live there today. **Policies aimed at fully utilizing this valuable natural resource for residential occupation, by encouraging increased population densities, are recommended.**

This study also shows that nearly 2,000 vacant, unused, or lightly used parcels, spanning 1.21 square miles, are dispersed throughout above-sea-level New Orleans. If these parcels were developed for residential living at 1960-level population densities, they could be home to an additional 21,000 people, possibly many more. Even if they were populated at 2000-level densities, around 9,000 people could be settled there, possibly many more. **Policies aimed at rezoning these parcels and encouraging their residential development at high population densities are recommended.**

**Further study regarding how land owners, developers, landlords, and others may be motivated and facilitated to increase the residential utilization of above-sea-level New Orleans are needed.**

**This valuable natural resource should be prioritized for human habitation.**