Review of the Engineering Geology of St. Bernard Parish, Louisiana

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Introduction

St. Bernard Parish has a total area of 1,330 square miles (3,445 square km). Of this area, about 465 square miles (1,200 square km) is land. The remaining 865 square miles (2,240 square km), 65 percent, of St. Bernard Parish consists of open water in the form of streams, lakes, and bays. This area lies entirely within the St. Bernard delta lobe of the Mississippi delta, which was created by the Mississippi River when its main channel occupied Bayou La Loutre (Figure 1)(Frazier, 1967; Wiseman et al., 1979; Saucier, 1994). The engineering properties of these deltaic sediments, as summarized and discussed in this article, provide guidance for the reconstruction of St. Bernard Parish.

The elevation of St. Bernard Parish varies from 6 ft (1.8 m) below sea level to 12 ft (3.6 m) above sea level. The portion of St. Bernard Parish, which lies below sea level, was marsh and swamp, which have been drained and protected by dikes. The highest natural parts of St. Bernard Parish are the natural levees, locally called "finger ridges", of the Mississippi River, its distributaries, and a former channel of it now occupied by Bayou La Loutre. The portion of these natural levees lying sufficiently above sea level that are suitable for agriculture and urban development without the use of dikes comprise only about 58 square miles (150 square km), of the land within St. Bernard Parish. In the northern part of St. Bernard Parish, near Arabia, a large man-made pile rises over 35 ft (11 m) above sea level.

Prior to being devastated by Hurricane Katrina, St. Bernard Parish had been a prosperous, populated, and culturally distinct part of the New Orleans metropolitan area. The U.S. Census Bureau estimated the population of St. Bernard Parish was 65,554 people in 2004 comprising 25,123 households in 2000 (U.S. Census Bureau 2004). This was a population density of about 141 persons per square mile. Given that the vast majority of the population was concentrated on only 58 square miles of high ground within St. Bernard Parish, the actual population density of its urban areas is several times higher than this figure. A significant part of this population comprised suburbs containing people who worked within various parts of Orleans Parish. Associated with these suburbs were well-developed wholesale, retail and service business sectors. In 2000, there were an estimated 27,078 housing units and 1,191 private, nonfarm businesses within St. Bernard Parish (U.S. Census Bureau, 2004). Not reflected in any of the published statistics was the closely-knit and

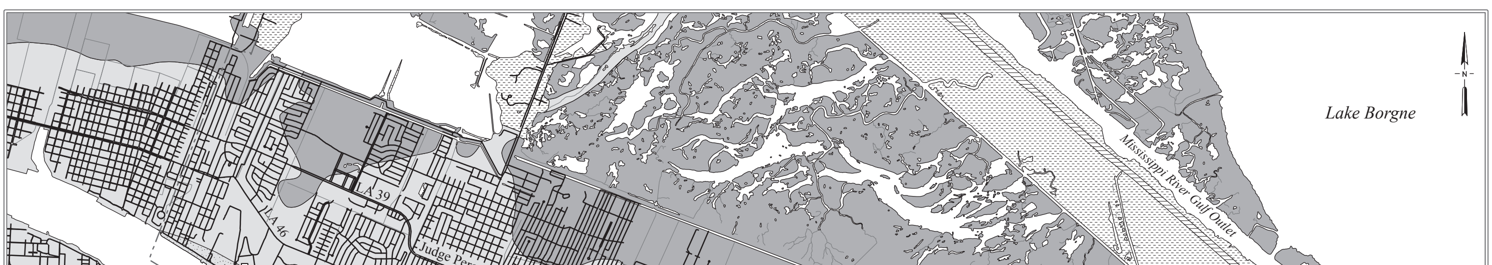

Figure 1. Surficial geologic map of the urban corridor within northwest St. Bernard Parish.

often culturally distinctive nature of many of the numerous communities that had developed within St. Bernard Parish since 1780, when it was first settled.

Before the devastation wrought by Hurricane Katrina, St. Bernard Parish possessed a diverse industrial base. Along the east bank of the Mississippi River, mostly between Arabia and Chalmette, the industrial base included sugar (American Sugar and Domino Sugar refineries) and petrochemical (Murphy Oil and Tenneco Oil refineries) refineries. Further south, the industrial base consisted mainly of seafood processing plants and some shipbuilding. The population within lowermost part of St. Bernard Parish depended almost entirely upon shrimping, fishing, and oyster farming.

The effort by the citizens of St. Bernard Parish to return to what is their home, rebuild their communities and livelihoods, and remain to lead productive lives will require an understanding of the nature and physical properties of the deltaic sediments that underlie St. Bernard Parish. The physical (engineering) properties of these sediments have been described and summarized in a number of published studies, i.e. Kolb and Van Lopik (1958), Dunbar et al. (1994), Kolb (1962), and Montgomery (1974). Additional geotechnical data is available from a study, U.S. Army Corps of Engineers (1958), conducted for the construction of the Mississippi River-Gulf Outlet (MRGO) channel. These reports, their plates, and 1:62,500 scale geologic maps are currently available online at U.S. Army Corps of Engineers (2004).

A summary of the information available from the above sources in relationship to a preliminary geologic map of the urban core of St. Bernard Parish will be presented in this report. This map was prepared from an examination of LIDAR (LIght Detecting And Ranging) digital elevation models, soil surveys by Trahan et al. (1989, 2000), 1:24,000 scale topographic mapping, and various historic and contemporary aerial imagery. The compilation and analysis of data from geotechnical investigations produced for various Louisiana Department of Transportation and Development, U.S. Army Corps of Engineers, local refineries, and local government projects would provide an even more detailed picture of the engineering geology of St. Bernard Parish.

Natural Levees

Within St. Bernard Parish, urban centers and industrial complexes occupy alluvial ridges, called natural levees, which flank both sides of river and distributary channels (Figure 1). Natural levees are asymmetric ridges, which are highest adjacent to their associated channel and slope gently away and downward in elevation from it until they merge with marshes and swamps of lower elevation (Shaw and Moresi 1936; Fisk and McFarlan, 1955, 1966).

Distributaries are channels that branch off of the modern and relict courses, i.e. Bayou La Loutre, of the Mississippi River. They are called "distributaries" because when active, they distributed floodwaters away from the Mississippi River into the surrounding deltaic plain. The channels of these distributaries and their natural levees radiate outward in a fan-like network from either the modern Mississippi River or its former St. Bernard delta lobe trunk channel (Shaw and Moresi 1936; Fisk and McFarlan, 1955, 1966; Kolb and Van Lopik, 1958, 1966; Saucier, 1994).

Within St. Bernard Parish, natural levees flank the active channel of the modern Mississippi River and the relict trunk channel and associated relict distributary channels of the St. Bernard delta lobe. Besides the Mississippi River, the relict trunk channel, now occupied by Bayou La Loutre, and a large relict distributary channel, now occupied by Bayou Terre Aux Boeufs, has large, well-developed natural levees (Fisk and McFarlan, 1955; Kolb and Van Lopik, 1958, 1966; Saucier, 1994; Shaw and Moresi, 1936).

As previously noted, the natural levees constitute the high ground within St. Bernard Parish. The highest part of this parish consists of the natural levee of Mississippi River, which forms its east, left-descending, bank. It is as much as 12 ft (3.6 m) above sea level. The towns of Arabia, Chalmette, Meaux, Poydras, and Violet along with major industrial complexes, i.e. the sugar refineries of American Sugar and Domino Sugar and petrochemical refineries of Murphy Oil and Tenneco Oil, occupied the natural levee along the east bank of the Mississippi River. Chalmette and Poydras occupy segments, which are wider than normal, where it joins respectively the natural levees of either an unnamed distributary or Bayou La Loutre (Shaw and Moresi, 1936; Kolb and Van Lopik, 1958, 1966).

These natural levees typically consist of equal proportions of high plasticity, fat clay, (CH, in the Unified Soil Classification System) and low plasticity, lean clay (CL, in the Unified Soil Classification System)(figure 2). The natural levees of the Mississippi River and Bayou La Loutre also consist of as much as 30 percent silt and sandy silty, which is ML in the Unified Soil Classification System. The silt and sandy silt comprise the crests of these natural levees. Typically, both the grain size and thickness of natural levee sediments decrease away from it crests towards where they merges with the surrounding delta plain (U.S. Army Corps of Engineers, 1958; Kolb and Van Lopik, 1958; Kolb, 1962).

Because of prolonged subaerial exposure, the sediments comprising natural levees are typically preconsolidated by desiccation and cementation. As a result, the cohesive clayey sediments found within natural levees typically possess high cohesive shear strength, 800 to 1200 lbs per square foot, and low water contents, 20 to 40 percent of dry weight. Their Liquid Limits range from 35 to 75. The water contents of sandy silt and silt are correspondingly low and typically range from 20 to 30 percent of dry weight (U.S. Army Corps of Engineers, 1958; Kolb and Van Lopik, 1958; Kolb, 1962).

Along short segments of the Mississippi River and its abandoned trunk channel, Bayou La Loutre, lateral migration of the channel created narrow, but thick, sequence of point bar sediments (Figure 1). These point bar deposits consist of 70 to 110 ft (21 to 34 m) thick sequence of sandy sediments, which locally underlie a narrow belt of natural levee sediments adjacent to their associated channel (Figure 2). Typically, the upper two-thirds to one-half of the point bar deposits consists of interstratified mixture of silty clay, silt, and sand (respectively CL, ML, and SP, in the Unified Soil Classification System). The remaining lower part of the point bar deposits consists of well-sorted (poorly graded) fine sand. Minor amounts of organic matter, either as fragments of either driftwood or ground up debris, occur within these sediments (U.S. Army Corps of Engineers, 1958; Kolb and Van Lopik, 1958; Kolb, 1962).

Deltaic Plain

The delta plain of the St. Bernard delta lobe within St. Bernard Parish consists of low tracts of periodically inundated land that is covered by a carpet of herbaceous plants. Depending on the degree of salinity, fresh, brackish, or saltwater marsh covers its surface. Adjacent to the natural levees of the major distributaries and major channels, cypress-tupelo swamps occupy portions of the delta plain, which are not permanently covered with water. The surface of the delta plain typically approximates mean high tide level, which is less than a foot (0.3 m) higher than mean sea level. Numerous lakes and interdistributary bays of various sizes and tidal channels break the surface of the delta plain.

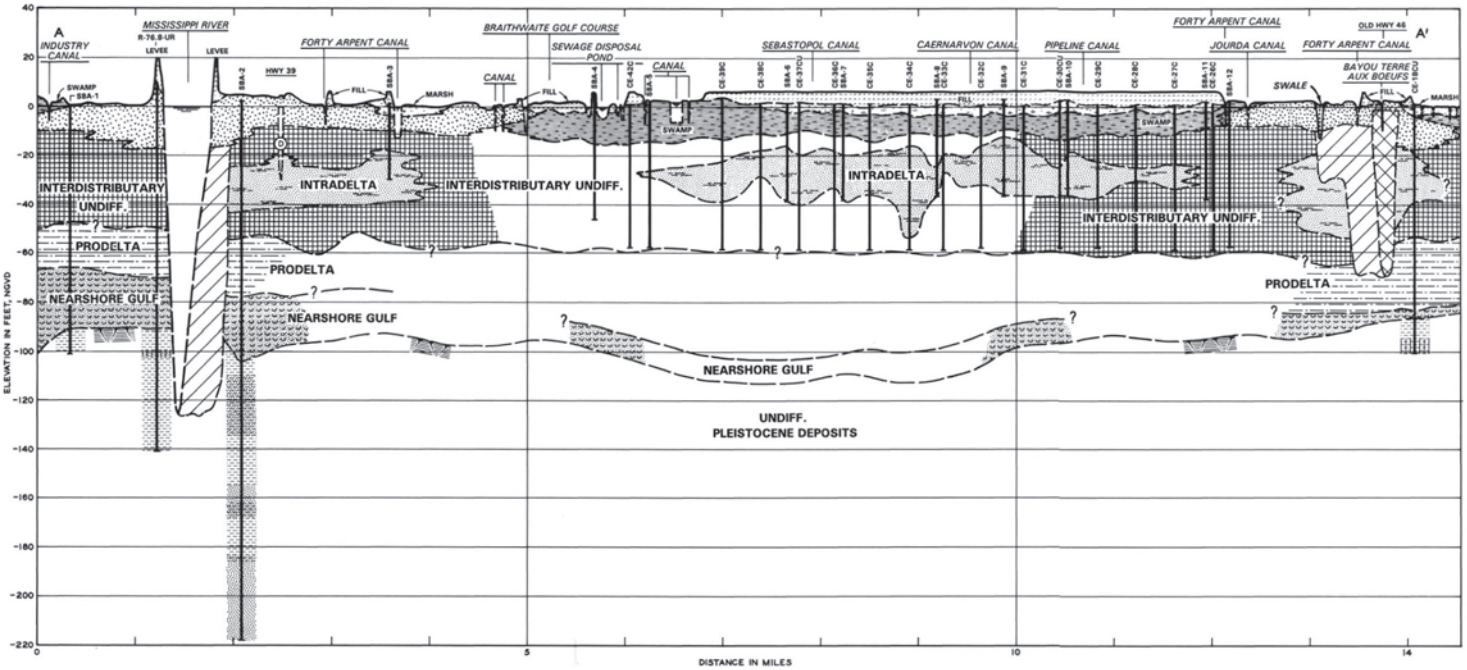

Figure 2. Cross Section of natural levees and delta plain within the urbanized part of St. Bernard Parish. (Reprinted from Dunbar et al. 1994)

The delta plain within St. Bernard Parish is the surface of a sequence of deltaic sediments deposited by the Mississippi River between 1,800 to 4,800 BP as it built out the St. Bernard delta lobe. From bottom to top, this sequence of deltaic sediments consists of (1) prodelta, (2) mixed intradelta and interdistributary, and (3) marsh and swamp deposits. Within St. Bernard Parish, the basal prodelta deposits lie upon a thin layer of shelly marine sands. These sands, in turn, lie upon the often deeply eroded surface of older Pleistocene sediments, which once was subaerially exposed as the Louisiana continental shelf. The total thickness of deltaic deposits within St. Bernard Parish ranges from less than 50 (15m) to over 150 ft (46 m) in thickness (Fisk and McFarlan, 1955; Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958; Frazier, 1967).

Prodelta Deposits

The lowermost layer of deltaic sediments of the St. Bernard delta lobe consists of a gulfward thickening blanket of clay (Figure 2). This layer accumulated within the Gulf of Mexico as clay carried by currents out of the delta mouth and into the Gulf of Mexico settled from suspension on its bottom. Visually, these clays appear massive although they show laminations when x-rayed (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958; Coleman, 1981).

These prodelta sediments consist of homogeneous, normally consolidated fat clay (CH). These sediments decrease in grain size with depth from silty clay to fine clay. Their water content typically ranges from 40 to 80 percent of dry weight. Their Liquid Limit ranges from 70 to 120 and their Plasticity Index ranges from 30 to 35. The cohesive strength of the prodelta sediments gradually increases with depth typically within the range of 200 to 600 lbs per square feet. In deeper borings, the cohesive strength of these sediments has been found to be as high as 900 to 1300 lbs per square feet (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958).

Intradelta and Interdistributary Deposits

The sediments underlying and composing the bulk of the delta plain within St. Bernard Parish consist of a mixture of interfingering and interlayered intradelta and interdistributary sediments overlying the prodelta sediments (figure 2). The intradelta deposits consist of silts and clayey silts deposited as a mixture of the delta front and as crevasse splays and sandy sediments deposited as distributary mouth bars. The interdistributary deposits consist of laminated clay, typically with silt laminae or partings, which accumulated within interdistributary bays from the settling of fine-grained sediments brought into them by floodwaters (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958; Coleman, 1981).

Intradelta deposits typically consist of a heterogeneous mixture of normally consolidated silt and clayey silt (ML), silty clay (CL), fat clay (CH), and about one-fourth fine-grained well-sorted (poorly-graded) sand (SP). The water content ranges from 30 to 40 percent of dry weight for the fat clay and 15 to 30 percent for the silt and clayey silt. The Liquid Limit of the clays range from 35 to 110 and of the silt and clayey silt is as much as to 30. The Plasticity Index of the clays ranges from 15 to 60 and for the silt and clayey silt it is as much as 10. These sediments have a moderate cohesive strength (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958).

Interdistributary deposits consist largely of underconsolidated fat clay (CH). Its water content typically ranges from 50 to 160 percent of dry weight. Its Liquid Limit ranges from 60 to 160 and their Plasticity Index ranges from 30 to 75. The cohesive strength of the fat clay erratically increases with depth and generally ranges from of 150 to 300 lbs per square feet with an observed maximum around 500 lbs per square feet (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958; Coleman, 1981).

Marsh and Swamp Deposits

A layer composed of swamp and marsh deposits overlies the intradelta and interdistributary deposits and forms the surface of the delta plain. Swamp sediments occupy a narrow strip of delta plain adjacent to the natural levees of major channels. Marsh sediments underlie the remaining majority of the delta plain. These sediments typically range in thickness from 5 to 10 ft (1.5 to 3 m)(Figure 2). Marsh deposits consist typically more than 60 percent of herbaceous plant material, which has largely accumulated in place. The high productivity of plant material and the permanently waterlogged nature of the delta plain provide an ideal environment for the preservation and accumulation of organic matter. Adjacent to the natural levees, where prior to the construction of artificial levees, floodwaters once regularly flushed sediment into the adjacent delta plains along with freshwater. In this belt, sediments composed primarily of silt and clay accumulated in freshwater swamps (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958; Coleman, 1981).

The swamp sediments, which border the natural levees of the Mississippi River and Bayou La Loutre, consist typically of clay (OH) containing less than 30 percent organic matter in the form of logs, roots, stumps, thin peat beds, and disseminated material. The water content of these sediments typically ranges from 60 to 200 percent of dry weight. Their Liquid Limit ranges from 60 to 150 and their Plasticity Index ranges from 30 to 60. The typical cohesive strength of these sediments ranges from 200 to 700 lbs per square foot. Typically, the cohesive strength of swamp sediments is very low (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958; Coleman, 1981).

Marsh sediments typically consist largely of peat (PT) and organic-rich clay (OH). The water content of these sediments ranges from 80 to 800 percent of dry weight. Their Liquid Limit ranges from 70 to 250. These sediments have a low cohesive strength and are readily compressible (Kolb and Van Lopik, 1958; U.S. Army Corps of Engineers, 1958). Within the St. Bernard delta lobe, marsh sediments average about 10 ft (3 m) thick. Within the delta plain between Lake Borgne and the natural levees of the Mississippi River and Bayou La Loutre, the peat comprising these sediments thickens towards Lake Borgne to a maximum thickness of 8 to 12 ft (2.4 to 3.6 m) (Snowden et al., 1980).

Discussion

In terms of engineering geology, the principle engineering concerns are (1) foundations, specifically for heavy structures, (2) settlement of the ground, and (3) subsidence. Of lesser concern is the corrosive nature of the surface sediments within St. Bernard Parish.

Foundation Conditions

The best conditions for foundations within St. Bernard Parish occur within the natural levees. Because of their preconsolidated nature and low plasticity, they provide relatively favorable foundation conditions for light structures and roads. Since these sediments are relatively thin and rest on more compressible and lower strength intradelta and interdistributary sediments, the construction of heavy structures will likely require the use of pilings, floating foundations or other engineering techniques. Where the natural levees overlie thick, sandy point bar sediments, the point bar deposits provide relatively favorable foundation conditions for heavy structures. Otherwise, where they are enough to the surface, pilings will likely need to be driven down to preconsolidated Pleistocene sediments, on which the sediments of the St. Bernard delta lobe lie. The shrink-swell potential of natural levees is low, except for a belt of moderate-to-high shrink-swell potential where these sediments grade into the adjacent swamp sediments of the delta plain.

In sharp contrast, the organic-rich sediments that underlie the delta plain are unsuited for foundations of all but the lightest structures. Their high water contents, low shear strength, and high compressibility result in an inadequate bearing capacity for the foundations of most structures. The porous nature of the peat makes seepage beneath levees a significant problem requiring specific design mitigation. The shrink-swell potential of the organic delta plain sediments is low to nonexistent. However, swamp deposits have a low-to-high shrink-swell potential where drained for development.

Settlement

Within St. Bernard Parish, settlement of the ground on which structures are built due to their weight is a significant concern. The settlement occurs because of two processes, primary and secondary consolidation. In case of primary consolidation, settlement occurs as the result of the reduction in the volume of the sediment as water is squeezed out of it by the weight of a sustained load. In case of secondary consolidation, the reduction in volume of the sediments results from the adjustment of the internal structure of the sediment in response to a sustained load after the water is squeezed out of it (Kolb and Van Lopik, 1958; Snowden et al., 1977, 1980).

The sediments underlying the natural levees within St. Bernard Parish are least affected by consolidation. Within the higher parts of the natural levees, these sediments are only partially saturated and have little water to be removed by primary consolidation. Also, even when they are saturated, the sandy and silty natural levee sediments have a grain-supported internal structure, which resists secondary consolidation to a limited extent. As a result, such sediments are only slightly affected by the dewatering of pore spaces. The presence of fine-grained, cohesive sediments within upper point bar deposits makes them susceptible to some consolidation, which results in relatively minor settlement. However, because of the interstratified nature of these sediments, which allows fine-grained layers to readily drain into coarse-grain layers, whatever settlement occurs is rapid. Where underlain by intradelta, interdistributary, and prodelta sediments, consolidation within these sediments can result in some settlement (U.S. Army Corps of Engineers, 1954; Snowden et al., 1977, 1980).

Because of their high water content, high plasticity, and the presence of compressible organic matter, marsh and swamp sediments are quite prone to significant, often severe, settlement resulting from loading. Loading often causes high rates of initial settlement as a result of the expulsion of water, the compression of organic matter, and adjustment of the internal structure of fine-grained sediments comprising these sediments. Typically, consolidation of these sediments continues for long period of time after the sediments have been loaded (U.S. Army Corps of Engineers, 1954, 1958; Snowden et al., 1977, 1980).

As documented by Snowden et al. (1977, 1980) both organic-rich swamp and marsh deposits, i.e. peat, can be especially treacherous because of settlement due to the destruction of organic matter by oxidation. When such sediments are drained for urban, agricultural, or other development, the organic sediments lying above the water table essentially disappear as they oxidize. This type of settlement will rapidly continue as long as organic deposits remain above the water table. Lake Big Mar, a failed agricultural reclamation project just over the parish boundary in Plaquemines Parish, demonstrates what the ultimate result of this process can be.

Subsidence

Subsidence, settlement on both semi-regional and regional scales, is the result of a number of processes. The natural levees within St. Bernard Parish and adjacent strips of the delta plain are subsiding relative to the adjacent delta plain. This is happening because of the load placed on the underlying intradelta, distributary, and prodelta deposits by the weight of the natural levees is causing these sediments to consolidate (Kolb and Van Lopik, 1958). The portions of the natural levee sediments overlying less compressible point bar sands and silts cut into preconsolidated Pleistocene deposits, and the parts overlying point bars are likely not experiencing this process. Also, removal of underground fluids by oil and gas production can locally cause subsidence within the delta plain as summarized by Morton et al. (2005).

On a much larger scale, St. Bernard Parish along with the entire Mississippi River Delta is subsiding. This subsidence is the result of compaction of the thousands of feet of sediments underlying the Mississippi River Delta, downwarping of the underlying crust, and salt tectonics caused by the enormous weight of these sediments overlying them. Such subsidence is a significant concern in that with time it increases the vulnerability of St. Bernard Parish to storm surges by lowering the land surface and the height of existing levees.

Corrosion

In general, the surface sediments within St. Bernard Parish are corrosive to both uncoated steel and concrete. There exists a uniform risk of corrosion for uncoated steel buried within the surface sediments comprising both the natural levees and delta plain. For concrete buried within the surface of the natural levees, swamps, and brackish marshes of St. Bernard Parish, there is the general, but not universal, moderate risk of corrosion. For concrete buried within the surface of the saline marshes, the risk of corrosion is low (Trahan et al., 1989).

Summary

As previously discussed, sediments with very different engineering properties underlie St. Bernard Parish. As decades of practical experience have demonstrated, the natural levee deposits provide the best conditions for development within St. Bernard Parish. The portions of the natural levees underlain by point bar deposits provide the most stable locations for the construction of large structures and reconstruction of critical infrastructure. In sharp contrast, organic-rich swamp and marsh sediments, characterized by high water content, high plasticity, and the presence of compressible organic matter, underlie the delta plain. These physical characteristics make the delta plain very poorly suited for development without special and expensive remediation. Most types of conventional development will ultimately result in irrevocable subsidence to subsea elevations. Continued settling of levees built within this area over a period of decades will compromise their effectiveness as protection against storm surge.

Ongoing regional and semi-regional subsidence also has implications for St. Bernard Parish. Subsidence not only accentuates the magnitude of flooding created by hurricane storm surge by physically lowering the land's surface with time, it also reduces the effectiveness of existing levees and other flood control structures by reducing their height. In addition, subsidence further exacerbates the damage caused by storm surges by significantly contributing to land loss that reduces the moderating affect that marshes have on them.

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Louisiana Parish Well Reference Cartographic, Production and Well Information Reference 1900 - 2004

Brian Harder

The Louisiana Geological Survey in cooperation with the Center for Energy Studies through the PTTC program have created the Louisiana Parish Well Reference Cartographic, Production and Well Information Reference 1900 - 2004. Modeled after the Louisiana Desktop Well Reference it is a Geographic Information System (GIS) for the Louisiana oil and gas industry emphasizing the historical field and LUW production at the parish. Developed using ESRI's Arcview software, the program is easy to use, allowing large amounts of data to be evaluated by combining geographical, image and well information. Included is a parish map with all well locations, parish boundaries, section, township and range boundaries, primary, secondary and tertiary roads, permanent and intermittent streams and water polygons. It contains production data from 1900 through 2005 and current well status information. The historical production data, including that prior to 1977, was compiled from two sources from the Louisiana Department of Natural Resources Office of Conservation. Monthly LUW production was taken from the Production Audit Cards and annual field production was taken from the Annual Oil and Gas Reports. Currently St Bernard Parish and Cameron Parish are complete and for sale for $75 on the PTTC web site (www.cgrpttc.lsu.edu). We are currently working on Vernon and Rapides parishes combined which should be available in early 2006.

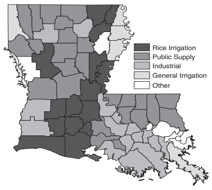
New Publications

Educational Series

Douglas Carlson - ***Louisiana Ground Water Resources:*** Louisiana Geological Survey, Educational Series #4, 27 p. (2005). A general interest publication providing basic information on ground water in Louisiana including aquifers, aquifer properties and definitions, ground water flow, usage and interesting water facts in the appendix.

Port Arthur 30 X 60 Minute Geologic Quadrangle Map (2005). Scale 1:100,000. Geology by Paul Heinrich, GIS compilation by R. Hampton Peele and P. Vijaiamernath and Cartography by John Snead and Lisa Pond. Multicolored, sheet size 20" X 46" with descriptions of map units.

Contact Patrick O'Neill to order LGS publications at 225/578-8590 or email at poneil2@lsu.edu.



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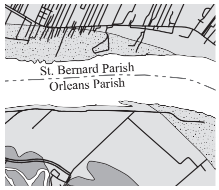

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Louisiana Geological Survey Staff Assist in Hurricane Katrina Effort

Members of the Louisiana Geological Survey (LGS) staff participated in preparations, emergency response, and recovery efforts for Hurricane Katrina. The LGS was cited by the Louisiana Department of Wildlife and Fisheries (LDWF) for its efforts and for "helping to save numerous lives."

LGS assistant director John E. Johnston III, the department's regular representative to the Louisiana Office of Emergency Preparedness, carried out scientific and liaison work with the LDWF, the U.S. Coast Guard, both the federal and state Departments of Homeland Security, the Federal Bureau of Investigation, and the Federal Emergency Management Agency. Along with Reed Bourgeois, LGS computer analyst, Johnston provided scientific input, housing and office space (after obtaining the necessary approvals from the LSU administration), Internet connections, printing and plotting support, computers, and software for search and rescue, law enforcement, and mapping operations. Johnston also helped to plan and coordinate early scientific missions into New Orleans to gather post-Katrina scientific data, which included obtaining clearances for water sampling for the LSU School of the Coast and Environment's Dean Edward Laws and the staff of the LSU Department of Environmental Studies and the LGS. Johnston was commended by the Louisiana National Guard for "outstanding effort."

Assistant professor Thomas van Biersel and accounting specialist Jeanne Johnson prepared a 911 phone call registry and also did mapping and database work in cooperation with the U.S. Geological Survey (USGS) and the National Wetland Research Center personnel in support of the LDWF's search and rescue operations. They prepared an emergency call database which was used to compile search and rescue maps of the location and time of emergency calls made in the New Orleans area during and after Hurricane Katrina by the USGS and LGS geographer Hampton Peele. These maps, multiple copies of which were printed by the LGS and the USGS and supplied to the agencies involved in search and rescue efforts, aided rescue teams in locating people trapped by the storm and saved lives. Van Biersel, Bourgeois, Johnson and Peele were all commended by the LDWF for their efforts.

Peele and two other LGS cartographers, Robert Paulsell and John Snead, also worked in association with other LSU GIS labs to provide important GIS and mapping support for state and federal agencies by manning GIS workstations at the Louisianan Emergancy Operations Center as well as their on-campus laboratory. Many hardcopy maps and digital data were prepared for distribution to rescue and relief operations. Oversized provisional base maps were produced for the Katrina and Rita impact areas.

Other LGS staff providing various forms of assistance during and after Hurricane Katrina included the director, Chacko John, research associates Brian Harder and Byron Miller, and office coordinator Ann Tircuit.

Subsequent to Hurricane Katrina, LGS assistant professors Thomas van Biersel, Douglas Carlson, and research associate Riley Milner took part in a joint study with the USGS and the Louisiana Department of Environmental Quality to determine the effects of Hurricane Katrina's storm surge on water wells on the north shore of Lake Pontchartrain. Ongoing efforts are underway to see if the flood resulting from the hurricane may have driven saline water down existing water wells or directly invaded shallow aquifers in the vicinity of Lake Pontchartrain.

Search and Rescue Mapping for Hurricane Rita

On September 22, 2005 the Louisiana Department of Wildlife and Fisheries (LDWF), requested LGS mapping assistance for the anticipated search and rescue effort that they would be leading in response to Hurricane Rita.