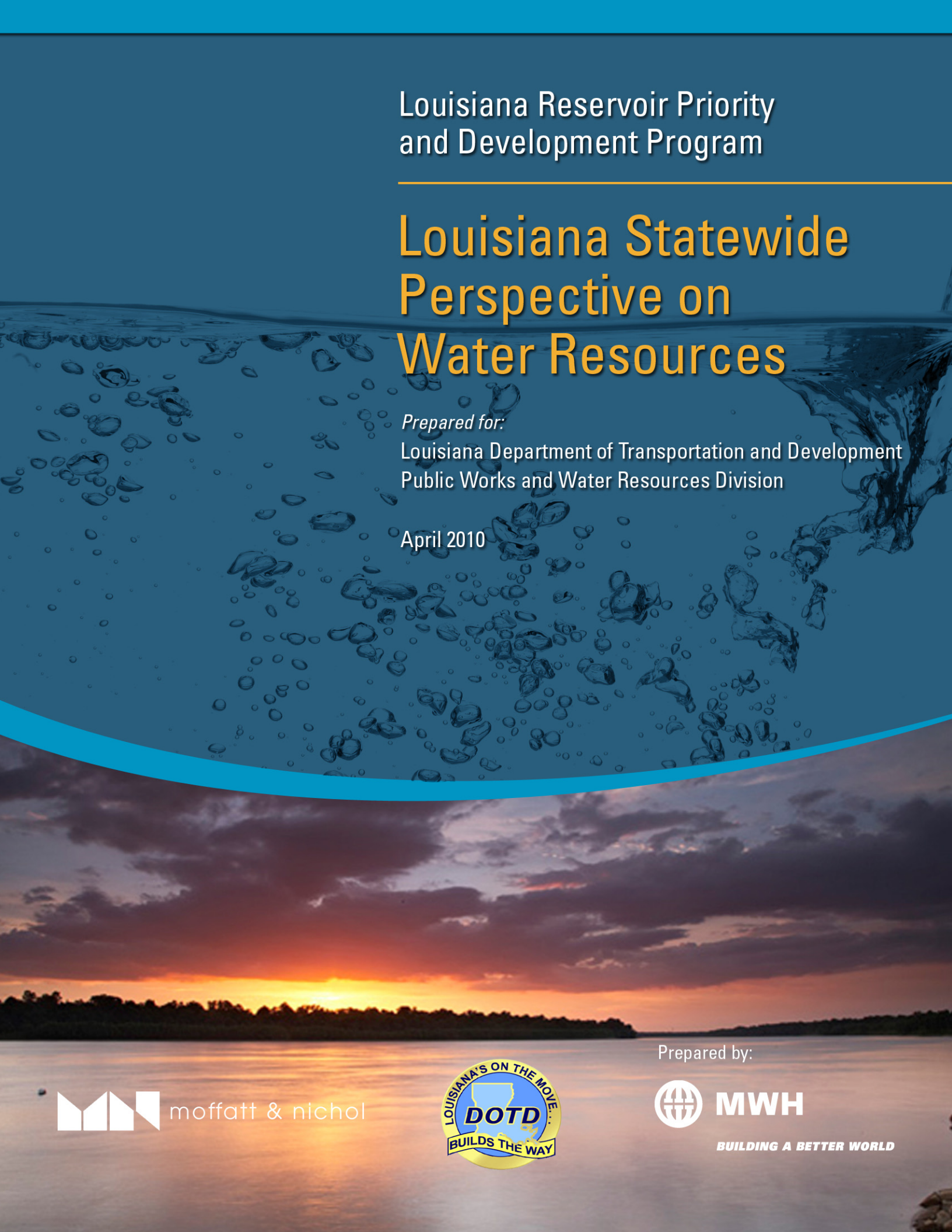
Louisiana Reservoir Priority and Development Program

Louisiana Statewide Perspective on Water Resources

Prepared for:

Louisiana Department of Transportation and Development
Public Works and Water Resources Division

April 2010



Prepared by:

moffatt & nichol

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MWH Americas, Inc.
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Louisiana Reservoir Priority and Development Program
LOUISIANA STATEWIDE PERSPECTIVE ON WATER RESOURCES

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Introduction

Water, both above and below ground, is Louisiana's most abundant resource. Approximately 11% of the total surface area of the state is composed of water bodies. The state has more than 40,000 linear miles of rivers, streams and bayous, and over 400 miles of coastline. Not only is water Louisiana's most abundant resource, it is also the most important. From the upland areas in the northern portion of the state to the water-dominated ecology of the Gulf Coast, Louisianans recognize the importance of sustainable water resource management to support healthy ecosystems and promote thriving economies.

For many years water resource development for consumptive and industrial uses in Louisiana occurred with limited concern about potential scarcity of supply. In the recent past, however, some consequences of water resources development have begun to appear in locations around the state, as evident in low surface water flows, impaired surface water quality, groundwater level decline, and degraded groundwater quality. Continued uncoordinated development of surface water and groundwater resources is expected to result in more severe and widespread impacts, which will affect economic development opportunities in the state.

It has become clear that a comprehensive strategy is needed to address the management of surface water and groundwater resources in Louisiana. Such a strategy should be designed to meet the present and future needs of municipalities, agriculture, industry, rural water users, and the environment. In particular, a strategy is needed to assure the sustainable use of groundwater resources and provide for orderly shifts to alternative water supplies, while preserving and enhancing economic and ecological vitality.

In one approach to address water resources needs, the Department of Transportation and Development (DOTD) Public Works and Water Resources Division is developing a priority program for proposed state-funded surface water reservoirs that could address current and emerging water resources issues and needs.

The Reservoir Priority and Development Program (RPDP) is being developed using existing information, insights provided in previous studies in Louisiana, and best practices applied elsewhere in the United States. Key information sources included a 2002 report by C.H. Fenstermaker and Associates (Fenstermaker, 2002) that described statewide water issues, numerous reports prepared by the United States Geological Service (USGS) and State of Louisiana agencies, and guidance documents for other existing Louisiana water resources programs and those of other states.

Purpose of this Statewide Perspectives Report on Water Resources

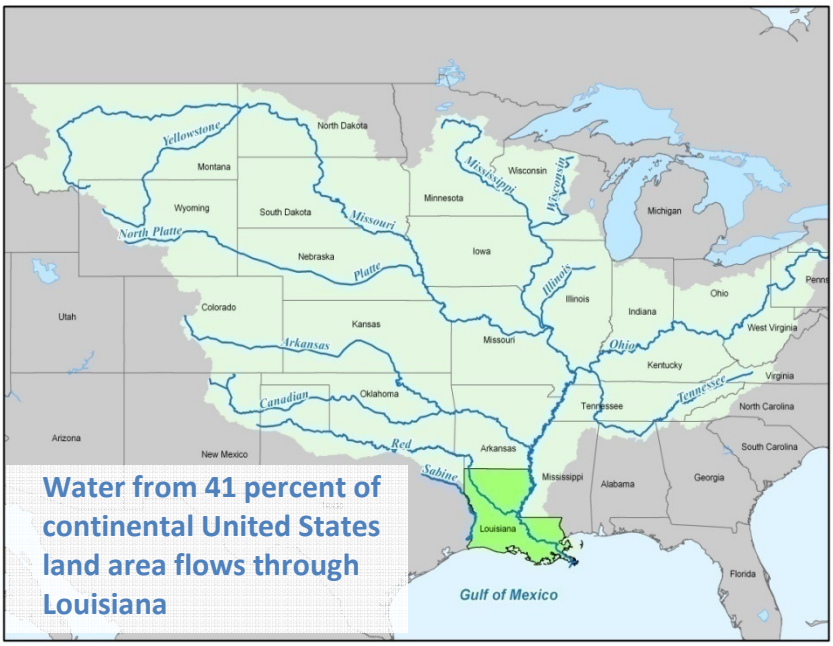
This report presents a consolidated overview of water resources throughout the state, including both surface water and groundwater, based on available information and multiple documents prepared for the RPDP. It presents water use information and summarizes groundwater aquifer conditions throughout the state. It identifies water resources issues and concerns affecting Louisiana at state-wide and regional scales and highlights current and future trends. It also describes the role of State and Federal agencies in development and management of water resources. This report concludes with a recommended strategy and actions to assure that state surface and groundwater resources are managed to meet the present and future needs of municipalities, agriculture, industry, rural water users, and the environment.

Water Resources Setting

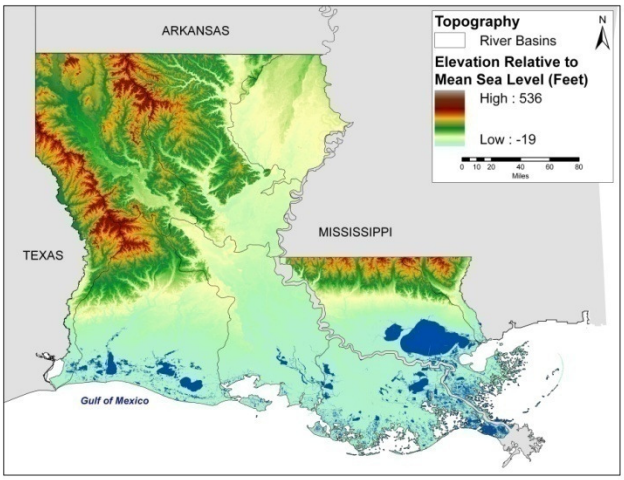
Much of the state of Louisiana is within the Mississippi River basin, which drains about 1,245,000 square miles including all or part of 31 states in the central United States.

Louisiana is bordered by Texas, Arkansas, Mississippi, and the Gulf of Mexico. Adjacent states all share watershed and groundwater basins with Louisiana. In southern Louisiana, several smaller, mainly coastal, rivers drain directly to the Gulf of Mexico.

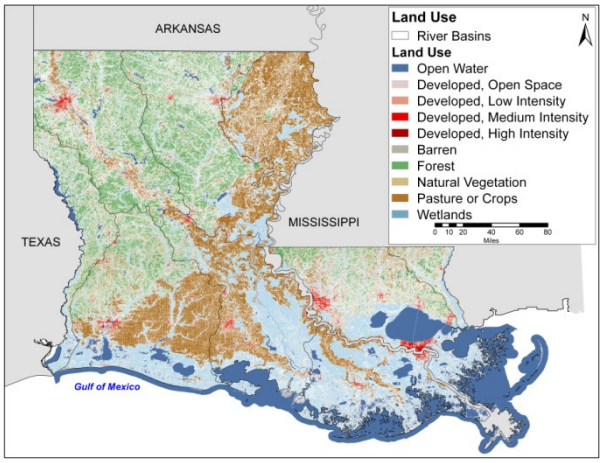
Louisiana has areas of pine forests in the northwest and western portions of the state, and also south of the Mississippi border. These areas generally have undulating topography. The river valleys, which are the flood plains of the Mississippi, Red and other rivers, are typically low and flat and support bottomland hardwood forests. The coastal areas are very flat and heavily vegetated.



Louisiana supports a variety of land uses, with over 13 million forested acres. Agricultural land use is also widespread with rice, sugarcane, cotton, and soybeans being the most common crops. Medium and high density development is distributed in urban centers, particularly along the I-10 and I-12 corridors.



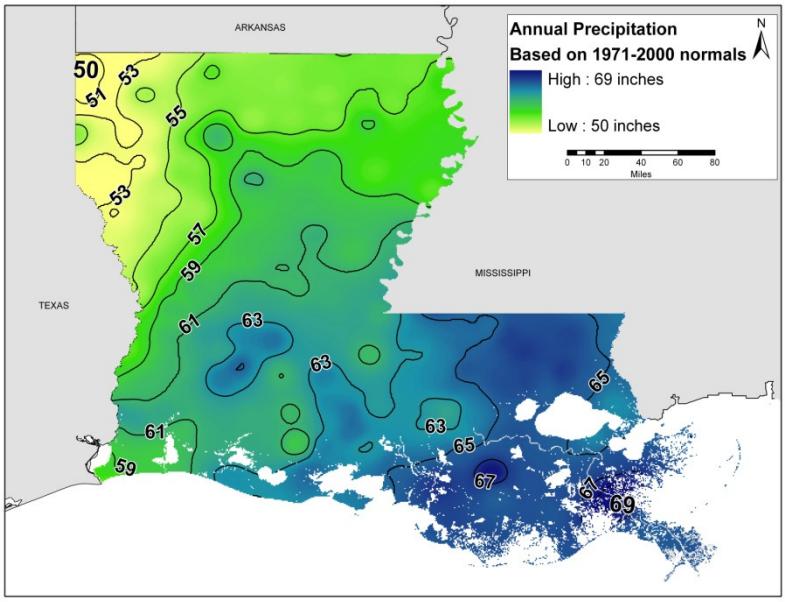
Topography is dominated by several upland areas, river valleys, and the Coastal Zone



Land use includes widespread forest, wetlands, and crops with sporadic medium and high density development

Surface Water Resources

Surface water is abundant in Louisiana, due to two facts of geography: its location at the terminus of the Mississippi River watershed, and its location in the humid southeastern United States.

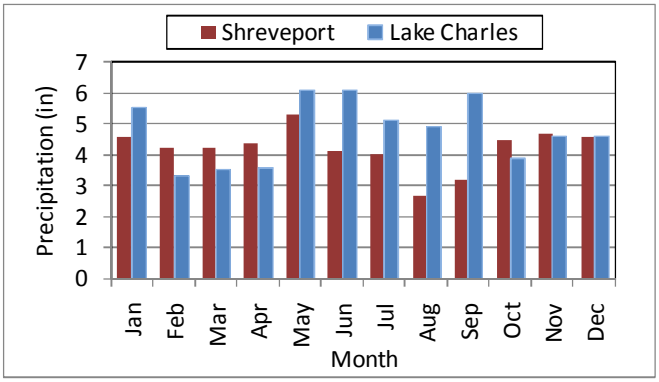


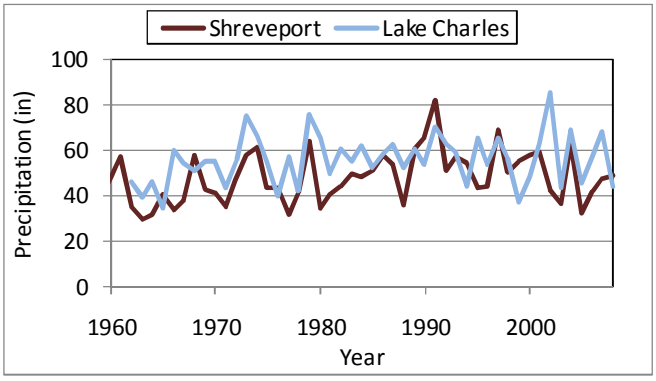
Average annual precipitation ranges from 50 to over 65 inches

Flows of the largest rivers in Louisiana, including the Mississippi, Atchafalaya, and Red Rivers, are most affected by precipitation and runoff in upstream states. Flows of smaller streams are correlated more closely with in-state precipitation. Annual average precipitation varies across the state from 50 to over 65 inches per year, with the most rainfall occurring in the southeast and the least amount occurring in the northwest.

In any given year, precipitation can vary from the average by 20 percent in the south and by more than 30 percent in the north. Droughts occur from time to time in Louisiana. The most recent drought, between 1998 and 2002, resulted in significant economic losses in the agricultural sector (Fenstermaker, 2002).

In coastal Louisiana, streamflows can be heavily influenced by tides, with streams regularly flowing in reverse. Reverse flow may also occur throughout the state during floods, particularly at the confluences of major rivers where backwaters tend to form, and hurricanes and tropical storms.





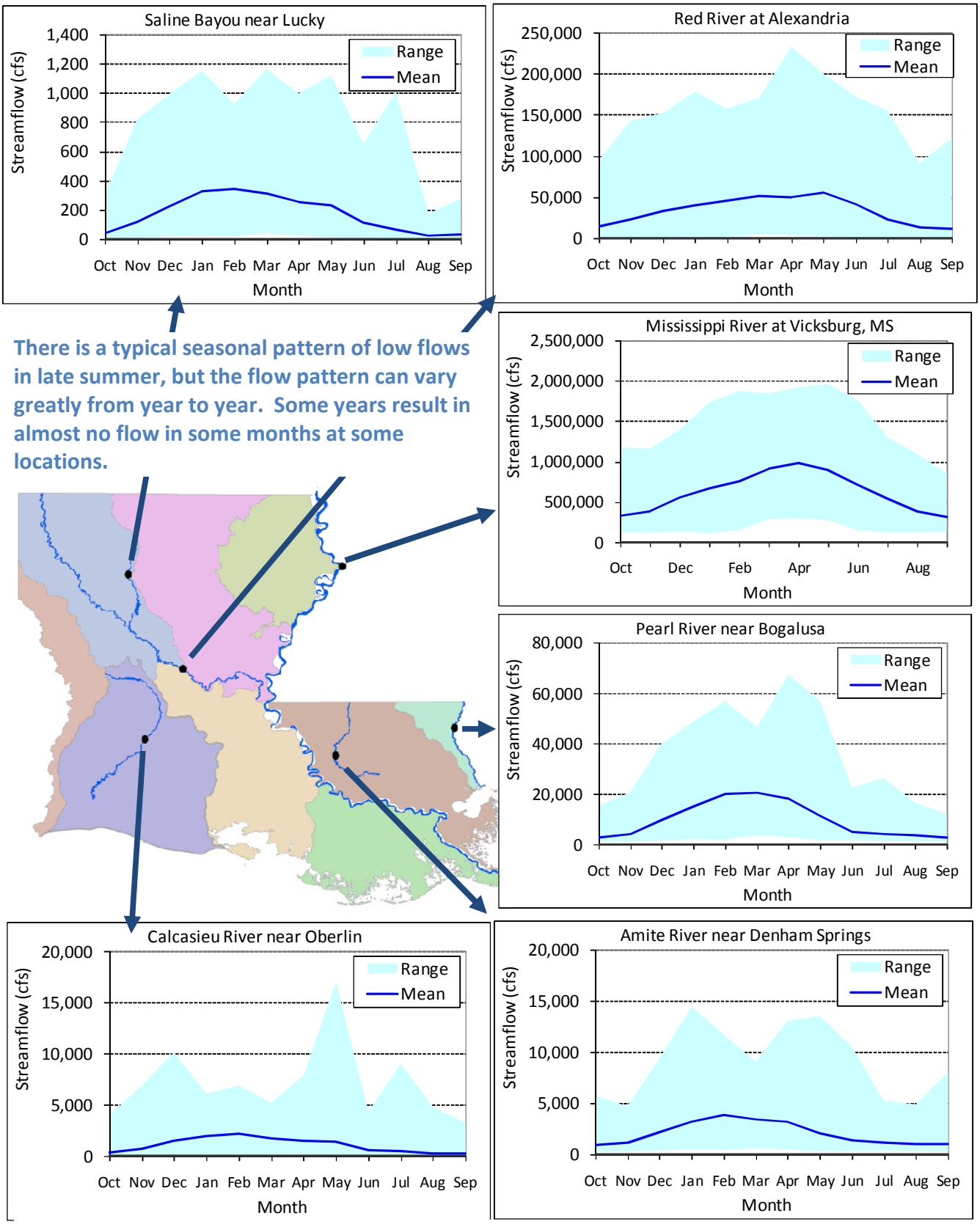
Precipitation in Louisiana varies moderately from month to month and from year to year

Surface water resources in Louisiana are categorized based on nine major surface water basins. In some cases these basins include headwater areas that originate in upstream states. Surface water basins are based on topographic features, and generally do not align with parish boundaries.

As part of the RPDP, Basin Characterization Reports were prepared for each of the 9 major surface water basins. Information provided in each basin report includes:

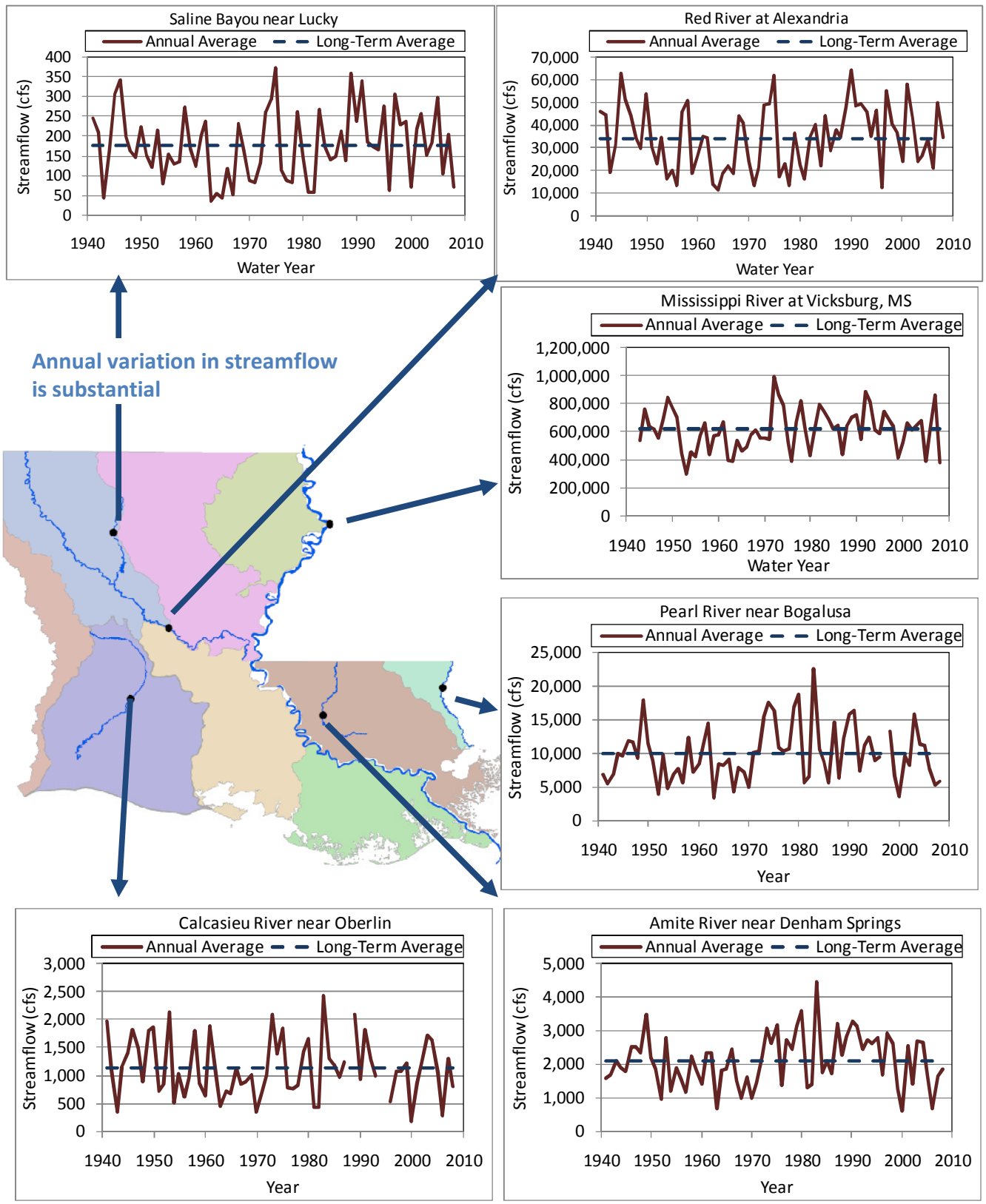
- Basin Overview
- Land Use and Legal Entities
- Physiographic and Climatic Information
- Water Use
- Surface Water
- Groundwater
- Flooding
- Environmental and Cultural Issues
- Recreation, Navigation and Hydropower
- Interbasin and Interstate Issues
- Summary of Water Resources Needs

Annual streamflow volumes are typically high in Louisiana, but vary significantly by season and from year to year. Daily flows of major Louisiana rivers and their tributaries have been gaged by the USGS and USACE since the 1920s. In the following figures, monthly and annual variations in streamflows are shown for four index stations selected by the USGS as representative of hydrology in the region. In addition, flows are shown for the Mississippi and Red rivers (USGS, 2006) using information collected by USACE. Each stream displays the typical annual pattern with peak flows occurring in late winter from about January to April and a drier period in late summer through fall. Variability in seasonal and annual streamflows affects the ability to develop surface water resources to reliably meet beneficial uses.



Historical monthly mean flow, and minimum and maximum of historical monthly mean flows

Data for USGS Stations: 02489500 – Pearl River near Bogalusa, 07352000 – Saline Bayou near Lucky, 07378500 – Amite River near Denham Springs, 08013500 – Calcasieu River near Oberlin; USGS 2008 water data reports. USACE stations on the Red River and Mississippi River, data from Vicksburg office.



Historical total annual streamflows

Water years grouped October through September. Data for USGS Stations: 02489500 – Pearl River near Bogalusa, 07352000 – Saline Bayou near Lucky, 07378500 – Amite River near Denham Springs, 08013500 – Calcasieu River near Oberlin; USGS 2008 water data reports. USACE stations on the Red River and Mississippi River, data from Vicksburg office.

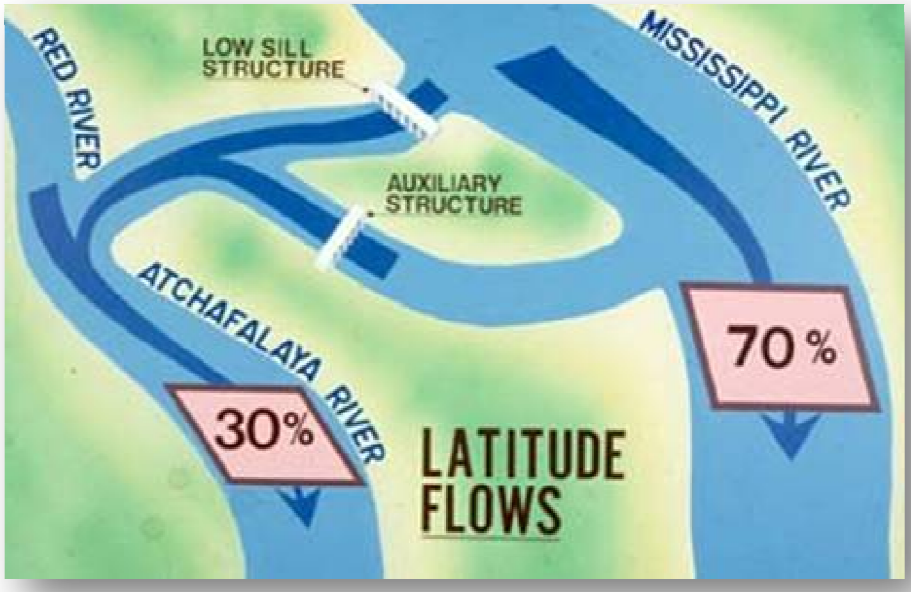
Using available daily flow data, average annual inflows and outflows of the nine major river basins in Louisiana were estimated. Flow estimates were based on data from 1985 to 2007 to represent the flow regime under the most recent level of water supply and flood control infrastructure development.

Old River Control Structure

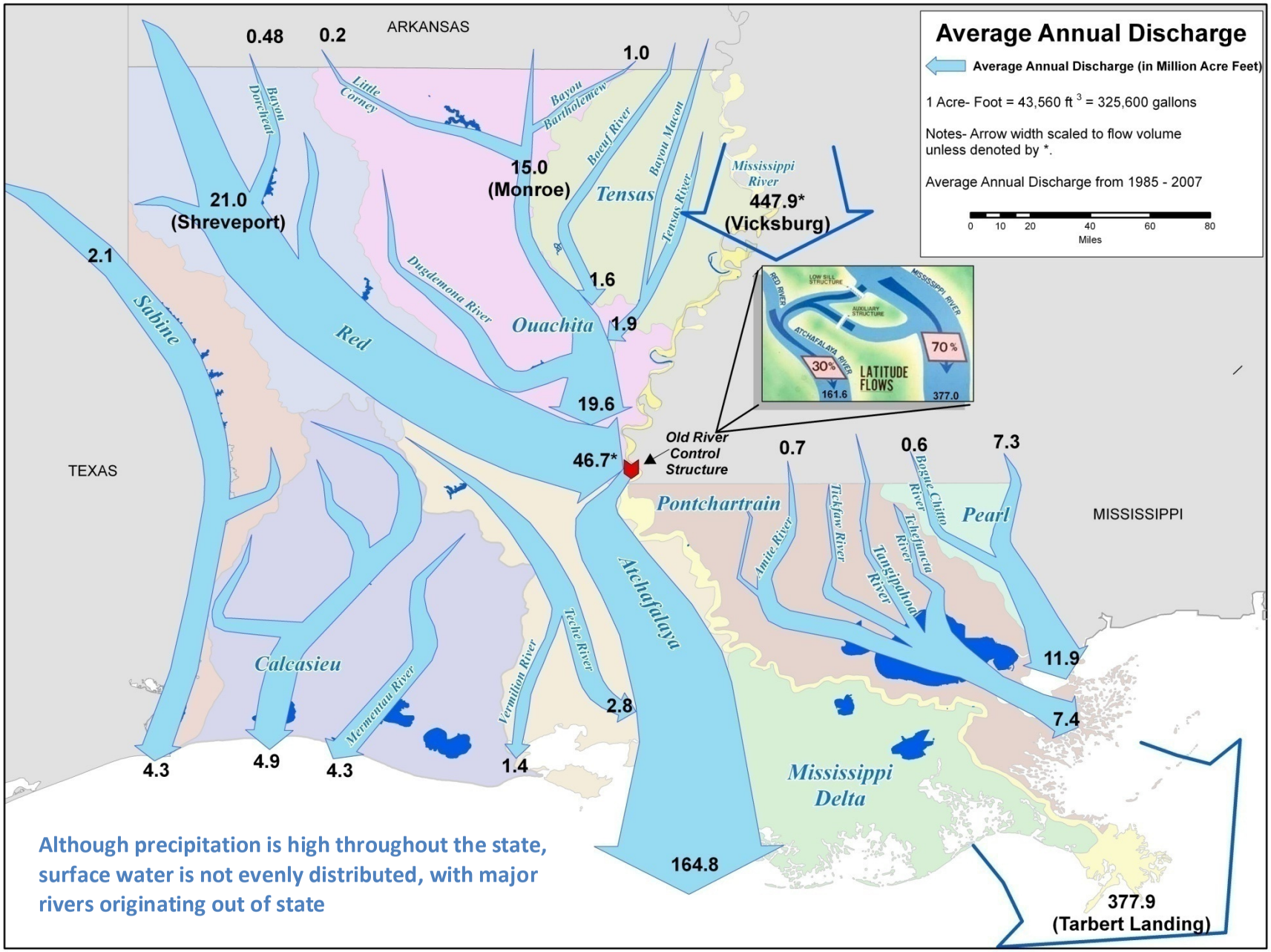
In total, over 577 million acre-feet per year (MAFY), or 188 trillion gallons per year of water flows to the Gulf of Mexico from Louisiana; about 459 MAFY, or 80 percent, originates upstream of the state. Of the 459 MAFY, over 98 percent (over 448 MAFY) enters the state via the Mississippi River system (Mississippi, Red, Ouachita, and Tensas rivers and tributaries).

Flow in the Atchafalaya River is subject to operations of the Old River Control Structure, which diverts 30 percent of the total combined latitudinal flow of the Mississippi and Red rivers upstream of the Old River Control Structure into the Atchafalaya River. Approximately 35 percent of Louisiana outflow to the Gulf of Mexico originates within the state as precipitation and groundwater discharge to surface water.

The figure on the following page illustrates, in general terms, the distribution and variation of annual average discharge in major Louisiana rivers.



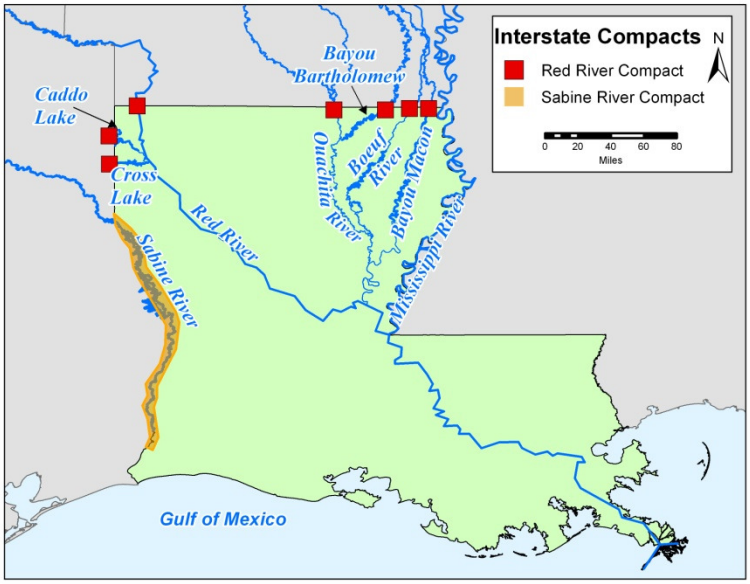
Old River Control Structure


Average Annual Discharge
Average Annual Discharge (in Million Acre Feet)
1 Acre- Foot = 43,560 ft 3 = 325,600 gallons
Notes- Arrow width scaled to flow volume unless denoted by *.
Average Annual Discharge from 1985 - 2007
0 10 20 40 60 80
Miles
ARKANSAS
TEXAS
MISSISSIPPI
0.48
0.2
1.0
21.0
(Shreveport)
15.0
(Monroe)
447.9*
(Vicksburg)
2.1
1.6
1.9
19.6
46.7*
0.7
0.6
7.3
11.9
7.4
2.8
4.3
4.9
4.3
1.4
164.8
377.9
(Tarbert Landing)
Sabine
Red
Dusdemona River
Ouachita
Tensas
Bayou Macon
Tensas River
Mississippi River
Bayou Dorcheat
Little Corney
Bayou Bartholemew
Boeuf River
Old River Control Structure
LOW SILL STRUCTURE
AUXILIARY STRUCTURE
RED RIVER
MISSISSIPPI RIVER
ATCHAFALAYA RIVER
30%
70%
LATITUDE FLOWS
161.6
377.0
Pontchartrain
Amite River
Tickfaw River
Tangipahoa River
Tchefuncta River
Bogue Chitto River
Pearl
Atchafalaya
Calcasieu
Mermentau River
Vermilion River
Teche River
Mississippi Delta
Although precipitation is high throughout the state, surface water is not evenly distributed, with major rivers originating out of state

Surface Water Regulatory Setting

Two interstate compacts pertain to Louisiana surface water resources; the Red River Compact and the Sabine River Compact. These interstate compacts provide for the equitable management of water resources in the basins, and are administered by committees chaired by Federal representatives appointed by the President. The Red River Compact is an agreement among Louisiana, Oklahoma, Texas, and Arkansas. It guides management of flows at the Louisiana border into and out of Caddo and Cross lakes, the Red River, Ouachita River, Bayou Bartholomew, Boeuf River, and Bayou Macon. The Red River Compact does not preclude the construction of new storage facilities, provided that storage does not adversely affect any state's apportionment of water.

The Sabine River serves as part of the border between Louisiana and Texas. Along the border with Texas, a minimum flow of 36 cfs must be maintained under the Sabine River Compact by both states. All water not stored in reservoirs in the Stateline Reach is to be distributed equally between the two states. Water stored in reservoirs constructed after 1953 (including Toledo Bend Reservoir and Lake Anacoco), is shared by Texas and Louisiana proportion to each state's contribution to storage costs and reduction in tributary flow.



Interstate compacts apply to the Red River and Sabine River basins

Downstream of Toledo Bend Reservoir, releases in excess of the Compact requirements are made for environmental purposes as required by a Federal Energy Regulatory Commission (FERC) permit and for downstream diversion to Lake Charles via the Houston Canal.

Water quality should be considered when developing surface waters. In some cases surface water will be of lower quality than available groundwater resources. The Louisiana Department of Environmental Quality (LDEQ) has primacy over surface water quality within the state, meaning that LDEQ is the primary overseer of water quality and is responsible for setting and enforcing standards equal to or greater than those set by the U.S. Environmental Protection Agency. LDEQ issues discharge permits and monitors the quality of the state's waters. The following map shows the spatial distribution of major industrial, municipal, and stormwater discharge permits throughout Louisiana. Major discharge permits are highest in density along the Mississippi River in southern Louisiana and upstream of Calcasieu Lake. Three large municipalities, Shreveport, Baton Rouge, and New Orleans each have stormwater discharge permits.

Pursuant to Section 303(d) of the Clean Water Act, the U.S. Environmental Protection Agency (EPA) maintains a list of impaired surface waters throughout the nation. In Louisiana, the most recent listing (2006) indicates that impaired waters are located throughout the state of Louisiana. Impaired waters are defined as those where water quality standards are not met, implying that designated uses such as fish and wildlife propagation, recreation, or drinking water supply, may be supported. Although a water body may be designated as impaired for one use, it may not be considered impaired for other uses. The majority of surface water quality impairments in Louisiana are related to fish and wildlife propagation. Some of the most common parameters affecting water quality standards attainment include:

- Mercury in fish tissue, leading to fish consumption advisories
- Dissolved oxygen, nutrients, suspended solids, dissolved solids, and turbidity are also common causes of impairment for aquatic life.
- Fecal coliform affecting oyster propagation and recreation

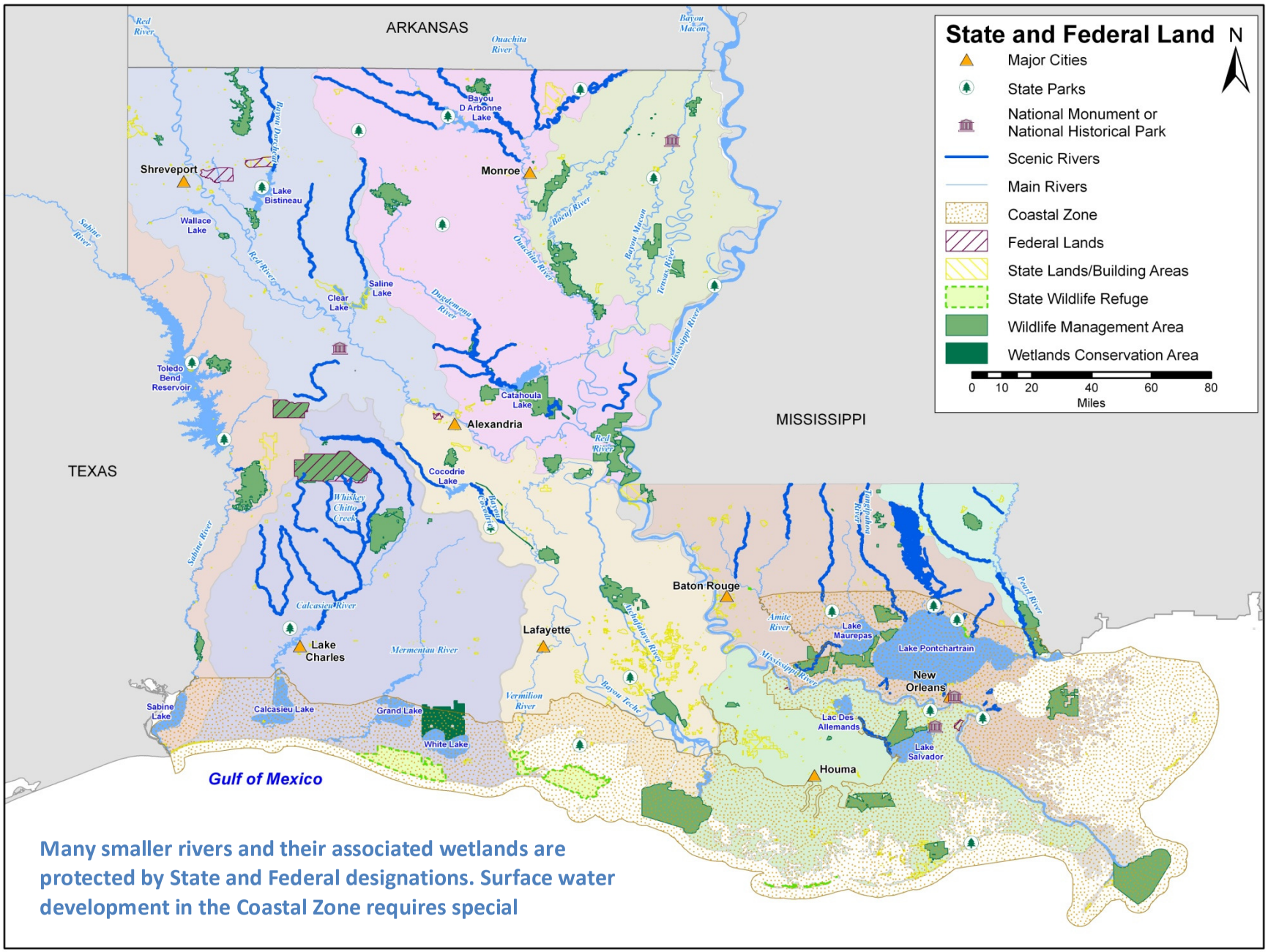
Minimum streamflows (also known as instream flows) to protect designated uses, such as environmental protection and recreation, constrain surface water development for other beneficial uses. Maintenance of minimum flows is critical for determining waste allocation permits. To date, formal minimum streamflows have not been established in Louisiana. However, the State's water quality statutes (Title 33 Part IX) require the following:

> *The natural flow of state waters shall not be altered to such an extent that the basic character and water quality of the ecosystem are adversely affected except in situations where alterations are necessary to protect human life or property. If alterations to the natural flow are deemed necessary, all reasonable steps shall be taken to minimize the adverse impacts of such alterations. Additionally, all reasonable steps shall be taken to mitigate the adverse impacts of unavoidable alterations.*

Wetlands and other sensitive riparian areas are an important environmental resource in Louisiana, and must be protected under state and federal law. Wetlands are prevalent in Louisiana in the coastal zone , along river valleys, and in other low lying areas. Alteration of these areas often requires a federal Clean Water Act Section 404 permit through the US Army Corps of Engineers (USACE).

Coastal wetlands are of particular importance in Louisiana. They support diverse functions including commercial and recreational fishing and hunting, habitat, water quality, navigation, flood control and buffering of storm surges. The rate of coastal wetland loss in Louisiana is high and represents most of the coastal wetland loss in the continental United States (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1998). The Louisiana Office of Coastal Restoration and Management regulates the uses of state's coastal zone and issues permits for a variety of activities, including development, within the designated Coastal Zone.

The State of Louisiana also has designated streams and lands for special protection in their natural state including Scenic Rivers, wildlife management areas, wetlands conservation areas and wildlife refuges. Locations of Federal- and State of Louisiana-designated lands, including scenic rivers, wetlands, wildlife conservation areas, and the Coastal Zone are shown on the figure on the next page.



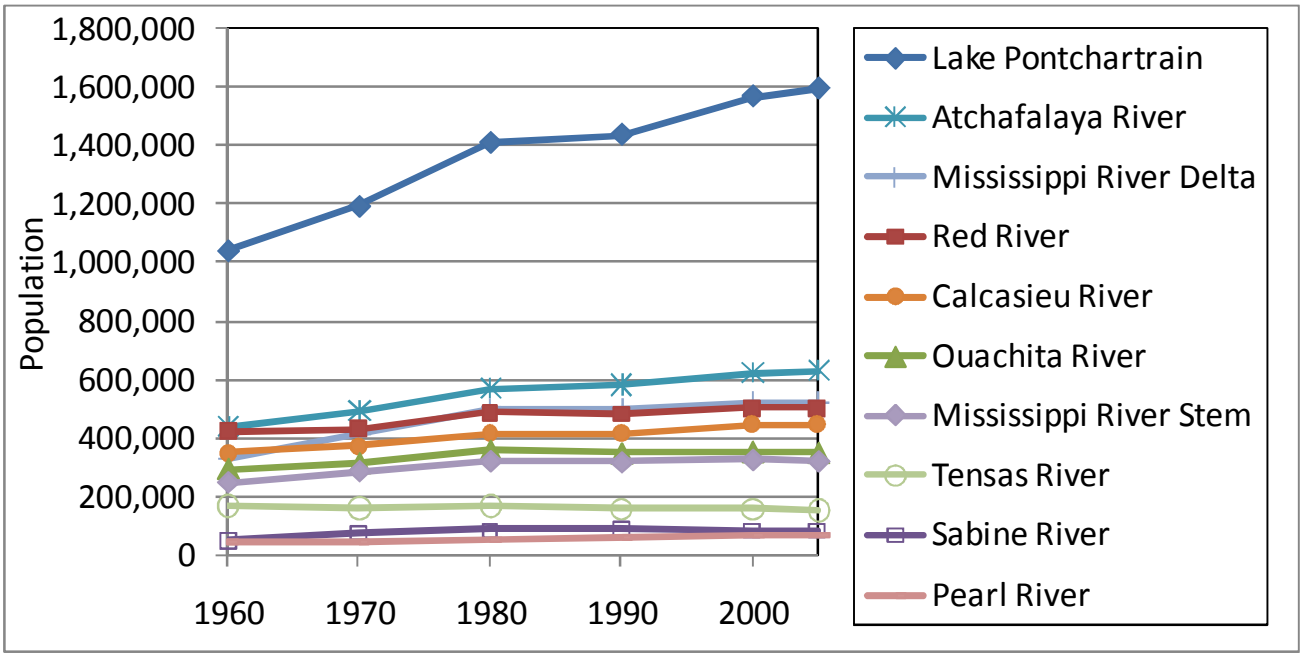
Many smaller rivers and their associated wetlands are protected by State and Federal designations. Surface water development in the Coastal Zone requires special

Surface Water Management Practices & Facilities

Many of Louisiana's waterways have been altered for water management reasons ranging from navigation to flood control to water supply. In fact, many of the rivers entering Louisiana are altered by dams and structures upstream of the state line. The map on the following page shows major surface water facilities including dams, locks, ports, and hydropower facilities. These facilities meet important needs ranging from flood control to commerce. Facilities constructed on waterways affect the natural flow of water and transport of sediment from upstream to downstream.

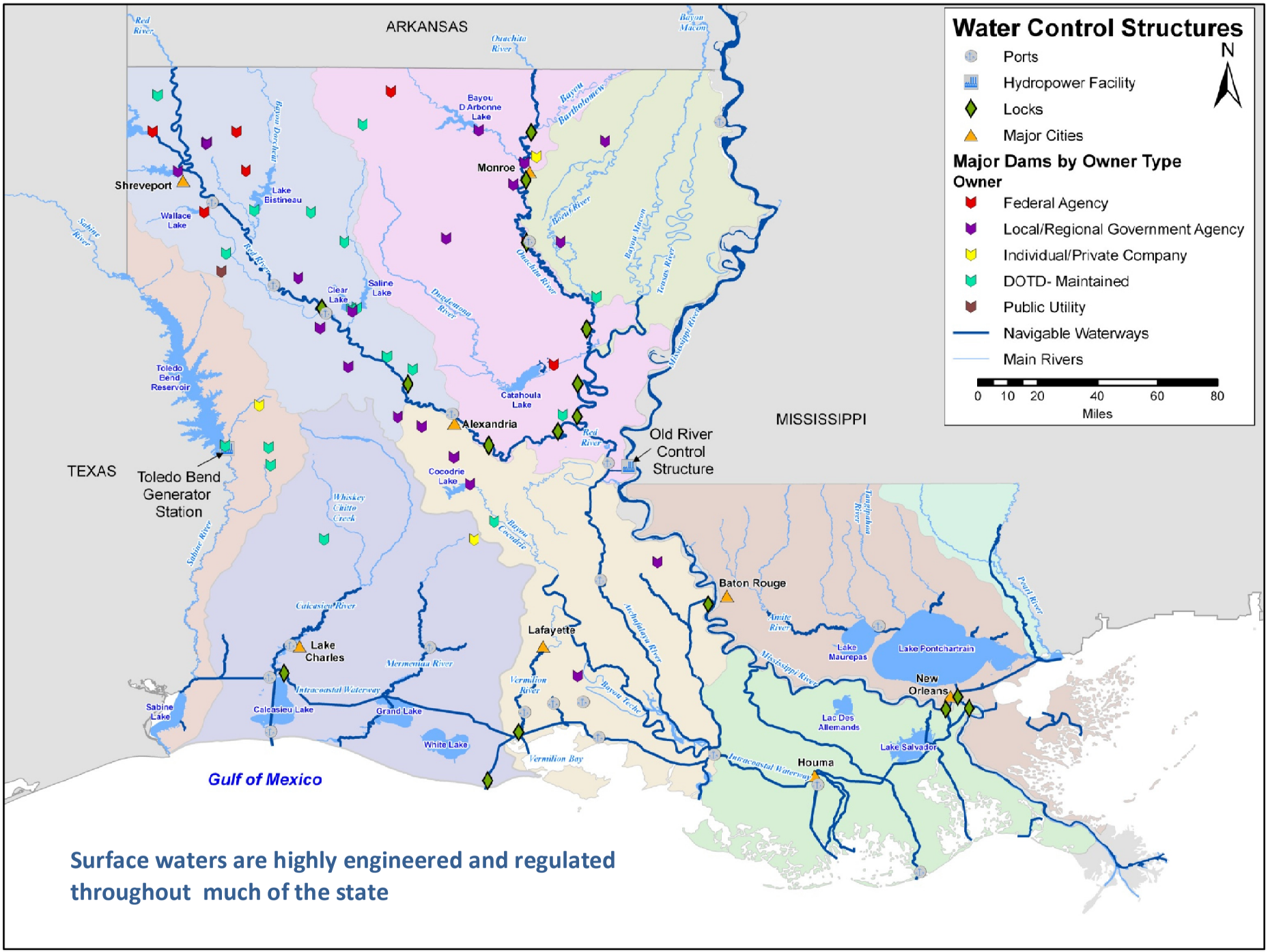
Most surface water projects were constructed for flood control, navigation, or other economic development purposes. In most of the state, population growth has not required construction of surface water reservoirs to supply drinking water. This demand is met primarily by groundwater. Most major dams are publicly owned and are located on smaller tributaries in northern Louisiana.

Straightening and dredging, combined with the construction of locks, has produced navigable waterways from the Gulf of Mexico to Shreveport and Monroe and to northern states. Many port facilities and industries take advantage of navigable waters and generate significant economic activity.



Population growth was minimal in much of the state over the last 50 years, but exceeded 10 percent per decade in the Lake Pontchartrain, Mississippi River Delta, and Atchafalaya River Basins.

As shown on the topography map on page 2, much of Louisiana is low lying, with some areas located at elevations below sea level. Large portions of the state are located within the 100-year flood zone. Flood control projects including extensive levees, pump stations, and canals serve to protect much of the developed land in Louisiana from flooding.



Surface waters are highly engineered and regulated throughout much of the state

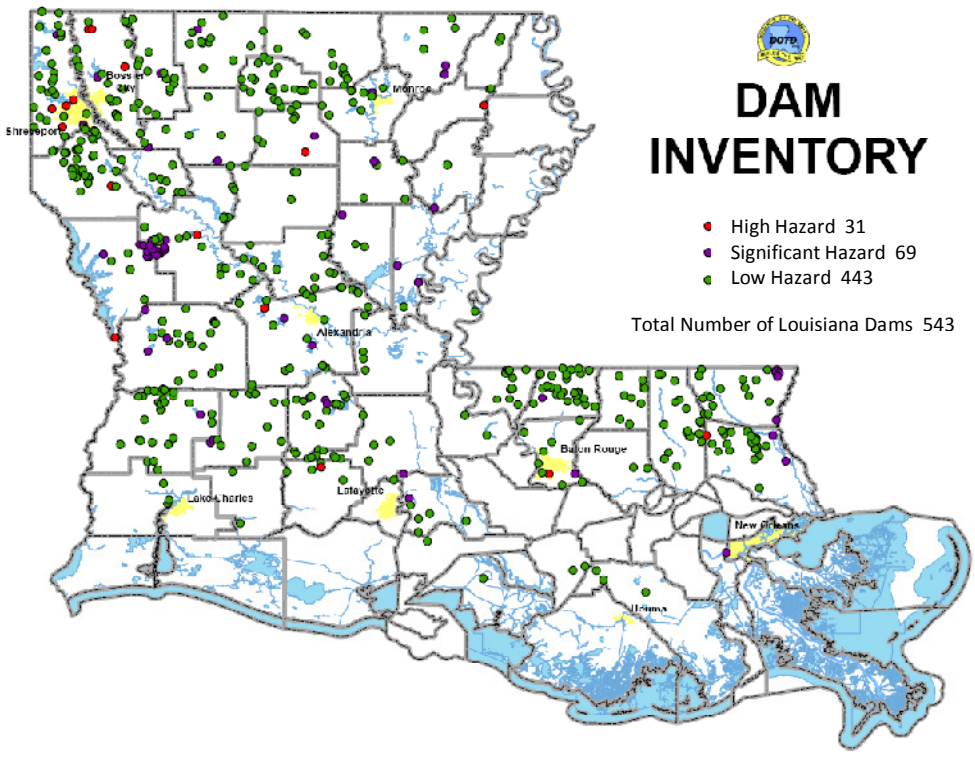
Louisiana Dam Safety Program

In recognition of the inherent danger posed by impoundments of significant volumes of water, the Louisiana Legislature authorized the Dam Safety Program by Act 733 in 1981 (R.S. 38:21-28). The Dam Safety Program, administered by DOTD, requires that owners of structures that impound water (or other liquids) ensure that such structures are designed, constructed, and maintained so as to minimize the risk to life and property.

Two criteria were established for inclusion of dams in the Dam Safety Program. These include dams twenty-five (25) feet or more in height that impound at least fifteen (15) acre-feet, and dams of six (6) feet or greater in height that impound at least fifty (50) acre-feet.

The Dam Safety Program classifies dams according to the potential impacts that would result in the event of a breech. Low hazard dams are those for which, because of size and/or location, little or no significant damage to life or property is likely to result from a failure of the dam. Significant hazard dams are those which could cause appreciable damage to property or could pose possible threat to human life in the event of failure. High hazard dams are those for which failure would cause excessive property damage or make loss of human life likely. Currently, 543 dams are included in a state-wide inventory maintained by DOTD, including 31 high hazard and 69 significant hazard dams.

DOTD inspects 150 to 175 dams annually, including all high and significant hazard dams. Low hazard dams are inspected once every five years. Information on the DOTD Dam Safety Program can be found at http://www.dotd.louisiana.gov/intermodal/dams.



Bayou D'Arbonne Dam

DOTD-Maintained Dams

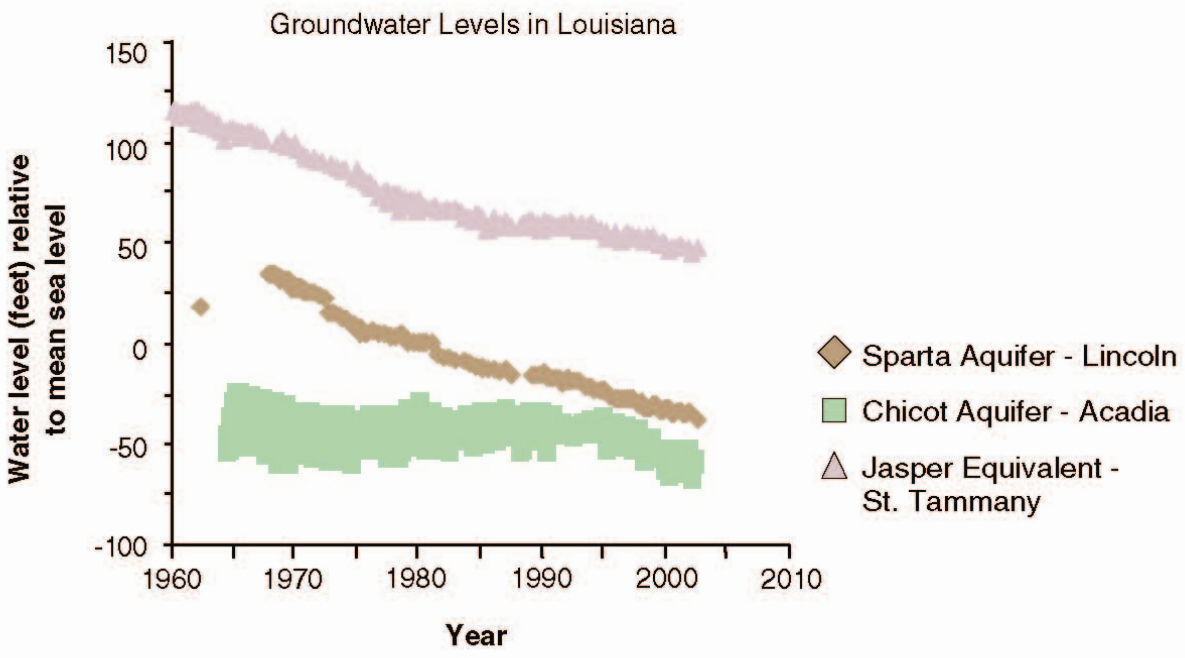
DOTD has developed and maintains 20 major dams in Louisiana (see list below). The dams are operated by DOTD and several local reservoir / lake commissions.

DOTD-Maintained Dams

`	Parish
Bayou Cocodrie Dam	Rapides
Bayou Darbonne Dam & Reservoir	Union
Black Bayou Dam	Caddo
Black Lake Bayou Reservoir	Natchitoches
Bundicks Creek Dam	Beauregard
Caney Creek Dam	Jackson
Chicot Lake Dam	Evangeline
Chivery Dam	Natchitoches
Grand Bayou Reservoir Dam	Red River
Iatt Lake Dam	Grant
Ivan lake Dam	Bossier
Kepler Creek Dam	Bienville
Lake Bistrineau Dam	Bossier
Lake Clariborne Dam	Claiborne
Lower Anacoco Dam	Vernon
Nantachie Lake Dam 1	Grant
Saline Lake Dam	Winn
Smithport Lake Dam	Desoto
Turkey Creek Dam	Franklin
Vernon Lake Dam	Vernon

Groundwater Resources

Groundwater supplies 15 percent of total water supply in Louisiana, about half of the public supply and most of the irrigation and aquaculture. The State of Louisiana has thirteen primary and secondary aquifer systems, all of which are utilized as sources of groundwater supply. Approximately 50 percent of Louisiana's population relies on groundwater as their primary source of potable water (USGS, 2007a). The most heavily utilized aquifer systems in the state are: the Chicot, the Mississippi River Alluvial, the Sparta, and the Southern Hills (including the Jasper Equivalent) aquifer systems. Of these, all but the Mississippi River Alluvial aquifer have experienced declines in groundwater levels over the past decades



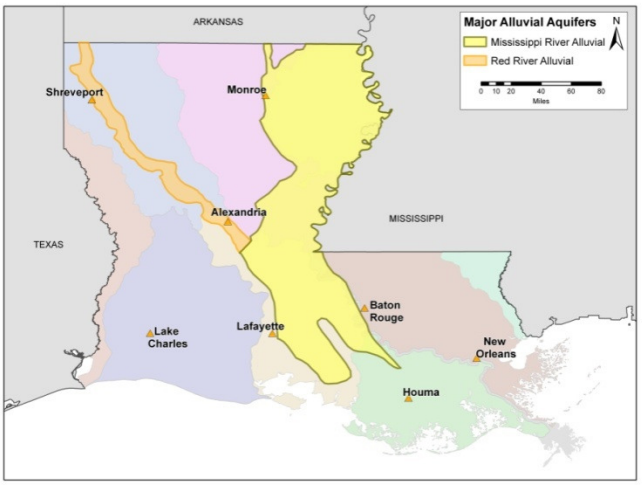
(LGS, 2005)

In 2001, the Louisiana Legislature established the Ground Water Management Commission in response to widespread concern about the sustainable use of the state's groundwater resources. A 2002 report prepared for the Commission documented Louisiana's water resources in support of future efforts to develop a statewide water management plan (Fenstermaker, 2002). This report compiled technical information, recommended several policy actions that required legislative action, and provided guidance for the preparation of a statewide water management plan. Much of the technical information presented in that report is widely used and a Ground Water Resources Commission with the authority to regulate some uses of groundwater and to investigate groundwater issues has been established. To date, a statewide water management plan has not yet been developed.

Although the aquifers in Louisiana are extensive, they are not contiguous throughout the state. The following sections provide general descriptions of major Louisiana aquifers. Much more detailed information is available in the groundwater references cited in this report.

Northern Louisiana Aquifers

Groundwater in northern Louisiana is used extensively for public supply, industry, and irrigation purposes. The Sparta and Mississippi River Alluvial aquifers are the primary sources of groundwater in northern Louisiana. Additionally, the Red River Alluvial, the Northern Louisiana Terrace, the Cockfield, and the Carrizo-Wilcox aquifers are utilized.

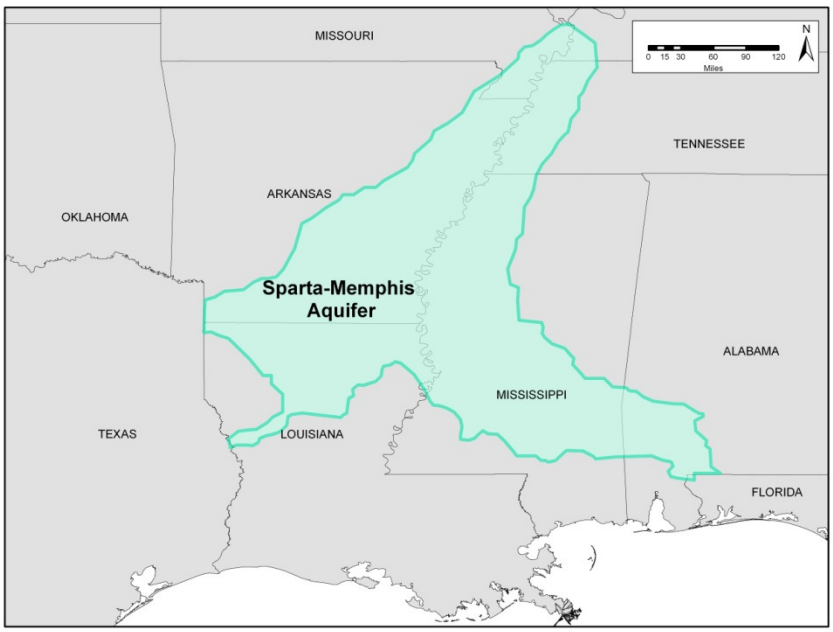


The Red River and Mississippi River Alluvial Aquifers extend along the river valleys and are hydraulically connected to surface water

Mississippi River Alluvial Aquifer

The Mississippi River Alluvial Aquifer is hydraulically connected to the Mississippi River and its major streams. This extensive aquifer extends as far north as Kentucky and Missouri, and east into Tennessee and Mississippi. In Louisiana, it underlies portions of Ouachita and Tensas River basins in the north, and portions of the Atchafalaya-Teche-Vermilion, Pontchartrain, and Mississippi River Delta basins in the south, as shown on the following map. Recharge occurs by direct infiltration of rainfall in the river valley, lateral and upward movement of water from adjacent and underlying aquifers, and overbank stream flooding. Water levels generally fluctuate seasonally in response to precipitation trends and river stages; however the Mississippi River Alluvial Aquifer has not shown any long term groundwater decline in Louisiana.

Although groundwater quality in the Mississippi River Alluvial Aquifer is generally good, some water quality concerns have been identified. In 2006, LDEQ found that several wells exceeded the federal primary drinking water standard for arsenic and several wells exceeded secondary standards for pH, total dissolved solids (TDS), color, and iron (LDEQ, 2006). Twenty-six percent of all groundwater in the State of Louisiana was withdrawn from the Mississippi River Alluvial Aquifer in 2005.



The Sparta Aquifer underlies portions of several states (USGS, 2002)

Sparta Aquifer

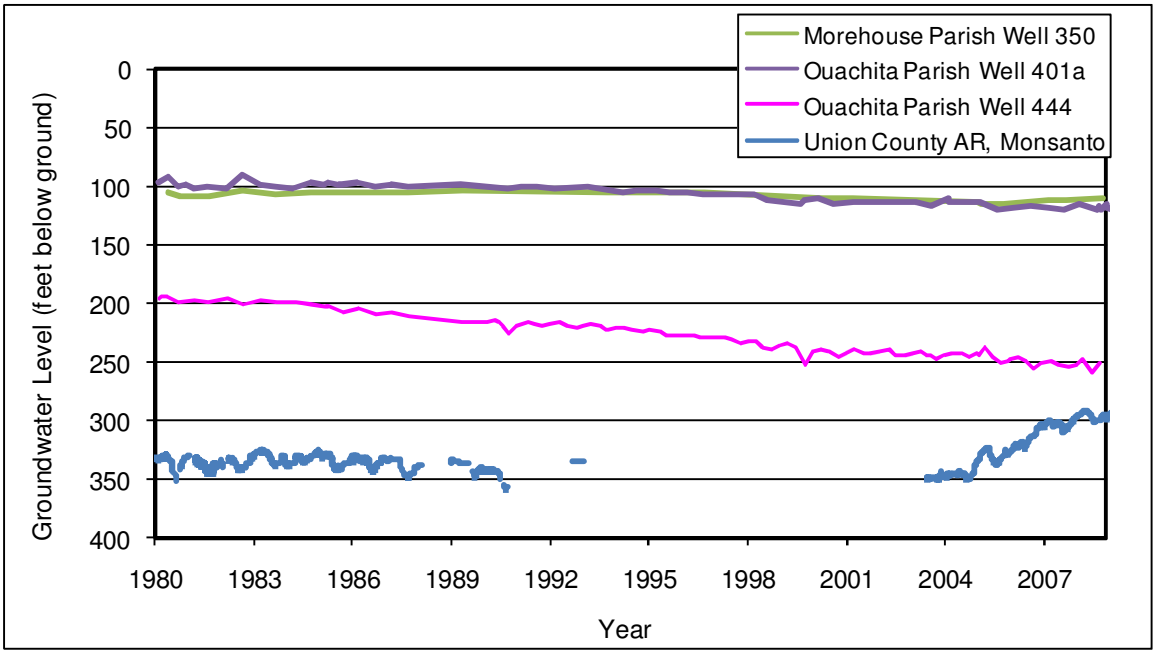
The Sparta Aquifer extends under portions of the Ouachita, Tensas, Red River, and Sabine River basins in Louisiana, and also extends into several neighboring states. The Sparta Aquifer is the fourth

most heavily pumped aquifer in Louisiana. Recharge occurs by infiltration of rainfall and runoff over outcrops in Arkansas, Louisiana, and Mississippi. Recharge also occurs from vertical leakage from overlying aquifers. In Louisiana, the areas with the greatest recharge potential are located in Bossier, Webster, Claiborne, Bienville, Jackson, and Winn Parishes. Major water use is for public supply and industrial use.

Since the mid-1990s, groundwater levels in southern Arkansas and northern Louisiana have been declining at a rate of 1 to 3 feet per year within the Sparta Aquifer. In 2005, the Louisiana Department of Natural Resources declared 3 areas within the Sparta Aquifer as "Areas of Groundwater Concern". These areas are designated because the sustainability of an aquifer cannot be maintained due to current usage and normal environmental conditions. According to the USGS, the sustainable use of the Sparta aquifer is about 52 million gallons per day (MGD), while usage exceeds 64 MGD (USGS, 2006).

The Areas of Groundwater Concern designation requires that the following remedial actions must be taken in the area:

- An aggressive water conservation education program must be conducted
- Owners of non-domestic wells must submit monthly water use reports
- Alternative sources of potable water should be pursued to reduce groundwater use



Groundwater levels in the Sparta Aquifer in Louisiana continue to decline although some recent recovery has occurred in Southern Arkansas

Implementation of management actions has reduced groundwater use, and groundwater levels in portions of the Sparta Aquifer have increased in recent years, particularly in the area underlying Arkansas (USGS 2007b). A joint study was conducted between the USGS and the Sparta Ground Water Conservation District to monitor groundwater levels and groundwater quality, including salt water intrusion. The Sparta Ground Water Conservation District also worked with a consultant to

develop a groundwater model, which was used to determine that a 50 percent reduction in Louisiana's use would likely stabilize, and potentially recharge, the Sparta Aquifer (GWRC 2008).

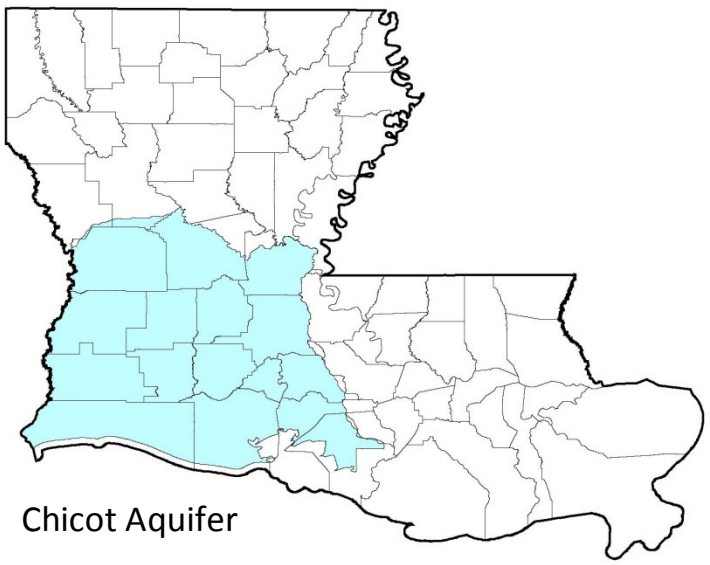
The Commission also authorized investigation of potential saltwater intrusion into the Sparta Aquifer. The groundwater quality is sufficient for most purposes in the Sparta Aquifer although, in 2006, some wells exceeded secondary standards for pH, TDS, color, chloride, and iron (LDEQ, 2006).

Southwestern Louisiana Aquifers

In southwestern Louisiana, the primary uses of groundwater are for public supply, industry, aquaculture, and irrigation – specifically rice irrigation. The Chicot Aquifer is the primary source of groundwater in this area with lesser amount of pumping from the Evangeline, Jasper, and Catahoula aquifers.

Chicot Aquifer

The Chicot Aquifer extends under the Calcasieu River Basin and portions of the Atchafalaya-Teche-Vermilion and Sabine River basins**.** The Chicot Aquifer is made up of several smaller aquifers, including: the "200-foot", "500-foot" and "700-foot" sands of the Lake Charles area, and the Upper and Lower sands of the Chicot Aquifer, which are mainly in the rice-growing areas (USGS, 2007a). The aquifer is hydraulically connected to the Atchafalaya and Mississippi Rivers. Recharge occurs mainly in southern Rapides and Vernon Parishes and in northern Allen, Beauregard, and Evangeline Parishes. In these areas, the aquifer outcrops and is recharged primarily through rainfall and streamflow losses.


Chicot Aquifer

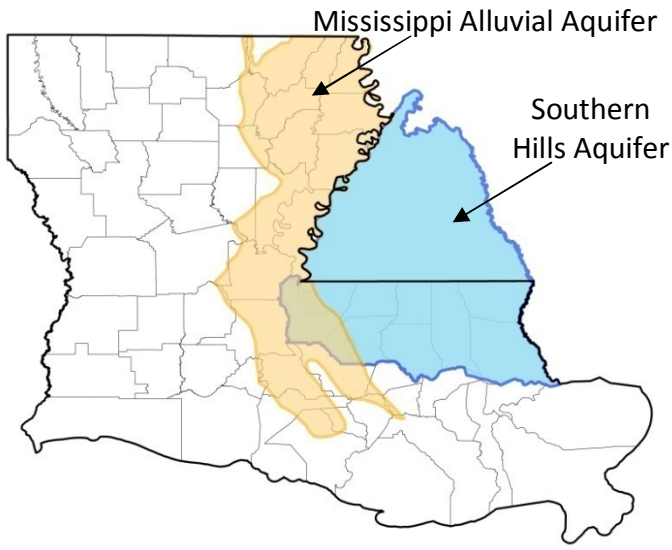
The Chicot Aquifer had the largest withdrawals of any aquifer in 2005 (approximately 660 MGD), which represents 42 percent of all Louisiana groundwater withdrawals. The largest withdrawals from the Chicot Aquifer occur in Arcadia, Calcasieu, Evangeline, Jefferson Davis, and Vermilion Parishes; all of which rely heavily on the aquifer to support rice production. Nearly 75 percent of the groundwater used from the Chicot Aquifer supports agriculture, which results in seasonal fluctuation of groundwater levels.

Between 1996 and 2005, localized areas of groundwater level decline of up to 12 feet in Arcadia Parish and 8 feet in Jefferson Davis Parish were observed. Over-pumping of the Chicot Aquifer has lead to salt water intrusion and groundwater declines in the underlying Evangeline aquifer. Overall, the groundwater quality is good in the Chicot Aquifer. None of the wells monitored by LDEQ in 2006 exceeded federal primary drinking water standards. Lead was detected in two wells at levels below the primary standard. Several Chicot Aquifer wells exceeded secondary, aesthetic standards for pH, TDS, color, and iron (LDEQ, 2006).

Other Southwestern Louisiana Aquifers

The Evangeline, Jasper, and Catahoula aquifer extents underlie southwestern Louisiana. Groundwater levels have declined in both the Evangeline and Jasper aquifers in the last decade. Cones of depression have formed around major pumping centers near Alexandria-Pineville, Leesville-Fort Polk, DeRidder, and the Kisatchie well field in Rapides Parish (USGS, 2005). Overall, groundwater levels in the Catahoula aquifer have held steady. The LDEQ reports the quality of water is good, with none of the monitored wells exceeding federal drinking water standards; however, wells in all three aquifers exceeded secondary standards for pH, TDS, color, chloride, and iron (LDEQ, 2006).

Southeastern Louisiana Aquifers



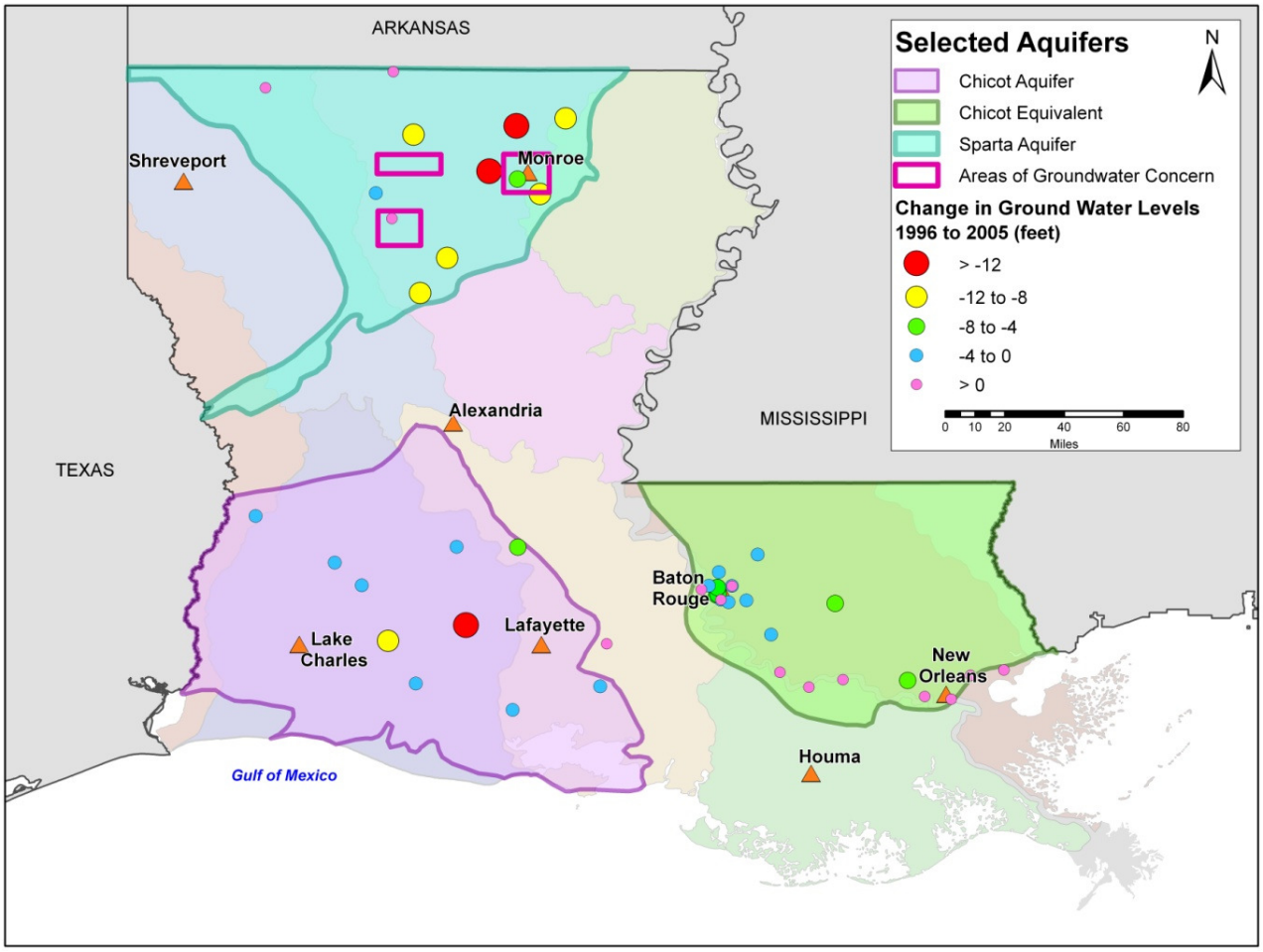
In southeastern Louisiana, the primary uses of groundwater are public supply and industry. The Mississippi River Alluvial and Southern Hills aquifer systems are the primary sources of groundwater in this area. The Southern Hills aquifer system is a collective term for the aquifers of the Southern Hills region, which extend from slightly west of the Mississippi River eastward to the Mississippi state line. Aquifers in the Southern Hills are independent and locally divided. Although local names have been given to the individual aquifers, the Southern Hills aquifer system is divided into three subsystems: the Chicot Equivalent, the Evangeline Equivalent, and the Jasper Equivalent aquifer systems, based on their equivalent depths to the southwestern aquifers of the same name. However, the Southern Hills aquifers are not hydraulically connected to the Chicot, Evangeline, or Jasper aquifers to the west, and should be considered separate aquifer systems.

The Chicot Equivalent Aquifer underlies the Pearl and Pontchartrain basins, as well as portions of the Atchafalaya-Teche-Vermilion and Lower Mississippi Delta basins. The Jasper Equivalent and Evangeline Equivalent aquifers have similar spatial extents. Groundwater investigations have determined that a freshwater-saltwater interface is located along the Baton Rouge fault. South of the fault, the aquifers contain saltwater.

Saltwater intrusion is an on-going concern in the Southern Hills aquifer system, particularly in the Baton Rouge area. Over-pumping has caused salt water encroachment into six of the freshwater aquifers in Baton Rouge. The Capital Area Groundwater Conservation District and Commission (CAGWCC) was formed to address concerns about the declines in groundwater levels and water quality concerns in the areas surrounding Baton Rouge. Since its formation in 1974, the CAGWCC has completed several groundwater remediation projects in hopes to halt the encroachment of saltwater into the area aquifers (CAGWCC, 2007).

Extent of Groundwater Drawdown

As described in the sections above, aquifers throughout the state of Louisiana have been subject to drawdown from pumping to support a variety of purposes. The following map developed from USGS well data shows the extent of measured groundwater level changes during the period of 1995 to 2005 (USGS 2006). In addition, this figure indicates designated areas of groundwater concern in the Sparta Aquifer.



Groundwater pumping has caused drawdown in several aquifers throughout the state. Areas of Groundwater Concern have been defined for the Sparta Aquifer by DNR Commissioner of Conservation.

Groundwater Management Commission and Conservation Districts

Groundwater in Louisiana is regulated by the Ground Water Management Commission and groundwater conservation districts. Act 446 of the Louisiana Legislature established the Ground Water Management Commission (Commission) within the Department of Natural Resources. The Commission can limit use of groundwater in Critical Groundwater Areas. In such cases, well owners must notify the Commission of intent to drill a new well.

Two groundwater districts were created by acts of the Louisiana Legislature:

- ***The Capital Area Groundwater Conservation Commission***, established in 1974, is a ground-water management district composed of five parishes in the Greater Baton Rouge area (East and West Baton Rouge, East and West Feliciana, and Pointe Coupee). The Commission's functions are to promote the orderly development of the groundwater resources in the Capital Area District and to protect the quality of these resources. The Commission has the authority to require registration of all wells, require permits for wells in excess of 50,000 gallons per day capacity, assess a uniform charge based on units of pumpage (with many limitations), and after detailed research limit rates of production when the quantity or quality of water is in danger

- ***The Sparta Groundwater Conservation District***, established in 1999, is authorized to conduct a study and survey of the groundwater resources in the district, including but not limited to consideration of what is necessary or advisable to conserve groundwater resources and where appropriate, prevent or alleviate damaging or potentially damaging drawdown, land surface subsidence, and groundwater quality degradation.

Estimate of Groundwater Availability

Effective water resources planning requires accurate assessments of groundwater availability. For most Louisiana aquifers, long-term groundwater sustainability is unknown. However, recently a working model was developed by the Louisiana Geological Survey for the Sparta Aquifer and the sustainable yield has been estimated at 52 MGD. Ongoing work by the Louisiana Geological Survey in other areas around the state is expected to provide similar estimates for other basins in the near future.

Interstate Groundwater Considerations

Issues with groundwater quality or quantity can frequently extend across state lines. The drawdown area of the Sparta Aquifer extends across the state line with Arkansas as described earlier. Active management in Arkansas has lead to some groundwater level recovery. Union County Arkansas, which was facing permanent damage due to drawdown, concluded that:

> *providing an alternative surface water source to three major industries offered the most feasible, fastest, and cost-effective way to reduce groundwater consumption*

The county constructed a surface water diversion from the Ouachita River to serve power, chemical, and refinery water users. Water levels in the area have begun to recover, partially due to the switch to surface water use (Union County, Arkansas, 2007).

Groundwater issues that are currently apparent in Texas could signal future concerns in Louisiana. Although no overall decline in groundwater levels has been observed in Louisiana for the Carrizo-

Wilcox aquifer, Texas has observed significant water level declines, with some areas experiencing declines in excess of 400 feet since the 1940's (Texas Water Development Board, 1995). The median water level change in Texas was a decline of 2.9 feet from 1990 to 2000 (Texas Water Development Board, 2008). Groundwater quality is also an issue in some parts of Texas.

In Texas, the Chicot, Evangeline, and Jasper aquifers are combined and considered the Gulf Coast Aquifer system. Excessive groundwater pumping has caused major issues in these aquifers within Texas. Large cones of depression have formed in Harris-Galveston, Whaton-Jackson-Matagorda, and Kleberg counties; some of these areas have experienced declines up to 350 feet. The City of Houston also relies heavily on these aquifers. Groundwater availability models in Texas estimate that the groundwater supply will decrease by 32 percent between 2010 and 2060. The Texas Water Development Board has developed a water management plan with several strategies to address these issues; however, groundwater is estimated to still account for at least 9 percent of the total projected water demand on a statewide basis in 2060 (Texas Water Development Board, 2007).

Recently in northwestern Louisiana, public concerns about significant groundwater extraction from the Carizo-WIlcox Aquifer were raised in response to hydraulic fracturing (fracking) to support development of the Haynseville Shale for natural gas extraction. Expanded use of the Carizo Wilcox Aquifer as water supply for drilling and fracking has alarmed the local population and water users, who had already experienced declining water levels resulting from local water usage. To address the concerns, several local agencies (including the Red River Waterway Commission and LSUS Red River Watershed Institute) organized meetings with the oil and gas companies and other interested parties, such as the US Army Corps of Engineers (Vicksburg), Louisiana DOTD, Louisiana DNR (Office of Conservation), Water Resources Committee of Northwest Louisiana, Caddo and Bossier Levee Districts and U.S. Fish and Wildlife Service.

Through a series of meetings, this group was able to accomplish the following:

- Establish a clear definition and understanding of the facts and issues
- Identify alternative water sources, including surface water (ponds, Red and Sabine rivers), recycling and reuse of treated wastewater
- Develop a rapport among interested parties to work together toward solutions
- Expedite the permitting process for surface water sources
- Establish a reporting and monitoring system for groundwater usage

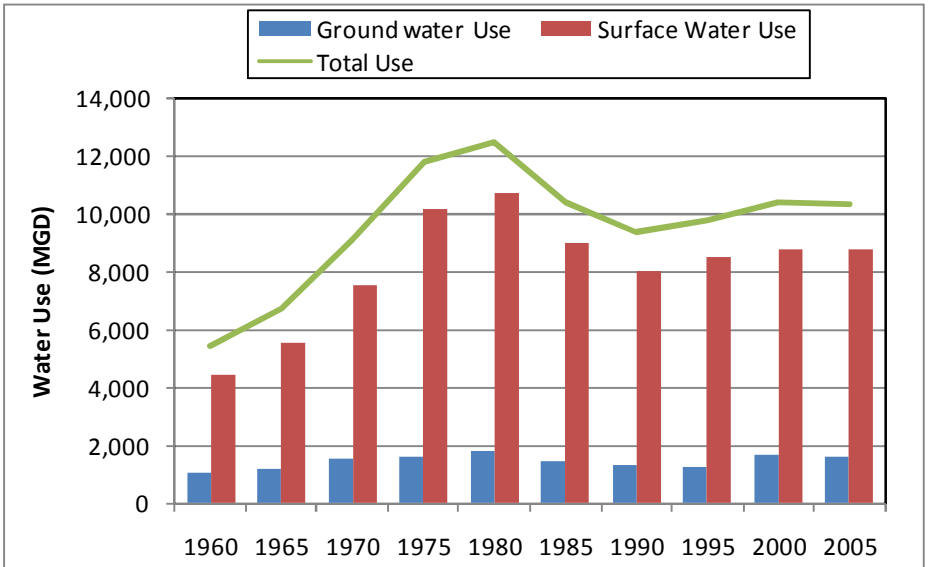
As of February 2009 surface water usage for Haynesville Shale natural gas extraction has increased to approximately 70%. This is a good example of a collaborative process among local users, regulators and other interested parties to successfully address a water resource concern. Through the coordinated efforts of these stakeholders, a sustainable solution was developed that allowed economic development of this valuable resource without adversely affecting water supplies to local water users.

Water Use In Louisiana

The right to use water in Louisiana is generally based on the riparian doctrine, where land owners directly adjacent to surface waters have the right to use it "for beneficial purposes". In addition, Louisiana Civil Code gives property owners the right to use the groundwater underlying their property. Historically, there were few limits on the amount of water that could be used. Case decisions and recent acts recognize that water, at least groundwater, is a public resource and that Louisiana agencies can and should regulate its consumption to protect its long-term sustainability. (USGS. 2007)

Surface water and groundwater resources in Louisiana have many uses. Water uses have been tracked at the parish level at five year intervals by the USGS and DOTD since 1950. On a statewide basis, water use peaked in 1980 and became relatively constant between 1995 and 2005. Generally, water use in 2005 was highest in parishes with large population centers, including New Orleans, Baton Rouge, Shreveport, and Monroe. Water use in 2005 was also generally higher in parishes along the main stem of the Mississippi River near and downstream of Baton Rouge, where many of the state's major population and industrial centers are located and where most of the state's surface water is found, in the Mississippi River.

Surface water and groundwater are used throughout the state, depending on availability and water quality. Surface water makes up a larger portion of the water used in most parishes with access to the state's major rivers, including the Mississippi, Atchafalaya, and Red rivers.



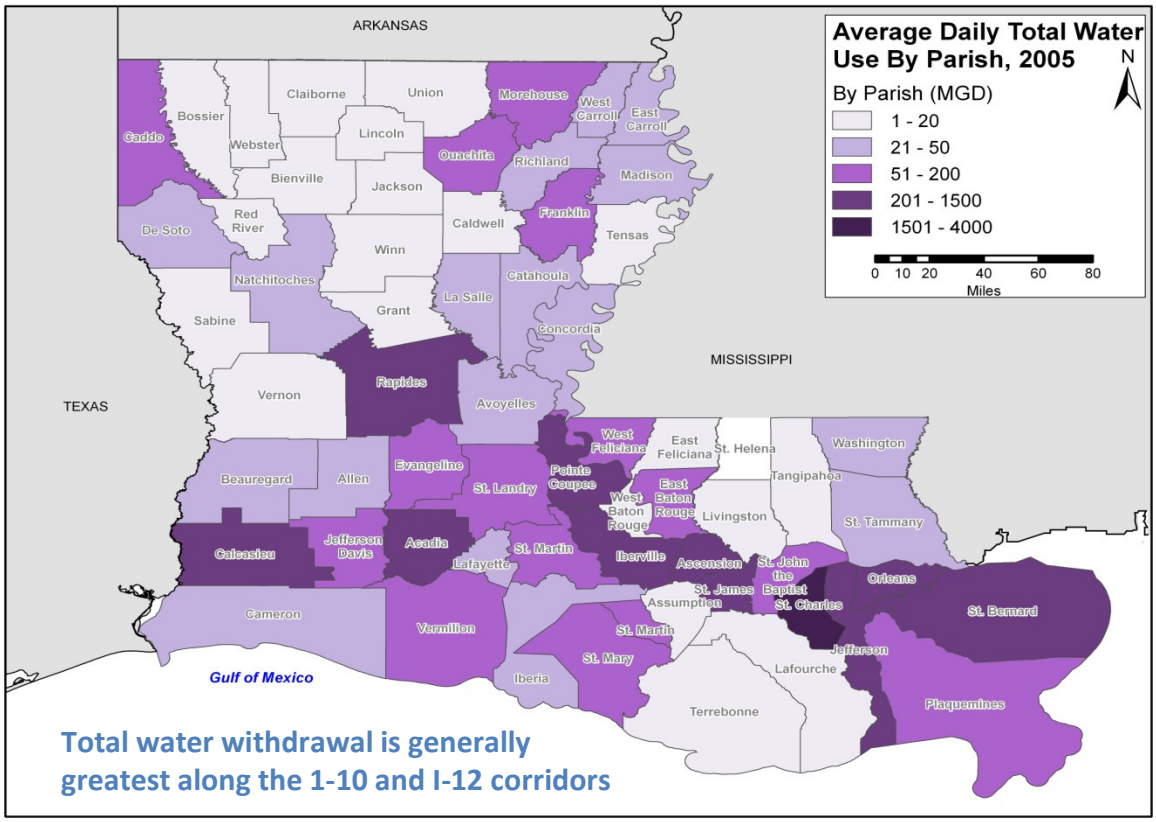
Total statewide water use has been relatively constant since 1995, following a period of rapid increase from 1960 to 1980

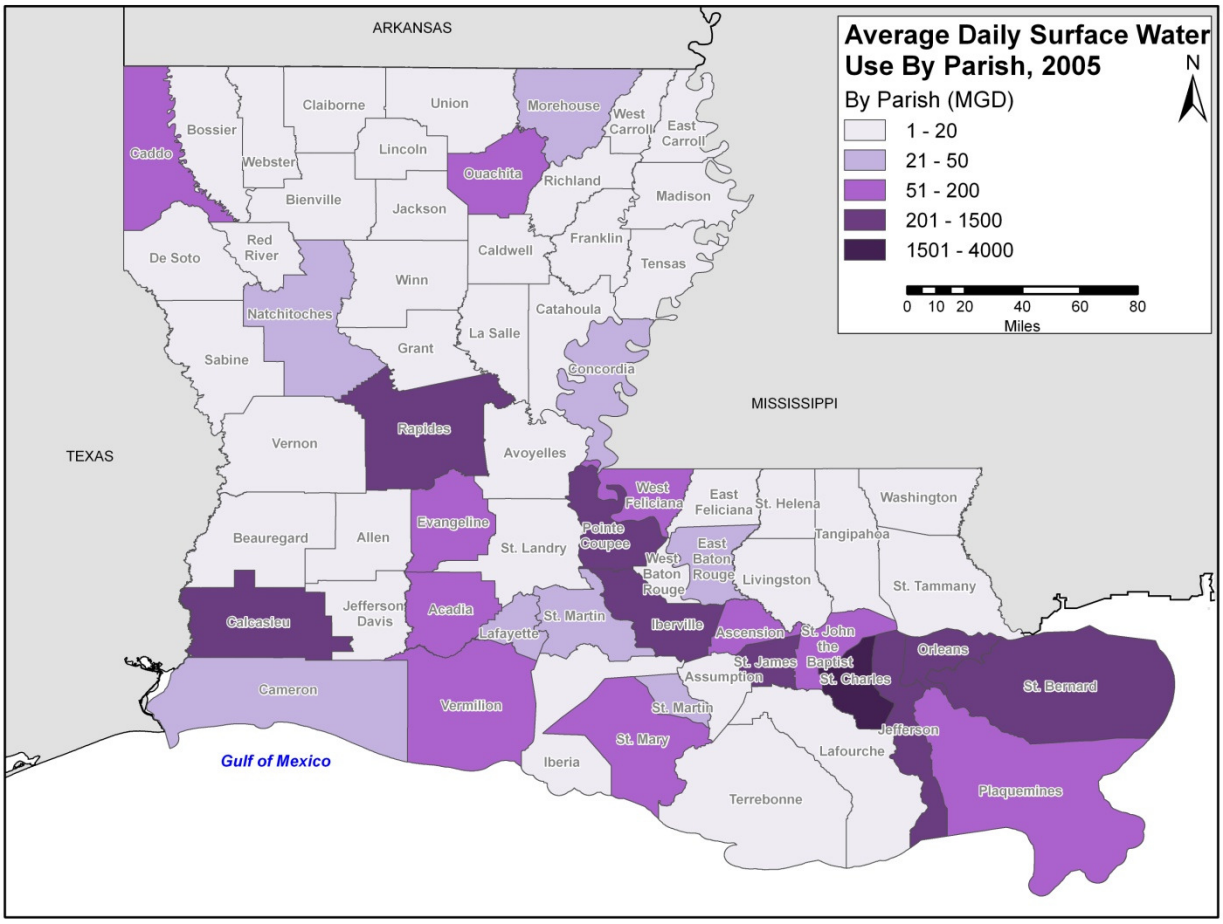
The following table summarizes total annual water withdrawals by use category in 2005. It should be noted that withdrawals often exceed total water consumptive use, particularly for the power generation sector, which generally returns a large portion of the total withdrawn water. Similarly, water withdrawn for irrigation is not entirely consumed by crops, as a percentage of the diverted water generally returns to a waterway.

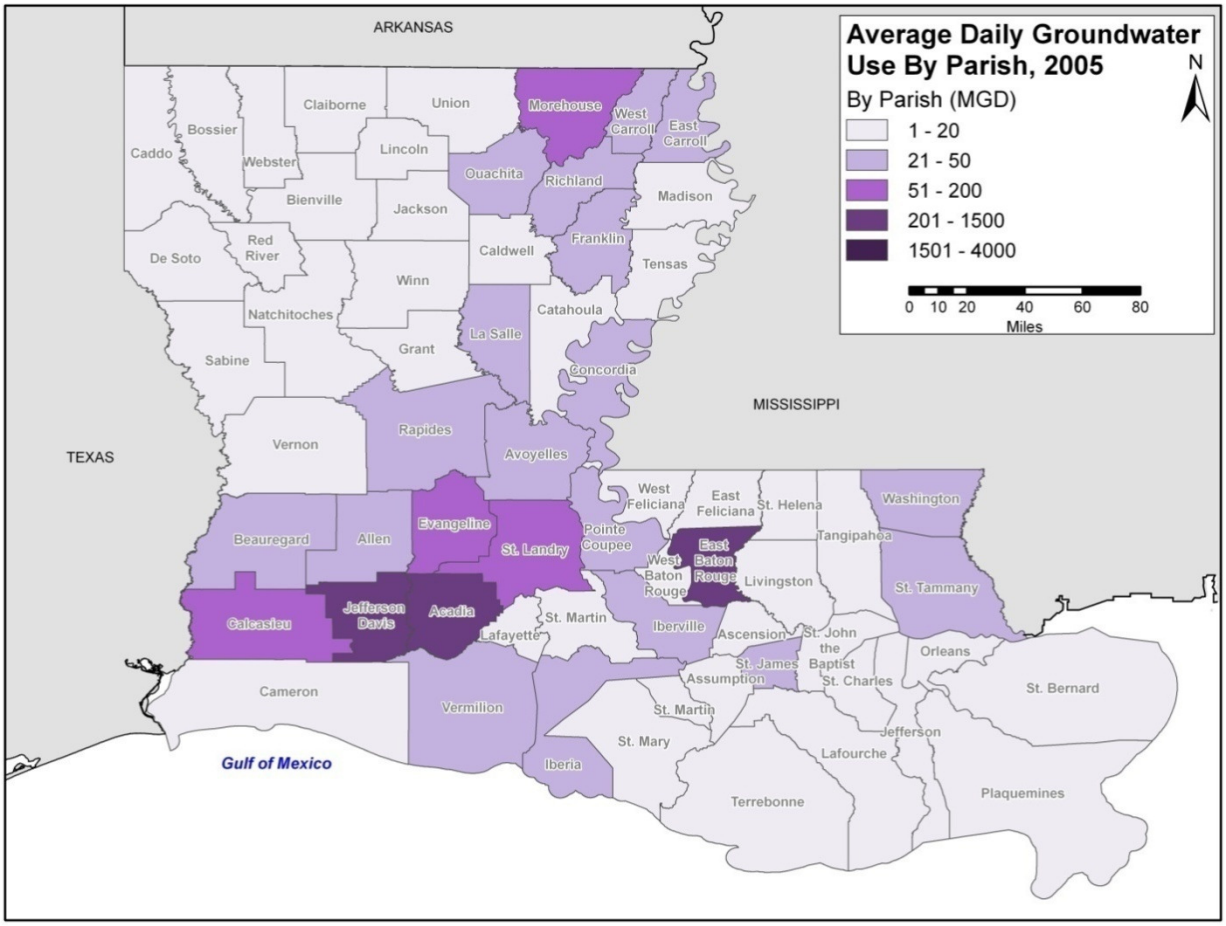
2005 Water Use in Louisiana

Water Use Category	Total Reported Average Daily Withdrawals (MGD)	Percent of Total Reported Withdrawals	Percent of Withdrawal from Surface Water	Percent of Withdrawal from Groundwater
Aquaculture	271	3	33	67
Industry	3,110	30	91	9
Irrigation	992	10	31	69
Livestock	8	<1	48	52
Power generation	5,155	50	>99	<1
Public supply	719	7	52	48
Rural domestic	44	<1	3	97
Totals	10,299	100	NA	NA
Source: USGS, 2007a				

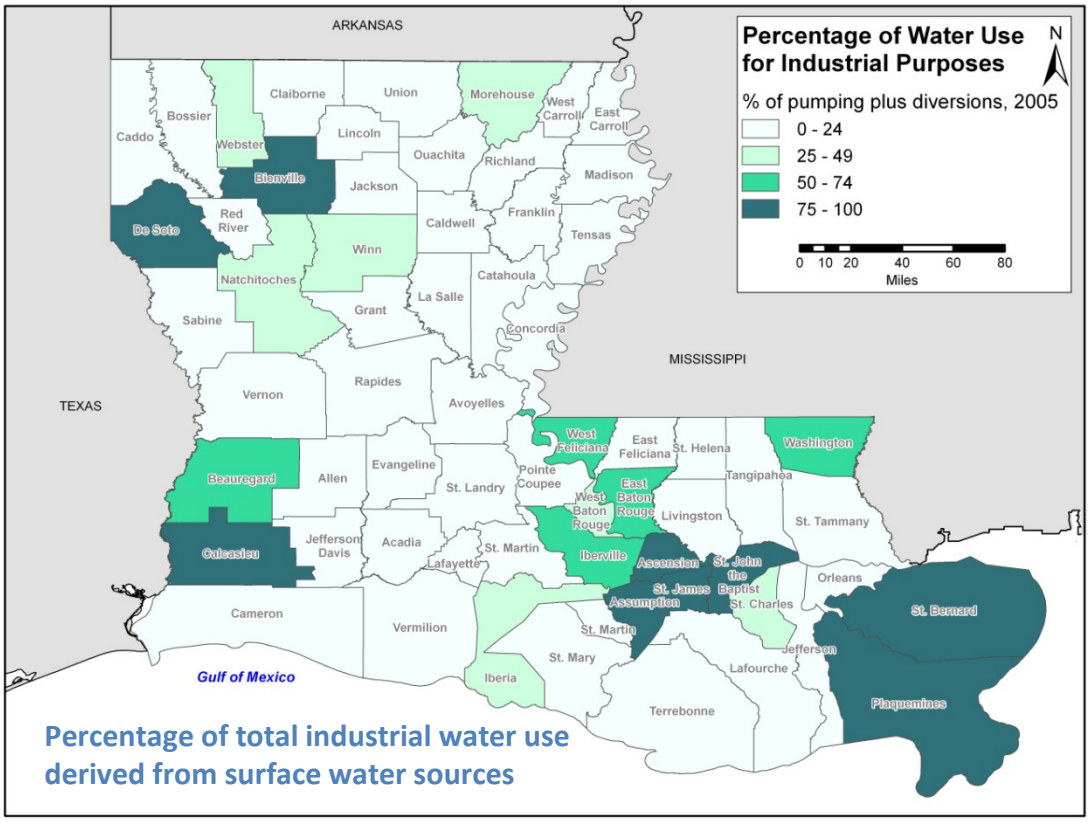
In 2005, average total daily water use in Louisiana exceeded 10,000 million gallons per day (MGD). Withdrawals for power generation and industry make up 50 and 30 percent of the total use, respectively. Surface water is used extensively to meet the needs of these two categories. However, rural domestic use, irrigation, and aquaculture rely heavily on groundwater, with very little surface water used for these purposes. Groundwater also provides about half of the water used to meet public supply and livestock needs. The following maps show total water use, surface water use, and groundwater use in 2005 for major water uses by parish (USGS, 2007a).



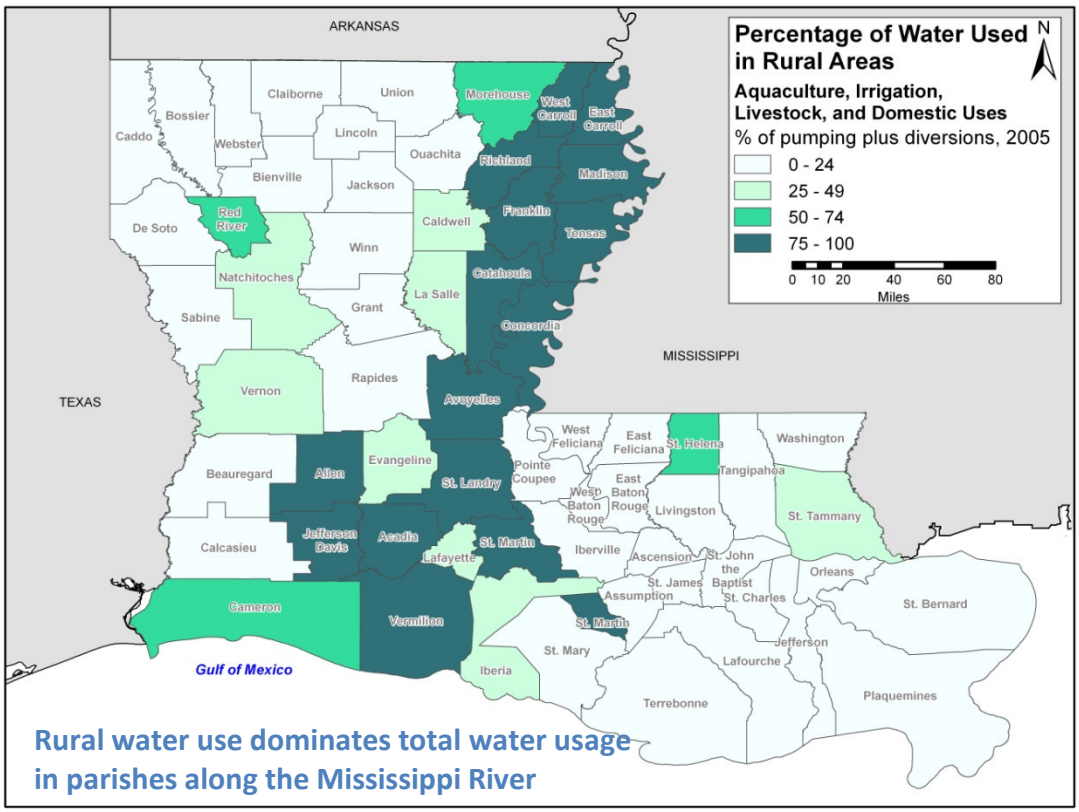

Average Daily Surface Water Use By Parish, 2005
By Parish (MGD)
1 - 20
21 - 50
51 - 200
201 - 1500
1501 - 4000
0 10 20 40 60 80
Miles
N
ARKANSAS
MISSISSIPPI
TEXAS
Gulf of Mexico
Claiborne
Union
Morehouse
West Carroll
East Carroll
Bossier
Caddo
Webster
Lincoln
Ouachita
Richland
Madison
Bienville
Jackson
Franklin
Red River
De Soto
Caldwell
Tensas
Winn
Natchitoches
Catahoula
La Salle
Grant
Sabine
Concordia
Rapides
Vernon
Avoyelles
West Feliciana
East Feliciana
St. Helena
Washington
Evangeline
Pointe Coupee
Tangipahoa
Beauregard
Allen
St. Landry
East Baton Rouge
West Baton Rouge
Livingston
St. Tammany
Calcasieu
Jefferson Davis
Acadia
St. Martin
Iberville
Ascension
St. John the Baptist
Lafayette
Orleans
St. James
Assumption
St. Charles
Cameron
Vermilion
St. Bernard
St. Martin
St. Mary
Jefferson
Lafourche
Iberia
Plaquemines
Terrebonne


Average Daily Groundwater Use By Parish, 2005
By Parish (MGD)
1 - 20
21 - 50
51 - 200
201 - 1500
1501 - 4000
0 10 20 40 60 80
Miles
N
ARKANSAS
MISSISSIPPI
TEXAS
Gulf of Mexico
Claiborne
Union
Morehouse
West Carroll
East Carroll
Bossier
Caddo
Webster
Lincoln
Ouachita
Richland
Madison
Bienville
Jackson
Franklin
Red River
De Soto
Caldwell
Tensas
Winn
Natchitoches
Catahoula
La Salle
Grant
Sabine
Concordia
Rapides
Vernon
Avoyelles
West Feliciana
East Feliciana
St. Helena
Washington
Evangeline
Pointe Coupee
Tangipahoa
Beauregard
Allen
St. Landry
East Baton Rouge
West Baton Rouge
Livingston
St. Tammany
Calcasieu
Jefferson Davis
Acadia
St. Martin
Iberville
Ascension
St. John the Baptist
Lafayette
Orleans
St. James
Assumption
St. Charles
Cameron
Vermilion
St. Bernard
St. Martin
St. Mary
Jefferson
Lafourche
Iberia
Plaquemines
Terrebonne

The following maps graphically portray the percentage of total water use by parish for industrial use and rural water use in 2005 (USGS, 2007a).

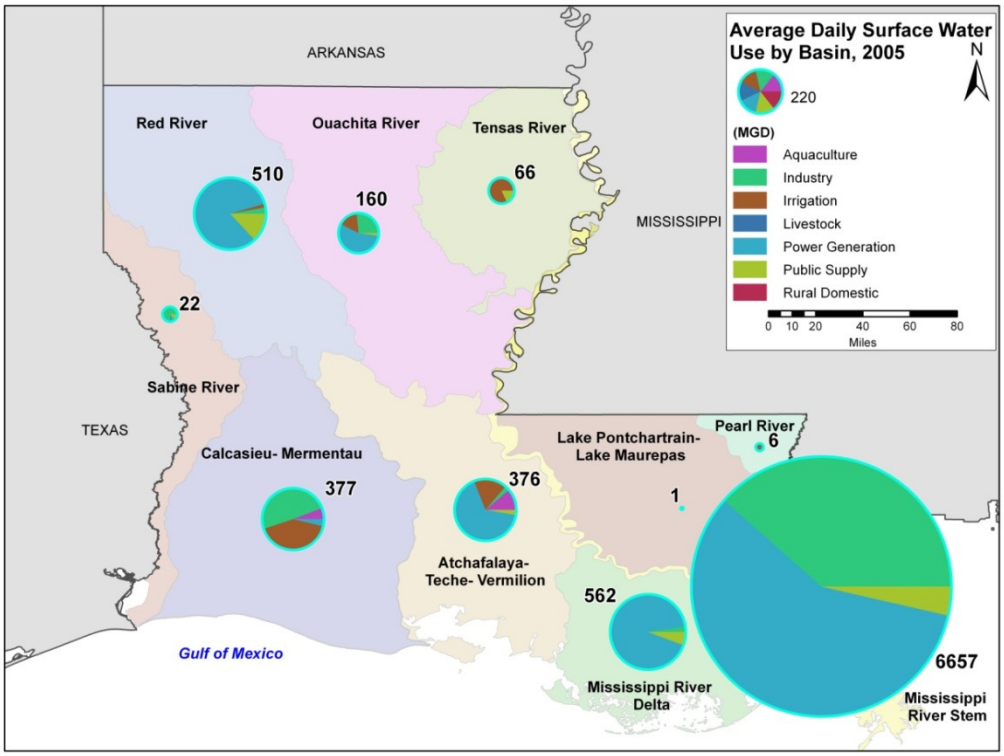


Percentage of total industrial water use derived from surface water sources

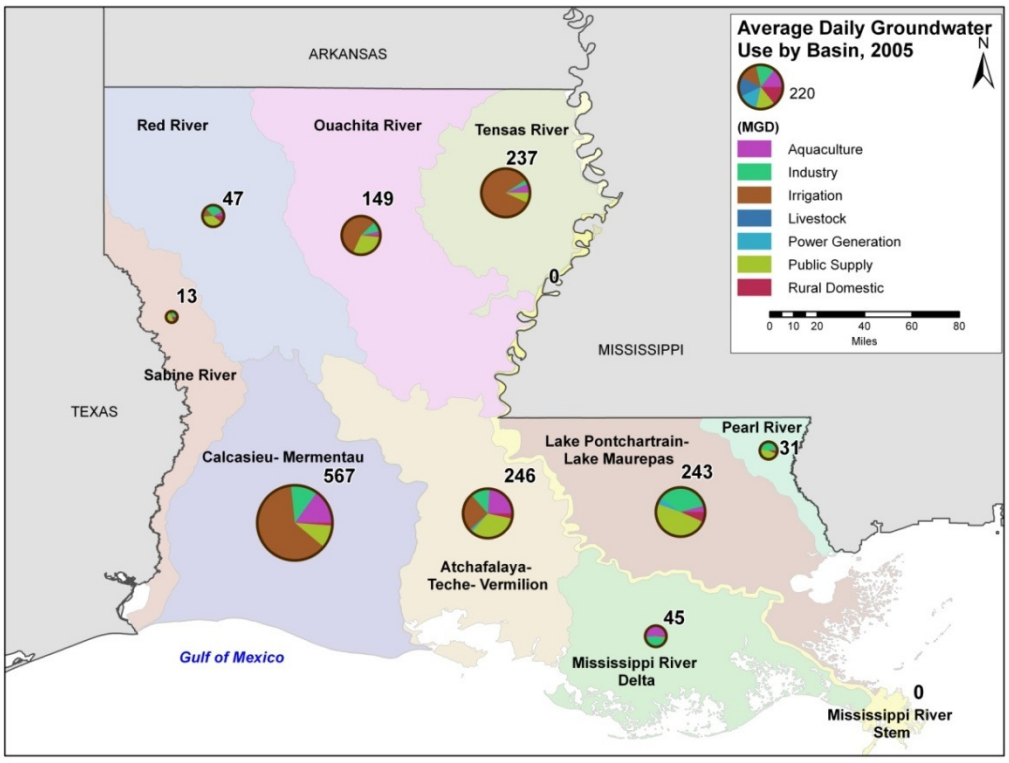


Rural water use dominates total water usage in parishes along the Mississippi River

The following maps graphically portray the distribution of surface water use and groundwater use by surface water basin in 2005 (USGS, 2007a).



Power generation (not fully consumptive use) is the greatest use of surface water in many areas



Groundwater use by sector is highly variable across the state, with most use for irrigation

Water Resources Issues and Concerns

Louisiana is facing several issues and concerns regarding the adequacy of water resources to support existing and desired economic activity while protecting environmental values and meeting social expectations.

During the past few decades, water use in some areas of the state has highlighted concerns regarding water supply availability, water use priorities, and environmental protection. In particular, groundwater draw down has caused water supply impacts and water quality degradation from salt water intrusion of some aquifers. Other issues related to surface water management, such as flood damage reduction and environmental protection, further highlight needs and potential issues. This section presents water resources issues and concerns affecting Louisiana at several scales. It begins with a discussion of issues and concerns that are prevalent state-wide, followed by discussions relevant to Northern and Southern Louisiana, and concludes with a summary of current and future trends in each of the nine surface water basins.

State-wide Water Resources Issues and Concerns

Several issues and concerns have been identified that pertain to many areas of the state. Issues that can affect water resources conditions throughout the state of Louisiana, and elsewhere in the Gulf Coast are summarized below.

Groundwater over pumping. As noted in previous sections of this report, the State of Louisiana has designated "Areas of Groundwater Concern" in the Sparta aquifer in northern Louisiana. In addition, groundwater over-pumping in other regions has created drawdown and induced water quality and water supply issues with current users. Continued reliance on groundwater resources in areas already subject to over-pumping will likely make these conditions more severe, and additional development of groundwater resources would accelerate these concerns.

Population and water use forecast uncertainty. Water resources planners generally use estimates of future population trends to develop associated future water demand estimates. A review of historical population projections in Louisiana demonstrates that such population estimates are highly error prone and may not be as relevant to water supply planning as once thought. Reliance on state-wide population projections as a basis to identify future water needs and potential water resources issues may not provide the necessary insight to anticipate future needs.

Limited information on sustainable yield. While information is available on the types of water uses and total water supply for each use, information to characterize the sustainable yield of surface water and groundwater aquifers is less readily available. In particular, detailed information needed to develop estimates of sustainable groundwater and surface water yield is not widely available for over drafted aquifers and rivers that could be potential replacement sources of water supply. Future planning and project development will require more accurate estimates of these and other important parameters to help more accurately evaluate the consequences of future decisions.

Agricultural demands for water. Throughout the state of Louisiana, agricultural uses for irrigation, livestock, and aquaculture comprise the greatest consumptive use of groundwater and surface water. These uses have contributed to groundwater overdraft, reduced surface water flow, and impaired surface waters.

Industry and energy demands for water. Some of the greatest demands for water in Louisiana are related to oil and gas extraction and refining, petrochemical processing, and energy generation. While not all water for industrial and energy purposes is consumptively used, the diversion and extraction of large volumes of groundwater and surface water affect regional conditions. Demands for these industrial developments are driven by economic conditions that are external to the state of Louisiana and can be difficult to anticipate. Consequently, some regions of the state can be subject to abrupt changes in water demand in response to large-scale resource development.

Declining water quality in certain surface and ground water resources. Extraction of surface water and groundwater resources, combined with waste product discharges from industrial and agricultural users, has resulted in degraded water quality at locations throughout the state. Impaired surface waters have been identified in all areas of the state, and groundwater quality is impacted by over-pumping in several locations. Alternatives to replace groundwater in areas of over-pumping may also need to address impaired surface water and groundwater quality.

Climate change uncertainty. Throughout the world, water resources planners are concerned about the effects of climate change on the availability and occurrence of water resources. In Louisiana, climate change forecasts suggest that extreme events will become more extreme. Hurricane intensity is expected to increase and drought conditions, such as those experienced in 1999 to 2002 are expected to become more frequent and prolonged. As a result, water resources planning for future needs will need to consider greater variability than has occurred in the past.

Increasing complexity of complying with environmental regulations. In the late 1960s and early 1970s, Federal legislation and regulations were promulgated to address the impact of water use on the environment and public health. As these regulations, and companion requirements of the State of Louisiana, are implemented, the requirements on water resources development and use become more restrictive. Water resources project developers and operators are sometimes ill-prepared to address the scope and complexity of multiple environmental requirements, often leading to extensive time and cost to prepare project plans.

Increasing competition for water resources. As described elsewhere in this report, water resources development and use throughout Louisiana is diverse, including uses for municipal, rural domestic, agricultural, environmental, recreation, energy, and industrial needs. As resource limitations have become evident through reduced available supply or impaired water quality, the competition for water supplies has grown. Competition for water resources is more pronounced in areas where water resources development and use is not coordinated.

Water Resource Issues and Concerns in Northern Louisiana.

The northern, or upland, surface water basins of Louisiana (Red River, Ouachita River, and Tensas River basins) generally have a more rural population and are less developed compared to those in the south, with the exception of the Shreveport-Bossier City area in the Red River Basin and the Monroe area in the Ouachita Basin. Forest, wetlands, and other natural vegetation cover much of the upland basin areas, with the exception of the Tensas Basin, which is dominated by agricultural land. Rivers and streams of the upland basins generally drain to the Achafalaya River, with the exception of the Sabine River, which spans both the upland and coastal regions and drains directly to the Gulf of Mexico. About 1,000 river miles in Northern Louisiana have been designated as scenic, and ecosystems are generally less disturbed than those in the coastal basins. Surface water and groundwater quality is generally good in most areas of northern Louisiana.

Surface water availability in the upland basins is subject to dramatic seasonal variation, resulting in a supply that can be vulnerable in areas where surface water is the main supply source. As a result, groundwater has been a significantly source of water supply, resulting in over drafted portions of the Sparta Aquifer. Groundwater in northern Louisiana aquifers is prone to salt water intrusion when over drafted. Significant issues resulting from groundwater pumping has led to the designation of three “Areas of Concern” by the state. Recent activity by oil and gas companies suggests that expanded oil and gas production could occur in many upland basins. Additional oil and gas production would place additional demands on water supplies. Exploration and resource production operations require water for drilling wells and fracturing formations. In addition, “produced” water must be properly disposed. Groundwater has been a common source of water for oil and gas operations, and produced water has often been disposed in deep aquifers.

Water Resource Issues and Concerns in Southern Louisiana

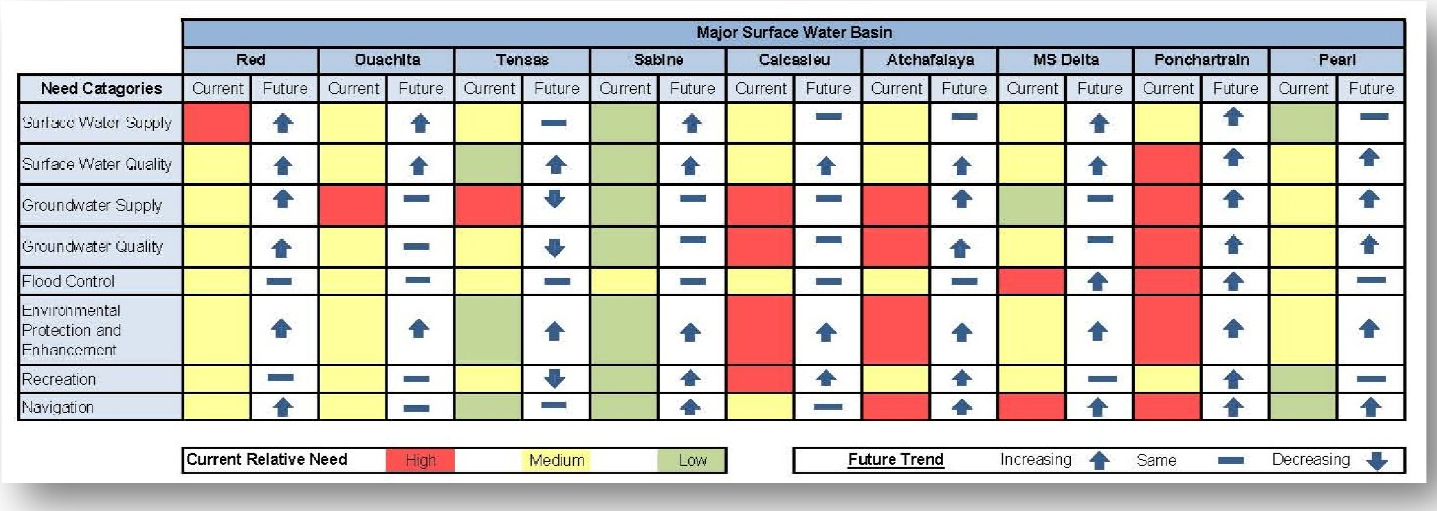
Coastal basins in Louisiana share several common water resources issues. The combined coastal basin population is three times larger than that of the combined upland basins, resulting in a greater demand for water resources for all uses. Groundwater in coastal areas also is subject to salt water intrusion, which when subjected to groundwater overdraft results in salination of groundwater resources. Intensive industrial and urban development has degraded surface water quality in many locations, resulting in greater complications with environmental protection, recreation, and supply uses.

Environmental, navigation, pipeline construction, and oil and gas exploration concerns are generally greater in the coastal basins than the upland portion of the state. Over 2,000 river miles have been designated as scenic rivers in the coastal basins, twice as many river miles as in the upland basins. Greater areas of sensitive wetland and coastal ecosystems are present, and a larger number of threatened and endangered species have been identified in the coastal basins. Construction of extensive networks of canals has impacted wetland environments, while siltation in rivers and canals presents challenges in providing adequate draft for navigation. Finally, although flooding is a concern throughout the entire state, the lower, flatter topography in the coastal basins, in combination with higher population and development and susceptibility to both fresh water and salt water flooding, indicates a greater need for regional flood control projects. Many of these issues are being addressed through Coastal Zone management actions; however water supply and water quality issues remain.

Summary of Water Resources Issues and Concerns by Basin

Each of the nine surface water basin reports includes a summary of water resources issues and concerns based on recent historical conditions and potential future trends. For each basin, water resources issues were identified for surface water supply, surface water quality, groundwater supply, groundwater quality, flood control, environmental protection and enhancement, recreation and navigation. Water supply and water quality issues focused on those that could potentially be addressed or affected through the construction of surface water diversion or reservoir projects.

Evaluation criteria were selected to support inter-basin comparison and to highlight the relative urgency of water resources issues and concerns throughout the state. To maintain objectivity, evaluation criteria are based on qualitative factors that could be applied to all basins. A relative scale (high, medium, low) is used to reflect the current level of concern or urgency for each basin. Future water resources trends are characterized as increasing, steady, or decreasing from the current level of concern based on a projected continuation of recent trends. Results from this assessment are shown in the following figure.

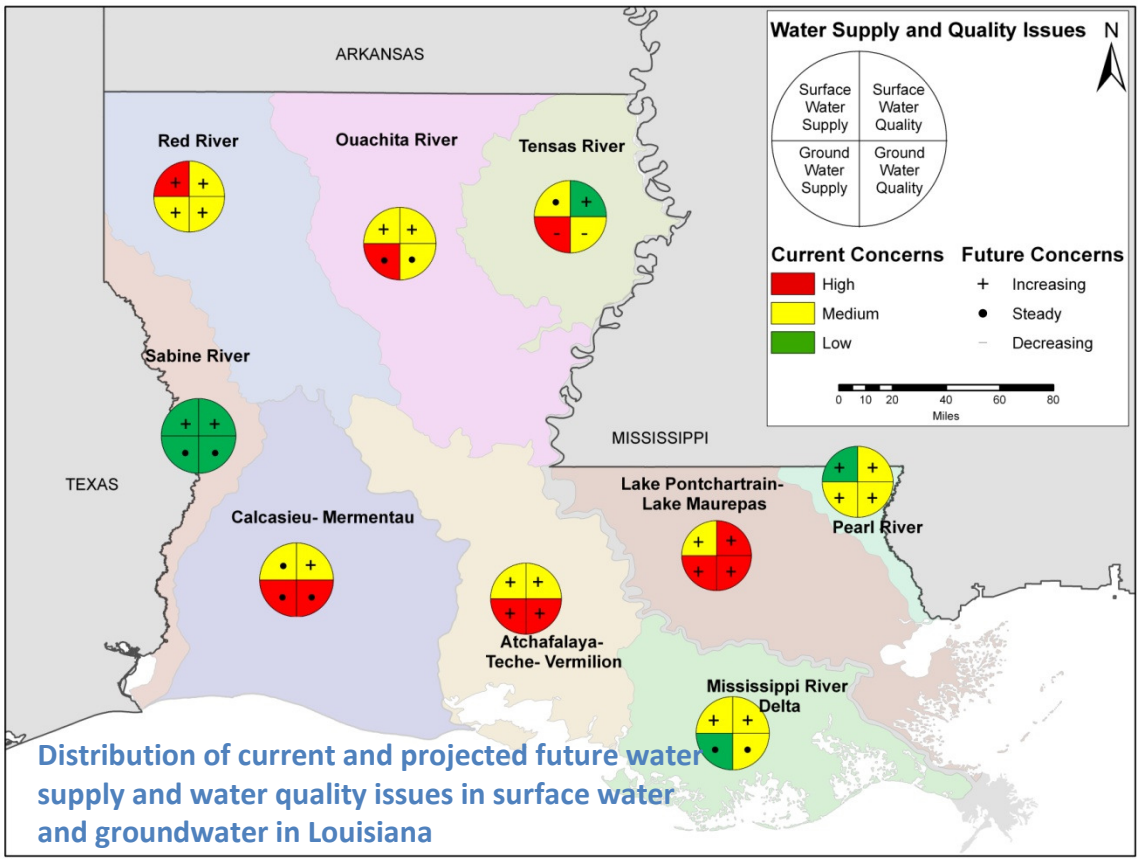


Summary of Louisiana Water Resources Issues and Concerns by Basin

To illustrate the methodology of this approach, consider the Tensas River Basin. In this region, groundwater supply needs were ranked as high because of the long-term decline of water levels in the Sparta Aquifer. Surface water supply was ranked as a medium-level need because flows in the late summer and fall tend to be quite low and there are indications that surface water supplies may not be adequate to fulfill agricultural demand in the northern part of the basin. Surface water quality is good in the Tensas Basin, with relatively few surface water impairments and no impairments related to drinking water standards. Groundwater quality was ranked as a medium because Federal secondary drinking water standards have been exceeded in water from some wells in all major aquifers in the basin, and groundwater quality has degraded in the Sparta aquifer in particular.

Flood control, environmental protection and enhancement, recreation, and navigation issues and concerns in the Tensas River Basin are ranked either low or medium. In comparison to other basins, flood control needs are considered medium-level because the existing flooding concerns do not affect population centers. The need for environmental protection was ranked low because much of the land in the Basin has been developed for agricultural production and relatively small areas of unprotected natural lands remain. The need for increased water-based recreation facilities is considered low because the relatively small population of the basin has access to several wildlife refuges and a state park on the Mississippi River. The need for navigation enhancement is considered low because the Tensas River Basin does not contain any navigable waters.

More detailed descriptions for each basin are presented in the surface water basin reports. The geographic distribution of current and projected surface water and groundwater supply and quality issues in Louisiana, as summarized in the table above, is shown in the following figure.

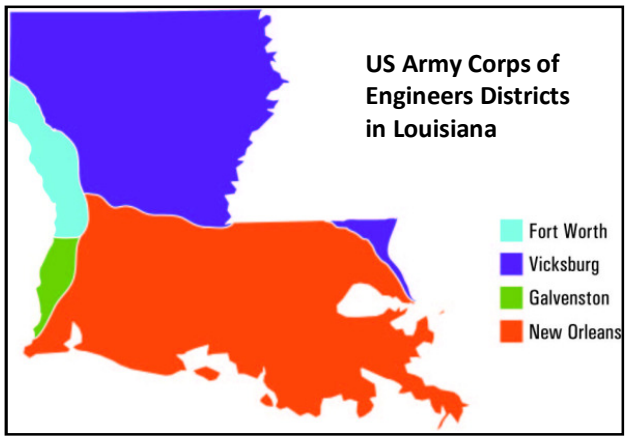


Distribution of current and projected future water supply and water quality issues in surface water and groundwater in Louisiana

State and Federal Agency Roles in Water Resources Management

Many state and federal agencies are involved in water resources management in Louisiana. However, no one agency is tasked with planning or implementing an overall water resources strategy for the state. In Louisiana, water management authority is shared by several state and federal agencies with no unified control. Accordingly, any new surface water development project or water resource management strategy to address the issues and concerns requires close coordination with and support by numerous state and federal water management and regulatory agencies.

The water well program was transferred from DOTD to the Department of Natural Resources , Office of Conservation, Environmental Division, effective January 1, 2010. With this transfer, DNR became the state agency with overall groundwater management authority. The DNR Office of Conservation tracks potential groundwater use through well drilling permits and requires prior notification by non-domestic well-owners in areas of groundwater concern. The Office of Conservation also works with the Louisiana Ground Water Resources Commission, which is directed by statute to develop Louisiana's groundwater management program.



No state agency is responsible for permitting or regulating surface water use in Louisiana. DOTD, in coordination with the USGS, regularly prepares reports on use of both surface water and groundwater, which provide valuable information on water use trends. However, no agency is authorized to regulate water use or administer water rights. Several state and federal agencies would be involved in permitting a new project to divert surface waters, but the eventual use of such water is not permitted by any agency. The Department of Health and Hospitals does have permit authority over the quality of potable water.

The US Army Corps of Engineers (USACE) and the US Fish and Wildlife Service (USFWS) are likely to be the most involved Federal agencies regarding surface water management in Louisiana. The USACE is tasked with protection of the nation's waters and wetland resources, maintenance of navigable waters, implementation of general river and habitat improvements, and development of and management of Federal flood control projects. The USFWS is responsible for administration of the Federal Endangered Species Act, and must render biological opinions of any Federal action that could adversely affect a proposed or listed species.

Construction of most surface water diversion or reservoir projects would require a Clean Water Act Section 404 permit for discharge of dredged or fill material into waters of the U.S. In planning such a project, USACE would be consulted to determine if the proposed action would affect water bodies or wetlands of the US. Because the 404 permit invokes the National Environmental Policy Act (NEPA), this process would require evaluation of other affected resources, including cultural resources and endangered species among others, and would trigger the involvement of several other State and Federal agencies.

The following table briefly summarizes State, Local and Federal agencies that would be involved in the review and permitting for a surface water diversion or reservoir project.

Agency	Responsibilities Related to Water Resources Projects
Louisiana State and Local Agencies	
State Historic Preservation Office	Identifies significant cultural resources, assesses effects upon them due to a proposed project, and considers alternatives to avoid, reduce or mitigate those effects
Department of Environmental Quality	Issues a water quality certification (per Section 401 of the Clean Water Act) for any activities that may affect the water quality of any of the State's streams, lakes, ponds, bays, or other water bottoms
Department of Natural Resources	Responsible for preserving and enhancing the nonrenewable natural resources of the state through conservation, regulation, and management/exploitation. Issues coastal use permits for activities within the Coastal Zone. Effective January 2010, DNR maintains information on well drilling and changes to wells.
Department of Wildlife and Fisheries	Responsible for the control and management of the state's wildlife and all aquatic life; involved in administration of Federal and state endangered species. Issues permits for regulated taking of Louisiana's endangered species. Issues Class B Use Permits for activities that may affect, directly or indirectly, streams included in the Louisiana Natural and Scenic Streams system.
Department of Transportation and Development	Administers the dam safety program, which provides the minimum standards for the design, construction, operation, and maintenance of dams. Administers statewide flood control program, administers state reservoir priority development program, and maintains data on statewide water use. Issues letters of no comment for activities that may affect state lands, water bottoms, or structures (e.g., roads, bridges, etc.).
Department of Health and Hospitals	Protects public health related to drinking water. Reviews construction plans and specifications for public supply wells, water treatment facilities, and water distribution systems.
Local levee districts and police juries	May have local permit requirements and should review project information for projects potentially affecting their areas of responsibility.
Federal Agencies	
US Army Corps of Engineers	Responsible for co-administering and enforcing Section 404 of the Clean Water Act for effects to wetlands and issuing Rivers and Harbors Action Section 10 permits for effects to navigable waters. Develop and manage Federal flood control and navigation projects. Would typically be the lead Federal agency for actions that require National Environmental Policy Act compliance.
US Environmental Protection Agency	Co-administration and enforcement of the Clean Water Act Section 404 permitting program. Would be consulted for the National Environmental Policy Act process.
US Department of Agriculture	Responsible for implementing the Farmland Protection Policy Act, which ensures that farmland is not irreversibly converted into nonagricultural land. Designs and constructs farm ponds.
Federal Emergency Management Agency	Responsible for floodplain management and floodplain map revision.
US Geological Survey	Collects and manages water resources data in coordination with Louisiana agencies, particularly DOTD. Conducts studies of water resources availability and water quality.
US Fish and Wildlife Service	Administers the Endangered Species Act (ESA) of 1973 and Migratory Bird Treaty Act. According to Section 7 of the ESA, federal agencies must consult with the Service to ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species.

Strategic Framework for Statewide Water Resources Management

The State of Louisiana has great regional diversity in water availability and in the amounts and types of water use. However, water resources management issues, particularly those related to groundwater extraction have occurred and are expected to grow in some areas of the state. Although water resources needs in Louisiana vary considerably across the state, a set of common concerns are evident in many regions of the state. These result, in part, from lack of coordinated planning, availability of information to support decision making, and funding.

To more proactively address water resources issues, the state of Louisiana should adopt a comprehensive water resources management strategy. The primary purpose of the strategy is to assure that state surface and groundwater resources are managed to meet the present and future needs of municipalities, agriculture, industry, rural domestic water users, and the environment. In particular, the strategy should focus on measures that would assure the protection and sustainable use of its groundwater resources. While the implementation of the approaches described below would not be expected to immediately resolve long-established water resources concerns, they would be beneficial in reducing or reversing adverse effects, and avoiding similar issues from occurring in the future.

A comprehensive strategy for water resources management does not necessarily require the establishment of new state agencies or the enactment of new regulation. Water management authority is shared by several state and federal agencies with no unified control. Rather than establishing a new state-wide agency with regulatory authority over regional water issues, it should be possible to establish a series of incentives that would encourage the management of water resources consistent with commonly-held state-wide goals.

One of the greatest challenges in water resources planning in Louisiana is that growth in water use by municipalities, agriculture, and industry remains difficult to forecast. Several previous projections of future water use have been proven inaccurate and were not reliable predictors of actual changes in water use. Accordingly, a statewide strategy for water planning should not rely on a single set of forecasts or estimates, but instead be adaptive to changing conditions.

Water users generally respond more favorably to incentives and voluntary water management measures rather than centralized regulatory control. While this preference has not yet been confirmed in Louisiana, water users in several other states have repeatedly demonstrated support for this approach. In recognition of the conditions described above, a statewide water management strategy for Louisiana should include the elements listed below, which are described in detail in the sections that follow.

- **Establish a statewide water supply advocacy program** – Promote increased state agency coordination through a governor-led initiative that establishes common water management objectives; emphasize the importance of sustainable water resources for public welfare, ecological health, and economic prosperity.
- **Adopt a state-wide process for water resources management** - Regularly identify the most serious water supply issues from a statewide perspective; focus on comprehensive processes that can identify and address potential regional water supply issues before they grow to crisis proportions; provide guidance for water resources planning.
- **Improve information on sustainable water use** – Increase data analysis, model development, and estimates of sustainable yields for surface water and groundwater resources. Coordinate the evaluation of monitoring data and development of analytical tools.
- **Communicate State and Federal permitting requirements** – Provide clear guidelines about regulatory compliance requirements of State and Federal agencies that must be addressed during water project planning, design, and construction.

- **Provide state-level financial incentives** – Develop state programs that provide financial assistance, either directly or through tax incentives, to develop projects that reduce the severity of known or emerging water supply issues.

Establish a Statewide Water Resources Advocacy Program

The State of Louisiana has organized some statewide water resources related programs by activity, such as waste discharge permitting and well registration. Other state water resources programs are organized by program benefits, such as dam safety, flood control, and navigation improvement. This approach, while effective for administration of specific objectives, has caused a lack of clarity on which state agency, if any, is charged with planning and managing state water supplies to meet future needs. While agencies willingly coordinate their participation with their counterparts, each agency is ultimately guided by its own mission in the absence of an overarching state vision that cross-cuts the priorities and behavior of all agencies.

DOTD currently has responsibility for the dam safety, reservoir development, flood control, and navigation programs. The flood control and navigation programs involve coordination with local governments to contribute to economic development and public safety. Through these programs, DOTD can provide engineering and technical assistance to local entities to guide the orderly development of water resources. The recent assignment of the Reservoir Development Prioritization Program to DOTD by the legislature further strengthens the authority of DOTD to take a lead role in assuring future water supply security for Louisiana.

While it may not be desirable at this time to establish a single agency with authority over all water resources planning and management actions, more coordination among state agencies currently involved in water resources management is clearly needed. To achieve this, executive leadership will be needed to highlight the greatest priorities, establish common objectives, and reinforce the need for coordinated activities of state agencies. This could be accomplished through a Governor-led initiative that establishes common objectives for water resources management and requires each agency to identify how it will contribute to those objectives though existing authorities and missions.

Common objectives for water resources management would be identified through statewide needs assessments periodically prepared jointly by multiple agencies. A set of clearly defined responsibilities would be established for each agency, with emphasis on achieving the objectives. This would be accomplished by aligning agency budgets, and establishing coordination and reporting mechanisms to assure statewide objectives are being actively pursued. Statewide needs assessments and objective statements should be updated on a regular basis to track progress and highlight needed course corrections in response to changing conditions.

Adopt a State-wide Process for Water Resources Management

State-level interest regarding long range water supply and demand issues is growing. Public officials and water users want to know how much water is available and how much additional development can be accommodated. But attempting to develop a comprehensive plan to guide future water use can be a difficult, frustrating, and error-prone task. Bringing together the very large amount of data required and conducting the necessary analysis is expensive and time consuming. A perception that such a plan would focus on facilities and control the future actions of water users could provoke deadlock among various interested parties, and suppress interest in developing a plan at all. Finally, future economic activity, population growth, and water use are very hard to predict, and as a result, a comprehensive facilities plan would be soon out of date and considered of limited value.

A more appropriate strategy for Louisiana is to develop a water supply management process that can identify concerns regarding non-sustainable water use and projected water shortages and resolve them in a timely manner. Such a process would involve state-wide leadership for development of regional water

resources management plans, guidance for planning that incorporates uncertainty, and funding to promote regional coordination.

Encourage Regional Water Resources Planning and Management

Water users such as municipalities, agricultural operations, and industries know their own water needs better than any outside party. The state should place more responsibility on major water users to project their future water needs and to determine what quality of water they need and what sources are most feasible. This would be accomplished through preparation of regional plans. By reviewing these plans on a regional basis, both the water users and the state develop a more accurate assessment of future demands to be placed on regional water sources and if these demands are compatible with the yield of water sources. Review of the water user plans in a region may also surface worthwhile possibilities for regional cooperation on water supply projects.

Due to the great diversity of Louisiana's economy, hydrology, and population density, the nature of water supply issues varies greatly across the state. Some regions have non-sustainable levels of water use, while others have supplies in balance with projected demands. In the absence of a consensus on regulatory solutions through Area of Concern designations, regional water supply conflicts can still be addressed. Water users dependent on overstressed groundwater or surface water sources recognize they have a shared problem that they also have a common interest in solving.

Building on the successful approach of the Capital Area Groundwater Conservation Commission and the Sparta Groundwater Commission, the State of Louisiana should convene regional working groups of water users in areas of unsustainable surface or groundwater use. After review of monitoring and water use data to reach a common understanding of the issues, a wide range of solutions can be considered, such as improved water use efficiency, conversion of some users to alternative sources, municipal and industrial wastewater reuse, use of lower quality water for some purposes, and so forth. These are only examples of a great number of measures that should be considered and evaluated. Through these regional water resources evaluations and discussions, water users will develop a greater understanding of the overall regional water issues and needs of other users. Experience in other areas of the US shows that if water users believe they all are being treated fairly and that the issue is defined by objective data, they may be willing to work together voluntarily toward regional solutions. When regional cooperative efforts fail, interested parties may be more willing to accept a regulatory solution as the next best option.

Groundwater management poses a special challenge in Louisiana. Monitoring data reveal that in several regions aquifers are being used at non-sustainable rates. Resolving groundwater over pumping may require permitting of withdrawals and possible cutbacks on water use. At this time, however, there does not appear to be a consensus on what regulatory steps should be taken. In addition, assessing the safe yield of aquifers is much more difficult, expensive, and uncertain than with surface water. Widely accepted tools have not yet been developed for most regions and modeling of some stressed aquifers may not be completed for some time.

In spite of these limitations, action should be taken to avoid dewatering of aquifers and harm to the economy if aquifer yields drop in response to over pumping. For example, DNR, in partnership with other State and Federal agencies, can use the regional working group process described above to convene major water users to plan remedies to groundwater pumping-induced impacts by increasing water use efficiency (such as reducing leakage from water distribution systems), and switching to alternative water sources (such as surface water, treated groundwater, imported groundwater, or reuse).

One successful example of this approach is the development of the Sabine River Diversion Canal. This project brings Sabine River water to an area that had been subject to issues associated with significant groundwater level decline. Since the completion of the Sabine River Diversion Canal, groundwater levels

have rebounded significantly. Another example is the recent collaborative process to support natural gas development in northwest Louisiana using surface water resources. Through the coordinated efforts of local water users, State agencies, and the oil and gas industry, a regional solution was developed that allows the economic development of gas deposits without reducing water supplies to local water users.

Although groundwater models are often useful, modeling complex regional aquifers can be slow and expensive. Consequently, it may be difficult to convince water users that they should make major expenditures to develop alternative water sources or submit to state regulation based on the results of a complicated model alone. It should be recognized that monitoring well data is a valuable supplement to modeling, and often provides important information long before models can be completed and accepted. Careful examination of monitoring data can provide aquifer water level declines and rate of change in drawdown in response to changes in pumping. This information can be used to provide a relative indication of how serious conditions have become. Particular attention should be paid to whether the declining water level is approaching the top of the aquifer. The regional working groups described above could provide forums to obtain information on aquifer conditions and review monitoring data with the advice of local and state groundwater experts. Through this process, a deeper understanding of aquifer conditions may be developed and consensus may be reached on measures to protect the long term productivity of the aquifers.

Provide State-Level Guidance and Funding for Water Resources Planning

The regional planning approach described above would provide valuable information to local entities and the State of Louisiana, however some guidance would be needed to assure consistent approaches that can be aggregated to a state-level review. The State of Louisiana should develop planning guidance for use by local entities on key technical issues, such as accommodating climate change and population projections into water supply planning. It also would provide guidance for preparing regional water supply and water conservation plans. State-wide guidance should emphasize scenario-based, rather than predictive forecasting to guide water resources decision-making. Scenario-based planning recognizes uncertainty in the major inputs to water resources planning, such as hydrology, environmental needs, population, and public responses to water conservation measures or economic incentives.

In addition, the State of Louisiana should provide funding to facilitate regional planning and assistance on the application of technical planning guidance. This could be accomplished through a program similar to the ongoing Reservoir Priority Development Program administered by DOTD. It would involve a water supply planning program to work with water users to identify regional concerns regarding non-sustainable levels of water use and projected supply deficits and develop short-term and long-term solutions.

Improve Information on Sustainable Water Use

Access to adequate data on water availability and use is essential to enable the state and water users to plan for the future and to identify and prioritize water supply needs. Most importantly, water users need to know how much water is available, and what level of use is considered sustainable. Whereas data are available for surface water flow, groundwater levels, and water quality, this information has not yet been used to develop estimates of sustainable yield in most areas of the state. Technical studies should be undertaken to develop estimates of sustainable yields for groundwater and surface water.

To support these estimates, ongoing data collection efforts should be reviewed to assure adequate and appropriate data are being collected to support sustainable yield estimates. For example, many Louisiana stream gages record stage only, whereas discharge measurements are needed for water supply planning. Conversion of stage measurements to flow estimates often is inaccurate, providing information of limited application. More urgently, the number of monitoring wells measuring aquifer water levels has significantly decreased in recent years. An adequate network of monitoring wells is not only necessary for building and

calibrating groundwater models, but water level data directly measures the amount and trend of groundwater depletion and provides understandable and credible information to guide groundwater management.

The state of Louisiana should form an interagency committee, as was done in 1980 – 1990 to evaluate the stream gage and monitoring well networks and recommend priorities for added monitoring stations to give an adequate measure of the availability of water resources and their response to the stress of increased water withdrawals. The USGS should be strongly considered for this work, as they already are closely involved in much of the ongoing monitoring and reporting for surface water and groundwater conditions. In coordination with the regional planning groups described above, the committee would identify data needs to support evaluations of surface water and groundwater conditions, review existing monitoring programs to meet these needs, and recommend additional monitoring requirements. Data from the existing and expanded monitoring network should be made readily available to the public in both raw (measurements) and processed (trend analysis) form. This program also should estimate or track the progress of ongoing activities to estimate sustainable yields in aquifers.

Streamlining of State and Federal Permitting Requirements

Historically, some water resources project developers, particularly industrial and private developers, have encountered difficulty in preparing project plans and seeking permits due to the complexity of sometimes unforeseen requirements. Lack of clarity in project review and approval processes may be seen as a disincentive to pursue potential investments in Louisiana that would provide economic benefits. In other cases, the lack of a clear road map can lead to unnecessary investments in project planning and place unneeded burdens on regulatory review agencies.

The State of Louisiana would provide a service to potential project developers, both in-state and out of state, by preparing simple and clear guidelines on the regulatory and permitting processes required for project development. The guidelines would describe which State agencies would be involved in each type of project development (surface water reservoir, river diversion, gray water, flood control, navigation) and what established programs are in place. The guidelines also would describe the required environmental compliance documents and relevant State and Federal agency reviews, as well as estimated time frames for preparation and review of key documents.

Provide State-Level Financial Incentives

The State of Louisiana can provide financial incentives to encourage wise use of water, particularly in designated Areas of Groundwater Concern. Several approaches should be explored at the state level, including: funding for the development of state-owned or state cost shared reservoirs; funding the design and construction of surface water diversion projects, cost-sharing for alternative water supply project development, and tax incentives for private investment in water infrastructure. Each is described below.

The Reservoir Priority Development Program (RPDP) was established by the Legislature to provide consistent technical information in support of decisions on state funding for surface water reservoirs. Currently, DOTD is developing guidelines for the RPDP that describes how surface water reservoir benefits would be evaluated and quantified. These guidelines describe methods for estimating project costs and benefits, and inform applicants of the review process to obtain funding for reservoir planning or construction. The range of potential applicants for the RPDP is not yet known, however it is expected to included municipalities, industry, and agricultural interests.

Because not all water supply development solutions require reservoir development, the State of Louisiana should also consider alternative funding methods to encourage wise use of water. For example, the State could provide funds for the design and construction of large scale water replacement projects. This

approach was successfully used to develop the Sabine River Diversion Canal, which significantly reduced groundwater pumping-induced impacts. Alternatively, the State could provide funding, through tax incentives or cost-sharing, to major water users to encourage voluntary shifts from groundwater to other sources. The other sources could include more sustainable groundwater supplies, including those of lesser quality, nearby surface water supplies, reuse of municipal and industrial wastewater, or water supplies imported from other regions from either surface water or groundwater sources. Administration of such a program should assure that replacement supplies would be available and used as planned.

Summary and Recommendations

This report provides a summary of water resources conditions throughout the State of Louisiana, with an emphasis on the use of surface water and groundwater resources. Through this review, it was found that although water resources needs in Louisiana vary considerably across the state, a set of common issues are evident in several locations. These issues are often revealed by water supply limitations and degraded quality in surface and groundwater supplies. Important factors that have led to these issues include lack of coordinated water resources planning and limited information on sustainable levels of water use.

To help address these limitations, this report presented a framework for water resources management to encourage increased coordination among State agencies and major water users, and the development of information on sustainable water use. While the implementation of such strategies would not be expected to immediately resolve long-established water resources issues, they would be beneficial in reducing or reversing adverse effects, and avoiding similar concerns from occurring in the future.

It is recommended that the following actions be taken to form regional planning groups, address known water resources issues and implement measures to reduce and avoid unsustainable water use.

- The Governor should direct water-related state agencies to collectively develop a coordinated plan for water resources management. The plan would identify the highest priorities at a state-wide and regional level, and highlight how each agency would be involved in advancing those objectives. These priorities should be reflected in agency budgets.

- The State of Louisiana should provide guidelines and funding to encourage local and regional cooperation in water resources planning and management. The State also should have the authority/responsibility to identify important issues in various regions and initiate the process to address them.

- The State of Louisiana should require municipalities, industries, and agricultural operations using more than a specified threshold amount of water to prepare water supply plans projecting their water needs 20 years into the future and identifying proposed water sources.

- The State of Louisiana should provide guidance to regional planning groups on the application of scenario based planning to address areas of uncertainty, including climate change, emerging environmental requirements, population forecasts, and expected adoption of conservation measures.

- The State of Louisiana should provide funding for water projects to reduce unsustainable groundwater use. The Reservoir Priority Development Program is one method to achieving this goal. Other options may include tax incentives to private entities to encourage investments in alternative water supplies.

- In coordination with regional planning groups, the State of Louisiana should review ongoing groundwater and surface water monitoring programs and identify necessary modifications to assure

that necessary data for long-term management and model development is collected. Emphasis should be placed on the importance of groundwater monitoring in aquifer management.

- In coordination with regional planning groups and Federal agencies, the State of Louisiana should develop models to estimate the sustainable yield of groundwater and surface water resources. State and Federal leadership is needed to provide consistent approaches in model development and assure that they receive adequate peer review.

- Through regional planning groups, water resources needs assessments should be completed on a regular basis. A consistent approach should be applied to allow information to be aggregated at a state-wide level on a periodic basis. State-wide priorities also should be adjusted as necessary as information from regional planning processes reveal changes.

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BUILDING A BETTER WORLD