2009

Atchafalaya-Teche-Vermilion Basin

Characterization Report

Louisiana State Reservoir Priority and Development Program

moffatt & nichol

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2009

Atchafalaya-Teche-Vermilion Basin

Characterization Report

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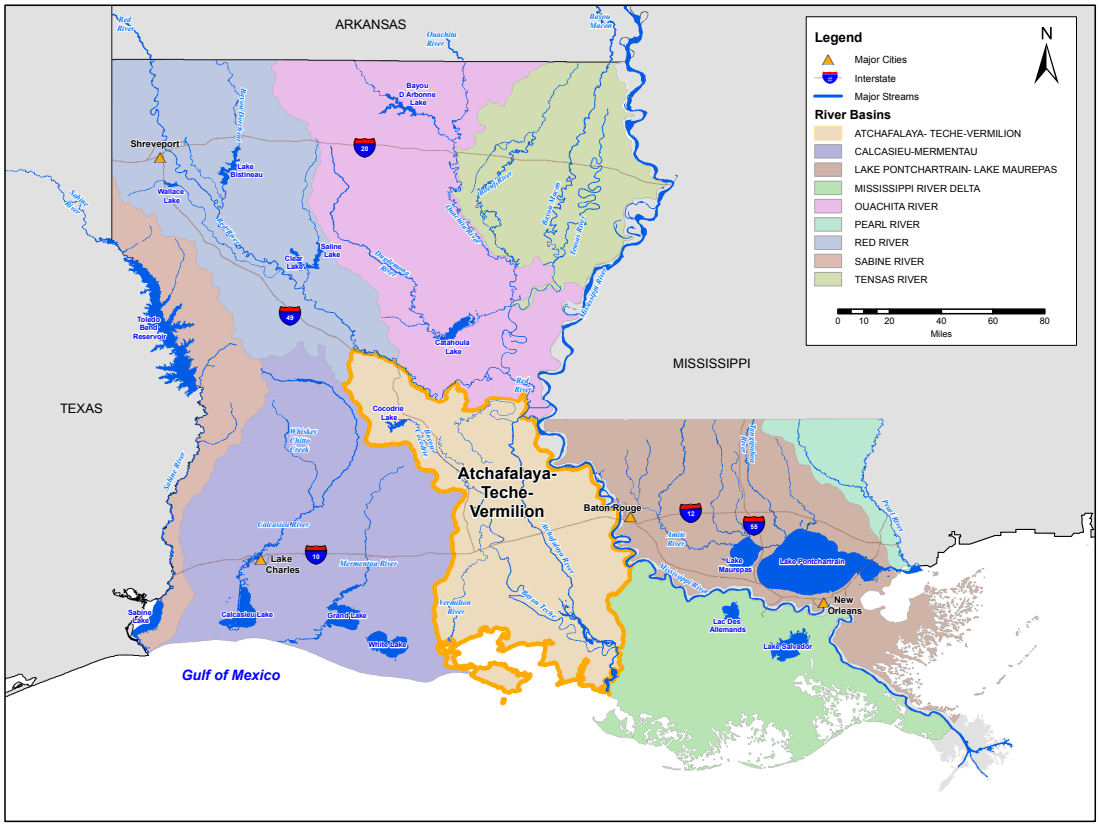
and Development Program

BASIN CHARACTERIZATION REPORT FOR THE ATCHAFALAYA-TECHE-VERMILION BASIN

The Louisiana Department of Transportation and Development (DOTD) is responsible for reviewing and prioritizing proposed reservoir projects for which State of Louisiana (State) funding is being sought, and then recommending projects to the State Legislature. To support reservoir project review, prioritization, and recommendation efforts, DOTD has prepared characterization reports of water resources conditions in each of the nine principal surface water basins in the State. These characterization reports provide an overview of water uses, needs, and concerns, and can be used by applicants for State funding, and by State agencies as they evaluate the applications. The basin characterization reports also contain extensive references that interested parties can use to find more information from Federal, State, and local agencies or other sources. The reports represent a "snapshot" of conditions in early 2009 (or when the references cited in the reports were published).

Based on available data, this basin characterization report provides an overview of the water uses, needs, and key water resources concerns for the Atchafalaya-Teche-Vermilion Basin (ATVB) (**Map 1**). Additional technical information on important issues may be provided in separate technical reports.

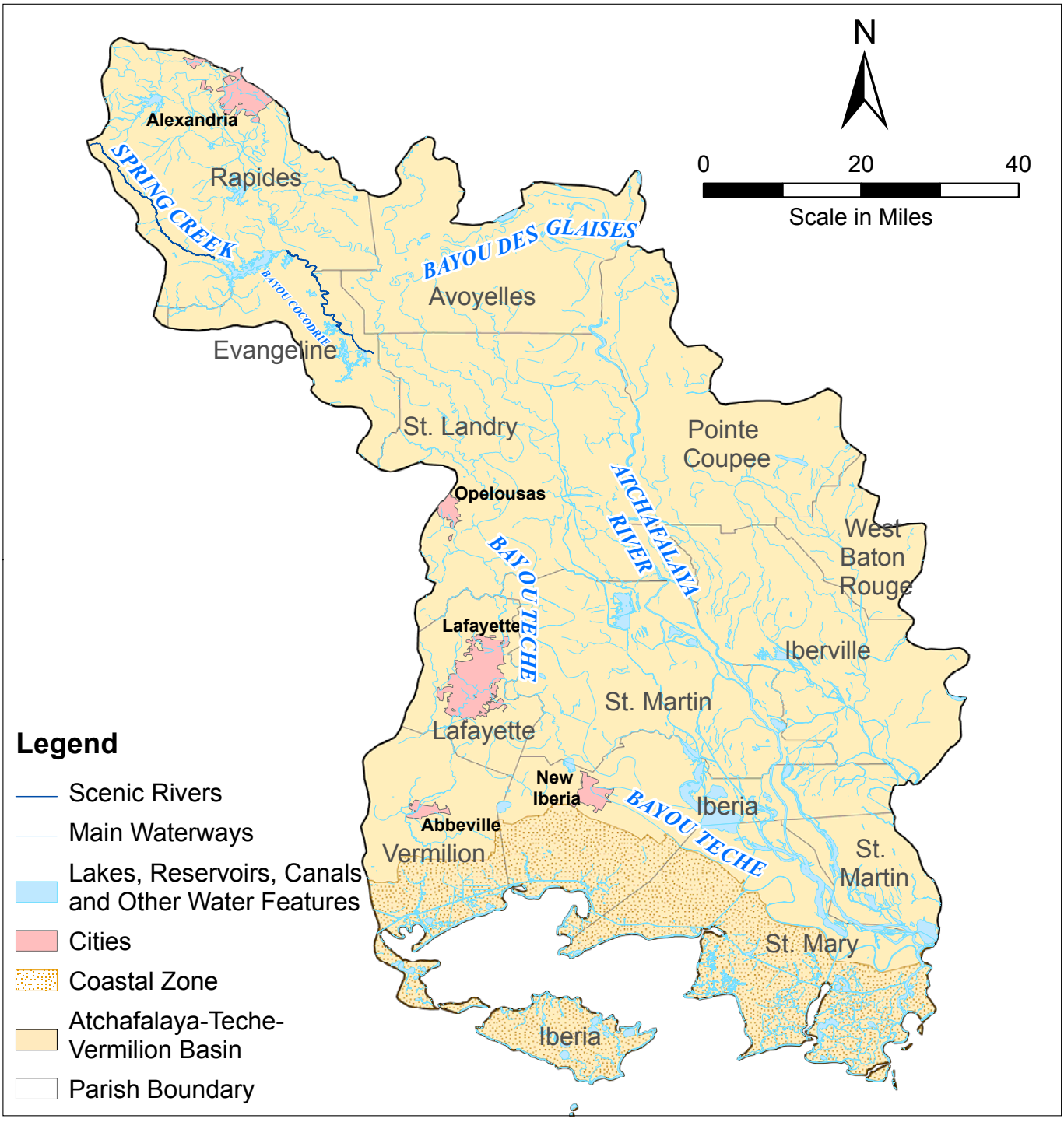
Report Topics **Page**



Map 1. Major Surface Water Basins of Louisiana[1]

BASIN OVERVIEW

The ATVB is located in south-central Louisiana and has an area of 6,644 square miles (see **Map 2**).[2] The ATVB is bounded by the Ouachita and Red River basins to the north, the Calcasieu-Mermentau Basin to the west, the Lake Pontchartrain-Lake Maurepas and Mississippi River Delta basins to the east, and by the Gulf of Mexico to the south. The western portion of the basin is composed of flat to slightly hilly terrace lands, while the remainder of the basin has alluvial topography. The southern ATVB is in the Coastal Zone, as delineated by the Louisiana Department of Natural Resources (LDNR).



Map 2. Parishes, Main Waterways, and City Boundaries[3]

Twelve parishes are either completely or partly encompassed by the ATVB (**Map 2**). The largest cities in the ATVB are Lafayette, Alexandria, Opelousas, and New Iberia (**Map 2**). Estimated total population in the ATVB in 2005 was 631,316. **Table 1** shows the 2005 population distribution in the ATVB by parish. **Figure 1** shows historical population in the basin. Population has increased steadily from the 1960s to the present. Continued growth at the historical rate will likely increase demand for high quality potable water sources.

Principal economic activities in the ATVB include agriculture- and forestry-related industries. The healthcare industry is growing in the region.[4]

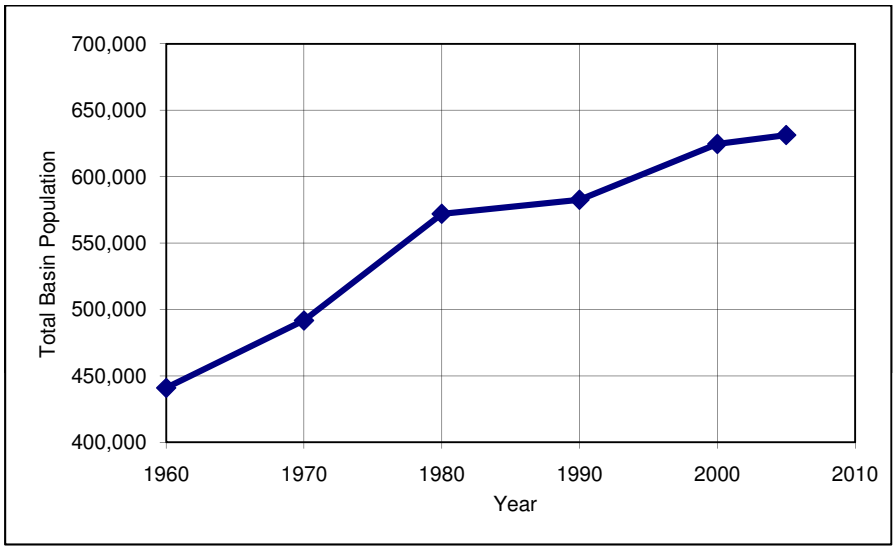


Figure 1. Historical ATVB Population

Table 1. ATVB Population by Parish in 2005[5]

Parish	Population
Avoyelles*	33,119
Evangeline*	7,141
Iberia	73,654
Iberville*	23,582
Lafayette*	192,791
Point Coupee*	21,211
Rapides*	72,678
St. Landry*	61,465
St. Martin*	48,440
St. Mary*	38,350
Vermilion*	39,374
West Baton Rouge*	19,511
TOTAL	631,316

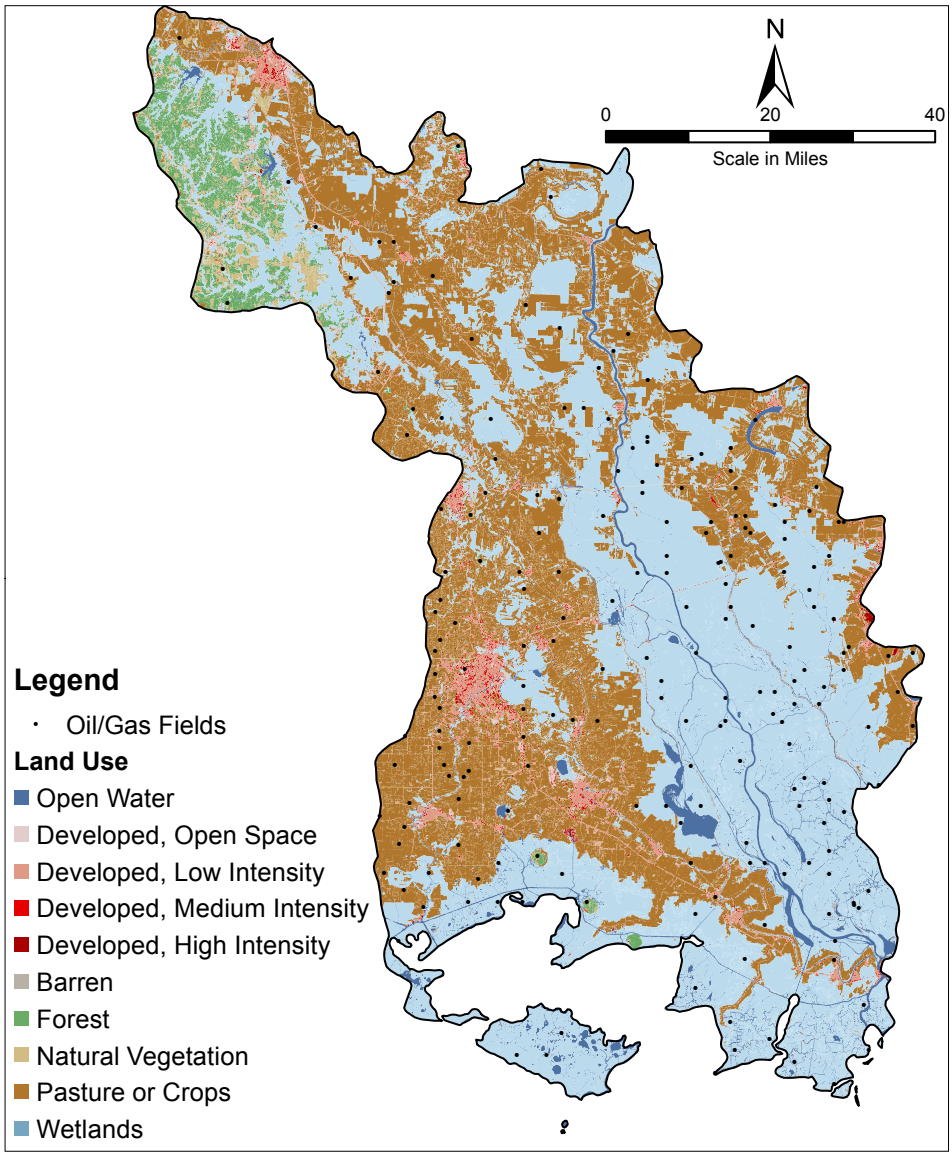
*Parish is located in more than one basin; population estimate is for the area within the ATVB.

ATVB = Atchafalaya-Teche-Vermilion Basin

LAND USE AND LEGAL ENTITIES

Map 3 shows 2003 land uses in the ATVB. Principal land uses are agriculture and wetlands, with the latter dominating the southeastern basin, including the Coastal Zone. Agricultural land use can indicate areas of demand for irrigation water. Large areas of urban development are present near the four large cities listed above. Economic modeling for 2020 indicates that forested land uses may decrease slightly in the ATVB in the future, and that negligible change in urban land uses is expected.[6]

The ATVB contains land considered Prime Farmland by the Federal Natural Resources Conservation Service (NRCS).[8] The NRCS must be contacted regarding proposed irreversible conversion of any Prime Farmland for reservoir construction and water storage. Many oil and gas fields are present throughout the basin, as shown in **Map 3**. Oil and gas drilling can require large amounts of water for extraction, which then needs to be disposed, either to surface water or groundwater. Existing oil and gas infrastructure and mineral rights holdings may present potential impediments to development of surface water resources. **Table 2** lists legal entities in the ATVB that may affect or be affected by water resources development.



Map 3. ATVB Land Uses in 2003[7]

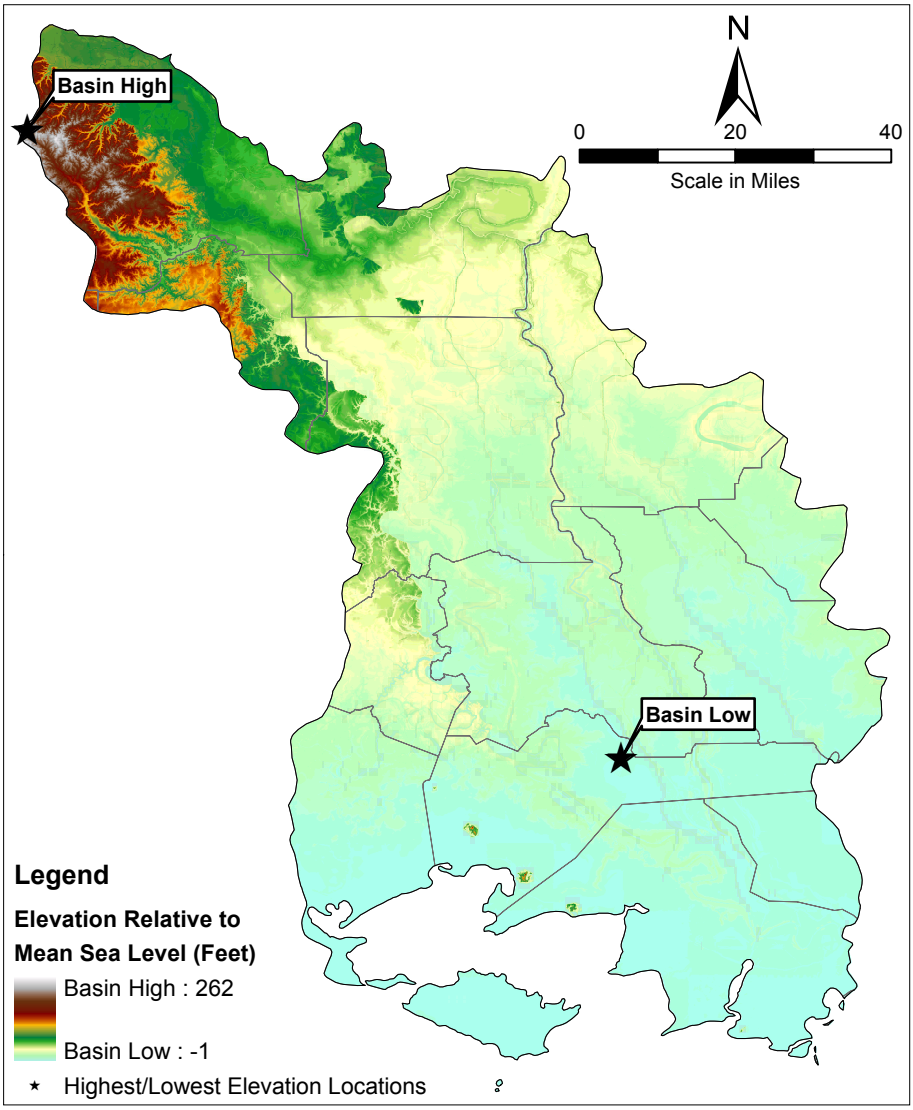
Table 2. ATVB Water Resources Legal Entities

Legal Entity	Responsibilities
Capital Area Ground Water Conservation Commission	Promotion of orderly use of groundwater
Capital Region Planning Commission	Planning and development in southeast/central Louisiana
Evangeline Economic and Planning District	Planning and development in south central Louisiana
Kisatchie-Delta Regional Planning and Development District	Planning and development in central Louisiana

ATVB=Atchafalaya-Teche-Vermilion Basin

PHYSIOGRAPHIC AND CLIMATIC INFORMATION

Map 4 shows general basin topography. The eastern ATVB is dominated by the Alluvial Plains physiographic region, which is characterized by flat lands with interconnecting streams that allow flow between some river basins. In the western ATVB, terrain transitions to the relatively treeless Prairies physiographic region. The lowest elevation within ATVB is 2 feet below mean sea level, located in Iberia Parish. The highest point, 216 feet above mean sea level, is located in Rapides Parish, on the northern basin boundary.



Map 4. ATVB Topography[9]

Soils in the Alluvial Plains physiographic region are dominated by loamy, clayey low terraces and floodplains, while soils in the Prairies physiographic region in the ATVB are mainly thick loess deposits.[10] No geologic faults are present in the ATVB.

Average annual rainfall throughout the ATVB varies geographically from 59 to 65 inches per year, increasing from north to south.[11] **Figure 2** shows historical annual precipitation at Lafayette, which varies from about 40 to 80 inches per year, with a historical average of about 60 inches per year. Average annual temperature generally increases from north to south from 65 to 68 degrees Fahrenheit (°F) in the ATVB.[11] Average high temperature at Lafayette during the warmest months is 91°F; average low temperature during the coldest month, January, is 42°F.

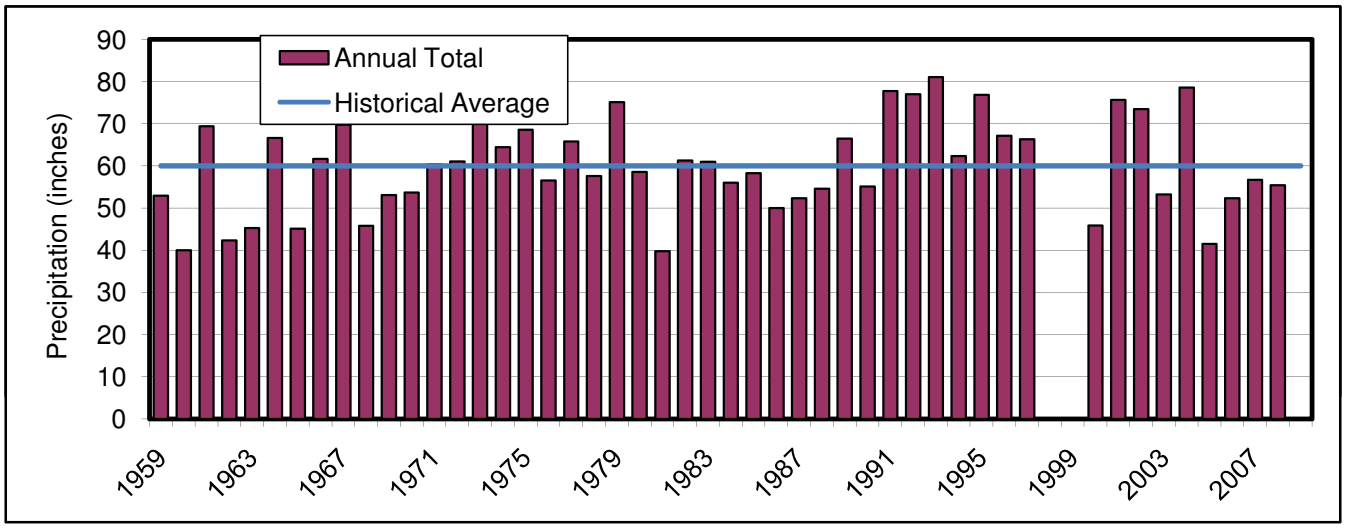


Figure 2. Historical Annual Precipitation at Lafayette[11]

WATER USE

Water use in the ATVB is summarized in **Table 3** by sector, water type, surface water body, and parish, as reported for 2005. **Table 3** is based on water withdrawal data, which may be greater than total water consumptive use. For example, the power generation sector withdraws water for both steam generation and cooling, uses which do not entirely consume the withdrawn water and allow a large percentage of the water to be returned to a waterway. In 2005, total water use was about 600 million gallons per day (mgd). ATVB water demands were met mainly by surface water in combination with a lesser amount of groundwater. Power generation used the most water in 2005, totaling over 250 mgd of mainly surface water from the Charenton Canal and Bayou Cocodrie. Rice irrigation used over 120 mgd of water, divided equally between surface and groundwater. Aquaculture used the third-largest amount of water, over 100 mgd, over half of which was groundwater.

Of all parishes in the basin, St. Mary Parish was the largest user of surface water and groundwater, totaling more than 168 mgd. Evangeline Parish, was the second-largest user, totaling 112 mgd of surface water and groundwater combined. The following ATVB municipal water suppliers, all supplied by groundwater, reported water use exceeding 2 mgd:

- Alexandria water system – 18 mgd
- Lafayette water system – 20 mgd
- New Iberia water system – 6.5 mgd

- Opelousas water system – 4.6 mgd
- Pineville water system – 3.3 mgd

In 2005, most groundwater across the ATVB was withdrawn from the Chicot and Mississippi River Alluvial aquifers. Public supply used most groundwater in 2005, totaling 81 mgd. Groundwater used for aquaculture and rice irrigation was about 57 mgd for each of the two sectors. Because groundwater use is not reported by surface water basin, individual parish groundwater use was estimated by multiplying total parish groundwater use by the percentage of total parish population within the ATVB (**Table 3**); actual groundwater use by parish may differ from this estimation.

Figure 3 shows trends in surface water and groundwater use in the ATVB at 5-year intervals from 1990. Industrial surface water use declined from 71 mgd in 1990 to 9 mgd 2005, and aquaculture and industrial surface water uses also decreased. Groundwater use in the aquaculture and rice irrigation sectors fluctuated from 1990 to 2005. Surface water and groundwater use for public supply increased slightly during this period.

Table 3. Water Use in the ATVB in 2005[12]

Sector	Surface Water (mgd)	Groundwater (mgd)
Aquaculture	42.1	58.6
General irrigation	1.7	4.8
Industry	9.4	30.9
Livestock	0.3	0.8
Power generation	249.1	4.2
Public supply	10.0	80.9
Rice irrigation	63.4	57.2
Rural domestic	0.0	8.1
TOTAL	375.9	245.3

Surface Water Body	Use (mgd)
Alligator Bayou	1.3
Atchafalaya River	1.7
Bayou Boeuf	9.0
Bayou Cocodrie	97.5
Bayou du Lac	1.4
Bayou Portage	10.3
Bayou Teche	19.4
Charenton Canal	153.3
Chatlin Lake Canal	1.9
Gulf Intracoastal Waterway	9.5
Lower Grand River	1.0
Six Mile Lake	1.1
Vermilion River	38.0
Other (not listed)	30.5
TOTAL	375.9

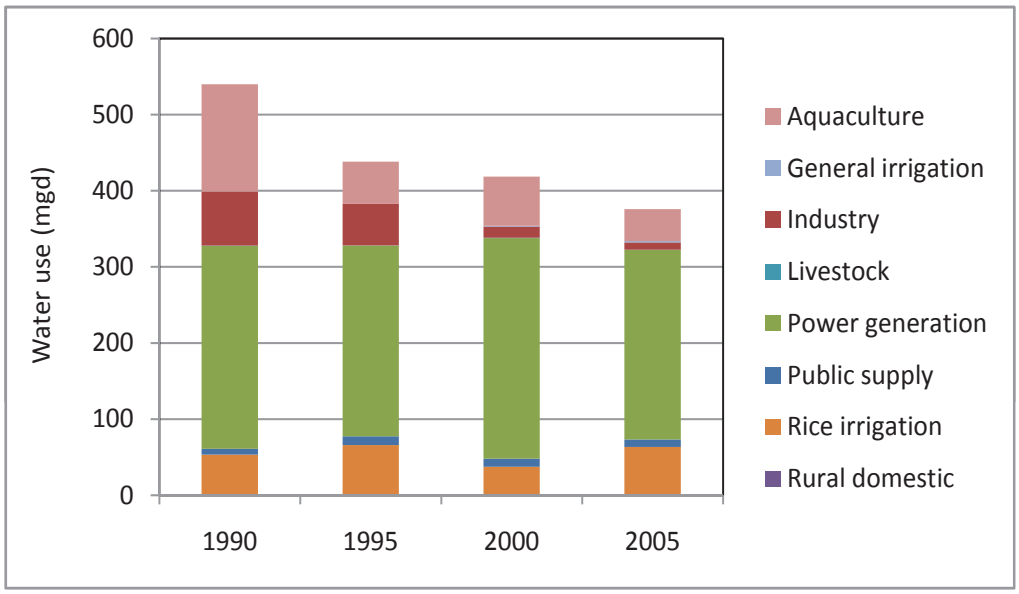
Parish	Surface Water (mgd)	Groundwater* (mgd)
Avoyelles	6.2	19.5
Evangeline	97.5	14.8
Iberia	8.4	20.5
Iberville	1.4	18.6
Lafayette	2.4	42.7
Point Coupee	0.1	20.1
Rapides	6.7	19.2
St. Landry	9.7	34.7
St. Martin	41.1	11.4
St. Mary	165.6	2.5
Vermilion	36.8	28.9
West Baton Rouge	0.0	12.5
TOTAL	375.9	245.3

*Groundwater use estimated for parishes with at least five percent of their area within the ATVB.

ATVB=Atchafalaya-Teche-Vermilion Basin

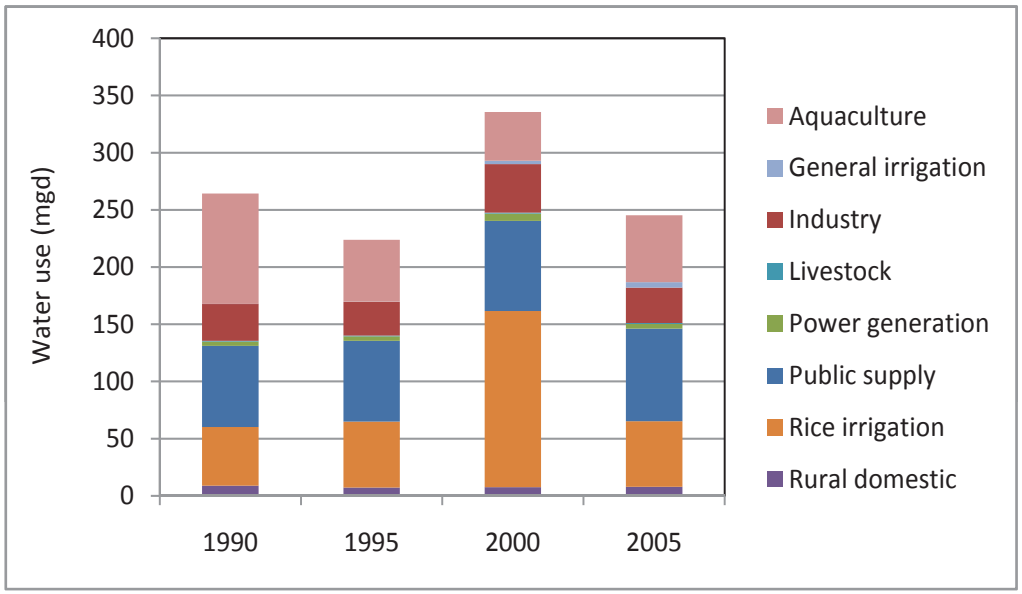
mgd=million gallons per day

Recent Historical Surface Water Use



mgd=million gallons per day

Recent Historical Groundwater Use



mgd=million gallons per day

Figure 3. Trends in Water Use in ATVB by Sector[2]

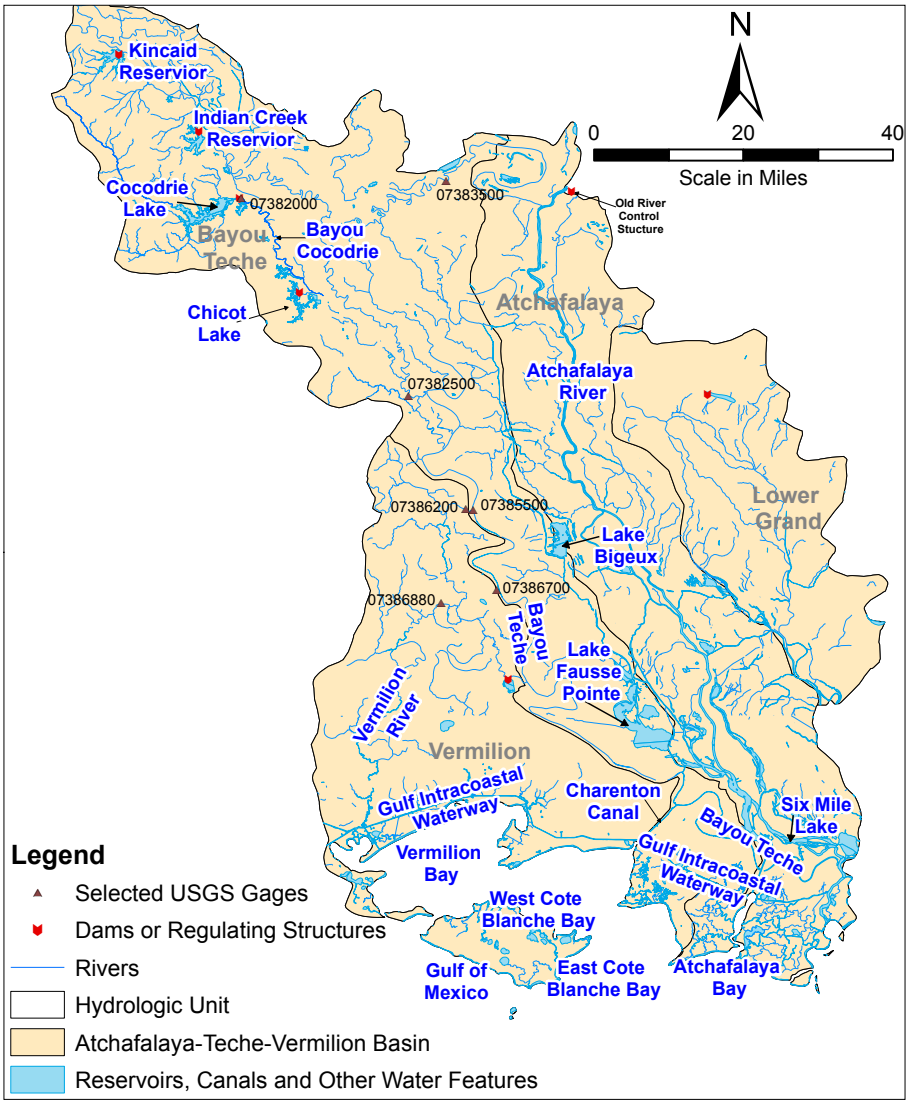
Reasonable per capita (person) water use could not be calculated for the ATVB based on rural domestic and public supply uses and parish populations.[12] Much of the water used in the ATVB is for agricultural purposes. Agricultural water use depends on weather in any given year, and selection of crops to be grown is largely based on response to market conditions and available government subsidies. Therefore, it is difficult to predict likely future trends in agricultural water use in the ATVB.

SURFACE WATER

Primary surface water features in the ATVB are shown in **Map 5**. **Map 5** also shows subwatersheds, or hydrologic units, delineated by the U.S. Geological Survey (USGS), and stream gages referenced in this report.

The Atchafalaya River receives flow from both the Mississippi and Red rivers, and is their largest distributary. The Old River Control Structure, a U.S. Army Corps of Engineers (USACE) project completed in 1963, was constructed to keep the Atchafalaya River from becoming the main channel for conveying Mississippi River flows. The Old River Control Structure maintains the distribution of flow between the Mississippi River and Atchafalaya River as a 70/30 split of the combined latitudinal flow of the Red and Mississippi rivers, respectively (see **Figure 4**).[14] Recent streamflow records are not available for this location.

The Teche-Vermillion Project, completed in 1982, moves water from the Atchafalaya River to the Vermillion River and Bayou Teche via Bayou Courtableu during low-flow periods. The project was conceived to provide irrigation water and improve water quality.[2]



Map 5. Surface Water Features[13]

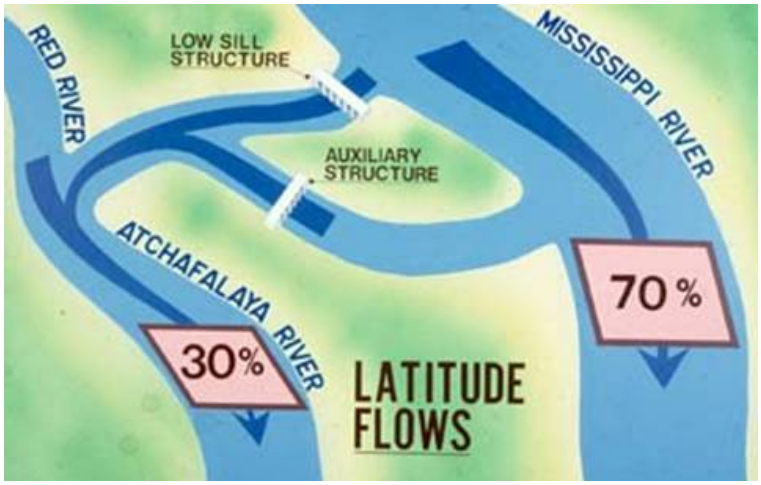


Figure 4. Old River Control Structure Schematic[15]

Extensive surface water and groundwater data for Louisiana, including gaged streamflows and lake levels, are available through the USGS National Water Information System (NWIS) Web site.[16] Some gages in the ATVB only measure stage and lack reliable stage-discharge relationships. Streamflow statistics for selected ATVB locations with long-term streamflow records are summarized in **Table 4**. Although recent flow data for the Atchafalaya River are not available, flow in the Atchafalaya River is substantial, with average flow reported for 1938 to 1982 of 187,400 cubic feet per second (cfs).[2]

Table 4. Historical Streamflow Statistics for Selected Gages[16]

Stream Gage Informaiton			Period of Record Streamflow Statistics (cfs)				Percent of Streamflows Exceed (cfs)		
				Instantaneous					
Location (USGS Gage)	Drainage Area (mi²)	Period of Record	Annual Average	Max. Peak (date)	Low Flow (date)	7Q10[17]	10	50	90
Bayou Des Glaises Diversion Channel at Moreauville, LA (07383500)	270	1943–Present	435	6,340 5/18/53	2.7 10/13/73	6.4	NA	NA	NA
Bayou Cocodrie near Clearwater, LA (07382000)	240	1922–Present	428	28,200 5/18/53	0.8 11/25/99	53	974	264	82
Bayou Cortableau at Washington, LA (07382500)	715	1946–Present	1,090	9,490 5/21/53	-536[a] 4/30/04	80	3,200	508	135
Bayou Fusilier at Weir at Arnaudville, LA (07386200)	NAb	1980–2005	282[c]	900 12/28/82	-800[a] 5/18/04	NA	NA	NA	NA
Bayou Teche at Arnaudville, LA (07385500)	1,530	1949–2006	1,041[d]	4,630 5/24/53	5,333 8/12/65	114	NA	NA	NA
Vermilion River at Surrey Street, at Lafayette, LA (07386880)	NAb	1967–Present	872[e]	6,280 7/17/89	-8,390[a] 12/18/95	NA	NA	NA	NA
Ruth Canal near Ruth, LA (07386700)	NAb	1959–2006	175[f]	802 4/21/66	-60[a] 1/31/93	NA	NA	NA	NA

[a] Minimum discharge for period of record – no flow at times, maximum negative discharge
[b] Drainage area is indeterminate
[c] 1983 – 1998
[d] 1983 – 2005
[e] 1988 – 1998
[f] 1960 – 1997

7Q10=7-day low flow with 10-year recurrence
cfs=cubic foot per second
LA=Louisiana
Max.=maximum
mi²=square mile
NA = not available

Statistics summarized in **Table 4** can be useful for various purposes. The 7-day low flow with a recurrence interval of 10 years (7Q10) is the statistic used to calculate available dilution for surface water discharge permits. Those water bodies with low 7Q10 flows, less than a few cfs, have extended periods of low flows. Few locations within the ATVB actually have calculated 7Q10 flows. Additionally, many ATVB waterways are tidally influenced. These waterways can have periods of no flow or reverse flow. Peak flows, including maximum instantaneous discharge, and streamflow exceeded by only 10 percent of flows, are useful for characterizing flooding and high-flow conditions on a stream.

Figure 5 shows historical monthly average flows for selected gages in the ATVB. Most streams in the ATVB do not exhibit as much seasonal variation as Louisiana streams farther from the Coastal Zone.

The ATVB contains 82 miles of streams designated under Louisiana's Natural and Scenic River System (shown in **Map 2**). These waterways are protected by a permit process and certain restrictions, including prohibitions against channelization, impoundment construction, and channel realignment.[19]

Published characteristics of major lakes and reservoirs in the ATVB are summarized in **Table 5**. No dependable yield information is available for surface water sources in the ATVB.

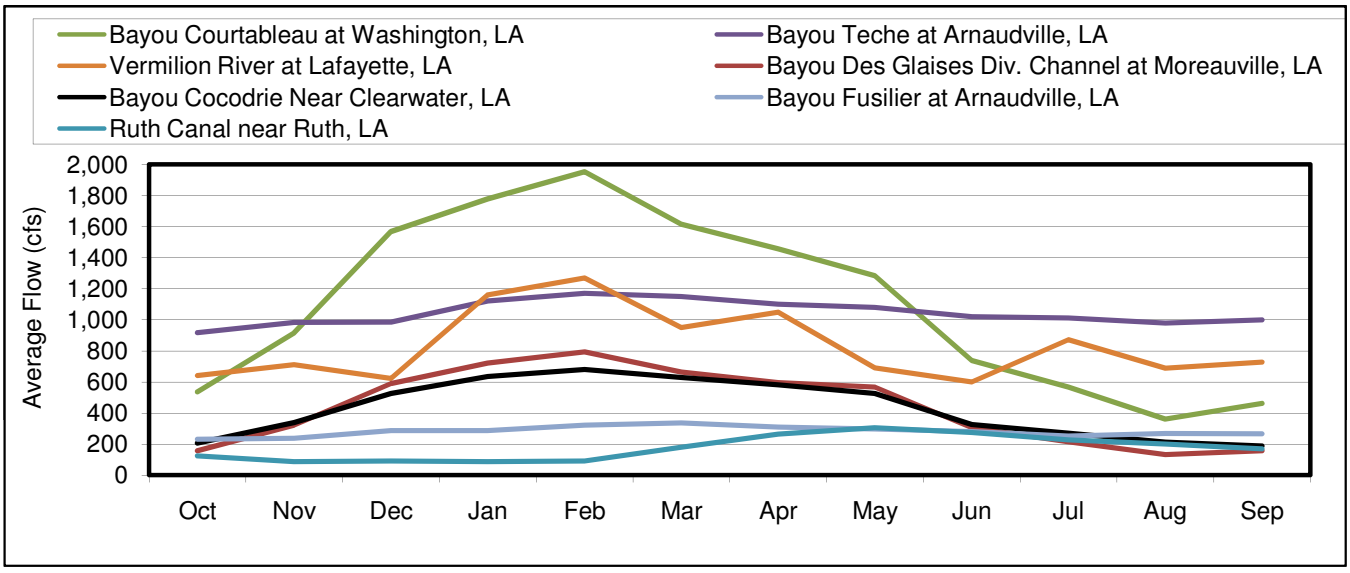


Figure 1. Historical Monthly Average Streamflow for Selected Gages[17]

Table 5. Characteristics of Major Lakes and Reservoirs in the ATVB[2]

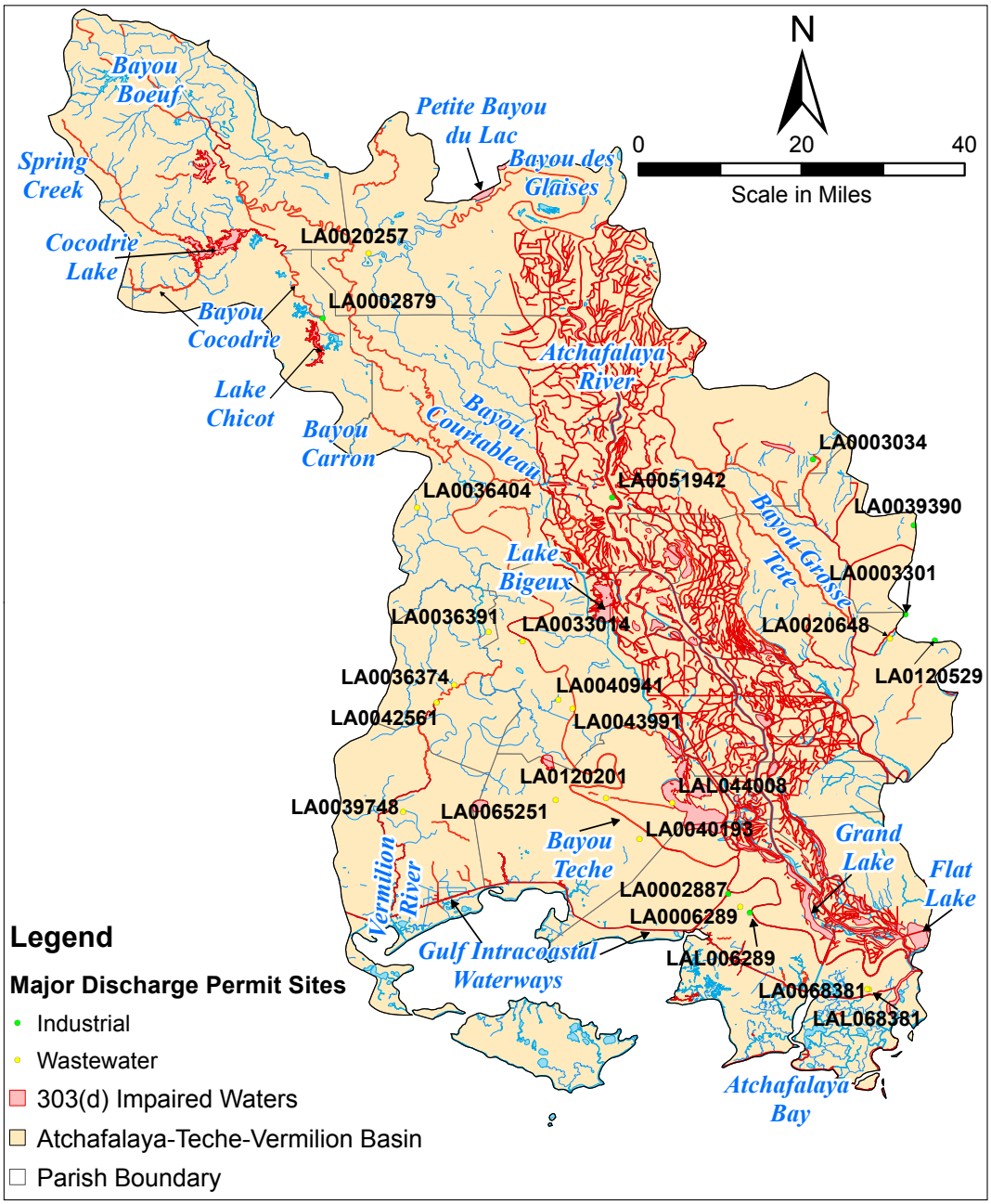
Name	Surface Area (acres)	Volume (acre-feet)
Cocodrie Lake	6,100	11,000
Chicot Lake	1,625	9,700
Indian Creek Reservoir	2,250	25,000
Kincaid Reservoir	1,920	25,000

ATVB=Atchafalaya-Teche-Vermilion Basin

Surface Water Quality

The 303(d) list (named after Section 303(d) of the Federal Clean Water Act) included in Louisiana's Integrated Water Quality Report provides an overview of surface water locations where water quality standards are not met.[20] In these cases, beneficial uses of the water bodies, such as fish and wildlife propagation, recreation, or drinking water supply may be impaired. Stream and lake sub-segments on the 2006 303(d) list for the ATVB are shown in **Map 6**. Design of new reservoirs either impounding impaired waters or discharging to impaired waters would need to consider these water quality challenges and any ongoing or planned water quality improvement projects.

Table 6 summarizes the number of stream and lake sub-segments in the ATVB that are on the 2006 303(d) list, and identifies impaired uses and parameters causing impairment. Many major water bodies in the ATVB are impaired. In most cases, each impaired sub-segment has at least five different impairments, some of which are related, such as nutrients and low dissolved



Map 6. ATVB Impaired Waters from 303(d) List and Major Permitted Discharge Sites[21]

oxygen, or total suspended solids and turbidity. Fish and wildlife propagation is the most frequently affected use in the ATVB. Dissolved oxygen, total suspended solids, and turbidity are common impairments affecting aquatic life. The presence of bacteria, as indicated by fecal coliform, affects recreational uses in 21 lakes and stream sub-segments in the ATVB.

Runoff from agricultural areas is the most commonly cited source of impairment for parameters ranging from nutrients to suspended solids. Agricultural lands in the ATVB are known to have slight to severe erosion problems.[2]

Table 6.Summary of ATVB Surface Water Quality Impairments[20]

Impaired Use	Sub-segments
Fish and wildlife propagation	224
Primary contact recreation	19
Secondary contact recreation	3
Outstanding natural resource	1

ATVB=Atchafalaya-Teche-Vermilion Basin
FWP = fish and wildlife propagation
ONR = outstanding natural resource
PCR = primary contact recreation (swimming)
SCR = secondary contact recreation (boating)

Parameter Causing Impairment (affected use)	Sub-segments
Nutrients (FWP)	47
Dissolved Oxygen (FWP)	41
Total Suspended Solids (FWP)	33
Turbidity (FWP and ONR)	23
Sedimentation (FWP)	22
Fecal Coliform (PCR and SCR)	21
Carbofuran (FWP)	17
Total Dissolved Solids (FWP)	10
Mercury (FWP)	9
Nonnative Aquatic Plants (FWP)	6
Sulfates (FWP)	6
Chloride (FWP)	4
Atrazine (FWP)	3
Ammonia (FWP)	2
Water Temperature (FWP and PCR)	2
Copper (FWP)	1

Permitted Surface Water Discharges

The Louisiana Department of Environmental Quality (LDEQ) issues permits for discharges of municipal and industrial wastewater. Permitted discharges classified as "major" by the U.S. Environmental Protection Agency (USEPA) (generally those with flow greater than 1 mgd) are shown in **Map 6**. Major municipal wastewater discharges are summarized in **Table 7** and major industrial permitted discharges in **Table 8**. Additional information on all dischargers in Louisiana can be obtained from LDEQ through their public records request process.

The Lafayette South wastewater treatment facility has the largest municipal discharge at 7 mgd, followed by St. Mary Parish Wards 5 and 8-MO at 6 mgd. Industrial dischargers include power facilities, industrial chemical facilities, and refineries; each discharges between 1 and 550 mgd. Discharge permit conditions are based on receiving-water low-flow quantity and quality. Future water development projects that change low-flow quantity or quality at the discharge location could affect the ability of permit holders to comply with permit conditions.

Table 7. Major Municipal Wastewater Discharge Permits in the ATVB[23]

Discharger	Permit Number	Permitted Flow (mgd)	Receiving Water	Parish
Abbeville, City of	LA0039748	1.6	Youngs North Coulee	Vermilion
Breaux Bridge, City of	LA0033014	1	Ruth Canal	St. Martin
Bunkie, City of	LA0020257	1.0	Bayou Dulac	Avoyelles
Cypress Island Coulee Wetland	LA0040941	1.0	Cypress Island Coulee	St. Martin
Franklin, City of	LA0006289	2.4	Bayou Yokely	St. Mary
Jeanerette, City of	LA0040193	1.3	Intracoastal Waterway/Vermilion	Iberia
Lafayette, City of (Ambassador Caffery)	LA0042561	6	Vermilion River	Lafayette
Lafayette, City of (Consolidated NE)	LA0036391	1.5	Bayou St. Claire, Vermilion River	Lafayette
Lafayette, City of (East Plant)	LA0036382	4	Vermilion River	Lafayette
Lafayette, City of (South)	LA0036374	7	Vermilion River	Lafayette
New Iberia, City of (Admiral Doyle)	LAL044008	3.6	Lake Fausse Pointe	Iberia
New Iberia, City of (Hwy 14)	LA0120201	NA	NA	Iberia
New Iberia, City of (Tete Bayou)	LA0065251	2.5	Tete Bayou	Iberia
Opelousas, City of	LA0036404	4.5	Bayou Yarbor/Bayou Callahan	St. Landry
Plaquemine, City of (South)	LA0020648	1.5	Terrebonne Basin	Iberville
St. Martin Parish	LA0043991	3	NA	St. Martin
St. Mary Parish Wards 5 and 8-MO	LAL068381	6	Gulf Intracoastal Waterway	St. Mary

Information presented in this table is directly from USEPA (2009a). For detailed explanation, this reference should be consulted.
ATVB=Atchafalaya-Teche-Vermilion Basin
Hwy=Highway
mgd=million gallons per day
NA=not available

Table 8. Major Industrial Discharge Permits in the ATVB[22]

Discharger	Permit Number	Permitted Flow (mgd)	Receiving Water	Type	Parish
Alma Plantation LTD	LA0003034	4.1	Stumpy Bayou, Poydras Bayou	Cane Sugar Refining	Point Coupee
Cleco – Evangeline Power Station	LA0002879	1.5	Bayou Cocodrie	Electric Services	St. Landry
Cleco Power LLC – Teche Power Station	LA0002887	1.7	Charenton Navigation Canal	Electric Services	St. Mary
Dow Chemical Company Louisiana Division	LA0003301	550	Mississippi River, Bayou Bourbeaux	Chemicals	Iberville
Placid Refining Company	LA0039390	9.1	Mississippi River or Gulf Intracoastal Waterway	Petroleum Refining	West Baton Rouge
Shintech LA, LLC – Plaquemine PVC	LA0120529	NA	NA	Chemicals	Iberville
Valero Refining Company	LA0051942	9.6	Atchafalaya River	Petroleum Refining	St. Landry

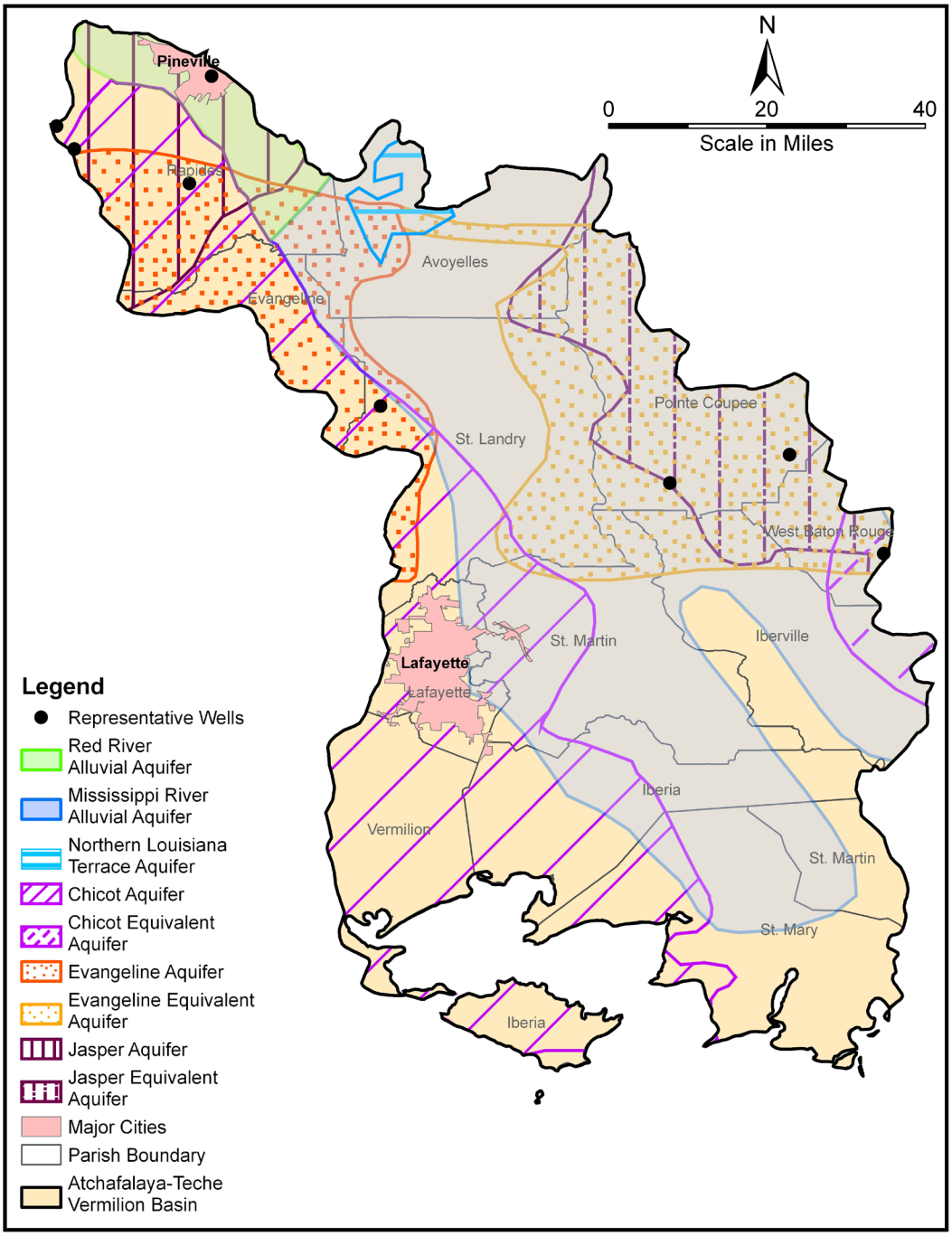
Information presented in this table is directly from USEPA (2009a). For detailed explanation, this reference should be consulted.
ATVB=Atchafalaya-Teche-Vermilion Basin
LA=Louisiana
LLC=Limited Liability Company
LTD=Limited
mgd=million gallons per day
NA=not available

GROUNDWATER

The State has registered about 3,500 groundwater wells in the ATVB.16 The following major aquifers underlie portions of the ATVB:

- Red River Alluvial Aquifer
- Mississippi River Alluvial Aquifer
- Northern Louisiana Terrace Aquifer
- Chicot Aquifer
- Chicot Equivalent Aquifer
- Evangeline Aquifer
- Evangeline Equivalent Aquifer

Jasper AquiferJasper Equivalent AquiferThe Chicot, Evangeline, and Jasper aquifers can be grouped as the Gulf Coast Aquifer System. The Chicot Equivalent, Evangeline Equivalent, and Jasper Equivalent aquifers collectively make up the Southern Hills Aquifer System. Aquifers in this system are recognized independently and are locally divided. Local names have been given to these aquifers, here called aquifer units for clarity, based on location and depth.[24]



Map 7. Spatial Extents of Major ATVB Aquifers[25]

Table 9. Overview of ATVB Major Aquifer Characteristics[2]

Aquifer	Range of Thickness of Freshwater Interval (feet)	Typical Well Yields (gpm)	Hydraulic Conductivity (feet/day)	Specific Capacity (gal/min/ft of drawdown)	Depth to Groundwater in 2005 (feet)[16]
Red River Alluvial	50 – 200	500 – 2,800	10 – 530	5 – 90	0 – 17
Mississippi River Alluvial	50 – 500	500 – 4,000 7,000 (large capacity)	10 – 530	5 – 90	0 – 15
Northern Louisiana Terrace	25 – 240	100 – 1,700	150 – 270	1 – 50	47 – 80
Chicot	50 – 1,050	500 – 2,500 4,000 (large capacity)	40 – 220	2 – 35	5 – 60
Chicot Equivalent	50 – 1,100	500 – 1,000 3,500 (large capacity)	10 – 200	10 – 200	NA
Evangeline	50 – 1,900	200 – 1,000 3,000 (large capacity)	20 – 180	2 – 38	40 – 70
Evangeline Equivalent	50 – 1,000	200 – 4,000	10 – 200	10 – 200	16 – 67
Jasper	50 – 2,400	40 – 800 3,000 (large capacity)	20 – 260	2 – 30	118 – 235
Jasper Equivalent	1,200 – 2,350	200 – 3,400	10 – 200	10 – 200	70 – 225

ATVB=Atchafalaya-Teche-Vermilion Basin
gpm = gallons per minute
gal/min/ft = gallons per minute per foot of drawdown
NA=not available

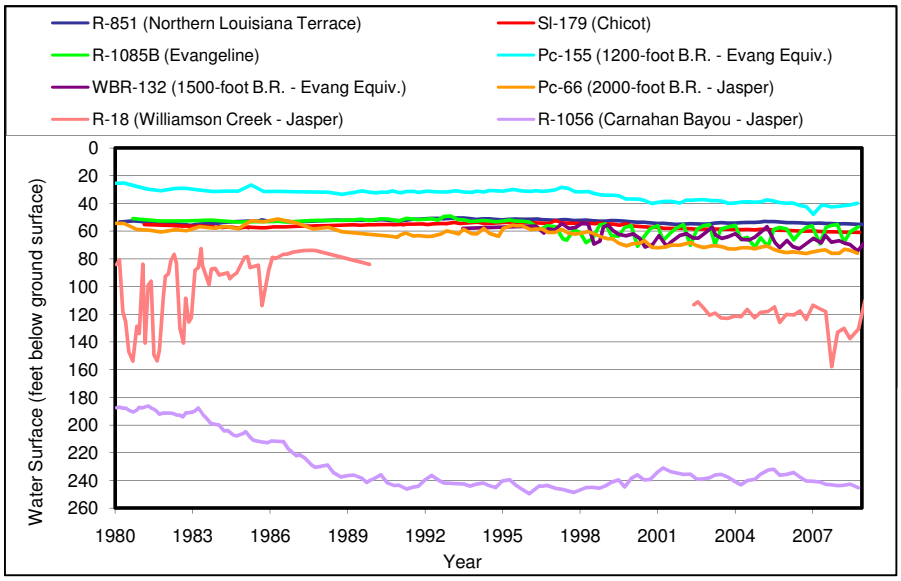


Figure 6. Historical Trends in ATVB Groundwater Levels in Representative Wells

Major aquifers in the ATVB are shown in **Map 7**, and their characteristics are summarized in **Table 9**. Aquifer areas overlap because the aquifers occur at different depths. **Figure 6** shows water levels in the most heavily used aquifers in the ATVB. Although the Chicot Equivalent Aquifer extends into the ATVB, the aquifer is not heavily used in the ATVB, and is not discussed in this report.

Historical data from well R-851, completed in the Northern Louisiana Terrace Aquifer in Rapides Parish, suggest that groundwater levels have remained fairly steady since 1980. There was a minor decline in groundwater levels from 1999 to 2001, probably due to the moderate to severe drought conditions that southern Louisiana experienced during that time.

The Chicot Aquifer is made up of several smaller aquifer units including the Upper and Lower sands, as well as the 200-foot, 500-foot, and 700-foot sands of the Lake Charles area. Historical data from well SI-179, completed in the Chicot Aquifer in St. Landry Parish, show a 2- to 5-foot annual decline in groundwater levels since 1999. The Chicot Aquifer is heavily and increasingly used for rice irrigation, especially in the western ATVB, and can experience fluctuations due to increased groundwater demand during the rice-growing season.[26]

Historical data from well R-1085B, completed in the Evangeline Aquifer in Rapides Parish, indicate that groundwater levels in this aquifer

were steady from 1980 to 1995. More recently observed groundwater level fluctuations (**Figure 6**) could result from seasonal pumping of the overlying Chicot Aquifer.[27] Furthermore, withdrawals from the Evangeline Aquifer increased by about 48 percent from 1995 to 2000. Groundwater level decline of about 8 feet from 1996 to 2005 have occurred in the northwestern ATVB.[28]

The Jasper Aquifer comprises the Carnahan Bayou and Williamson Creek aquifer units. Historical data from well R-1056, completed in the Carnahan Bayou aquifer unit in Rapides Parish, indicate that groundwater levels declined about 5 feet per year from 1980 to 1990 in this aquifer unit. From 1990 to 1999, groundwater levels declined another 1 foot per year, but levels have remained fairly stable since 1999.[12] Historical data from well R-18, completed in the Williamson Creek aquifer unit in Rapides Parish, show increasing groundwater levels from 1980 to 1990, and decreasing groundwater levels between 1990 and 2001; groundwater levels have remained fairly stable since 2001. Between 1996 and 2003, groundwater levels in the Williamson Creek aquifer unit near Pineville declined 2 to 4 feet.[28]

In the ATVB, the 1,200-foot and 1,500-foot sands of the Baton Rouge aquifer unit are the most heavily used units of the Evangeline Equivalent Aquifer. Historical data from well Pc-155, completed in the 1,200-foot sand of the Baton Rouge aquifer unit in Pointe Coupee Parish, indicate that groundwater levels have been declining since 1980, with sharper declines of approximately 1 foot per year over the past 10 years. USGS data from 1996 and 2005 indicate that groundwater levels decreased by about 10 to 20 feet in the 1,200-foot sand in the ATVB during this time period, focused in southwestern Pointe Coupee Parish, near the town of Fordoche. Historical data from well WBR-132, completed in the 1,500-foot sand of the Baton Rouge aquifer unit in West Baton Rouge Parish, show groundwater level decline of approximately 1 foot per year since 1993; drawdown in the 1,500-foot sand is similarly centered near Baton Rouge.

Of the Jasper Equivalent Aquifer, only the 2,000-foot sand of Baton Rouge aquifer unit is heavily used in the ATVB. Historical data from well Pc-66, completed in the 2,000-foot sand of Baton Rouge aquifer in Pointe Coupee Parish, indicate that groundwater levels have declined approximately 1 foot per year since in the 2,000-foot sand since the year 2000. USGS data from 1996 and 2005 indicate that groundwater levels in this aquifer unit decreased by up to15 feet in the ATVB over the 9-year period.[28] This is likely because of increased withdrawals from the aquifer, particularly east of the ATVB. Saltwater encroachment is also a concern for this aquifer. Since 2005, two public supply wells have produced water with chloride concentrations approaching 200 mg/L.[29]

The Red River and the Mississippi River alluvial aquifers are primarily used for irrigation and aquaculture in the ATVB.[12] The Red River Alluvial Aquifer is hydraulically connected to the Red River and its major streams, just as the Mississippi River Alluvial Aquifer is hydraulically connected to the Mississippi River and its major streams. Both aquifers are recharged by direct infiltration of rainfall, lateral and upward movement of water from adjacent and underlying aquifers, and overbank stream flooding. Water levels fluctuate seasonally in response to precipitation and river stage.[30] Because of rapid recharge from surface water, neither aquifer shows long-term groundwater decline.

Groundwater Quality

Groundwater quality issues identified in the 2005 and 2006 LDEQ Baseline Monitoring Program reports are summarized by aquifer in Table 10. Water in five wells in the Mississippi River Alluvial Aquifer exceeded the Federal primary drinking water standard for arsenic in 2006. Only one affected well was within the ATVB. None of the other tested wells in major ATVB aquifers exceeded Federal primary drinking water standards. Water in some wells exceeded secondary standards for pH, TDS (total dissolved solids), color, chloride, and iron. Lead was detected at concentrations below primary drinking water standards in two Chicot Aquifer wells and one Red River Alluvial Aquifer well outside the ATVB. Although no Federal or State standard has been established for chloroform, a volatile organic compound, it was detected at very low levels in one Chicot Equivalent Aquifer well outside the ATVB. Water in wells completed in the Jasper Equivalent Aquifer did not exceed the water quality standard for chloride, but the aquifer does show an increasing trend for this constituent.

Groundwater quality issues identified in the 2005 and 2006 LDEQ Baseline Monitoring Program reports are summarized in **Table 10**.[32] No water in any of the tested wells in major CMB aquifers exceeded Federal primary drinking water standards. Water in some wells exceeded secondary drinking water standards for pH, total dissolved solids (TDS), color, chloride, and iron. Lead was detected at concentrations below the primary drinking water standard in two Chicot Aquifer wells. Only one of these wells, well V-535 in Vernon Parish, is located in the CMB.

Table 10. Secondary Drinking Water Standards Exceedences in Major ATVB Aquifers

Aquifer	pH	TDS	Color	Chloride	Iron
Red River Alluvial		■	■	■	■
Mississippi River Alluvial	■	■	■		■
Northern Louisiana Terrace	■	■	■	■	■
Chicot	■	■	■		■
Chicot Equivalent	■	■	■	■	■
Evangeline	■	■	■		■
Evangeline Equivalent	■		■		■
Jasper Williamson Creek Carnahan Bayou	■	■	■ ■		■
Jasper Equivalent	■		■		

■ – One or more wells exceeded the secondary standard
ATVB=Atchafalaya-Teche-Vermilion Basin
TDS = total dissolved solids

FLOODING

A large number of regional flood protection projects exist in the ATVB. Floodways follow both sides of the Atchafalaya River to the end of the levee system along the river. There, they merge into a single broad floodway that discharges into the Gulf of Mexico through Wax Lake Outlet and the Atchafalaya River.[32] Flood problems within the basin include backwater flooding from many of the rivers and bayous, overbank flooding due to intense rainfall events, and storm surge flooding in the coastal areas and inland lakes. Selected USACE flood control projects located within the ATVB include the following:

- Morganza Floodway – This project involves the introduction of floodwaters from the Mississippi River to the Atchafalaya Basin Floodway at a rate of 600,000 cfs. This floodway has only been opened once in the history of its operation.
- Atchafalaya Basin Levees – The levee system in the basin is designed to protect agricultural areas and towns from the normal high waters of the Mississippi River-Red River backwater area, floods on the Atchafalaya River, and, when necessary, to contain excess floodwaters of the Mississippi and Red rivers.

Ten of the parishes wholly or partially located in the ATVB (Iberia, Iberville, Lafayette, Pointe Coupee, Rapides, St. Landry, St. Martin, St. Mary, West Baton Rouge, and Vermillion) have become participants in the National Flood Insurance Program (NFIP) offered through the Federal Emergency Management Agency (FEMA). As part of the NFIP, FEMA prepares Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRM) for rivers

and bayous prone to damaging floods in a parish; member communities regulate development in floodplains. These studies and maps document flooding problems within parishes and delineate 100-year flood zones along major waterways. Some 100-year flood zone maps are available as digital geographic information system layers; detailed maps and reports can be obtained from FEMA.[33]

USGS estimated flood flow magnitudes for different return periods at streamflow gages throughout the State. Gages within the ATVB where significant historical data have been collected are listed in **Table 11** along with their estimated peak discharges for various recurrence intervals. The USGS analysis is only valid for rural, unaltered waterways. Also included are peak discharges for major waterways, as reported in the FISs reviewed as part of this basin characterization.

Table 11. Estimated Peak Flow Discharges of ATVB Streams[34]

Source	Location		Flood Magnitude (cfs)			
	Gage Number	Name	2-year	10-year	100-year	500-year
USGS	07381800	Spring Creek near Glenmora, LA	2,280	6,710	15,800	24,300
	07386500	Bayou Bourbeau at Shuteston, LA	1,170	1,830	2,360	2,660
	07386000	Bayou Carencro near Sunset, LA	2,190	3,320	4,590	5,480
	07383000	Chatlin Lake Canal near Lecompte, LA	2,330	3,280	4,390	5,040
FIS	Bayou Courtableau at US Highway 190		NA	15,100	19,100	22,000
	Bayou Teche at confluence with Bayou Little Teche		NA	3,150	4,030	4,150
	Bayou Portage at St. Martin Parish boundary		NA	16,619	21,289	24,600
	Bayou Peyronnet downstream of confluence with Bayou Portage		NA	16,250	22,850	26,000
	Bayou Berrard at borrow pit		NA	16,800	23,675	27,075
	Lower Atchafalaya River		NA	345,000	684,000	994,000

ATVB=Atchafalaya-Teche-Vermilion Basin
cfs=cubic feet per second
FIS=Flood Insurance Study
LA=Louisiana
US= United States
USGS=United States Geological Survey

ENVIRONMENTAL AND CULTURAL ISSUES

Environmental and cultural resources are important elements of the quality of life in Louisiana, and can affect siting and operation of water resources facilities, as regulated by State and Federal permitting requirements. As shown in **Map 2**, the southern area of the ATVB is designated by LDNR as Coastal Zone. Existing environmental issues in the Coastal Zone, such as loss of wetlands and land subsidence, can affect water resources facilities, such as reservoirs.[35]

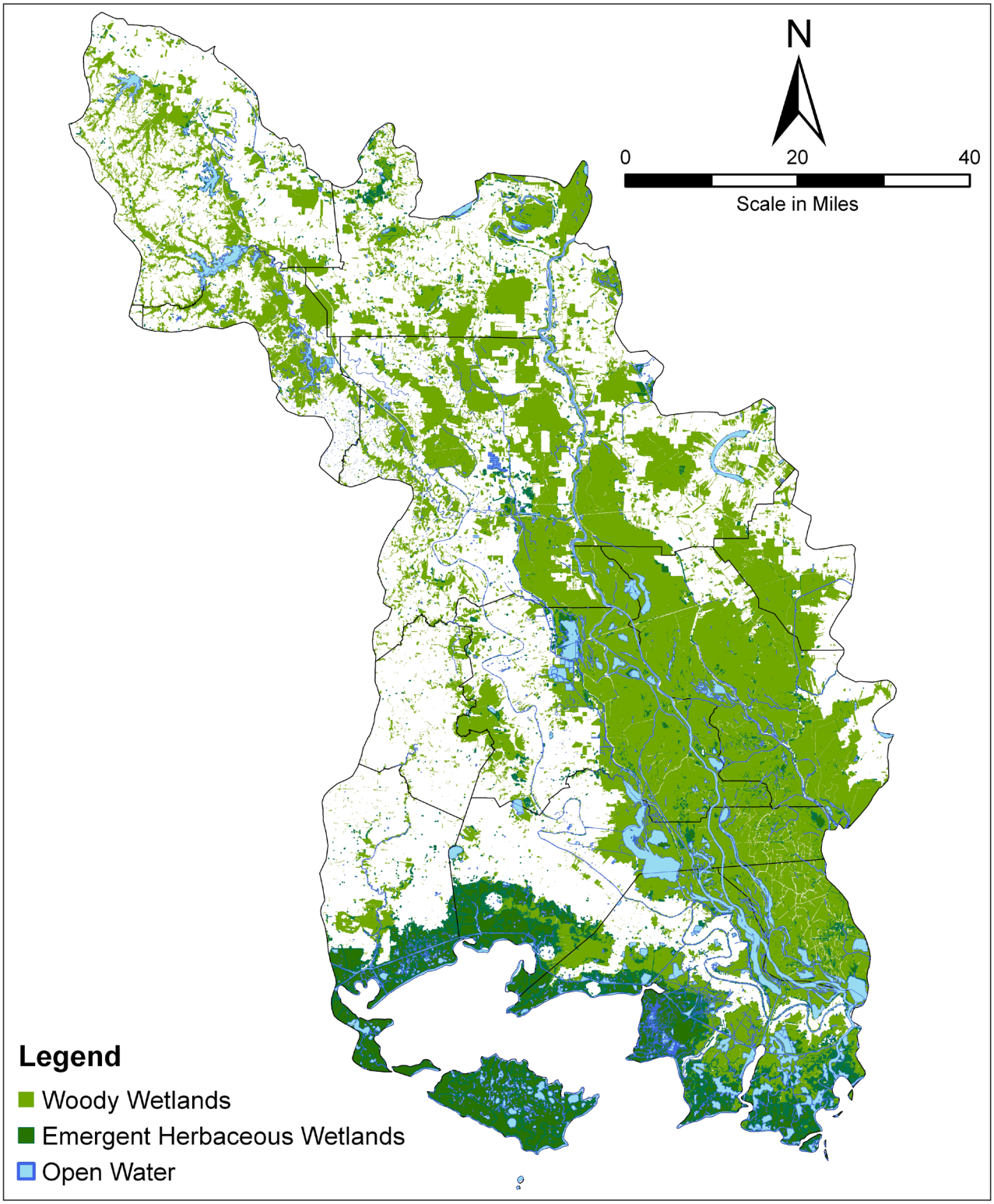
Habitat and Wildlife

The ATVB includes parts of the Mississippi River Alluvial Plain, Western Gulf Coastal Plain, and South Central Plains ecoregions, as designated by USEPA.[36] Each ecoregion contains a range of habitats, some of which are associated with species of conservation concern. The Louisiana Comprehensive Wildlife Conservation Strategy (Wildlife Action Plan) prioritizes particular terrestrial habitat types within each ecoregion for conservation.[19]

Terrestrial species Federally listed as threatened or endangered that may reside in the ATVB are the Louisiana black bear, red-cockaded woodpecker, brown pelican, piping plover, and interior least tern.[37]

Aquatic habitats in the ATVB support about 100 species of freshwater fishes, 22 species of mussels, and 10 species of crawfish.[19] State species of concern include four crustacean, six freshwater fish, one mussel, and three reptile species. The State regulates aquatic habitat through surface water quality standards in water bodies designated for fish and wildlife propagation.[38] The Wildlife Action Plan does not prioritize aquatic habitats for conservation. The U.S. Fish and Wildlife Service has identified several subwatersheds within the ATVB containing surface waters important for conservation of the pallid sturgeon and the Louisiana pearlshell mussel, which are species Federally listed as threatened or endangered.[39]

Wetlands are an important environmental resource throughout the United States, particularly in Louisiana. Alteration of these areas often requires a Federal Section 404 permit through USACE. **Map 8** shows areas of wetlands in the ATVB. About 40 percent of the ATVB's surface area, or 2,378 square miles, is woody wetlands (i.e., areas where forest or shrubland vegetation accounts for a large portion of the cover, and the soil is periodically saturated or inundated).[40] About 9 percent is emergent herbaceous wetlands (i.e., areas where perennial herbaceous vegetation accounts for most of the cover, and the soil is periodically saturated or inundated). There is concern that channelization of major rivers, such as the Atchafalaya, and resulting reduction in siltation have degraded Louisiana's salt marsh wetlands and have caused populated and agricultural lands to subside. Additional degradation of ATVB wetlands has been attributed to historical cutting of channels to allow navigation for oil and gas exploration.



Map 8. Wetlands in the ATVB[23]

Cultural Resources

Information on cultural issues and resources is provided by parish-level organizations. Prehistoric (before European colonization) and historical sites are registered with the Louisiana Department of Culture, Recreation, and Tourism (LCRT) and the National Register of Historic Places (NRHP). Featured historic sites in the basin include churches, mills, houses, post offices, and schools. There are 223 historic points and 4 historic regions in the ATVB, as shown in **Map 9**. Generalized locations of known cultural resources that could affect reservoir siting or operations are available from the NRHP. Thirteen archaeological sites are listed in the NRHP in the ATVB.[41] Additional information is available from the LCRT, Office of Cultural Development, Division of Historic Preservation.

Federally recognized Native American tribes in the ATVB are the Chitimacha Tribe of Louisiana and the Tunica/Biloxi Tribe. The only State-recognized tribe in the ATVB is the United Houma Nation.[42] Potentially affected Native American tribes must be notified of any proposed reservoir plans.

Map 9. Cultural and Recreational Resources and Navigable Waterways in the ATVB[43]

RECREATION, NAVIGATION, AND HYDROPOWER

The ATVB is used extensively for water-oriented recreation, and hunting, fishing, and boating are popular activities in the area.[14] Twelve Wildlife Management Areas are in the ATVB; these areas serve as hunting and camping grounds for the general public. Specific recreational resources of regional value are shown in **Map 9**. Nine major navigable waterways are within the ATVB, as listed in **Table 12**.[32]

Annual traffic on Bayou Teche was over 1 million tons from 1986 through 1995. Major cargoes are crude petroleum and sugar. Bayou Teche provides excellent recreational opportunities and is extensively used for boating, fishing, and waterskiing. Evangeline State Park and New Iberia City Park are located on the bayou and add to its recreational value.

Freshwater Bayou Channel is a 12-foot-deep channel that provides efficient access points to petroleum, gas, salt, and sulfur resource facilities operating in the Gulf of Mexico, and shore support facilities. Freshwater Bayou Channel is located between the Gulf Intracoastal Waterway (GIWW) in the vicinity of the Vermilion River and Gulf of Mexico. Average annual traffic from 1986 through 1995 was 672,000 tons.

Although there is substantial commercial traffic on the Delcambre Canal (Petit Anse, Tigre, and Carlin bayous), it is primarily used for access to boating, fishing and hunting, and waterskiing.

The Vermilion River stretches for 46 miles, from the mouth, near Lafayette, to the Gulf of Mexico; its maintained depth is 9 feet. Similar to Bayou Teche, the Vermilion River provides excellent recreational opportunities and is extensively used for boating, fishing, and waterskiing. Numerous boating facilities are located along the banks.

The GIWW is a 1,300-mile-long, man-made canal that runs along the Gulf of Mexico coastline, from Texas's southernmost tip at Brownville to St. Marks, Florida. Primarily used for shipping, the GIWW links all Gulf Coast ports, and provides access from these ports to the national inland waterway system.[45] In Louisiana, the GIWW stretches 306 miles along the Louisiana coastline from the Pearl River to the Sabine River, and is maintained at a depth of 12 feet. In 2006, a total of approximately 84 million tons of cargo was transported through the GIWW in Louisiana.[46] The GIWW Alternate Route (Morgan City/Port Allen) extends from the GIWW at Morgan City to the Mississippi River via the Atchafalaya and Old rivers. It is used as a shortcut from the Gulf of Mexico to the upper Mississippi River. Average annual traffic from 1986 through 1995 was over 10 million tons.

The Atchafalaya River affords transportation for large offshore drilling equipment and offshore drilling operations. Bayou Grosse Tete is a shallow-draft channel with a navigable depth of 5 feet and minimal cargo traffic.

Six ports are located in the ATVB and are shown in **Map 9**:[47]

- The Port of Morgan City is located near the east bank of the Atchafalaya

Table 12. Summary of Major Navigable Waterways in the ATVB

River	Outflow	Navigable Depth (feet)[46]	Navigable Length (miles)
Atchafalaya River, GIWW to Gulf of Mexico	Gulf of Mexico	20	9
Atchafalaya River to GIWW	GIWW Alternate Route (Morgan City/Port Allen)	12	114.5
Bayou Grosse Tete	GIWW Alternate Route (Morgan City/Port Allen)	5	27
Bayou Teche	Atchafalaya River	11	125
Delcambre Canal	GIWW	9	12.5
Freshwater Bayou	Gulf of Mexico	12	20.5
GIWW	Traverses Louisiana	12	70
GIWW Alternate Route – Morgan City/Port Allen	GIWW	12	62
Vermilion River	Gulf of Mexico	9	46

ATVB=Atchafalaya-Teche-Vermilion Basin; GIWW=Gulf Intracoastal Waterway

River in a natural wide and deep harbor known as Berwick Bay. The port is only 29 miles from the Gulf of Mexico. The primary inbound cargoes for the Port of Morgan City include steel, project cargo, offshore equipment, stone aggregate, and drilling supplies; primary outboard cargoes include heavy lift project cargo, general cargo, rice and molasses, and salt.

- The Port of West St. Mary is located on the Central Gulf Coast of Louisiana on the GIWW. The West St. Mary Parish Port, Harbor, and Terminal District houses primarily marine fabricators and oil and gas service companies.
- The Port of Iberia is the oldest shallow draft port in Louisiana. It is located near the Louisiana coast in Iberia Parish, with access to the GIWW and Gulf of Mexico through its Commercial Canal.
- Limited information is available about the Twin Parish Port (Port of Delcambre), which was heavily damaged by Hurricane Rita. It falls within the jurisdiction of the Twin Parish Port District.
- The Port of Vermilion is located on the west bank of the Vermilion River, 8 miles north of the GIWW. Primary inbound and outbound cargoes include oilfield equipment.
- The Port of Krotz Springs is located on the Atchafalaya River below the junction of the Atchafalaya and Mississippi rivers. The primary inbound cargo is crude oil; the primary outbound cargoes are refined petroleum products and grain.

No hydropower projects exist in the ATVB, although the Sidney Murray Hydropower Plant is located in the Ouachita River Basin near the ATVB boundary. The U.S. Department of Energy has identified several potential sites for small hydropower projects (between 1 and 30 megawatts) and microhydropower projects (less than 100 kilowatts) in the ATVB.[48]

INTERBASIN AND INTERSTATE ISSUES

The Chicot, Evangeline, and Jasper Aquifers extend across the border of Louisiana and Texas. These aquifers (along with the Carrizo-Wilcox Aquifer) are grouped into the Gulf Coast Aquifer System. The Gulf Coast Aquifer System is used for municipal, industrial, and irrigation purposes. Over-pumping in the Gulf Coast Aquifer System has led to land subsidence in several counties in Texas. In 2006, the City of Houston used approximately 170 mgd of groundwater. The population of Houston is expected to more than double between 2000 and 2060, and water demand is expected to increase 27 percent by 2060. Groundwater availability models estimate the groundwater supply will decrease by 32 percent between 2010 and 2060. The Texas Water Development Board has prepared a water management plan with several strategies to address future needs. However, groundwater will account for 9 percent of the total projected volume to be provided by all recommended water management strategies on a statewide basis in 2060. Because groundwater levels in the Gulf Coast Aquifer System have been declining, and demand is projected to increase due to population increase, further investigations into the effects of Houston area groundwater use on the Louisiana portion of the aquifers might be warranted.

Groundwater withdrawals in southeastern Louisiana, particularly in the Baton Rouge area, have caused saltwater to encroach into some of the 10 freshwater aquifers in the region. Saltwater was initially detected as early as the 1960s, and groundwater investigations delineated a freshwater-saltwater interface at the Baton Rouge fault east of the ATVB. Generally, aquifers south of the fault contain saltwater, and aquifers to the north contain freshwater. By the 1990s, saltwater had been detected in six of the aquifers north of the fault, including the 2,000-foot sand.[29] In 1999, the Capital Area Groundwater Conservation Commission (CAGWCC) completed a saltwater remediation project that connected the 800-foot and 1,500-foot sands, allowing groundwater from the 800-foot sand to flow directly to the 1,500-foot sand. The resulting hydraulic head that builds up extends outward and acts as a barrier against movement of saltwater toward pumping wells.[49] Since October 2007, CAGWCC has been modeling the 1,500-foot and 2,000-foot sands of Baton Rouge. The 4-year study is a joint venture with DOTD, USGS, and the East Baton Rouge Department of Public Works.[50] Saltwater encroachment problems and activities outside the ATVB could be important to water resources within the ATVB.

SUMMARY OF WATER RESOURCES NEEDS

To identify and prioritize statewide water resources issues, a needs assessment of each of the nine major surface water basins within Louisiana was performed. Because the needs assessment provides the foundation for developing reservoir priority evaluation criteria, it focuses on needs that can be addressed by surface water reservoirs. At the same time, the integrated nature of water resources management requires evaluating issues that could not necessarily be solved by, but could be affected by, a reservoir.

Based on the existing compiled information, eight categories of State water resources needs that could be addressed or affected by construction of surface water reservoirs were identified and evaluated. Evaluation criteria were developed for each category to allow interbasin comparison of the needs. To maintain objectivity in the evaluation process, evaluation criteria were developed based on factors that could be evaluated as quantitatively as possible across all basins. High, medium, and low levels of current need were defined based on differences in these factors between basins. Future needs in each basin were assessed by determining whether each current need is increasing, constant, or decreasing. Evaluation criteria are described in detail in the main body of the Statewide Perspective on Water Management Report, to which this basin characterization is an appendix. Details of the assessed needs for all nine major Louisiana surface water basins, as well as a comparison of statewide needs by issue, are also presented in the main body of the Statewide Perspective on Water Management Report.

Assessed needs in the ATVB are shown in **Table 13**, and are discussed below in general order of need, from high-level needs (colored red in **Table 13**) to low-level needs (colored green in **Table 13**). No low-level needs were identified in the ATVB. Current needs are very similar to those of the neighboring Calcasieu-Mermentau River Basin, and were evaluated identically for both basins. Most existing needs in the ATVB were identified as increasing.

Because groundwater is heavily used in the basin and groundwater levels and quality show long-term declines, groundwater supply and quality were identified as high-level needs. Water level drops of up to 50 feet in areas of the Chicot, Evangeline, Jasper, and local equivalent aquifers threaten the sustainability of agricultural and potable water supplies for parts of the ATVB. Chicot, Evangeline, and Jasper aquifers issues are complicated because the aquifers extend into Texas and have experienced historical drawdown. Coastal aquifers are experiencing saltwater intrusion resulting in declining water quality. Groundwater supply is expected to increase in importance if population and development continue to grow in the ATVB.

Environmental protection was ranked as a high-level need. Many environmental issues threaten the protection of existing water resources and/or constrain future development of additional water supplies, including the presence of widespread wetland and naturally vegetated areas covering over 50 percent of the basin; substantial areas considered Prime Farmland, 82 miles of State-designated Natural and Scenic Rivers; and the presence of two threatened and endangered aquatic species and several terrestrial species. Channels historically cut into marshes have impacted the coastal environment, and some water quality impairments in the basin can be attributed to oil refineries.

Navigation was evaluated as a high-level need with increasing importance in the future. Located along the Mississippi River and the GIWW, the ATVB is highly trafficked, making it one of the most important shipping areas in the country. With six major ports and more than 400 miles of navigable waterways, annual cargo throughput

Table 13. Assessed Water Resources Needs in the ATVB

Category	Current	Future
Surface Water Supply	medium	–
Surface Water Quality	medium	↑
Groundwater Supply	high	↑
Groundwater Quality	high	↑
Flood Control	medium	–
Environmental Protection and Enhancement	high	↑
Recreation	medium	↑
Navigation	high	↑

ATVB = Atchafalaya-Teche-Vermilion Basin
Red = high-level need; Yellow=medium-level need; Green=low-level need
↑ = increasing importance
– = same importance
↓ = decreasing importance

totals about 40 million tons. Recent hurricanes caused extensive shoaling, and USACE has used emergency funds to dredge navigation channels in the region. Commercial traffic shows trends of increase, and the region will continue to require dredging maintenance costing tens of millions of dollars.

Although there is extensive surface water quality degradation in the ATVB, it was ranked as a medium-level need because of more pressing needs in other categories. Many reaches of surface water are designated by the State as impaired. Agricultural runoff is the most commonly cited source of impairment for parameters ranging from nutrients to suspended solids. Most of these impairments are related to aquatic habitat.

Flood control was ranked as a medium-level need. Similar to other basins, extensive areas of potential flooding are present in the ATVB, but no major population centers are threatened. Comprehensive flood control projects have been implemented for much of the basin, but flood control and floodplain management measures may still be needed to protect existing land uses and minimize future flood damages.

Recreation was ranked as a medium-level need. Four wildlife refuges, one State Park with direct water access, and several lakes are present in the ATVB. However, only one major water body is located in the northern part of the basin. The trend of increasing population in the ATVB suggests that recreational opportunities will also increase in importance in the future.

ABBREVIATIONS

°F	degrees Fahrenheit
7Q10	7-day low flow with a recurrence interval of 10 years
ATVB	Atchafalaya-Teche-Vermilion Basin
cfs	cubic feet per second
DOTD	Louisiana Department of Transportation and Development
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GIWW	Gulf Intracoastal Waterway
LCRT	Louisiana Department of Culture, Recreation, and Tourism
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
mgd	million gallons per day
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWIS	National Water Information System
State	State of Louisiana
TDS	total dissolved solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

REFERENCES

1 U.S. Geological Survey (USGS). 1999. 1:2,000,000-scale Hydrologic Units of the United States. Available at <*http://water.usgs.gov/GIS/metadata/usgswrd/XML/huc2m.xml*>.

2 Louisiana Ground Water Management Commission (LAGWMC). 2002. Assistance in Developing the Statewide Water Management Plan. Prepared by C. H. Fenstermaker & Assoc., Inc.; LBG-Guyton Assoc.; Hydro-Environmental Technology, Inc.; and Onebane, Bernard, Torian, Diaz, McNamara & Abell.

3 Louisiana Department of Transportation and Development (DOTD). 2007. Atlas: Louisiana Statewide GIS. Available at <*http://www.atlas.lsu.edu/*>.; Coastal Management Division, Louisiana Department of Natural Resources (LDNR). 1998. Louisiana Coastal Zone Boundary.

4 Louisiana Economic Development. 2009. Industries Division. Baton Rouge, LA: Louisiana Economic Development. Available at <*http://www.ledlouisiana.com/opportunities/key-industries/life-science.aspx*>.

5 U.S. Census Bureau. 2009. Population data for Louisiana. Available at <*http://www.census.gov*>.

6 Sun, G., S. McNulty, J. Moore Myers, and E. Cohen. 2008. Impacts of Multiple Stresses on Water Demand and Supply Across the Southeastern United States. Journal of the American Water Resources Association 44/6:1441-1457.

7 Louisiana Department of Natural Resources (LDNR), Office of Conservation. 2007. Oil and Gas Field Locations, January. Available at <*http://lagic.lsu.edu/data/losco/oil_gas_fields_ldnr_2007_faq.html*>.; USGS. 2003a. Louisiana Land Cover Data Set. Available at <*http://lagic.lsu.edu/loscoweb*>.

8 Natural Resources Conservation Service. 1997. Acres of Prime Farmland. Available at <*http://www.nrcs.usda.gov/technical/NRI/maps/meta/m4983.html*>.

9 Louisiana Department of Environmental Quality (LDEQ). 2004a. 1:24,000 DEM Mosaic. Available at <*http://www.atlas.lsu.edu*>.; Stoeser, D. B. , G. Green, L. Morath, W. Heran, A. Wilson, D. Moore, and B. Van Gosen. 2005. Preliminary Integrated Geologic Map Databases for the United States Central States: Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas, and Louisiana - The State of Louisiana: USGS Open-File Report 2005-1351, Denver, CO. Available at <*http://tin.er.usgs.gov/geology/state/state.php?state=LA*>.

10 USGS. 1998. National Wetlands Research Center. Louisiana State Soil Geographic, General Soil Map.

11 Southern Regional Climate Center (SRCC). 2009. Available at <*http://www.srcc.lsu.edu*>.

12 USGS. 2007. Water Use in Louisiana 2005. Water Resources Special Report No. 16. Prepared by B.P. Sargent. Published by DOTD. Available at <*http://la.water.usgs.gov/WaterUse/default.htm*>.

13 USGS. 2009a. Streamgages-NHD Locations. Available at <*http://water.usgs.gov/lookup/getgislist*>.; DOTD. 1984. The Louisiana Water Resources Study Commission's Report to the 1984 Legislature.; USGS. 2006. National Atlas of the United States, Major dams of the United States. Available at <*http://nationalatlas.gov/mld/dams00x.html*>.; U.S. Department of Commerce, U.S. Census Bureau, Geography Division, 2006 Second Edition, Census Places of Louisiana.; LDEQ. 2004b. Basin Subsegments from LDEQ source data. Available at <*http://lagic.lsu.edu/data/losco/basin_subsegments_ldeq_2004_faq.html*>.

14 DOTD (1984)

15 America's Wetland Foundation. 2009. Louisiana River Control. Available at <*http://www.americaswetlandresources.com/background_facts/detailedstory/LouisianaRiverControl.html*>.

16 USGS. 2009b. National Water Information System. Available at <*http://nwis.waterdata.usgs.gov/la/nwis*>.

17 USGS (2006)

18 USGS. 2003b. Low-Flow Characteristics of Louisiana Streams. Water Resources Technical Report No. 70. P.A. Ensminger and L.S. Wright. Published by DOTD.

19 Louisiana Department of Wildlife and Fisheries (LDWF). 2005. Louisiana Comprehensive Wildlife Conservation Strategy.

20 LDEQ. 2006a. Louisiana Water Quality Inventory: Integrated Report. Available at <*http://www.deq.louisiana.gov/portal/LinkClick.aspx?link=planning%2F2006+IR+Cover+and+Acknowledgements.pdf*>.

21 U.S. Environmental Protection Agency. 2009a. Permit Compliance System. Available at <*http://www.epa.gov/enviro/html/pcs/pcs_query_java.html*>.; USEPA. 2009b. NHD Indexed locations for Section 303(d) Listed Waters. Available at <*http://www.epa.gov/waterspb/data/303D_metadata.pdf*>.

22 LDEQ. 2009. Information and Records. Available at <*http://www.deq.louisiana.gov/portal/Default.aspx?tabid=223*>.

23 USEPA (2009a)

24 USGS. 2002. Assistance in Developing the Statewide Water Management Plan, Vol. 1.

25 Smoot, Charles W. 1986. Water-Resources Investigations Report 86-4150. Louisiana Hydrologic Atlas Map No. 2: Aerial Extent of Freshwater in Major Aquifers of Louisiana.

26 USGS. 2004a. Withdrawals, Water Levels, and Specific Conductance in the Chicot Aquifer System in Southwestern Louisiana, 2000-03.

27 USGS. 2004b. Louisiana Ground-Water Map No. 21 : Generalized Potentiometric Surface of the Evangeline Aquifer in South-Central Louisiana, January - March 2004.

[28] USGS Water Resources Data Louisiana Water Year 2005, Water-Data Report LA-05-1; USGS Water Resources Data Louisiana Water Year 1996, Water-Data Report LA-96-1.

[29] Tomaszewski, D.J., 2005. Movement of Saltwater in the "2000-foot" Sand of the Baton Rouge Area, Louisiana, American Geophysical Union, Spring Meeting. Available at <*http://adsabs.harvard.edu/abs/2005AGUSM.H13C..04T*>.

[30] LDEQ. 2006b. Red River Alluvial Aquifer Baseline Monitoring Program, Appendix 3 of the Triennial Summary Report.

[31] LDEQ. 2006c. Baseline Monitoring Program, Triennial Summary Report. Baseline Monitoring Program reports available at <*http://www.deq.louisiana.gov/portal/tabid/1717/Default.aspx*>.

[32] U.S. Army Corps of Engineers (USACE). 1998. Water Resources Development in Louisiana. Available at <*http://www.mvn.usace.army.mil/environmental/lca.asp*>.

[33] Louisiana Geographic Information Center (LAGIC). 2007. Louisiana 2007 DVD Collection. Available at <*http://lagic.lsu.edu/geodata/LOSCO/2007_DVD/catalog_2007DVD.htm*>.; Federal Emergency Management Agency (FEMA). 2009. 100 Year Flood Zone Maps. Available at <*http://www.fema.gov/*>.

[34] Ensminger, P.A. 1998. Floods in Louisiana, magnitude and frequency (5th ed.): Louisiana Department of Transportation and Development Water Resources Technical Report no. 60, 333 p.

[35] Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1998. Coast 2050: Toward a Sustainable Coastal Louisiana. Louisiana Department of Natural Resources. Baton Rouge, La. 161 p. Available at <*http://www.lacoast.gov/Programs/2050/MainReport/report1.pdf*>.

[36] USEPA. 2004. Ecoregions for Louisiana. Available at <*http://lagic.lsu.edu/data/losco/ecoregions_epa_2004_faq.html#what*>.

[37] U.S. Fish and Wildlife Service (USFWS). 2001. Threatened and Endangered Species by Parish. Available at <*http://lagic.lsu.edu/data/losco/t_e_la_parish_usfws_2001_faq.html*>.

[38] Louisiana Administrative Code. 2009. Title 33, Part IX, Chapter 11 – Surface Water Quality Standards. Available at <*http://www.deq.louisiana.gov/portal/Default.aspx?tabid=167*>.

[39] USFWS. 2008. 2008-2009 Implementation Strategy for the Louisiana Department of Environmental Quality and the U.S. Fish and Wildlife Service Memorandum of Understanding. Available at <*http://www.deq.louisiana.gov/portal/LinkClick.aspx?fileticket=NedPkSZRWhs%3d&tabid=243*>.

[40] USGS. 2001. Louisiana Land Cover Data Set, Sioux Falls, SD. Available at <*http://lagic.lsu.edu/loscoweb*>; LDNR (2007)

[41] Louisiana Division of Archaeology. 2005. National Register. Available at <*http://www.crt.state.la.us/archaeology/homepage/sites.shtml*>.

[42] Louisiana Governor's Office of Indian Affairs. 2009. Tribes. Available at <*http://www.indianaffairs.com/tribes.htm*>.

[43] DOTD (2007); National Register of Historic Places. 2008. National Park Service Available at <*http://www.nr.nps.gov*>.; U.S. Department of Commerce, U.S. Census Bureau, Geography Division. 2006. TIGER/Line 2006 Second Edition, Landmarks of Louisiana.; Louisiana Oil Spill Coordinator's Office. 1999. Navigated Waterways of Louisiana; Louisiana Department of Wildlife and Fisheries. 2006. Wildlife Management Areas (WMAs) and Refuges in Louisiana.

[44] USACE. 2006a. National Waterway Network. Shapefile of Navigable Waters. Available at <*http://lagic.lsu.edu/loscoweb/*>.

[45] Texas Department of Transportation. 2009. Gulf Intracoastal Waterway. Available at <*http://www.texasgulfcoastonline.com/portals/0/pdfs/tx_gulfcoastwaterway.pdf*>.

[46] USACE. 2006b. Waterborne Commerce of the United States, Part 2–Waterways and Harbors. Gulf Coast, Mississippi River System and Antilles. Available at <*http://www.ndc.iwr.usace.army.mil/wcsc/pdf/wcusmvgc06.pdf*>.

[47] Ports of Louisiana. 2009. Available at <*http://portsoflouisiana.org*>.

[48] U.S. Department of Energy. 2009. Idaho National Laboratory Virtual Hydropower Prospector. Available at <*http://hydropower.id.doe.gov/prospector/index.shtml*>.

[49] U.S. Water News Online. 1996. Available at <*http://www.uswaternews.com/archives/arcconserv/6grocom.html*>.

[50] CAGWCC. 2007. Progress Report, October 2007. Available at <*http://www.cagwcc.com/newsletters/newsletter_oct_2007.pdf*>.



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