1.0 INTRODUCTION

In November of 1996, the Sabine River Authority of Texas authorized Freese and Nichols, Inc., to prepare a regional water management plan for the Sabine Basin that would address water supply issues through the year 2050. This project was partially funded by the Texas Water Development Board (TWDB). Brown and Root, Inc. and LBG-Guyton were subconsultants to Freese and Nichols on this project. This plan was intended to provide an assessment of the current water resources within the Basin, identify future water needs and provide a plan to address these needs. The contractual scope of work identified twenty tasks relating to water management within the Basin. These tasks, along with the primary responsible party are listed below.

- Task 1: Update General Basin Information — Brown & Root
- Task 2: Sabine Watershed Hydrology — Brown & Root
- Task 3: Ground Water Evaluations — LBG-Guyton
- Task 4: Water Rights — Freese & Nichols
- Task 5: Update Surface Water Information — Freese & Nichols
- Task 6: Population Projections and Water Use — Brown & Root
- Task 7: Water Treatment Needs * — Freese & Nichols
- Task 8: Wastewater Treatment Needs * — Freese & Nichols
- Task 9: Water Conservation — Brown & Root
- Task 10: Water Quality Program — Freese & Nichols
- Task 11: Mineral Resources Evaluation — Brown & Root
- Task 12: Environmental Considerations — Freese & Nichols
- Task 13: Public Participation — Brown & Root
- Task 14: Lake Sedimentation — Freese & Nichols
- Task 15: Aquifer Storage and Recovery * — LBG-Guyton
- Task 16: Information Resource Issues — Brown & Root
- Task 17: Surface Water Project Issues — Freese & Nichols
- Task 18: Other Water-Related Issues — Brown & Root
- Task 19: Preparation of the Management Plan — Freese & Nichols
- Task 20: Mitigation Banking — Freese & Nichols

* Tasks 7, 8 and 15 were funded by the TWDB.

This Comprehensive Sabine Watershed Management Plan is a compilation of the information and data assembled for the above listed tasks. Detailed discussions of the methodology and findings are presented in Task Memoranda, which were submitted to SRA as separate documents. This report contains an executive summary, the main report and appendices, and is generally organized in the following order: 1) an identification of existing conditions, 2) projected water demands, 3) existing water supplies, 4) identification of future needs or available supply, 5) potential future water supply, 6) other Basin issues (water and wastewater needs, environmental issues, etc.) and 7) recommended water resource management plan. A list of reports and information used in developing this report is included in Appendix A.

1.1 Background

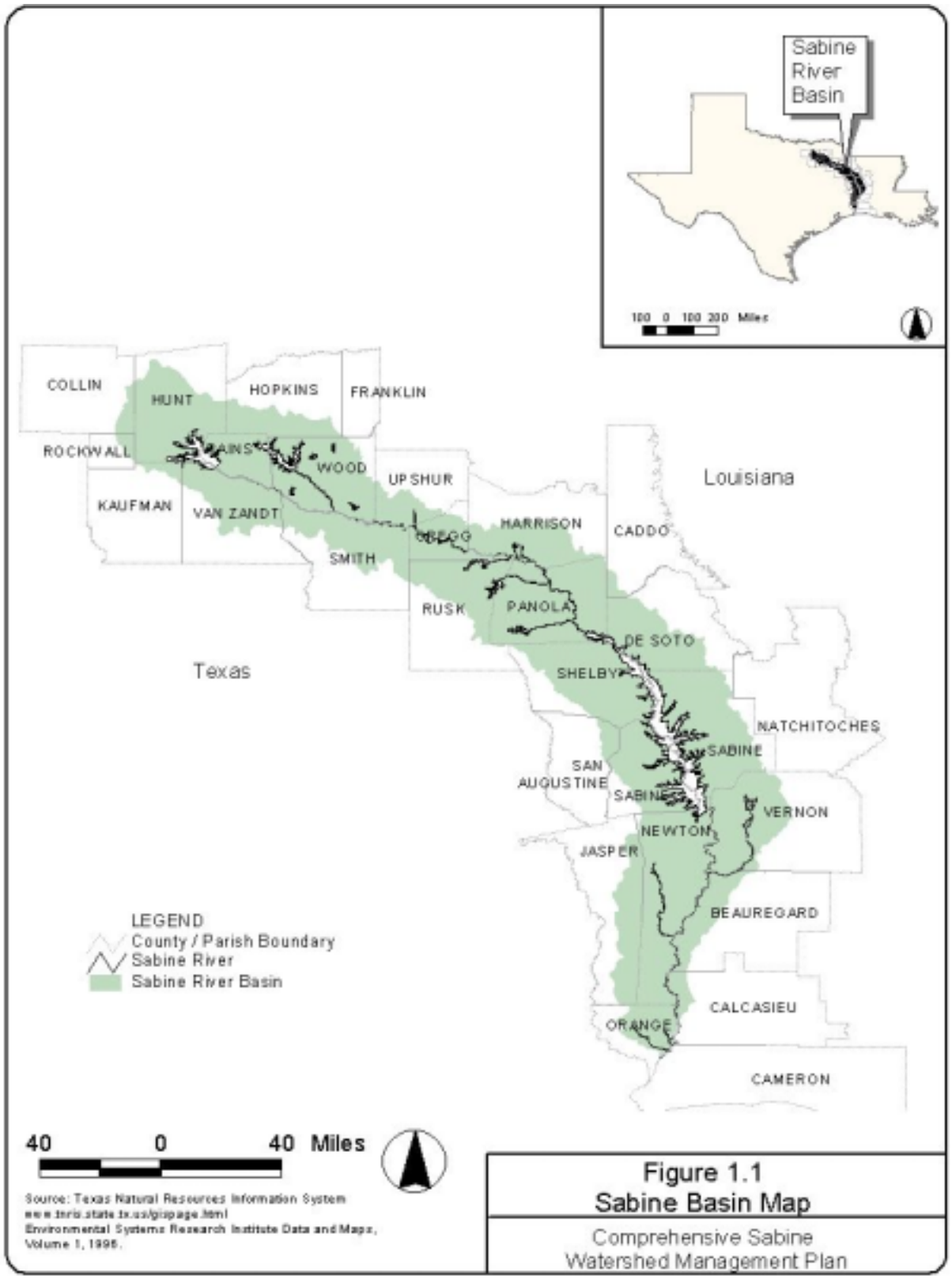
The Sabine River originates in Texas northeast of Dallas and flows southeast towards Logansport, Louisiana, then south to Sabine Lake. The crescent-shaped Basin, shown on Figure 1.1, is 48 miles across at its widest point and over 300 miles in length from its headwaters to its mouth at Sabine Lake. All or part of twenty-one Texas counties and seven Louisiana parishes are in the Sabine Basin. The total drainage area of the Basin is 9,756 square miles, with 7,396 square miles (76 percent) in Texas and 2,360 square miles (24 percent) in Louisiana. Table 1.1 lists the Texas Counties in the Sabine Basin.

The Sabine River Authority of Texas, the Sabine River Authority of Louisiana, and the Sabine River Compact Administration all have responsibilities relating to the waters of the Sabine Basin.

The Sabine River Authority of Texas

The Sabine River Authority was created by the Legislature in 1949 as an official agency of the State of Texas. The SRA was created as a conservation and reclamation district with responsibilities to control, store, preserve, and distribute the waters of the Sabine River and its tributary streams for useful proposes.

The SRA of Texas is governed by a nine-member Board of Directors, who serve six-year terms, with three members being appointed by the Governor of Texas every two years. Directors are required to reside within a county situated wholly or partially within the watershed of the Sabine River and are vested with the management and control of the affairs of the Authority.



Source: Texas Natural Resources Information System
www.tnris.state.tx.us/gispage.html
Environmental Systems Research Institute Data and Maps,
Volume 1, 1996.

Figure 1.1
Sabine Basin Map

Comprehensive Sabine
Watershed Management Plan

The Authority, as an agency of the State, receives no appropriations and is not empowered to levy or collect any kind of taxes. Operating funds are primarily derived from the sale of raw and treated water, hydro-electric power, water quality services, and recreational and land use permit fees.

Table 1.1: Texas Counties in the Sabine Basin

Upper Basin	Percent of County in Basin	Lower Basin	Percent of County in Basin
Collin	6	Shelby	79
Rockwall	19	San Augustine	8
Hunt	69	Sabine	87
Kaufman	4	Jasper	55
Van Zandt	44	Newton	100
Rains	100	Orange	56
Hopkins	30		
Wood	97		
Smith	45		
Franklin	<5		
Upshur	27		
Gregg	90		
Rusk	49		
Harrison	42		
Panola	100		

The General Manager's office of SRA is responsible for the implementation of Board policy, project development, operations, management, accounting, and personnel management. The General Manager's office has two major branches: development and operations. The Development Branch evaluates existing water quantity and quality conditions throughout the river Basin by performing planning studies, monitoring and implementing water quality and pollution control activities, performing basin-wide resource management and new project development. A large portion of this work is accomplished through SRA's Environmental Services Division, which operates a water quality and biomonitoring laboratory as well as the Upper Basin Field Office and Lower Basin Field Office. The Development Branch is also

responsible for economic development activities, public participation in SRA programs, and SRA's extensive Information System, GIS, and website. The Operations Branch is responsible for managing SRA-owned facilities. These facilities include Lake Fork Dam and Reservoir, Iron Bridge Dam and Lake Tawakoni, Toledo Bend Dam and Reservoir, and the SRA Canal System. (SRA Texas jointly with SRA Louisiana owns, operates, and maintains Toledo Bend Dam and Reservoir.)

The Sabine River Authority, State of Louisiana

The Sabine River Authority, State of Louisiana (SRA Louisiana) was created in 1950 for the purpose of conservation and reclamation of water within the Sabine watershed in Louisiana. The Board of Commissioners for SRA Louisiana is composed of 13 members appointed by the Governor of Louisiana, with one acting as chairman.

SRA Louisiana has the authority to conserve, store, control, preserve, and distribute the waters of the Sabine watershed in Louisiana. It also has the authority to provide works of public improvement for flood control, soil conservation, water supply to municipalities, navigation of the Sabine River, and hydroelectric generating facilities.

SRA Louisiana has three offices: an administrative office; an engineering office; and the Sabine River Diversion Canal office. SRA Louisiana's Administrative Office is responsible for water sales, recreational site construction and maintenance, shoreline management, and sewage regulation and permitting for all of SRA Louisiana. The Engineering Office at Toledo Bend administers all engineering, maintenance, and operational aspects of the waters in Toledo Bend Reservoir for SRA Louisiana. The Sabine River Diversion Office is responsible for managing the canal diversion system.

The Sabine River Compact

The Sabine River Compact was signed by representatives of the State of Texas and Louisiana, and the United States on January 26, 1953, and subsequently was ratified by the legislatures of the Sates and approved by the Congress of the United States. The major purposes of the Compact are to provide for the equitable apportionment between the States of Louisiana and Texas of the waters of the Sabine River and its tributaries; and, to establish a basis for cooperative planning and action by the States for the construction, operation and maintenance of projects for water conservation and utilization on the reach of the Sabine River common to both

States, and for the apportionment of the benefits therefrom. As used in the Compact, the word "Stateline" means the point on the Sabine River where its waters in downstream flow first touch the States of both Louisiana and Texas. The essentials of water apportionment provisions of the Compact are as follows:

- Texas retains free and unrestricted use of the water of the Sabine River and its tributaries above the Stateline, subject only to the provisions that the minimum flow of 36 cubic feet per second must be maintained at the Stateline.
- Any reservoir constructed in the watershed above the Stateline subsequent to January 1, 1953, will be liable for its pro rata share of the guaranteed minimum flow.
- Texas may either use the yield of these Upper reservoirs above the Stateline or allow it to flow downstream in the Stateline reach to a desired point of removal without loss of ownership.
- All free water (free water means all waters other than stored water) in the Stateline reach, without reference to origin will be divided equally between the two States.
- Neither State may contract a dam on the Stateline reach without the consent of the other State.
- Water stored in reservoirs constructed by the States in the Stateline reach shall be shared by each State in proportion to its contribution to the cost of storage.
- Should either State construct a reservoir on a stream tributary to the Stateline reach of the Sabine River, that State is entitled to the yield of the reservoir, but its share of the flow of the Sabine River is reduced by the reduction in flow resulting from the operation of the reservoir.
- Water consumed for domestic and stock water purposed is excluded from the apportionment under the Compact.

1.2 Sabine Basin Hydrology

Diverse climatologic, topographic, and geologic features that generally trend from north to south across the Sabine Basin characterize its hydrology. Climatologic factors such as temperature, rainfall, and humidity directly affect the rate at which water enters and leaves the river system. Topography and geologic factors define the river/stream system within the Basin,

and can affect runoff, evaporation, sedimentation rates, reservoir storage capacity, and water quality.

Due to the natural diversity within the Basin, the hydrology of the northern region is significantly different from the southern region. These distinct regions are commonly referred to as the "Upper Basin" in the north and the "Lower Basin" in the south. The division between the two areas is the headwaters of Toledo Bend Reservoir. The Upper Basin is characterized by cool winters, hot summers, and seasonal rainfall patterns. The Lower Basin has a coastal climate with mild winters, high annual rainfall, and moderate to high humidity.

The average annual precipitation over the Sabine Basin ranges from a low of 40 inches in the far northern portion of the Upper Basin to 59 inches near the Gulf Coast, as illustrated on Figure 1.2. Generally, the heaviest rainfall occurs in the late spring, with the mid-summer months being the driest. The drier air and hot summers in the Upper Basin result in higher rates of evaporation than the Lower Basin. Average annual net reservoir evaporation rates range from a low of 8 inches per year at the Toledo Bend Dam to 32.5 inches per year at Lake Tawakoni. High evaporation and reduced rainfall and runoff can lead to drought conditions. Since 1900 several droughts have occurred in the Sabine Basin. Even with the recent drought periods, the droughts of the 1950s and 1960s still appear to be the most severe of meteorological record.

The local topography is characterized by a gentle slope north to south with elevations ranging from 700 feet above mean sea level at the Basin's headwaters to sea level in the coastal region. Land surfaces in the Upper Basin are rolling to hilly with streams in shallow valleys. The Lower Basin is generally flat with a fairly uniform slope.

Soils in the Basin fall into three main types: Blackland Prairie, East Texas Timberland, and Coastal Prairie. The Blackland Prairie group is located in the uppermost part of the Basin, and is comprised of various clayey soils. Due to their sloping nature and clay texture, these soils are susceptible to erosion. Documented sediment production rates for Blackland Prairie are three to five times greater than the other soil types in the Basin. The East Texas Timberland series soils are primarily light-colored sandy loam, and cover nearly 90 percent of the Basin. The light sandy texture of these soils makes them susceptible to heavy erosion when the natural vegetation is removed. Reforestation and reseeding efforts can reduce erosion in this region. The Coastal Prairie soils, located along the Gulf Coast, are primarily dark gray to black clays. This region,

with its flat topography, poor drainage and grassy vegetation, has the lowest erosion and sedimentation rates in the Basin.

Streamflow in the Sabine Basin is measured by the United States Geological Survey (USGS) at continuous recording streamflow-gaging stations. There are currently 20 gages in the Basin. Sixteen of these stations are located in Texas and four are located in Louisiana. Of the 20 gages, five were selected as representative of discharge patterns in the Basin based on their location, period of record, and proximity to a rainfall monitoring station. The selected gages are Quitman, Mineola, Beckville, Burkeville and Bon Wier, and are shown on Figure 1.2.

The historical data from these flow gages indicate that the average annual streamflow varies from 426 cubic feet per second (cfs) at the Quitman gage on Lake Fork Creek in the Upper Basin, to 6,853 cfs at the Bon Wier gage in the Lower Basin. As shown on Figure 1.3, average monthly streamflows generally increase from November to May, then decrease from June to October. This follows typical rainfall patterns in the Basin. The largest streamflow discharges have occurred in the Lower Sabine River. Over 130,000 cfs of streamflow was recorded at the Ruliff gage in 1884. The second largest discharge of 117,000 cfs occurred on February 1, 1999, at the Burkeville gage. The third largest discharge event on record occurred in 1989, with a recorded flow of 116,000 cfs also at the Burkeville gage. Such extreme hydrologic flood conditions are less common in the Upper Basin.

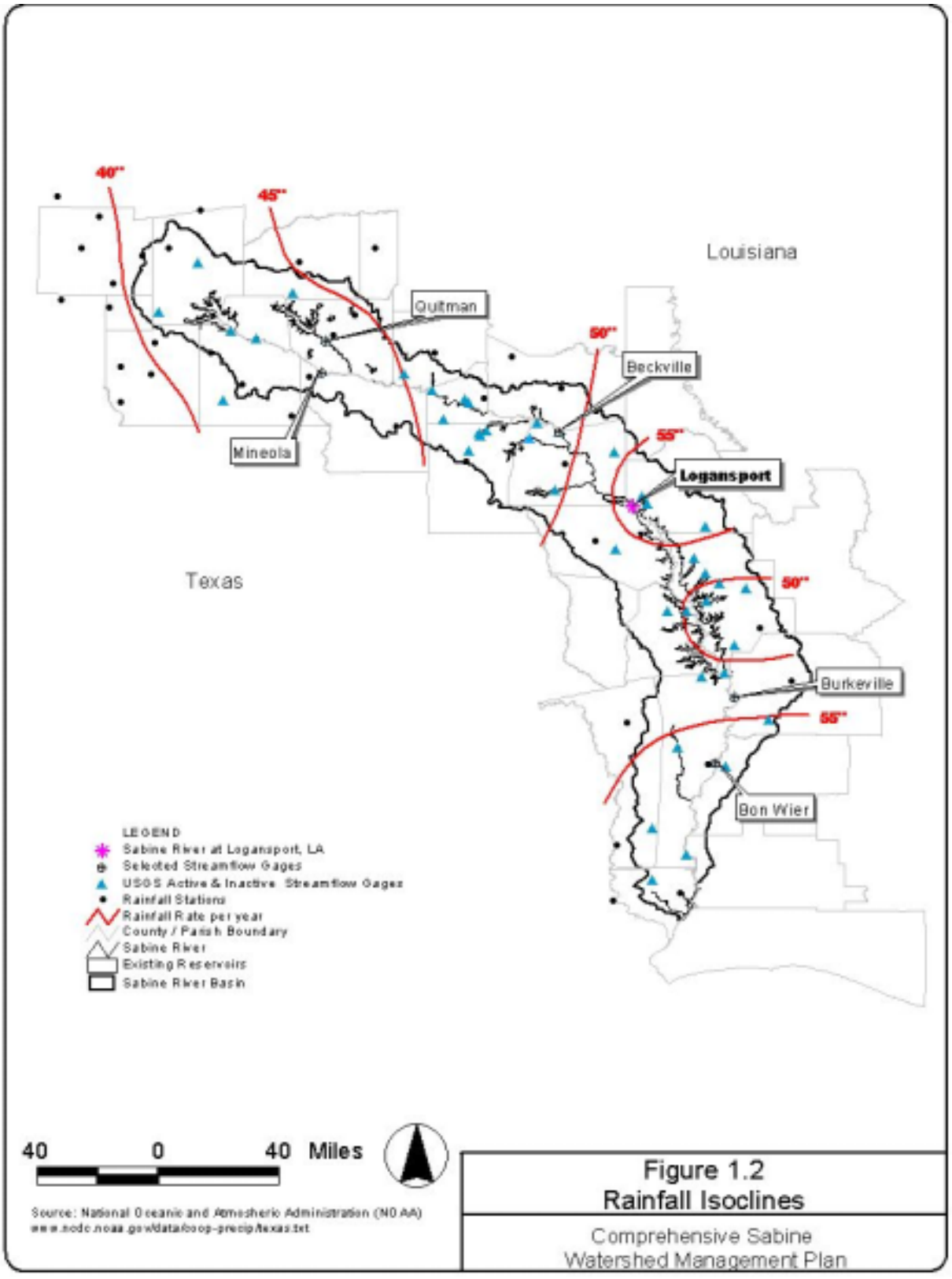


Figure 1.2
Rainfall Isoclines

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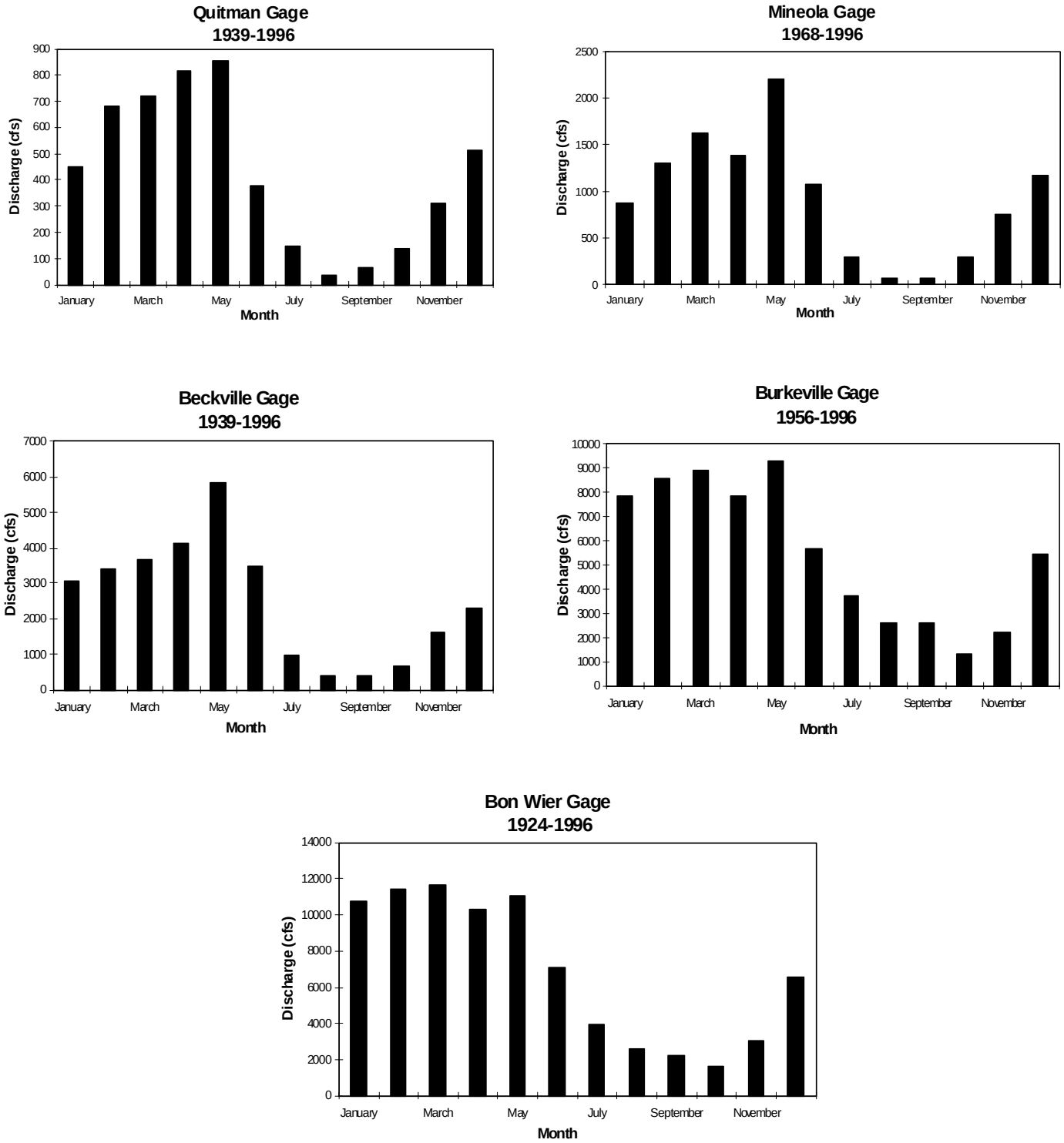
Figure 1.3: Average Monthly Streamflow Discharges



1.3 Water Rights

In Texas, surface water is public property, and the state confers the right to impound and to use surface water. In most instances state law requires a water right for the use of surface water in Texas. The various types of water right documents are known as certificates of adjudication, permits, term permits, and temporary permits.

As discussed in Section 1.2, the Sabine Basin consists of the Upper Basin and the Lower Basin. The Upper Basin can be further divided into three distinct areas: a) the area between the headwaters of Toledo Bend Reservoir and Lake Fork and Iron Bridge Dams; b) the area upstream of Lake Fork Dam; and c) the area upstream of Iron Bridge Dam. (Iron Bridge Dam is located at Lake Tawakoni.) By far the greatest number of water rights within the Basin are located between Toledo Bend reservoir and Lake Fork and Iron Bridge Dams. There are 163 water rights located in this area totaling 178,140 acre-feet per year. In the Lower Basin, there are only 15 water rights, but they total almost 900,000 acre-feet per year. Most of the rights in the Lower Basin are currently being used for industrial and irrigation purposes because municipal water use in the area is generally from ground water sources. A summary of the water rights by area is presented in Table 1.2. Details of the individual water rights are included in Appendix B.

Table 1.2: Summary of Water Rights in the Sabine Basin

Area	No. of permits	Annual Permitted Use (ac-ft/yr)							
		Mun	Mun/Ind	Ind	Irr	Mining	Other	Total	Out of Basin Use[3]
Lower Basin[1]	15	101,460	100,400	600,235[2]	96,817	0	0	898,912	
Lake Fork & Iron Bridge to Toledo Bend	163	109,254	0	62,068	5,456	701	661	178,140	
Above Lake Fork Dam	13	169,160	0	19,500	506	0	0	189,166	120,000
Above Iron Bridge Dam	5	242,259	0	0	250	0	0	242,509	190,480
Total – Sabine Basin	**196**	**622,133**	**100,400**	**681,803**	**103,029**	**701**	**661**	**1,775,727**	**310,480**

1. There is one hydroelectric right, permitted at 21,000 cfs.
2. E.I. DuPont de Nemours Company's right for 267,000 AF/Y of brackish water is in the Lower Basin, but is not included in this total because the brackish water is not a useable source of supply.
3. Permitted to City of Dallas for Out of Basin Use.

Mun – Municipal Mun/Ind – Municipal/Industrial Ind – Industrial
Irr – Irrigation Other – Recreation or Miscellaneous

Review of the historical use of water rights in the Sabine Basin indicates there may potentially be water available from existing unused or underutilized rights. There is a significant amount of permitted surface water that is not currently being used in the Lower Basin. At this time there is no shortage in the Lower Basin that needs to be met by this permitted but unused water or by additional water via a new water right.

The area between the headwaters of Toledo Bend Reservoir and Lake Fork and Iron Bridge Dams is currently the largest demand center in the Basin. It includes the Longview/Marshall/Kilgore area. Based on historical use, there appears to be several large water rights in this area that are only being partially utilized. However, at this time, most of this water is being reserved for the future use of the right holders and will not be made available for other users.

The area upstream of Lake Fork and Iron Bridge Dams is an area of fairly significant demand, including the City of Greenville and a number of rural water supply corporations. The historical records show that the use from Lake Tawakoni is steadily increasing. Historical use from Lake Fork has been less than 10 percent of the permitted amount; but essentially the entire permitted amount has been contracted. SRA has a joint use permit for Lake Tawakoni and Lake Fork. This permit enables SRA to provide water to Lake Fork and Tawakoni customers from either lake, which provides flexibility and efficiency in operating the system. Most of the entities with contracts in the lakes have secured this water for future demands. There is some potential for a limited amount of water becoming available from the two lakes. This is discussed further in Section 3.2 of this report.

Another potential source of water lies in the Louisiana portion of the Sabine Basin. There are three categories of water rights in Louisiana: absolute ownership, riparian, and state ownership. Ground water is considered part of the land and is owned outright under the Doctrine of Absolute Ownership. Surface waters are in the public domain and are “owned” by the State except where riparian rights were established before 1910. The lack of clear delineation between the rights of the public, state, and landowners makes ownership of surface water a complicated issue. The overlapping nature of these rights continues due to lack of legislation and legal precedents regarding them.

Louisiana’s abundant supply of water has resulted in limited development of regulatory authority regarding surface water rights, sales or transfers. Water supply transfers between

Louisiana and other states are not excluded by State statute. Interstate transfers of Louisiana's waters may be possible through negotiated agreements with the state government. SRA Louisiana currently allows sales of its water interstate through Logansport, Louisiana to Joaquin, Texas. The location of Logansport is shown on Figure 1.2.

1.4 Mineral Resource Evaluation

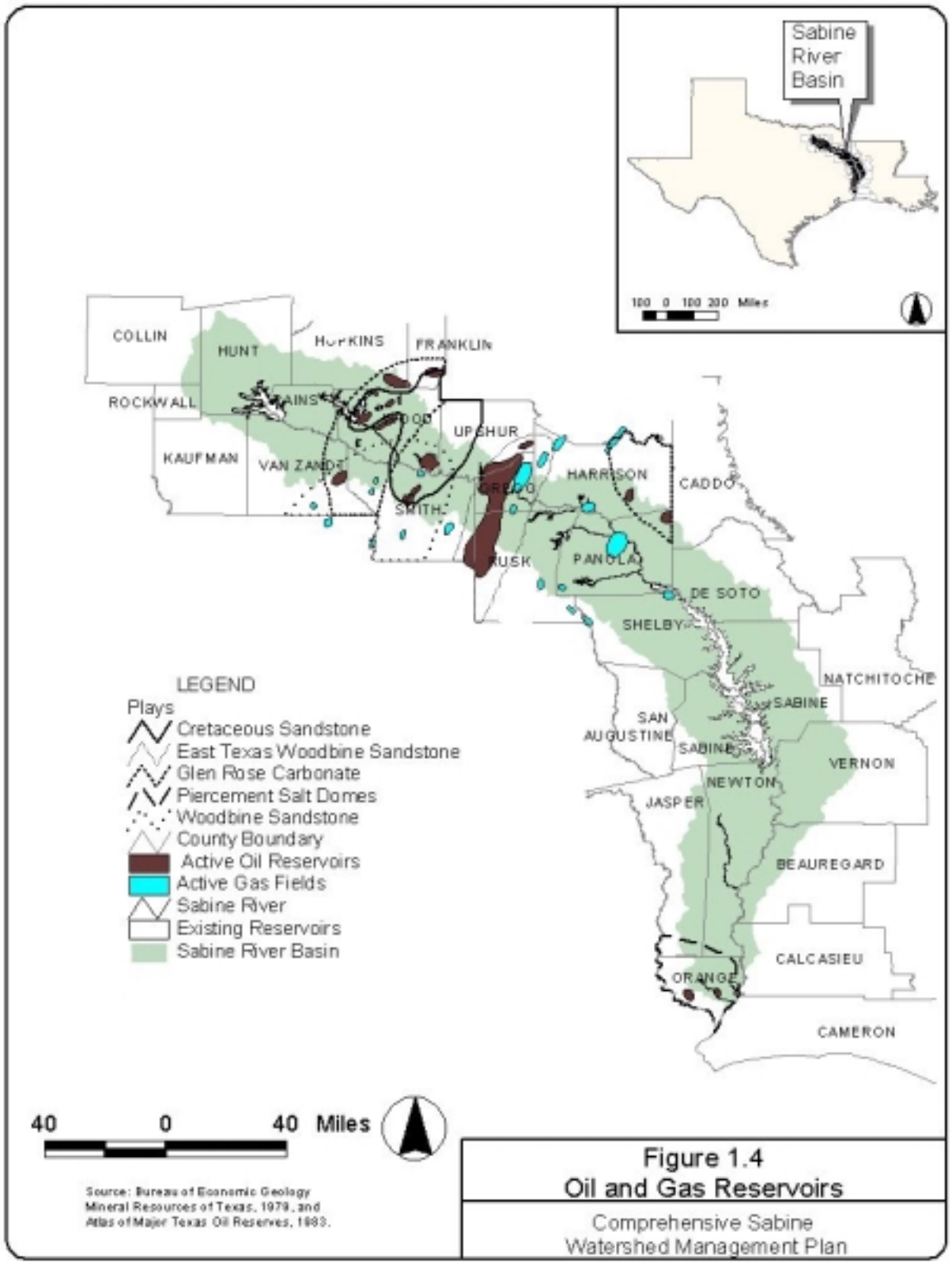
Mineral resources in the Sabine Basin include energy resources of oil, natural gas and lignite, and the industrial mineral resources of limestone, clay, sand and gravel, salt and sulfur. Historically, these resources have had an important role in the area's economy and growth. However, development of these resources also has the potential to impact future water supply projects and water quality within the Basin. An overview of the current mineral resource developments in the Sabine Basin was conducted to examine possible impacts and locations of on-going mining activities.

Oil and gas are a major energy resource in the Sabine Basin. Proven fields, such as East Texas Oilfield in Rusk and Gregg counties, continue to produce a large percentage of the Basin's total production. Overall, production in the Sabine Basin has declined over the past decade as prices of crude have fallen and proven reserves have been depleted. In 1997, there were ten of the 21 counties producing oil and gas, with the largest production in Gregg, Harrison, Rusk and Upshur counties. The generalized areas of reserves currently under development are shown on Figure 1.4.

The second major energy resource found in the Sabine Basin is lignite. Lignite, a low-grade coal, is present in both near-surface and deep-basin sediments. The near-surface deposits are most commonly developed due to more economical mining methods. There are five permitted lignite mines currently in operation in the Basin. The total 1996 production from these mines was 27.6 million tons, 51 percent of the state's total production. The locations of the active mines are shown on Figure 1.5.

Industrial minerals occurring in the Sabine Basin include limestone, clay, salt, sulfur, sand and gravel. These minerals are used as bulk products for construction materials, raw materials for ceramics, chemicals and fertilizers, refractors and specialty-grade rock and mineral products. As shown on Figure 1.6, there are significant deposits and active mining of these minerals throughout the Basin.

Consideration of mineral development should be given when planning the location of new water resource projects, such as reservoirs. Proper siting of water resource development projects reduces the risk of surface water contamination from contact with exposed minerals and mineral formations, and also reduces the cost of conflict mitigation. Potential impacts of mineral development on proposed reservoir sites are discussed in Section 7 of this report.



Source: Bureau of Economic Geology
Mineral Resources of Texas, 1979, and
Atlas of Major Texas Oil Reserves, 1983.

Figure 1.4
Oil and Gas Reservoirs

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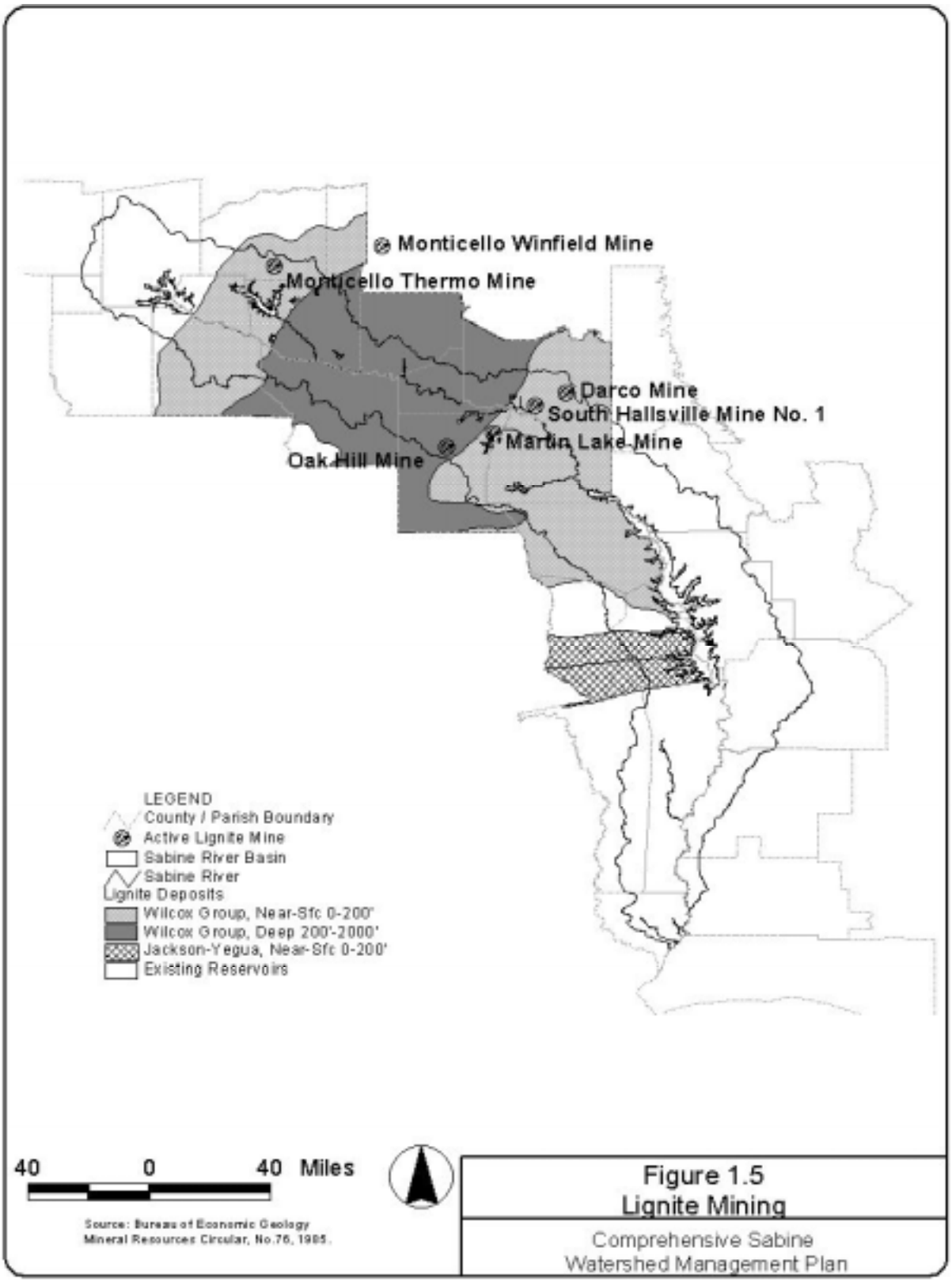

Figure 1.5
Lignite Mining

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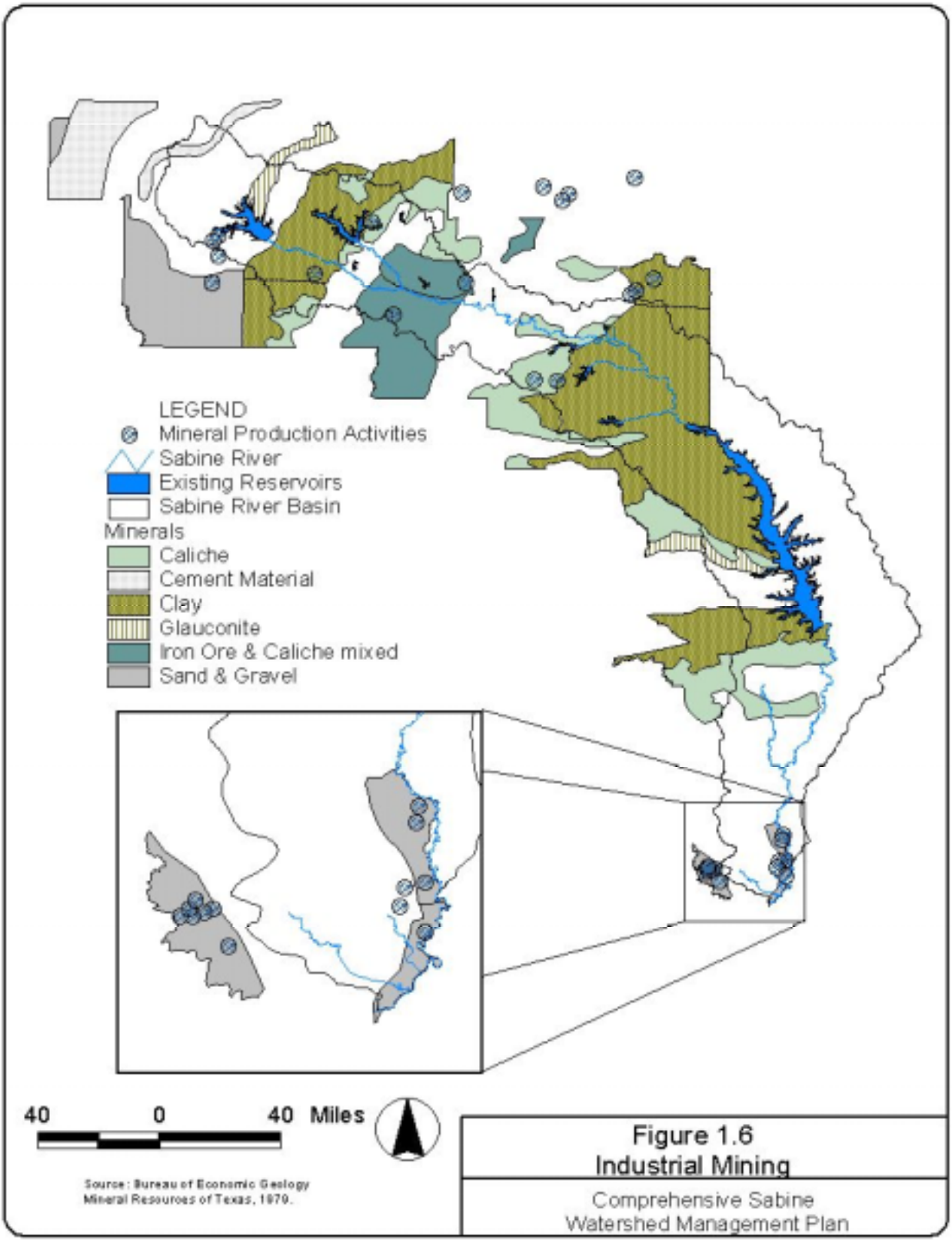

Figure 1.6
Industrial Mining

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