

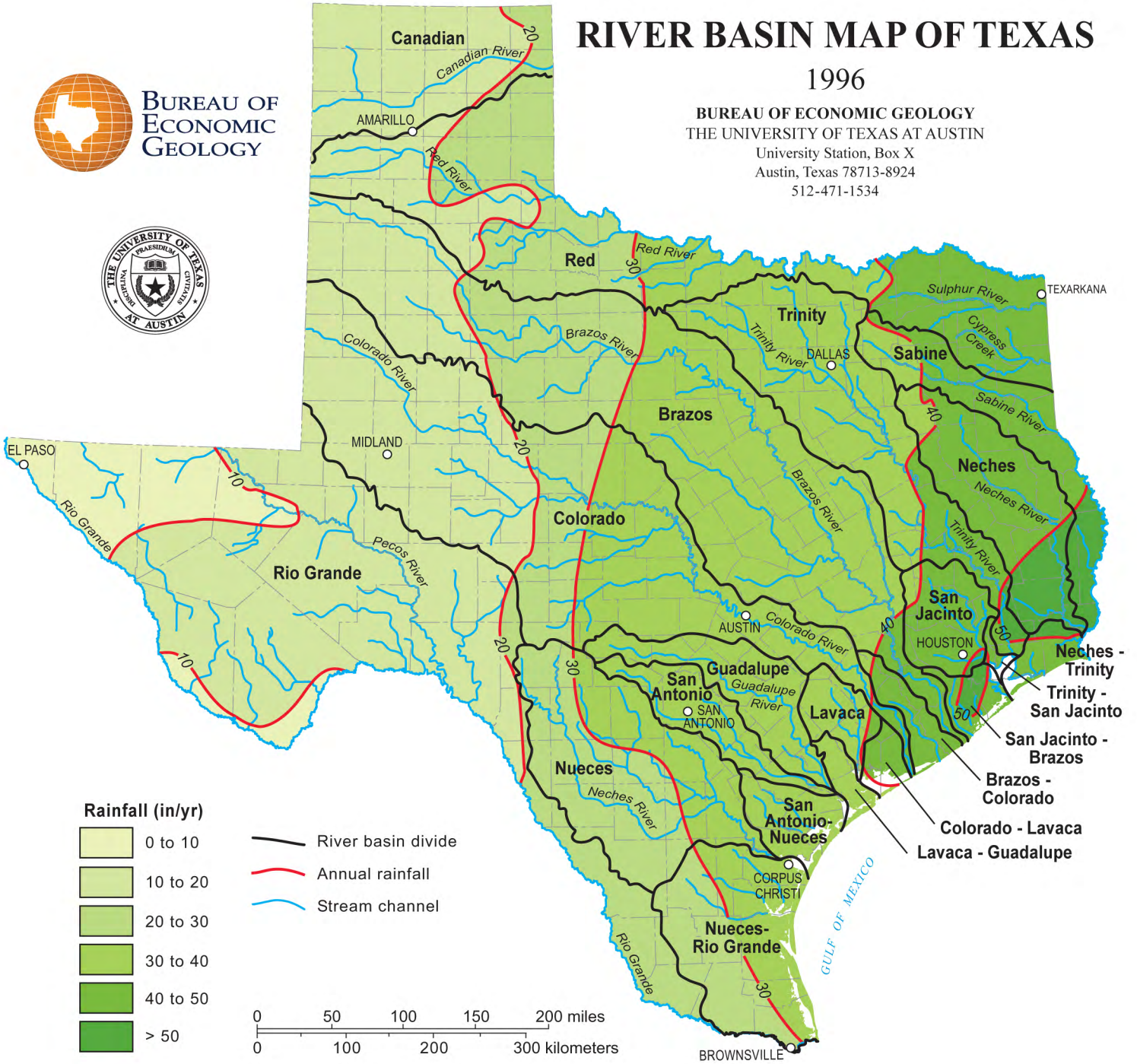
RIVER BASIN MAP OF TEXAS

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River basins	Texas length (miles)	Texas area (sq mi)	Number of major reservoirs*	Conservation storage (acre ft)*	Storage (acre ft/sq mi)
Brazos	840	42,800	19	3,322,880	75
Canadian	200	12,700	2	560,900	44
Colorado	600	39,893	11	3,803,900	95
Guadalupe	250	6,070	2	420,000	70
Lavaca	74	2,309	1	157,900	68
Neches	416	10,011	4	3,455,500	345
Nueces	315	16,950	2	931,640	60
Red	680	30,823	7	4,593,460	149
Rio Grande	1,250	48,259	3	3,772,000	78
Sabine	360	7,426	2	6,041,300	814
San Jacinto	70	5,600	2	570,400	102
Trinity	550	17,696	14	6,969,710	388

*Data from Texas Water Development Board.

River Basins of Texas

In river basins of Texas, streams transport a precious resource—surface waters. They contain the essential nutrients for maintaining life in plants, animals, and people. They are the feedstock of nature—forests, prairies, meadows, swamps, and marshes, as well as pastures and croplands. All the products that build our communities—concrete, bitumen, bricks, wood, paper, and plastics—require their waters.

A river basin is the entire area drained by a stream and its tributaries. The highest land surrounds the river basin, forming its outside boundary as well as dividing it from adjacent basins. From this boundary, or divide, all water falling into the basin flows downhill to a pour point. At the pour point, small stream basins spill into larger stream or river basins.

The 13 major river basins of Texas vary greatly in size, shape, and stream patterns. Although the river basins share many common features, each is unique. River basins reflect the climate, geology, topography, and vegetation of an area.

Five Texas river basins originate outside Texas. Two begin in Colorado: the Rio Grande in the San Juan Mountains at about 14,000 feet and the Canadian River in Raton Pass at nearly 8,500 feet. Three rivers commence in New Mexico: the Red River as Blanca Creek at 4,640 feet, the Brazos River in Running Water Draw at about the same elevation, and the Colorado River in Sulfur Draw at about 4,000 feet. The eight other Texas river basins originate within Texas.

The Canadian and the Red Rivers have their outlets, or pour points, beyond Texas. Our remaining 11 river basins spill into the Gulf of Mexico. Only the Rio Grande and the Brazos River discharge directly into the Gulf of Mexico, where they built substantial deltas in the recent past. On the *River Basin Map of Texas*, the remains of their deltas make the shoreline bulge into the Gulf.

The remaining river basins spill into estuaries and bays along the coast. The Sabine and Nueces Rivers flow into Sabine Lake and were formerly joined as one river basin. Similarly, the Trinity and San Jacinto Rivers drain into the connected Galveston and Trinity Bays. The Colorado River, which formerly combined with the Brazos River in delta building, now flows into Matagorda Bay. The Lavaca River empties into Lavaca Bay, the Guadalupe and San Antonio together build a delta into San Antonio Bay, and the Nueces River discharges into Corpus Christi Bay. Marshes, seagrasses, shrimp, fish, and bottom fauna such as oysters require the nourishment provided by nutrients contained

in the inflow of fresh water and sediments from these rivers.

As shown on the table below the map, Texas river basins vary greatly in area and length. The largest, the Rio Grande, contrasts markedly with the smallest, the San Jacinto River, in both size and length. The Red, Colorado, and Brazos Rivers have similar areas, but the Brazos River is 25 percent longer than the other two. Most of the river basins have elongated shapes. Only the Nueces, Lavaca, and San Jacinto Rivers round into teardrop shapes.

Poorly drained coastal basins are situated between many of the large river basins. Coastal basins along the Gulf of Mexico contain only small streams, commonly named “bayous,” east of the Brazos River. Their small discharges into the bays are estimated, and these basins lack instruments to measure stream flow.

Climate, especially rainfall and evaporation, strongly controls the flows of rivers and streams in Texas. In the Sabine River basin, mean annual rainfall is nearly 60 inches and annual evaporation is less than 70 inches, whereas in the Rio Grande basin, mean annual rainfall ranges from 8 to 20 inches and annual evaporation is as much as 105 inches. Therefore, East Texas streams flow year round, but most West Texas streams flow only part of the year or intermittently.

East of the Trinity and south of the Red Rivers, river basins generally contain dark and murky streams because of high organic content. West of Austin, principal streams in river basins run clear when not in flood. In East Texas, the flow in basins, which is the volume of water flowing past a point per unit of time, remains relatively constant. In west and north Texas, flow changes rapidly from none or dry to flood stage following storms; consequently these intermittent streams are called “flashy.”

We take advantage of the climatic effects on basin streams in selecting where we build reservoirs, as shown in the table on the *River Basin Map of Texas*. The largest reservoir is Toledo Bend in the Sabine River Basin, which has a storage capacity of 4,472,900 acre-feet. One acre-foot is the amount of water it takes to cover 1 acre of land 1 foot deep. The smallest reservoir, which is far to the west, is the Mackenzie Reservoir of the Red River, holding 46,250 acre-feet.

River basins strongly reflect their geology. For example, in wetter East Texas where uncemented sands and muds dominate the terrain, river valleys are wider and contain broadly meandering streams carrying abundant suspended brown mud. Meanders are the large snakelike bends that migrate back and forth

across the floodplain over time. Eastern stream bars are composed of fine sands, silts, and clays. East Texas rivers have gentle mean gradients of 1.4 to 2.3 feet per mile; the gradient is the slope of the stream bed from its high point of origin to its final pour point.

In contrast, far West Texas streams cut deep gorges with nearly vertical canyon walls into hard limestones and sandstones. These stream courses are incised and normally flow quite clear. Western stream bars have larger proportions of gravel and coarse sand components. Western rivers have steeper mean gradients of 7.3 to 12.5 feet per mile.

Bedrocks, the sources of sediments transported by streams, contribute to the stream character. The Red River gets its name from the red sediment it erodes from red Permian strata. These same Permian strata contain thick salt beds that dissolve into waters of the Canadian and upper Brazos Rivers, making them too salty to drink. Black rocks that come from volcanic lavas are especially common in the Rio Grande gravels. These gravels also contain many rock types transported from New Mexico, like granites.

In terrains where river basins cross adjacent hard and soft rocks, stream patterns and gradients reflect the differences in erosion resistance. Waterfalls commonly increase flow rates, dropping over hard resistant rocks onto soft rocks. Pedernales Falls State Park contains a good example. In gently sloping hard and soft rock formations, streams flow in valleys preferentially eroded into soft rocks; they rarely erode through the harder rocks.

Geologic structures commonly control the directions, patterns, and local gradients of streams. Streams typically occupy areas of easily eroded, highly fractured bedrocks. Fault- and fracture-controlled drainage is common throughout the state. River basins commonly align parallel to faults and fractures and then abruptly bend at high angles, forming kinks controlled by intersections of structures. In East Texas, salt domes near the land surface cause streams to curve around them.

No Texas river basin is in a natural state along its entire length. All are somewhere impacted by humans and have dams, levees or engineered channels, and wastewater treatment plants. Texas rivers quench our thirst, carve a magnificent scenery, provide recreation, create habitats for wildlife, and supply water for agriculture and industry. As the population of Texas increases, we must continue to guard the availability and quality of these assets and wisely allocate our water resources.

—Text by E. G. Wermund

Bureau of Economic Geology

The **Bureau of Economic Geology**, established in 1909, is the oldest research unit at The University of Texas at Austin. The Bureau functions as the state geological survey of Texas, and Director Scott W. Tinker is the State Geologist. The Bureau conducts basic and applied research programs in energy resources and economics, coastal and environmental studies, land resources and use, geologic and mineral mapping, hydrogeology, geochemistry, and subsurface nanotechnology.