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2.4.9 **Channel Diversions**

The following site-specific information evaluates potential impacts of channel diversions on the power block at the VCS site and the safety-related water supply to the station.

The VCS site is located in the Lower Guadalupe River Basin, approximately 4 miles (6.4 kilometers) west of the Guadalupe River and about 5 miles (8 kilometers) north of the San Antonio River. The natural ground at the site varies in elevation from approximately 60 feet (18.3 meters) to above 80 feet (24.4 meters) in North American Vertical Datum of 1988 (NAVD 88). The minimum finished site grade of the power block is elevation 95 feet (29.0 meters) NAVD 88. As the site is situated in relatively high ground and far away from the two main river corridors in the region, channel diversions, if they occur, are not expected to pose any flooding hazards to the power block structures, systems and components (SSCs) at VCS as described in the following subsections. In addition, the safety-related water supply of VCS does not rely on the continuous availability of river flows. Therefore, in the unlikely event that channel diversions occur and interrupt the nonsafety normal cooling water supply to the plant, the safety functions of VCS will not be affected.

2.4.9.1 **Historical Channel Diversions**

The VCS site lies within the Gulf Coastal Plain physiographic province that extends from the Balcones Escarpment in the north to the Gulf of Mexico in the south (Reference 2.4.9-7), as shown in Figure 2.4.9-1. The surrounding topography consists of relatively flat, gently undulating ranch land dissected by well-defined streams (see Figures 2.4.1-2 and 2.4.1-9). The site area has a natural relief of about 40 to over 60 feet (12.2 to 18.3 meters) above the floodplains. The general terrain in the site area slopes down sharply towards the western edge of the Guadalupe River floodplain. Along the eastern/northern edge of the San Antonio River floodplain, a similar steep slope exists. Because the VCS site is further away from the San Antonio River corridor, the following discussion focuses on the Guadalupe River, which is closer to the VCS site, is the larger river with a bigger drainage area and, therefore, exhibits a higher hypothetical risk of affecting the safety and operation of the plant.

Near the site, the Guadalupe River is approximately 160 feet (48.8 meters) wide with an incised valley width of nearly 4 miles (6.4 kilometers). The floodplains extend on both sides of the river and are separated by low natural levees on the riverbanks. The Victoria Barge Canal, which provides navigation from the San Antonio Bay to Victoria, Texas, and connects to the Gulf Intracoastal Waterway, is located within the floodplain east of the river. The present-day Guadalupe and San Antonio Rivers near the VCS site are shown in Figure 2.4.9-2.

The Guadalupe River planform and floodplain topography near the VCS site are examined from the U.S. Geological Survey (USGS) topographic maps (References 2.4.9-13, 2.4.9-14, 2.4.9-15, 2.4.9-16). The meandering river planform, along with meander cutoffs, abandoned meander channels, and oxbows, provides evidence of channel adjustments within the floodplain and warrants further examination of channel migration within the meander-belt of the river.

The lower reach of the river downstream from the site has a very mild slope with the sinuosity of the river decreasing in the downstream direction, as discussed in Subsection 2.4.9.2. The Guadalupe-Blanco River Authority (GBRA) diverts flow from the Guadalupe River upstream of the Saltwater Barrier and Diversion Dam near Tivoli, Texas to the GBRA Diversion Canal. The main course of the river downstream of the Saltwater Barrier and Diversion Dam empties into the Guadalupe-San Antonio Bay system. A comparison of the U.S. Geological Survey topographic map with the historical river planform (Reference 2.4.9-10) in the lower reach downstream of the flow diversion structure shows that the river planform has remained nearly unchanged over the past 160 years. A portion of the Mitchell Map showing the Guadalupe River mouth is presented in Figure 2.4.9-3. At the river mouth and the head waters of the San Antonio Bay and Guadalupe Estuary, the Guadalupe River forms a prograding 'thin-delta' that shows the stages of delta-lobe construction, abandonment, and subsidence. White and Calnan (Reference 2.4.9-18) hypothesized that this delta progression has been continuing over approximately the last 2000 years. An extensive literature search did not indicate any avulsion of the river away from its present course within this period.

2.4.9.2 **Regional Topographic Evidence**

The Guadalupe River originates in Kerr County, Texas within the Edwards Plateau physiographic province north of the Ouachita Structural Front in the Llano Uplift (detailed description on regional geology is provided in Subsection 2.5.1). The river crosses the Balcones Escarpment, which separates the Edwards Plateau from the Texas Gulf Coastal Plain physiographic province, and flows southeast to the Guadalupe-San Antonio Bay. The gradient of the Guadalupe River is affected by the uplift along the San Marcos Arch and has a steeper slope compared to the rivers in the Houston Embayment (the Neches, Trinity, and Brazos Rivers) and the Rio Grande Embayment (the Nueces and Rio Grande Rivers) in the Texas Coast, as shown in Figure 2.4.9-4 (Reference 2.4.9-18). The upper reach of the river is characterized as an incised bedrock river with discontinued alluvial fills. At the Balcones Escarpment, it forms deep-incised valleys with steeper slopes. In the lower reach, the river has wide floodplains and meandering planform.

The morphodynamic characteristics of the rivers in the Texas Gulf Coastal Plain province are strongly influenced by drainage basin size, sediment load, and the long-term sea level change (References 2.4.9-1 and 2.4.9-18). During the period of the last major glaciation ending in Late Pleistocene (Wisconsin glaciation), approximately 18,000 years ago, sea level in the Texas Coast was approximately 400 feet (120 meters) below today's level, with the shoreline located between 50 and 140 miles (80 and 220 kilometers) further off the present shore. During the lowstand period, the rivers formed deep incised valleys. As the sea level started to rise, the rivers adjusted to the changing gradient and the valleys were filled with alluvial sediments (Reference 2.4.9-18). Extrabasinal rivers, such as the Colorado, Brazos, and Rio Grande, that drain the tectonic hinterlands and are affected by regional climate beyond the basin, have large sediment supplies and construct laterally extensive deltaic-alluvial plains. Due to large sediment loads, floodplain aggradation and valley fills in these rivers have kept pace with the Holocene sea level rise. In contrast to the extrabasinal rivers, basin-fringe rivers, such as the Trinity, Guadalupe, and Nueces, that drain the coastal plain, have smaller sediment load discharging into estuaries, and are presently constructing small bay-head deltas. Sediment accommodation space is abundant in these river valleys, suggesting early stages of valley filling (Reference 2.4.9-1).

The sediment transport rate in the Guadalupe River is among the lowest of the rivers in the Gulf Coastal Plain physiographic province (Reference 2.4.9-18). Aslan and Blum (Reference 2.4.9-1) hypothesized that avulsion of such rivers occurs by reoccupation of Late Pleistocene falling-stage and lowstand channel courses that are buried by a thin veneer of Holocene sediments; however, an extensive literature search did not return any evidence of such avulsions in the Guadalupe River. As discussed in Subsection 2.5.1, the VCS site region is located on the outcrop of the mid-Pleistocene Beaumont Formation. The Late Pleistocene Beaumont Clay extends to the east of the Guadalupe River. The river valley having valley fills of Holocene and Modern origin demarcates the extent of the present day river meander-belt. Therefore, it is unlikely that any avulsion of the Guadalupe River would take place that could affect the power block of the VCS.

Strike-oriented growth faults are found in the Gulf Coastal Plain physiographic province that occur parallel to the coastline (Reference 2.4.9-9). Activities in these non-tectonic fault zones are not seismogenic and are estimated to have displacement rates of 0.2 to 0.8 inches (5.1 to 20.3 millimeters) per year (Reference 2.4.9-9). These growth faults have throws that increase with depth and strata that are thicker on the downthrown side than on the upthrown side (Reference 2.4.9-9). A detailed discussion on the growth faults is presented in Subsection 2.5.1. The growth fault that is closest to the VCS site is the Vicksburg fault zone (also known as the Sam Fordyce fault zone), which is located south of the VCS site and is approximately 18 miles (28.8 kilometers) along the valley from the river mouth (Reference 2.4.9-12). Response of the Guadalupe River to the development of the fault zone is summarized by Schumm et al. (Reference 2.4.9-12). The downstream fault block is subsiding and moving southeast towards the coast. Because of the movement, the upstream river profile shows a steeper slope compared to that of the downstream reach. The upstream cross sections are wider and deeper than the downstream cross sections (Reference 2.4.9-12). In addition, Schumm et al. (Reference 2.4.9-12) indicated higher sinuosity of the river upstream of the fault zone while the sinuosity decreases downstream of the fault zone. A similar change of geomorphic properties in rivers is also characterized in Holbrook and Schumm (Reference 2.4.9-6).

VCS does not rely on the Guadalupe River for safety-related water supply. The raw water makeup system intake canal and pumphouse for the VCS, located on the Guadalupe River (as shown in Figure 2.4.1-10), are nonsafety-related facilities providing makeup water to the normal plant heat sink. The raw water makeup system canal inlet is located just upstream of the saltwater barrier near Tivoli, Texas and downstream of the Vicksburg fault zone. The smaller river gradient and lower sinuosity of the river downstream of the fault zone result in more stable river planform and geometry compared to those from the reach upstream of the fault.

2.4.9.3 **Ice Causes**

There is no historical evidence of an ice jam event in the Guadalupe River, as discussed in Subsection 2.4.7. Therefore, channel diversion due to ice causes is not considered to be a credible event.

2.4.9.4 **Flooding of Site Due to Channel Diversion**

The VCS site is located approximately 4 miles (6.4 kilometers) west of the Guadalupe River in the Pleistocene Beaumont formation. The minimum finished site grade at the power block is 95 feet (29.0 meters) NAVD 88, and the topographic relief is over 70 feet (21.3 meters) above the Guadalupe River floodplain, as shown in Figure 2.4.9-2. As discussed in Subsection 2.4.9.5, water levels within the Guadalupe River near the site due to postulated extreme flood events remain within the river valley. Consequently, for the site to be flooded as a result of channel diversions, the river corridor would have to meander approximately 4 miles away from its present course into the valley wall. Such erosion would be gradual and unlikely to affect plant operation because appropriate remedial measures against erosion would be taken as they occur. It is therefore unlikely that the VCS site would be flooded by the diversion of the Guadalupe River or other rivers in the area.

2.4.9.5 **Human-Induced Causes of Channel Diversion**

Over the years, several water control structures have been constructed on the Guadalupe River, as presented in Subsection 2.4.1. Most of the structures are run-of-river dams with minor storage capacities with the exception of the Canyon Dam, which has substantial storage capacity (Table 2.4.1-1). However, because the Canyon Dam is located in the upper reach of the river within the Edwards Plateau physiographic province and cannot provide flood control when intense rainfall occurs in the downstream basin, such an event could produce severe flooding in the lower reach of the river. Locations of all major dams on the Guadalupe River are shown on Figure 2.4.4-1. The flood of record of the Guadalupe River at Victoria, Texas, approximately 13 miles (20.8 kilometers) north of the VCS site, was due to the October 1998 flood that occurred after the construction of the dam (Reference 2.4.9-17).

Construction of dams in a river intercepts nearly all but the very fine sediments. The Canyon Dam, along with other low dams downstream, would contribute to sediment deposition upstream of the dams. Low sediment concentration combined with very high flood peaks may considerably alter river geometry and change the flow regime downstream of the river control structures. Subsections 2.4.3 and 2.4.4 show that the flood level due to the probable maximum flood at the VCS site and postulated upstream dam failure, respectively, would be contained within the river valley near the site. As a result, channel adjustments due to these extreme flood events would likely remain within the floodplain valley width. Consequently, flooding of the power block at the VCS site because of channel diversion due to extreme flood events is precluded.

Occasional logjams on the Guadalupe River are observed at the saltwater barrier near Tivoli, Texas. However, the GBRA established procedures to remove any logjams in the area, such that flooding of the area is minimized (Reference 2.4.9-4), thereby reducing the possibility of logjam-induced channel migration.

Sand and gravel mining are reported within Guadalupe, Gonzales, and Victoria counties (Reference 2.4.9-5). Although, information on its location and extent was not documented, the Guadalupe River valley could be a source of such mining activities. Studies on gravel mining in the Colorado River basin indicated that artificial meander cutoff and localized bank erosion occur as a result of extensive gravel mining from the floodplain (Reference 2.4.9-11). Similar impacts would be expected on the Guadalupe River even though they have not been documented. These impacts would be localized and can be controlled with operational and engineering mitigations. Consequently, channel diversion due to sand and gravel mining effects are not considered to be a flood risk that will impact the safety function of the VCS site.

The Texas coastal region is identified for possible geopressured geothermal sources (Reference 2.4.9-3). Geopressured geothermal sources occur where deeply buried fluids (brines) and dissolved methane contained in permeable sedimentary rocks are warmed due to the burial depth (Reference 2.4.9-8). The thermal fluid and natural gas are trapped between layers of impermeable sedimentary formation and bear pressure much greater than hydrostatic. Past investigations and demonstration efforts in the 1970s to 1990s to capture this energy resource had not proven to be economically viable due to the relatively low cost of fossil fuel. With the recent growing world energy demand and rising cost of fossil fuel, the commercial potential of the geopressured geothermal aquifers as an alternative energy source are being reevaluated in conjunction with advances in emerging geothermal technology. Land surface subsidence, fault activation and/or reactivation, and freshwater aquifer contamination were identified as potential risks associated with this type of energy production. These risks are well understood in Texas due to the long history of oil and gas extraction activities in the state. Land movements, in particular, could be managed through microseismic monitoring and benchmark surveying, and controlled under new federal and state regulations if geopressured geothermal-based commercial power generation becomes a reality in the future. No impact to the safety of VCS is currently anticipated as a result of these aquifers and future production activities associated with these aquifers.

2.4.9.6 Alternate Water Sources

The only water supply for VCS from the Guadalupe River is for the nonsafety-related makeup to the cooling basin, as described in Subsection 2.4.1. The cooling basin primarily provides the heat dissipation function for the nonsafety-related, closed-cycle circulating water system.

The above review of the potential channel diversion in the lower reaches of the Guadalupe River indicates that while there are potentials of channel migrations of the Guadalupe River, such diversion would likely result from river meander development and would remain within the extent of the valley. Moreover, any natural diversion of the rivers would come from gradual changes, which can be remedied as they occur. In the unlikely event that the river course was suddenly diverted from its present location, cutting off the river water supply to the VCS, the plant could be safely shutdown using the onsite inventory of storage water.

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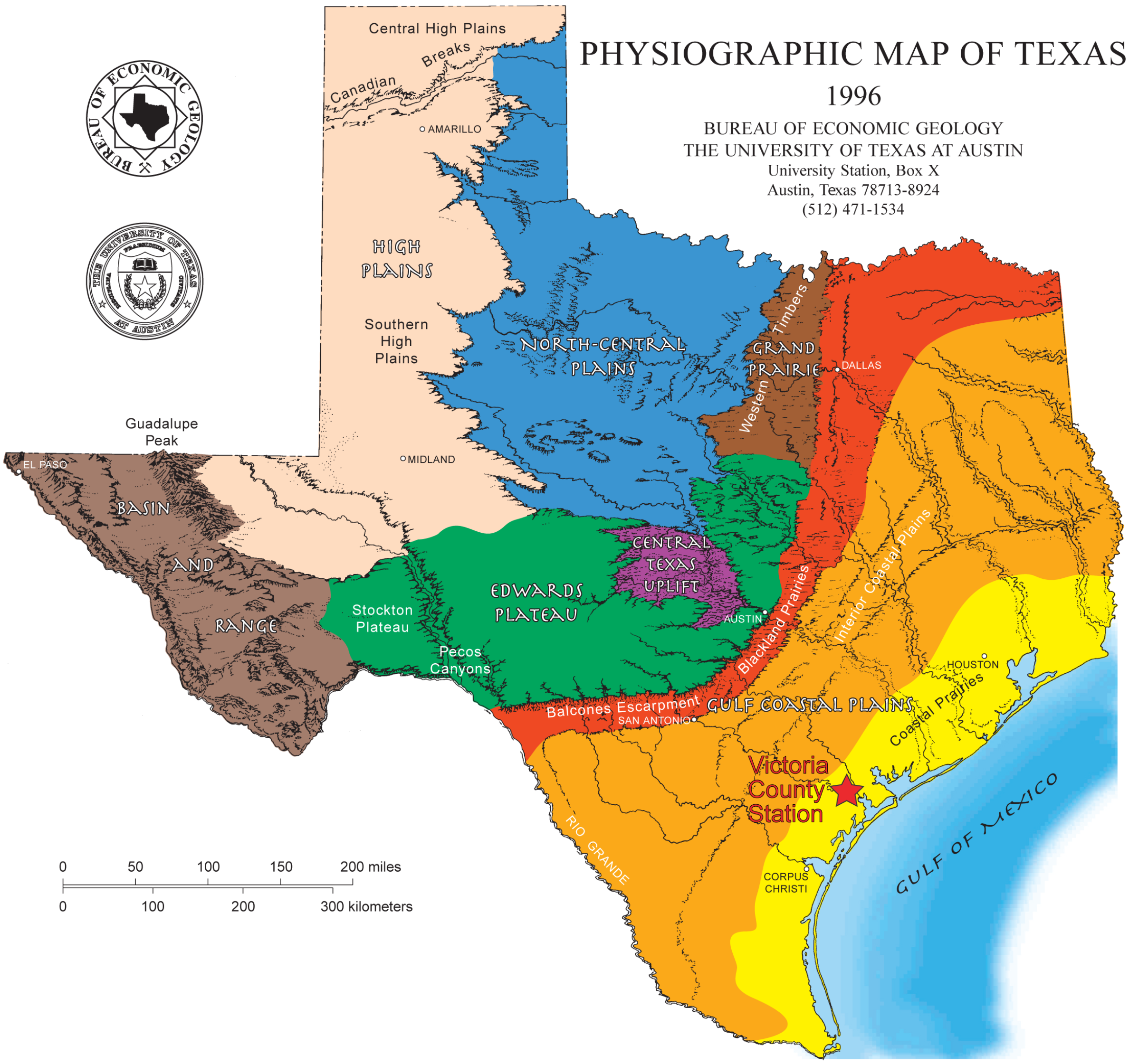


PROVINCE	MAX. ELEV. (ft)	MIN. ELEV. (ft)	TOPOGRAPHY	GEOLOGIC STRUCTURE	BEDROCK TYPES
Gulf Coastal Plains					
Coastal Prairies	300	0	Nearly flat prairie, <1 ft/mi to Gulf	Nearly flat strata	Deltaic sands and muds
Interior Coastal Plains	800	300	Parallel ridges (questas) and valleys	Beds tilted toward Gulf	Unconsolidated sands and muds
Blackland Prairies	1000	450	Low rolling terrain	Beds tilted south and east	Chalks and marls
Grand Prairie	1250	450	Low stairstep hills west; plains east	Strata dip east	Calcareous east; sandy west
Edwards Plateau					
Principal	3000	450	Flat upper surface with box canyons	Beds dip south; normal faulted	Limestones and dolomites
Pecos Canyons	2000	1200	Steep-walled canyons		Limestones and dolomites
Stockton Plateau	4200	1700	Mesa-formed terrain; highs to west	Unfaulted, near-horizontal beds	Carbonates and alluvial sediments
Central Texas Uplift	2000	800	Knobby plain; surrounded by questas	Centripetal dips, strongly faulted	Granites; metamorphics; sediments
North-Central Plains	3000	900	Low north-south ridges (questas)	West dip; minor faults	Limestones; sandstones; shales
High Plains					
Central	4750	2900	Flat prairies slope east and south	Slight dips east and south	Eolian silts and fine sands
Canadian Breaks	3800	2350	Highly dissected; local solution valleys		
Southern	3800	2200	Flat; many playas; local dune fields		
Basin and Range	8750	1700	North-south mountains and basins	Some complex folding and faulting	Igneous; metamorphics; sediments

Figure 2.4.9-1 Physiographic Map of Texas and the VCS Site Location (Modified from Reference 2.4.9-2)

Figure 2.4.9-2 The Guadalupe and San Antonio Rivers Near the VCS Site

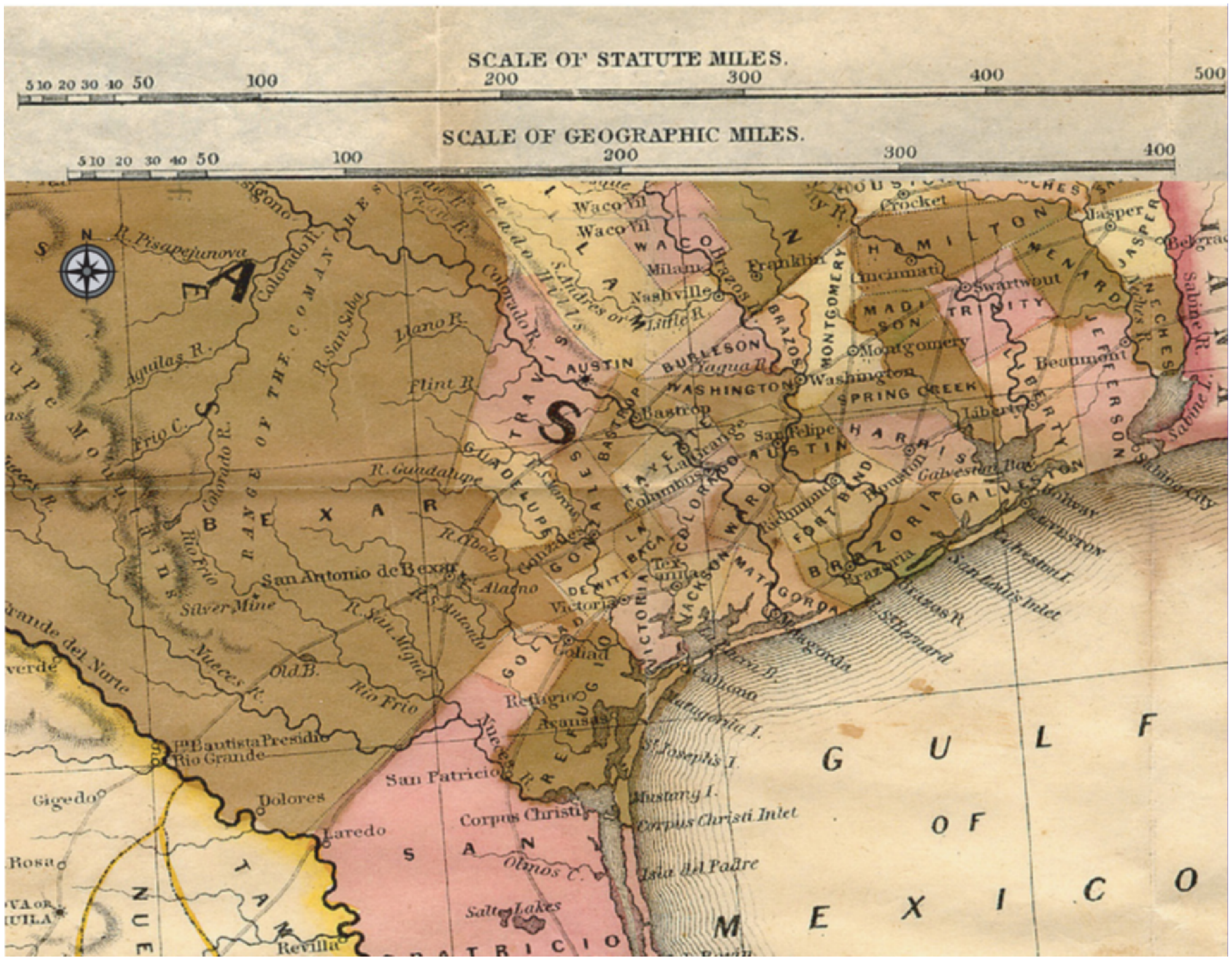
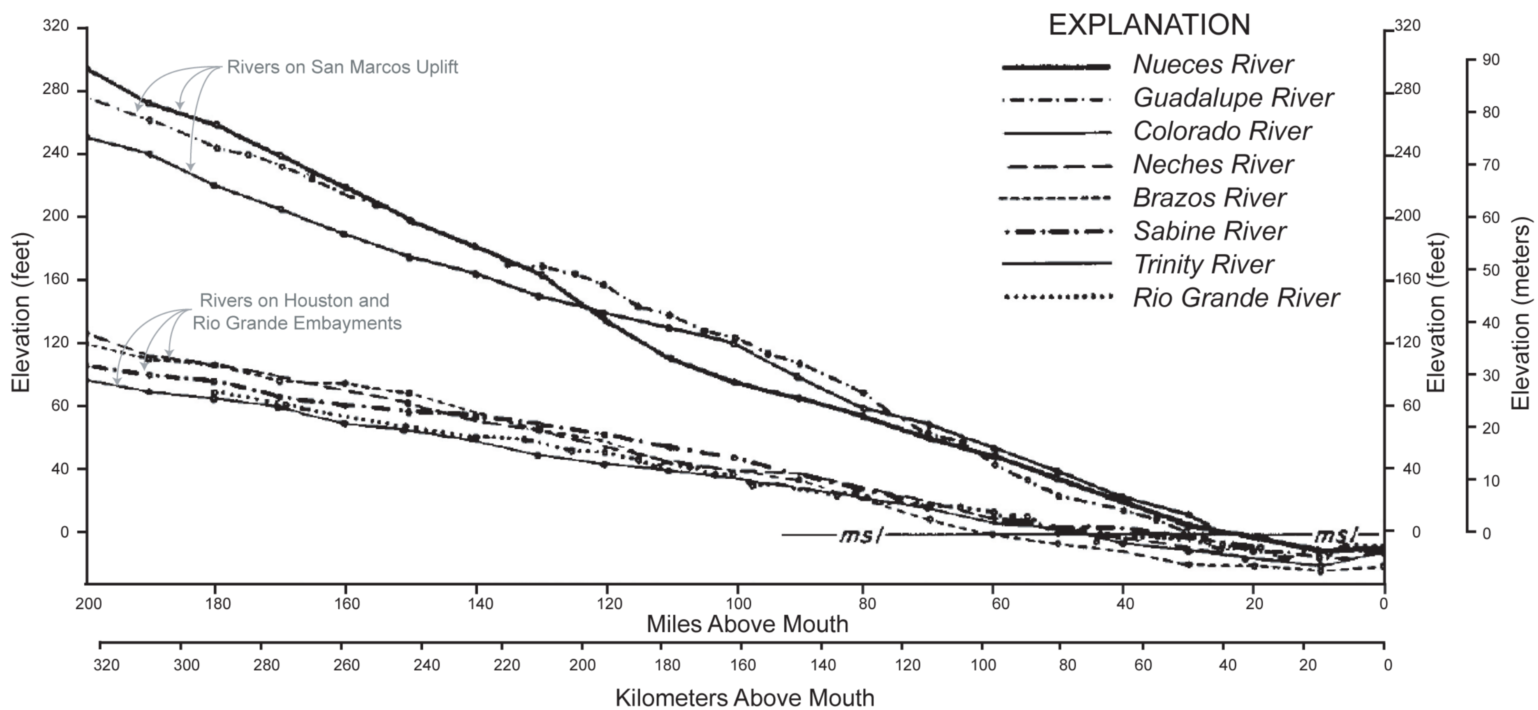


Figure 2.4.9-3 Portion of Mitchell Map Showing the Guadalupe River and Texas Gulf Coast (Modified from Reference 2.4.9-10)



Note: The MSL is the same as the National Geodetic Vertical Datum of 1929

Figure 2.4.9-4 Longitudinal Channel Profiles of the Guadalupe and Other Major Texas Rivers (Modified from Reference 2.4.9-18)