7.0 Geology of the Trinity Group: Cypress Creek Study

7.1 Geologic Setting

The Trinity Group in western Hays County is Lower Cretaceous in age, extending from the Neocomian to the Albo-Aptian. The geologic section consists of the wedge-edge of a shallow-water, carbonate shelf which onlapped the thrusted Paleozoic rocks of the buried Ouachita Mountains. The Llano Uplift and highlands to the west and northwest were the provenance for a coarse-clastic sedimentary base (Sycamore/Hosston) that shoals upwards in a series of carbonate-dominated sequences. Tectonic movement during Early Miocene time resulted in a series of northeast-southwest striking, en-echelon, normal faults that cut the Lower Cretaceous sedimentary rocks and dropped the section by as much as 1,200 feet to the south-southeast (Balcones Fault Zone).

The purpose of the geology section of this report is to provide a geologic framework for analyzing the hydrogeology of the Cypress Creek Basin (Figure 12). For a complete and detailed study of the lithostratigraphy and sequence stratigraphy of the Trinity, the reader is directed to publications by David Amesbury, 1974; Lozo, Smith and Strickland, 1956; and Bob Perkins, 1974. Recent work by R. Scott, 2007 and Bill Ward, 2007 cover the detailed lithology, sequence stratigraphy and paleontology of the Glen Rose Formation. Other major reports used in the HTGCD analysis are listed in the bibliography.

7.2 Lithostratigraphy

The Trinity Group is approximately 1000 feet thick in the project area and rests unconformably over the Paleozoic thrusted fold belt. The section onlaps the Llano Uplift to the west-northwest and thickens to the southeast towards the Lower Cretaceous shelf margin. The Trinity is divided into three hydrogeologic units: The Upper Trinity, the Middle Trinity and the Lower Trinity. The primary aquifers in the project area are the Middle Trinity—including the Lower Glen Rose and Cow Creek formations, and the Lower Trinity—including the Sligo and Hosston formations. The general stratigraphy is shown on Figure 14.

7.3 Lower Trinity (300 feet thick)

7.3.1 Sycamore/Hosston Formation

The coarse clastic Sycamore Formation outcrops in Blanco County and the northwest corner of Hays County. The Sycamore represents those sedimentary rocks equivalent to the subsurface Hosston Formation. The basal conglomerates and sands are fluvial, representing early Cretaceous erosion of the Llano highlands. Geophysical logs and cuttings samples of the Hosston in western Hays County are interpreted as stacked fluvial channel sands, shoreline sandstones and siltstones with silty shale overbank deposits.

The Hosston is 95 feet thick at the Brushy Top No. 3 well drilled along Highway 281 in Blanco County, approximately 5 miles west northwest of the study area. The formation is water-bearing at that location and rests unconformably over Paleozoic shale. At Willis No.1, drilled on the bank of Dry Cypress Creek in Hays County, the Hosston is 170 feet thick. The formation produces water from a basal conglomerate and sand unit that sits directly on the Paleozoic. Most Hosston water wells are partial penetrations with total depth some distance above the Paleozoic section. Further southeast along the Dry Cypress Creek, Dry Cypress/Byrum No. 1 well penetrated 65 feet of Hosston Formation. At the base is a siltstone, pale red-brown, mottled yellow-gray, hard with fine fractures; this unit is overlain by a very fine grained sandstone with rare pebbles, quartz grains and dolomite clasts; sandstone, dolomitic, very fine grained, quartz grains, tite, very light gray-green with dolomite nodules. Near the top of the unit is 18 feet of water bearing sandstone, fine-grained, silty, quartz grains, pale yellow-brown, with limestone clasts. The unit coarsens upwards to grit with very coarse angular quartz grains and sandstone.

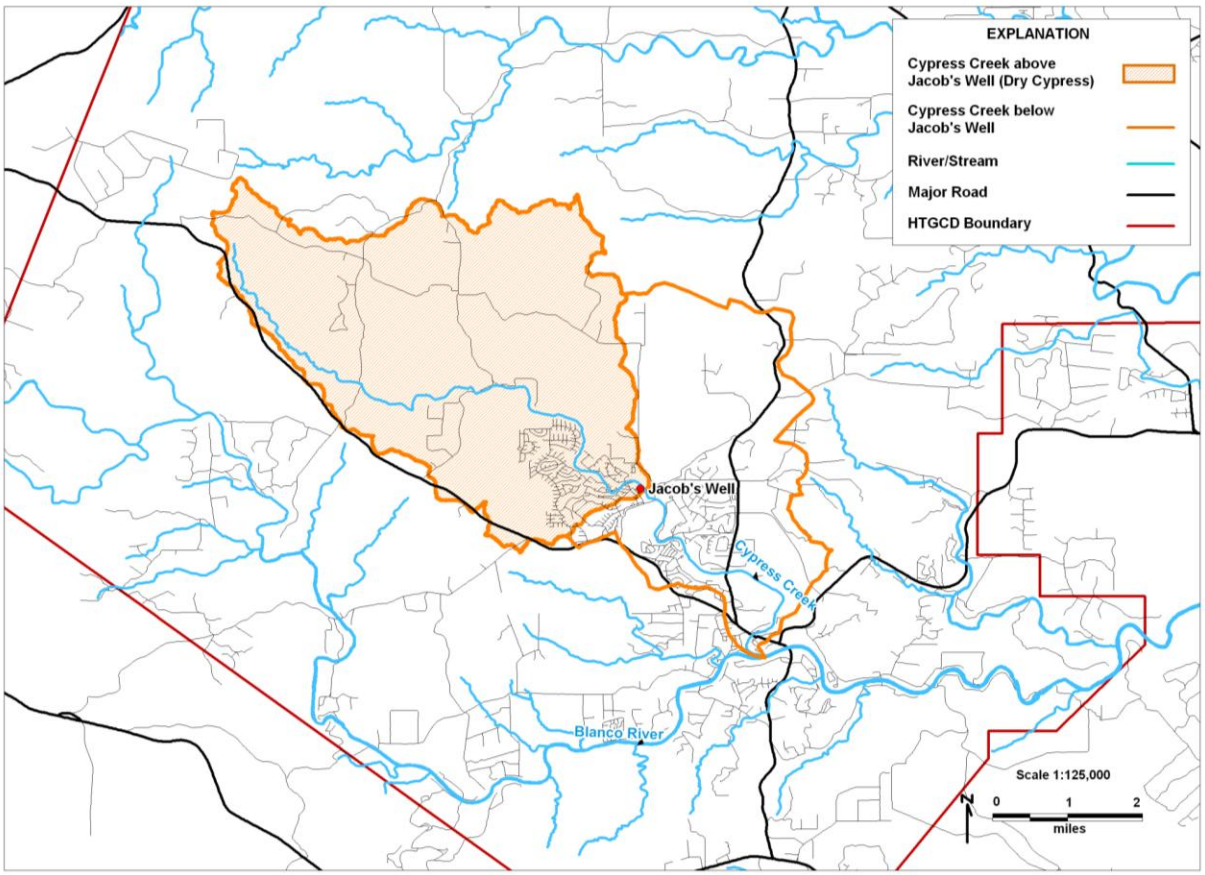

Figure 12. Cypress Creek/Jacob's Well Study Area showing watershed boundaries

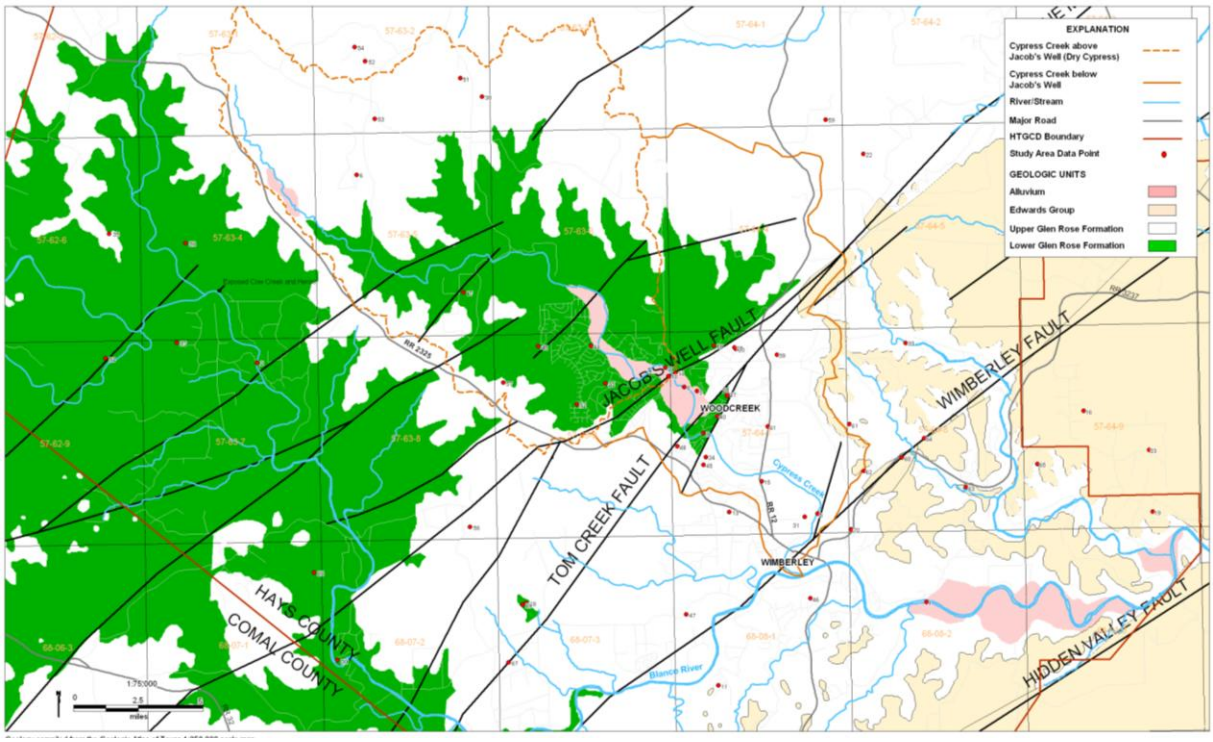

Figure 13. Cypress Creek/Jacob's Well Study Area Geologic Map (base map from Geologic Atlas of Texas, faults modified by HTGCD)

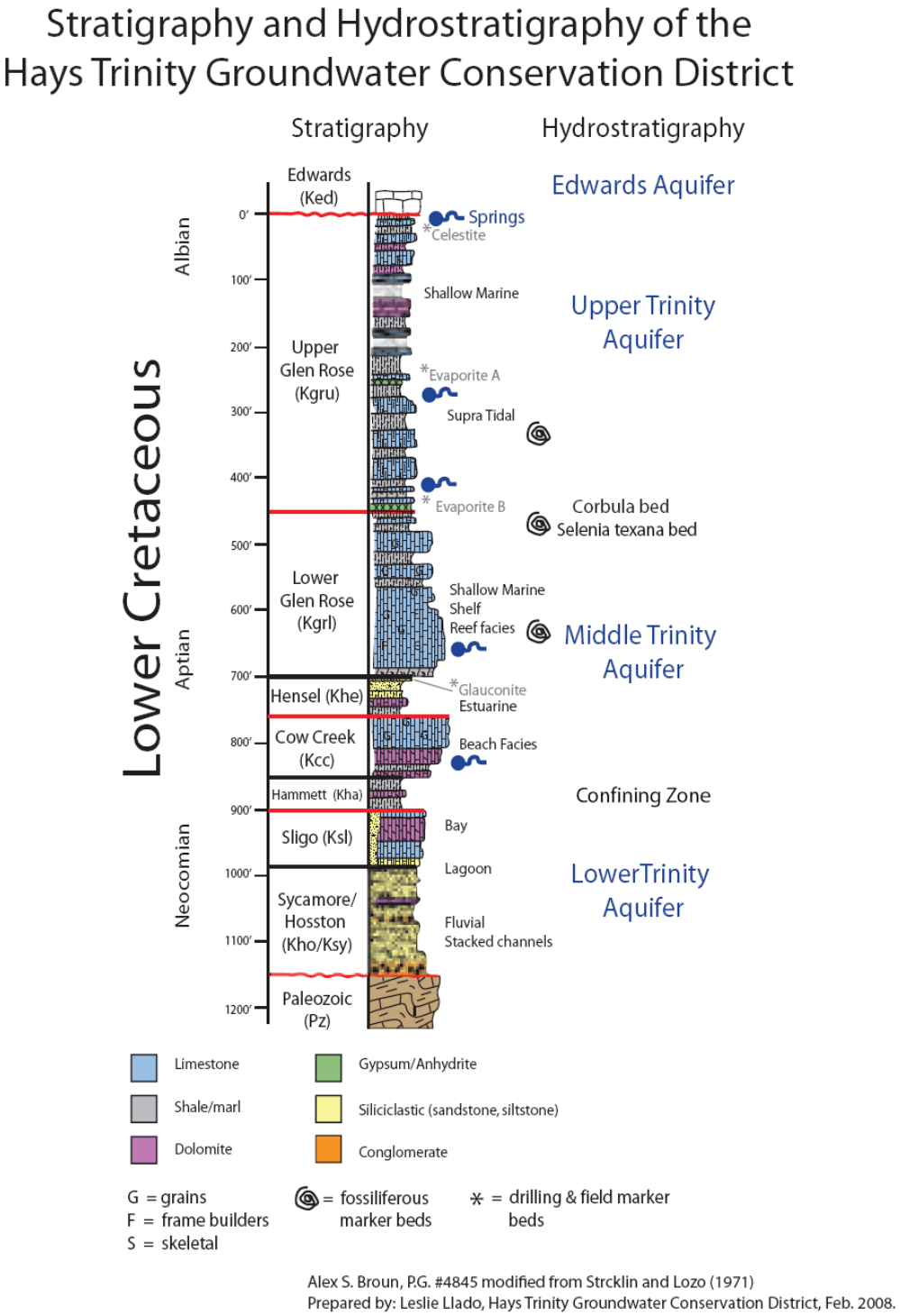

Figure 14. Stratigraphic Column

The upper contact with the overlying Sligo Formation is picked from gamma logs and a change in cuttings samples lithology interpreted as more marine.

7.3.2 Sligo Formation

The Sligo is a subsurface formation that is not exposed at the surface. The formation is cut out in the subsurface by onlapping Hammett shale in Blanco and northwest Hays County. The formation is absent at Brushy Top No. 3 water well drilled in Blanco County. The Hammett Shale rests directly on Hosston sandstone that is 65 feet thick and water-bearing. To the southeast in Hays County, the Sligo is at least 66 feet thick at the Longhorn Trail No. 1 well.

At the Dry Cypress/Byrum well, drilled along Dry Cypress Creek, the Sligo is 111 feet thick. The formation is shaley and silty at the base with interbedded dolomite and dolomitic siltstone. The siltstone—very fine-grained sandstone—contains coarse skeletal fragments. A 45-foot dolomite interval overlies the basal section. The rock is light brown-gray, and appears to be a dolomitized "organic" limestone with very good visual porosity. The dolomite is an aquifer in the well. The upper 25 feet of the Sligo is limestone, coated grain/oolite-lump-skeletal, with a micritic matrix and calcite filled fractures. It contains algal material, very thin-shelled pelecypods and coarse grain skeletal fragments at the base. Beneath this limestone is a 25-foot sandstone, fine to medium grain, tite, hard with dolomitic cement.

Along Fischer Store Road, the Wallace well cut 130 feet of Sligo. The aquifer is a 60-foot section of dolomite, with "framebuilders", organic-skeletal relic texture, gray-brown, with rudistid and oyster fragments, gastropods, and excellent visual moldic porosity. Above this is 40 feet of limestone, grain/oolite, rounded to elongate medium grains, sparry calcite cement, well-sorted, buff color and tite. The Sligo produces moderate amounts of water at several wells within the report area.

7.4 Middle Trinity (400 feet thick)

7.4.1 Hammett Shale

The Hammett claystone section is 40 thick in the Cypress Creek area. Although the base and top are usually claystone, the Hammett contains silty dolomite and siltstone. The basal contact with the Sligo is sharp and easily picked on logs. Some pyrite and minor reworked Sligo limestone is often found at the base. The Hammett is the confining unit for the Lower Trinity aquifers.

In Blanco County, in the Brushy Top No. 3 well, the Hammett is 27 feet thick. The formation is 24 feet thick at Longhorn Trail in Hays County and consists of a dark gray claystone. At Dry Cypress, Hodges and Wallace water wells, the Hammett is 40 feet thick. The lithology is claystone/shale, gray-green-olive, gummy, dolomitic and silty in places. Thin siltstone beds contain shell fragments, and may have coarse Oyster fragments and Orbitolina. The Hammett is 38 feet thick at the Sabino Ranch well near Blue Hole in Wimberley.

The consistent thickness and claystone lithology make the Hammett a drilling marker throughout much of Hays County. Many water wells top the formation and stop if they have encountered sufficient water in the Middle Trinity.

7.4.2 Cow Creek Member

The Cow Creek is an important aquifer in the Cypress Creek area and most new wells are completed in the interval. The Cow Creek averages 90 to 100 feet in thickness. The unit's upper contact with the Hensel is sharp but the lower contact with the Hammett is often gradational. The Cow Creek is generally shaley at the base and gradually shoals and coarsens upwards to give an "inverted triangle" signature on the gamma log. Care must be taken however, as there are exceptions to the rule. The only outcrop in the report area is along the bed of the Blanco River, as shown on the geologic map Figure 13. Here the partially exposed Cow Creek section consists of a cross-bedded, skeletal limestone–calcarenite that may

represent a beach facies. The HTGCD has not as yet measured and described the outcrop in detail.

At the Dick Scott well in western Hays County, the Cow Creek Member is 66 feet thick and is water-bearing. The unit retains this thickness at the Brushy Top wells in Blanco County. At the Longhorn Trail and Dry Cypress wells in Hays County, the Cow Creek is 95 feet thick. The basal section at Dry Cypress is siltstone, very dark gray, hard, fractured; shale, and sandstone, very fine grained with coarse shell fragments and calcite common. "Dolomite sand" overlies this unit, medium crystalline, light brown to tan with some chert nodules and open vuggy porosity ("brown sand" marker). The upper Cow Creek is dolomite at this location; fine crystalline, pale cream-green-buff, some fractures, and calcite filled vugs, loose calcite with minor chert. The uppermost Cow Creek often contains coarse quartz grains.

At the Hodges water well the Cow Creek is 105 feet thick. At this location the upper Cow Creek is grain-skeletal-micritic limestone overlying a very fine crystalline dolomite section. The Cow Creek is 108 feet thick at the Shellman No. 1 well. Here the top unit is water bearing and the lithology is a dolomitized, "organic" calcarenite with some chert and very good visual porosity. Other wells in the area find an off white, skeletal-grain Cow Creek limestone at the top of the section overlying a fine crystalline, sucrosic dolomite with good vuggy porosity. The lower units are normally shale and siltstone and may have a very coarse, Oyster, shell-hash at the base.

The primary, horizontal passageway at Jacob's Well is within the Cow Creek. At the Aquatex 23 well, drilled on the bluff above Dry Cypress Creek, there is an open conduit visible on the downhole-televiewer at roughly the same interval. These open conduits that developed in the porous dolomite and skeletal-grain limestone facies may be part of a paleokarst system that is associated with carbonate "exposure" during early Hensel "caliche-calcrete- hardground" deposition (Hopkins, 1982).

7.4.3 Hensel Member

The Hensel "Sandstone" facies is well developed and crops out in Blanco County. The unit is also exposed along the banks of the Blanco River in Hays County and along the Pedernales River tributaries in the northwest. Inden, (Trinity Depositional Model, 1974) describes 80 feet of section in the Colorado River area. Here the Hensel is red-green mudstones with caliche zones…overlain by dolomitic pebble conglomerate and coarse sub-arkosic sandstone. Along the Blanco River it consists of ochre colored siltstone and very fine grain sandstone.

The Hensel is interpreted in this report as a clastic lithofacies or rock unit in the west, equivalent to the lower Glen Rose marine carbonate sequence to the southeast. The unit interfingers with the carbonate lithofacies down depositional dip in Hays County as shown in the Stratigraphic cross sections Figures 20 and 21. The Hensel is 30 to 38 feet thick in the Cypress Creek area.

At Pump Station No.1, the Hensel is 32 feet thick and is dolomitic with quartz grains and rock fragments. At the Dry Cypress/Byrum well to the east-southeast, the upper beds are siltstone, with glauconite, dolomitic and very fine-grained sandstone; dark gray shale with some coarse shell fragments. Below this is siltstone and dolomitic claystone that is green-gray and iron stained. On the south side of the Blanco River near Fischer Store Road, the Shellman No. 1 well cut 32 feet of Hensel. The upper beds show a flood of glauconite near the contact and dolomite, fine to medium crystalline, brown to dark gray with vuggy and rhombic porosity. This overlies black-brown shale and a dolomite, fine crystalline, silty, dark gray-green. The unit is shaley at the base. To the north, along Ranch Road 12, Kelly's No. 1 well encountered 37 feet of Hensel. The upper zone is composed of very fine-grained dolomitic sandstone and siltstone. This zone overlies a dolomite, brown, fine crystalline with shale and lignite. The Hensel is again shaley at the base.

7.4.4 Lower Glen Rose

The Lower Glen Rose shallow marine, shelf carbonate has been the primary aquifer for western Hays County during many years and continues to be productive in specific areas. The limestone contains good porosity zones that appear to be facies related and is faulted and fractured in proximity to the Balcones Fault Zone. The Lower Glen Rose can be subdivided into four subsurface lithologic units: A lower massive limestone or mound/reef facies that is well exposed in outcrop at the Narrows "biostrome" section in western Hays County along the Blanco River (Cycle 1, Scott, 2007); an intermediate shale, siltstone and thin bedded carbonate unit with regionally correlated "flood" spikes on the gamma log; An upper massive limestone or mound/reef facies with caprinid rudistids (Cycle 2, Scott) that is equivalent to the Pipe Creek Bioherms; and a fine grained carbonate and shale upper unit which includes the "CA" marker bed, the Salinia texana zone and the base of the "Corbula" bed.

The exposed Lower Glen Rose soluble carbonate section along both Cypress Creek and the Blanco River basin forms a Karst landform. This geomorphologic feature is critical in the analysis of recharge to the Middle Trinity.

The Lower Glen Rose at the Brushy Top Ranch No.3 well in Blanco County is 180 feet thick. It contains the lower "massive limestone" unit (45 feet) but the other units are not as well defined. There is a 10-foot thick anhydrite bed in the upper section that is equivalent to the regional "CA" marker bed. At Dick Scott No.1 and Pump Station No.1 TH, in Hays County, the Lower Glen Rose is 197 feet thick. There is a thick, basal calcarenite in both wells that is interpreted as transitional from the more clastic Hensel/Lower Glen Rose section to the west and the carbonate facies to the east-southeast in Cypress Creek. The "CA" marker bed occurs 25 feet below the Upper Glen Rose contact. This interval is generally consistent throughout the study area.

The subsurface "stratotype" section of the Lower Glen Rose can be seen on geophysical logs and cuttings samples at several Cypress Creek wells. At Bass No. 1, Hodges No. 1, and Lederman No.1, the Lower Glen Rose is 235 feet thick. The basal "massive limestone" unit can be 70 to 100 feet thick. Individual biostromes and mounds however, with "reef rock", rudistid fragments and coral are not more than 10 to 20 feet thick. To the south at Las Missiones No.3 the basal unit breaks up and contains only two suspected mounds of 5 and 15 feet in thickness. At the type section wells, the "flood" unit is about 25 feet thick but the gamma log signature correlates to well logs throughout the area. The upper "massive limestone" unit is well developed in the Cypress Creek-Wimberley area. Stacked mounds, interbedded biostromes and "reef" debris are 50 feet thick and increase to over 80 feet along the Winter's Mill Parkway (Wimberley Bypass) at Crainshaw No. 2 well. Here, fist sized rock samples with coarse rudistid fragments were blown out of the borehole by water pressure when the upper reef was first encountered.

Surface exposures of Lower Glen Rose mounds can be observed throughout the Cypress Creek-Blanco River project area. The AquaTexas Well 23 well spudded in rocks of the upper mounded unit on a bluff overlooking Dry Cypress Creek. The mounded or humplike surface of the reef is visible at the surface. The rock is a caprinid rudistid limestone, "reef rock", with extensive moldic porosity. The matrix is composed of fine skeletal hash and micrite; brecciated matrix rock fills collapsed rudistid shells. The Lower Glen Rose crops out at the entrance to Jacob's Well. The upper mound facies is exposed but the lower "reef" or "biostrome" facies is present in the Well as seen on the Jacob's Well cross section.

7.5 Upper Glen Rose (300 to 450 feet thick)

The Upper Glen Rose Formation outcrops over much of western Hays County. The formation is eroded to expose the Lower Glen Rose in the Cypress Creek and Blanco River Basins. Unless covered by an Edwards Group remnant, the full section is not preserved.

270 feet of Upper Glen Rose sedimentary rocks were penetrated at Pump Station No. 1 well. The section consists of alternating nodular, argillaceous limestone, calcareous and dolomitic shale, marl, thin skeletal-micritic limestone with miliolids, and dolomite. There is a small, 10-foot biostrome that contains very coarse shell fragments including rudustids. The foram, Orbitolina texana is usually first observed in cuttings samples about 100 feet above the Corbula bed. The Upper Glenn Rose thickens to the east-southeast and is 400 to 450 feet thick in water wells immediately east of Wimberley.

Exposed Upper Glen Rose section can be observed in road cuts along Ranch Road 12, FM 2325 and in surrounding developments. The contact with the Lower Glen Rose, the "Corbula bed" (Eoursivivas harveyi, Ward, 2007), is well exposed in numerous locations and can be mapped on air photos. The subsurface pick is discussed in Appendix 2 of this report. The outcropping beds are fractured and contact seeps or springs are common at the intersection of a fractured carbonate bed and a less permeable shale or claystone. Surface expression of faulting and fracturing is discussed in the section under Structural geology.

7.5.1 Structural Geology

Structural cross sections, structure contour maps and isopach maps of key geologic units are presented on Figures 15-20. Srutural cntour and isopach maps were developed by the HTGCD from field mapping data, water well records and geophysical logs with assistance fro the Barton Springs Edward Aquifer Conservation District. Structural cross section A–A' is oriented roughly southwest-northeast cross section and is strike-line parallel to the structural strike and the major faults of the Cypress Creek Drainage (Figure 20). It is constructed perpendicular to Cypress Creek and intersects section B–B' at the Dry Cypress Well.

The line of section stays high to the Tom Creek Fault System. Downcutting from the Blanco River exposes the Lower Glen Rose carbonate section just below the Arrowhead Point Well. Upstream and off the line of section both the Hensel and the Cow Creek crop out in the riverbed and along the bank on the high side (hanging wall) of a normal fault. The cross section cuts the axis of a gentle, southeast plunging nose (Cow Creek Structure Map, Broun, et al., 2007) near RR 2325 and the Rough Hollow fracture zone. The apparent structural dip is generally flat to the northeast approaching Kelley's Well No.1. The Trinity Group lithology and structural style is similar to that described along cross section B–B'. The deepest erosion is at the Blanco River and along the cut of Cypress Creek where the upper reef/mound facies of the Lower Glen Rose is exposed.

Structural cross section B–B' is constructed down structural dip from northwest to southeast, and generally follows the course of Cypress Creek (Figure 21). The creek valley cuts through the Upper Glen Rose formation and exposes the Lower Glen Rose soluble carbonate section. Karstic features are evident as sink holes, caves, Jacob's Well, the dry Cypress Creek bed and surface joint sets providing conduits for groundwater recharge. Seeps of water from the base of limestone cliffs lining the creek bed are common. Structural dips are gentle, less than 2 degrees to the southeast. Normal faults, sympathetic to the major northeast-southwest trending Balcones Fault Zone (BFZ), cut the section in the Cypress Creek Valley. The Tom Creek and the Wimberley Fault Systems, at the western edge of the BFZ, drop the Lower Cretaceous interval by 350–400' to the southeast. Joint sets perpendicular to the strike of the fault systems are structural controls for surface streams and pathways for aquifer recharge.