U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with the
Edwards Aquifer Authority

Scientific Investigations Map 3526
Supersedes USGS Scientific Investigations Map 3461
Pamphlet accompanies map

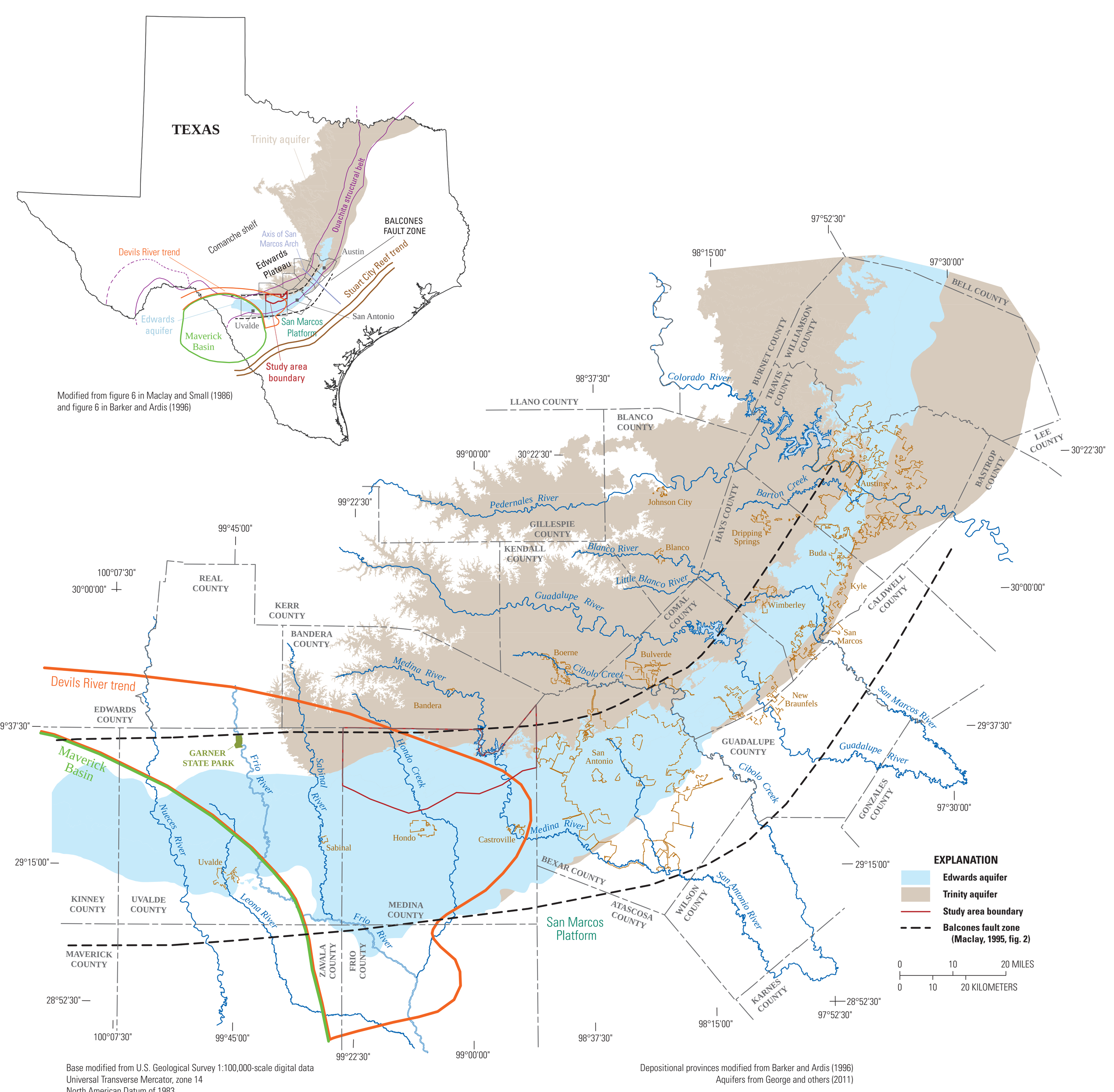
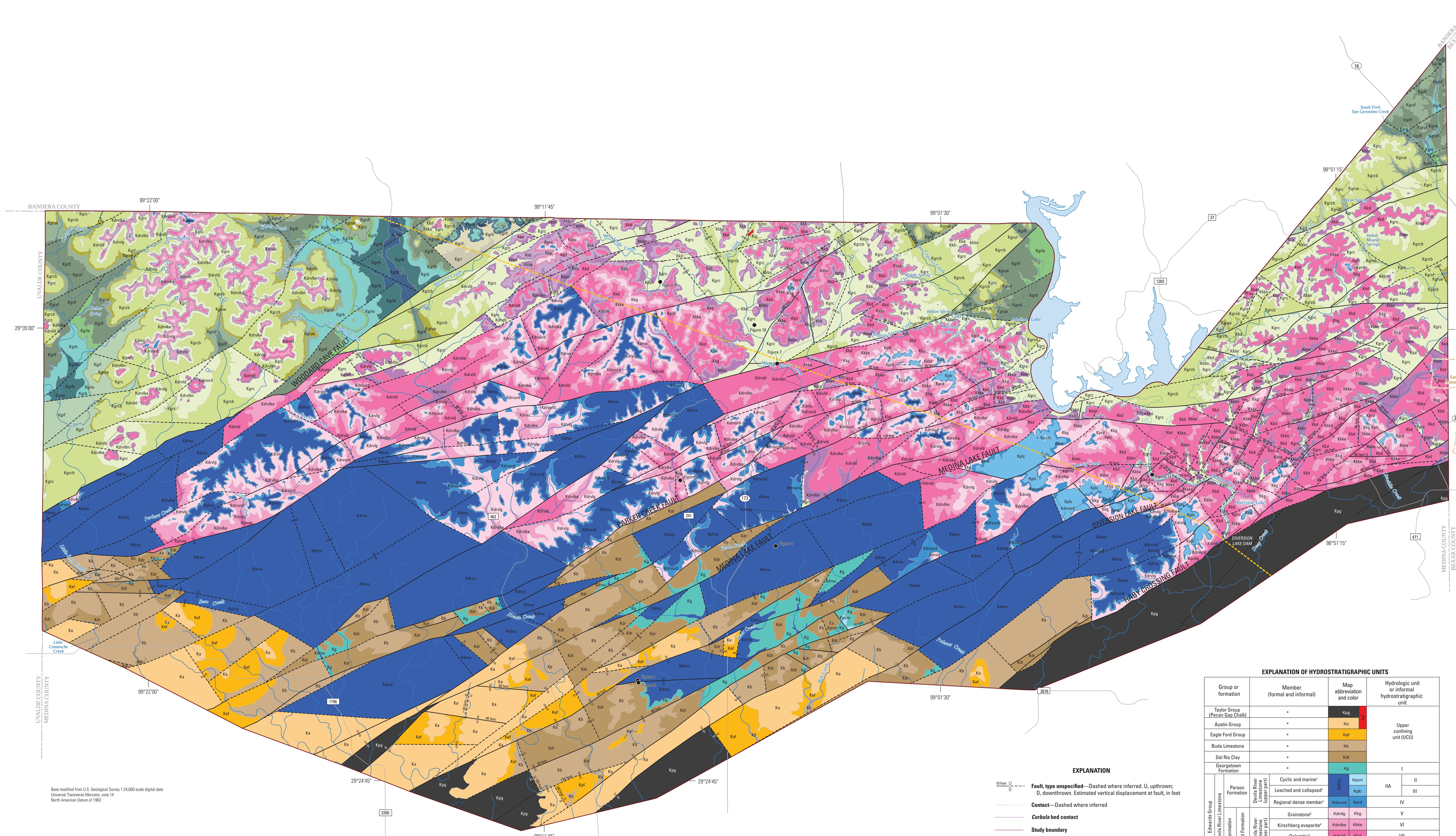


Figure 1. Location of the study area relative to the State of Texas, Medina County, the surficial extent of the rocks that contain the Edwards and Trinity aquifers, and the surficial extent of the Balcones fault zone.

Period	Epoch	Group	Formation	Member (formal and informal)	Lithology	Map abbreviation and color	Hydrologic unit	Hydrostratigraphic unit[1]	Thickness[2] of outcrop in the study area (in feet)	Hydrologic function	Porosity type	Field identification
Cretaceous	Late Cretaceous	Taylor	Pecan Gap Chalk	*	Argillaceous limestone, calcareous clay, blue in the subsurface weathers greenish yellow; fossils, large *Exogyra ponderosa*	Kpg; Kig[3] (Coarse-grained ultramafic)	Upper confining unit to the Edwards aquifer	*	230–540	Confining unit	None	Yellow clay, blue clay in freshly dug exposure; large *Exogyra ponderosa*
Cretaceous	Late Cretaceous	Austin	*	*	Massive, chalky, locally argillaceous, mudstone, nodular wackestone, nodular bioturbated wackestone; *Gryphaea aucella, Inoceramus* sp.; volcanic and terrigenous clastics, calcite	Ka; Kig[3] (Coarse-grained ultramafic)	Upper confining unit to the Edwards aquifer	*	130–160	Confining unit, locally water bearing in cavernous zones	IP, MO, FR, BP, CH, CV	White, chalky limestone; *Gryphaea aucella, Inoceramus* sp.
Cretaceous	Late Cretaceous	Eagle Ford	*	*	Brown, flaggy, sandy shale and argillaceous limestone; iron nodules; *Inoceramus* sp., shark teeth, fossil fragments; petroliferous odor	Kef	Upper confining unit to the Edwards aquifer	*	20–40	Confining unit	IP, FR, BP	Brownish-red sand, thin flagstones; petroliferous
Cretaceous	Late Cretaceous	Washita	Buda Limestone	*	Buff to light-gray, dense nodular mudstone and wackestone, calcite-filled veins, bluish dendrites, iron nodules, iron stained; shell fragments	Kb	Upper confining unit to the Edwards aquifer	*	40–50	Confining unit	FR	Porcelaneous limestone with calcite-filled veins, bluish dendrites
Cretaceous	Late Cretaceous	Washita	Del Rio Clay	*	Fossiliferous blue-green to yellow-brown clay, packstone, iron nodules; *Ilymatogyra arietina*	Kdr	Upper confining unit to the Edwards aquifer	*	50–60	Confining unit	None	Clay, holds water (stock tanks), fossiliferous; *Ilymatogyra arietina*
Cretaceous	Late Cretaceous	Washita	Georgetown Formation	*	Reddish-brown, gray to light-tan shaly mudstone and wackestone, black dendrites, iron nodules, iron stained; *Plesioturrilites brazoensis, Waconella wacoensis*	Kg	Edwards aquifer	I	2–20	Confining unit	MO	Holds water (stock tanks), black dendrites, iron nodules and staining, *Plesioturrilites brazoensis, Waconella wacoensis*
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Person Formation (Upper part of the Devils River Limestone)	Cyclic and marine[4]	Mudstone to grainstone, framestone, boundstone chert (bedded and large nodules); Caprinidae, Requieniidae, *Montastrea roemeriana*. Pelletal limestone, mudstone, miliolid grainstone, packstone, chert (bedded and large nodules); Caprinidae, crossbedded	Kdrvu; Kpcm	Edwards aquifer	IIA; II	150–250[5]; 80–90	Aquifer	MO, BU, VUG, BP, FR, BR, CV	Large amount of chert, chert containing fossils including Caprinidae, recrystallized limestone. Thin graded cycles; massive beds to relatively thin beds; crossbeds, Caprinidae
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Person Formation (Upper part of the Devils River Limestone)	Leached and collapsed[4]	Mudstone to grainstone, framestone, boundstone chert (bedded and large nodules); Caprinidae, Requieniidae, *Montastrea roemeriana*. Recrystallized limestone, mudstone, wackestone, packstone, grainstone; chert (bedded and large nodules); iron stained, stromatolitic, Requieniidae, *Montastrea roemeriana*, oysters	Kdrvu; Kplc	Edwards aquifer	IIA; III	150–250[5]; 70–90	Aquifer	MO, BU, VUG, BP, FR, BR, CV	Large amount of chert, chert containing fossils including Caprinidae, recrystallized limestone. Bioturbated iron-stained beds separated by massive limestone beds; stromatolitic limestone, *Montastrea roemeriana*
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Person Formation (Upper part of the Devils River Limestone)	Regional dense[1]	Dense, shaly, mudstone, wackestone, oystershell mudstone and wackestone; iron stained, chert	Kdrvurd; Kprd	Edwards aquifer	IV	20–24	Confining unit	FR, CV	Wispy iron stains, thin bedded, in Devils River Limestone sometimes capped with oolitic limestone, often white in aerial photographs
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Kainer Formation / Fort Terrett Formation (Lower part of the Devils River Limestone)	Grainstone[1]	Miliolid, skeletally fragmented grainstone, mudstone, wackestone; chert (beds and nodules); crossbedded and ripple marked	Kdrvlg; Kkg	Edwards aquifer	V	40–60	Aquifer	IP, IG, BU, FR, BP, CV	Crossbedded, ripple marks, miliolid grainstone
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Kainer Formation / Fort Terrett Formation (Lower part of the Devils River Limestone)	Kirschberg evaporite[6]	Highly altered crystalline limestone, chalky mudstone, occasional grainstone associated with tidal channels; chert (beds and nodules); coarse-grained spar, breccia and travertine; dissolution has removed all evaporites in the study area	Kdrvlke; Kkke	Edwards aquifer	VI	50–60	Aquifer	IG, MO, VUG, FR, BR, CV	Boxwork porosity with neospar and travertine frame
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Kainer Formation / Fort Terrett Formation (Lower part of the Devils River Limestone)	Dolomitic[1]	Chert (absent in lower 20 feet), dolomitic mudstone, wackestone, packstone, grainstone	Kdrvld; Kkd	Edwards aquifer	VII	90–140	Aquifer	IP, IG, MO, BU, VUG, FR, BP, CV	Massively bedded light gray, Requieniidae, abundant
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Kainer Formation / Fort Terrett Formation (Lower part of the Devils River Limestone)	Burrowed[1]	Alternating mudstone and wackestone beds; burrowed, chert nodules	Kdrvlb; Kkb	Edwards aquifer	Seco Pass	20–70	Aquifer	IP, IG, IC, MO, BU, FR, BP, CV	Slope/cliff forming, alternating burrowed beds with connected porosity and mudstone beds
Cretaceous	Early Cretaceous	Edwards	Devils River Limestone; Kainer Formation / Fort Terrett Formation (Lower part of the Devils River Limestone)	Basal nodular[1]	Shaly, nodular limestone, burrowed mudstone, wackestone, packstone, miliolid grainstone, dolomite, BRBs; Caprinidae, *Ceratostreon (Exogyra) texana, Montastrea* sp., *Tylostoma* sp., Mitolites, gastropods	Kdrvlbn; Kkbn	Edwards aquifer	VIII	40–60	Aquifer, confining unit in areas without caves	IP, MO, BU, BP, FR, CV	Massive, nodular and mottled limestone, BRBs and orange wisps, *Ceratostreon (Exogyra) texana*, regional white grainstone bed at the top of the unit, seeps and springs, forms greening near contact of underlying unit
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Upper	Evaporites (dissolved at surface), wackestone, packstone, miliolid grainstone, argillaceous limestone, dolomitic limestone, heavily bioturbated, occasional dinosaur tracks	Kgrc	Upper zone of the Trinity aquifer	Cavernous	90–140	Aquifer	MO, BR, BP, FR, CV	Heavily bioturbated, evaporite beds, rhizoconcretions (root fossils), caves
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Upper	Alternating beds of wackestone, packstone, miliolid grainstone, argillaceous limestone, burrowed	Kgrcb	Upper zone of the Trinity aquifer	Camp Bullis	120–140	Confining unit	MO, BR, FR, CV (occasional)	Alternating beds of limestone and argillaceous limestone, fissile, terra stairstep topography
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Upper	Evaporites (dissolved at surface), highly altered crystalline limestone and chalky mudstone, breccia, boxwork voids	Kgrue	Upper zone of the Trinity aquifer	Upper evaporite	10	Aquifer	IP, MO, BU, BR	Weathers to an orangish red with a pebbly texture, often has less *Juniperus ashei* (cedar) growth and thicker grasses, boxwork and vug porosity, springs and seeps, often with karst in evaporite beds
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Upper	Alternating wackestone, packstone, miliolid grainstone, argillaceous limestone, mudstone, silty mudstone at base; Caprinidae, Monopleuridae, Requieniidae, *Homomya* sp., *Neithea* sp., *Orbitolina minuta* (Douglass, 1960), *Porocystis globularis, Protocardia texana, Tapes decepta, Turritella* sp., gastropods, mollusks	Kgrf; Kgruf	Upper zone of the Trinity aquifer	Fossiliferous[7]; Upper	150–180; 20–50	Semiconfining unit	MO, BU, FR	Caprinid biostroms, limestone, argillaceous limestone, *Orbitolina minuta* (Douglass, 1960)
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Upper		Kgrf; Kgrlf	Upper zone of the Trinity aquifer	Fossiliferous[7]; Lower	150–180; 70–90	Semiconfining unit	MO, BU, FR	Limestone and argillaceous limestone, fossils much more abundant than in the units above, *Orbitolina minuta* (Douglass, 1960)
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Upper	Evaporites (dissolved at surface), highly altered crystalline limestone and chalky mudstone, breccia, boxwork voids, *Corbula* beds	Kgrle	Upper zone of the Trinity aquifer	Lower evaporite	6–10	Aquifer	IP, MO, BU, VUG, BR	Weathers to an orangish red with a pebbly texture, often has less *Juniperus ashei* (cedar) growth and thicker grasses, boxwork and vug porosity, springs and seeps, often with karst in evaporite beds, *Corbula* sp. at base
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Lower	Wackestone, grainstone, argillaceous wackestone, shale, evaporites (dissolved at surface), Monopleuridae, *Neithea* sp., *Orbitolina texana* (Roemer, 1852), *Porocystis globularis, Salenia texana*, gastropods, pectens, and pelecypods	Kgrb	Middle zone of the Trinity aquifer	Bulverde	30–40	Semiconfining unit	MO, BR, BP, FR	*Salenia texana* bed immediately below *Corbula* bed, abundant fossils including *Porocystis globularis, Orbitolina texana* (Roemer, 1852), *Macraster* sp., *Neithea* sp., pectens, gastropods, pelecypods
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Lower	Mudstone, wackestone, argillaceous wackestone, boundstone, *Orbitolina texana* (Roemer, 1852), Caprinidae, Monopleuridae, and Requieniidae, gastropods, pectens, and pelecypods	Kgrlb	Middle zone of the Trinity aquifer	Little Blanco	30–40	Semiconfining unit	MO, BU, BP, FR	Limestone beds thicker and more resistive to erosion than overlying and underlying units, patch reefs
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Lower	Argillaceous wackestone, shale; *Orbitolina texana* (Roemer, 1852), gastropods, pelecypods	Kgrts	Middle zone of the Trinity aquifer	Twin Sisters	20–70	Semiconfining unit	IP	Thick argillaceous beds, thin shale beds, *Orbitolina texana* (Roemer, 1852), contains ponds and seeps
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Lower	Mudstone, wackestone, packstone, grainstone, boundstone, argillaceous wackestone and packstone; *Orbitolina texana* (Roemer, 1852), *Neithea* sp., *Tylostoma* sp., oysters, pectens, pelecypods	Kgrd	Middle zone of the Trinity aquifer	Doeppenschmidt	40–80	Aquifer	IP, MO, BU, FR, BP, CV	*Orbitolina texana* (Roemer, 1852), limestone beds thicker and more resistive than overlying and underlying units
Cretaceous	Early Cretaceous	Trinity	Glen Rose Limestone	Lower	Alternating beds of argillaceous wackestone, packstone, mudstone, wackestone, grainstone, miliolid grainstone; *Orbitolina texana* (Roemer, 1852), *Neithea* sp., *Monopleura* sp., *Nerinea* sp., *Tylostoma* sp., oysters, pectens, pelecypods	Kgrr	Middle zone of the Trinity aquifer	Rust	40–70	Semiconfining unit	IP, FR, CV	Forms stairstep topography with soils, *Orbitolina texana* (Roemer, 1852)

[1]Informal.
[2]Thickness range based on field mapping.
[3]Intrusive igneous rock; igneous activity occurred during the deposition of the Austin and Taylor Groups.
[4]Informal, undivided.
[5]The upper part of the Devils River Limestone thickens to the west off the San Marcos Platform facies and into the Devils River trend.
[6]Informal in the Kainer Formation and formal in the Fort Terrett Formation.
[7]The fossiliferous hydrostratigraphic unit thins from the east to the west.
*No further subdivision.

Figure 2. Summary of geologic framework and hydrostratigraphy of the Edwards and Trinity aquifers within northern Medina County, Texas. Chart modified from Clark and others (2024). Period, Epoch, group, formation, formal and informal members, and lithology modified from Shumard (1860), Hill (1887, 1888, 1891, 1892), Hill and Vaughan (1898), Vaughan (1900a, b), Udden (1907), Adkins (1932), Stenzel (1938), Wilmarth (1938), Hazzard (1939), Ross (1943), Lozo and Stricklin (1956), Stricklin and others (1971), Rose (1972), Inden (1974), Perkins (1974), Stein and Ozuna (1995), Small and Clark (2000), Clark (2003), Clark and others (2009), Blome and Clark (2014), Clark and others (2023), and the National Geologic Map Database, Geolex (U.S. Geological Survey, 2023); *Orbitolina minuta* (Douglass, 1960), *Orbitolina texana* (Roemer, 1852); BRBs, spherical textural features locally known as black rotund bodies (Maclay and Small, 1986); aquifers from Maclay and Small (1976) and Ashworth (1983); thickness from outcrop, Clark (2003), Clark and others (2009), and Clark and others (2023); hydrogeologic function modified from outcrop, Stein and Ozuna (1995), Small and Clark (2000), Clark (2003), Clark and others (2009), and Clark and others (2016); carbonate classification from Dunham (1962) and Wright (1992). Porosity types modified from Choquette and Pray (1970): Fabric selective: IP, interparticle porosity; MO, moldic porosity; BP, bedding plane porosity; BU, burrow porosity; IG, intergranular porosity; IC, intercrystalline porosity. Non-fabric selective: FR, fracture porosity; CH, channel porosity; CV, cave porosity; VUG, vug porosity; BR, breccia porosity.



SCALE 1:75,000

0 3 6 9 12 MILES

0 3 6 9 12 KILOMETERS

EXPLANATION

- **Fault, type unspecified**—Dashed where inferred. U, upthrown; D, downthrown. Estimated vertical displacement at fault, in feet (10 feet U/D)
- **Contact**—Dashed where inferred
- ***Corbula* bed contact**
- **Study boundary**
- **Facies transition line**
- **Approximate Medina Lake boundary at conservation pool elevation**
- **Location where photograph in identified figure was taken** (Figure 7)
- **Spring**—Tail points in the direction of flow

EXPLANATION OF HYDROSTRATIGRAPHIC UNITS

Group or formation				Member (formal and informal)	Map abbreviation and color		Hydrologic unit or informal hydrostratigraphic unit	
Taylor Group (Pecan Gap Chalk)				*	Kpg	Kig[1]	Upper confining unit (UCU)	
Austin Group				*	Ka	Kig[1]	Upper confining unit (UCU)	
Eagle Ford Group				*	Kef		Upper confining unit (UCU)	
Buda Limestone				*	Kb		Upper confining unit (UCU)	
Del Rio Clay				*	Kdr		Upper confining unit (UCU)	
Georgetown Formation				*	Kg		I	
Edwards Group	Devils River Limestone	Person Formation	Devils River Limestone (upper part)	Cyclic and marine[2]	Kdrvu	Kpcm	IIA	II
Edwards Group	Devils River Limestone	Person Formation	Devils River Limestone (upper part)	Leached and collapsed[2]	Kdrvu	Kplc	IIA	III
Edwards Group	Devils River Limestone	Person Formation	Devils River Limestone (upper part)	Regional dense member[3]	Kdrvurd	Kprd	IV	
Edwards Group	Devils River Limestone	Kainer Formation / Fort Terrett Formation	Devils River Limestone (lower part)	Grainstone[3]	Kdrvlg	Kkg	V	
Edwards Group	Devils River Limestone	Kainer Formation / Fort Terrett Formation	Devils River Limestone (lower part)	Kirschberg evaporite[4]	Kdrvlke	Kkke	VI	
Edwards Group	Devils River Limestone	Kainer Formation / Fort Terrett Formation	Devils River Limestone (lower part)	Dolomitic[3]	Kdrvld	Kkd	VII	
Edwards Group	Devils River Limestone	Kainer Formation / Fort Terrett Formation	Devils River Limestone (lower part)	Burrowed[3]	Kdrvlb	Kkb	Seco Pass	
Edwards Group	Devils River Limestone	Kainer Formation / Fort Terrett Formation	Devils River Limestone (lower part)	Basal nodular[3]	Kdrvlbn	Kkbn	VIII	
Trinity Group	Glen Rose Limestone			Upper	Kgrc		Cavernous	
Trinity Group	Glen Rose Limestone			Upper	Kgrcb		Camp Bullis	
Trinity Group	Glen Rose Limestone			Upper	Kgrue		Upper evaporite	
Trinity Group	Glen Rose Limestone			Upper	Kgrf	Kgruf	Fossiliferous	Upper
Trinity Group	Glen Rose Limestone			Upper	Kgrf	Kgrlf	Fossiliferous	Lower
Trinity Group	Glen Rose Limestone			Upper	Kgrle		Lower evaporite	
Trinity Group	Glen Rose Limestone			Lower	Kgrb		Bulverde	
Trinity Group	Glen Rose Limestone			Lower	Kgrlb		Little Blanco	
Trinity Group	Glen Rose Limestone			Lower	Kgrts		Twin Sisters	
Trinity Group	Glen Rose Limestone			Lower	Kgrd		Doeppenschmidt	
Trinity Group	Glen Rose Limestone			Lower	Kgrr		Rust	

[1]Intrusive igneous rock; igneous activity occurred during the deposition of the Austin and Taylor Groups.
[2]Informal, undivided.
[3]Informal.
[4]Informal in the Kainer Formation and formal in the Fort Terrett Formation.
*No further subdivision.

Figure 3. Surficial extent of the mapped rocks that contain the Edwards and Trinity aquifers within northern Medina County, Texas.

Figure 4. A rudist (*Toucasia* sp.) biostrome at the top of the Devils River Limestone, northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, July 7, 2019).

Figure 5. Del Rio Clay (Washita Group), northern Medina County, Texas (photograph by Robert R. Morris, U.S. Geological Survey, July 18, 2019).

Figure 6. Late Cretaceous age igneous intrusive rocks exposed along County Road 241, northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, December 4, 2019).

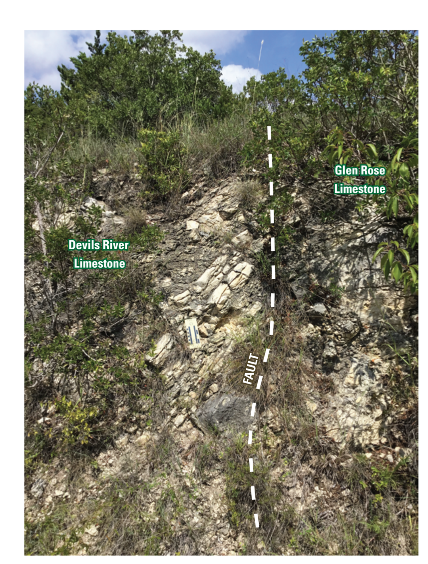


Figure 7. A high-angle fault juxtaposing the Glen Rose Limestone (Trinity Group) against the Devils River Limestone along State Highway 173 (4.47 miles south of the Bandera and Medina County line), northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, December 4, 2019).

Figure 8. Channel porosity in the Devils River Limestone, northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, February 26, 2019).

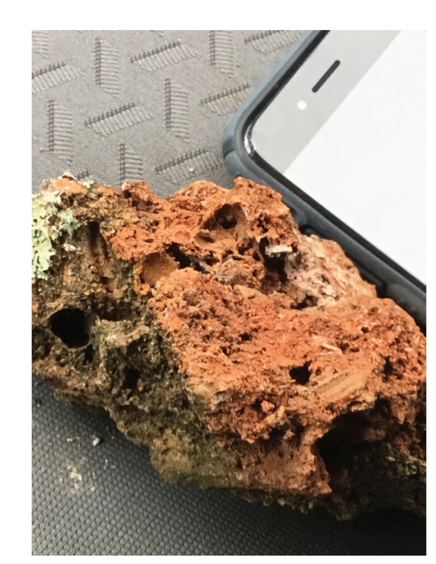


Figure 9. A sample of evaporite with vug and boxwork porosity in the cavernous hydrostratigraphic unit of the upper zone of the Trinity aquifer, northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, February 4, 2019).

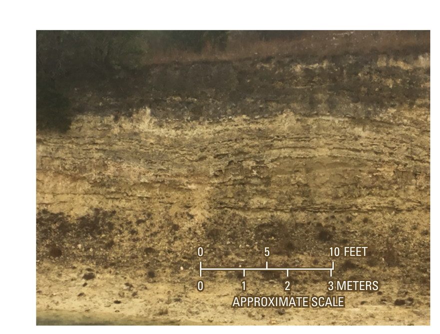


Figure 10. Evaporitic beds of the cavernous hydrostratigraphic unit of the upper zone of the Trinity aquifer, northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, February 4, 2019).

Figure 11. Burrow porosity at the contact of hydrostratigraphic unit VIII of the Edwards aquifer (basal nodular member of the Edwards Group) and the cavernous hydrostratigraphic unit of the upper zone of the Trinity aquifer (Glen Rose Limestone of the Trinity Group), northern Medina County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, May 23, 2018).

Geologic Framework and Hydrostratigraphy of the Edwards and Trinity Aquifers Within Northern Medina County, Texas

By Allan K. Clark, Robert R. Morris, and Alexis P. Lamberts

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