In cooperation with the U.S. Department of Agriculture and the Texas State Soil and Water Conservation Board

Geologic Framework and Hydrogeologic Properties of the Seco Creek Watershed, Texas

In 1991, the U.S. Geological Survey (USGS), in cooperation with the U.S. Department of Agriculture (USDA) and the Texas State Soil and Water Conservation Board, began a study to evaluate the effects of agricultural best-management practices on surface- and ground-water quantity and quality in the Seco Creek watershed. The USGS study is part of a larger study known as the Seco Creek Water-Quality Demonstration Project, which is intended to demonstrate to urban and rural land and water users the potential to reduce transport of agricultural chemicals and sediment, improve groundwater and downstream surface-water quality, and improve the quality and abundance of vegetative cover. The Seco Creek watershed is approximately 50 miles (mi) west of San Antonio (fig. 1) and has a drainage area of approximately 255 square miles (mi^2). Agricultural activities account for more than 99 percent of the land use in the watershed (Steffens and Wright, 1996). The purpose of this fact sheet is to describe the geologic framework and hydrogeologic properties of the Seco Creek watershed.

Geologic Framework

Rocks exposed in the Seco Creek watershed are of sedimentary origin. The formations in the watershed (fig. 1; table 1) primarily are Lower and Upper Cretaceous marine limestone and marl, with some Tertiary and Quaternary sandstone and shale; marine invertebrate fossils are common as well. Alluvial-plain sediments (clay, sand, gravel, cobbles of limestone, dolomite, and chert) are extensive and cover much of the bedrock throughout the study area. Generally, the age of the exposed bedrock decreases from north to south. The oldest rocks exposed are the Lower Cretaceous rocks in the north, which are topographically higher than the Upper Cretaceous, Tertiary, and Quaternary rocks in the south. Strata in the north have a regional dip of approximately 8 to 9 feet per mile (ft/mi) (Reeves and Lee, 1962, p. 17) toward the southeast. However, regional dips in the Seco Creek watershed are disrupted by faults of the Balcones fault zone (fig. 1).

Extensional normal faults in the Balcones fault zone typically have strikes trending slightly northeastward and dip a few feet per mile to the southeast. Balcones faults are en echelon (in steplike arrangement), high-angle (nearly vertical), normal, and generally downthrown to the southeast. Normal faults have juxtaposed stratigraphically younger rocks against stratigraphically older rocks. South of the Balcones fault zone, the regional dip steepens toward the south-southeast (15 to 20 ft/mi) (Holt, 1956, p. 14).

The Lower Cretaceous upper member of the Glen Rose Limestone is greater than 500 feet (ft) thick in the Seco Creek watershed and consists of alternating beds of dense limestone and fossiliferous impermeable marl (table 1). Overlying the Glen Rose Limestone in the Balcones fault zone are the Devils River, Fort Terrett, and Segovia Formations (Lozo and Smith, 1964).

The Devils River Formation is stratigraphically equivalent to the Fort Terrett and Segovia Formations. The Devils River Formation is about 380 to 620 ft thick (table 1) and is mostly hard, *miliolid* (a small foraminifera) grainstone to mudstone, with abundant chert nodules and beds. Nodular argillaceous limestone is found in the lower Devils River Formation, collapsed breccia in the middle, and rudist mounds at the top. The Fort Terrett Formation, the thickness of which ranges from 0 to about 250 ft, consists of porcelaneous limestone, collapsed breccia, and chert (Rose, 1972). The 0- to 80-ft-thick Segovia Formation overlies the Fort Terrett Formation and consists of a marly limestone in the lower part, dolomite and collapsed breccia in the middle, and *miliolid* and shell-fragmented limestone and chert at the top (Rose, 1972, p. 35).

The Georgetown Formation is not known to yield water in the study area. However, because well drillers historically have considered the Georgetown Formation the top of the Edwards aquifer, the formation is considered part of the aquifer. The Georgetown Formation, which is 0 to about 82 ft thick (table 1), consists of whitish, fossiliferous, dense limestone near the bottom that grades upward into a buff to yellow argillaceous limestone near the top.

Groups and formations above the Georgetown Formation consist of the Upper Cretaceous Del Rio Clay, Buda Limestone, Eagle Ford Group, Austin Group, Anacacho Limestone, and Escondido Formation; the Tertiary Midway Group, Wilcox Group, and Uvalde Gravel; and the Quaternary Leona Formation and alluvium (table 1). The Del Rio Clay is about 45 to 90 ft thick and consists of blue-green to yellow-brown clay. The Buda Limestone consists of about 60 to 90 ft of dense, massive micritic limestone (Maclay and Small, 1984, p. 12). The Eagle Ford Group, about 55 to 70 ft thick, consists of shale, sandy siltstone, and flaggy limestone (Holt, 1956, p. 29). The

Seco Creek watershed, Medina County, Texas (Bat Cave). *(Photograph by J.R. Gilhousen, U.S. Geological Survey)*

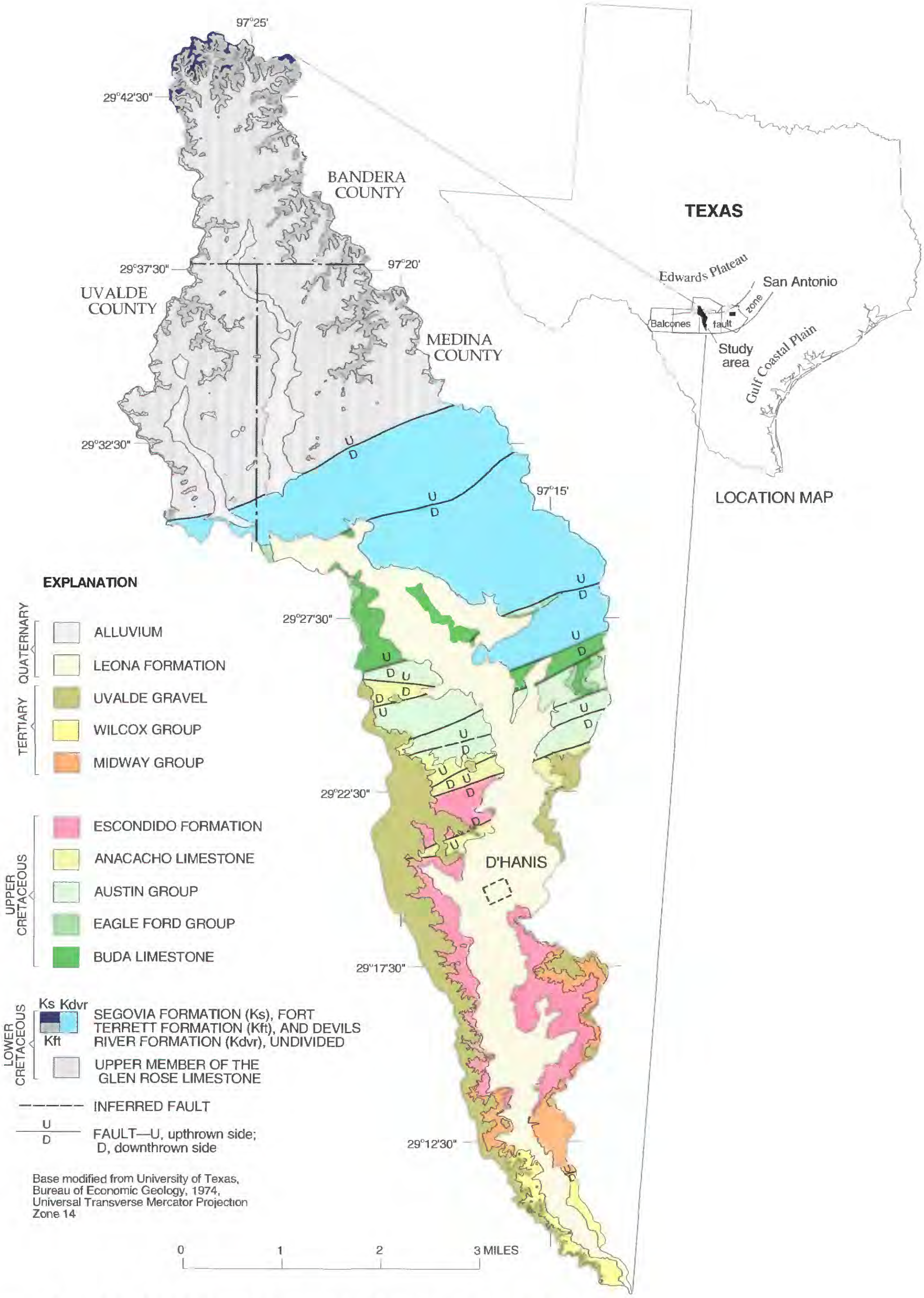

Figure 1. Location and surficial geology of the Seco Creek watershed, Texas.

230- to 290-ft-thick Austin Group overlies the Eagle Ford Group and consists of massive chalky to marly, fossiliferous limestone. The Anacacho Limestone is about 290 to 530 ft thick and consists of fossiliferous limestone, chalk, marl, and clay. The Escondido Formation, about 550 to 770 ft thick, conformably overlies the Anacacho Limestone and consists of flaggy to argillaceous, fine-grained sandstone, siltstone, and shale, with lenses of sandy marl and limestone.

The Tertiary Midway Group, Wilcox Group, and Uvalde Gravel overlie the Escondido Formation. Glauconitic sandstone and shale predominantly compose the 20- to 150-ft-thick Midway Group (table 1). The Wilcox Group is about 200 to 400 ft thick and consists of thin-bedded sandstone, siltstone, and shale. The Uvalde Gravel, which overlies the Wilcox Group, is 0 to about 30 ft thick and consists primarily of caliche-cemented, cherty gravel, which caps hilltops and stream divides.

Quaternary deposits (cobble, gravel, sand, silt, and clay) in the Seco Creek watershed include the Leona Formation and alluvium. These deposits are found along stream valleys and flood plains, with thicknesses of as much as about 70 ft for the Leona Formation and about 40 ft for the alluvium (table 1).

Hydrogeologic Properties

The Edwards aquifer and the Leona Formation are the primary aquifers in the Seco Creek watershed, and the Trinity

Table 1. Summary of the lithologic and hydrologic properties of the geologic units of the Seco Creek watershed, Texas

[Colors keyed to those of figure 1; groups and formations modified from Welder and Reeves (1962), Lozo and Smith (1964), Rose (1972), Humphreys (1984), Miller (1984); lithology modified from Dunham (1962); porosity type modified from Choquette and Pray (1970). AQ, aquifer; gal/min, gallons per minute; CU, confining unit]

System	Hydrogeologic unit	Group or formation	Hydrologic function	Thickness (feet)	Lithology	Field identification	Relative porosity/permeability and well yields
Quaternary		Alluvium	AQ where saturated	0–40	Gravel, sand, silt, and clay	Gravel, sand, silt, and clay; confined to stream valleys	High porosity/high permeability; water-yielding
Quaternary		Leona Formation	AQ	0–70	Cobble, gravel, sand, silt, and clay beneath terraces along larger streams	Broad, flood-plain deposits of cobbles, gravel, sand, silt, and clay	High porosity/high permeability; water-yielding (2 to 86 gal/min)
Tertiary		Uvalde Gravel	AQ where saturated	0–30	Coarse, cherty gravel and caliche on hilltops and divides	Alluvial deposits of coarse gravel composed of chert and limestone cemented by caliche	Low to high porosity and permeability; lack of saturation probably limits water-yielding capacity in watershed
Tertiary	Upper confining unit	Wilcox Group	CU	200–400	Thin-bedded, iron-rich sandstone, siltstone, and shale; contains lignite and calcareous nodules	Fine-grained sandstone, shale, and siltstone; possibly some lignite	Low porosity/low permeability
Tertiary	Upper confining unit	Midway Group	CU	20–150	Shale, siltstone, fine-grained sandstone and limestone	Glauconitic sandstone and shale; locally fossiliferous	Low porosity/low permeability; not known to yield water in the watershed
Upper Cretaceous	Upper confining unit	Escondido Formation	CU	550–770	Flaggy to argillaceous, fine-grained sandstone, siltstone, and shale; sandy marl and limestone, with conglomerates of fossil shells	Brown, fine-grained sandstone; locally fossiliferous; may contain pyroclastics and asphaltic sand	Low porosity/low permeability; water-yielding (3 to 12 gal/min) in places
Upper Cretaceous	Upper confining unit	Anacacho Limestone	CU	290–530	Fossiliferous limestone, chalk, marl, and clay	White to gray argillaceous limestone; light-gray chalk; light-yellow to blue marl; and sandy yellow clay; asphaltic limestone	Low porosity/low permeability; not known to yield significant quantities of water (0 to 6 gal/min)
Upper Cretaceous	Upper confining unit	Austin Group	CU	230–290	Massive chalky to marly, fossiliferous, flaggy limestone	White, chalky limestone, with locally abundant *Gryphaea aucella*	Low porosity/low to moderate permeability; water-yielding (0 to 2 gal/min)
Upper Cretaceous	Upper confining unit	Eagle Ford Group	CU	55–70	Black shale, sandy siltstone, and flaggy limestone	Weathers to yellow clay and brown flagstone; petroliferous	Low porosity/low permeability
Upper Cretaceous	Upper confining unit	Buda Limestone	CU	60–90	Buff, light-gray, dense, massive, micritic limestone	Light-yellow to buff, porcelaneous limestone; nodular, angular, or concoidal fractures	Low porosity/low permeability; not known to yield water in the study area
Upper Cretaceous	Upper confining unit	Del Rio Clay	CU	45–90	Blue-green to yellow-brown clay	Fossiliferous clay; *Ilymatogyra arietina*	Low porosity/low permeability; least permeable part of the upper confining unit of the Edwards aquifer
Lower Cretaceous	Edwards aquifer[1]	Georgetown Formation	CU	0–82	Whitish, dense limestone that grades upward into a buff to yellow argillaceous limestone	Dense to argillaceous detrital limestone; fossiliferous; *Waconella wacoensis*	Low porosity/low permeability; considered part of Edwards aquifer but acts predominantly as a confining unit
Lower Cretaceous	Edwards aquifer[1]	Devils River Formation, undivided[1] Segovia Formation[2] Fort Terrett Formation[2]	Devils River: AQ Segovia: AQ where saturated Fort Terrett: AQ where saturated	Devils River: 380–620 Segovia: 0–80 Fort Terrett: 0–250	Devils River: Hard, *miliolid*, shell-fragmented grainstone to mudstone; chert; argillaceous limestone Segovia: Light-gray, *miliolid*, shell-fragmented limestone; dolomite; chert Fort Terrett: Porcelaneous limestone, collapsed breccia, and chert	Devils River: Massive, fossiliferous limestone; *Caprinids*; chert nodules and beds; collapsed breccias; *miliolids* Segovia: Limestone and dolomite, *miliolid*, collapsed breccia, and marly limestone; chert Fort Terrett: Limestone and dolomite; chert	Devils River: High porosity/high permeability; major aquifer (7 to 950 gal/min) Segovia: High porosity/high permeability; seeps and springs at base along marl contact; lack of saturation might limit water-yielding capacity in watershed Fort Terrett: High porosity/high permeability; springs and seeps at base; lack of saturation might limit water-yielding capacity in watershed
Lower Cretaceous	Upper Trinity aquifer	Trinity Group: Upper member of the Glen Rose Limestone	AQ	Greater than 500	Gray to yellow, dense to thinly bedded limestone and marl	Stair-step topography[2]; alternating limestone and marl	Low porosity/relatively impermeable in upper part and permeable in lower part; springs and seeps[2]; water-yielding (2 to 18 gal/min)

[1] Balcones fault zone (southern two-thirds of watershed).

[2] North of Balcones fault zone (northern one-third of watershed).

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aquifer (Glen Rose Limestone) is secondary. Many formations in the study area contain ground water of limited quantity or quality, which makes their use as aquifers limited. Ground water is unconfined in the northern part of the Seco Creek watershed (fig. 1) where the Glen Rose Limestone and the Devils River Formation are exposed at land surface. In the southern part, ground water in the Leona Formation is both unconfined and confined and in the Devils River Formation is confined.

Currently (1998), the Edwards aquifer provides public water supply to more than 1 million people and sustains several endangered species in south-central Texas. Large-capacity municipal, military, and agricultural wells withdraw water from the Edwards aquifer. Permeable zones are associated with the collapsed breccias and rudist mounds in the limestone (Maclay and Small, 1984, p. 12). The Edwards aquifer has undergone extensive diagenesis, resulting in primary depositional textures being masked or destroyed by recrystallization. Recrystallization, principally by dedolomitization due to extensive leaching in the freshwater zone, has resulted in increased porosity (Maclay and Small, 1984). Dissolution along bedding planes also has been observed in the outcrop; rainfall rapidly infiltrates into the very porous and permeable aquifer.

Wells completed in the Quaternary Leona Formation typically yield about 7 gallons per minute (gal/min) of water. Holt (1956, p. 51) reported that the Leona Formation generally does not contain water where the underlying formation is permeable. However, in areas of impermeable bedrock (southern part of the watershed), observed well yields (about 2 to 86 gal/min) are adequate for domestic and stock use in the Seco Creek watershed.

North of the Balcones fault zone (northern one-third of the watershed), the Trinity aquifer is largely exposed at land surface. The upper member of the Glen Rose Limestone composes the uppermost part of the Trinity aquifer. This member is relatively impermeable in its upper part and permeable in its lower part. Springs and seeps commonly are associated with the contacts of marl, limestone, and evaporite beds in the upper member of the Glen Rose Limestone. Springs issuing from the Glen Rose Limestone provide perennial base flow in the northern part of the Seco Creek watershed. Wells completed in the Glen Rose Limestone can yield sufficient quantities of water (about 2 to 18 gal/min) for domestic and stock use.

In the Balcones fault zone (southern two-thirds of the watershed), the Trinity aquifer underlies the Edwards aquifer and is considered the lower confining unit of the highly productive Edwards because of its low permeability relative to that of the Edwards. The characteristics of the upper member of the Glen Rose Limestone described above might not apply in the Balcones fault zone.

Alluvium in the study area is not used locally as an aquifer, although water potentially could be withdrawn in limited quantities in the high-porosity and high-permeability stream-valley deposits. The potential yield of this unit would be limited by its saturated thickness and by climatic conditions.

The Uvalde Gravel above the upper confining unit, although classified as an aquifer (table 1), does not yield significant quantities of water to wells in the study area, probably because of lack of saturation.

The Upper Cretaceous Del Rio Clay probably is the least permeable part of the upper confining unit of the Edwards aquifer. Above the Del Rio Clay, other units also contribute to the confinement of the Edwards aquifer. The Buda Limestone and Eagle Ford Group generally do not yield water. The Austin Group yields small quantities (about 2 gal/min) of bitter-tasting water, and the overlying Anacacho Limestone yields no significant quantities (about 0 to 6 gal/min) of water. The Escondido Formation can yield moderate quantities (about 3 to 12 gal/min) of moderately to highly mineralized water (about 357 to 1,320 milligrams per liter dissolved solids) but generally has low porosity and permeability, which precludes its use as an aquifer. Moderately to highly mineralized water typically is not suitable for human consumption but can be suitable for stock use. The Tertiary Midway Group and Wilcox Group are not known to yield significant quantities of water within the study area, although the Wilcox Group forms the lower part of the productive Carrizo-Wilcox aquifer outside the study area.

References Cited

Choquette, P.W., and Pray, L.C., 1970, Geologic nomenclature and classification of porosity in sedimentary carbonates: American Association of Petroleum Geologists Bulletin, v. 54, no. 2, p. 207–250.

Dunham, R.J., 1962, Classification of carbonate rocks according to depositional texture, *in* Classification of carbonate rocks Symposium: American Association of Petroleum Geologists Memoir 1, p. 108–121.

Holt, C.L.R., Jr., 1956, Geology and ground-water resources of Medina County, Texas: U.S. Geological Survey Water-Supply Paper 1422, 213 p.

Humphreys, C.H., 1984, Stratigraphy of the Lower Cretaceous (Albian) Salmon Peak Formation of the Maverick Basin, south Texas, *in* Stratigraphy and structure of the Maverick Basin and Devils River trend, Lower Cretaceous, southwest Texas: San Antonio Geological Society, p. 34–59.

Lozo, F.E., Jr., and Smith, C.I., 1964, Revision of Comanche Cretaceous stratigraphic nomenclature, southern Edwards Plateau, southwest Texas: Gulf Coast Association of Geological Societies Transactions, v. 14, p. 285–306.

Maclay, R.W., and Small, T.A., 1984, Carbonate geology and hydrology of the Edwards aquifer in the San Antonio area, Texas: U.S. Geological Survey Open-File Report 83–537, 72 p.

Miller, B.C., 1984, Physical stratigraphy and facies analysis, Lower Cretaceous, Maverick Basin and Devils River trend, Uvalde and Real Counties, Texas, *in* Stratigraphy and structure of the Maverick Basin and Devils River trend, Lower Cretaceous, southwest Texas: San Antonio Geological Society, p. 3–33.

Reeves, R.D., and Lee, F.C., 1962, Ground-water geology of Bandera County, Texas: Texas Water Commission Bulletin 6210, 74 p.

Rose, P.R., 1972, Edwards Group, surface and subsurface, central Texas: Austin, University of Texas, Bureau of Economic Geology Report of Investigations 74, 198 p.

Steffens, T., and Wright, P., 1996, Seco Creek Water-Quality Demonstration Project, annual project report fiscal year 1996: Project Administrators, McFarland, M. (Texas Agricultural Extension Service), Colwick, A. (Natural Resources Conservation Service), and Orange, S. (Farm Service Agency), 338 p.

University of Texas, Bureau of Economic Geology, 1974, Geologic atlas of Texas, San Antonio sheet: Austin, scale 1:250,000.

Welder, F.A., and Reeves, R.D., 1962, Geology and ground-water resources of Uvalde County, Texas: Texas Water Commission Bulletin 6212, 263 p.

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