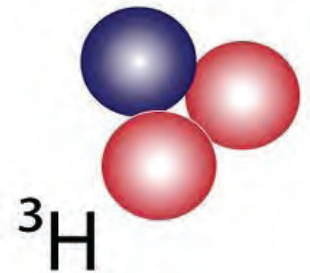


In cooperation with the Lone Star Groundwater Conservation District

Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers in Montgomery County and Adjacent Counties, Texas, 2008



Data Series 580

Front cover:

Top left, CFC-11 (trichlorofluoromethane) molecule.

Bottom left, Sulfur hexafluoride molecule.

Middle, U.S. Geological Survey scientist collects a sample for CFC analysis (in bucket).

Right, Hydrogen isotope, tritium (^3H).

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By Timothy D. Oden

In cooperation with the Lone Star Groundwater Conservation District

Data Series 580

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

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2011

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Conversion Factors, Datums, and Water-Quality Units

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Radioactivity	
picocurie per liter (pCi/L)	0.037	Becquerel per liter (Bq/L)
picocurie per liter (pCi/L)	0.313	Tritium units (TU)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$$

Datums

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Altitude, as used in this report, refers to distance above the vertical datum.

Water-Quality Units

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L), femtograms per kilogram (fg/kg), picograms per kilogram (pg/kg), picocuries per liter (pCi/L), cubic centimeters per gram at standard temperature and pressure water (cc/g STP H_2O), and tritium units (TU).

Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers in Montgomery County and Adjacent Counties, Texas, 2008

By Timothy D. Oden

Abstract

The Gulf Coast aquifer system is the primary water supply for Montgomery County in southeastern Texas, including part of the Houston metropolitan area and the cities of Magnolia, Conroe, and The Woodlands Township, Texas. The U.S. Geological Survey, in cooperation with the Lone Star Groundwater Conservation District, collected environmental tracer data in the Gulf Coast aquifer system, primarily in Montgomery County. Forty existing groundwater wells screened in the Gulf Coast aquifer system were selected for sampling in Montgomery County (38 wells), Waller County (1 well), and Walker County (1 well). Groundwater-quality samples, physicochemical properties, and water-level data were collected once from each of the 40 wells during March–September 2008. Groundwater-quality samples were analyzed for dissolved gases and the environmental tracers sulfur hexafluoride, chlorofluorocarbons, tritium, helium-4, and helium-3/tritium. Water samples were collected and processed onsite using methods designed to minimize changes to the water-sample chemistry or contamination from the atmosphere. Replicate samples for quality assurance and quality control were collected with each environmental sample. Well-construction information and environmental tracer data for March–September 2008 are presented.

Introduction

Between 2000 and 2010, the population of the Houston, Tex., metropolitan area increased 26 percent, and in 2010 the population of the Houston area, which includes Harris, Montgomery, Fort Bend, and Galveston Counties, was about 5.9 million people (Texas State Data Center, 2010). Much of the growth has been to the north of Houston. Municipal and industrial water supplies are needed to support population growth in the newly developed areas, including historically predominately rural Montgomery County, where groundwater withdrawals have increased since 1980 (Texas Water Development Board, 2011). The Lone Star Groundwater Conservation District (LSGCD) was created in 2001 by

the 77th Texas Legislature and was charged with managing and protecting the groundwater resources of Montgomery County. The LSGCD has worked cooperatively with the U.S. Geological Survey (USGS) to monitor and appraise the Gulf Coast aquifer system, comprised of the Chicot, Evangeline, and Jasper aquifers, Burkeville confining unit, and Catahoula Sandstone. Annual groundwater-level measurements are recorded and periodic groundwater-level change maps are produced to provide short-term and long-term trends of the effects of groundwater withdrawal on the regional aquifer flow system. In 2003, the LSGCD set a maximum amount of sustainable yield for the Gulf Coast aquifer in Montgomery County equal to previously determined estimates of recharge. In 2007, as the LSGCD began planning for an alternative source of water to curtail groundwater withdrawals, the LSGCD required more detailed information on the rate of groundwater recharge to evaluate whether there is a consistent recharge value across Montgomery County and vertically within the aquifer system.

Purpose and Scope

This report presents the well-construction and water-quality data (environmental tracers) from discrete groundwater samples collected during March–September 2008 in Montgomery, Waller, and Walker Counties, Tex. Methods used to select sites and techniques used to collect and analyze the water-quality data are described. This report complements previous USGS investigations in the Gulf Coast aquifer system as described in Noble and others (1996) and Nolan and others (2007).

Description of Study Area

Most of the wells sampled were in Montgomery County in southeastern Texas, which includes part of the Houston metropolitan area and the municipalities of Magnolia, Conroe, and The Woodlands Township (Texas State Data Center, 2010). Of 40 existing groundwater wells from which samples were collected, 38 were in Montgomery County, 1 was in Waller County, and 1 was in Walker County (fig. 1). Montgomery

2 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

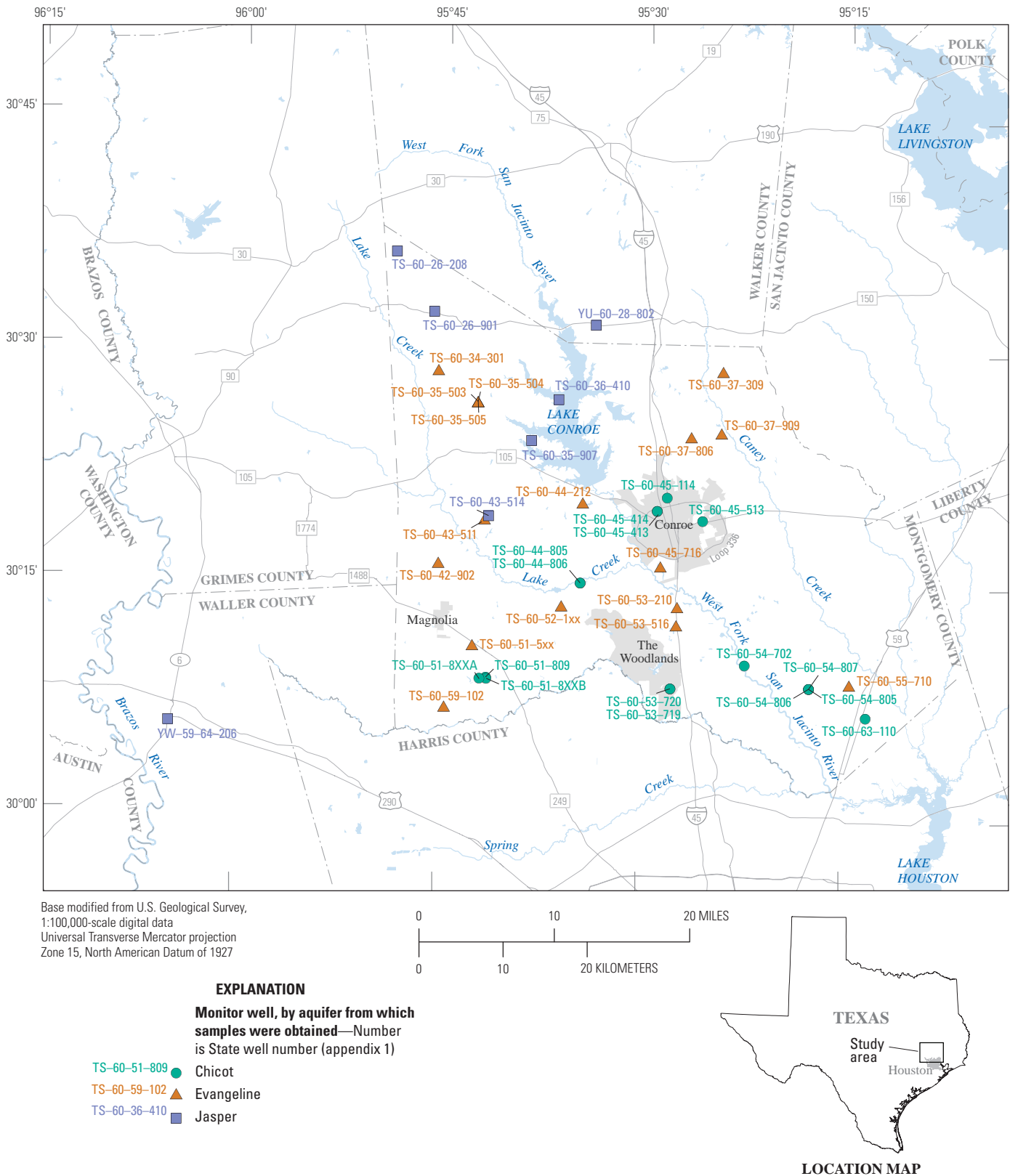


Figure 1. Locations of wells sampled during March–September 2008 in Montgomery County and adjacent counties, Texas.

County is forecasted to be one of the fastest growing counties in the Houston area, more than doubling its 2000 population of 373,000 by 2035 (Houston-Galveston Area Council, 2006). This rapid increase of population will likely result in appreciable land-use changes and a more suburban and urban land use, with a subsequent increased water demand. The topography of Montgomery County ranges from essentially flat near the larger streams and coastward to undulating rolling hills in the northern part of the county. Land-surface altitude ranges from about 79 feet (ft) above North American Vertical Datum of 1988 (NAVD 88) in the southeastern corner of the county to about 330 ft above NAVD 88 in the northwestern corner (U.S. Department of Agriculture, 1972). Montgomery County is entirely within the San Jacinto River drainage basin, which trends from the northwest to the southeast. Lake Conroe, a reservoir completed in 1973, is at the upper end of the West Fork San Jacinto River (fig. 1). Montgomery County has a humid subtropical climate characterized by hot and humid summers and cool winters. For the period 1947–2008, the average precipitation in the Houston area was 51.67 inches per year (National Climatic Data Center, 2010). During the last 61 years, many periods of drought have occurred (National Climatic Data Center, 2010).

Hydrogeologic Setting

The Gulf Coast aquifer system in Montgomery County consists of the Chicot aquifer, Evangeline aquifer, Burkeville confining unit, Jasper aquifer, and the underlying Catahoula Sandstone (table 1). The uppermost Chicot aquifer consists of Pleistocene- and Holocene-age unconsolidated sand, silt, and clay sediments; the Evangeline aquifer consists of Miocene- and Pliocene-age unconsolidated sand, silt, and clay sediments, and the lowermost Jasper aquifer consists of Miocene-age unconsolidated sand, silt, and clay sediments (Baker, 1979). The Jasper aquifer is separated from the Evangeline aquifer by the Burkeville confining unit. The Catahoula sandstone consists of Miocene- and Oligocene-age sediments at the base of the Gulf Coast aquifer system and contains small amounts of freshwater in shallow restricted sands near the outcrop area to the north of the study area (Baker, 1979). The Catahoula Sandstone is the deepest freshwater source in Montgomery County (Popkin, 1971) (fig. 2). Detailed information on the hydrogeology of the area can be found in Popkin (1971), Baker (1979), Chowdhury and Turco (2006), Kasmarek and others (2010).

In the natural groundwater-flow system, water recharges the aquifers in the unconfined outcrop areas, moves downward and coastward through the interbedded sands, and discharges upward as diffuse upward leakage in the confined downdip areas (Kasmarek and others, 2010). Much of the water that infiltrates into the saturated zone flows through locally continuous shallow sand layers and discharges into streams; the remainder of the water flows to intermediate and deep zones of the aquifer system southeastward of the outcrop, where it is captured and withdrawn by wells or naturally discharged by

upward leakage in topographic lows along the coast. On the basis of historical groundwater-level-change maps, major areas of withdrawal include the municipalities of Magnolia, Conroe, and The Woodlands Township. Compared to predevelopment conditions (prior to the 1890s; Kasmarek and Robinson, 2004), when the normal flow direction was from the northwest to southeast, the current areas experiencing groundwater-level declines have induced flow from the Chicot aquifer into the Evangeline aquifer. As development increased, the withdrawal of groundwater from wells increased to meet water demand, and the number of water wells increased. Withdrawal of water from a well creates a cone of depression in the saturated aquifer sediments, thereby increasing the gradient and radial flow of water towards the well. In this study area, the cumulative effect of groundwater withdrawn from all wells in Harris County and surrounding counties has resulted in water-level declines as individual cones of depression coalesced. This has resulted in areally extensive cones of depression with water levels as much as 200, 300, and 200 ft below National Geodetic Vertical Datum of 1929 or NAVD 88 in the Chicot, Evangeline, and Jasper aquifers, respectively (Kasmarek and others, 2010).

Methods

All of the samples were collected in 2008 from wells screened in the Gulf Coast aquifer system. Wells selected for sampling had to meet specific criteria, including the following: depth of well within targeted aquifer (Chicot, Evangeline, or Jasper, depending on well), short length of screened interval (less than 30 ft), and well cannot be completed in multiple aquifer units. After evaluating all wells that met these criteria, wells were selected to represent an areal distribution throughout Montgomery County (and adjacent small parts of Waller and Walker Counties). To the extent possible, wells with relatively short open intervals (less than 30 ft) were preferred for selection. Well depths ranged from 52 to 1,240 ft, with a median depth of 192 ft. Length of screened intervals for the wells ranged from 10 to 118 ft (appendix 1).

Sample Collection

Groundwater samples were collected using procedures described in the USGS “National Field Manual for the Collection of Water-Quality Data” (U.S. Geological Survey, variously dated) and provided by the USGS Chlorofluorocarbon Laboratory, Reston, Va. (U.S. Geological Survey, 2009). Groundwater-quality samples, physicochemical properties, and water-level data (when access allowed) were collected once from each site (fig. 1) during March–September 2008 (appendixes 2–7). Groundwater samples were analyzed for dissolved gases and the environmental tracers sulfur hexafluoride (SF₆), chlorofluorocarbons (CFCs), tritium (³H), helium-4 (⁴He), and helium-3/tritium (³He/³H). Water levels in

4 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

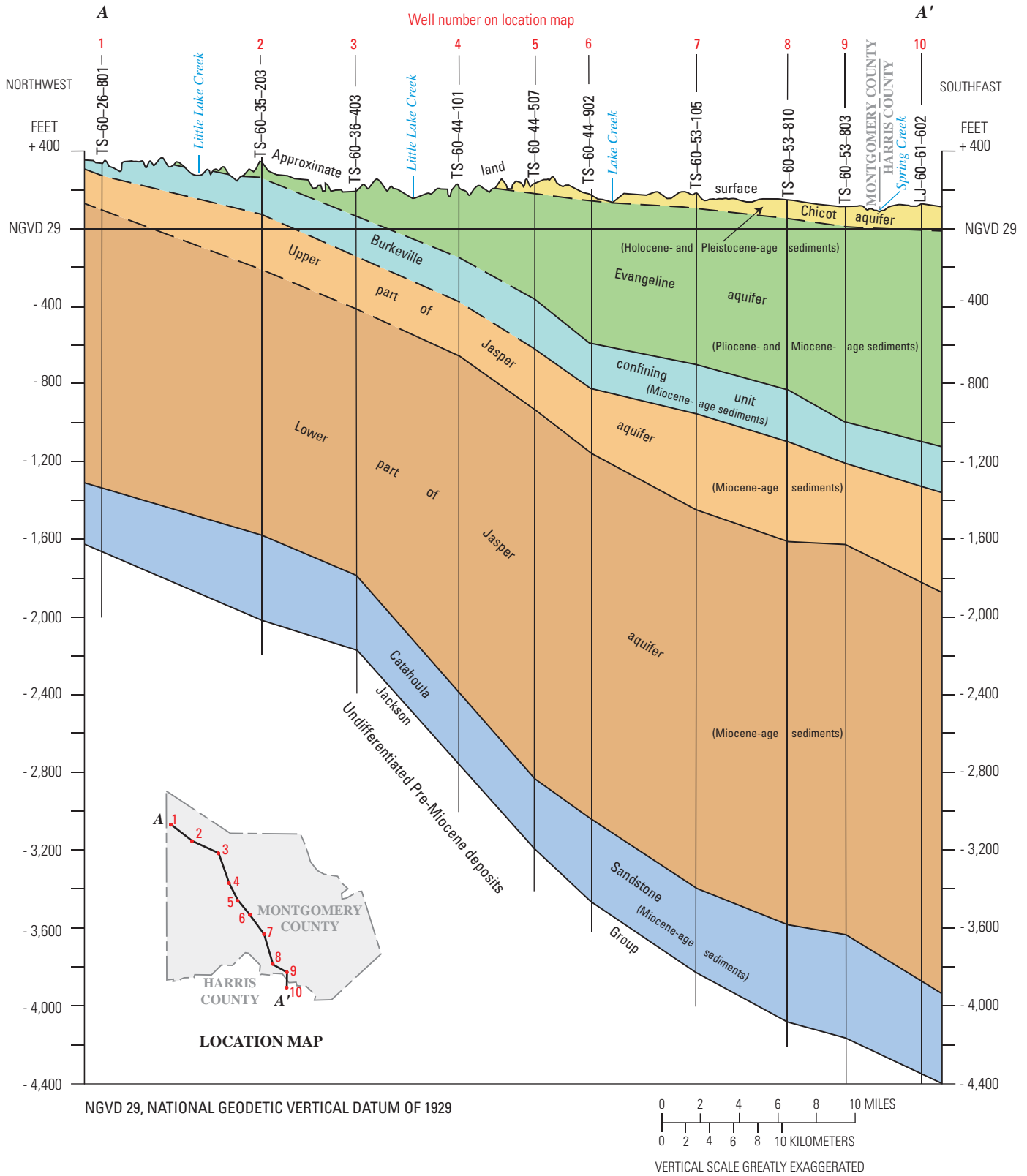


Figure 2. Hydrogeologic section of the Gulf Coast aquifer system in Montgomery and Harris Counties, Texas (modified from Popkin, 1971, fig. 29).

Table 1. Geologic and hydrostratigraphic units of the Gulf Coast aquifer system in Montgomery County and adjacent counties, Texas.

System	Series	Geologic unit			Hydrostratigraphic unit
		Wood and Gabrysch, 1965	Popkin, 1971	Ryder, 1988	
Quaternary	Holocene	Beaumont Clay and Alta Loma Sand	Alluvium	Alluvium	Chicot aquifer
	Pleistocene		Beaumont Clay Montgomery Formation Bentley Formation	Beaumont Clay Montgomery Formation Bentley Formation Willis Sand	
			Willis Sand (?)		
Tertiary	Pliocene	Heavily pumped layer	Goliad Sand	Goliad Sand	Evangeline aquifer
	Miocene	Zone 2	Fleming Formation	Fleming Formation	Burkeville confining unit
		Zone 1		Oakville Sandstone	Jasper aquifer
			Catahoula Sandstone	Catahoula Sandstone	Anahuac Formation "Frio" Formation
	Oligocene			Vicksburg Group	
	Eocene		Jackson Group	Jackson Group	

wells were measured manually at the time of sampling, when possible, by using an electric tape or steel tape. In some wells with pumps, when water levels were not obtained because of either a lack of access point or an obstruction in the well, the most recent water-level measurement stored in the USGS Groundwater Site Inventory (GWSI) database is listed in appendix 1.

Observation wells were pumped using an electric, portable, submersible, positive displacement pump (Grundfos Redi-flo2, Redi-flo-3 or Fultz SP400R) constructed of stainless steel and Teflon. When practical, the intake on the portable submersible pump was set at a position about 10 times the diameter of the well above the top of the first screen in the well. Additionally, a stainless steel splitter was installed on top of the pump, above the check valve, allowing water to simultaneously discharge for physicochemical properties monitoring and waste through Teflon or polyethylene tubing and to discharge for sample collection through a refrigeration-grade copper line. Water was pumped from domestic and municipal wells using existing pumps, and samples were collected at the

wellhead prior to installation of any pressure tanks or filtering or other treatment devices. Prior to any treatment, a connection was made for purging and sampling by using a brass connector with compression fitting to refrigeration-grade copper tubing.

Prior to sample collection, one to three casing volumes were purged from the well, depending on well type, either observation or supply. For wells that are continuously pumped (or pumped regularly every few hours) such as those used for public supply, domestic supply, or industrial purposes, purging less than three casing volumes is permissible (U.S. Geological Survey, variously dated, chapter A4). The purge procedure removes stagnant water in the well, reduces chemical artifacts of well installation or well construction materials, or mitigates effects of infrequent pumping. After purging was complete, the physicochemical properties dissolved oxygen, pH, specific conductance, and water temperature were measured until readings were stable (U.S. Geological Survey, variously dated, appendix 2). Once readings stabilized, water samples were collected in new, pre-cleaned bottles. Water samples were

collected and processed onsite using methods designed to minimize changes to the water-sample chemistry or contamination from the atmosphere. To prevent degradation of water samples and maintain the initial concentration of compounds between the time of sample collection and laboratory analyses, bottle lids were taped on, copper tubes were crimped shut, and samples were stored according to the laboratory protocols, which might include storing upside down, or storing either chilled or at room temperature.

All equipment used for the collection of the environmental tracers was cleaned with tap water and a native water rinse. The external parts of the submersible pump were rinsed with tap water and the interior of sample and discharge lines was rinsed with multiple volumes of native water prior to collection. The introduction of solvents, such as methanol, or detergents may impact the quality of the samples.

Analytical Methods

SF₆ and CFCs analyses were done at the USGS Chlorofluorocarbon Laboratory by using a purge-and-trap gas chromatography procedure with an electron capture detector (ECD) documented by Busenberg and Plummer (1992, 2000). ³He/³H analyses were done at the Noble Gas Laboratory of Lamont-Doherty Earth Observatory (LDEO) of Columbia University, Palisades, N.Y., using ³He-ingrowth with mass spectrometry for ³H (Clarke and others, 1976) and mass spectrometry for ³He as described in Schlosser and others (1988) and Ekwurzel and others (1994). ³H analyses were done at the USGS Tritium Laboratory, Menlo Park, Calif., using electrolytic enrichment (Östlund and Werner, 1962) and liquid scintillation (Thatcher and others, 1977). Sample analysis for ⁴He and dissolved gases was done at the USGS Dissolved Gas Laboratory, Reston, using gas chromatography as described in Busenberg and others (1993) and Busenberg, and others (2001).

Quality Control

No blank samples were collected as part of this study due to the difficulty in preparation of tracer- and dissolved-gas-free water. For quality assurance, all samples were collected and analyzed as replicate samples, in accordance with standard procedure for collecting the environmental tracers specific to this report. A summary of replicate analyses and relative percent differences is not included in this report. Although samples were collected as replicate samples, all values were analyzed, reviewed and included in the determination of apparent groundwater ages. Summary statistics for environmental tracers are not provided. The evaluation of an individual analyte in relation to its replicate, for example CFCs, is also dependent upon the SF₆ and/or ³He/³H result provided. Even if a result for CFCs appears valid, it may be contradicted by evidence in one of the other environmental tracers.

Groundwater Environmental Tracer Data

Well-construction data for groundwater wells from which samples were collected and analyzed for dissolved gases and environmental tracer data in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties are presented in appendix 1. Physicochemical data collected to help ensure that groundwater samples characterized water from the Chicot, Evangeline, and Jasper aquifers are presented in appendix 2. Dissolved-gas and environmental tracer data analyzed in groundwater samples collected from the Chicot, Evangeline and Jasper aquifers during March–September 2008 are presented in appendixes 3–7. Appendix 3 contains dissolved-gas data analyzed by the USGS Dissolved Gas Laboratory. Appendix 4 contains SF₆ and CFC data analyzed by the USGS Chlorofluorocarbon Laboratory. Appendix 5 contains ³H data analyzed by the USGS Tritium Laboratory. Appendix 6 contains ⁴He data analyzed by the USGS Dissolved Gas Laboratory. Appendix 7 contains helium, tritium, and neon data analyzed by the Noble Gas Laboratory of LDEO of Columbia University.

Summary

The Gulf Coast aquifer system is the primary water supply for Montgomery County in southeastern Texas, including part of the Houston, Texas, metropolitan area and the municipalities of Magnolia, Conroe, and The Woodlands Township, Texas. Montgomery County is forecasted to be one of the fastest growing counties in the Houston area, more than doubling its 2000 population of 373,000 by 2035. The U.S. Geological Survey (USGS), in cooperation with the Lone Star Groundwater Conservation District, conducted a study to appraise groundwater recharge in the Gulf Coast aquifer within Montgomery County and adjacent counties by using environmental tracers. The Gulf Coast aquifer system in Montgomery County consists of the Chicot, Evangeline, and Jasper aquifers, the Burkeville confining unit, and the underlying Catahoula Sandstone.

Of the 40 existing groundwater wells screened in the Gulf Coast aquifer system that were selected for sampling, 38 were in Montgomery County, 1 was in Waller County, and 1 was in Walker County. Groundwater-quality samples, physicochemical properties, and water-level data were collected once from each of the 40 wells during March–September 2008. Groundwater-quality samples were analyzed for dissolved gases and the environmental tracers sulfur hexafluoride (SF₆), chlorofluorocarbons (CFCs), tritium (³H), helium-4 (⁴He), and helium-3/tritium (³He/³H). Water samples were collected from wells using procedures described in the USGS “National Field Manual for the Collection of Water-Quality Data” and provided by the USGS Chlorofluorocarbon Laboratory. Samples

were collected and processed onsite using methods designed to minimize changes to the water-sample chemistry or contamination from the atmosphere. Samples were analyzed for SF₆ and CFCs at the USGS Chlorofluorocarbon Laboratory, for ³H at the USGS Tritium Laboratory, for ³He/³H at the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, and for ⁴He and dissolved gases at the USGS Dissolved Gas Laboratory. Sample procedures required replicate samples for quality assurance and quality control to be collected with each environmental sample; no blank samples were collected.

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Appendixes 1–7

10 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008.

[Station name refers to State well number (TS, Montgomery County; YU, Walker County; YW, Waller County); 4-digit identifiers are Groundwater Site Inventory components; NAVD 88, North American Vertical Datum of 1988; ft, feet; LSD, land-surface datum; in., inches; S, steel; P, polyvinyl chloride; U, unknown; --, data not available; SS, stainless steel; GI, galvanized iron; GS, galvanized steel]

Station name (C012)	Station number (C001)	Altitude of land surface, NAVD 88 (ft) (C016)	Primary use of site (C023)	Pri- mary use of water (C024)	Aquifer name	Well depth (ft) (C028)	Water-level measurement date (C235)	Water level below LSD (ft) (C237)	Date of construction (C060)
TS-60-53-719	300824095274703	138	Observation	Unused	Chicot	120	3/12/2008	21.61	2/14/1991
TS-60-53-720	300824095274702	138	Observation	Unused	Chicot	85	3/13/2008	22.51	2/20/1991
TS-60-44-805	301505095343702	171	Observation	Unused	Chicot	161	3/17/2008	39	3/20/1991
TS-60-45-413	301948095290003	240	Observation	Unused	Chicot	109.5	3/19/2008	53.56	10/19/1989
TS-60-45-414	301948095290004	240	Observation	Unused	Chicot	80	3/19/2008	53.56	10/20/1989
TS-60-54-805	300833095173201	116	Observation	Unused	Chicot	165	3/21/2008	46.84	7/12/1991
TS-60-54-806	300833095173202	116	Observation	Unused	Chicot	128	3/24/2008	46.74	7/15/1991
TS-60-35-504	302636095422802	243	Observation	Unused	Evangeline	83	3/25/2008	13.60	3/5/1991
TS-60-35-505	302636095422803	243	Observation	Unused	Evangeline	60	3/25/2008	13.85	3/8/1991
TS-60-54-807	300833095173203	116	Observation	Unused	Chicot	66	3/26/2008	32.29	7/22/1991
TS-60-35-503	302636095422801	240	Observation	Unused	Evangeline	118	3/26/2008	13.50	3/1/1991
TS-60-44-806	301505095343703	171	Observation	Unused	Chicot	75	3/27/2008	37.73	3/22/1991

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name	Depth to top of casing string (ft)	Depth to bottom of casing string (ft)	Diameter of casing string (in.)	Casing material	Depth to top of open interval (ft)	Depth to bottom of open interval (ft)	Diameter of open interval (in.)	Type of material in open interval	Type of open interval
(C012)	(C077)	(C078)	(C079)	(C080)	(C083)	(C084)	(C087)	(C086)	(C085)
TS-60-53-719	0	88	6	S	100	120	4	S	Screen
	80	100	4	S					
TS-60-53-720	0	58	6	S	65	85	4	S	Screen
	50	65	4	S					
TS-60-44-805	0	138	6	P	141	161	4	P	Screen
	135	141	4	P					
TS-60-45-413	0	99.5	4	P	99.5	109.5	4	P	Screen
TS-60-45-414	0	70	4	P	70	80	4	P	Screen
TS-60-54-805	0	139	6	S	146	165	4	S	Screen
	129	145	4	S					
TS-60-54-806	0	106	6	S	108	128	4	S	Screen
	98	108	4	S					
TS-60-35-504	0	59	6	P	63	83	4	P	Screen
	49	63	4	P					
TS-60-35-505	0	39	6	P	40	60	4	P	Screen
	30	40	4	P					
TS-60-54-807	0	56	6	S	56	66	6	S	Screen
TS-60-35-503	0	97	6	P	98	118	4	P	Screen
	90	98	4	P					
TS-60-44-806	0	53	6	P	55	75	4	P	Screen
	48	55	4	P					

12 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name	Station number	Altitude of land surface, NAVD 88 (ft)	Primary use of site	Primary use of water	Aquifer name	Well depth (ft)	Water-level measurement date	Water level below LSD (ft)	Date of construction
(C012)	(C001)	(C016)	(C023)	(C024)		(C028)	(C235)	(C237)	(C060)
TS-60-26-901	303222095455301	312	Withdrawal	Domestic	Jasper	324	1/31/2008	115.19	10/26/2005
TS-60-26-208	303610095484501	410	Unused	Unused	Jasper	172	1/31/2008	146.72	8/1992
TS-60-45-513	301912095253701	195	Withdrawal	Industrial	Chicot	168	1/29/1977	38	1/29/1977
TS-60-34-301	302836095452701	380	Withdrawal	Domestic	Evangeline	52	3/17/1983	35	3/17/1983
YW-59-64-206	300542096045403	235	Withdrawal	Public supply	Jasper	1,240	1/23/2008	93.85	1967
TS-60-43-511	301904095414801	308	Withdrawal	Public supply	Evangeline	389	2/4/2008	223.54	9/1978
TS-60-63-110	300642095131701	90	Withdrawal	Domestic	Chicot	97	--	--	1988
TS-60-37-309	302850095241801	390	Observation	Unused	Evangeline	61	--	--	4/4/1978
TS-60-54-702	300958095221901	95	Withdrawal	Industrial	Chicot	95	--	--	1983
TS-60-44-212	302014095343201	203	Withdrawal	Public supply	Evangeline	477	4/8/1989	70	4/8/1989
TS-60-55-710	300849095143301	112	Observation	Unused	Evangeline	600	7/16/2008	130.52	8/13/1991
YU-60-28-802	303143095334801	315	Observation	Unused	Jasper	181	7/17/2008	76.21	10/27/1989
TS-60-45-114	302040095281701	263	Withdrawal	Irrigation	Chicot	128	8/6/1984	51	8/6/1984

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name	Depth to top of casing string (ft)	Depth to bottom of casing string (ft)	Diameter of casing string (in.)	Casing material	Depth to top of open interval (ft)	Depth to bottom of open interval (ft)	Diameter of open interval (in.)	Type of material in open interval	Type of open interval
(C012)	(C077)	(C078)	(C079)	(C080)	(C083)	(C084)	(C087)	(C086)	(C085)
TS-60-26-901	0	290	4	S	295	324	2.5	S	Screen
	285	295	2.5	S					
TS-60-26-208	0	157	4	U	157	172	3	U	Screen
TS-60-45-513	0	150	4	P	158	168	2.5	SS	Screen
	146	168	2.5	P					
TS-60-34-301	0	37	2		37	47	2	P	Screen
	47	52	2	P					
YW-59-64-206	0		10.75	U	1,111	1,229	--	U	Screen
TS-60-43-511	0	347	7	S	347	389	4.5	SS	Wire-wound screen
	305	347	4.5	S					
TS-60-63-110	0	95			85	95	--	U	Screen
TS-60-37-309	0	51	4	P	51	61	--	U	Screen
TS-60-54-702	0	90	4	P	80	90	4	P	Screen
TS-60-44-212	0	436	5	P	457	477	2.5	U	Screen
	426	457	2.5	P					
TS-60-55-710	--	--	--	U	570	600	4	S	Screen
YU-60-28-802	0	171	4	P	171	181	4	P	Screen
TS-60-45-114	0	118	4	P	118	128	2.5	S	Wire-wound screen
	107	128	2.5	GI					

14 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name (C012)	Station number (C001)	Altitude of land surface, NAVD 88 (ft) (C016)	Primary use of site (C023)	Primary use of water (C024)	Aquifer name	Well depth (ft) (C028)	Water-level measurement date (C235)	Water level below LSD (ft) (C237)	Date of construction (C060)
TS-60-53-210	301338095272301	125	Withdrawal	Industrial	Evangeline	222	2/24/1984	27	2/24/1984
TS-60-43-514	301917095413101	312	Withdrawal	Public supply	Jasper	1,050	2/4/2008	296.93	2003
TS-60-45-716	301614095284201	132	Withdrawal	Recreations	Evangeline	710	2/5/2008	260.30	5/30/1997
TS-60-42-902	301612095450901	281	Withdrawal	Domestic	Evangeline	212	7/23/1990	85	7/22/1990
TS-60-53-516	301228095272501	129	Observation	Unused	Evangeline	807	8/18/2008	370.48	5/21/1991
TS-60-36-410	302651095362901	205	Withdrawal	Public supply	Jasper	467	2/8/2008	130.39	3/27/1995
TS-60-35-907	302412095382101	238	Withdrawal	Public supply	Jasper	490	2/1/2008	175.48	5/14/1982
TS-60-37-806	302436095263501	280	Withdrawal	Public supply	Evangeline	350	1/31/2008	177.98	11/19/1984

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name	Depth to top of casing string (ft)	Depth to bottom of casing string (ft)	Diameter of casing string (in.)	Casing material	Depth to top of open interval (ft)	Depth to bottom of open interval (ft)	Diameter of open interval (in.)	Type of material in open interval	Type of open interval
(C012)	(C077)	(C078)	(C079)	(C080)	(C083)	(C084)	(C087)	(C086)	(C085)
TS-60-53-210	0	210	4	P	212	222	2	S	Screen
	201	222	2	GI					
TS-60-43-514	0	840	14	S	844	864	8.62	U	Screen
	744	844	8.62	S	874	886	8.62	U	Screen
	864	874	8.62	S	890	902	8.62	U	Screen
	886	890	8.62	S	930	940	8.62	U	Screen
	902	930	8.62	S	968	1,028	8.62	U	Screen
	940	968	8.62	S					
	1,028	1,050	8.62	S					
TS-60-45-716	0	20	14	S	647	710	5	SS	Screen
	0	632	9	S					
	605	647	5	S					
TS-60-42-902	0	182	4	P	192	212	2.5	P	Perforated or slotted
	177	212	2.5	P					
TS-60-53-516	0	774	6	S	777	807	4	S	Screen
	747	777	4	S					
TS-60-36-410	0	--	5	U	444	465	--	U	Screen
TS-60-35-907	0	470	6	S	470	490	4	SS	Wire-wound screen
	449	470	4	GI	480	490	4	SS	Wire-wound screen
TS-60-37-806	0	330	4	S	330	350	3	SS	Wire-wound screen
	316	330	3	S					

16 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name (C012)	Station number (C001)	Altitude of land surface, NAVD 88 (ft) (C016)	Primary use of site (C023)	Primary use of water (C024)	Aquifer name	Well depth (ft) (C028)	Water-level measurement date (C235)	Water level below LSD (ft) (C237)	Date of construction (C060)
TS-60-37-909	302452095242001	280	Withdrawal	Public supply	Evangeline	515	1/31/2008	164.90	3/1985
TS-60-59-102	300658095443101	231	Withdrawal	Public supply	Evangeline	298	2/2/2007	108.03	12/21/2001
TS-60-51-809	300853095412701	195	Withdrawal	Public supply	Chicot	203	7/29/1994	59	7/27/1994
TS-60-51-8XXB	300849095412601	204	Withdrawal	Public supply	Chicot	203	--	--	--
TS-60-51-8XXA	300849095415701	212	Withdrawal	Public supply	Chicot	252	--	--	--
TS-60-52-1xx	301332095361901	216	Withdrawal	Public supply	Evangeline	440	--	--	--
TS-60-51-5xx	301057095421901	246	Withdrawal	Public supply	Evangeline	416	--	--	--

Appendix 1. Well-construction information for groundwater wells sampled in the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name	Depth to top of casing string (ft)	Depth to bottom of casing string (ft)	Diameter of casing string (in.)	Casing material	Depth to top of open interval (ft)	Depth to bottom of open interval (ft)	Diameter of open interval (in.)	Type of material in open interval	Type of open interval
(C012)	(C077)	(C078)	(C079)	(C080)	(C083)	(C084)	(C087)	(C086)	(C085)
TS-60-37-909	0 466	470 515	4 3	U U	500	515	3	U	Screen
TS-60-59-102	0 296	275 298	6.88 4.5	GS	275	296	4.5	U	Screen
TS-60-51-809	0 183	190 203	5 3	P P	190	203	3	P	Perforated or slotted
TS-60-51-8XXB	--	--	--	U	183	--	--	U	U
TS-60-51-8XXA	--	--	--	U	232	--	--	U	U
TS-60-52-1xx	--	--	--	U	340	--	--	U	U
TS-60-51-5xx	--	--	--	U	384	--	--	U	U

18 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 2. Physicochemical data measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008.

[Station name refers to State well number (TS, Montgomery County; YU, Walker County; YW, Waller County); 5-digit numbers are National Water Information System parameter codes; mg/L, milligrams per liter; std, standard; $\mu\text{S}/\text{cm}$, microsiemens per centimeter at 25 degrees Celsius; $^{\circ}\text{C}$, degrees Celsius; U, analyzed for, not detected; --, no sample; M, presence verified, not quantified; N, presumptive evidence of presence]

Station name	Station number	Sample date	Sample time	Dissolved oxygen (mg/L) (00300)	pH, std units (00400)	Specific conductance ($\mu\text{S}/\text{cm}$) (00095)	Water temperature ($^{\circ}\text{C}$) (00010)	Hydrogen sulfide, presence/absence, water unfiltered (mg/L) (71875)
TS-60-53-719	300824095274703	3/12/2008	1415	3.9	5.7	627	23.3	U
TS-60-53-720	300824095274702	3/13/2008	1410	.7	8.2	602	29.1	U
TS-60-44-805	301505095343702	3/17/2008	1300	5.4	5.6	114	22.1	U
TS-60-45-413	301948095290003	3/19/2008	845	5.6	7.1	305	22.5	U
TS-60-45-414	301948095290004	3/19/2008	1215	5.6	6.7	270	24.6	--
TS-60-54-805	300833095173201	3/21/2008	1315	3.0	6.2	420	21.7	--
TS-60-54-806	300833095173202	3/24/2008	1200	2.1	6.1	466	21.5	--
TS-60-35-504	302636095422802	3/25/2008	1100	3.8	6.8	527	21.1	--
TS-60-35-505	302636095422803	3/25/2008	1330	3.6	6.0	173	20.6	--
TS-60-54-807	300833095173203	3/26/2008	900	3.6	6.8	529	21.5	--
TS-60-35-503	302636095422801	3/26/2008	1400	4.4	7.0	638	21.3	--
TS-60-44-806	301505095343703	3/27/2008	1230	3.2	5.8	648	23.0	--
TS-60-26-901	303222095455301	4/21/2008	1030	1.2	7.0	575	22.1	--
TS-60-26-208	303610095484501	4/21/2008	1400	.5	7.1	451	22.9	--
TS-60-45-513	301912095253701	4/22/2008	930	3.2	5.8	151	21.2	--
TS-60-34-301	302836095452701	4/22/2008	1330	1.6	7.0	600	22.5	--
YW-59-64-206	300542096045403	4/23/2008	1045	.4	7.6	1,270	30.9	M
TS-60-43-511	301904095414801	4/23/2008	1345	1.6	6.9	696	23.0	--
TS-60-63-110	300642095131701	4/24/2008	1530	.3	5.9	301	21.2	--
TS-60-37-309	302850095241801	4/28/2008	1200	.7	7.0	713	22.7	N

Appendix 2. Physicochemical data measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008—Continued.

Station name	Station number	Sample date	Sample time	Dissolved oxygen (mg/L) (00300)	pH, std units (00400)	Specific conductance (µS/cm) (00095)	Water temperature (°C) (00010)	Hydrogen sulfide, presence/absence, water unfiltered (mg/L) (71875)
TS-60-54-702	300958095221901	4/30/2008	1030	1.4	5.5	114	23.1	--
TS-60-44-212	302014095343201	7/10/2008	1224	1.5	7.3	613	23.8	U
TS-60-55-710	300849095143301	7/16/2008	1630	.7	7.7	367	24.2	U
YU-60-28-802	303143095334801	7/17/2008	1620	.6	8.2	411	28.9	U
TS-60-45-114	302040095281701	7/18/2008	1135	5.6	5.2	93	23.2	U
TS-60-53-210	301338095272301	7/21/2008	935	4.0	7.2	458	22.3	U
TS-60-43-514	301917095413101	7/21/2008	1245	.9	7.2	575	27.9	--
TS-60-45-716	301614095284201	8/1/2008	845	1.3	7.5	588	25.4	M
TS-60-42-902	301612095450901	8/1/2008	1400	6.3	7.0	265	21.8	U
TS-60-53-516	301228095272501	8/18/2008	1530	.2	8.8	529	25.6	U
TS-60-36-410	302651095362901	9/2/2008	950	.4	7.0	517	23.1	U
TS-60-35-907	302412095382101	9/2/2008	1215	.7	7.1	551	24.3	U
TS-60-37-806	302436095263501	9/3/2008	1245	.3	7.0	688	22.6	--
TS-60-37-909	302452095242001	9/3/2008	1520	.3	7.1	708	23.2	--
TS-60-59-102	300658095443101	9/4/2008	915	5.3	7.4	410	22.2	--
TS-60-51-809	300853095412701	9/4/2008	1040	6.1	6.2	386	22.3	U
TS-60-51-8XXB	300849095412601	9/4/2008	1140	2.4	6.5	461	21.8	--
TS-60-51-8XXA	300849095415701	9/4/2008	1415	5.7	6.6	393	22.4	--
TS-60-52-1xx	301332095361901	9/5/2008	900	.3	7.5	460	22.2	--
TS-60-51-5xx	301057095421901	9/5/2008	1035	.4	7.3	615	23.5	--

20 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 3. Dissolved-gas concentrations measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Dissolved Gas Laboratory, Reston, Virginia).

[Station name refers to State well number (TS, Montgomery County; YU, Walker County; YW, Waller County); mg/L, milligrams per liter; °C, degrees Celsius; cc STP/L, cubic centimeters at standard temperature and pressure per liter; <, less than; >, greater than; --, not determined]

Station name	Station number	Sample date	Sample time	Nitrogen (N ₂) (mg/L)	Argon (Ar) (mg/L)	Oxygen (O ₂) (mg/L)	Carbon dioxide (CO ₂) (mg/L)	Methane (CH ₄) (mg/L)	Recharge temperature (°C)	Excess air in water sample (cc STP/L)
TS-60-53-719	300824095274703	3/12/2008	1415	18.56	0.64	2.86	132.12	<0.0005	16.3	2.8
TS-60-53-719	300824095274703	3/12/2008	1415	18.69	.64	3.00	131.55	<.0005	16.3	2.9
TS-60-53-720	300824095274702	3/13/2008	1410	14.87	.53	.20	0.40	.8389	23.5	1.0
TS-60-53-720	300824095274702	3/13/2008	1410	14.72	.53	.20	0.35	.9841	23.6	.9
TS-60-44-805	301505095343702	3/17/2008	1300	18.79	.66	5.06	94.30	<.0005	14.3	2.4
TS-60-44-805	301505095343702	3/17/2008	1300	18.93	.66	4.21	95.22	<.0005	14.2	2.5
TS-60-45-413	301948095290003	3/19/2008	845	18.83	.64	3.12	7.47	.0082	16.3	3.1
TS-60-45-413	301948095290003	3/19/2008	845	18.94	.65	2.70	9.57	.0072	16.1	3.2
TS-60-45-414	301948095290004	3/19/2008	1215	19.30	.64	4.69	58.95	<.0005	18.1	4.1 ^a
TS-60-45-414	301948095290004	3/19/2008	1215	17.90	.61	4.37	69.15	<.0005	18.5	2.8
TS-60-54-805	300833095173201	3/21/2008	1315	20.58	.69	1.62	117.19	<.0005	14.0	4.1
TS-60-54-805	300833095173201	3/21/2008	1315	19.63	.68	1.56	116.94	<.0005	14.2	3.2
TS-60-54-806	300833095173202	3/24/2008	1200	20.07	.68	1.02	134.31	.0014	14.0	3.6
TS-60-54-806	300833095173202	3/24/2008	1200	19.56	.68	1.01	137.12	.0015	14.1	3.0
TS-60-35-504	302636095422802	3/25/2008	1100	18.11	.62	1.98	49.93	<.0005	17.7	2.8
TS-60-35-504	302636095422802	3/25/2008	1100	18.09	.62	1.96	49.88	<.0005	17.3	2.7
TS-60-35-505	302636095422803	3/25/2008	1330	19.59	.64	2.90	83.67	<.0005	18.7	4.6
TS-60-35-505	302636095422803	3/25/2008	1330	19.19	.63	2.87	81.76	<.0005	18.7	4.2
TS-60-35-503	302636095422801	3/26/2008	1400	16.96	.60	2.80	36.52	<.0005	18.5	1.9
TS-60-35-503	302636095422801	3/26/2008	1400	17.03	.60	2.61	36.65	<.0005	18.7	2.0
TS-60-54-807	300833095173203	3/26/2008	900	19.85	.66	.82	62.17	.0064	17.3	4.4
TS-60-54-807	300833095173203	3/26/2008	900	20.86	.69	.82	64.98	.0053	15.7	4.9
TS-60-44-806	301505095343703	3/27/2008	1230	20.58	.70	.89	119.88	<.0005	13.6	4.0
TS-60-44-806	301505095343703	3/27/2008	1230	20.17	.69	.60	116.06	<.0005	13.6	3.6
TS-60-26-208	303610095484501	4/21/2008	1400	19.19	.65	.25	21.10	<.0005	16.2	3.6
TS-60-26-208	303610095484501	4/21/2008	1400	18.98	.65	.25	20.80	<.0005	16.2	3.4
TS-60-26-901	303222095455301	4/21/2008	1030	18.30	.63	.23	32.68	.0049	17.2	2.9
TS-60-26-901	303222095455301	4/21/2008	1030	18.19	.63	.26	32.66	.0058	17.2	2.8
TS-60-45-513	301912095253701	4/22/2008	930	19.60	.68	3.22	94.40	<.0005	13.4	2.9
TS-60-45-513	301912095253701	4/22/2008	930	19.49	.68	3.20	95.05	<.0005	13.4	2.8

Appendix 3. Dissolved-gas concentrations measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Dissolved Gas Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Nitrogen (N ₂) (mg/L)	Argon (Ar) (mg/L)	Oxygen (O ₂) (mg/L)	Carbon dioxide (CO ₂) (mg/L)	Methane (CH ₄) (mg/L)	Re-charge temperature (°C)	Excess air in water sample (cc STP/L)
TS-60-34-301	302836095452701	4/22/2008	1330	18.71	0.64	0.49	26.81	0.0230	15.9	2.9
TS-60-34-301	302836095452701	4/22/2008	1330	18.56	.64	.38	26.68	.0222	16.4	2.9
YW-59-64-206	300542096045403	4/23/2008	1045	8.23	.31	.07	20.86	>40	--	--
YW-59-64-206	300542096045403	4/23/2008	1045	8.08	.30	.07	20.85	>40	--	--
TS-60-43-511	301904095414801	4/23/2008	1345	17.57	.61	1.36	41.81	<.0005	17.6	2.2
TS-60-43-511	301904095414801	4/23/2008	1345	17.29	.61	1.27	45.63	<.0005	17.9	2.1
TS-60-63-110	300642095131701	4/24/2008	1530	19.70	.68	.26	106.26	.0012	13.9	3.1
TS-60-63-110	300642095131701	4/24/2008	1530	19.72	.68	.25	106.44	.0011	13.8	3.1
TS-60-37-309	302850095241801	4/28/2008	1200	20.71	.70	.56	43.48	<.0005	12.5	3.9
TS-60-37-309	302850095241801	4/28/2008	1200	20.41	.70	.46	43.99	<.0005	12.8	3.7
TS-60-54-702	300958095221901	4/30/2008	1030	20.78	.66	1.44	81.11	<.0005	18.9	5.8
TS-60-54-702	300958095221901	4/30/2008	1030	20.44	.66	1.51	79.67	<.0005	18.8	5.4
TS-60-44-212	302014095343201	7/10/2008	1224	20.58	.72	.25	20.02	.0015	11.1	3.1
TS-60-44-212	302014095343201	7/10/2008	1224	20.47	.71	.23	19.92	.0016	11.5	3.1
TS-60-44-212	302014095343201	7/10/2008	1224	20.40	.71	.25	19.96	.0012	11.5	3.1
TS-60-55-710	300849095143301	7/16/2008	1630	18.44	.64	.24	5.05	<.0005	15.7	2.5
TS-60-55-710	300849095143301	7/16/2008	1630	18.48	.64	.23	5.05	<.0005	15.7	2.5
YU-60-28-802	303143095334801	7/17/2008	1620	17.70	.62	.23	2.20	.0778	16.7	2.1
YU-60-28-802	303143095334801	7/17/2008	1620	17.62	.62	.24	3.10	.0750	16.9	2.1
TS-60-45-114	302040095281701	7/18/2008	1135	17.30	.61	3.89	96.76	<.0005	17.0	1.8
TS-60-45-114	302040095281701	7/18/2008	1135	16.74	.60	4.65	88.45	<.0005	17.2	1.3
TS-60-53-210	301338095272301	7/21/2008	935	19.52	.66	1.20	18.35	<.0005	16.0	3.7
TS-60-53-210	301338095272301	7/21/2008	935	19.61	.66	.52	19.22	<.0005	16.0	3.7
TS-60-43-514	301917095413101	7/21/2008	1245	20.15	.70	.26	25.23	.0124	11.7	3.0
TS-60-43-514	301917095413101	7/21/2008	1245	19.77	.69	.26	24.78	.0122	12.1	2.7
TS-60-45-716	301614095284201	8/1/2008	845	20.52	.72	.24	21.26	.0053	11.1	3.0
TS-60-45-716	301614095284201	8/1/2008	845	20.21	.71	.23	21.16	.0045	11.2	2.7
TS-60-42-902	301612095450901	8/1/2008	1400	19.41	.66	2.52	47.01	<.0005	15.9	3.6
TS-60-42-902	301612095450901	8/1/2008	1400	19.51	.66	3.25	46.65	<.0005	16.0	3.7
TS-60-53-516	301228095272501	8/18/2008	1530	20.06	.70	.21	1.10	2.3809	11.9	2.8
TS-60-53-516	301228095272501	8/18/2008	1530	20.04	.70	.23	1.38	2.3926	12.0	2.8

22 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 3. Dissolved-gas concentrations measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Dissolved Gas Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Nitrogen (N ₂) (mg/L)	Argon (Ar) (mg/L)	Oxygen (O ₂) (mg/L)	Carbon dioxide (CO ₂) (mg/L)	Methane (CH ₄) (mg/L)	Recharge temperature (°C)	Excess air in water sample (cc STP/L)
TS-60-36-410	302651095362901	9/2/2008	950	18.23	0.63	0.23	17.39	0.0111	16.9	2.7
TS-60-36-410	302651095362901	9/2/2008	950	18.24	.63	.23	17.44	.0109	16.5	2.6
TS-60-35-907	302412095382101	9/2/2008	1215	19.28	.67	.25	21.03	.0090	13.4	2.6
TS-60-35-907	302412095382101	9/2/2008	1215	19.65	.68	.26	21.32	.0089	13.3	2.9
TS-60-37-806	302436095263501	9/3/2008	1245	20.36	.65	1.06	38.35	.0038	18.5	*5.4
TS-60-37-806	302436095263501	9/3/2008	1245	17.13	.60	.22	37.45	.0039	18.8	2.1
TS-60-37-909	302452095242001	9/3/2008	1520	17.17	.59	.22	29.48	.0027	19.9	2.5
TS-60-37-909	302452095242001	9/3/2008	1520	17.19	.59	.22	29.40	.0023	2.1	2.6
TS-60-59-102	300658095443101	9/4/2008	915	17.91	.62	.83	14.17	<.0005	17.7	2.6
TS-60-59-102	300658095443101	9/4/2008	915	17.83	.61	.78	13.94	<.0005	18.2	2.7
TS-60-51-809	300853095412701	9/4/2008	1040	16.72	.60	1.55	67.56	<.0005	18.3	1.5
TS-60-51-809	300853095412701	9/4/2008	1040	16.70	.59	1.67	68.06	<.0005	18.6	1.6
TS-60-51-8XXB	300849095412601	9/4/2008	1140	16.59	.59	1.41	45.81	<.0005	18.4	1.4
TS-60-51-8XXB	300849095412601	9/4/2008	1140	16.64	.59	1.64	45.61	<.0005	18.4	1.5
TS-60-51-8XXA	300849095415701	9/4/2008	1415	16.80	.59	5.05	4.96	<.0005	18.5	1.7
TS-60-51-8XXA	300849095415701	9/4/2008	1415	16.91	.60	5.21	41.08	<.0005	18.2	1.7
TS-60-52-1xx	301332095361901	9/5/2008	900	19.23	.67	.25	8.97	.0014	13.9	2.7
TS-60-52-1xx	301332095361901	9/5/2008	900	19.31	.67	.25	8.99	.0010	13.5	2.7
TS-60-51-5xx	301057095421901	9/5/2008	1035	19.18	.65	.26	15.09	<.0005	15.8	3.3
TS-60-51-5xx	301057095421901	9/5/2008	1035	19.06	.65	.26	15.02	<.0005	15.7	3.1

^a Slight leak in bottle.

Appendix 4. Sulfur hexafluoride and chlorofluorocarbons measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Chlorofluorocarbon Laboratory, Reston, Virginia).

[Station name refers to State well number (TS, Montgomery County; YU, Walker County; YW, Waller County); 5-digit numbers are National Water Information System parameter codes; fg/kg, femtogram per kilogram; CFC, chlorofluorocarbon; pg/kg, picogram per kilogram; U, analyzed for, not detected; B, bottle broken in transit or at laboratory; --, no sample]

Station name	Station number	Sample date	Sample time	Sulfur hexafluoride, water, unfiltered (fg/kg) (63149)	CFC-113, for age dating, water, unfiltered (pg/kg) (50283)	CFC-12, for age dating, water, unfiltered (pg/kg) (50282)	CFC-11, for age dating, water, unfiltered (pg/kg) (50281)
TS-60-53-719	300824095274703	3/12/2008	1416	28.8	U	1.4	1.4
TS-60-53-719	300824095274703	3/12/2008	1417	20.1	U	1.2	1.3
TS-60-53-720	300824095274702	3/13/2008	1411	105	U	120	1.1
TS-60-53-720	300824095274702	3/13/2008	1412	105	U	120	1.1
TS-60-44-805	301505095343702	3/17/2008	1301	16.7	.3	2.4	4.1
TS-60-44-805	301505095343702	3/17/2008	1302	16.2	.6	3.3	3.3
TS-60-45-413	301948095290003	3/19/2008	846	19.6	13	14	33
TS-60-45-413	301948095290003	3/19/2008	847	B	18	16	31
TS-60-45-414	301948095290004	3/19/2008	1216	38.4	20	130	190
TS-60-45-414	301948095290004	3/19/2008	1217	40.4	21	140	190
TS-60-45-414	301948095290004	3/19/2008	1218	--	22	120	200
TS-60-54-805	300833095173201	3/21/2008	1316	31.4	1.1	18	19
TS-60-54-805	300833095173201	3/21/2008	1317	14.9	1.1	18	17
TS-60-54-806	300833095173202	3/24/2008	1201	18.9	1	20	13
TS-60-54-806	300833095173202	3/24/2008	1202	10.5	1	18	11
TS-60-35-504	302636095422802	3/25/2008	1101	53	.1	7.2	11
TS-60-35-504	302636095422802	3/25/2008	1102	52.5	U	7.4	12
TS-60-35-505	302636095422803	3/25/2008	1331	35.3	1.9	27	41
TS-60-35-505	302636095422803	3/25/2008	1332	37.2	1.7	39	39
TS-60-35-505	302636095422803	3/25/2008	1333	--	1.5	26	38

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Appendix 4. Sulfur hexafluoride and chlorofluorocarbons measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Chlorofluorocarbon Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Sulfur hexafluoride, unfiltered (fg/kg) (63149)	CFC-113, for age dating, water, unfiltered (pg/kg) (50283)	CFC-12, for age dating, water, unfiltered (pg/kg) (50282)	CFC-11, for age dating, water, unfiltered (pg/kg) (50281)
TS-60-54-807	300833095173203	3/26/2008	901	37.2	10	130	82
TS-60-54-807	300833095173203	3/26/2008	902	B	9	130	79
TS-60-54-807	300833095173203	3/26/2008	903	--	8.1	120	72
TS-60-35-503	302636095422801	3/26/2008	1401	49.8	.8	1	10
TS-60-35-503	302636095422801	3/26/2008	1402	49.9	U	.4	1
TS-60-35-503	302636095422801	3/26/2008	1403	--	U	1.2	2.9
TS-60-44-806	301505095343703	3/27/2008	1231	12	18	22	28
TS-60-44-806	301505095343703	3/27/2008	1232	24.3	25	22	41
TS-60-44-806	301505095343703	3/27/2008	1233	--	25	22	29
TS-60-26-901	303222095455301	4/21/2008	1031	12.1	.3	4.1	2.6
TS-60-26-901	303222095455301	4/21/2008	1032	12.7	.4	2.9	5.4
TS-60-26-901	303222095455301	4/21/2008	1033	--	.4	2.8	1.4
TS-60-26-208	303610095484501	4/21/2008	1401	75.9	U	.9	3.2
TS-60-26-208	303610095484501	4/21/2008	1402	86.2	U	.9	3.4
TS-60-45-513	301912095253701	4/22/2008	931	23.8	.6	1.3	4.1
TS-60-45-513	301912095253701	4/22/2008	932	20.9	.6	3.3	11
TS-60-45-513	301912095253701	4/22/2008	933	--	.3	1.4	3.5
TS-60-34-301	302836095452701	4/22/2008	1331	31	1.9	11	16
TS-60-34-301	302836095452701	4/22/2008	1332	26.8	1.5	10	11
TS-60-34-301	302836095452701	4/22/2008	1333	--	1.8	9.7	14
YW-59-64-206	300542096045403	4/23/2008	1046	11.9	.2	1.3	3.5
YW-59-64-206	300542096045403	4/23/2008	1047	8.35	U	1.4	3.1

Appendix 4. Sulfur hexafluoride and chlorofluorocarbons measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Chlorofluorocarbon Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Sulfur hexafluoride, water, unfiltered (fg/kg) (63149)	CFC-113, for age dating, water, unfiltered (pg/kg) (50283)	CFC-12, for age dating, water, unfiltered (pg/kg) (50282)	CFC-11, for age dating, water, unfiltered (pg/kg) (50281)
TS-60-43-511	301904095414801	4/23/2008	1346	84.5	0.6	1.5	7.5
TS-60-43-511	301904095414801	4/23/2008	1347	86.3	.6	1.5	8
TS-60-63-110	300642095131701	4/24/2008	1531	19.4	1.2	15	8.3
TS-60-63-110	300642095131701	4/24/2008	1532	15.1	1.5	14	5.6
TS-60-37-309	302850095241801	4/28/2008	1201	23.6	2.3	13	15
TS-60-37-309	302850095241801	4/28/2008	1202	27	1.1	8.5	12
TS-60-37-309	302850095241801	4/28/2008	1203	--	5.5	16	16
TS-60-54-702	300958095221901	4/30/2008	1031	63.8	12	78	140
TS-60-54-702	300958095221901	4/30/2008	1032	65.6	13	81	140
TS-60-44-212	302014095343201	7/10/2008	1225	13.8	1.1	1.7	5.1
TS-60-44-212	302014095343201	7/10/2008	1226	15.2	1.3	1.9	7.7
TS-60-55-710	300849095143301	7/16/2008	1631	60.6	3.2	2.5	7.7
TS-60-55-710	300849095143301	7/16/2008	1632	49.3	3.3	1.6	2.6
YU-60-28-802	303143095334801	7/17/2008	1621	66.4	10	27	4.8
YU-60-28-802	303143095334801	7/17/2008	1622	54.1	9.2	25	7.7
TS-60-45-114	302040095281701	7/18/2008	1136	28.5	6.9	170	81
TS-60-45-114	302040095281701	7/18/2008	1137	30.3	7.5	170	83
TS-60-53-210	301338095272301	7/21/2008	936	54.2	1.8	8.4	5.8
TS-60-53-210	301338095272301	7/21/2008	937	56.7	1.9	8	6.9
TS-60-53-210	301338095272301	7/21/2008	938	--	3.1	9.9	13

26 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 4. Sulfur hexafluoride and chlorofluorocarbons measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Chlorofluorocarbon Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Sulfur hexafluoride, unfiltered (fg/kg) (63149)	CFC-113, for age dating, water, unfiltered (pg/kg) (50283)	CFC-12, for age dating, water, unfiltered (pg/kg) (50282)	CFC-11, for age dating, water, unfiltered (pg/kg) (50281)
TS-60-43-514	301917095413101	7/21/2008	1246	18.1	1	0.9	U
TS-60-43-514	301917095413101	7/21/2008	1247	21.5	3.1	2.5	3.6
TS-60-43-514	301917095413101	7/21/2008	1248	--	2	2.8	3.8
TS-60-45-716	301614095284201	8/1/2008	846	13	4.7	3	U
TS-60-45-716	301614095284201	8/1/2008	847	9.1	6	3.8	.1
TS-60-42-902	301612095450901	8/1/2008	1401	43.8	4.3	19	22
TS-60-42-902	301612095450901	8/1/2008	1402	42.5	3.8	20	22
TS-60-53-516	301228095272501	8/18/2008	1531	82.9	U	3.1	1.7
TS-60-53-516	301228095272501	8/18/2008	1532	79.8	U	3.4	2.1
TS-60-36-410	302651095362901	9/2/2008	951	10.2	.6	1.9	2.3
TS-60-36-410	302651095362901	9/2/2008	952	14.1	.6	1.5	2.4
TS-60-35-907	302412095382101	9/2/2008	1216	10.8	.6	1.6	2.8
TS-60-35-907	302412095382101	9/2/2008	1217	12.9	.4	1.6	1.9
TS-60-37-806	302436095263501	9/3/2008	1246	11.7	12	53	32
TS-60-37-806	302436095263501	9/3/2008	1247	14.7	4.4	2.1	3.3
TS-60-37-806	302436095263501	9/3/2008	1248	--	2.3	3.1	4.4
TS-60-37-909	302452095242001	9/3/2008	1521	10.9	U	.9	1.7
TS-60-37-909	302452095242001	9/3/2008	1522	6.1	U	1.5	3.1
TS-60-59-102	300658095443101	9/4/2008	916	42.8	1.4	1.9	3.4
TS-60-59-102	300658095443101	9/4/2008	917	41.2	1.6	8.7	8.8
TS-60-59-102	300658095443101	9/4/2008	918	--	U	1.7	3.6

Appendix 4. Sulfur hexafluoride and chlorofluorocarbons measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Chlorofluorocarbon Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Sulfur hexafluoride, water, unfiltered (fg/kg) (63149)	CFC-113, for age dating, water, unfiltered (pg/kg) (50283)	CFC-12, for age dating, water, unfiltered (pg/kg) (50282)	CFC-11, for age dating, water, unfiltered (pg/kg) (50281)
TS-60-51-809	300853095412701	9/4/2008	1041	25.7	1.5	3.8	5
TS-60-51-809	300853095412701	9/4/2008	1042	18.3	1	3.9	5.8
TS-60-51-8XXB	300849095412601	9/4/2008	1141	25.4	U	1.8	3.1
TS-60-51-8XXB	300849095412601	9/4/2008	1142	28.8	U	3.1	2.9
TS-60-51-8XXB	300849095412601	9/4/2008	1143	--	.6	5.4	4.7
TS-60-51-8XXA	300849095415701	9/4/2008	1416	40.4	U	360	1.8
TS-60-51-8XXA	300849095415701	9/4/2008	1417	38.2	U	350	2.2
TS-60-52-1xx	301332095361901	9/5/2008	901	5.2	U	1.1	1.5
TS-60-52-1xx	301332095361901	9/5/2008	902	11.1	U	1.5	2.05
TS-60-51-5xx	301057095421901	9/5/2008	1036	54.4	U	1.1	.8
TS-60-51-5xx	301057095421901	9/5/2008	1037	62.8	2.7	2.3	2.6
TS-60-51-5xx	301057095421901	9/5/2008	1038	--	U	1.4	2.4

28 Groundwater Environmental Tracer Data Collected from the Chicot, Evangeline, and Jasper Aquifers

Appendix 5. Tritium measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Tritium Laboratory, Menlo Park, California).

[Station name refers to State well number (TS, Montgomery County; YU, Walker County; YW, Waller County); 07000, National Water Information parameter code; pCi/L, picocuries per liter; ssLc, sample specific critical level; R, radiochemical non-detect]

Station name	Station number	Sample date	Sample start time	Tritium, water, unfiltered (pCi/L) (07000)	ssLc	Analysis date
TS-60-53-719	300824095274703	3/12/2008	1415	R0.2	0.35	10/28/2009
TS-60-53-720	300824095274702	3/13/2008	1410	R-.1	.32	10/21/2009
TS-60-44-805	301505095343702	3/17/2008	1300	R0	.32	10/21/2009
TS-60-45-413	301948095290003	3/19/2008	845	.7	.32	10/21/2009
TS-60-45-414	301948095290004	3/19/2008	1215	5.5	.32	10/21/2009
TS-60-54-805	300833095173201	3/21/2008	1315	1.3	.32	10/21/2009
TS-60-54-806	300833095173202	3/24/2008	1200	R.2	.32	10/21/2009
TS-60-35-504	302636095422802	3/25/2008	1100	1.9	.32	10/21/2009
TS-60-35-505	302636095422803	3/25/2008	1330	7	.32	10/21/2009
TS-60-54-807	300833095173203	3/26/2008	900	.4	.32	10/21/2009
TS-60-35-503	302636095422801	3/26/2008	1400	R-.2	.32	10/21/2009
TS-60-44-806	301505095343703	3/27/2008	1230	.6	.32	10/21/2009
TS-60-26-901	303222095455301	4/21/2008	1030	R-.3	.32	10/21/2009
TS-60-26-208	303610095484501	4/21/2008	1400	R.1	.32	10/21/2009
TS-60-45-513	301912095253701	4/22/2008	930	R-.3	.38	10/28/2009
TS-60-34-301	302836095452701	4/22/2008	1330	R0	.38	10/28/2009
YW-59-64-206	300542096045403	4/23/2008	1045	R.1	.38	10/28/2009
TS-60-43-511	301904095414801	4/23/2008	1345	R0	.41	10/28/2009
TS-60-63-110	300642095131701	4/24/2008	1530	.5	.41	10/28/2009
TS-60-37-309	302850095241801	4/28/2008	1200	R.2	.35	10/28/2009

Appendix 5. Tritium measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Tritium Laboratory, Menlo Park, California)—Continued.

Station name	Station number	Sample date	Sample start time	Tritium, water, unfiltered (pCi/L) (07000)	ssLc	Analysis date
TS-60-54-702	300958095221901	4/30/2008	1030	9.4	0.38	10/28/2009
TS-60-44-212	302014095343201	7/10/2008	1224	.4	.35	10/28/2009
TS-60-55-710	300849095143301	7/16/2008	1630	.5	.32	11/7/2009
YU-60-28-802	303143095334801	7/17/2008	1620	R.2	.32	11/7/2009
TS-60-45-114	302040095281701	7/18/2008	1135	5.8	.32	11/7/2009
TS-60-53-210	301338095272301	7/21/2008	935	R.3	.32	11/7/2009
TS-60-43-514	301917095413101	7/21/2008	1245	R0	.35	11/7/2009
TS-60-45-716	301614095284201	8/1/2008	845	R.3	.35	11/7/2009
TS-60-42-902	301612095450901	8/1/2008	1400	R-.2	.35	11/7/2009
TS-60-53-516	301228095272501	8/18/2008	1530	R.1	.35	11/7/2009
TS-60-36-410	302651095362901	9/2/2008	950	.7	.32	11/7/2009
TS-60-35-907	302412095382101	9/2/2008	1215	.5	.32	11/7/2009
TS-60-37-806	302436095263501	9/3/2008	1245	R.2	.32	11/7/2009
TS-60-37-909	302452095242001	9/3/2008	1520	R.2	.32	11/7/2009
TS-60-59-102	300658095443101	9/4/2008	915	.8	.32	11/7/2009
TS-60-51-809	300853095412701	9/4/2008	1040	.5	.32	11/7/2009
TS-60-51-8XXB	300849095412601	9/4/2008	1140	.5	.38	10/28/2009
TS-60-51-8XXA	300849095415701	9/4/2008	1415	R.1	.32	11/7/2009
TS-60-52-1xx	301332095361901	9/5/2008	900	R.3	.38	10/28/2009
TS-60-51-5xx	301057095421901	9/5/2008	1035	R0	.38	10/28/2009

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Appendix 6. Helium-4 measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Dissolved Gas Laboratory, Reston, Virginia).

[Station name refers to State well number (TS, Montgomery County; YU, Walker County; YW, Waller County); cc/g STP, cubic centimeter per gram at standard temperature and pressure; H₂O, water]

Station name	Station number	Sample date	Sample time	Helium-4, (cc/g STP H ₂ O)
TS-60-53-719	300824095274703	3/12/2008	1415	71 x 10 ⁻⁹
TS-60-53-720	300824095274702	3/13/2008	1410	57 x 10 ⁻⁹
TS-60-44-805	301505095343702	3/17/2008	1300	63 x 10 ⁻⁹
TS-60-45-413	301948095290003	3/19/2008	845	73 x 10 ⁻⁹
TS-60-45-414	301948095290004	3/19/2008	1215	68 x 10 ⁻⁹
TS-60-54-805	300833095173201	3/21/2008	1315	62 x 10 ⁻⁹
TS-60-54-806	300833095173202	3/24/2008	1200	65 x 10 ⁻⁹
TS-60-35-504	302636095422802	3/25/2008	1100	69 x 10 ⁻⁹
TS-60-35-505	302636095422803	3/25/2008	1330	83 x 10 ⁻⁹
TS-60-54-807	300833095173203	3/26/2008	900	75 x 10 ⁻⁹
TS-60-35-503	302636095422801	3/26/2008	1400	61 x 10 ⁻⁹
TS-60-44-806	301505095343703	3/27/2008	1230	61 x 10 ⁻⁹
TS-60-26-901	303222095455301	4/21/2008	1030	78 x 10 ⁻⁹
TS-60-26-208	303610095484501	4/21/2008	1400	74 x 10 ⁻⁹
TS-60-45-513	301912095253701	4/22/2008	930	73 x 10 ⁻⁹
TS-60-34-301	302836095452701	4/22/2008	1330	86 x 10 ⁻⁹
YW-59-64-206	300542096045403	4/23/2008	1045	723 x 10 ⁻⁹
TS-60-43-511	301904095414801	4/23/2008	1345	80 x 10 ⁻⁹
TS-60-63-110	300642095131701	4/24/2008	1530	75 x 10 ⁻⁹
TS-60-37-309	302850095241801	4/28/2008	1200	73 x 10 ⁻⁹

Appendix 6. Helium-4 measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent counties, Texas, 2008 (samples analyzed by the U.S. Geological Survey Dissolved Gas Laboratory, Reston, Virginia)—Continued.

Station name	Station number	Sample date	Sample time	Helium-4, (cc/g STP H ₂ O)
TS-60-54-702	300958095221901	4/30/2008	1030	75 x 10 ⁻⁹
TS-60-44-212	302014095343201	7/10/2008	1224	219 x 10 ⁻⁹
TS-60-55-710	300849095143301	7/16/2008	1630	90 x 10 ⁻⁹
YU-60-28-802	303143095334801	7/17/2008	1620	76 x 10 ⁻⁹
TS-60-45-114	302040095281701	7/18/2008	1135	61 x 10 ⁻⁹
TS-60-53-210	301338095272301	7/21/2008	935	83 x 10 ⁻⁹
TS-60-43-514	301917095413101	7/21/2008	1245	313 x 10 ⁻⁹
TS-60-45-716	301614095284201	8/1/2008	845	198 x 10 ⁻⁹
TS-60-42-902	301612095450901	8/1/2008	1400	54 x 10 ⁻⁹
TS-60-53-516	301228095272501	8/18/2008	1530	458 x 10 ⁻⁹
TS-60-36-410	302651095362901	9/2/2008	950	144 x 10 ⁻⁹
TS-60-35-907	302412095382101	9/2/2008	1215	167 x 10 ⁻⁹
TS-60-37-806	302436095263501	9/3/2008	1245	83 x 10 ⁻⁹
TS-60-37-909	302452095242001	9/3/2008	1520	75 x 10 ⁻⁹
TS-60-59-102	300658095443101	9/4/2008	915	72 x 10 ⁻⁹
TS-60-51-809	300853095412701	9/4/2008	1040	63 x 10 ⁻⁹
TS-60-51-8XXB	300849095412601	9/4/2008	1140	61 x 10 ⁻⁹
TS-60-51-8XXA	300849095415701	9/4/2008	1415	65 x 10 ⁻⁹
TS-60-52-1xx	301332095361901	9/5/2008	900	219 x 10 ⁻⁹
TS-60-51-5xx	301057095421901	9/5/2008	1035	170 x 10 ⁻⁹

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Appendix 7. Helium, tritium, and neon measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent county, Texas, 2008 (samples analyzed by the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York).

[Station name refers to State well number (TS, Montgomery County; YU, Walker County); TU, tritium unit; 1σ , combined standard uncertainty; δ , delta; %, percent; cc STP/g, cubic centimeters at standard temperature and pressure per gram; H₂O, water; --, not analyzed; a, terrigenic helium; b, negative delta neon value; c, high helium in tritium bulb; d, possible gas fractionation; e, helium broken; f, sampled pumped, high gas pressure; g, possible air contamination during sampling; h, delta helium and delta neon equal, gas loss during sampling or in situ; i, low tritium sample; j, improper seal on copper tube or ends deformed; k, no second sample received; l, sample cannot be dated, low tritium and high terrigenic helium concentrations indicate "old water"]

Station name ^a	Sample date	Sample time	Helium extraction date	Helium measurement date	Channel 1 tritium (TU)	Channel 1 tritium error (1 σ)	Channel 2 tritium (TU)	Channel 2 tritium error (1 σ)	Tritium from bottle sample (TU)	Tritium error from bottle sample (1 σ)
TS-60-53-719	3/12/2008	1415	9/10/2008	9/12/2008	0.20	0.06	--	--	0.04	0.05
TS-60-53-720	3/13/2008	1410	9/12/2008	10/2/2008	.32	.06	--	--	.07	.06
TS-60-44-805	3/17/2008	1300	9/10/2008	9/11/2008	.14	.06	--	--	.04	.05
TS-60-45-413	3/19/2008	845	--	--	.35	.07	--	--	.34	.05
TS-60-45-414	3/19/2008	1215	9/10/2008	9/11/2008	1.84	.07	--	--	2.02	.07
TS-60-54-805	3/21/2008	1315	9/10/2008	9/12/2008	.52	.06	--	--	.60	.05
TS-60-54-806	3/24/2008	1200	9/10/2008	9/12/2008	.24	.05	--	--	.17	.05
TS-60-35-504	3/25/2008	1100	9/10/2008	9/11/2008	.00	.04	--	--	.83	.05
TS-60-35-505	3/25/2008	1330	9/12/2008	10/2/2008	-1.81	.09	--	--	2.24	.06
TS-60-54-807	3/26/2008	900	9/10/2008	9/12/2008	.28	.05	--	--	.04	.04
TS-60-35-503	3/26/2008	1400	9/10/2008	9/12/2008	.12	.06	--	--	.05	.05
TS-60-44-806	3/27/2008	1230	9/12/2008	10/2/2008	-.02	.04	--	--	.38	.06

Appendix 7. Helium, tritium, and neon measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent county, Texas, 2008 (samples analyzed by the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York)—Continued.

Station name ^a	δ Helium-3 uncorrected (%)	δ Percent helium-3 error (1s)	Helium-4 (cc STP/g H ₂ O)	δ Helium-4, 1 σ (+/- cc STP/g H ₂ O)	Neon (cc STP/g H ₂ O)	δ Neon, 1 σ (+/- cc STP/g H ₂ O)	Lab comments
TS-60-53-719	-6.23	0.31	5.96E-08	2.20E-10	1.56E-07	8.10E-10	a,b
TS-60-53-720	-5.02	.02	5.91E-08	1.00E-10	2.31E-07	7.60E-10	a,c
TS-60-44-805	-7.39	.15	6.27E-08	9.00E-11	3.03E-07	1.41E-08	a,c,d
TS-60-45-413	--	--	--	--	--	--	e,f
TS-60-45-414	15.27	.15	5.68E-08	8.00E-11	28.713	1.313	d
TS-60-54-805	5.95	.30	5.98E-08	2.20E-10	5.16E-07	5.41E-09	d,g
TS-60-54-806	.03	.30	6.69E-08	2.50E-10	1.89E-07	1.03E-09	a
TS-60-35-504	18.49	.15	5.92E-08	8.00E-11	2.909E-07	1.362E-08	a
TS-60-35-505	42.32	.17	6.42E-08	1.10E-10	2.612E-07	8.700E-10	c,h
TS-60-54-807	.15	.31	6.01E-08	2.20E-10	2.55E-07	2.01E-09	d
TS-60-35-503	-10.54	.31	5.88E-08	2.20E-10	2.326E-07	1.370E-09	h,i
TS-60-44-806	2.73	.18	6.28E-08	1.10E-10	2.67E-07	8.80E-10	d

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Appendix 7. Helium, tritium, and neon measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent county, Texas, 2008 (samples analyzed by the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York)—Continued.

Station name ^a	Sample date	Sample time	Helium extraction date	Helium measurement date	Channel 1 tritium (TU)	Channel 1 tritium error (1 σ)	Channel 2 tritium (TU)	Channel 2 tritium error (1 σ)	Tritium from bottle sample (TU)	Tritium error from bottle sample (1 σ)
TS-60-26-901	4/21/2008	1030	9/12/2008	10/2/2008	0.16	0.06	--	--	-0.32	0.05
TS-60-26-208	4/21/2008	1400	9/12/2008	10/2/2008	.04	.05	--	--	.08	.06
TS-60-45-513	4/22/2008	930	9/12/2008	10/2/2008	.15	.05	2.02	0.05	.06	.05
TS-60-34-301	4/22/2008	1330	9/12/2008	10/2/2008	.11	.06	--	--	.04	.05
TS-60-43-511	4/23/2008	1345	9/12/2008	10/2/2008	.19	.05	--	--	-.11	.05
TS-60-63-110	4/24/2008	1530	10/22/2008	12/22/2008	--	--	--	--	.08	.05
TS-60-37-309	4/28/2008	1200	--	--	--	--	.09	.06	.05	.05
TS-60-54-702	4/30/2008	1030	10/22/2008	12/22/2008	2.77	.08	--	--	2.50	.07
TS-60-55-710	7/16/2008	1630	2/16/2009	6/1/2009	.08	.13	--	--	.10	.06
YU-60-28-802	7/17/2008	1620	2/16/2009	6/1/2009	-.08	.13	.08	.06	.09	.06
TS-60-45-114	7/18/2008	1135	2/16/2009	6/1/2009	1.57	.14	--	--	1.72	.07
TS-60-53-210	7/21/2008	935	2/16/2009	6/1/2009	-.02	.13	.06	.05	.06	.05

Appendix 7. Helium, tritium, and neon measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent county, Texas, 2008 (samples analyzed by the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York)—Continued.

Station name ^a	δ Helium-3 uncorrected (%)	δ Percent helium-3 error (1s)	Helium-4 (cc STP/g H ₂ O)	δ Helium-4, 1 σ (+/- cc STP/g H ₂ O)	Neon (cc STP/g H ₂ O)	δ Neon, 1 σ (+/- cc STP/g H ₂ O)	Lab comments
TS-60-26-901	-14.06	0.02	6.57E-08	1.20E-10	2.397E-07	8.000E-10	a,i
TS-60-26-208	-6.66	.02	6.90E-08	1.20E-10	2.584E-07	8.600E-10	a,i
TS-60-45-513	-11.43	.18	6.70E-08	1.10E-10	2.468E-07	8.200E-10	a,c
TS-60-34-301	-25.03	.18	7.67E-08	1.30E-10	2.380E-07	8.000E-10	a,i
TS-60-43-511	-23.25	.20	3.70E-08	7.00E-11	9.049E-08	3.000E-10	a,h,i
TS-60-63-110	-2.08	.46	6.38E-08	3.30E-10	2.480E-07	8.300E-10	j
TS-60-37-309	--	--	--	--	--	--	j,k
TS-60-54-702	40.14	.05	6.16E-08	3.10E-10	2.558E-07	8.400E-10	d
TS-60-55-710	-26.25	.18	8.78E-08	9.00E-11	2.596E-07	3.390E-09	a,i,l
YU-60-28-802	-26.08	.02	7.64E-08	6.00E-11	2.291E-07	2.600E-09	a,i,l
TS-60-45-114	32.1	.04	5.42E-08	3.00E-11	2.180E-07	2.570E-09	
TS-60-53-210	-11.5	.23	7.23E-08	6.00E-11	2.593E-07	3.390E-09	a,i,l

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Appendix 7. Helium, tritium, and neon measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent county, Texas, 2008 (samples analyzed by the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York)—Continued.

Station name ^a	Sample date	Sample time	Helium extraction date	Helium measurement date	Channel 1 tritium (TU)	Channel 1 tritium error (1σ)	Channel 2 tritium (TU)	Channel 2 tritium error (1σ)	Tritium from bottle sample (TU)	Tritium error from bottle sample (1σ)
TS-60-45-716	8/1/2008	845	2/16/2009	6/1/2009	-0.02	0.12	--	--	0.08	0.05
TS-60-42-902	8/1/2008	1400	2/16/2009	6/1/2009	.08	.13	--	--	.10	.06
TS-60-36-410	9/2/2008	950	2/16/2009	6/1/2009	-.01	.10	--	--	.07	.05
TS-60-35-907	9/2/2008	1215	2/18/2009	5/31/2009	-.08	.14	--	--	.01	.05
TS-60-37-806	9/3/2008	1245	2/18/2009	5/31/2009	.07	.15	--	--	.15	.06
TS-60-37-909	9/3/2008	1520	2/18/2009	5/31/2009	.23	.12	--	--	.04	.06
TS-60-59-102	9/4/2008	915	2/18/2009	6/1/2009	-.05	.13	--	--	.21	.06
TS-60-51-809	9/4/2008	1040	2/18/2009	6/1/2009	.00	.10	--	--	.07	.06
TS-60-51-8XXB	9/4/2008	1140	2/18/2009	6/1/2009	.02	.13	--	--	-.11	.06
TS-60-51-8XXA	9/4/2008	1415	2/18/2009	6/1/2009	-.01	.11	--	--	.07	.05
TS-60-51-5xx	9/5/2008	1035	2/19/2009	5/31/2009	.17	.14	--	--	.14	.06

^a Samples from five wells not analyzed due to excess helium.

Appendix 7. Helium, tritium, and neon measured in groundwater samples collected from the Chicot, Evangeline, and Jasper aquifers in Montgomery County and adjacent county, Texas, 2008 (samples analyzed by the Noble Gas Laboratory of Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York)—Continued.

Station namea	δ Helium-3 uncorrected (%)	δ Percent helium-3 error (1s)	Helium-4 (cc STP/g H ₂ O)	δ Helium-4, 1 σ (+/- cc STP/g H ₂ O)	Neon (cc STP/g H ₂ O)	d Neon, 1 σ (+/- cc STP/g H ₂ O)	Lab comments
TS-60-45-716	-70.44	0.07	2.01E-07	7.00E-11	2.437E-07	2.980E-09	a,i,l
TS-60-42-902	-2.8	.26	6.25E-08	4.00E-11	2.507E-07	3.150E-09	a,i,l
TS-60-36-410	-61.31	.10	1.41E-07	2.60E-10	2.242E-07	2.490E-09	a,i,l
TS-60-35-907	-66.75	.10	1.67E-07	4.30E-10	2.294E-07	2.260E-09	a,i,l
TS-60-37-806	-27.7	.19	7.52E-08	7.00E-11	2.228E-07	2.200E-09	a,i,l
TS-60-37-909	-32.29	.20	7.58E-08	7.00E-11	2.181E-07	2.010E-09	a,i,l
TS-60-59-102	-13.07	.24	6.38E-08	4.00E-11	2.298E-07	2.570E-09	a,i,l
TS-60-51-809	-5.48	.26	5.37E-08	3.00E-11	2.124E-07	2.160E-09	a,i,l
TS-60-51-8XXB	-5.21	.27	5.33E-08	3.00E-11	2.108E-07	2.160E-09	a,i,l
TS-60-51-8XXA	-19.07	.26	6.50E-08	4.00E-11	2.175E-07	2.300E-09	a,i,l
TS-60-51-5xx	-68.23	.10	1.82E-07	6.10E-10	2.378E-07	2.520E-09	a,i,l

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