Supporting Information

Methane and Benzene in Drinking-Water Wells Overlying the Eagle Ford, Fayetteville, and Haynesville Shale Hydrocarbon Production Areas

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1. – General Description of Hydrogeology

Eagle Ford study area. The Eagle Ford (EF) study area is located in south Texas (Figure S1). Water wells sampled in that area were completed in various aquifers within the Texas Coastal Uplands and Coastal Lowlands principal aquifer systems,[1,2] including sands in the Evangeline aquifer, Catahoula sandstone, the Sparta sand, and Carrizo sand (Table S1, Figure S4). The aquifer systems were generally composed of a series of interbedded, semiconsolidated sands and clays of Tertiary age that were deposited in various environments, including deltaic, lacustrine, fluvial, and near-shore marine.[2,3] The underlying Eagle Ford Shale is Cretaceous in age (Figure S4).[4] The Eagle Ford was generally 1000 to 3700 m below land surface in the study area, and about 850 to 3300 m below the base of drinking water resources.[5] Depths of sampled water wells were as follows: Domestic wells, minimum=37 m, median=107 m, maximum=1219 m; Public-supply wells, minimum=162 m, median=401 m, maximum=1299 m (Table S1).

Fayetteville study area. The Fayetteville (FV) study area is located in north-central Arkansas (Figure S2). Water wells sampled in that area were completed in various permeable zones within the Western Interior Plains confining system,[2,6,7] including in the Atoka and Hale Formations and Bloyd Shale (Table S1, Figure S4). These hydrogeologic units were generally composed of a series of interbedded shales, sandstones, and limestones of Pennsylvanian age.[2,6,7] The underlying Fayetteville Shale is Mississippian in age (Figure S4).[8] The Fayetteville was generally 300 to 2000 m below land surface in the study area, and about 200 to 2000 m below the base of drinking water resources.[5] Depths of sampled water wells were as follows: Domestic wells, minimum=12 m, median=43 m, maximum=186 m (Table S1).

Haynesville study area. The Haynesville (HV) study area is located in east Texas and northwest Louisiana (Figure S3). Water wells sampled in this area were completed in various aquifers within the Texas Coastal Uplands and Mississippi Embayment principal aquifer systems,[1,2] but primarily in sands of the Wilcox Group (Table S1, Figure S4). The aquifer systems were generally composed of a series of interbedded, semi-consolidated sands and clays of Tertiary age that were deposited in various environments, including deltaic, lacustrine, fluvial, and near-shore marine.[2,3,9] The Wilcox Group contains abundant lignite deposits.[9] The underlying Haynesville Shale is Jurassic in age (Figure S4).[10] The Haynesville was generally 3200 to 4100 m below land surface in the study area, and about 3100 to 4000 m below the base of drinking water resources.[5] Depths of sampled water wells were as follows: Domestic wells, minimum=23 m, median=73 m, maximum=158 m; Public-supply wells, minimum=44 m, median=172 m, maximum=329 m (Table S1).

2. – Sample Collection and Analysis

Groundwater samples were collected from domestic and public-supply wells in the EF study area in 2015–16, in the FV study area in 2015 (domestic wells only), and in the HV study area in 2014–15. One sample of produced water was collected from a gas well in the Haynesville Shale in Rusk County, Texas in 2010, and five samples of produced water were collected from oil and condensate wells in the Eagle Ford Shale in Gonzales and Lavaca Counties, Texas in 2015. The 26 public-supply wells used in this study were part of a larger network of 94 public-supply wells distributed throughout the Mississippi Embayment and Texas Coastal Uplands aquifer systems.[2] For that larger network, public-supply wells were selected using an equal-area grid to subdivide the aquifers.[11] Within each grid cell, one well was randomly selected from a population of existing public supply wells.[11–13] If a well was not available within a grid cell (for example, because permission to sample could not be obtained), an additional well was selected within an adjacent grid cell, not to exceed two wells in any one cell. Equal area grids were also used to select domestic wells to be sampled. Areas within 1 km of unconventional hydrocarbon wells (wells completed in the Eagle Ford, Fayetteville, or Haynesville Shales) within each study area were divided into 20 (EF, HV) or 30 (FV) equal area grid cells. Within each grid cell, one well was randomly selected from a population of existing domestic wells. Areas farther than 1 km from an unconventional hydrocarbon well were divided into 10 equal area grid cells (EF, HV). Within each grid cell, one well was randomly selected from a population of existing domestic wells. For FV, domestic wells located >1 km from hydrocarbon wells were sampled by the USGS in 2011,[7] and those data, along with the data for wells located ≤1 km from hydrocarbon wells that were collected for this study, were used in our analysis of methane concentrations relative to the location of hydrocarbon wells.

This supplement presents data for groundwater that include: field measurements of dissolved oxygen, pH, water temperature, and alkalinity; concentrations of major ions, nutrients, trace elements, methane, C_1-C_5 hydrocarbon gases, volatile organic compounds (VOCs), noble gases, tritium, carbon-14 in dissolved inorganic carbon (DIC), and sulfur hexafluoride (SF_6); and isotopic compositions of water (δ^2H-H_2O, $\delta^{18}O$-H_2O), methane (δ^2H-CH_4, $\delta^{13}C$-CH_4), DIC ($\delta^{13}C$-DIC), and selected noble gases ($^3He/^4He$, ^{20}Ne,^{22}Ne, $^{40}Ar/^{36}Ar$) (Tables S3–S5).

Data for water from unconventional hydrocarbon wells include: concentrations of bromide, chloride, and C_1-C_5 hydrocarbons; and isotopic compositions of water (δ^2H-H_2O, $\delta^{18}O$-H_2O) and methane (δ^2H-CH_4, $\delta^{13}C$-CH_4) (Table S6).

Groundwater samples were collected at the wellhead or as close to the wellhead as possible using standard methods of the USGS.[14,15] Water from hydrocarbon wells was collected at the wellhead of producing wells using standard methods.[16–18] Methane-saturation concentrations in aquifers will be higher than those at land surface because of higher pressures at depth compared to land surface. The concern with this is that methane at high concentrations will degas from the groundwater as it is brought to land surface and sampled, resulting in an underestimation of in situ methane concentrations. Based on average land-surface elevations (90–145 m) and groundwater temperatures (18–30°C) for the study areas, calculated methane-saturation concentrations in groundwater at land surface ranged from ~19 (Eagle Ford) to 25 (Fayetteville) mg/L. At least one sample from each area had a methane concentration near or above saturation levels. In order to reduce the loss of methane from the samples due to degassing during sample collection, samples for the analysis of C_1-C_5 concentrations and methane isotopes were collected using a closed-loop method in which the sample discharge line at the wellhead was directly connected to a collapsible, pre-evacuated sample container.[19,20] Samples collected for the analysis of alkalinity, major ions, nutrients, trace elements, δ^{13}C-DIC, and carbon-14 were filtered in the field using a 0.45-micron capsule filter. All other samples were unfiltered. Cation and trace element samples were acidified in the field with 7.5 N nitric acid. VOC samples were acidified in the field with 1:1 hydrochloric acid. Noble gas samples were collected in copper tubes using standard methods.[21]

Field-blank and replicate samples of groundwater were collected at selected sites for the analysis of major ions, trace elements, nutrients, and VOCs. Sampling equipment was washed or replaced after sampling each well.[15] At sites where field blanks were collected, blank samples were collected by passing certified blank water obtained from the USGS National Water Quality

Laboratory in Lakewood, Colorado through the washed or replaced sampling equipment using the same procedures as for environmental samples. VOC matrix-spike samples were also collected at selected groundwater sites to evaluate the effects of groundwater matrix interferences on VOC recoveries. Matrix-spike samples were spiked in the laboratory. Percent recoveries (R) were calculated using equation 1.

$$R = (C_{ms} - C_{env}) \times 100 / C_{spiked} \qquad (1)$$

Where C_{ms} is the concentration of the analyte in the matrix-spike sample, C_{env} is the concentration in the environmental sample, and C_{spiked} is the concentration expected in the matrix-spike sample.

Major ions, trace elements, nutrients, and VOCs in groundwater were measured by standard methods of the USGS National Water Quality Laboratory.[22–26] Bromide and chloride in water from hydrocarbon wells was analyzed at the USGS Energy Research Laboratory in Menlo Park, California (HVOG sample) or the USGS Eastern Energy Research Laboratory in Reston, VA (EFOG samples). $\delta^{2}H\text{-}H_2O$ and $\delta^{18}O\text{-}H_2O$ were measured at the USGS Stable Isotope Laboratory in Reston, Virginia,[27] and reported relative to Vienna Standard Mean Ocean Water (VSMOW). To prevent shifts in water isotope values due to changes in salinity, $\delta^{2}H\text{-}H_2O$ and $\delta^{18}O\text{-}H_2O$ values for the highly saline waters (>35 g/L) from hydrocarbon wells were converted from an activity basis to a concentration basis.[28,29] $\delta^{13}C$-DIC and carbon-14 were measured at the Woods Hole Oceanographic Institute Accelerator Mass Spectroscopy Laboratory in Woods Hole, Massachusetts.[30] $\delta^{13}C$-DIC is reported relative to Vienna Peedee belemnite (VPDB), and carbon-14 is reported in percent modern carbon (pmc) (not normalized for ^{13}C fractionation).[31,32] The reported instrument background level for carbon-14 was 0.36 pmc. $\delta^{2}H\text{-}CH_4$ and $\delta^{13}C\text{-}CH_4$

were measured at Isotech Laboratoies, Champaign, Illinois and reported relative to VSMOW and VPDB, respectively.[19] C_1-C_5 concentrations were also measured at Isotech. Tritium was measured at the USGS Tritium Laboratory in Menlo Park, California with a detection level of 0.1 Tritium Unit (TU) or better.[33,34] SF_6 was measured at the USGS Groundwater Dating Laboratory in Reston, Virginia.[35] Noble gases were analyzed at the USGS Noble Gas Laboratory in Denver, Colorado.[36]

3. – Assessing Detections of Volatile Organic Compounds

VOCs in groundwater were analyzed using standard methods of the USGS that involved a purge-and-trap technique with gas chromatography/mass spectrometry detection.[26] Data for 25 VOCs are reported in Table S5. Reporting levels (RLs) for the compounds ranged from 0.012 µg/L for MTBE to 0.26 µg/L for naphthalene. The benzene RL was 0.026 µg/L. RLs for the VOCs were 2× their long-term method detection levels (LT-MDLs).[26] VOC detections were assessed as follows.

1. A VOC detection in an environmental sample was considered to be real if the concentration was above the LT-MDL and the compound was not detected in a field or laboratory blank. For detections ≥LT-MDL and <RL, the concentration was coded with the prefix "J." Detections ≥RL were not coded.
2. If a VOC was detected in an environmental sample and also in an associated field or laboratory blank the detection in the environmental sample was not considered to be real unless the concentration in the environmental sample was greater than 5× the concentration in the blank.[37,38] VOC concentrations in environmental samples that were less than 5× the concentration in the blank were not considered to be real and

were coded with the prefix “FB” (<5× field blank concentration) or “LB” (<5× laboratory blank concentration).

Analyte recoveries in matrix-spike samples ranged from 71.4 to 123.5% (median=96.8%) (Table S5), meeting the data-quality objectives of the laboratory (70 to 130%) for each compound.[26] Seventy-five percent of the recoveries in matrix-spike samples were within 100±10%. Recoveries for benzene in matrix-spike samples ranged from 103.9 to 109.3 (n=3). These data indicate groundwater matrix interference was not a substantial issue for the recovery of VOCs in the samples.

4. – Groundwater-Age Dating

Qualitative estimates of groundwater age were made by grouping the samples into three groundwater-age categories (pre-1950s, mixed, post-1950s) on the basis of their tritium and carbon-14 concentrations. Tritium concentrations ranging from 0.1 to 0.2 TU were used as the upper limits for pre-1950s water (recharged before the early 1950s when substantial above-ground testing of nuclear weapons began) (Figure S12), and are based on the tritium input history for precipitation and sampling date in each study area.[39,40] The upper limit for carbon-14 in pre-1950s water was set equal to the maximum carbon-14 concentration in tritium-dead (<0.1 to <0.2 TU) water and ranged from about 52 to 82 pmc (Figure S12). Samples with tritium and carbon-14 concentrations above these limits were assumed to contain post-1950s water (recharged after the early 1950s) or a mixture of pre- and post-1950s water. Post-1950s samples were further restricted to those with tritium concentrations greater than 0.9 to 1.8 TU and carbon-14 concentrations above the pre-1950s cutoff (Figure S12). The higher tritium cutoff concentrations generally represented minimum tritium concentrations in post-1950s water decayed to the year of sampling in each study area (Figures S12D–S12E).

Concentrations of tritium, tritiogenic helium-3 ($^{3}He_{trit}$), SF_6, and carbon-14 were modeled using the lumped-parameter modeling software TracerLPM to derive more refined estimates of the fractions of post-1950s groundwater in the samples and mean ages of the pre- and post-1950s fractions.[41] Concentrations of $^{3}He_{trit}$ were calculated from helium-4 concentrations and helium-3/helium-4 ratios using methods described in ref. 42 (Table S9). The calculations assumed a helium-3/helium-4 ratio of $2×10^{-8}$ for any terrigenic helium (R_{terr}) in the samples.[43] Linear regression of helium-3/helium-4 ratios versus the fraction of terrigenic helium in samples, corrected for excess air, suggested R_{terr} values were on the order of $6.1±2×10^{-8}$ (EF) and $2.7±2×10^{-7}$ (FV) in the two study areas where $^{3}He_{trit}$ was used for age dating. These R_{terr} values suggest small contributions of mantle-derived helium-3 of about 0.5 (EF) to 2.4% (FV) to the terrigenic helium, assuming a helium-3/helium-4 ratio ($1×10^{-5}$) for mantle helium as characterized by mid-oceanic ridge basalt.[44] The assumed R_{terr} value was about 10× lower than the regressed value in FV but was used in the FV calculations nevertheless because of the large number of samples with relatively high terrigenic helium concentrations that also contained tritium (the decay of which is another source of helium-3 besides the mantle). Moreover, there was no obvious source for mantle helium in FV, such as volcanic rocks, in the Pennsylvanian sediments. The generally low permeability of sediments in the Western Interior Plains confining system and general lack of fracture systems in the study area might also limit vertical migration of mantle-derived helium.[2,45]

For SF_6, TracerLPM computations are based on the SF_6 concentration in air that would be in equilibrium with the measured concentration in groundwater. The equilibrium SF_6

concentration in air was calculated using methods described in refs. 46 and 47 (Table S9). The $^3He_{trit}$ and SF_6 calculations require estimates of recharge temperature and concentration of excess air in the samples, which were calculated from the noble gas data using methods described in ref. 48. A least-squares fitting routine was used to calculate recharge temperature and excess air in the samples and minimize the sum of the weighted squared difference (chi-squared, χ^2) between measured and modeled noble-gas concentrations.[41,47,48]

TracerLPM can use carbon-14 data that have been corrected for additions of ^{14}C-dead carbon by geochemical reactions in the aquifer.[41] Carbon-14 data were corrected using NetpathXL mass-balance models and selected other correction models (revised Fontes and Garnier, Tamers), as implemented in NetpathXL.[49,50] Model input data are in Tables S3 and S4, and model parameters and output are listed in Tables S9 and S10. In NetpathXL, carbon-14 corrections are applied to the assumed concentration of carbon-14 in the initial well.[49] In TracerLPM, carbon-14 corrections are applied to the final (measured) concentration.[41] NetpathXL-derived carbon-14 corrections were applied to the measured carbon-14 concentration using equation 2.[40]

$$^{14}C_{corrected\ final} = {}^{14}C_{measured} + ({}^{14}C_{measured}/{}^{14}C_{corrected\ initial})(A_o - {}^{14}C_{corrected\ initial}) \quad (2)$$

Where $^{14}C_{corrected\ final}$ is the value input into TracerLPM, $^{14}C_{measured}$ is the measured value in the sample, $^{14}C_{corrected\ initial}$ is the corrected value from NetpathXL, and A_o is the assumed initial ^{14}C concentration in recharge (assumed to be 100 pmc in TracerLPM). Values for $^{14}C_{corrected\ final}$, $^{14}C_{measured}$, and $^{14}C_{corrected\ initial}$ are listed in Table S10.

If carbon-14 data were used in binary mixing models in TracerLPM then concentrations of DIC in the pre- and post-1950s fractions were required because the carbon-14 content of the mixed sample depended on the carbon-14 and DIC concentrations of both endmembers.[41] DIC concentrations were assigned to the pre- and post-1950s fractions as follows and are listed in Table S10:

1. Median concentrations of alkalinity were determined for the 0–25th, 25th–75th, and 75th–100 percentile concentration ranges in each study area.
2. The median alkalinity in the 0–25th percentile was assigned to the post-1950s fraction in each study area.
3. The sample to be modeled was assigned the median alkalinity concentration in the percentile range that contained the measured concentration for that sample.

TracerLPM includes several lumped-parameter model options for estimating groundwater age and mixing fractions.[41] It was determined through trial-and-error that dispersion models (DM) consistently provided the best fit to the tracer concentration data for samples that only contained post-1950s water, and for binary mixing between pre- and post-1950s water. Example tracer-tracer plots and DM output for FV are shown in Figure S13. Through trial-and-error, dispersion parameters of 0.1 and 0.01 were selected for use in the DMs for the pre-and post-1950s fractions, respectively.[41] Data for two to four age tracers (tritium, $^{3}He_{trit}$, SF_6, and carbon-14) were used to estimate the fraction of post-1950s water and mean age of either the pre- or post-1950s water in each sample. A least-squares fitting routine was used to calculate water fraction and mean ages and minimize the sum of the weighted squared difference (chi-squared, χ^2) between measured and modeled age-tracer concentrations.[41,47,48] TracerLPM model results are listed in Table S9.

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6. FIGURES

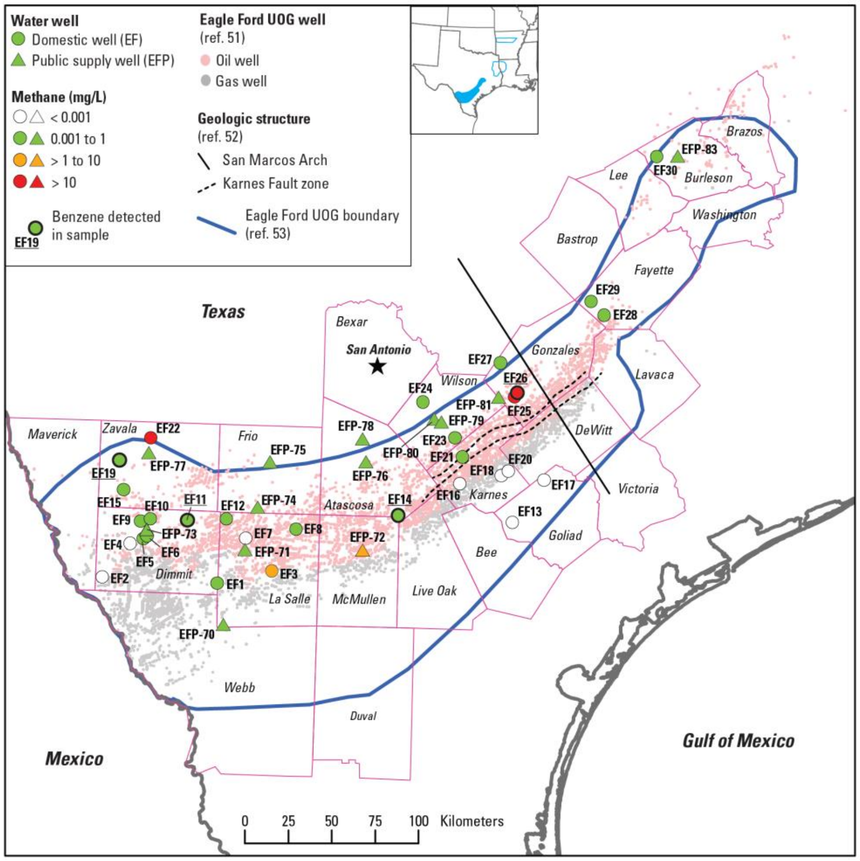


Figure S1. Map of the Eagle Ford Shale study area showing locations of water wells sampled for this study (n=43) and hydrocarbon wells completed in the Eagle Ford Shale. Symbols for water wells are color-coded according to their methane concentration. Symbols for water wells with benzene detections have thick edges.

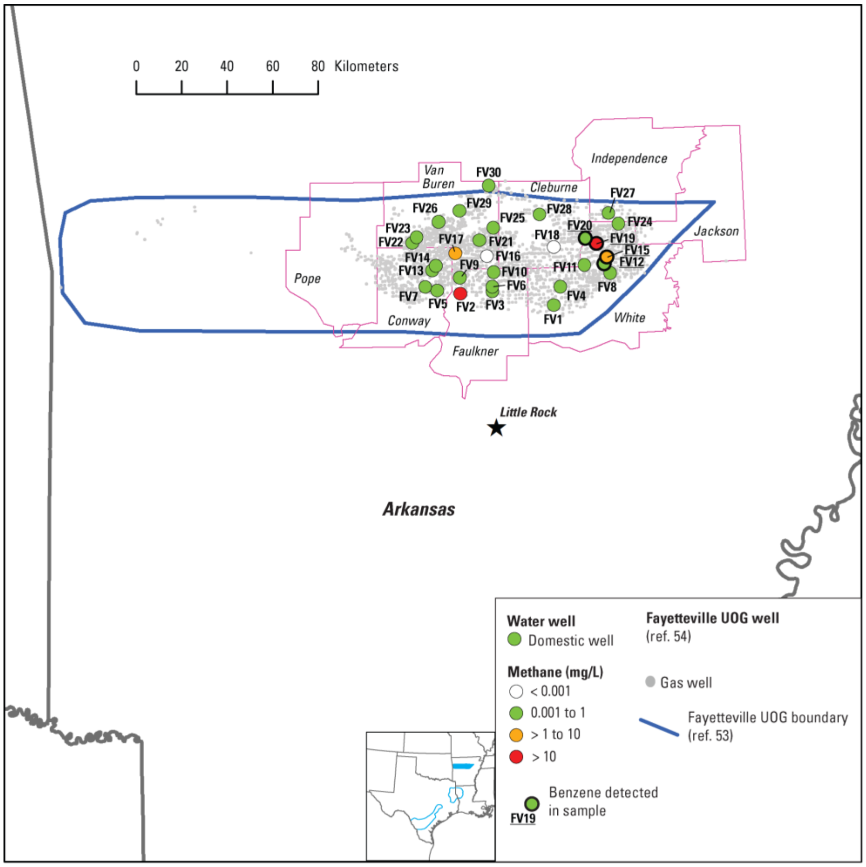


Figure S2. Map of the Fayetteville Shale study area showing locations of water wells sampled for this study (n=30) and hydrocarbon wells completed in the Fayetteville Shale. Symbols for water wells are color-coded according to their methane concentration. Symbols for water wells with benzene detections have thick edges.

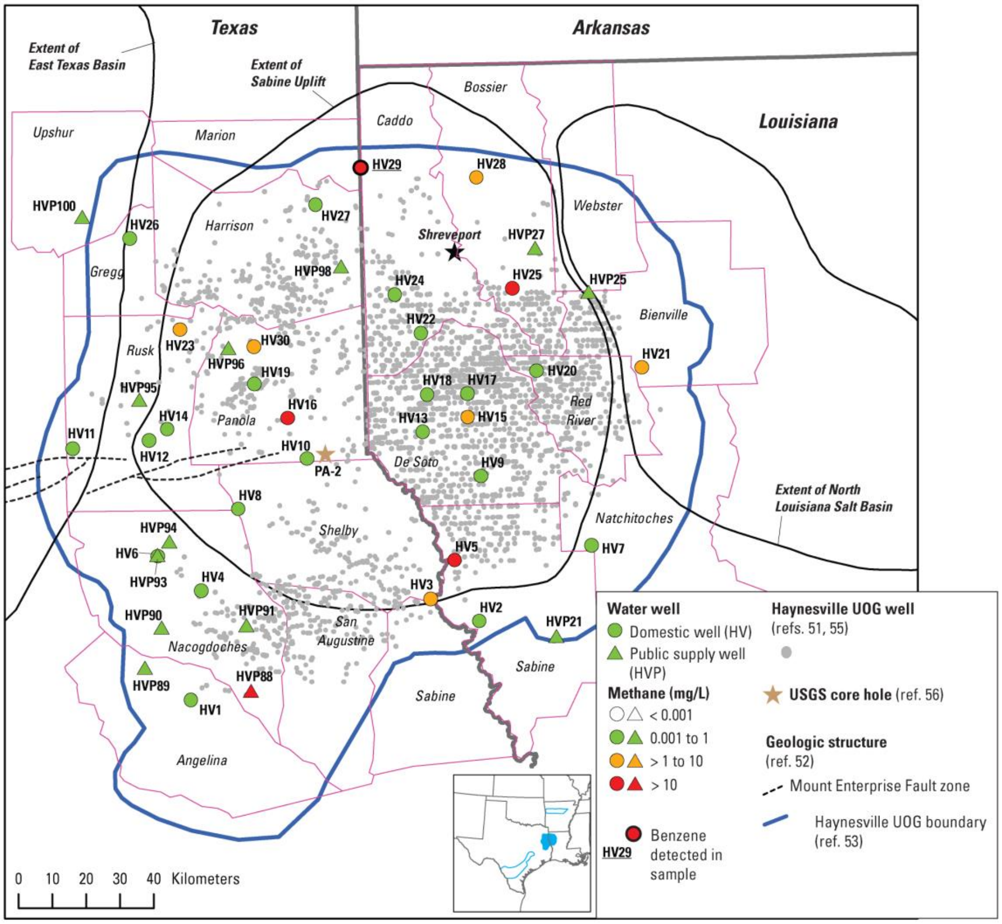
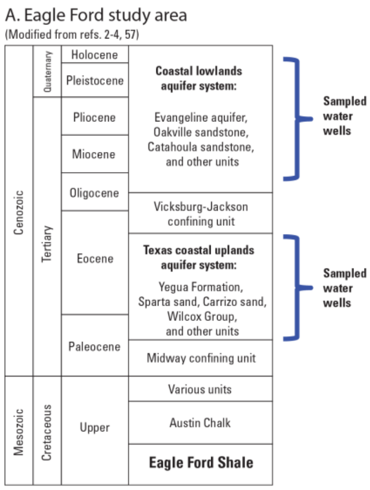
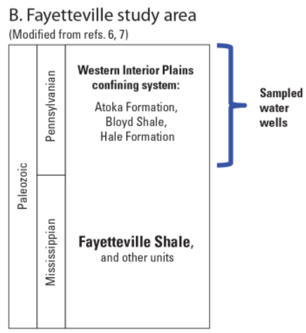


Figure S3. Map of the Haynesville Shale study area showing locations of water wells sampled for this study (n=43) and hydrocarbon wells completed in the Haynesville Shale. Symbols for water wells are color-coded according to their methane concentration. Symbols for water wells with benzene detections have thick edges.





Shale play	Approximate depth below land surface (m)[a]	Approximate distance between top of production zone and base of treatable groundwater (m)[a]
Eagle Ford	1,000 to 3,700	850 to 3,300
Fayetteville	300 to 2,000	200 to 2,000
Haynesville	3,200 to 4,100	3,100 to 4,000

[a]Data from ref. 5

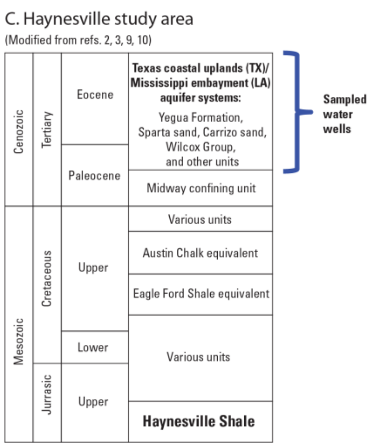


Figure S4. Generalized stratigraphic sections of the study areas.

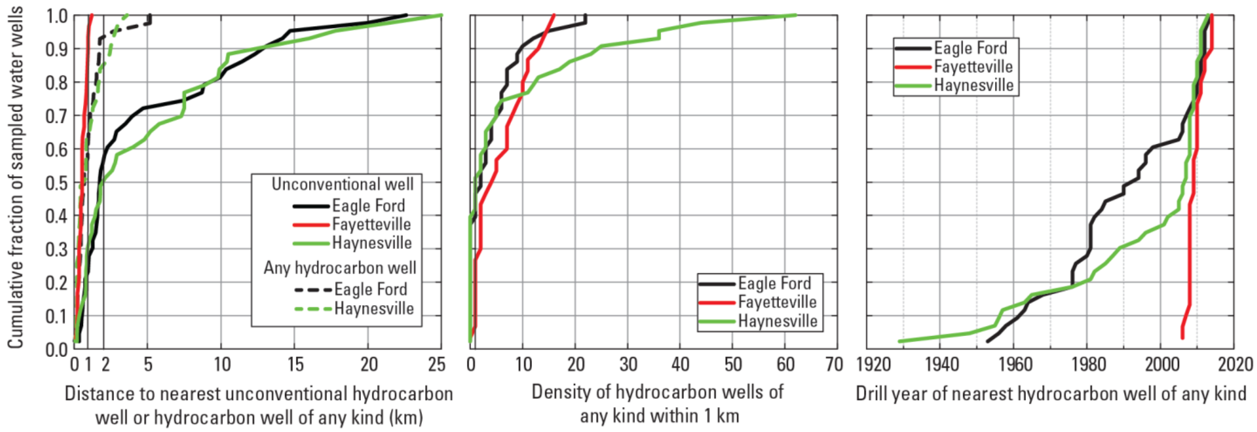


Figure S5. Spatial and temporal relations between sampled water wells and hydrocarbon wells. Data for unconventional hydrocarbon wells from refs. 51, 54, 55. Data for hydrocarbon wells of any kind from ref. 58 and include gas wells; oil wells; multiple completion gas wells, oil wells, and oil and gas wells; and junked and abandoned wells. The combined total count of hydrocarbon wells of any kind in the three study areas, regardless of proximity to the sampled water wells or which formation the hydrocarbon wells were completed in, is 108,059 wells.[58]

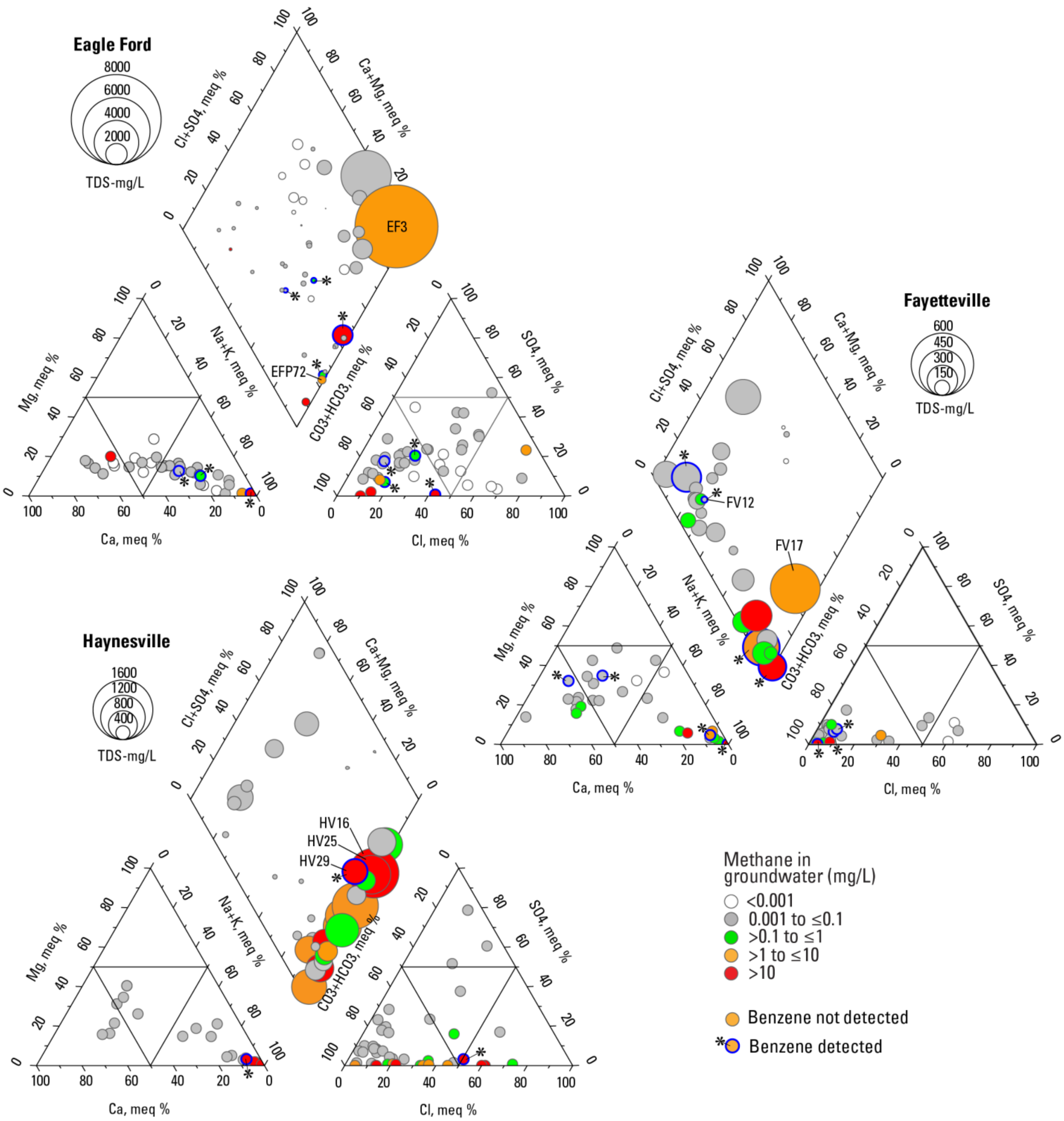


Figure S6. Piper diagrams for the study areas. Symbols are coded according to methane concentration and whether benzene was detected in the sample. Symbols in the diamond regions are also sized relative to concentrations of total dissolved solids (TDS).

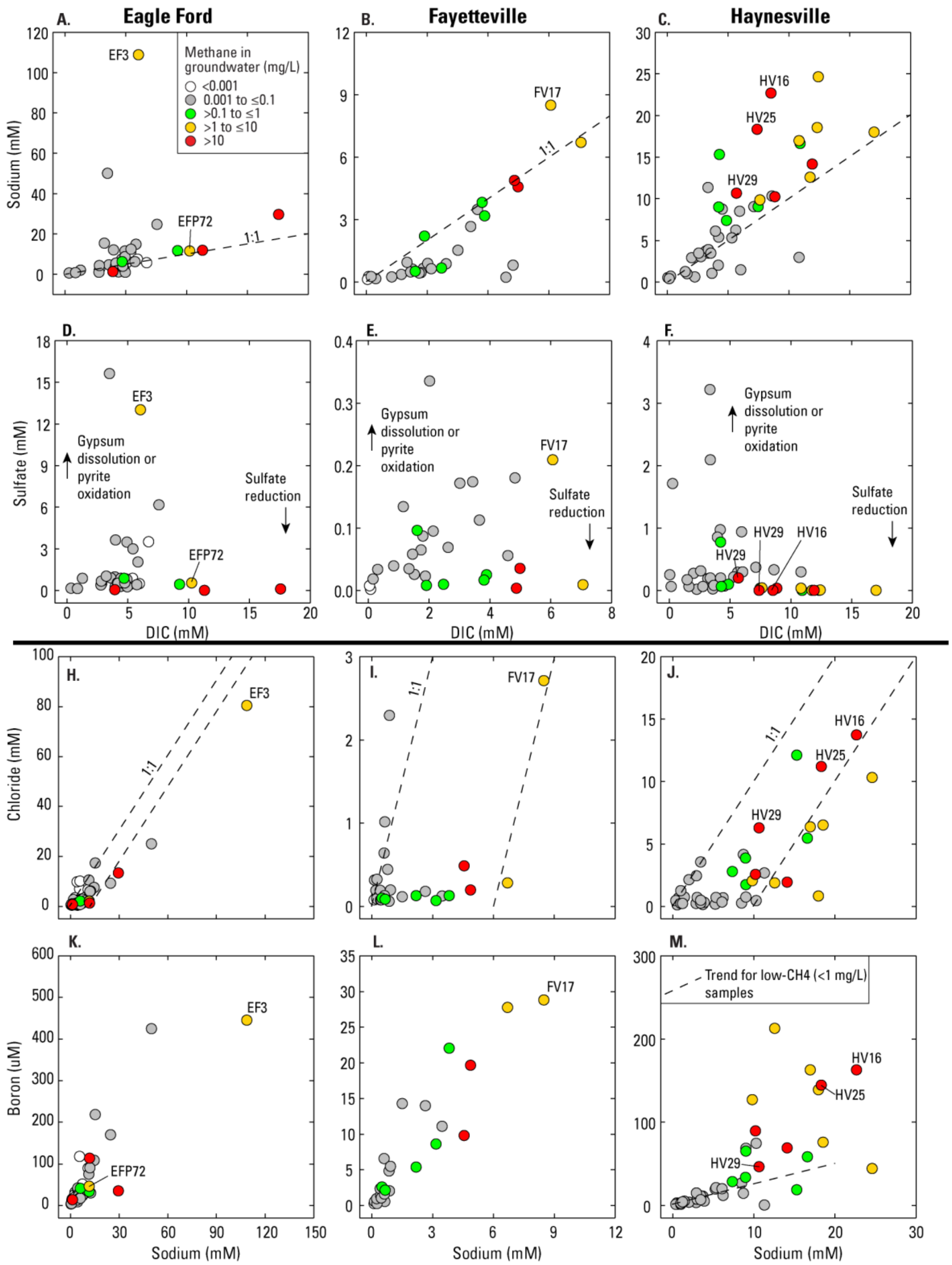


Figure S7. Concentrations of major ions and boron in groundwater from the Eagle Ford (**A.**, **D.**, **H.**, **K.**), Fayetteville (**B.**, **E.**, **I.**, **L.**), and Haynesville (**C.**, **F.**, **J.**, **M.**) study areas. In **A.–C.**, 1:1 lines are consistent with the reaction $CaCO_3+CO_2+H_2O+Na_2X \rightarrow 2HCO_3^-+2Na^++CaX$. In **H.–J.**, 1:1 lines are consistent with the reaction $NaCl \rightarrow Na^++Cl^-$.

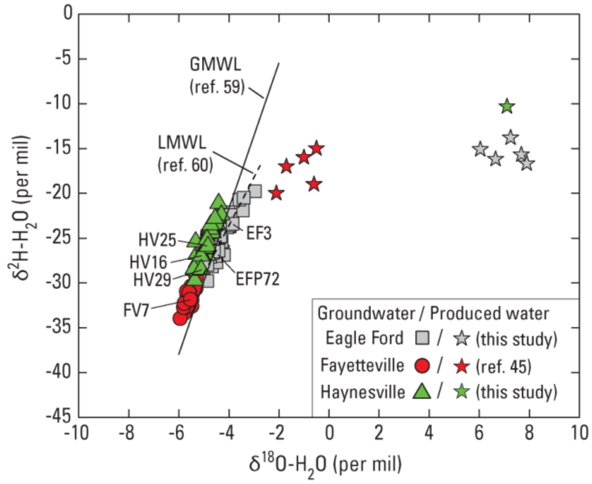


Figure S8. Isotopic composition of water from water wells and unconventional hydrocarbon wells.

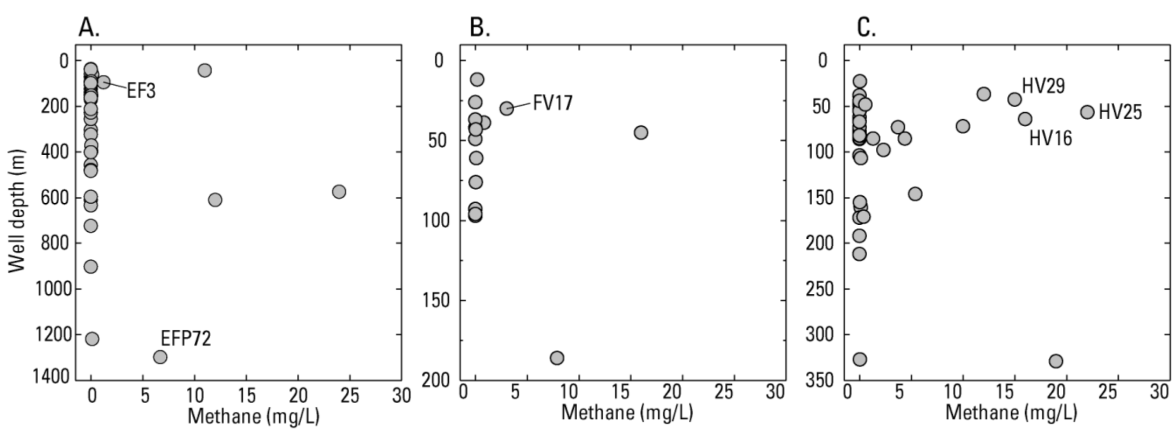


Figure S9. Methane concentration in relation to well depth in the **A.** Eagle Ford, **B.** Fayetteville, and **C.** Haynesville study areas.

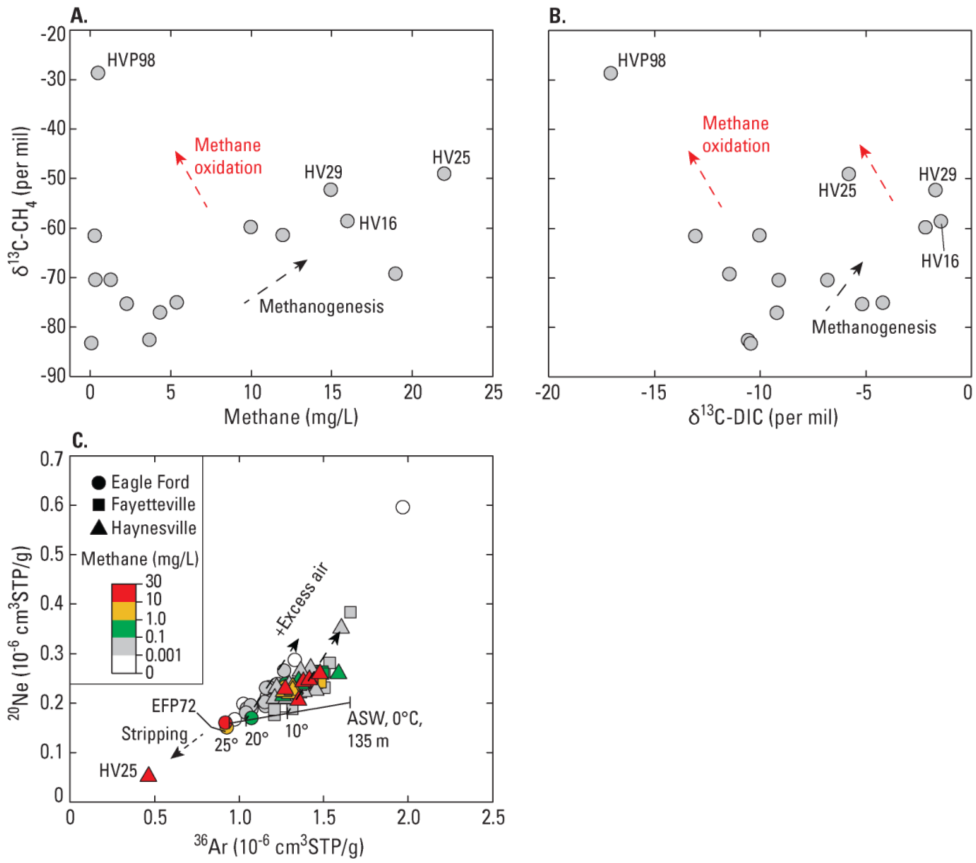


Figure S10. Selected geochemical data from the Haynesville study area: (**A.**) $\delta^{13}C\text{-}CH_4$ as a function of methane concentrations in groundwater samples, (**B.**) $\delta^{13}C\text{-}CH_4$ as a function of $\delta^{13}C$-DIC in groundwater samples, and (**C.**) ^{20}Ne concentrations as a function of ^{36}Ar concentrations in groundwater samples. ASW, air-saturated water.

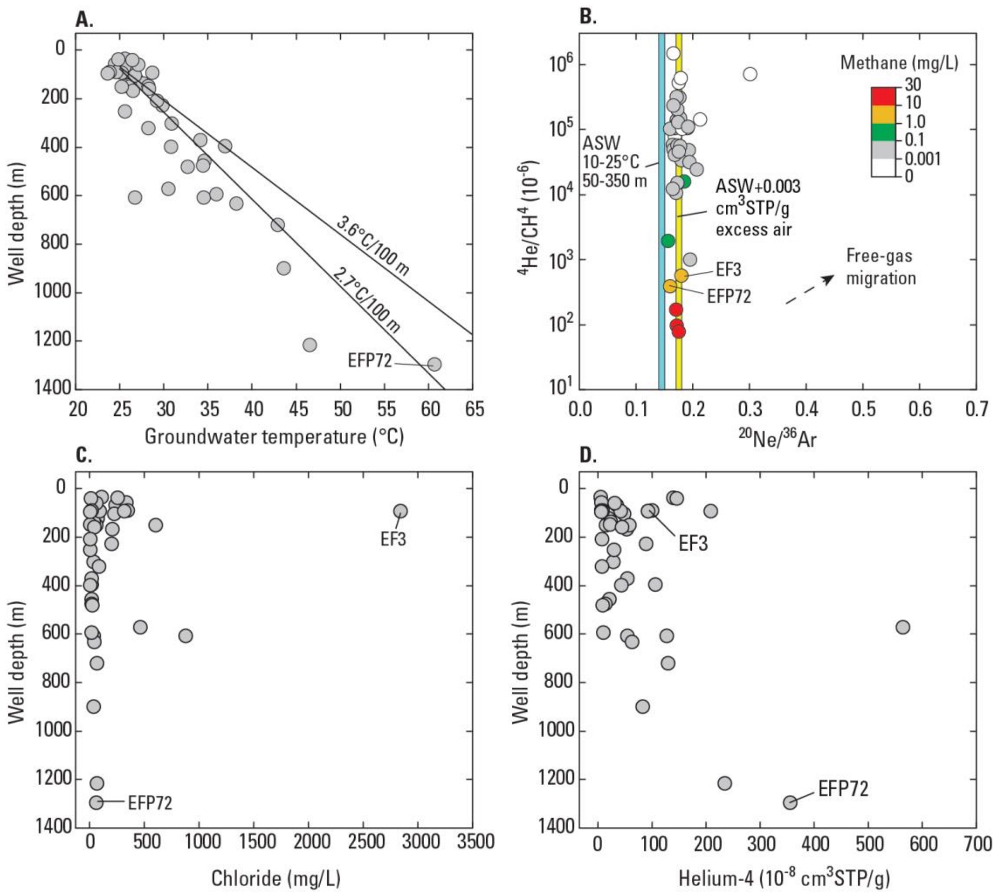


Figure S11. **A.** Selected geochemical data from the Eagle Ford study area: (**A.**) groundwater temperature as a function of water-well depth, (**B.**) $^{4}He/CH_4$ ratios as a function of $^{20}Ne/^{36}Ar$ ratios in groundwater samples, and water-well depth as a function of (**C.**) chloride and (**D.**) ^{4}He concentrations in groundwater samples. Geothermal gradients in (**A.**) from ref. 61. ASW, air-saturated water.

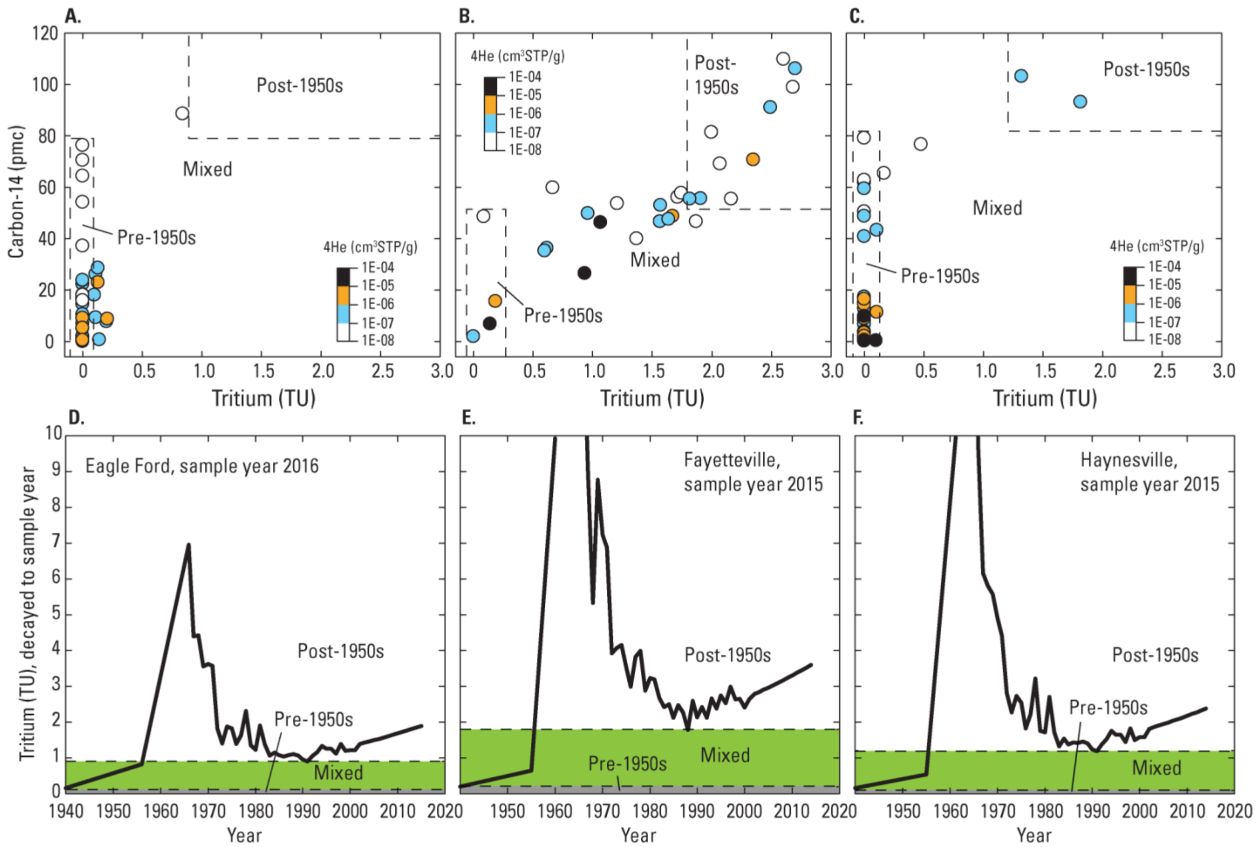


Figure S12. Concentrations of tritium and carbon-14 in groundwater samples from the (**A.**) Eagle Ford, (**B.**) Fayetteville, and (**C.**) Haynesville study areas; and tritium concentrations in precipitation as a function of time in the (**D.**) Eagle Ford, (**E.**) Fayetteville, and (**F.**) Haynesville study areas. Tritium concentrations in (**D.**)-(**F.**) were decayed to the sample year in each study area and are from ref. 39. Pre-1950s, water recharged before the early 1950s; Post-1950s, water recharged after the early 1950s; Mixed, mixture of pre- and post-1950s water.

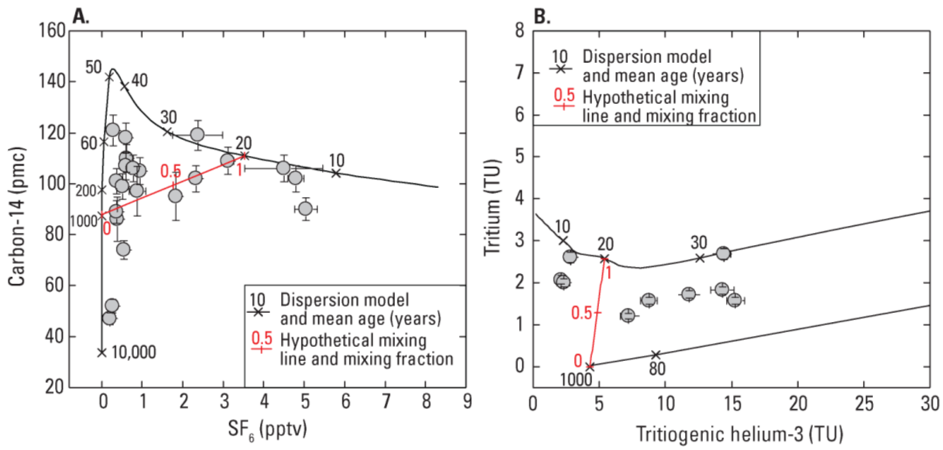


Figure S13. Concentrations of selected age tracers in groundwater samples from the Fayetteville study area; (**A.**) carbon-14 as a function of sulfur hexafluoride and (**B.**) tritium as a function of tritiogenic helium-3. Binary mixing between dispersion models representing pre- and post-1950s water are from TracerLPM.[41] Dispersion parameters were set equal to 0.1 and 0.01 for pre- and post-1950s water. In (**A.**), concentrations of DIC were assumed to be equal in pre- and post-1950s water.

Table S1. Water-well construction information.

Shale play	Well name	Well type	Land surface elevation (m above sea level)	Hydrogeologic/Stratigraphic unit	Well depth (m below land surface)
Eagle Ford	EF1	Domestic	171	Bigford Formation	<150
Eagle Ford	EF2	Domestic	210	Carrizo sand	37
Eagle Ford	EF3	Domestic	113	Carrizo sand	94
Eagle Ford	EF4	Domestic	208	Carrizo sand	91
Eagle Ford	EF5	Domestic	190	Carrizo sand	125
Eagle Ford	EF6	Domestic	180	Carrizo sand	152
Eagle Ford	EF7	Domestic	159	Carrizo sand	91
Eagle Ford	EF8	Domestic	119	Carrizo sand	902
Eagle Ford	EF9	Domestic	181	Carrizo sand	139
Eagle Ford	EF10	Domestic	166	Carrizo sand	305
Eagle Ford	EF11	Domestic	154	Carrizo sand	457
Eagle Ford	EF12	Domestic	177	Carrizo sand	610
Eagle Ford	EF13	Domestic	98	Evangeline aquifer	72
Eagle Ford	EF14	Domestic	94	Carrizo sand	1219
Eagle Ford	EF15	Domestic	182	Carrizo sand	149
Eagle Ford	EF16	Domestic	138	Catahoula sandstone	107
Eagle Ford	EF17	Domestic	93	Evangeline aquifer	60
Eagle Ford	EF18	Domestic	77	Oakville sandstone	96
Eagle Ford	EF19	Domestic	205	Carrizo sand	62
Eagle Ford	EF20	Domestic	95	Oakville sandstone	91
Eagle Ford	EF21	Domestic	99	Jackson Group	40
Eagle Ford	EF22	Domestic	229	Carrizo sand	43
Eagle Ford	EF23	Domestic	125	Yegua Formation	96
Eagle Ford	EF24	Domestic	163	Carrizo sand	91
Eagle Ford	EF25	Domestic	97	Carrizo sand	610
Eagle Ford	EF26	Domestic	98	Carrizo sand	574
Eagle Ford	EF27	Domestic	125	Carrizo sand	99
Eagle Ford	EF28	Domestic	112	Yegua Formation	171
Eagle Ford	EF29	Domestic	122	Sparta sand	152
Eagle Ford	EF30	Domestic	148	Carrizo sand	256
Eagle Ford	EFP70	Public supply	171	Carrizo sand	229
Eagle Ford	EFP71	Public supply	137	Carrizo sand	724
Eagle Ford	EFP72	Public supply	77	Carrizo sand	1299
Eagle Ford	EFP73	Public supply	177	Carrizo sand	162
Eagle Ford	EFP74	Public supply	164	Carrizo sand	635
Eagle Ford	EFP75	Public supply	190	Carrizo sand	479
Eagle Ford	EFP76	Public supply	141	Carrizo sand	597
Eagle Ford	EFP77	Public supply	223	Carrizo sand	212
Eagle Ford	EFP78	Public supply	130	Carrizo sand	324
Eagle Ford	EFP79	Public supply	149	Carrizo sand	398
Eagle Ford	EFP80	Public supply	139	Carrizo sand	372
Eagle Ford	EFP81	Public supply	121	Carrizo sand	482
Eagle Ford	EFP83	Public supply	131	Carrizo sand	401
Fayetteville	FV1	Domestic	120	Atoka Formation	--
Fayetteville	FV2	Domestic	142	Atoka Formation	45
Fayetteville	FV3	Domestic	144	Atoka Formation	--
Fayetteville	FV4	Domestic	230	Atoka Formation	--
Fayetteville	FV5	Domestic	203	Atoka Formation	--
Fayetteville	FV6	Domestic	178	Atoka Formation	--
Fayetteville	FV7	Domestic	148	Atoka Formation	--
Fayetteville	FV8	Domestic	130	Bloyd Shale	--
Fayetteville	FV9	Domestic	149	Atoka Formation	37
Fayetteville	FV10	Domestic	206	Atoka Formation	97
Fayetteville	FV11	Domestic	82	Prairie Grove Member of Hale Formation	39
Fayetteville	FV12	Domestic	140	Prairie Grove Member of Hale Formation	93
Fayetteville	FV13	Domestic	216	Atoka Formation	49
Fayetteville	FV14	Domestic	236	Atoka Formation	96
Fayetteville	FV15	Domestic	69	Bloyd Shale	186
Fayetteville	FV16	Domestic	265	Atoka Formation	26
Fayetteville	FV17	Domestic	216	Atoka Formation	30
Fayetteville	FV18	Domestic	251	Atoka Formation	42
Fayetteville	FV19	Domestic	78	Bloyd Shale	--

Table S1. Water-well construction information.

Shale play	Well name	Well type	Land surface elevation (m above sea level)	Hydrogeologic/Stratigraphic unit	Well depth (m below land surface)
Fayetteville	FV20	Domestic	177	Bloyd Shale	--
Fayetteville	FV21	Domestic	222	Atoka Formation	37
Fayetteville	FV22	Domestic	200	Atoka Formation	43
Fayetteville	FV23	Domestic	229	Atoka Formation	76
Fayetteville	FV24	Domestic	168	Bloyd Shale	--
Fayetteville	FV25	Domestic	162	Bloyd Shale	12
Fayetteville	FV26	Domestic	207	Atoka Formation	--
Fayetteville	FV27	Domestic	242	Prairie Grove Member of Hale Formation	--
Fayetteville	FV28	Domestic	277	Prairie Grove Member of Hale Formation	--
Fayetteville	FV29	Domestic	186	Atoka Formation	61
Fayetteville	FV30	Domestic	357	Bloyd Shale	26
Haynesville	HV1	Domestic	85	Yegua Formation	66
Haynesville	HV2	Domestic	69	Wilcox Group	86
Haynesville	HV3	Domestic	72	Wilcox Group	72
Haynesville	HV4	Domestic	109	Wilcox Group	158
Haynesville	HV5	Domestic	61	Wilcox Group	37
Haynesville	HV6	Domestic	135	Carrizo sand	85
Haynesville	HV7	Domestic	56	Wilcox Group	54
Haynesville	HV8	Domestic	101	Wilcox Group	82
Haynesville	HV9	Domestic	94	Wilcox Group	38
Haynesville	HV10	Domestic	83	Wilcox Group	54
Haynesville	HV11	Domestic	106	Wilcox Group	49
Haynesville	HV12	Domestic	131	Wilcox Group	104
Haynesville	HV13	Domestic	85	Wilcox Group	49
Haynesville	HV14	Domestic	174	Wilcox Group	78
Haynesville	HV15	Domestic	67	Wilcox Group	85
Haynesville	HV16	Domestic	82	Wilcox Group	64
Haynesville	HV17	Domestic	76	Wilcox Group	73
Haynesville	HV18	Domestic	105	Wilcox Group	79
Haynesville	HV19	Domestic	102	Wilcox Group	62
Haynesville	HV20	Domestic	43	Red River Alluvial aquifer	23
Haynesville	HV21	Domestic	68	Wilcox Group	73
Haynesville	HV22	Domestic	73	Wilcox Group	73
Haynesville	HV23	Domestic	89	Wilcox Group	146
Haynesville	HV24	Domestic	85	Wilcox Group	55
Haynesville	HV25	Domestic	45	Wilcox Group	56
Haynesville	HV26	Domestic	124	Wilcox Group	107
Haynesville	HV27	Domestic	88	Wilcox Group	67
Haynesville	HV28	Domestic	80	Wilcox Group	85
Haynesville	HV29	Domestic	58	Wilcox Group	43
Haynesville	HV30	Domestic	90	Wilcox Group	98
Haynesville	HVP21	Public supply	110	Sparta sand	44
Haynesville	HVP25	Public supply	61	Wilcox Group	82
Haynesville	HVP27	Public supply	73	Wilcox Group	161
Haynesville	HVP88	Public supply	85	Wilcox Group	329
Haynesville	HVP89	Public supply	86	Wilcox Group	327
Haynesville	HVP90	Public supply	112	Wilcox Group	212
Haynesville	HVP91	Public supply	129	Wilcox Group	192
Haynesville	HVP93	Public supply	135	Wilcox Group	--
Haynesville	HVP94	Public supply	137	Wilcox Group	172
Haynesville	HVP95	Public supply	130	Wilcox Group	212
Haynesville	HVP96	Public supply	82	Wilcox Group	171
Haynesville	HVP98	Public supply	73	Wilcox Group	48
Haynesville	HVP100	Public supply	130	Wilcox Group	155

Table S2. Spatial and temporal relations between sampled water wells and hydrocarbon wells.

Shale play	Well name	Well type	State	Distance to nearest unconventional hydrocarbon well (km)[a,b]	Distance to nearest hydrocarbon well of any kind (km)[c,d]	Drill year of nearest hydrocarbon well of any kind[c]	Type of nearest hydrocarbon well of any kind[c]	Number of hydrocarbon wells of any kind within 1 km of sampled well[c]	Types of hydrocarbon wells of any kind within 1 km of sampled well[c,e]	Decade in which hydrocarbon wells within 1 km of sampled well were spudded[c,f]
Eagle Ford	EF1	Domestic	TX	1.52	1.52	2010	gas well	0	--	--
Eagle Ford	EF2	Domestic	TX	2.88	0.27	1985	oil well	22	gas well (3), oil well (19)	1971 (1), 1976 (1), 1985 (9), 1989 (2), 1990 (1), 1991 (2), 1993 (1), 1994 (1), 1996 (1), 1997 (2), 2008 (1)
Eagle Ford	EF3	Domestic	TX	0.50	0.50	2010	oil well	3	oil well (3)	2010 (1), 2012(2)
Eagle Ford	EF4	Domestic	TX	0.68	0.68	2013	oil well	7	oil well (7)	2011 (1), 2013 (6)
Eagle Ford	EF5	Domestic	TX	1.95	0.35	1996	gas well	2	gas well (2)	1982 (1), 1996 (1)
Eagle Ford	EF6	Domestic	TX	1.58	0.95	1996	oil well	3	oil well (3)	1996 (3)
Eagle Ford	EF7	Domestic	TX	0.76	0.76	2012	oil well	4	oil well (4)	2012 (4)
Eagle Ford	EF8	Domestic	TX	1.75	1.75	2012	oil well	0	--	--
Eagle Ford	EF9	Domestic	TX	3.48	1.29	1977	oil well	0	--	--
Eagle Ford	EF10	Domestic	TX	0.35	0.24	2008	oil well	7	oil well (7)	2008 (5), 2012 (1), 2013 (1)
Eagle Ford	EF11	Domestic	TX	2.08	0.03	2009	oil well	5	junked&abandoned (1), oil well (4)	1991 (1), 2009 (1), 2010 (3)
Eagle Ford	EF12	Domestic	TX	0.95	0.45	1994	oil well	10	oil well (10)	1978 (1), 1980 (1), 1981 (1), 1991 (1), 1994 (1), 2011 (1), 2014 (4)
Eagle Ford	EF13	Domestic	TX	22.6	2.67	1961	gas well	0	--	--
Eagle Ford	EF14	Domestic	TX	1.46	1.46	2014	oil well	0	--	--
Eagle Ford	EF15	Domestic	TX	0.75	0.18	1958	oil well	22	gas well (2), oil well (19), oil and gas well (1)	1958 (6), 1959 (1), 1960 (2), 1965 (1), 1968 (3), 1971 (1), 1977 (1), 1996 (3), 1997 (1), 2000 (1), 2004 (1), 2011 (1)
Eagle Ford	EF16	Domestic	TX	0.98	0.98	2012	oil well	3	oil well (3)	2012 (3)
Eagle Ford	EF17	Domestic	TX	14.7	0.27	1953	gas well	12	gas well (7), oil well (5)	1953 (2), 1978 (1), 1982 (1), 1996 (1), 1999 (1), 2000 (3), 2001 (2), 2002 (1)
Eagle Ford	EF18	Domestic	TX	0.57	0.16	2005	gas well	6	gas well (5), oil well (1)	2005 (2), 2009 (1), 2013 (3)
Eagle Ford	EF19	Domestic	TX	8.81	1.11	1963	gas well	0	--	--
Eagle Ford	EF20	Domestic	TX	0.53	0.53	2011	gas well	1	gas well (1)	2011 (1)
Eagle Ford	EF21	Domestic	TX	1.59	0.93	1964	gas well	1	gas well (1)	1964 (1)
Eagle Ford	EF22	Domestic	TX	14.2	0.2	1984	gas well	9	gas well (9)	1984 (3), 1985 (3), 1990 (3)
Eagle Ford	EF23	Domestic	TX	0.34	0.34	2011	oil well	1	oil well (1)	2011 (1)
Eagle Ford	EF24	Domestic	TX	20.0	1.1	1994	oil well	0	--	--
Eagle Ford	EF25	Domestic	TX	0.60	0.4	1981	oil well	4	oil well (4)	1981 (3), 2013 (1)
Eagle Ford	EF26	Domestic	TX	1.26	0.46	1981	oil well	4	oil well (4)	1980 (1), 1981 (3)
Eagle Ford	EF27	Domestic	TX	12.3	5.15	1968	oil well	0	--	--
Eagle Ford	EF28	Domestic	TX	1.00	0.56	1980	oil well	6	oil well (6)	1980 (1), 1981 (1), 2014 (4)
Eagle Ford	EF29	Domestic	TX	9.95	0.91	1981	oil well	2	oil well (2)	1980 (1), 1981 (1)
Eagle Ford	EF30	Domestic	TX	7.41	0.43	1981	oil well	9	oil well (9)	1980 (1), 1981 (2), 1982 (3), 1983 (3)
Eagle Ford	EFP70	Public supply	TX	1.68	0.20	1976	gas well	7	gas well (7)	1960s (2), 1970s (4), 1990s (1)
Eagle Ford	EFP71	Public supply	TX	1.28	1.52	2011	oil well	0	--	--
Eagle Ford	EFP72	Public supply	TX	1.82	1.05	2007	oil well	0	--	--
Eagle Ford	EFP73	Public supply	TX	1.66	1.32	1990	oil well	0	--	--
Eagle Ford	EFP74	Public supply	TX	3.95	0.68	1976	oil well	6	junked&abandoned (1), oil well (5)	1970s (1), 1980s (2), 1990s (3)
Eagle Ford	EFP75	Public supply	TX	10.34	0.59	1976	oil well	1	oil well (1)	1970s (1)
Eagle Ford	EFP76	Public supply	TX	2.28	0.55	2006	oil well	15	junked&abandoned (1), oil well (14)	1980s (4), 1990s (3), 2000s (8)
Eagle Ford	EFP77	Public supply	TX	4.71	0.66	1982	oil well	2	gas well (1), oil well (1)	1980s (2)
Eagle Ford	EFP78	Public supply	TX	13.10	5.17	2006	oil well	0	--	--
Eagle Ford	EFP79	Public supply	TX	8.71	1.67	1956	oil well	0	--	--
Eagle Ford	EFP80	Public supply	TX	11.43	1.74	1990	oil well	0	--	--
Eagle Ford	EFP81	Public supply	TX	1.72	1.71	2012	oil well	0	--	--
Eagle Ford	EFP83	Public supply	TX	2.74	2.50	1998	oil well	0	--	--
Fayetteville	FV1	Domestic	AR	1.2	1.2	2009	gas well	0	--	--
Fayetteville	FV2	Domestic	AR	0.95	0.95	2008	gas well	2	gas well (2)	2000s (2)
Fayetteville	FV3	Domestic	AR	0.83	0.83	2011	gas well	1	gas well (1)	2010s (1)
Fayetteville	FV4	Domestic	AR	0.56	0.55	2008	gas well	8	gas well (7), junked&abandoned (1)	2000s (2), 2010s (6)
Fayetteville	FV5	Domestic	AR	0.78	0.76	2012	gas well	7	gas well (5), junked&abandoned (2)	2000s (3), 2010s (4)
Fayetteville	FV6	Domestic	AR	0.94	0.94	2010	gas well	1	gas well (1)	2010s (1)
Fayetteville	FV7	Domestic	AR	0.88	0.86	2011	gas well	2	gas well (2)	2000s (1), 2010s (1)
Fayetteville	FV8	Domestic	AR	0.11	0.11	2006	gas well	5	gas well (5)	2000s (5)
Fayetteville	FV9	Domestic	AR	0.33	0.31	2006	gas well	11	gas well (11)	2000s (5), 2010s (6)
Fayetteville	FV10	Domestic	AR	0.46	0.43	2009	gas well	9	gas well (9)	2000s (5), 2010s (4)
Fayetteville	FV11	Domestic	AR	0.54	0.54	2010	gas well	2	gas well (2)	2000s (1), 2010s (1)
Fayetteville	FV12	Domestic	AR	0.36	0.36	2008	gas well	14	gas well (14)	2000s (7), 2010s (7)
Fayetteville	FV13	Domestic	AR	0.36	0.39	2008	gas well	7	gas well (7)	2000s (3), 2010s (4)

Table S2. Spatial and temporal relations between sampled water wells and hydrocarbon wells.

Shale play	Well name	Well type	State	Distance to nearest unconventional hydrocarbon well (km)[a,b]	Distance to nearest hydrocarbon well of any kind (km)[c,d]	Drill year of nearest hydrocarbon well of any kind[c]	Type of nearest hydrocarbon well of any kind[c]	Number of hydrocarbon wells of any kind within 1 km of sampled well[c]	Types of hydrocarbon wells of any kind within 1 km of sampled well[c,e]	Decade in which hydrocarbon wells within 1 km of sampled well were spudded[c,f]
Fayetteville	FV14	Domestic	AR	0.35	0.34	2010	gas well	15	gas well (15)	2000s (2), 2010s (13)
Fayetteville	FV15	Domestic	AR	0.45	0.96	2008	gas well	2	gas well (2)	2000s (1), 2010s (1)
Fayetteville	FV16	Domestic	AR	0.19	0.21	2008	gas well	10	gas well (10)	2000s (3), 2010s (7)
Fayetteville	FV17	Domestic	AR	0.54	0.53	2012	gas well	16	gas well (16)	2010s (16)
Fayetteville	FV18	Domestic	AR	1.00	1.00	2014	gas well	1	gas well (1)	2010s (1)
Fayetteville	FV19	Domestic	AR	0.93	0.90	2008	gas well	1	gas well (1)	2000s (1)
Fayetteville	FV20	Domestic	AR	0.55	0.51	2010	gas well	11	gas well (11)	2010s (11)
Fayetteville	FV21	Domestic	AR	0.23	0.78	2014	gas well	10	gas well (10)	2010s (10)
Fayetteville	FV22	Domestic	AR	0.24	0.24	2014	gas well	7	gas well (7)	2000s (4), 2010s (3)
Fayetteville	FV23	Domestic	AR	0.22	0.22	2008	gas well	4	gas well (4)	1990s (1), 2000s (3)
Fayetteville	FV24	Domestic	AR	0.86	0.84	2009	gas well	5	gas well (5)	2000s (2), 2010s (3)
Fayetteville	FV25	Domestic	AR	0.56	0.56	2007	gas well	13	gas well (13)	2000s (3), 2010s (10)
Fayetteville	FV26	Domestic	AR	0.69	0.69	2009	gas well	1	gas well (1)	2000s (1)
Fayetteville	FV27	Domestic	AR	0.69	0.68	2010	gas well	1	gas well (1)	2010s (1)
Fayetteville	FV28	Domestic	AR	0.59	0.58	2014	gas well	3	gas well (3)	2010s (3)
Fayetteville	FV29	Domestic	AR	0.46	0.46	2008	gas well	2	gas well (2)	2000s (2)
Fayetteville	FV30	Domestic	AR	0.40	0.92	2008	gas well	1	gas well (1)	2000s (1)
Fayetteville	FAU001	Domestic[g]	AR	11.80	--	--	gas well	0	--	--
Fayetteville	FAU002	Domestic[g]	AR	8.40	--	--	gas well	0	--	--
Fayetteville	FAU004	Domestic[g]	AR	1.80	--	--	gas well	0	--	--
Fayetteville	FAU005	Domestic[g]	AR	1.70	--	--	gas well	0	--	--
Fayetteville	FAU008	Domestic[g]	AR	1.80	--	--	gas well	0	--	--
Fayetteville	FAU010	Domestic[g]	AR	7.00	--	--	gas well	0	--	--
Fayetteville	FAU012	Domestic[g]	AR	4.80	--	--	gas well	0	--	--
Fayetteville	FAU013	Domestic[g]	AR	2.80	--	--	gas well	0	--	--
Fayetteville	FAU032	Domestic[g]	AR	1.00	--	--	gas well	0	--	--
Fayetteville	FAU033	Domestic[g]	AR	1.60	--	--	gas well	0	--	--
Fayetteville	FAU044	Domestic[g]	AR	1.00	--	--	gas well	0	--	--
Fayetteville	VB020	Domestic[g]	AR	3.30	--	--	gas well	0	--	--
Fayetteville	VB045	Domestic[g]	AR	6.10	--	--	gas well	0	--	--
Fayetteville	VB046	Domestic[g]	AR	2.80	--	--	gas well	0	--	--
Haynesville	HV1	Domestic	TX	4.8	2.2	1987	gas well	0	--	
Haynesville	HV2	Domestic	LA	7.5	2.4	1963	oil well	0	--	--
Haynesville	HV3	Domestic	TX	4.0	3.0	2001	gas well	0	--	--
Haynesville	HV4	Domestic	TX	1.8	0.43	2007	gas well	4	gas well (4)	2000s (3), 2010s (1)
Haynesville	HV5	Domestic	LA	0.44	0.44	2011	gas well	3	gas well (2), oil well (1)	1960s (1), 2010s (2)
Haynesville	HV6	Domestic	TX	7.5	0.30	2008	gas well	2	gas well (2)	2000s (2)
Haynesville	HV7	Domestic	LA	9.9	2.7	1981	gas well	0	--	--
Haynesville	HV8	Domestic	TX	10.5	1.3	2006	gas well	0	--	--
Haynesville	HV9	Domestic	LA	0.81	0.81	2009	gas well	3	gas well (3)	2000s (3)
Haynesville	HV10	Domestic	TX	8.9	1.8	1976	gas well	0	--	--
Haynesville	HV11	Domestic	TX	16.0	2.8	1957	gas well	0	--	--
Haynesville	HV12	Domestic	TX	1.4	0.21	1982	oil and gas well	19	gas well (18), oil and gas (1)	1980s (8), 2000s (11)
Haynesville	HV13	Domestic	LA	0.31	0.31	2010	gas well	2	gas well (2)	2000s (1), 2010s (1)
Haynesville	HV14	Domestic	TX	0.77	0.37	2007	gas well	12	gas well (10), oil well (2)	1960s (1), 1980s (4), 2000s (5), 2010s (2)
Haynesville	HV15	Domestic	LA	1.2	1.7	2009	gas well	0	--	--
Haynesville	HV16	Domestic	TX	0.21	0.21	2012	gas well	25	gas well (25)	1940s (1), 1970s (1), 1990s (6), 2000s (8), 2010s (9)
Haynesville	HV17	Domestic	LA	0.57	0.44	1929	oil well	17	gas well (11), oil well (6)	1920s (1), 1930s (1), 1940s (4), 1970s (1), 2000s (1), 2010s (9)
Haynesville	HV18	Domestic	LA	0.81	0.81	2011	gas well	1	gas well (1)	2010s (1)
Haynesville	HV19	Domestic	TX	0.22	0.08	2006	gas well	36	gas well (33), oil well (2), oil and gas (1)	1940s (1), 1950s (1), 1970s (1), 1980s (5), 1990s (10), 2000s (9), 2010s (9)

Table S2. Spatial and temporal relations between sampled water wells and hydrocarbon wells.

Shale play	Well name	Well type	State	Distance to nearest unconventional hydrocarbon well (km)[a,b]	Distance to nearest hydrocarbon well of any kind (km)[c,d]	Drill year of nearest hydrocarbon well of any kind[c]	Type of nearest hydrocarbon well of any kind[c]	Number of hydrocarbon wells of any kind within 1 km of sampled well[c]	Types of hydrocarbon wells of any kind within 1 km of sampled well[c,e]	Decade in which hydrocarbon wells within 1 km of sampled well were spudded[c,f]
Haynesville	HV20	Domestic	LA	0.87	0.86	2011	gas well	5	gas well (4), junked and abandoned (1)	2000s (1), 2010s (4)
Haynesville	HV21	Domestic	LA	7.3	3.6	2013	oil well	0	--	--
Haynesville	HV22	Domestic	LA	0.19	0.19	2008	gas well	5	gas well (5)	2000s (4), 2010s (1)
Haynesville	HV23	Domestic	TX	1.2	0.20	2008	gas well	23	gas well (21), oil well (2)	1970s (1), 1980s (1), 1990s (11), 2000s (8), 2010s (2)
Haynesville	HV24	Domestic	LA	0.93	1.1	2011	gas well	0	--	--
Haynesville	HV25	Domestic	LA	0.82	0.82	2010	gas well	2	gas well (2)	2010s (2)
Haynesville	HV26	Domestic	TX	10.4	0.14	1994	gas well	36	gas well (20), oil well (16)	unknown (7), 1950s (3), 1960s (4), 1970s (2), 1980s (6), 1990s (6), 2000s (6), 2010s (2)
Haynesville	HV27	Domestic	TX	2.9	0.18	2008	gas well	3	gas well (3)	2000s (3)
Haynesville	HV28	Domestic	LA	13.3	2.5	1948	oil well	0	--	--
Haynesville	HV29	Domestic	LA	2.8	0.13	1955	oil well	62	oil well (62)	unknown (1), 1910s (1), 1930s (3), 1940s (6), 1950s (10), 1960s (19), 1970s (1), 1980s (15), 1990s (1), 2010s (5)
Haynesville	HV30	Domestic	TX	0.86	0.19	2002	gas well	13	gas well (12), oil and gas (1)	1970s (1), 1990s (1), 2000s (10), 2010s (1)
Haynesville	HVP21	Public supply	LA	21.51	1.61	1965	oil well	0	--	--
Haynesville	HVP25	Public supply	LA	1.05	1.05	2009	gas well	0	--	--
Haynesville	HVP27	Public supply	LA	1.77	1.77	2009	gas well	0	--	--
Haynesville	HVP88	Public supply	TX	1.50	1.51	2010	gas well	0	--	--
Haynesville	HVP89	Public supply	TX	17.8	0.84	1956	gas well	1	gas well (1)	1950s (1)
Haynesville	HVP90	Public supply	TX	9.8	0.33	1985	gas well	1	gas well (1)	1980s (1)
Haynesville	HVP91	Public supply	TX	2.6	0.40	2005	gas well	1	gas well (1)	2000s (1)
Haynesville	HVP93	Public supply	TX	7.5	0.30	2008	gas well	0	--	--
Haynesville	HVP94	Public supply	TX	5.8	0.83	2005	gas well	1	gas well (1)	2000s (1)
Haynesville	HVP95	Public supply	TX	5.2	0.21	2008	gas well	11	gas well (11)	2000s (11)
Haynesville	HVP96	Public supply	TX	1.8	0.40	2007	gas well	6	gas well (6)	1950s (1), 2000s (4), 2010s (1)
Haynesville	HVP98	Public supply	TX	2.1	0.10	1996	gas well	44	gas well (29), oil well (14), oil and gas (1)	1950s (1), 1960s (3), 1970s (1), 1980s (17), 1990s (16), 2000s (6)
Haynesville	HVP100	Public supply	TX	25.4	1.25	1989	gas well	0	--	--

[a]Data from refs. 51, 54, 55.

[b]Unconventional (UOG) hydrocarbon well, hydrocarbon well completed in the Eagle Ford, Fayetteville, or Haynesville Shale.

[c]Data from ref. 58.

[d]Includes UOG wells and hydrocarbon wells completed in other formations.

[e]Number in parentheses is number of wells of that type.

[f]Number in parentheses is number of wells in that decade.

Table S3. Concentration of inorganic constituents in groundwater and quality-assurance samples.

Shale play	Well name	NAWQA well ID	Well type	Sample type	Sample date	pH	Water temperature (°C)	Dissolved oxygen (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Alkalinity (mg/L as CaCO3)	Chloride (mg/L)	Bromide (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Silica (mg/L)	Total dissolved solids (mg/L)	Ammonia (mg-N/L)
Eagle Ford	EF1	METXGWOG2-03	Domestic	Environmental	1/14/2016	7.0	26.2	1.6	173	60.4	262	14.1	248	370	1.50	0.53	333	24.0	1380	0.18
Eagle Ford	EF2	METXGWOG2-01X	Domestic	Environmental	1/11/2016	6.7	25.7	2.1	119	20.0	65.8	15.2	198	119	0.530	0.83	94.0	51.4	669	< 0.01
Eagle Ford	EF3	METXGWOG2-08	Domestic	Environmental	1/26/2016	7.7	25.7	< 0.1	134	19.4	2500	5.99	303	2850	9.21	0.95	1250	11.6	7750	0.10
Eagle Ford	EF4	METXGWOG2-02	Domestic	Environmental	1/13/2016	6.6	25.8	< 0.1	54.3	9.10	60.6	4.71	144	80.7	0.343	0.31	46.9	35.8	383	0.07
Eagle Ford	EF5	METXGWOG2-10	Domestic	Environmental	1/27/2016	7.2	27.0	< 0.1	47.3	10.0	102	4.66	198	82.5	0.373	0.45	92.5	24.7	493	0.05
Eagle Ford	EF6	METXGWOG2-01	Domestic	Environmental	1/12/2016	7.2	26.1	0.4	43.1	12.0	104	4.21	181	73.0	0.346	0.39	85.1	16.7	463	0.09
Eagle Ford	EF7	METXGWOG2-06	Domestic	Environmental	1/24/2016	7.0	26.2	< 0.1	91.2	51.8	131	12.4	336	65.5	0.336	0.48	336	21.0	924	0.10
Eagle Ford	EF8	METXGWOG2-05	Domestic	Environmental	1/21/2016	8.2	43.7	0.1	3.28	1.20	172	2.23	234	45.5	0.215	0.46	73.3	19.5	477	0.23
Eagle Ford	EF9	METXGWOG2-02X	Domestic	Environmental	1/18/2016	7.3	27.7	< 0.1	43.0	13.2	85.6	4.18	208	43.8	0.215	0.28	52.1	23.4	389	0.10
Eagle Ford	EF10	METXGWOG2-04	Domestic	Environmental	1/20/2016	7.3	31.0	< 0.1	45.5	12.9	82.1	3.78	209	45.7	0.224	0.39	46.4	22.4	388	0.09
Eagle Ford	EF11	METXGWOG2-07	Domestic	Environmental	1/25/2016	7.2	34.7	0.2	35.4	10.5	89.9	4.83	236	28.7	0.139	0.45	56.7	20.0	402	0.13
Eagle Ford	EF12	METXGWOG2-18	Domestic	Environmental	2/16/2016	7.2	26.8	0.1	285	133	1150	20.4	176	886	4.56	0.27	1500	14.6	4660	1.12
Eagle Ford	EF13	METXGWOG2-05X	Domestic	Environmental	2/1/2016	7.1	25.6	3.4	95.6	25.9	129	5.17	255	247	0.799	0.72	33.6	36.4	741	< 0.01
Eagle Ford	EF14	METXGWOG2-16	Domestic	Environmental	2/10/2016	7.9	46.6	< 0.1	3.46	0.56	268	2.83	464	76.4	0.333	0.69	41.4	29.3	720	0.32
Eagle Ford	EF15	METXGWOG2-09	Domestic	Environmental	1/27/2016	7.3	28.3	0.1	48.6	11.9	53.3	2.94	245	17.4	0.104	0.37	34.9	17.2	330	0.06
Eagle Ford	EF16	METXGWOG2-12	Domestic	Environmental	2/8/2016	7.4	26.8	6.5	46.5	4.51	252	23.2	270	234	0.941	0.99	82.9	76.0	907	< 0.01
Eagle Ford	EF17	METXGWOG2-06X	Domestic	Environmental	2/2/2016	7.0	24.5	5.8	162	30.0	94.2	7.64	199	346	0.995	0.48	23.8	40.0	975	< 0.01
Eagle Ford	EF18	METXGWOG2-15	Domestic	Environmental	2/9/2016	7.4	25.3	4	42.7	6.74	170	8.78	299	100	0.342	0.60	46.0	42.3	580	< 0.01
Eagle Ford	EF19	METXGWOG2-03X	Domestic	Environmental	1/19/2016	7.2	27.2	0.1	35.0	11.0	142	3.92	236	72.9	0.324	0.55	83.1	16.5	524	0.04
Eagle Ford	EF20	METXGWOG2-14	Domestic	Environmental	2/9/2016	7.0	24.7	5.8	146	38.8	137	7.92	231	358	0.873	0.65	35.5	30.8	938	< 0.01
Eagle Ford	EF21	METXGWOG2-13	Domestic	Environmental	2/8/2016	7.5	24.9	< 0.1	47.0	2.73	339	22.4	292	265	1.06	0.52	195	63.3	1130	0.10
Eagle Ford	EF22	METXGWOG2-04X	Domestic	Environmental	1/19/2016	7.1	26.5	0.2	55.1	12.4	28.6	3.19	197	23.2	0.127	0.48	4.40	13.5	258	0.06
Eagle Ford	EF23	METXGWOG2-17	Domestic	Environmental	2/10/2016	7.4	28.8	< 0.1	49.1	28.5	568	9.49	379	326	1.30	0.25	591	18.1	1840	0.96
Eagle Ford	EF24	METXGWOG2-10X	Domestic	Environmental	3/8/2016	6.6	23.9	< 0.1	11.1	2.85	15.8	5.17	44	26.9	0.115	0.16	11.3	26.2	137	0.02
Eagle Ford	EF25	METXGWOG2-11	Domestic	Environmental	2/3/2016	8.2	34.6	< 0.1	3.74	1.23	273	3.66	566	46.3	0.176	1.32	0.11	16.4	723	0.55
Eagle Ford	EF26	METXGWOG2-20	Domestic	Environmental	3/8/2016	8.2	30.6	< 0.1	12.4	4.31	681	5.66	880	472	1.61	1.75	9.65	15.3	1850	1.13
Eagle Ford	EF27	METXGWOG2-07X	Domestic	Environmental	2/4/2016	5.8	23.7	< 0.1	5.75	2.22	11.0	6.07	18	16.9	0.066	0.08	13.9	24.6	99	0.02
Eagle Ford	EF28	METXGWOG2-19	Domestic	Environmental	2/24/2016	7.4	26.6	< 0.1	76.0	12.3	284	10.4	272	218	0.848	0.03	287	20.0	1120	0.89
Eagle Ford	EF29	METXGWOG2-08X	Domestic	Environmental	2/15/2016	7.7	25.3	0.1	89.2	29.6	354	11.5	162	615	2.36	0.35	96.7	13.0	1370	1.87
Eagle Ford	EF30	METXGWOG2-09X	Domestic	Environmental	2/17/2016	8.6	25.7	0.2	2.62	0.40	97.8	1.62	142	12.4	0.046	0.12	62.3	14.6	276	0.56
Eagle Ford	EF4		Domestic	Replicate	1/13/2016	--	--	--	55.3	9.03	62.8	4.76	147	80.7	0.343	0.31	46.9	36.4	382	0.06
Eagle Ford	EF10		Domestic	Field blank	1/20/2016	--	--	--	0.031	< 0.011	< 0.06	< 0.03	--	< 0.02	< 0.01	< 0.01	< 0.02	< 0.018	< 20	--
Eagle Ford	EF14		Domestic	Field blank	2/10/2016	--	--	--	< 0.022	< 0.011	< 0.06	< 0.03	--	< 0.02	< 0.01	< 0.01	< 0.02	< 0.018	< 20	0.01
Eagle Ford	EFP70	METXPAS1-73	Public supply	Environmental	7/29/2015	7.6	29.9	0.1	35.9	20.4	277	4.71	201	212	0.921	0.40	348	16.8	1070	0.25
Eagle Ford	EFP71	METXPAS1-70	Public supply	Environmental	7/27/2015	8.3	43.0	0.1	2.00	0.72	199	1.53	247	77.2	0.369	0.42	75.5	19.7	539	0.20
Eagle Ford	EFP72	METXPAS1-74	Public supply	Environmental	7/29/2015	8.2	60.8	0.1	1.58	0.28	265	2.35	514	70.6	0.338	0.75	51.7	30.3	766	0.55
Eagle Ford	EFP73	METXPAS1-71	Public supply	Environmental	7/28/2015	7.2	28.4	6.0	35.4	11.4	114	3.96	222	54.2	0.280	0.34	82.5	18.8	453	0.13
Eagle Ford	EFP74	METXPAS1-80	Public supply	Environmental	8/10/2015	7.3	38.3	0.1	35.3	11.6	121	6.28	240	49.9	0.230	0.51	81.1	22.4	466	0.21
Eagle Ford	EFP75	METXPAS1-83	Public supply	Environmental	8/12/2015	6.8	34.5	< 0.1	102	15.6	28.4	6.05	243	28.4	0.137	0.42	66.4	15.0	394	0.03
Eagle Ford	EFP76	METXPAS1-81	Public supply	Environmental	8/11/2015	7.0	36.0	0.1	76.4	10.3	26.1	7.23	221	27.2	0.139	0.41	25.8	16.4	301	0.06
Eagle Ford	EFP77	METXPAS1-72	Public supply	Environmental	7/28/2015	6.6	29.3	< 0.1	80.6	13.2	21.1	2.33	249	15.2	0.063	0.21	24.3	16.9	317	0.02
Eagle Ford	EFP78	METXPAS1-82	Public supply	Environmental	8/11/2015	6.1	28.3	0.1	58.2	10.6	44.9	9.43	64	95.4	0.372	0.12	82.3	16.6	382	0.03
Eagle Ford	EFP79	METXPAS1-89	Public supply	Environmental	8/31/2015	7.6	37.0	0.1	13.8	5.08	142	6.32	288	26.5	0.118	0.39	39.7	19.0	407	0.34
Eagle Ford	EFP80	METXPAS1-84	Public supply	Environmental	8/13/2015	7.1	34.2	0.1	36.5	12.6	88.4	10.1	239	28.2	0.135	0.35	51.9	18.4	354	0.27
Eagle Ford	EFP81	METXPAS1-90	Public supply	Environmental	9/1/2015	7.2	32.8	0.1	54.9	6.04	22.1	9.31	140	34.1	0.137	0.10	36.0	15.8	272	0.07
Eagle Ford	EFP83	METXPAS1-91	Public supply	Environmental	9/2/2015	8.5	30.9	0.1	1.31	0.30	127	0.89	211	16.9	0.070	0.16	49.8	14.3	351	0.48
Fayetteville	FV1	--	Domestic	Environmental	7/28/2015	6.6	19.0	0.3	26.0	7.67	19.8	2.18	132	2.07	< 0.03	0.12	6.61	29.7	161	0.60
Fayetteville	FV2	--	Domestic	Environmental	7/27/2015	8.0	18.6	0.5	17.4	3.99	105	0.42	250	17.2	0.107	0.33	3.35	18.5	321	0.22
Fayetteville	FV3	--	Domestic	Environmental	7/20/2015	6.4	17.3	0.3	18.7	8.75	9.68	0.57	87	6.82	0.042	0.18	6.23	31.8	139	0.04
Fayetteville	FV4	--	Domestic	Environmental	7/28/2015	5.9	19.3	0.3	4.39	3.80	11.7	0.67	--	7.15	0.049	0.13	1.83	31.7	80	< 0.01
Fayetteville	FV5	--	Domestic	Environmental	6/29/2015	6.4	18.2	0.4	30.3	5.64	14.3	0.67	107	4.50	0.035	0.13	9.13	41.7	170	0.04
Fayetteville	FV6	--	Domestic	Environmental	7/16/2015	6.5	17.4	0.4	15.3	3.44	73.0	0.95	195	2.43	< 0.03	0.12	2.40	25.0	226	0.31
Fayetteville	FV7	--	Domestic	Environmental	6/29/2015	6.5	18.2	0.3	31.1	5.04	15.1	0.63	124	3.01	< 0.03	0.11	0.91	31.7	156	0.10
Fayetteville	FV8	--	Domestic	Environmental	7/30/2015	6.5	17.5	0.3	32.1	8.57	14.9	0.81	94	35.9	0.343	0.14	2.20	23.6	175	< 0.01
Fayetteville	FV9	--	Domestic	Environmental	7/22/2015	6.6	21.2	0.4	58.0	13.7	20.2	0.88	101	81.3	0.640	0.14	32.2	36.1	364	0.22

Table S3. Concentration of inorganic constituents in groundwater and quality-assurance samples.

Shale play	Well name	NAWQA well ID	Well type	Sample type	Sample date	pH	Water temperature (°C)	Dissolved oxygen (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Alkalinity (mg/L as CaCO3)	Chloride (mg/L)	Bromide (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Silica (mg/L)	Total dissolved solids (mg/L)	Ammonia (mg-N/L)
Fayetteville	FV10	--	Domestic	Environmental	7/20/2015	6.2	17.2	0.5	12.7	5.41	8.17	0.51	58	4.35	< 0.03	0.13	12.9	30.3	119	0.08
Fayetteville	FV11	--	Domestic	Environmental	7/21/2015	6.7	18.8	0.3	1.58	0.41	50.4	0.48	96	4.47	0.032	0.10	0.75	14.5	136	0.12
Fayetteville	FV12	--	Domestic	Environmental	8/6/2015	5.6	18.4	--	7.26	4.05	5.51	0.87	42	3.07	0.042	0.15	3.76	18.2	65	0.08
Fayetteville	FV13	--	Domestic	Environmental	6/29/2015	6.4	17.0	0.3	22.1	5.20	9.94	0.60	90	2.68	< 0.03	0.13	8.37	30.9	126	< 0.01
Fayetteville	FV14	--	Domestic	Environmental	6/30/2015	6.2	16.9	0.3	16.0	4.49	10.9	0.50	73	2.69	< 0.03	0.11	5.57	42.6	109	0.09
Fayetteville	FV15	--	Domestic	Environmental	7/21/2015	8.0	16.4	0.4	8.41	4.28	154	1.36	354	9.96	0.087	0.49	0.84	11.4	379	0.30
Fayetteville	FV16	--	Domestic	Environmental	7/27/2015	4.3	17.0	7.2	0.97	2.17	5.76	0.42	4	4.51	< 0.03	0.02	0.15	11.0	48	< 0.01
Fayetteville	FV17	--	Domestic	Environmental	7/1/2015	7.6	18.0	0.3	7.11	7.72	195	0.90	304	96.1	0.762	0.83	20.1	12.5	509	0.14
Fayetteville	FV18	--	Domestic	Environmental	7/15/2015	4.5	16.9	6.4	1.33	1.08	2.66	0.19	2	2.71	< 0.03	0.02	0.69	11.5	34	< 0.01
Fayetteville	FV19	--	Domestic	Environmental	8/6/2015	8.8	17.0	0.5	0.30	0.08	112	0.52	244	6.87	0.045	0.70	0.29	15.2	285	0.26
Fayetteville	FV20	--	Domestic	Environmental	7/20/2015	6.6	19.3	0.3	64.1	23.1	18.2	1.02	242	15.7	0.164	0.15	17.3	23.3	305	0.04
Fayetteville	FV21	--	Domestic	Environmental	7/14/2015	5.7	18.4	0.3	11.9	14.4	14.2	1.20	76	22.6	0.059	0.27	2.46	24.7	127	0.03
Fayetteville	FV22	--	Domestic	Environmental	7/1/2015	6.8	16.5	0.3	25.2	12.3	34.8	0.62	151	4.03	0.041	0.12	16.5	19.0	190	0.19
Fayetteville	FV23	--	Domestic	Environmental	6/30/2015	7.3	18.2	0.3	18.3	6.77	60.9	0.68	172	6.32	0.056	0.19	16.7	19.8	228	0.44
Fayetteville	FV24	--	Domestic	Environmental	7/29/2015	8.2	19.7	0.3	5.05	1.51	79.7	1.19	183	4.37	0.032	0.08	10.8	10.4	208	0.33
Fayetteville	FV25	--	Domestic	Environmental	7/13/2015	5.9	16.1	0.3	22.2	4.70	11.7	0.37	81	3.39	0.034	0.04	9.19	15.4	117	0.07
Fayetteville	FV26	--	Domestic	Environmental	6/30/2015	7.1	17.9	0.3	3.85	1.62	87.8	0.80	191	4.43	< 0.03	0.54	1.60	14.1	237	0.08
Fayetteville	FV27	--	Domestic	Environmental	7/29/2015	5.0	16.8	0.3	6.70	4.52	3.34	0.86	16	11.2	0.034	0.04	3.19	14.3	68	< 0.01
Fayetteville	FV28	--	Domestic	Environmental	7/15/2015	5.1	16.8	0.3	1.21	2.93	5.87	0.41	8	11.4	0.036	0.04	1.71	16.8	55	< 0.01
Fayetteville	FV29	--	Domestic	Environmental	7/13/2015	5.5	17.8	0.3	8.59	5.09	21.5	0.49	67	6.97	0.047	0.16	3.30	15.5	92	0.08
Fayetteville	FV30	--	Domestic	Environmental	7/13/2015	6.2	15.7	0.3	84.7	8.67	4.86	0.44	230	6.73	0.077	0.12	5.34	12.8	267	< 0.01
Fayetteville	FV8	--	Domestic	Replicate	7/30/2015	--	--	--	32.0	8.57	14.7	0.78	--	35.9	0.346	0.14	2.20	23.3	179	< 0.01
Fayetteville	FV27	--	Domestic	Replicate	7/29/2015	--	--	--	6.67	4.51	3.43	0.87	--	11.2	0.030	0.04	3.20	14.8	78	< 0.01
Fayetteville	FV12	--	Domestic	Field blank	8/6/2015	--	--	--	< 0.022	< 0.011	< 0.06	< 0.03	--	0.05	< 0.03	< 0.01	< 0.02	< 0.018	< 20	< 0.01
Fayetteville	FV19	--	Domestic	Field blank	8/6/2015	--	--	--	< 0.022	< 0.011	< 0.06	< 0.03	--	< 0.02	< 0.03	< 0.01	< 0.02	< 0.018	< 20	< 0.01
Fayetteville	FAU001	--	Domestic	Environ., data from ref. 7	10/31/2011	6.3	--	--	--	--	13.0	--	--	25.3	--	--	--	--	--	--
Fayetteville	FAU002	--	Domestic	Environ., data from ref. 7	10/31/2011	6.6	--	--	--	--	20.5	--	--	10.2	--	--	--	--	--	--
Fayetteville	FAU004	--	Domestic	Environ., data from ref. 7	10/31/2011	8.6	--	--	--	--	144.0	--	--	7.96	--	--	--	--	--	--
Fayetteville	FAU005	--	Domestic	Environ., data from ref. 7	10/31/2011	7.1	--	--	--	--	53.5	--	--	52.3	--	--	--	--	--	--
Fayetteville	FAU006	--	Domestic	Environ., data from ref. 7	10/31/2011	7.3	--	--	--	--	50.4	--	--	6.18	--	--	--	--	--	--
Fayetteville	FAU008	--	Domestic	Environ., data from ref. 7	10/31/2011	6.5	--	--	--	--	22.9	--	--	4.74	--	--	--	--	--	--
Fayetteville	FAU010	--	Domestic	Environ., data from ref. 7	10/31/2011	6.7	--	--	--	--	42.0	--	--	7.77	--	--	--	--	--	--
Fayetteville	FAU012	--	Domestic	Environ., data from ref. 7	11/1/2011	7.4	--	--	--	--	36.5	--	--	3.69	--	--	--	--	--	--
Fayetteville	FAU013	--	Domestic	Environ., data from ref. 7	11/1/2011	6.5	--	--	--	--	44.0	--	--	2.44	--	--	--	--	--	--
Fayetteville	FAU032	--	Domestic	Environ., data from ref. 7	11/3/2011	6.3	--	--	--	--	15.8	--	--	4.24	--	--	--	--	--	--
Fayetteville	FAU033	--	Domestic	Environ., data from ref. 7	11/3/2011	6.4	--	--	--	--	9.14	--	--	6.18	--	--	--	--	--	--
Fayetteville	FAU042	--	Domestic	Environ., data from ref. 7	11/4/2011	6.0	--	--	--	--	4.83	--	--	2.99	--	--	--	--	--	--
Fayetteville	FAU044	--	Domestic	Environ., data from ref. 7	11/4/2011	7.1	--	--	--	--	10.3	--	--	1.91	--	--	--	--	--	--
Fayetteville	FAU045	--	Domestic	Environ., data from ref. 7	11/7/2011	7.1	--	--	--	--	9.66	--	--	1.46	--	--	--	--	--	--
Fayetteville	FAU055	--	Domestic	Environ., data from ref. 7	11/8/2011	5.9	--	--	--	--	6.91	--	--	2.21	--	--	--	--	--	--
Fayetteville	FAU057	--	Domestic	Environ., data from ref. 7	11/9/2011	6.4	--	--	--	--	34.0	--	--	10.9	--	--	--	--	--	--
Fayetteville	FAU058	--	Domestic	Environ., data from ref. 7	11/9/2011	7.8	--	--	--	--	61.1	--	--	9.17	--	--	--	--	--	--
Fayetteville	FAU059	--	Domestic	Environ., data from ref. 7	11/9/2011	7.9	--	--	--	--	67.8	--	--	11.8	--	--	--	--	--	--
Fayetteville	FAU060	--	Domestic	Environ., data from ref. 7	11/9/2011	7.0	--	--	--	--	25.3	--	--	3.17	--	--	--	--	--	--
Fayetteville	VB001	--	Domestic	Environ., data from ref. 7	7/6/2011	5.5	--	--	--	--	6.16	--	--	6.44	--	--	--	--	--	--
Fayetteville	VB011	--	Domestic	Environ., data from ref. 7	7/7/2011	6.6	--	--	--	--	< 2.1	--	--	2.94	--	--	--	--	--	--
Fayetteville	VB019	--	Domestic	Environ., data from ref. 7	7/7/2011	6.5	--	--	--	--	< 2.1	--	--	1.40	--	--	--	--	--	--
Fayetteville	VB020	--	Domestic	Environ., data from ref. 7	7/7/2011	6.3	--	--	--	--	4.84	--	--	2.63	--	--	--	--	--	--
Fayetteville	VB021	--	Domestic	Environ., data from ref. 7	7/7/2011	6.0	--	--	--	--	4.80	--	--	1.85	--	--	--	--	--	--
Fayetteville	VB022	--	Domestic	Environ., data from ref. 7	7/7/2011	6.8	--	--	--	--	18.0	--	--	13.5	--	--	--	--	--	--
Fayetteville	VB023	--	Domestic	Environ., data from ref. 7	7/7/2011	6.9	--	--	--	--	35.0	--	--	56.3	--	--	--	--	--	--
Fayetteville	VB033	--	Domestic	Environ., data from ref. 7	7/11/2011	6.8	--	--	--	--	0.85	--	--	1.40	--	--	--	--	--	--
Fayetteville	VB045	--	Domestic	Environ., data from ref. 7	7/12/2011	6.2	--	--	--	--	7.62	--	--	1.23	--	--	--	--	--	--
Fayetteville	VB046	--	Domestic	Environ., data from ref. 7	7/12/2011	6.7	--	--	--	--	45.3	--	--	20.60	--	--	--	--	--	--
Fayetteville	VB050	--	Domestic	Environ., data from ref. 7	7/12/2011	5.4	--	--	--	--	< 2.1	--	--	2.94	--	--	--	--	--	--
Fayetteville	VB051	--	Domestic	Environ., data from ref. 7	7/12/2011	7.8	--	--	--	--	71.0	--	--	3.04	--	--	--	--	--	--
Fayetteville	VB052	--	Domestic	Environ., data from ref. 7	7/13/2011	7.0	--	--	--	--	27.0	--	--	60.90	--	--	--	--	--	--

Table S3. Concentration of inorganic constituents in groundwater and quality-assurance samples.

Shale play	Well name	NAWQA well ID	Well type	Sample type	Sample date	pH	Water temperature (°C)	Dissolved oxygen (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Alkalinity (mg/L as CaCO3)	Chloride (mg/L)	Bromide (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Silica (mg/L)	Total dissolved solids (mg/L)	Ammonia (mg-N/L)
Fayetteville	VB053	--	Domestic	Environ., data from ref. 7	7/13/2011	7.0	--	--	--	--	3.00	--	--	2.22	--	--	--	--	--	--
Fayetteville	VB054	--	Domestic	Environ., data from ref. 7	7/13/2011	6.2	--	--	--	--	3.00	--	--	3.15	--	--	--	--	--	--
Haynesville	HV1	METXGWOG1-01	Domestic	Environmental	4/13/2015	7.8	21.2	3.6	8.91	2.22	260	3.79	168	94.4	0.238	0.08	309	13.1	806	0.74
Haynesville	HV2		Domestic	Environmental	4/22/2015	8.7	21.3	1.9	0.62	0.23	208	0.85	357	26.3	0.095	0.40	35.2	10.1	511	0.53
Haynesville	HV3	METXGWOG1-14	Domestic	Environmental	4/30/2015	8.7	21.7	< 0.1	0.94	0.30	413	1.62	852	29.1	< 0.15	2.93	0.05	10.1	992	0.93
Haynesville	HV4	METXGWOG1-02	Domestic	Environmental	4/13/2015	6.1	23.8	0.7	5.97	3.31	27.9	3.13	74	8.07	0.036	0.08	16.4	15.1	125	0.39
Haynesville	HV5		Domestic	Environmental	4/29/2015	7.7	20.6	0.3	7.60	2.44	235	4.13	444	90.8	0.255	1.66	2.90	20.8	662	1.40
Haynesville	HV6	METXGWOG1-15	Domestic	Environmental	7/16/2015	4.9	21.5	< 0.1	32.4	19.8	15.7	4.01	14	22.7	0.101	0.04	164	20.2	297	0.14
Haynesville	HV7		Domestic	Environmental	6/29/2015	8.7	21.0	0.9	2.10	1.06	237	1.08	432	16.4	0.096	0.41	31.8	11.1	565	0.54
Haynesville	HV8	METXGWOG1-03	Domestic	Environmental	4/14/2015	8.2	23	1.0	12.2	2.26	79.2	1.46	180	16.5	0.074	0.09	2.05	16.6	247	0.60
Haynesville	HV9		Domestic	Environmental	5/6/2015	6.3	19.8	0.3	94.8	35.5	79.0	3.20	169	126	0.798	0.24	201	40.2	684	0.33
Haynesville	HV10	METXGWOG1-12	Domestic	Environmental	4/29/2015	6.8	20.6	0.4	63.8	9.62	23.0	2.37	184	44.3	0.198	0.08	7.70	68.1	339	0.07
Haynesville	HV11	METXGWOG1-04	Domestic	Environmental	4/15/2015	4.4	19.4	1.3	1.67	2.09	11.5	2.40	3	9.34	0.065	0.01	23.8	31.0	76	--
Haynesville	HV12	METXGWOG1-05	Domestic	Environmental	4/15/2015	8.5	22.0		2.55	0.76	195	2.10	298	8.73	0.037	0.13	90.1	11.6	460	1.01
Haynesville	HV13		Domestic	Environmental	5/12/2015	8.7	20.3	0.3	2.18	0.44	208	1.04	374	60.8	0.238	0.42	3.06	10.2	529	0.73
Haynesville	HV14	METXGWOG1-06	Domestic	Environmental	4/16/2015	7.1	21.6	0.9	1.68	0.72	66.2	2.22	101	8.33	0.047	0.39	26.3	41.4	191	0.67
Haynesville	HV15		Domestic	Environmental	6/10/2015	8.7	20.9	0.4	1.89	0.43	226	1.44	382	71.9	0.270	0.94	3.85	9.72	555	0.81
Haynesville	HV16	METXGWOG1-13	Domestic	Environmental	4/29/2015	8.3	21.2	3.6	2.37	0.78	521	2.14	427	486	2.69	0.77	< 0.2	10.1	1401	1.27
Haynesville	HV17		Domestic	Environmental	6/9/2015	7.0	21.5	0.3	96.6	22.9	46.1	2.43	211	75.6	0.366	0.10	93.3	40.1	511	0.25
Haynesville	HV18		Domestic	Environmental	6/2/2015	8.2	21.5	0.4	11.0	2.48	143	2.37	282	23.8	0.108	0.09	27.9	13.5	400	0.83
Haynesville	HV19	METXGWOG1-10	Domestic	Environmental	4/28/2015	6.3	20.2	0.8	10.4	3.28	22.8	1.69	82	7.64	0.041	0.16	6.16	59.5	123	0.04
Haynesville	HV20		Domestic	Environmental	4/30/2015	6.9	20.3	0.3	127	59.7	67.6	1.84	543	86.5	0.369	0.44	28.3	25.4	729	1.27
Haynesville	HV21		Domestic	Environmental	6/30/2015	8.0	20.5	0.4	17.6	6.55	289	3.24	589	66.5	0.163	2.84	0.07	12.7	769	0.73
Haynesville	HV22		Domestic	Environmental	6/11/2015	8.0	21.4	1.8	8.80	2.30	69.8	2.68	139	24.5	0.118	0.11	6.06	17.7	215	0.93
Haynesville	HV23	METXGWOG1-07	Domestic	Environmental	4/16/2015	8.5	23.3	0.7	2.15	0.67	566	2.40	622	365	0.512	1.16	0.20	11.8	1305	1.16
Haynesville	HV24		Domestic	Environmental	5/26/2015	7.2	20.2	0.3	75.4	29.0	33.2	2.75	303	25.7	0.144	0.15	28.3	25.5	386	0.21
Haynesville	HV25		Domestic	Environmental	4/21/2015	8.3	20.3	0.4	3.60	1.16	421	2.43	371	397	1.56	0.90	< 0.2	9.75	1098	1.14
Haynesville	HV26	METXGWOG1-08	Domestic	Environmental	4/27/2015	8.5	21.5	0.3	6.16	1.94	352	3.70	215	429	0.196	0.21	5.64	10.3	962	1.40
Haynesville	HV27	METXGWOG1-09	Domestic	Environmental	4/27/2015	8.4	20.8	< 0.1	6.59	1.61	123	2.13	212	24.5	0.110	0.17	18.9	14.0	311	0.78
Haynesville	HV28		Domestic	Environmental	7/1/2015	8.2	21.3	0.3	9.61	1.95	390	7.71	543	225.0	1.32	3.61	2.95	20.8	1004	1.13
Haynesville	HV29		Domestic	Environmental	5/13/2015	8.2	20.2	0.3	14.8	4.59	245	2.82	286	222	0.706	0.24	18.9	11.5	710	0.97
Haynesville	HV30	METXGWOG1-11	Domestic	Environmental	4/28/2015	8.6	21.1	1.7	3.10	0.89	426	2.28	618	230	0.500	1.72	0.11	10.9	1087	1.07
Haynesville	HV2		Domestic	Field blank	4/22/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.01
Haynesville	HV14		Domestic	Replicate	4/16/2015	--	--	--	1.64	0.73	64.7	2.23	--	8.33	0.040	0.38	26.3	40.9	194	--
Haynesville	HV16		Domestic	Field blank	4/29/2015	--	--	--	< 0.022	< 0.011	< 0.06	< 0.03	--	< 0.02	< 0.03	< 0.01	< 0.02	< 0.018	< 20	< 0.01
Haynesville	HVP21	METXPAS1-25	Public supply	Environmental	7/22/2014	5.0	20.1	0.3	3.22	1.79	8.56	4.06	9	16.1	0.075	0.02	6.15	35.5	81	< 0.01
Haynesville	HVP25	METXPAS1-21	Public supply	Environmental	6/17/2014	6.6	20.9	0.4	30.6	5.04	13.3	1.48	115	4.04	< 0.03	0.09	1.57	45.7	179	< 0.01
Haynesville	HVP27	METXPAS1-30	Public supply	Environmental	7/30/2014	8.7	24.1	0.4	1.24	0.25	169	1.11	244	98.9	0.279	0.18	9.05	11.3	468	0.635
Haynesville	HVP88	METXPAS1-61	Public supply	Environmental	7/13/2015	8.6	31.2	< 0.1	0.97	0.28	325	1.79	598	68.5	0.208	0.84	0.05	13.1	775	0.79
Haynesville	HVP89	METXPAS1-64	Public supply	Environmental	7/15/2015	8.7	29.5	< 0.1	0.26	0.06	140	0.72	199	11.4	0.049	0.20	81.8	13.5	369	0.38
Haynesville	HVP90	METXPAS1-62	Public supply	Environmental	7/14/2015	7.2	25.7	< 0.1	0.34	0.24	85.5	1.18	160	4.92	< 0.03	0.21	17.9	12.7	212	0.23
Haynesville	HVP91	METXPAS1-63	Public supply	Environmental	7/14/2015	6.8	23.8	< 0.1	0.75	0.26	79.6	1.21	130	9.29	0.04	0.20	29.8	12.6	216	0.28
Haynesville	HVP93		Public supply	Environmental	7/16/2015	4.9	21.5	< 0.1	32.4	19.8	15.7	4.01	14.4	22.7	0.101	0.04	164	20.2	297	0.14
Haynesville	HVP94	METXPAS1-78	Public supply	Environmental	8/5/2015	8.2	24.1	< 0.1	2.42	0.58	121	1.32	266	5.51	< 0.03	0.10	20.8	12.7	321	0.70
Haynesville	HVP95	METXPAS1-65	Public supply	Environmental	7/20/2015	8.0	25.5	< 0.1	5.55	0.67	89.3	1.36	170	11.2	0.053	0.09	19.2	14.1	246	0.76
Haynesville	HVP96	METXPAS1-75	Public supply	Environmental	8/3/2015	8.6	23.5	0.3	0.90	0.26	382	1.14	547	193	0.406	1.10	0.14	10.4	947	0.80
Haynesville	HVP98	METXPAS1-66	Public supply	Environmental	7/21/2015	7.9	22.6	< 0.1	3.15	1.14	207	1.50	212	137	0.558	0.14	74.1	10.5	551	0.74
Haynesville	HVP100	METXPAS1-68	Public supply	Environmental	7/22/2015	8.0	23.0	0.3	3.80	0.90	201	2.06	227	147	0.113	0.23	6.22	11.2	522	0.77

Table S3. Concentration of inorganic constituents in groundwater and quality-assurance samples.

Shale play	Well name	Nitrate (mg-N/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Strontium (µg/L)
Eagle Ford	EF1	< 0.039	0.26	25.2	806	1110	< 0.04	269	30.4	1270
Eagle Ford	EF2	13.4	47.8	174	338	< 4	0.12	26.1	< 0.4	780
Eagle Ford	EF3	< 0.04	< 0.5	22.9	4810	1090	< 0.2	456	63.3	4320
Eagle Ford	EF4	< 0.04	1.9	102	271	62.0	0.072	17.8	39.2	427
Eagle Ford	EF5	< 0.04	0.28	41.5	426	457	0.083	29.5	81.4	681
Eagle Ford	EF6	< 0.04	0.32	85.2	451	266	4.01	27.1	43.9	756
Eagle Ford	EF7	< 0.04	< 0.1	19.5	1270	701	< 0.04	331	2.45	758
Eagle Ford	EF8	< 0.04	< 0.1	69.8	246	55.9	< 0.04	29.0	10.2	204
Eagle Ford	EF9	< 0.04	< 0.1	108	206	242	0.098	18.2	18.2	639
Eagle Ford	EF10	< 0.039	< 0.1	109	235	652	0.041	15.4	29.5	587
Eagle Ford	EF11	< 0.04	< 0.1	72.5	209	410	< 0.04	21.8	21.0	692
Eagle Ford	EF12	< 0.04	< 0.4	9.51	4590	1510	< 0.16	479	63.2	4050
Eagle Ford	EF13	1.07	0.47	141	427	< 4	0.408	51.6	< 0.4	1370
Eagle Ford	EF14	< 0.04	< 0.1	116	362	369	< 0.04	30.8	50.6	218
Eagle Ford	EF15	< 0.04	< 0.1	106	200	487	< 0.04	17.0	38.1	639
Eagle Ford	EF16	3.58	83.9	52.7	963	4.2	0.987	42.5	0.44	448
Eagle Ford	EF17	0.84	5.0	208	263	< 4	0.386	38.8	< 0.4	952
Eagle Ford	EF18	1.06	6.1	77.3	552	< 4	1.76	56.6	< 0.4	661
Eagle Ford	EF19	< 0.04	0.17	41.6	438	517	< 0.04	34.8	40.4	595
Eagle Ford	EF20	1.7	1.7	157	314	4.9	0.51	40.6	< 0.4	2890
Eagle Ford	EF21	< 0.04	11.7	25.6	1170	< 4	0.138	131	75.4	386
Eagle Ford	EF22	< 0.04	1.3	3430	147	341	0.08	14.4	28.4	338
Eagle Ford	EF23	< 0.04	< 0.2	14.1	1830	206	< 0.08	186	17.4	1240
Eagle Ford	EF24	< 0.04	0.19	127	46	6690	< 0.04	12.5	166	66.5
Eagle Ford	EF25	< 0.04	< 0.1	75.7	1220	128	0.174	46.2	4.11	260
Eagle Ford	EF26	< 0.04	< 0.2	165	378	228	0.081	52.2	42.1	442
Eagle Ford	EF27	< 0.04	0.18	121	37	1150	0.271	8.03	36.2	43.0
Eagle Ford	EF28	< 0.04	< 0.2	25.9	323	407	< 0.08	157	21.2	2050
Eagle Ford	EF29	< 0.04	< 1	119	2360	391	< 0.4	31.6	34.7	3070
Eagle Ford	EF30	< 0.04	< 0.1	27.1	93	< 4	0.782	41.3	23.4	193
Eagle Ford	EF4	< 0.04	1.9	102	273	62.2	0.043	18.0	39.8	434
Eagle Ford	EF10	--	< 0.1	< 0.25	< 5	< 4	< 0.04	< 0.22	< 0.4	< 0.8
Eagle Ford	EF14	< 0.04	< 0.1	< 0.25	< 5	< 4	< 0.04	< 0.22	< 0.4	< 0.8
Eagle Ford	EFP70	< 0.04	0.14	18.4	972	120	3.73	107	31.3	1460
Eagle Ford	EFP71	< 0.04	< 0.1	91.0	308	6.4	0.073	27.8	6.10	120
Eagle Ford	EFP72	< 0.04	< 0.1	30.5	492	4.9	< 0.04	43.3	6.47	91.6
Eagle Ford	EFP73	< 0.04	0.31	90.5	244	9.5	6.14	19.3	11.9	671
Eagle Ford	EFP74	< 0.04	< 0.1	114	304	360	< 0.04	33.7	8.96	695
Eagle Ford	EFP75	< 0.04	< 0.1	85.5	133	312	0.079	17.5	9.23	1090
Eagle Ford	EFP76	< 0.04	< 0.1	223	166	388	0.044	20.8	22.0	453
Eagle Ford	EFP77	< 0.04	0.31	146	121	123	0.119	8.99	6.95	609
Eagle Ford	EFP78	< 0.04	0.30	156	83	1110	0.063	20.1	84.7	282
Eagle Ford	EFP79	< 0.04	< 0.1	282	178	24.0	< 0.04	42.2	9.15	655
Eagle Ford	EFP80	< 0.04	< 0.1	112	132	21.2	< 0.04	42.1	15.7	955
Eagle Ford	EFP81	< 0.04	< 0.1	154	54	250	< 0.04	24.2	291	259
Eagle Ford	EFP83	< 0.04	< 0.1	19.4	185	9.5	0.069	23.2	11.2	98.6
Fayetteville	FV1	< 0.04	0.14	42.4	52	653	0.076	15.8	60.8	722
Fayetteville	FV2	< 0.04	< 0.1	72.7	106	5.0	< 0.04	28.2	110	183
Fayetteville	FV3	< 0.04	0.16	85.8	25	1280	< 0.04	13.5	432	65.4
Fayetteville	FV4	0.375	0.14	4.91	10	63.0	0.051	12.0	13.3	39.0
Fayetteville	FV5	0.687	0.40	70.2	17	2400	0.056	12.8	507	94.2
Fayetteville	FV6	< 0.04	< 0.1	99.7	93	118	0.083	19.6	21.2	178
Fayetteville	FV7	< 0.04	2.1	84.7	23	1170	0.045	10.6	207	152
Fayetteville	FV8	< 0.04	1.2	44.1	6	1530	0.168	14.6	1600	65.4
Fayetteville	FV9	< 0.04	0.53	216	22	4450	< 0.04	28.0	560	239

Table S3. Concentration of inorganic constituents in groundwater and quality-assurance samples.

Shale play	Well name	Nitrate (mg-N/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Strontium (µg/L)
Fayetteville	FV10	< 0.04	2.7	59.8	9	4730	< 0.04	9.18	972	41.4
Fayetteville	FV11	0.052	< 0.1	9.24	58	11.5	0.077	3.46	4.84	13.3
Fayetteville	FV12	< 0.04	0.13	55.9	10	268	0.302	18.3	1090	87.1
Fayetteville	FV13	< 0.04	0.36	47.4	15	950	0.081	7.86	74.4	61.4
Fayetteville	FV14	< 0.04	0.23	47.2	11	2500	0.128	8.24	285	42.3
Fayetteville	FV15	< 0.04	< 0.1	111	300	382	< 0.04	23.8	27.3	186
Fayetteville	FV16	4.67	< 0.1	51.5	< 5	10.3	0.730	2.50	56.7	10.2
Fayetteville	FV17	0.04	0.16	26.9	311	35.8	0.083	14.4	6.45	74.2
Fayetteville	FV18	2.21	< 0.1	17.3	< 5	6.1	2.49	3.80	169	6.60
Fayetteville	FV19	< 0.04	0.33	9.60	212	14.4	< 0.04	5.22	0.91	8.89
Fayetteville	FV20	< 0.04	< 0.1	35.7	22	240	< 0.04	6.09	398	128
Fayetteville	FV21	0.082	0.15	44.2	71	48.5	< 0.04	9.36	46.2	88.5
Fayetteville	FV22	< 0.04	0.13	64.7	154	479	0.095	5.14	102	118
Fayetteville	FV23	< 0.04	0.60	30.2	151	202	< 0.04	7.03	43.6	148
Fayetteville	FV24	< 0.04	< 0.1	74.2	120	11.5	0.173	10.7	27.3	138
Fayetteville	FV25	< 0.04	0.10	21.0	28	1660	< 0.04	2.47	354	49.5
Fayetteville	FV26	< 0.04	2.2	17.0	238	290	0.095	4.50	85.5	29.8
Fayetteville	FV27	3.05	< 0.1	12.5	6	70.2	1.70	12.7	43.3	30.6
Fayetteville	FV28	0.399	< 0.1	19.5	< 5	566	0.960	9.29	107	6.15
Fayetteville	FV29	< 0.04	0.26	17.8	59	5150	< 0.04	4.10	1210	20.5
Fayetteville	FV30	< 0.04	0.35	12.7	8	338	< 0.04	1.16	634	66.0
Fayetteville	FV8	< 0.04	1.3	46.3	7	1620	0.092	14.5	1690	65.5
Fayetteville	FV27	3.04	< 0.1	12.6	5	68.9	1.63	12.0	41.8	31.2
Fayetteville	FV12	< 0.04	< 0.1	< 0.25	< 5	< 4	< 0.04	< 0.22	< 0.4	< 0.8
Fayetteville	FV19	< 0.04	< 0.1	< 0.25	< 5	< 4	< 0.04	< 0.22	< 0.4	< 0.8
Fayetteville	FAU001	--	0.78	111	< 22	1070	1.94	12.2	264	214
Fayetteville	FAU002	--	< 0.11	54.6	45	1120	< 0.03	6.56	150	113
Fayetteville	FAU004	--	< 0.11	15.9	235	< 50	< 0.03	26.8	< 15	19.1
Fayetteville	FAU005	--	< 0.11	229	107	103	< 0.03	23.9	156	952
Fayetteville	FAU006	--	< 0.11	129	63	186	< 0.03	14.6	39	478
Fayetteville	FAU008	--	0.25	97.6	54	240	< 0.03	18.7	86	231
Fayetteville	FAU010	--	0.20	113	101	922	< 0.03	13.5	170	287
Fayetteville	FAU012	--	< 0.11	47.5	118	114	0.095	7.77	26	229
Fayetteville	FAU013	--	< 0.11	31.0	82	846	< 0.03	11.6	114	63.9
Fayetteville	FAU032	--	< 0.11	70.3	53	1830	< 0.03	33.2	237	164
Fayetteville	FAU033	--	0.25	90.8	24	2560	< 0.03	12.7	485	65.0
Fayetteville	FAU042	--	0.89	41.5	9	1530	0.029	6.50	122	40.0
Fayetteville	FAU044	--	0.63	73.4	8	78.6	0.112	4.42	15	95.3
Fayetteville	FAU045	--	0.34	72.7	7	313	< 0.03	3.89	169	92.3
Fayetteville	FAU055	--	0.40	7.78	11	< 50	0.171	7.48	< 15	28.1
Fayetteville	FAU057	--	< 0.11	146	104	309	< 0.03	16.10	129	451
Fayetteville	FAU058	--	< 0.11	6.57	107	< 50	0.026	5.33	< 15	12.3
Fayetteville	FAU059	--	< 0.11	22.2	110	< 50	< 0.03	8.31	19	55.8
Fayetteville	FAU060	--	< 0.11	53.2	67	459	< 0.03	5.88	185	166
Fayetteville	VB001	--	< 0.11	62.1	28	472	< 0.03	1.55	89	35.5
Fayetteville	VB011	--	< 0.11	11.0	< 22	470	< 0.03	< 1.25	< 15	52.5
Fayetteville	VB019	--	0.31	13.0	< 22	< 50	0.064	1.79	1840	20.3
Fayetteville	VB020	--	0.29	6.82	< 22	5680	< 0.03	8.64	4370	< 9.27
Fayetteville	VB021	--	0.44	6.41	< 22	5150	0.489	9.36	1820	10.0
Fayetteville	VB022	--	0.30	92.4	24	< 50	0.397	6.69	529	236
Fayetteville	VB023	--	< 0.11	124	< 22	462	0.123	2.56	403	82.0
Fayetteville	VB033	--	< 0.11	<2.45	< 22	< 50	< 0.03	< 1.25	< 15	59.8
Fayetteville	VB045	--	0.28	25.3	< 22	2240	< 0.03	9.23	1240	33.9
Fayetteville	VB046	--	< 0.11	29.5	99	469	< 0.03	6.97	< 15	111
Fayetteville	VB050	--	< 0.11	7.32	< 22	< 50	1.33	4.76	< 15	< 9.27
Fayetteville	VB051	--	0.54	46.5	77	< 50	0.175	2.86	< 15	56.5
Fayetteville	VB052	--	0.59	46.6	77	127	0.145	2.66	< 15	56.6

Table S3. Concentration of inorganic constituents in groundwater and quality-assurance samples.

Shale play	Well name	Nitrate (mg-N/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Strontium (µg/L)
Fayetteville	VB053	--	< 0.11	<2.45	< 22	32.6	0.094	< 1.25	< 15	48.5
Fayetteville	VB054	--	< 0.11	20.2	< 22	1680	0.077	4.02	981	19.7
Haynesville	HV1	0.212	< 0.1	1.30	< 5	9.3	< 0.04	< 0.22	0.46	3.79
Haynesville	HV2	0.038	0.10	39.9	743	16.4	0.197	4.65	5.77	57.8
Haynesville	HV3	< 0.04	< 0.1	42.8	1500	28.3	0.050	8.85	3.15	85.0
Haynesville	HV4	< 0.04	< 0.1	53.4	43	5360	0.165	32.6	41.3	125
Haynesville	HV5	< 0.04	< 0.1	163	967	125	< 0.04	39.1	9.76	557
Haynesville	HV6	0.041	< 0.1	35.3	22	8730	0.198	63.6	81.8	531
Haynesville	HV7	0.114	< 0.1	31.0	806	15.9	0.849	10.8	7.17	70.2
Haynesville	HV8	< 0.04	< 0.1	136	75	21.5	0.091	7.55	23.1	493
Haynesville	HV9	< 0.04	0.73	98.7	67	6940	< 0.04	77.4	335	2470
Haynesville	HV10	< 0.04	< 0.1	324	27	3050	< 0.04	26.8	92.9	682
Haynesville	HV11	< 0.04	1.1	75.3	33	1380	0.376	27.7	29.4	30.8
Haynesville	HV12	< 0.04	< 0.1	43.1	288	24.6	0.042	8.32	6.71	124
Haynesville	HV13	< 0.04	< 0.1	29.3	705	4.9	0.134	12.1	4.94	123
Haynesville	HV14	0.184	< 0.1	19.8	34	49.1	0.939	11.0	8.68	84.1
Haynesville	HV15	< 0.04	0.13	29.5	1370	17.2	0.214	17.8	8.68	116
Haynesville	HV16	< 0.04	0.23	51.2	1760	12.2	< 0.08	27.1	1.38	247
Haynesville	HV17	< 0.04	0.34	172	42	1120	0.054	78.6	192	1840
Haynesville	HV18	< 0.04	< 0.1	87.4	128	34.3	0.617	20.4	34.3	523
Haynesville	HV19	< 0.04	0.72	63.5	15	8330	< 0.04	17.5	272	153
Haynesville	HV20	< 0.04	0.88	410	160	4990	< 0.04	13.8	349	698
Haynesville	HV21	< 0.04	< 0.1	186	2300	63.2	< 0.04	21.8	5.53	1050
Haynesville	HV22	0.092	< 0.1	113	78	28.7	0.157	18.6	29.9	486
Haynesville	HV23	< 0.04	0.13	57.3	478	26.6	< 0.04	22.7	3.70	176
Haynesville	HV24	< 0.04	0.61	211	56	298	< 0.04	39.9	191	2600
Haynesville	HV25	< 0.04	0.15	50.3	1560	16.3	0.093	29.8	12.8	284
Haynesville	HV26	< 0.04	0.17	146	200	15.0	< 0.04	21.9	5.05	388
Haynesville	HV27	< 0.04	< 0.1	32.7	229	17.3	< 0.04	19.3	14.6	325
Haynesville	HV28	0.066	0.13	87.5	1760	27.1	0.105	22.2	1.30	361
Haynesville	HV29	< 0.04	0.18	217	501	58.0	< 0.08	24.1	38.0	1070
Haynesville	HV30	< 0.04	0.11	69.3	821	21.4	0.072	25.7	1.58	273
Haynesville	HV2	< 0.04	< 0.1	< 0.25	< 5	--	< 0.04	< 0.22	< 0.4	< 0.8
Haynesville	HV14	--	--	--	--	--	--	--	--	--
Haynesville	HV16	< 0.04	< 0.1	< 0.25	< 5	< 4	< 0.04	< 0.22	< 0.4	< 0.8
Haynesville	HVP21	< 0.04	0.10	350	12	490	--	4.46	15.8	115
Haynesville	HVP25	< 0.04	0.11	62.4	12	2500	--	13.0	155	199
Haynesville	HVP27	< 0.04	< 0.1	14.5	309	5.9	--	13.0	4.79	61.6
Haynesville	HVP88	< 0.04	< 0.1	17.5	744	8.7	0.080	11.0	1.61	60.0
Haynesville	HVP89	< 0.04	< 0.1	6.65	216	< 4	0.700	4.87	0.63	13.4
Haynesville	HVP90	< 0.04	< 0.1	11.8	121	15.1	0.301	4.82	1.85	13.0
Haynesville	HVP91	< 0.04	< 0.1	10.9	125	20.5	0.110	5.13	3.62	25.5
Haynesville	HVP93	0.04	< 0.1	35.3	22	8730	0.198	63.6	81.8	531
Haynesville	HVP94	< 0.04	< 0.1	40.1	209	13.9	0.129	6.32	13.6	96.5
Haynesville	HVP95	< 0.04	0.15	48.2	55	23.1	0.349	6.51	29.9	168
Haynesville	HVP96	< 0.04	0.16	20.5	631	12.1	0.234	19.8	2.15	90.3
Haynesville	HVP98	< 0.04	< 0.1	31.3	364	639	0.088	25.0	58.7	209
Haynesville	HVP100	< 0.04	0.11	51.5	156	18.4	< 0.04	12.4	16.9	138

Table S4. Isotope and dissolved-gas data for groundwater samples.

Shale play	Well name	Well type	Sample type	Sample date	δ^2H-H_2O (per mil relative to Vienna Standard Mean Ocean Water [VSMOW])	$\delta^{18}O$-H_2O (per mil relative to VSMOW])	Tritium-H_2O (Tritium Units [TU])	$\delta^{13}C$-DIC (per mil relative to Vienna Peedee Belemnite [VPDB])	^{14}C-DIC (percent modern carbon [pmc])	SF_6 (femtomoles per kilogram water [fmol/kg])	CH_4 (mg/L)	δ^2H-CH_4 (per mil relative to VSMOW])	$\delta^{13}C$-CH_4 (per mil relative to VPDB)	C_1 (mole %)	C_2 (mole %)	C_3 (mole %)	iC_4 (mole %)	nC_4 (mole %)
Eagle Ford	EF1	Domestic	Environmental	1/14/2016	-26.5	-4.23	< 0.1	-14.39	10.5	0.61	0.001	--	--	0.0050	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF2	Domestic	Environmental	1/11/2016	-28.2	-4.67	0.84	-14.65	88.6	1.14	< 0.001	--	--	0.0022	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF3	Domestic	Environmental	1/26/2016	-23.4	-3.84	< 0.1	-15.23	0.8	0.04	1.2	-318.0	-25.47	6.32	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF3	Domestic	Environmental	4/27/2016	--	--	--	--	--	--	0.27	-312.3	-30.3	1.41	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF4	Domestic	Environmental	1/13/2016	-29.8	-4.86	< 0.1	-14.53	54.1	0.07	< 0.001	--	--	0.0009	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF5	Domestic	Environmental	1/27/2016	-26.9	-4.19	0.11	-13.31	26.2	0.02	0.001	--	--	0.0039	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF6	Domestic	Environmental	1/12/2016	-27.7	-4.48	< 0.1	-13.28	23.7	0.08	0.001	--	--	0.0050	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF7	Domestic	Environmental	1/24/2016	-23.5	-3.99	< 0.1	-12.96	9.1	0.66	< 0.001	--	--	0.0018	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF8	Domestic	Environmental	1/21/2016	-26.0	-4.47	< 0.1	-8.96	0.8	0.08	0.003	--	--	0.0157	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF9	Domestic	Environmental	1/18/2016	-23.7	-3.96	< 0.1	-9.13	16.7	0.07	0.003	--	--	0.0175	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF10	Domestic	Environmental	1/20/2016	-23.8	-4.07	< 0.1	-9.49	16.4	0.02	0.002	--	--	0.0124	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF11	Domestic	Environmental	1/25/2016	-23.3	-4.05	< 0.1	-10.06	18.1	0.02	0.003	--	--	0.0180	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF12	Domestic	Environmental	2/16/2016	-23.4	-3.93	< 0.1	-20.21	1.7	0.07	0.004	--	--	0.0264	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF13	Domestic	Environmental	2/1/2016	-22.1	-4.01	0.20	-8.09	7.7	2.20	< 0.001	--	--	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF14	Domestic	Environmental	2/10/2016	-27.0	-4.52	< 0.1	-11.70	0.1	0.06	0.11	--	-25.94	0.692	0.0013	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF15	Domestic	Environmental	1/27/2016	-21.9	-3.44	0.13	-10.13	28.6	1.30	0.005	--	--	0.0398	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF16	Domestic	Environmental	2/8/2016	-27.1	-4.74	0.11	-7.78	9.3	2.54	< 0.001	--	--	0.0015	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF17	Domestic	Environmental	2/2/2016	-23.2	-4.14	< 0.1	-9.70	18.0	1.30	< 0.001	--	--	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF18	Domestic	Environmental	2/9/2016	-24.2	-4.42	< 0.1	-7.53	5.1	1.23	< 0.001	--	--	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF19	Domestic	Environmental	1/19/2016	-22.4	-3.92	< 0.1	-11.35	23.9	0.14	0.12	--	-56.2	0.822	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF20	Domestic	Environmental	2/9/2016	-24.3	-4.37	< 0.1	-7.21	16.0	0.51	< 0.001	--	--	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF21	Domestic	Environmental	2/8/2016	-25.0	-4.48	0.21	-9.29	8.8	0.17	0.008	--	--	0.0502	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF22	Domestic	Environmental	1/19/2016	-19.8	-2.95	0.13	-12.52	22.9	0.28	11	-178.3	-64.48	42.52	0.0186	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF23	Domestic	Environmental	2/10/2016	-23.6	-4.00	< 0.1	-15.41	5.2	0.07	0.005	--	--	0.0298	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF24	Domestic	Environmental	3/8/2016	-27.4	-5.00	< 0.1	-18.3	70.5	0.05	0.047	--	--	0.280	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF25	Domestic	Environmental	2/3/2016	-26.9	-5.12	< 0.1	-8.13	0.2	6.00	12	-197.9	-65.90	43.09	0.0045	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF26	Domestic	Environmental	3/8/2016	-25.8	-4.72	< 0.1	-9.26	0.5	0.05	24	-188.0	-60.12	58.01	0.0034	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF27	Domestic	Environmental	2/4/2016	-24.8	-4.86	< 0.1	-20.5	76.3	0.09	0.001	--	--	0.0083	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF28	Domestic	Environmental	2/24/2016	-23.8	-4.57	< 0.1	-16.54	0.5	0.06	0.008	--	--	0.0472	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF29	Domestic	Environmental	2/15/2016	-23.3	-4.48	< 0.1	-16.19	0.2	0.04	0.029	--	--	0.167	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EF30	Domestic	Environmental	2/17/2016	-27.6	-5.02	0.14	-17.66	0.7	0.03	0.004	--	--	0.0231	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP70	Public supply	Environmental	7/29/2015	-25.1	-4.33	< 0.1	-12.79	2.0	0.10	0.012	--	--	0.0584	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP71	Public supply	Environmental	7/27/2015	-25.4	-4.28	< 0.1	-9.09	0.4	1.73	0.003	--	--	0.0177	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP72	Public supply	Environmental	7/29/2015	-26.5	-4.59	< 0.1	-11.16	0.5	1.25	6.7	-169.6	-43.68	29.36	0.0529	0.0004	< 0.0001	< 0.0001
Eagle Ford	EFP73	Public supply	Environmental	7/28/2015	-26.4	-4.41	0.10	-9.37	18.0	2.82	0.005	--	--	0.0065	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP74	Public supply	Environmental	8/10/2015	-24.9	-4.37	< 0.1	-8.75	7.0	0.26	0.002	--	--	0.0142	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP75	Public supply	Environmental	8/12/2015	-24.8	-4.33	< 0.1	-10.18	22.2	0.08	0.001	--	--	0.0041	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP76	Public supply	Environmental	8/11/2015	-20.7	-3.58	< 0.1	-8.50	14.4	0.09	0.002	--	--	0.0082	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP77	Public supply	Environmental	7/28/2015	-20.5	-3.40	< 0.1	-11.2	64.3	0.04	0.006	--	--	0.0430	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP78	Public supply	Environmental	8/11/2015	-28.0	-4.86	< 0.1	-14.81	37.2	0.14	0.002	--	--	0.0096	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP79	Public supply	Environmental	8/31/2015	-26.0	-4.63	--	--	--	0.10	0.052	--	--	0.3540	0.0007	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP80	Public supply	Environmental	8/13/2015	-26.7	-4.63	< 0.1	-10.25	0.8	0.10	0.033	--	--	0.2000	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP81	Public supply	Environmental	9/1/2015	-25.8	-4.92	--	--	--	0.10	0.003	--	--	0.0154	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Eagle Ford	EFP83	Public supply	Environmental	9/2/2015	-25.8	-5.03	--	--	--	0.10	0.007	--	--	0.0420	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV1	Domestic	Environmental	7/28/2015	-32.17	-5.68	1.57	-18.94	52.9	0.35	0.017	--	--	0.0828	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV2	Domestic	Environmental	7/27/2015	-31.94	-5.47	0.93	-15.03	26.5	0.12	16	-183.4	-63.33	45.15	0.0023	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV3	Domestic	Environmental	7/20/2015	-32.6	-5.47	2.16	-17.81	55.4	0.21	0.006	--	--	0.0266	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Maximum 1-sigma errors: He (±1%); Ne, Ar (±2%); Kr, Xe (±3%); R/Ra (1%); $^{20}Ne/^{22}Ne$ (0.1%); $^{40}Ar/^{36}Ar$ (1%).

[b] (R/Ra), $(^3He/^4He)_s/(^3He/^4He)_{atm}$, atmospheric $^3He/^4He$ ratio is 1.384×10^{-6}.

Table S4. Isotope and dissolved-gas data for groundwater samples.

Shale play	Well name	Well type	Sample type	Sample date	δ^2H-H_2O (per mil relative to Vienna Standard Mean Ocean Water [VSMOW])	$\delta^{18}O-H_2O$ (per mil relative to VSMOW])	Tritium-H_2O (Tritium Units [TU])	$\delta^{13}C$-DIC (per mil relative to Vienna Peedee Belemnite [VPDB])	^{14}C-DIC (percent modern carbon [pmc])	SF_6 (femtomoles per kilogram water [fmol/kg])	CH_4 (mg/L)	δ^2H-CH_4 (per mil relative to VSMOW])	$\delta^{13}C-CH_4$ (per mil relative to VPDB)	C_1 (mole %)	C_2 (mole %)	C_3 (mole %)	iC_4 (mole %)	nC_4 (mole %)
Fayetteville	FV4	Domestic	Environmental	7/28/2015	-32.45	-5.58	2.07	-20.73	69.2	1.92	0.002	--	--	0.0097	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV5	Domestic	Environmental	6/29/2015	-32.82	-5.73	1.87	-18.56	46.7	0.36	0.082	--	--	0.386	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV6	Domestic	Environmental	7/16/2015	-31.93	-5.64	0.62	-17.55	36.3	0.17	0.75	-173.0	-68.29	3.74	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV7	Domestic	Environmental	6/29/2015	-31.85	-5.53	0.96	-19.28	49.9	0.6	0.21	-253.0	-63.30	1.00	< 0.0001	< 0.0001	< 0.0001	0.0004
Fayetteville	FV8	Domestic	Environmental	7/30/2015	-32.15	-5.56	0.27	--	--	0.85	0.003	--	--	0.0132	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV9	Domestic	Environmental	7/22/2015	-30.37	-5.5	1.21	-19.03	53.8	3.71	0.011	--	--	0.0455	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV10	Domestic	Environmental	7/20/2015	-30.76	-5.42	2.35	-19.04	70.6	0.21	0.003	--	--	0.0152	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV11	Domestic	Environmental	7/21/2015	-29.05	-5.33	1.67	-19.04	48.7	1.36	0.84	--	--	3.02	0.0007	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV12	Domestic	Environmental	8/6/2015	-30.14	-5.36	2.00	-21.32	81.4	2.58	0.006	--	--	0.0219	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV13	Domestic	Environmental	6/29/2015	-32.76	-5.73	1.71	-19.56	56.1	0.3	0.006	--	--	0.0263	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV14	Domestic	Environmental	6/30/2015	-32.51	-5.75	1.74	-20.22	57.7	0.17	0.008	--	--	0.0355	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV15	Domestic	Environmental	7/21/2015	-31.61	-5.63	0.14	-12.77	6.9	3214	7.9	-190.6	-67.97	30.05	0.0011	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV16	Domestic	Environmental	7/27/2015	-33.38	-5.77	2.60	-21.15	109.8	1.96	< 0.001	--	--	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV17	Domestic	Environmental	7/1/2015	-31.9	-5.64	0.60	-21.06	35.2	0.31	3.0	-168.1	-65.49	15.52	0.0174	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV18	Domestic	Environmental	7/15/2015	-31.59	-5.56	2.68	-21.79	98.9	0.99	< 0.001	--	--	< 0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV19	Domestic	Environmental	8/6/2015	-30.61	-5.44	0.19	-9.18	15.6	0.16	25	-212.0	-73.23	54.64	0.0054	0.0004	< 0.0001	< 0.0001
Fayetteville	FV20	Domestic	Environmental	7/20/2015	-31.48	-5.66	0.09	-18.43	48.6	1.52	0.002	--	--	0.0076	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV21	Domestic	Environmental	7/14/2015	-30.95	-5.68	1.91	-20.43	55.7	0.66	0.001	--	--	0.0069	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV22	Domestic	Environmental	7/1/2015	-30.19	-5.35	1.57	-16.88	46.7	0.31	0.025	--	--	0.124	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV23	Domestic	Environmental	6/30/2015	-30.64	-5.31	1.37	-16.27	40.0	1.14	0.047	--	--	0.227	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV24	Domestic	Environmental	7/29/2015	-33.97	-5.94	< 0.1	-14.45	1.8	0.17	0.011	--	--	0.0574	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV25	Domestic	Environmental	7/13/2015	-31.06	-5.56	1.64	-16.96	47.6	0.47	0.16	--	--	0.738	0.0005	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV26	Domestic	Environmental	6/30/2015	-32.7	-5.67	1.07	-19.96	46.3	0.42	0.87	-142.6	-68.85	4.30	0.0008	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV27	Domestic	Environmental	7/29/2015	-29.36	-5.29	2.70	-21.96	106.2	2.16	0.003	--	--	0.0134	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV28	Domestic	Environmental	7/15/2015	-32.74	-5.8	2.49	-22.06	91.1	1.27	0.005	--	--	0.0269	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV29	Domestic	Environmental	7/13/2015	-31.06	-5.58	0.67	-20.18	59.9	1.58	0.066	--	--	0.326	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FV30	Domestic	Environmental	7/13/2015	-32.29	-5.77	1.82	-15.64	55.5	0.44	0.001	--	--	0.0027	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Fayetteville	FAU001	Domestic	Environ., data from ref. 7	10/31/2011	--	--	--	--	--	--	0.042	--	--	--	--	--	--	--
Fayetteville	FAU002	Domestic	Environ., data from ref. 7	10/31/2011	--	--	--	--	--	--	0.324	--	-44.58	--	--	--	--	--
Fayetteville	FAU004	Domestic	Environ., data from ref. 7	10/31/2011	--	--	--	--	--	--	28	--	-63.04	--	--	--	--	--
Fayetteville	FAU005	Domestic	Environ., data from ref. 7	10/31/2011	--	--	--	--	--	--	0.350	--	-58.59	--	--	--	--	--
Fayetteville	FAU008	Domestic	Environ., data from ref. 7	10/31/2011	--	--	--	--	--	--	0.016	--	--	--	--	--	--	--
Fayetteville	FAU010	Domestic	Environ., data from ref. 7	10/31/2011	--	--	--	--	--	--	0.480	--	-54.37	--	--	--	--	--
Fayetteville	FAU012	Domestic	Environ., data from ref. 7	11/1/2011	--	--	--	--	--	--	0.822	--	-60.11	--	--	--	--	--
Fayetteville	FAU013	Domestic	Environ., data from ref. 7	11/1/2011	--	--	--	--	--	--	0.344	--	-60.03	--	--	--	--	--
Fayetteville	FAU032	Domestic	Environ., data from ref. 7	11/3/2011	--	--	--	--	--	--	< 0.001	--	--	--	--	--	--	--
Fayetteville	FAU033	Domestic	Environ., data from ref. 7	11/3/2011	--	--	--	--	--	--	< 0.001	--	--	--	--	--	--	--
Fayetteville	FAU044	Domestic	Environ., data from ref. 7	11/4/2011	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--
Fayetteville	VB020	Domestic	Environ., data from ref. 7	7/7/2011	--	--	--	--	--	--	0.069	--	--	--	--	--	--	--
Fayetteville	VB045	Domestic	Environ., data from ref. 7	7/12/2011	--	--	--	--	--	--	0.001	--	--	--	--	--	--	--
Fayetteville	VB046	Domestic	Environ., data from ref. 7	7/12/2011	--	--	--	--	--	--	< 0.001	--	--	--	--	--	--	--
Haynesville	HV1	Domestic	Environmental	4/13/2015	-26.3	-4.93	< 0.1	-17.98	12.8	0.88	0.008	--	--	0.0503	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV2	Domestic	Environmental	4/22/2015	-21.1	-4.41	0.11	-11.42	11.4	0.64	0.008	--	--	0.0489	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV3	Domestic	Environmental	4/30/2015	-25.5	-5.02	< 0.1	-2.16	0.2	0.36	10	-189.0	-59.92	36.60	0.0058	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV4	Domestic	Environmental	4/13/2015	-23.5	-4.59	< 0.1	-17.98	50.5	0.94	0.093	--	--	0.485	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV5	Domestic	Environmental	4/29/2015	-23.8	-4.66	< 0.1	-10.00	9.8	0.18	12	-185.4	-61.58	35.81	0.0114	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV6	Domestic	Environmental	7/16/2015	-22.8	-4.55	< 0.1	-21.04	62.8	0.21	0.001	--	--	0.003	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a]Maximum 1-sigma errors: He (±1%); Ne, Ar (±2%); Kr, Xe (±3%); R/Ra (1%); $^{20}Ne/^{22}Ne$ (0.1%); $^{40}Ar/^{36}Ar$ (1%).

[b](R/Ra), $(^3He/^4He)s/(^3He/^4He)atm$, atmospheric $^3He/^4He$ ratio is 1.384×10^{-6}.

Table S4. Isotope and dissolved-gas data for groundwater samples.

Shale play	Well name	Well type	Sample type	Sample date	$\delta^{2}H$-H_2O (per mil relative to Vienna Standard Mean Ocean Water [VSMOW])	$\delta^{18}O$-H_2O (per mil relative to VSMOW])	Tritium-H_2O (Tritium Units [TU])	$\delta^{13}C$-DIC (per mil relative to Vienna Peedee Belemnite [VPDB])	^{14}C-DIC (percent modern carbon [pmc])	SF_6 (femtomoles per kilogram water [fmol/kg])	CH_4 (mg/L)	$\delta^{2}H$-CH_4 (per mil relative to VSMOW])	$\delta^{13}C$-CH_4 (per mil relative to VPDB)	C_1 (mole %)	C_2 (mole %)	C_3 (mole %)	iC_4 (mole %)	nC_4 (mole %)
Haynesville	HV7	Domestic	Environmental	6/29/2015	-25.8	-4.96	< 0.1	-5.25	3.4	0.53	0.006	--	--	0.0303	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV8	Domestic	Environmental	4/14/2015	-24.1	-4.80	< 0.1	-12.86	14.4	0.24	0.018	--	--	0.112	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV9	Domestic	Environmental	5/6/2015	-23.6	-4.60	0.17	-17.17	65.4	0.19	0.001	--	--	0.0041	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV10	Domestic	Environmental	4/29/2015	-23.6	-4.68	< 0.1	-18.08	59.5	0.26	0.051	--	--	0.268	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV11	Domestic	Environmental	4/15/2015	-23.4	-4.48	0.48	-22.58	76.6	0.36	0.001	--	--	0.0023	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV12	Domestic	Environmental	4/15/2015	-26.6	-4.96	< 0.1	-9.81	1.3	0.24	0.007	--	--	0.0392	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV13	Domestic	Environmental	5/12/2015	-26.4	-4.95	< 0.1	-13.04	16.5	0.22	0.31	-165.0	-61.65	1.56	0.0008	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV14	Domestic	Environmental	4/16/2015	-24.2	-4.71	< 0.1	-17.13	40.8	0.37	0.001	--	--	0.0076	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV15	Domestic	Environmental	6/10/2015	-26	-5.04	< 0.1	-9.08	2.0	0.18	1.3	-194.0	-70.52	6.87	0.0084	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV16	Domestic	Environmental	4/29/2015	-27	-5.11	< 0.1	-1.41	0.5	1.29	16	-185.1	-58.73	42.25	0.0444	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV17	Domestic	Environmental	6/9/2015	-24.1	-4.66	< 0.1	-15.57	48.7	2.27	0.002	--	--	0.0086	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV18	Domestic	Environmental	6/2/2015	-26.9	-4.87	< 0.1	-12.11	8.9	0.17	0.002	--	--	0.0117	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV19	Domestic	Environmental	4/28/2015	-24.5	-4.82	< 0.1	-19.45	79.1	0.47	0.004	--	--	0.0167	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV20	Domestic	Environmental	4/30/2015	-22.8	-4.44	1.82	-13.70	93.1	0.31	0.015	--	--	0.0729	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV21	Domestic	Environmental	6/30/2015	-25.1	-4.90	< 0.1	-10.54	0.4	0.16	3.7	-219.4	-82.66	17.15	0.0044	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV22	Domestic	Environmental	6/11/2015	-26.1	-4.92	< 0.1	-14.60	15.2	0.57	0.005	--	--	0.0269	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV23	Domestic	Environmental	4/16/2015	-26.8	-5.10	0.10	-4.16	0.3	0.25	5.4	-203.4	-75.15	25.12	0.0014	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV24	Domestic	Environmental	5/26/2015	-24.4	-4.64	0.11	-17.05	43.4	0.15	0.003	--	--	0.0132	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV25	Domestic	Environmental	4/21/2015	-25.9	-4.83	< 0.1	-5.78	0.5	0.29	22	-181.9	-49.13	69.88	0.0483	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV26	Domestic	Environmental	4/27/2015	-29.7	-5.35	< 0.1	-10.40	0.5	0.55	0.12	--	-83.43	0.647	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV27	Domestic	Environmental	4/27/2015	-27.7	-5.27	< 0.1	-14.15	3.8	0.25	0.009	--	--	0.0537	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV28	Domestic	Environmental	7/1/2015	-26.2	-5.02	< 0.1	-9.19	0.5	0.24	4.4	-206.9	-77.21	19.77	0.0087	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV29	Domestic	Environmental	5/13/2015	-28.5	-5.10	< 0.1	-1.68	0.8	0.27	15	-180.0	-52.36	43.37	0.0253	< 0.0001	< 0.0001	< 0.0001
Haynesville	HV30	Domestic	Environmental	4/28/2015	-26.1	-5.11	< 0.1	-5.15	0.1	0.75	2.3	-200.1	-75.38	12.15	0.0025	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP21	Public supply	Environmental	7/22/2014	-22.4	-4.30	1.32	-22.68	103	0.27	0.002	--	--	0.0068	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP25	Public supply	Environmental	6/17/2014	-24.0	-4.73	< 0.1	-18.07	61.7	0.17	0.001	--	--	0.0036	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP27	Public supply	Environmental	7/30/2014	-26.8	-5.28	< 0.1	-14.53	3.5	0.17	0.110	--	--	0.6050	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP88	Public supply	Environmental	7/13/2015	-25.8	-4.99	< 0.1	-11.43	0.2	0.18	19	-194.7	-69.35	49.23	0.0033	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP89	Public supply	Environmental	7/15/2015	-25.4	-4.96	< 0.1	-17.12	1.5	0.18	0.014	--	--	0.0750	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP90	Public supply	Environmental	7/14/2015	-26.9	-5.09	< 0.1	-14.78	8.0	0.12	0.005	--	--	0.0258	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP91	Public supply	Environmental	7/14/2015	-23.5	-4.72	< 0.1	-19.20	17.3	0.12	0.009	--	--	0.0471	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP93	Public supply	Environmental	7/16/2015	-22.8	-4.55	< 0.1	-21.04	62.8	0.21	0.001	--	--	0.0030	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP94	Public supply	Environmental	8/5/2015	-25.4	-5.33	< 0.1	-10.19	1.9	0.02	0.005	--	--	0.0302	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP95	Public supply	Environmental	7/20/2015	-28.6	-5.38	< 0.1	-12.04	6.7	0.10	0.006	--	--	0.0325	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP96	Public supply	Environmental	8/3/2015	-26.1	-4.96	< 0.1	-6.78	0.3	0.05	0.380	-163.3	-70.53	2.15	0.0009	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP98	Public supply	Environmental	7/21/2015	-25.1	-4.87	< 0.1	-17.02	15.2	0.21	0.550	-12.4	-28.73	3.18	0.0267	< 0.0001	< 0.0001	< 0.0001
Haynesville	HVP100	Public supply	Environmental	7/22/2015	-28.4	-5.39	--	--	--	0.17	0.019	--	--	0.105	< 0.0001	< 0.0001	< 0.0001	< 0.0001

[a] Maximum 1-sigma errors: He (±1%); Ne, Ar (±2%); Kr, Xe (±3%); R/Ra (1%); $^{20}Ne/^{22}Ne$ (0.1%); $^{40}Ar/^{36}Ar$ (1%).

[b] (R/Ra), $(^{3}He/^{4}He)s/(^{3}He/^{4}He)atm$, atmospheric $^{3}He/^{4}He$ ratio is 1.384×10^{-6}.

Table S4. Isotope and dissolved-gas data for groundwater samples.

Shale play	Well name	iC_5 (mole %)	nC_5 (mole %)	$C_1/(C_2+C_3)$	He (10^{-8} cubic centimeters at standard temperature and pressure per gram water [cm^3STP/g])[a]	Ne (10^{-7} cm^3STP/g)[a]	Ar (10^{-4} cm^3STP/g)[a]	Kr (10^{-8} cm^3STP/g)[a]	Xe (10^{-8} cm^3STP/g)[a]	(R/Ra)[a,b]	$^{20}Ne/^{22}Ne$[a]	$^{40}Ar/^{36}Ar$[a]
Eagle Ford	EF1	< 0.0001	< 0.0001	--	19.1	2.23	3.49	7.45	1.01	0.275	9.771	296.8
Eagle Ford	EF2	< 0.0001	< 0.0001	--	5.39	1.83	2.94	6.22	0.80	0.861	9.819	300.0
Eagle Ford	EF3	< 0.0001	< 0.0001	> 31600	93.9	2.55	3.83	8.03	1.06	0.0717	9.770	298.6
Eagle Ford	EF3	< 0.0001	< 0.0001	> 7050	--	--	--	--	--	--	--	--
Eagle Ford	EF4	< 0.0001	< 0.0001	--	7.16	2.17	3.16	6.78	0.912	0.771	9.812	306.1
Eagle Ford	EF5	< 0.0001	< 0.0001	--	20.2	2.06	3.14	6.64	0.962	0.291	9.788	298.4
Eagle Ford	EF6	< 0.0001	< 0.0001	--	16.2	2.05	3.20	6.91	1.00	0.322	9.790	295.5
Eagle Ford	EF7	< 0.0001	< 0.0001	--	101	2.33	3.76	8.16	1.08	0.154	9.769	296.4
Eagle Ford	EF8	< 0.0001	< 0.0001	--	83.4	2.40	3.73	7.91	1.07	0.129	9.790	297.1
Eagle Ford	EF9	< 0.0001	< 0.0001	--	24.1	2.15	3.49	7.60	1.11	0.282	9.792	295.8
Eagle Ford	EF10	< 0.0001	< 0.0001	--	28.8	2.24	3.55	7.66	1.11	0.236	9.802	296.1
Eagle Ford	EF11	< 0.0001	< 0.0001	--	21.4	2.44	3.71	7.91	1.12	0.302	9.794	297.4
Eagle Ford	EF12	< 0.0001	< 0.0001	--	55.5	2.19	3.68	7.84	1.05	0.100	9.750	296.8
Eagle Ford	EF13	< 0.0001	< 0.0001	--	35.3	2.28	3.47	7.19	0.904	0.168	9.786	294.9
Eagle Ford	EF14	< 0.0001	< 0.0001	532	236	2.61	3.79	7.85	1.02	0.0705	9.782	295.4
Eagle Ford	EF15	< 0.0001	< 0.0001	--	23.2	2.14	3.20	6.72	0.974	0.307	9.794	297.3
Eagle Ford	EF16	< 0.0001	< 0.0001	--	48.9	6.56	5.84	10.46	1.30	0.389	9.786	295.2
Eagle Ford	EF17	< 0.0001	< 0.0001	--	7.06	2.34	3.46	7.19	0.938	0.821	9.788	295.9
Eagle Ford	EF18	< 0.0001	< 0.0001	--	42.5	2.53	3.81	8.05	1.08	0.151	9.797	296.7
Eagle Ford	EF19	< 0.0001	< 0.0001	> 4110	31.6	1.87	3.20	6.97	0.992	0.188	9.776	295.6
Eagle Ford	EF20	< 0.0001	< 0.0001	--	9.85	3.15	3.95	7.78	0.994	0.783	9.780	295.6
Eagle Ford	EF21	< 0.0001	< 0.0001	--	140	2.49	3.82	8.12	1.11	0.0513	9.778	295.6
Eagle Ford	EF22	< 0.0001	< 0.0001	2290	147	1.75	2.75	6.08	0.919	0.290	9.811	297.5
Eagle Ford	EF23	< 0.0001	< 0.0001	--	210	2.57	3.93	8.54	1.19	0.0497	9.778	297.4
Eagle Ford	EF24	< 0.0001	< 0.0001	--	6.40	2.53	3.45	7.00	0.941	0.968	9.784	296.0
Eagle Ford	EF25	< 0.0001	< 0.0001	9580	128	2.49	3.85	8.13	1.01	0.0801	9.810	300.1
Eagle Ford	EF26	< 0.0001	< 0.0001	17060	565	2.39	3.75	7.95	1.03	0.0396	9.766	296.4
Eagle Ford	EF27	< 0.0001	< 0.0001	--	6.59	2.54	3.55	7.37	0.948	0.967	9.794	297.6
Eagle Ford	EF28	< 0.0001	< 0.0001	--	53.6	2.29	3.73	8.24	1.13	0.103	9.793	300.1
Eagle Ford	EF29	< 0.0001	< 0.0001	--	59.1	2.52	3.90	8.18	1.13	0.101	9.771	296.7
Eagle Ford	EF30	< 0.0001	< 0.0001	--	30.8	2.61	4.03	8.61	1.15	0.206	9.785	296.0
Eagle Ford	EFP70	< 0.0001	< 0.0001	--	90.0	2.50	3.78	8.03	1.09	0.0761	9.777	297.3
Eagle Ford	EFP71	< 0.0001	< 0.0001	--	131	2.20	3.42	7.34	0.98	0.0844	9.786	296.3
Eagle Ford	EFP72	< 0.0001	< 0.0001	551	356	1.65	2.77	6.70	0.81	0.0538	9.773	296.4
Eagle Ford	EFP73	< 0.0001	< 0.0001	--	44.7	9.22	--	--		0.564	9.772	--
Eagle Ford	EFP74	< 0.0001	< 0.0001	--	63.5	2.25	3.64	7.90	1.11	0.112	9.784	296.6
Eagle Ford	EFP75	< 0.0001	< 0.0001	--	15.0	2.62	3.66	7.58	1.01	0.477	9.781	296.4
Eagle Ford	EFP76	< 0.0001	< 0.0001	--	11.0	2.31	3.68	7.98	1.13	0.508	9.803	296.8
Eagle Ford	EFP77	< 0.0001	< 0.0001	--	8.78	1.97	3.10	6.69	0.91	0.652	9.787	296.0
Eagle Ford	EFP78	< 0.0001	< 0.0001	--	8.52	2.54	3.50	7.20	0.95	0.724	9.782	296.4
Eagle Ford	EFP79	< 0.0001	< 0.0001	--	107	2.22	3.43	7.37	1.03	0.104	9.793	296.4
Eagle Ford	EFP80	< 0.0001	< 0.0001	--	54.7	2.12	3.48	7.55	1.03	0.152	9.803	299.7
Eagle Ford	EFP81	< 0.0001	< 0.0001	--	10.0	2.91	3.77	7.67	1.07	0.719	9.781	295.9
Eagle Ford	EFP83	< 0.0001	< 0.0001	--	44.2	2.54	3.87	8.33	1.16	0.139	9.780	295.8
Fayetteville	FV1	< 0.0001	< 0.0001	--	17.5	2.54	4.18	9.32	1.32	0.445	9.789	296.1
Fayetteville	FV2	< 0.0001	< 0.0001	19630	2950	2.70	4.28	9.19	1.13	0.0747	9.779	296.8
Fayetteville	FV3	< 0.0001	< 0.0001	--	7.26	2.56	4.29	9.57	1.42	1.08	9.781	297.0

[a] Maximum 1-sigma errors: He (±1%); Ne, Ar (±2%); Kr, Xe (±3%); R/Ra (1%); $^{20}Ne/^{22}Ne$ (0.1%); $^{40}Ar/^{36}Ar$ (1%).

[b] (R/Ra), $(^3He/^4He)_s/(^3He/^4He)_{atm}$, atmospheric $^3He/^4He$ ratio is 1.384×10^{-6}.

Table S4. Isotope and dissolved-gas data for groundwater samples.

Shale play	Well name	iC_5 (mole %)	nC_5 (mole %)	$C_1/(C_2+C_3)$	He (10^{-8} cubic centimeters at standard temperature and pressure per gram water [cm^3STP/g])[a]	Ne (10^{-7} cm^3STP/g)[a]	Ar (10^{-4} cm^3STP/g)[a]	Kr (10^{-8} cm^3STP/g)[a]	Xe (10^{-8} cm^3STP/g)[a]	(R/Ra)[a,b]	$^{20}Ne/^{22}Ne$[a]	$^{40}Ar/^{36}Ar$[a]
Fayetteville	FV4	< 0.0001	< 0.0001	--	5.13	2.05	3.60	8.28	1.24	1.01	9.791	296.4
Fayetteville	FV5	< 0.0001	< 0.0001	--	8.48	2.71	4.27	9.56	1.53	1.03	9.786	296.5
Fayetteville	FV6	< 0.0001	< 0.0001	> 18700	33.5	2.85	4.46	9.82	1.24	0.277	9.785	296.8
Fayetteville	FV7	0.0012	< 0.0001	> 5000	19.6	2.89	4.45	9.70	1.45	0.444	9.785	296.4
Fayetteville	FV8	< 0.0001	< 0.0001	--	7.36	2.90	4.48	9.61	1.39	1.03	9.788	296.7
Fayetteville	FV9	< 0.0001	< 0.0001	--	9.39	3.10	4.58	10.0	1.49	0.953	9.776	296.3
Fayetteville	FV10	< 0.0001	< 0.0001	--	171	2.62	4.26	9.41	1.37	0.169	9.790	296.4
Fayetteville	FV11	< 0.0001	< 0.0001	4310	130	2.70	4.34	9.74	1.40	0.111	9.798	297.0
Fayetteville	FV12	< 0.0001	< 0.0001	--	9.46	2.63	4.12	8.92	1.26	0.733	9.790	297.7
Fayetteville	FV13	< 0.0001	< 0.0001	--	8.63	2.75	4.37	9.59	1.41	1.03	9.795	296.7
Fayetteville	FV14	< 0.0001	< 0.0001	--	8.48	2.84	4.19	8.83	1.42	0.958	9.789	296.5
Fayetteville	FV15	< 0.0001	< 0.0001	27320	1150	2.67	4.41	9.53	1.06	0.173	9.772	296.0
Fayetteville	FV16	< 0.0001	< 0.0001	--	5.20	2.12	3.72	8.26	1.15	1.05	9.794	296.2
Fayetteville	FV17	< 0.0001	< 0.0001	892	92.9	2.72	4.20	8.69	0.732	0.281	9.795	298.4
Fayetteville	FV18	< 0.0001	< 0.0001	--	5.69	2.32	3.89	8.50	1.19	1.41	9.818	298.5
Fayetteville	FV19	< 0.0001	< 0.0001	9420	505	2.82	4.22	8.76	0.921	0.153	9.785	297.3
Fayetteville	FV20	< 0.0001	< 0.0001	--	7.19	2.74	4.15	8.84	1.19	0.948	9.786	295.9
Fayetteville	FV21	< 0.0001	< 0.0001	--	13.4	1.94	3.62	8.30	1.21	0.488	9.785	297.8
Fayetteville	FV22	< 0.0001	< 0.0001	--	16.8	2.64	4.36	9.52	1.33	0.547	9.797	296.4
Fayetteville	FV23	< 0.0001	< 0.0001	--	9.33	2.91	4.41	9.39	1.38	0.925	9.788	304.9
Fayetteville	FV24	< 0.0001	< 0.0001	--	64.8	2.54	4.49	10.27	1.43	0.153	9.787	296.6
Fayetteville	FV25	< 0.0001	< 0.0001	1480	12.0	2.80	4.34	9.57	1.40	0.887	9.783	296.6
Fayetteville	FV26	< 0.0001	< 0.0001	5380	1020	2.56	4.14	9.11	1.24	0.170	9.768	296.6
Fayetteville	FV27	< 0.0001	< 0.0001	--	14.0	2.71	4.15	8.87	1.18	0.624	9.791	296.8
Fayetteville	FV28	< 0.0001	< 0.0001	--	33.7	2.07	3.92	8.78	1.24	0.268	9.784	296.5
Fayetteville	FV29	< 0.0001	< 0.0001	--	7.47	2.59	4.06	8.78	1.34	0.876	9.785	296.6
Fayetteville	FV30	< 0.0001	< 0.0001	--	10.8	4.23	4.94	9.80	1.28	1.23	9.783	296.2
Fayetteville	FAU001	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU002	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU004	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU005	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU008	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU010	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU012	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU013	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU032	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU033	--	--	--	--	--	--	--	--		--	--
Fayetteville	FAU044	--	--	--	--	--	--	--	--		--	--
Fayetteville	VB020	--	--	--	--	--	--	--	--		--	--
Fayetteville	VB045	--	--	--	--	--	--	--	--		--	--
Fayetteville	VB046	--	--	--	--	--	--	--	--		--	--
Haynesville	HV1	< 0.0001	< 0.0001	--	56.9	2.31	3.81	8.46	1.24	0.149	9.778	295.9
Haynesville	HV2	< 0.0001	< 0.0001	--	686	2.39	3.90	8.75	1.28	0.349	9.771	297.1
Haynesville	HV3	< 0.0001	< 0.0001	6310	1240	2.68	4.10	9.01	1.18	0.0945	9.756	295.7
Haynesville	HV4	0.0005	0.0009	--	8.03	2.61	3.88	8.17	1.11	0.815	9.780	297.8
Haynesville	HV5	< 0.0001	< 0.0001	3140	1300	2.72	4.19	9.02	1.22	0.0807	9.760	295.2
Haynesville	HV6	< 0.0001	< 0.0001	--	6.37	2.49	3.96	8.46	1.15	0.958	9.794	295.5

[a]Maximum 1-sigma errors: He (±1%); Ne, Ar (±2%); Kr, Xe (±3%); R/Ra (1%); $^{20}Ne/^{22}Ne$ (0.1%); $^{40}Ar/^{36}Ar$ (1%).

[b](R/Ra), $(^{3}He/^{4}He)s/(^{3}He/^{4}He)atm$, atmospheric $^{3}He/^{4}He$ ratio is 1.384×10^{-6}.

Table S4. Isotope and dissolved-gas data for groundwater samples.

Shale play	Well name	iC_5 (mole %)	nC_5 (mole %)	$C_1/(C_2+C_3)$	He (10^{-8} cubic centimeters at standard temperature and pressure per gram water [cm^3STP/g])[a]	Ne (10^{-7} cm^3STP/g)[a]	Ar (10^{-4} cm^3STP/g)[a]	Kr (10^{-8} cm^3STP/g)[a]	Xe (10^{-8} cm^3STP/g)[a]	(R/Ra)[a,b]	$^{20}Ne/^{22}Ne$[a]	$^{40}Ar/^{36}Ar$[a]
Haynesville	HV7	< 0.0001	< 0.0001	--	368	2.59	4.08	8.71	1.24	0.243	9.784	295.1
Haynesville	HV8	< 0.0001	< 0.0001	--	155	2.53	3.95	8.66	1.39	0.129	9.782	295.0
Haynesville	HV9	< 0.0001	< 0.0001	--	8.62	2.45	3.92	8.46	1.18	0.746	9.832	296.2
Haynesville	HV10	< 0.0001	< 0.0001	--	96.2	2.59	4.01	8.53	1.17	0.321	9.801	295.3
Haynesville	HV11	< 0.0001	< 0.0001	--	7.69	2.98	4.25	8.66	1.13	1.20	9.771	297.4
Haynesville	HV12	< 0.0001	< 0.0001	--	44.9	2.48	4.31	9.61	1.36	0.201	9.776	295.1
Haynesville	HV13	< 0.0001	< 0.0001	1950	493	2.50	3.96	8.77	1.27	0.101	9.780	297.0
Haynesville	HV14	< 0.0001	< 0.0001	--	17.9	2.40	3.96	8.91	1.30	0.340	9.790	296.7
Haynesville	HV15	< 0.0001	< 0.0001	818	353	2.44	3.79	8.47	1.22	0.120	9.789	293.9
Haynesville	HV16	< 0.0001	< 0.0001	952	431	2.85	4.41	9.63	1.37	0.131	9.785	297.0
Haynesville	HV17	< 0.0001	< 0.0001	--	20.2	2.54	3.62	7.74	1.10	0.364	9.820	295.1
Haynesville	HV18	< 0.0001	< 0.0001	--	103	2.45	3.86	8.39	1.33	0.114	9.808	295.5
Haynesville	HV19	< 0.0001	< 0.0001	--	8.90	2.91	4.03	8.39	1.11	0.829	9.796	294.1
Haynesville	HV20	< 0.0001	< 0.0001	--	40.7	2.43	3.84	8.18	1.13	0.394	9.790	295.8
Haynesville	HV21	< 0.0001	< 0.0001	3900	437	2.45	3.79	8.00	1.06	0.165	9.816	298.1
Haynesville	HV22	< 0.0001	< 0.0001	--	60.4	2.38	3.81	8.17	1.26	0.165	9.790	296.4
Haynesville	HV23	< 0.0001	< 0.0001	17900	1070	2.49	3.92	8.64	1.20	0.0230	9.790	296.7
Haynesville	HV24	< 0.0001	< 0.0001	--	12.2	2.56	4.00	8.47	1.09	0.532	9.768	296.1
Haynesville	HV25	< 0.0001	< 0.0001	1450	157	0.569	1.38	4.02	0.684	0.172	9.872	295.8
Haynesville	HV26	< 0.0001	< 0.0001	> 3235	614	2.69	4.01	8.75	1.19	0.0581	9.785	296.0
Haynesville	HV27	< 0.0001	< 0.0001	--	102	2.45	4.11	9.18	1.34	0.0751	9.773	295.4
Haynesville	HV28	< 0.0001	< 0.0001	2270	1020	2.55	3.93	8.41	1.01	0.115	9.778	297.5
Haynesville	HV29	< 0.0001	< 0.0001	1710	442	2.26	4.02	8.92	1.40	0.0989	9.789	296.3
Haynesville	HV30	< 0.0001	< 0.0001	4860	731	2.40	3.88	8.50	1.14	0.0248	9.781	296.7
Haynesville	HVP21	< 0.0001	< 0.0001	--	16.4	2.30	3.62	7.75	1.06	0.622	9.797	297.7
Haynesville	HVP25	< 0.0001	< 0.0001	--	6.02	2.29	3.78	8.36	1.15	0.931	9.806	296.9
Haynesville	HVP27	< 0.0001	< 0.0001	--	446	2.86	4.72	10.5	1.50	0.101	9.783	296.3
Haynesville	HVP88	< 0.0001	< 0.0001	14918	2307	2.51	3.81	8.34	1.14	0.0641	9.762	298.1
Haynesville	HVP89	< 0.0001	< 0.0001	--	214	2.43	3.97	8.75	1.24	0.0742	9.780	297.9
Haynesville	HVP90	< 0.0001	< 0.0001	--	31.9	2.35	3.95	8.90	1.32	0.198	9.786	296.2
Haynesville	HVP91	< 0.0001	< 0.0001	--	21.9	2.50	4.00	8.66	1.30	0.290	9.778	296.1
Haynesville	HVP93	< 0.0001	< 0.0001	--	--	--	--	--	--	--	--	--
Haynesville	HVP94	< 0.0001	< 0.0001	--	58.7	3.86	4.75	9.89	1.35	0.254	9.841	295.5
Haynesville	HVP95	< 0.0001	< 0.0001	--	27.2	2.42	4.02	9.09	1.34	0.218	9.783	296.0
Haynesville	HVP96	< 0.0001	< 0.0001	2389	744	2.62	4.08	8.77	1.18	0.0228	9.781	296.5
Haynesville	HVP98	< 0.0001	< 0.0001	119	301	2.37	3.75	8.44	1.35	0.228	9.770	296.8
Haynesville	HVP100	< 0.0001	< 0.0001	--	594	2.53	3.94	8.55	1.18	0.0630	9.776	296.2

[a] Maximum 1-sigma errors: He (±1%); Ne, Ar (±2%); Kr, Xe (±3%); R/Ra (1%); $^{20}Ne/^{22}Ne$ (0.1%); $^{40}Ar/^{36}Ar$ (1%).

[b] (R/Ra), $(^3He/^4He)s/(^3He/^4He)atm$, atmospheric $^3He/^4He$ ratio is 1.384×10^{-6}.

Table S5. Concentration of volatile organic compounds in groundwater and quality-assurance samples. Yellow cells highlight detected compounds.

					Hydrocarbons										Chlorinated solvents					
Shale play	Well name	Well type	Sample type	Sample date	Benzene (µg/L)	Ethylbenzene (µg/L)	Toluene (µg/L)	m- + p-Xylene (µg/L)	o-Xylene (µg/L)	1,2,4-Trimethylbenzene (µg/L)	Naphthalene (µg/L)	sec-Butylbenzene (µg/L)	Butane (µg/L)	n-Pentane (µg/L)	1,1,1-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)	Tetrachloroethene (µg/L)	Trichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	trans-1,2-Dichloroethene (µg/L)
Eagle Ford	EF1	Domestic	environmental	1/14/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF2	Domestic	environmental	1/11/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF3	Domestic	environmental	1/26/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	**0.042**	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF4	Domestic	environmental	1/13/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF5	Domestic	environmental	1/27/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF6	Domestic	environmental	1/12/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF7	Domestic	environmental	1/24/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF8	Domestic	environmental	1/21/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF9	Domestic	environmental	1/18/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF10	Domestic	environmental	1/20/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF11	Domestic	environmental	1/25/2016	**0.067**	< 0.036	**FB 0.05**	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	**0.038**	**J 0.011**	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF12	Domestic	environmental	2/16/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF13	Domestic	environmental	2/1/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF14	Domestic	environmental	2/10/2016	**J 0.02**	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF15	Domestic	environmental	1/27/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF16	Domestic	environmental	2/8/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF17	Domestic	environmental	2/2/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF18	Domestic	environmental	2/9/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF19	Domestic	environmental	1/19/2016	**0.04**	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF20	Domestic	environmental	2/9/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF21	Domestic	environmental	2/8/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF22	Domestic	environmental	1/19/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF23	Domestic	environmental	2/10/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF24	Domestic	environmental	3/8/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF25	Domestic	environmental	2/3/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF26	Domestic	environmental	3/8/2016	**J 0.018**	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	**0.164**	**0.068**	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF27	Domestic	environmental	2/4/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF28	Domestic	environmental	2/24/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF29	Domestic	environmental	2/15/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF30	Domestic	environmental	2/17/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF3		field blank	1/26/2016	< 0.026	< 0.036	**0.09**	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF3		Source solution blank	1/26/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF4		replicate	1/13/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF6		spiked sample	1/12/2016	0.612	0.567	0.58	1.13	0.589	0.536	0.52	0.513	0.56	0.517	0.482	0.568	0.48	0.552	0.585	0.52
Eagle Ford	EF6		spike recovery (%)		109.3	101.3	103.6	102.7	105.2	95.7	92.9	91.6	100.0	92.3	86.1	101.4	85.7	98.6	104.5	92.9
Eagle Ford	EF25		field blank	2/3/2016	< 0.026	< 0.036	**0.06**	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF25		Source solution blank	2/3/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF30		field blank	2/17/2016	< 0.026	< 0.036	**0.05**	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EF30		Source solution blank	2/17/2016	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.26	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV1	Domestic	environmental	7/28/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV2	Domestic	environmental	7/27/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV3	Domestic	environmental	7/20/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV4	Domestic	environmental	7/28/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV5	Domestic	environmental	6/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV6	Domestic	environmental	7/16/2015	< 0.026	< 0.036	< 0.02	**0.1**	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV7	Domestic	environmental	6/29/2015	< 0.026	**0.061**	**LB 0.02**	**J 0.05**	**0.047**	< 0.032	< 0.18	< 0.034	**0.546**	**0.212**	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV8	Domestic	environmental	7/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV9	Domestic	environmental	7/22/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	**0.084**	**0.039**	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV10	Domestic	environmental	7/20/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV11	Domestic	environmental	7/21/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV12	Domestic	environmental	8/6/2015	**J 0.025**	< 0.036	**0.15**	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV13	Domestic	environmental	6/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018

J-Between long-term method detection level (LT-MDL) and reporting level (RL)
FB-Environmental concentration less than 5x max. concentration in field blank
LB-Environmental concentration less than 5x max. concentration in lab blank
E-estimated

Table S5. Concentration of volatile organic compounds in groundwater and quality-assurance samples. Yellow cells highlight detected compounds.

					Hydrocarbons										Chlorinated solvents					
Shale play	Well name	Well type	Sample type	Sample date	Benzene (µg/L)	Ethylbenzene (µg/L)	Toluene (µg/L)	m- + p-Xylene (µg/L)	o-Xylene (µg/L)	1,2,4-Trimethylbenzene (µg/L)	Naphthalene (µg/L)	sec-Butylbenzene (µg/L)	Butane (µg/L)	n-Pentane (µg/L)	1,1,1-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)	Tetrachloroethene (µg/L)	Trichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	trans-1,2-Dichloroethene (µg/L)
Fayetteville	FV14	Domestic	environmental	6/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV15	Domestic	environmental	7/21/2015	J 0.023	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV16	Domestic	environmental	7/27/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV17	Domestic	environmental	7/1/2015	< 0.026	< 0.036	LB 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV18	Domestic	environmental	7/15/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV19	Domestic	environmental	8/6/2015	J 0.023	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	0.082	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV20	Domestic	environmental	7/20/2015	J 0.013	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV21	Domestic	environmental	7/14/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV22	Domestic	environmental	7/1/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV23	Domestic	environmental	6/30/2015	< 0.026	< 0.036	LB 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV24	Domestic	environmental	7/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV25	Domestic	environmental	7/13/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV26	Domestic	environmental	6/30/2015	< 0.026	< 0.036	LB 0.03	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	J 0.011	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV27	Domestic	environmental	7/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV28	Domestic	environmental	7/15/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV29	Domestic	environmental	7/13/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV30	Domestic	environmental	7/13/2015	< 0.026	< 0.036	LB 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV8		replicate	7/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV8		spiked sample	7/30/2015	0.242	0.245	0.24	0.56	0.258	0.253	1.11	0.232	0.277	0.333	0.23	0.284	0.226	0.221	0.271	0.228
Fayetteville	FV8		spike recovery (%)		103.9	87.5	104.3	85.9	92.1	90.4	79.5	82.9	74.9	90.0	98.7	101.4	98.3	94.4	96.8	99.1
Fayetteville	FV12		field blank	8/6/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV19		field blank	8/6/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Fayetteville	FV27		replicate	7/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV1	Domestic	environmental	4/13/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV2	Domestic	environmental	4/22/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV3	Domestic	environmental	4/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV4	Domestic	environmental	4/13/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV5	Domestic	environmental	4/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV6	Domestic	environmental	7/16/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV7	Domestic	environmental	6/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV8	Domestic	environmental	4/14/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV9	Domestic	environmental	5/6/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	J 0.011	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV10	Domestic	environmental	4/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV11	Domestic	environmental	4/15/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV12	Domestic	environmental	4/15/2015	< 0.026	< 0.036	FB 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV13	Domestic	environmental	5/12/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV14	Domestic	environmental	4/16/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV15	Domestic	environmental	6/10/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV16	Domestic	environmental	4/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV17	Domestic	environmental	6/9/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV18	Domestic	environmental	6/2/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV19	Domestic	environmental	4/28/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV20	Domestic	environmental	4/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV21	Domestic	environmental	6/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV22	Domestic	environmental	6/11/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV23	Domestic	environmental	4/16/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV24	Domestic	environmental	5/26/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV25	Domestic	environmental	4/21/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV26	Domestic	environmental	4/27/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV27	Domestic	environmental	4/27/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV28	Domestic	environmental	7/1/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV29	Domestic	environmental	8/16/2004	0.360	< 0.030	< 0.05	< 0.06	< 0.038	0.112	< 0.52	< 0.060	--	--	< 0.032	< 0.035	< 0.060	< 0.038	< 0.024	< 0.032

J-Between long-term method detection level (LT-MDL) and reporting level (RL)
FB-Environmental concentration less than 5x max. concentration in field blank
LB-Environmental concentration less than 5x max. concentration in lab blank
E-estimated

Table S5. Concentration of volatile organic compounds in groundwater and quality-assurance samples. Yellow cells highlight detected compounds.

					Hydrocarbons										Chlorinated solvents					
Shale play	Well name	Well type	Sample type	Sample date	Benzene (µg/L)	Ethylbenzene (µg/L)	Toluene (µg/L)	m- + p-Xylene (µg/L)	o-Xylene (µg/L)	1,2,4-Trimethylbenzene (µg/L)	Naphthalene (µg/L)	sec-Butylbenzene (µg/L)	Butane (µg/L)	n-Pentane (µg/L)	1,1,1-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)	Tetrachloroethene (µg/L)	Trichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	trans-1,2-Dichloroethene (µg/L)
Haynesville	HV29	Domestic	environmental	5/13/2015	**0.127**	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV30	Domestic	environmental	4/28/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV2		field blank	4/22/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV2		Source solution blank	4/22/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV2		spiked sample	4/22/2015	0.248	0.258	0.25	0.61	0.268	0.301	1.14	0.283	0.273	0.318	0.242	0.283	0.284	0.237	0.277	0.252
Haynesville	HV2		spike recovery (%)		106.4	92.1	108.7	93.6	95.7	107.5	81.7	101.1	73.8	85.9	103.9	101.1	123.5	101.3	98.9	109.6
Haynesville	HV8		field blank	4/14/2015	< 0.026	< 0.036	**0.03**	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV8		Source solution blank	4/14/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV10		field blank	4/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV10		Source solution blank	4/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	**0.026**	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HV14		replicate	4/16/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	--		field blank	3/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	--		Source solution blank	3/30/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP70	Public supply	environmental	7/29/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP71	Public supply	environmental	7/27/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP72	Public supply	environmental	7/29/2015	**FB 0.028**	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP73	Public supply	environmental	7/28/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP74	Public supply	environmental	8/10/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP75	Public supply	environmental	8/12/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP76	Public supply	environmental	8/11/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP77	Public supply	environmental	7/28/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP78	Public supply	environmental	8/11/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP79	Public supply	environmental	8/31/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP80	Public supply	environmental	8/13/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP81	Public supply	environmental	9/1/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Eagle Ford	EFP83	Public supply	environmental	9/2/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP21	Public supply	environmental	7/22/2014	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP25	Public supply	environmental	6/17/2014	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP27	Public supply	environmental	7/30/2014	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	**FB 0.034**	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP88	Public supply	environmental	7/13/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP89	Public supply	environmental	7/15/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP90	Public supply	environmental	7/14/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP91	Public supply	environmental	7/14/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP94	Public supply	environmental	8/5/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP95	Public supply	environmental	7/20/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP96	Public supply	environmental	8/3/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
Haynesville	HVP98	Public supply	environmental	7/21/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
	--		field blank	6/16/2014	< 0.026	< 0.036	**0.03**	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
	--		Source solution blank	6/16/2014	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	< 0.032	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
	--		field blank	8/26/2015	**J 0.013**	< 0.036	**0.09**	< 0.08	< 0.032	**0.135**		< 0.034	< 0.038	< 0.022	--	--	< 0.026	--	--	--
	--		Source solution blank	8/26/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	**0.161**		< 0.034	< 0.038	< 0.022	--	--	< 0.026	--	--	--
	--		field blank	8/3/2015	< 0.026	< 0.036	**0.03**	< 0.08	< 0.032	**0.16**	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018
	--		Source solution blank	8/3/2015	< 0.026	< 0.036	< 0.02	< 0.08	< 0.032	**0.085**	< 0.18	< 0.034	< 0.038	< 0.022	< 0.03	< 0.044	< 0.026	< 0.022	< 0.022	< 0.018

J-Between long-term method detection level (LT-MDL) and reporting level (RL)
FB-Environmental concentration less than 5x max. concentration in field blank
LB-Environmental concentration less than 5x max. concentration in lab blank
E-estimated

Table S5. Concentration of volatile organic compounds in groundwater and quality-assurance samples. Yellow cells highlight detected compounds.

								Trihalomethanes				Other
Shale play	Well name	Well type	Sample type	1,1-Dichloroethene (µg/L)	Dichloromethane (µg/L)	Vinyl chloride (µg/L)	Carbon tetrachloride (µg/L)	Chloroform (µg/L)	Bromodichloromethane (µg/L)	Dibromochloromethane (µg/L)	Bromoform (µg/L)	Methyl tert-butyl ether (µg/L)
Eagle Ford	EF1	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF2	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF3	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF4	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF5	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF6	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF7	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF8	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF9	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF10	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF11	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF12	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF13	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF14	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF15	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF16	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF17	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF18	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF19	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF20	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF21	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF22	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF23	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF24	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF25	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF26	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF27	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF28	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF29	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF30	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF3		field blank	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF3		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF4		replicate	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF6		spiked sample	0.527	0.54	1.18	0.45	0.57	0.496	E 0.43	E 0.4	0.93
Eagle Ford	EF6		spike recovery (%)	94.1	96.4	107.3	80.4	101.8	88.6	76.8	71.4	110.7
Eagle Ford	EF25		field blank	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF25		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF30		field blank	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Eagle Ford	EF30		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV1	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV2	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV3	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV4	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	**FB 0.02**
Fayetteville	FV5	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**FB 0.1**	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV6	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV7	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	**4.44**
Fayetteville	FV8	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV9	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV10	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV11	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV12	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV13	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**J,FB 0.02**	< 0.034	< 0.12	< 0.1	< 0.012

J-Between long-term method detection level (LT-MDL) and reporting level (RL)
FB-Environmental concentration less than 5x max. concentration in field blank
LB-Environmental concentration less than 5x max. concentration in lab blank
E-estimated

Table S5. Concentration of volatile organic compounds in groundwater and quality-assurance samples. Yellow cells highlight detected compounds.

								Trihalomethanes				Other
Shale play	Well name	Well type	Sample type	1,1-Dichloroethene (µg/L)	Dichloromethane (µg/L)	Vinyl chloride (µg/L)	Carbon tetrachloride (µg/L)	Chloroform (µg/L)	Bromodichloromethane (µg/L)	Dibromochloromethane (µg/L)	Bromoform (µg/L)	Methyl tert-butyl ether (µg/L)
Fayetteville	FV14	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV15	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**FB 0.04**	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV16	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV17	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**J,FB 0.02**	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV18	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**FB 0.04**	< 0.034	< 0.12	< 0.1	**FB 0.04**
Fayetteville	FV19	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV20	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV21	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV22	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV23	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV24	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV25	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV26	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV27	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	**FB 0.14**
Fayetteville	FV28	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV29	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV30	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV8		replicate	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Fayetteville	FV8		spiked sample	0.224	0.36	0.43	0.34	0.23	0.361	0.82	0.71	0.68
Fayetteville	FV8		spike recovery (%)	97.4	96.6	91.5	91.2	98.7	97.6	88.1	84.7	104.3
Fayetteville	FV12		field blank	< 0.022	< 0.04	< 0.06	< 0.06	**0.48**	< 0.034	< 0.12	< 0.1	**0.03**
Fayetteville	FV19		field blank	< 0.022	< 0.04	< 0.06	< 0.06	**0.36**	< 0.034	< 0.12	< 0.1	**0.06**
Fayetteville	FV27		replicate	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	**FB 0.13**
Haynesville	HV1	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV2	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV3	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**FB 0.03**	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV4	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV5	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV6	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV7	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV8	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV9	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV10	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV11	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV12	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**J,FB 0.02**	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV13	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV14	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	**FB 0.06**	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV15	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV16	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV17	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV18	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV19	Domestic	environmental	< 0.022	< 0.04	< 0.06	**J 0.04**	**0.39**	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV20	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV21	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV22	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV23	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV24	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV25	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV26	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV27	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV28	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06	< 0.03	< 0.034	< 0.12	< 0.1	< 0.012
Haynesville	HV29	Domestic	environmental	< 0.024	< 0.04	< 0.06	< 0.06	< 0.024	< 0.028	< 0.10	< 0.1	< 0.012

J-Between long-term method detection level (LT-MDL) and reporting level (RL)
FB-Environmental concentration less than 5x max. concentration in field blank
LB-Environmental concentration less than 5x max. concentration in lab blank
E-estimated

Table S5. Concentration of volatile organic compounds in groundwater and quality-assurance samples. Yellow cells highlight detected compounds.

									Trihalomethanes					Other
Shale play	Well name	Well type	Sample type	1,1-Dichloroethene (µg/L)	Dichloromethane (µg/L)	Vinyl chloride (µg/L)	Carbon tetrachloride (µg/L)		Chloroform (µg/L)	Bromodichloromethane (µg/L)	Dibromochloromethane (µg/L)	Bromoform (µg/L)		Methyl tert-butyl ether (µg/L)
Haynesville	HV29	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06		**0.11**	**0.048**	< 0.12	< 0.1		< 0.012
Haynesville	HV30	Domestic	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HV2		field blank	< 0.022	< 0.04	< 0.06	< 0.06		**J 0.02**	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HV2		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HV2		spiked sample	0.24	0.38	0.41	0.36		0.24	0.378	0.88	0.78		0.67
Haynesville	HV2		spike recovery (%)	104.3	102.0	87.2	96.5		103.0	102.2	94.5	93.1		102.8
Haynesville	HV8		field blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.1
Haynesville	HV8		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.1
Haynesville	HV10		field blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HV10		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HV14		replicate	< 0.022	< 0.04	< 0.06	< 0.06		**FB 0.05**	< 0.034	< 0.12	< 0.1		< 0.1
Haynesville	--		field blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	--		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP70	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		**0.15**	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP71	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP72	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP73	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP74	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP75	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP76	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP77	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP78	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP79	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP80	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP81	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Eagle Ford	EFP83	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP21	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP25	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP27	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP88	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP89	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP90	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP91	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP94	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP95	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP96	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
Haynesville	HVP98	Public supply	environmental	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
	--		field blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
	--		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
	--		field blank	--	--	--	< 0.06		< 0.03	< 0.034	--	--		< 0.012
	--		Source solution blank	--	--	--	< 0.06		< 0.03	< 0.034	--	--		< 0.012
	--		field blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012
	--		Source solution blank	< 0.022	< 0.04	< 0.06	< 0.06		< 0.03	< 0.034	< 0.12	< 0.1		< 0.012

J-Between long-term method detection level (LT-MDL) and reporting level (RL)
FB-Environmental concentration less than 5x max. concentration in field blank
LB-Environmental concentration less than 5x max. concentration in lab blank
E-estimated

Table S6. Chloride and bromide concentrations, isotope data, and hydrocarbon gas compositions in water samples from unconventional hydrocarbon wells.

Shale play	Well	Alternate id	Sample date	Chloride (mg/L)	Bromide (mg/L)	δ^2H-H_2O (per mil, VSMOW)	$\delta^{18}O$-H_2O (per mil, VSMOW)	δ^2H-CH_4 (per mil, VSMOW)	$\delta^{13}C$-CH_4 (per mil, VPDB)	C_1 (mole %)	C_2 (mole %)	C_3 (mole %)	iC_4 (mole %)	nC_4 (mole %)	iC_5 (mole %)	nC_5 (mole %)
Eagle Ford	EFOG1	15-TX-23B	12/13/2015	36,900	218	-16.68[a]	7.86[a]	-220.2	-44.90	6.77	9.93	5.48	1.21	3.26	2.10	1.92
Eagle Ford	EFOG2	15-TX-26B	12/13/2015	37,300	197	-14.02[a]	7.25[a]	-220.8	-43.17	10.76	9.50	3.79	0.482	1.17	0.356	0.318
Eagle Ford	EFOG3	15-TX-30B	12/14/2015	18,200	107	-15.79[a]	6.7[a]	-217.7	-42.98	12.48	8.85	3.66	0.468	1.06	0.240	0.179
Eagle Ford	EFOG3-dup	15-TX-30B dup	--	17,900	109	-16.54[a]	6.66[a]	--	--	--	--	--	--	--	--	--
Eagle Ford	EFOG4	15-TX-34B	12/14/2015	38,300	249	-15.63[a]	7.69[a]	-220.3	-42.31	4.58	6.66	3.33	0.549	1.31	0.582	0.506
Eagle Ford	EFOG5	15-TX-38B	12/14/2015	39,700	267	-15.03[a]	6.06[a]	-253.3	-44.31	18.67	11.44	3.68	0.313	0.810	0.149	0.142
Haynesville	HVOG1	--	12/1/2010	111,000	618	-10.31[a]	7.11[a]	--	--	--	--	--	--	--	--	--

[a]Concentration basis.[28,29]

[VSMOW, Vienna Standard Mean Ocean Water; VPDB, Vienna Peedee belemnite; iC4, isobutane; nC4, normal butane]

Table S7. Comparison of methane concentrations in water wells ≤1 and >1 km from hydrocarbon wells.

Comparison	Mann-Whitney test, p-value		
	Eagle Ford	Fayetteville	Haynesville
CH_4 concentration in domestic wells ≤1 km versus >1 km from nearest unconventional hydrocarbon well	0.49 (≤1 km, n=12; >1 km, n=18)	0.40 (≤1 km, n=31; >1 km, n=13)	0.48 (≤1 km, n=13; >1 km, n=17)
CH_4 concentration in domestic and public supply wells ≤1 km versus >1 km from nearest unconventional hydrocarbon well	0.29 (≤1 km, n=12; >1 km, n=31)	--[a]	0.68 (≤1 km, n=13; >1 km, n=29)
CH_4 concentration in domestic wells ≤1 km versus >1 km from nearest hydrocarbon well of any kind	0.78 (≤1 km, n=22; >1 km, n=8)	--[a]	0.99 (≤1 km, n=19; >1 km, n=11)
CH_4 concentration in domestic and public supply wells ≤1 km versus >1 km from nearest hydrocarbon well of any kind	0.26 (≤1 km, n=27; >1 km, n=16)	--[a]	0.79 (≤1 km, n=27; >1 km, n=16)

[a]Analysis not done because public supply wells were not sampled in the Fayetteville study and unconventional hydrocarbon wells generally were the only type of hydrocarbon wells present in the study area.

Table S8. Correlations between methane and distance to hydrocarbon wells, density of hydrocarbon wells within 1 km of sampled water wells, drill year of nearest hydrocarbon well, and concentrations of chloride, helium-4, carbon-14, and benzene.

Correlation	Spearman correlation, rho (p-value, sample count)		
	Eagle Ford	Fayetteville	Haynesville
CH_4 concentration in domestic wells versus distance to nearest unconventional hydrocarbon well	0.025 (0.89, n=30)	0.209 (0.17, n=44)	-0.006 (0.97, n=30)
CH_4 concentration in domestic and public wells versus distance to nearest unconventional hydrocarbon well	0.052 (0.74, n=43)	--[a]	-0.101 (0.52, n=42)
CH_4 concentration in domestic wells versus distance to nearest hydrocarbon well of any kind	-0.033 (0.86, n=30)	--[a]	-0.030 (0.88, n=30)
CH_4 concentration in domestic and public wells versus distance to nearest hydrocarbon well of any kind	0.017 (0.91, n=43)	--[a]	0.006 (0.97, n=43)
CH_4 concentration in domestic wells versus density of hydrocarbon wells of any kind within 1 km	-0.108 (0.57, n=30)	-0.109 (0.48, n=44)	0.098 (0.61, n=30)
CH_4 concentration in domestic and public wells versus density of hydrocarbon wells of any kind within 1 km	-0.183 (0.24, n=43)	--[a]	0.142 (0.36, n=43)
CH_4 concentration in domestic and public wells versus drill year of nearest hydrocarbon well of any kind	-0.206 (0.19, n=43)	-0.089 (0.64, n=30)	0.158 (0.31, n=43)
CH_4 concentration in domestic and public wells versus well depth	0.292 (0.06, n=42)	0.169 (0.52, n=17)	0.058 (0.71, n=42)
CH_4 concentration in domestic and public wells versus chloride concentration	-0.148 (0.34, n=43)	0.067 (0.66, n=44)	**0.660 (<0.001, n=43)**
CH_4 concentration in domestic and public wells versus helium-4 concentration	**0.594 (<0.001, n=43)**	**0.671 (<0.001, n=30)**	**0.808 (<0.001, n=42)**
CH_4 concentration in domestic and public wells versus carbon-14 concentration	**-0.409 (0.009, n=40)**	**-0.783 (<0.001, n=29)**	**-0.727 (<0.001, n=42)**
CH_4 concentration in domestic and public wells versus benzene concentration	**0.314 (0.041, n=43)**	0.160 (0.40, n=30)	0.227 (0.15, n=41)

[a]Analysis not done because public supply wells were not sampled in the Fayetteville study and unconventional hydrocarbon wells generally were the only type of hydrocarbon wells present in the study area.

Table S9. Results of recharge temperature, excess air, and groundwater age calculations.

Shale play	Well name	Excess air model[a]	Modeled gases	Chi-squared	Noble-gas recharge temperature (°C)	Noble-gas recharge temperature 1σ error (°C)	Entrapped air (cubic centimeters at standard temperature and pressure per gram water [cm^3STP/g])	Excess air (cm^3STP/g)	CE model fractionation [F]	Lumped-parameter model[b]	Modeled tracers	SF_6 (parts per trillion by volume)	Tritiogenic ^3He (Tritium units)	^{14}C, corrected final (percent modern carbon)	DIC-young fraction; DIC old fraction (mg/L as $CaCO_3$)	Chi-squared	Dispersion parameter young fraction	Dispersion parameter old fraction	Fraction young water	Mean age young fraction (yr)
Eagle Ford	EF1	CE	Ne, Ar, Kr, Xe	0.26	18.7	1.8	0.0206	0.0023	0.73	DM	^{14}C	--	--	18	--	--	--	0.1	0	--
Eagle Ford	EF2	CE	Ne, Ar, Kr, Xe	1.62	25.6	1.1	0.127	0.0007	0.92	DM	^3He(trit), SF_6, ^{14}C	4.78	0.7	100	162; 162	0.90	0.01	--	1	6
Eagle Ford	EF3	CE	Ne, Ar, Kr, Xe	0.08	17.1	2.0	0.0293	0.0043	0.60	DM	^{14}C	--	--	1	--	--	--	0.1	0	--
Eagle Ford	EF4	UA	Ne, Ar, Kr, Xe	0.05	21.3	0.6	--	0.0021	--	DM	^{14}C	--	--	89	--	--	--	0.1	0	--
Eagle Ford	EF5	UA	Ne, Ar, Kr	0.88	21.6	0.8	--	0.0016	--	BMM-DM-DM	^3H, ^3He(trit), SF_6, ^{14}C	0.06	3.1	48	162; 162	0.16	0.01	0.1	0.06	36
Eagle Ford	EF6	UA	Ne, Ar, Kr, Xe	3.20	19.3	0.6	--	0.0012	--	DM	^{14}C	--	--	52	--	--	--	0.1	0	--
Eagle Ford	EF7	CE	Ne, Ar, Kr, Xe	0.03	18.6	5.3	0.0790	0.0031	0.76	DM	^{14}C	--	--	18	--	--	--	0.1	0	--
Eagle Ford	EF8	CE	Ne, Ar, Kr, Xe	0.22	17.9	1.9	0.0265	0.0031	0.68	DM	^{14}C	--	--	3	--	--	--	0.1	0	--
Eagle Ford	EF9	UA	Ne, Ar, Kr, Xe	2.54	15.7	0.6	--	0.0015	--	DM	^{14}C	--	--	52	--	--	--	0.1	0	--
Eagle Ford	EF10	UA	Ne, Ar, Kr, Xe	2.47	15.7	0.6	--	0.0020	--	DM	^{14}C	--	--	48	--	--	--	0.1	0	--
Eagle Ford	EF11	UA	Ne, Ar, Kr, Xe	1.62	15.3	0.6	--	0.0031	--	DM	^{14}C	--	--	49	--	--	--	0.1	0	--
Eagle Ford	EF12	CE	Ne, Ar, Kr, Xe	0.76	18.4	9.7	0.1046	0.0025	0.80	DM	^{14}C	--	--	1.3	--	--	--	0.1	0	--
Eagle Ford	EF13	CE	Ne, Ar, Kr, Xe	0.36	26.2	2.4	0.179	0.0033	0.73	DM	^{14}C	--	--	27	--	--	0.01	0.1	< 0.2	--
Eagle Ford	EF14	CE	Ne, Ar, Kr, Xe	0.03	20.1	2.1	0.0283	0.0044	0.59	DM	^{14}C	--	--	0.2	--	--	--	0.1	0	--
Eagle Ford	EF15	UA	Ne, Ar, Kr	1.05	21.4	0.8	--	0.0020	--	DM	^{14}C	--	--	74	--	--	0.01	0.1	< 0.15	--
Eagle Ford	EF16	UA	Ne, Ar, Kr, Xe	0.88	15.6	0.8	--	0.0259	--	BMM-DM-DM	^3H, ^3He(trit), ^{14}C	--	3.4	33	162; 236	< 0.01	0.01	0.1	0.09	48
Eagle Ford	EF17	CE	Ne, Ar, Kr, Xe	0.08	22.6	2.5	0.0310	0.0031	0.69	DM	^{14}C	--	--	51	--	--	--	0.1	0	--
Eagle Ford	EF18	CE	Ne, Ar, Kr, Xe	0.12	17.8	1.7	0.0222	0.0037	0.61	DM	^{14}C	--	--	19	--	--	--	0.1	0	--
Eagle Ford	EF19	UA	Ne, Ar, Kr, Xe	1.35	18.3	0.6	--	0.0002	--	DM	^{14}C	--	--	57	--	--	--	0.1	0	--
Eagle Ford	EF20	CE	Ne, Ar, Kr, Xe	0.24	21.9	1.8	0.0201	0.0068	0.36	DM	^{14}C	--	--	63	--	--	--	0.1	0	--
Eagle Ford	EF21	CE	Ne, Ar, Kr, Xe	0.33	16.3	1.5	0.0176	0.0033	0.61	BMM-DM-DM	^3H, SF_6, ^{14}C	0.40	--	27	162; 336	< 0.01	0.01	0.1	0.18	27
Eagle Ford	EF22	UA	Ne, Ar, Kr	0.30	24.8	0.8	--	0.0001	--	BMM-DM-DM	^3H, SF_6, ^{14}C	1.21	--	42	162; 162	2.4	0.01	0.1	0.13	1
Eagle Ford	EF23	UA	Ne, Ar, Kr, Xe	0.81	12.7	0.6	--	0.0037	--	DM	^{14}C	--	--	19	--	--	--	0.1	0	--
Eagle Ford	EF24	UA	Ne, Ar, Kr, Xe	2.14	21.0	0.7	--	0.0041	--	DM	^{14}C	--	--	97	--	--	--	0.1	0	--
Eagle Ford	EF25	CE	Ne, Ar, Kr, Xe	0.74	24.6	2.4	0.2470	0.0045	0.69	DM	^{14}C	--	--	0.6	--	--	--	0.1	0	--
Eagle Ford	EF26	CE	Ne, Ar, Kr, Xe	0.01	21.6	9.2	0.0980	0.0036	0.73	DM	^{14}C	--	--	1.4	--	--	--	0.1	0	--
Eagle Ford	EF27	CE	Ne, Ar, Kr, Xe	0.01	22.0	1.9	0.0195	0.0039	0.56	DM	^{14}C	--	--	100	--	--	--	0.1	0	--
Eagle Ford	EF28	CE	Ne, Ar, Kr, Xe	< 0.01	14.9	1.5	0.0175	0.0022	0.73	DM	^{14}C	--	--	0.6	--	--	--	0.1	0	--
Eagle Ford	EF29	CE	Ne, Ar, Kr, Xe	0.90	16.3	1.7	0.0238	0.0036	0.63	DM	^{14}C	--	--	0.5	--	--	--	0.1	0	--
Eagle Ford	EF30	CE	Ne, Ar, Kr, Xe	< 0.01	16.1	2.0	0.0337	0.0042	0.63	DM	^{14}C	--	--	0.6	--	--	--	0.1	0	--
Eagle Ford	EFP70	CE	Ne, Ar, Kr, Xe	0.26	16.6	1.5	0.016657214	0.0034	0.58	DM	^{14}C	--	--	3.9	--	--	--	0.1	0	--
Eagle Ford	EFP71	CE	Ne, Ar, Kr, Xe	0.04	19.7	1.9	0.021247389	0.0021	0.74	DM	^{14}C	--	--	1.3	--	--	--	0.1	0	--
Eagle Ford	EFP72	UA	Ne, Ar, Kr, Xe	34.01	22.9	0.6	--	0.0000	--	DM	^{14}C	--	--	1.2	--	--	--	0.1	0	--
Eagle Ford	EFP73	--	--	--	--	--	--	--	--	DM	^{14}C	--	--	53	--	--	--	0.1	0	--
Eagle Ford	EFP74	UA	Ne, Kr, Xe	0.17	15.1	0.6	--	0.0020	--	DM	^{14}C	--	--	23	--	--	--	0.1	0	--
Eagle Ford	EFP75	CE	Ne, Ar, Kr, Xe	0.29	19.4	1.5	0.013693174	0.0041	0.47	DM	^{14}C	--	--	60	--	--	--	0.1	0	--
Eagle Ford	EFP76	UA	Ne, Ar, Kr, Xe	1.18	14.7	0.6	--	0.0023	--	DM	^{14}C	--	--	46	--	--	--	0.1	0	--
Eagle Ford	EFP77	UA	Ne, Ar, Kr, Xe	0.16	20.8	0.8	--	0.0010	--	DM	^{14}C	--	--	100	--	--	--	0.1	0	--
Eagle Ford	EFP78	CE	Ne, Ar, Kr, Xe	0.26	21.6	1.6	0.012772695	0.0037	0.48	DM	^{14}C	--	--	71	--	--	--	0.1	0	--
Eagle Ford	EFP79	UA	Ne, Ar, Kr, Xe	0.83	17.7	0.6	--	0.0021	--	--	--	--	--	--	--	--	--	--	--	--
Eagle Ford	EFP80	CE	Ne, Ar, Kr, Xe	0.21	18.2	2.2	0.032173969	0.0017	0.82	DM	^{14}C	--	--	2.7	--	--	--	0.1	0	--
Eagle Ford	EFP81	UA	Ne, Ar, Kr, Xe	2.21	18.2	0.6	--	0.0059	--	--	--	--	--	--	--	--	--	--	--	--

[a]CE, closed-system equilibration; UA, unfractionated excess air.

[b]BMM-DM-DM, binary mixing model (BMM) composed of dispersion models (DMs) for the young and old fractions of water.

Table S9. Results of recharge temperature, excess air, and groundwater age calculations.

Shale play	Well name	Excess air model[a]	Modeled gases	Chi-squared	Noble-gas recharge temperature (°C)	Noble-gas recharge temperature 1σ error (°C)	Entrapped air (cubic centimeters at standard temperature and pressure per gram water [cm^{3}STP/g])	Excess air (cm^{3}STP/g)	CE model fractionation [F]	Lumped-parameter model[b]	Modeled tracers	SF_6 (parts per trillion by volume)	Tritiogenic ^{3}He (Tritium units)	^{14}C, corrected final (percent modern carbon)	DIC-young fraction; DIC old fraction (mg/L as $CaCO_3$)	Chi-squared	Dispersion parameter young fraction	Dispersion parameter old fraction	Fraction young water	Mean age young fraction (yr)
Eagle Ford	EFP83	UA	Ne, Ar, Kr, Xe	1.14	13.9	0.6	--	0.0035	--	--	--	--	--	--	--	--	--	--	--	--
Fayetteville	FV1	CE	Ne, Ar, Kr, Xe	0.08	10.7	1.2	0.0146	0.0030	0.61	BMM-DM-DM	3H, 3He(trit), SF6	0.70	9.3	122	--	1.2	0.01	0.1	0.60	30
Fayetteville	FV2	UA	Ne, Ar, Kr	3.09	10.1	0.7	--	0.0040	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.21	--	47	29; 243	0.05	0.01	0.1	0.24	36
Fayetteville	FV3	UA	Ne, Ar, Kr, Xe	1.38	8.3	0.5	--	0.0030	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.38	--	86	29; 101	< 0.01	0.01	0.1	0.49	37
Fayetteville	FV4	UA	Ne, Ar, Kr	< 0.01	12.7	0.6	--	0.0008	--	BMM-DM-DM	^{3}H, ^{3}He(trit), SF_6, ^{14}C	5.05	2.1	90	29; 29	1.0	0.01	0.1	0.58	1
Fayetteville	FV5	UA	Ne, Ar, Kr	0.21	8.9	0.6	--	0.0040	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.62	--	110	29; 101	0.66	0.01	0.1	0.57	34
Fayetteville	FV6	UA	Ne, Ar, Kr	1.19	8.1	0.6	--	0.0047	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.27	--	52	29; 243	0.14	0.01	0.1	0.21	32
Fayetteville	FV7	UA	Ne, Ar, Kr, Xe	2.51	8.4	0.5	--	0.0049	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.95	--	105	29; 101	0.76	0.01	0.1	0.40	25
Fayetteville	FV8	CE	Ne, Ar, Kr, Xe	1.430002	10.1	1.2	0.0144	0.0047	0.44	--	--	--	--	--	--	--	--	--	--	--
Fayetteville	FV9	UA	Ne, Ar, Xe	0.1	7.1	0.7	--	0.0058	--	BMM-DM-DM	3H, 3He(trit), 14C	5.31	7.4	61	29; 101	< 0.01	0.01	0.1	0.49	29
Fayetteville	FV10	UA	Ne, Ar, Kr, Xe	1.32	8.9	0.5	--	0.0035	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.37	--	101	29; 29	0.12	0.01	0.1	0.51	38
Fayetteville	FV11	UA	Ne, Ar, Kr, Xe	0.38	8.6	0.5	--	0.0038	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	2.33	--	102	29; 101	0.14	0.01	0.1	0.65	20
Fayetteville	FV12	UA	Ne, Ar, Kr, Xe	1.82	11.3	0.5	--	0.0037	--	BMM-DM-DM	^{3}He(trit), SF_6, ^{14}C	4.81	2.5	102	29; 29	< 0.01	0.01	0.1	0.81	10
Fayetteville	FV13	UA	Ne, Ar, Kr, Xe	1.59	8.4	0.5	--	0.0042	--	BMM-DM-DM	^{3}H, ^{3}He(trit), SF_6, ^{14}C	0.60	12.0	118	101; 101	3.6	0.01	0.1	0.52	33
Fayetteville	FV14	UA	Ne, Ar, Kr	2.71	11.8	0.7	--	0.0051	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.29	--	121	101; 101	2.6	0.01	0.1	0.38	37
Fayetteville	FV15	UA	Ne, Ar, Kr	3.70	8.8	0.6	--	0.0037	--	DM	^{14}C	--	--	16	--	--	--	0.1	0	--
Fayetteville	FV16	CE	Ne, Ar, Kr, Xe	0.18	14.8	4.2	0.0743	0.0016	0.86	DM	3H, 3He(trit), SF6	5.38	2.8	110	--	1.8	0.01	--	1	13
Fayetteville	FV17	UA	Ne, Ar, Kr	6.44	11.7	0.7	--	0.0045	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.55	--	74	29; 243	< 0.01	0.01	0.1	0.25	27
Fayetteville	FV18	CE	Ne, Ar, Kr, Xe	0.41	13.7	1.7	0.0267	0.0025	0.74	DM	^{3}H, ^{3}He(trit), SF_6, ^{14}C	2.37	14.4	119	--	0.63	0.01	--	1	28
Fayetteville	FV19	UA	Ne, Ar, Kr	4.81	12.4	0.7	--	0.0049	--	DM	^{14}C	--	--	32	--	--	--	0.1	0	--
Fayetteville	FV20	CE	Ne, Ar, Kr, Xe	0.02	14.6	1.6	0.0253	0.0047	0.56	DM	^{14}C	--	--	73	--	--	--	0.1	0	--
Fayetteville	FV21	UA	Ne, Ar, Kr, Xe	0.36	12.0	0.5	--	0.0634	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	1.84	--	95	29; 101	0.03	0.01	0.1	0.81	26
Fayetteville	FV22	CE	Ne, Ar, Kr, Xe	0.13	11.1	1.6	0.0300	0.0041	0.64	BMM-DM-DM	^{3}H, ^{3}He(trit), SF_6, ^{14}C	0.60	15.9	107	29; 101	3.5	0.01	0.1	0.43	35
Fayetteville	FV23	UA	Ne, Ar, Kr, Xe	3.41	9.3	0.5	--	0.0052	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.36	--	89	29; 101	0.02	0.01	0.1	0.38	35
Fayetteville	FV24	CE	Ne, Ar, Kr, Xe	0.18	8.6	1.8	0.0424	0.0033	0.74	DM	^{14}C	--	--	2.2	--	--	--	0.1	0	--
Fayetteville	FV25	UA	Ne, Ar, Kr, Xe	1.08	8.9	0.5	--	0.0044	--	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.78	--	106	29; 101	0.58	0.01	0.1	0.37	37
Fayetteville	FV26	CE	Ne, Ar, Kr, Xe	0.03	12.8	1.7	0.0288	0.0037	0.66	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.89	--	97	29; 243	< 0.01	0.01	0.1	0.44	27
Fayetteville	FV27	CE	Ne, Ar, Kr, Xe	0.01	14.8	1.8	0.0301	0.0048	0.59	DM	^{3}H, SF_6, ^{14}C	4.50	--	106	--	0.16	0.01	--	1	15
Fayetteville	FV28	UA	Ne, Kr, Xe	0.15	10.6	0.6	--	0.0007	--	DM	^{3}H, SF_6, ^{14}C	3.11	--	109	--	0.68	0.01	--	1	22
Fayetteville	FV29	UA	Ne, Ar, Kr, Xe	5.13	10.9	0.5	--	0.0035	--	--	--	--	--	87	--	--	--	--	--	--
Fayetteville	FV30	CE	Ne, Ar, Kr, Xe	0.07	13.4	1.4	0.0218	0.0114	0.18	BMM-DM-DM	^{3}H, ^{3}He(trit), SF_6, ^{14}C	0.51	14.5	99	29; 243	0.41	0.01	0.1	0.55	34
Haynesville	HV1	UA	Ne, Ar, Kr, Xe	1.59	12.4	0.5	--	0.0020	--	DM	^{14}C	--	--	16	--	--	--	0.1	0	--
Haynesville	HV2	UA	Ne, Ar, Kr	0.12	11.9	0.7	--	0.0024	--	DM	^{14}C	--	--	27	--	--	--	0.1	0	--
Haynesville	HV3	CE	Ne, Ar, Kr, Xe	0.94	14.6	1.7	0.0272	0.0044	0.60	DM	^{14}C	--	--	1.1	--	--	--	0.1	0	--
Haynesville	HV4	CE	Ne, Ar, Kr, Xe	0.34	16.8	1.6	0.0180	0.0039	0.56	DM	^{14}C	--	--	79	--	--	--	0.1	0	--
Haynesville	HV5	CE	Ne, Ar, Kr, Xe	< 0.01	13.9	1.6	0.0245	0.0044	0.58	DM	^{14}C	--	--	24	--	--	--	0.1	0	--
Haynesville	HV6	CE	Ne, Ar, Kr, Xe	0.31	15.6	1.9	0.0298	0.0035	0.67	DM	^{14}C	--	--	78	--	--	--	0.1	0	--
Haynesville	HV7	UA	Ne, Kr, Xe	0.39	12.5	0.6	--	0.0035	--	DM	^{14}C	--	--	16	--	--	--	0.1	0	--
Haynesville	HV8	UA	Ne, Ar, Kr	0.53	12.5	0.7	--	0.0033	--	DM	^{14}C	--	--	25	--	--	--	0.1	0	--
Haynesville	HV9	CE	Ne, Ar, Kr, Xe	0.41	14.5	1.5	0.0191	0.0030	0.66	BMM-DM-DM	^{3}H, SF_6, ^{14}C	0.43	--	88	82; 82	< 0.01	0.01	0.1	0.09	16
Haynesville	HV10	CE	Ne, Ar, Kr, Xe	0.35	15.2	1.6	0.0216	0.0038	0.61	DM	^{14}C	--	--	70	--	--	--	0.1	0	--

[a]CE, closed-system equilibration; UA, unfractionated excess air.

[b]BMM-DM-DM, binary mixing model (BMM) composed of dispersion models (DMs) for the young and old fractions of water.

Table S9. Results of recharge temperature, excess air, and groundwater age calculations.

Shale play	Well name	Excess air model[a]	Modeled gases	Chi-squared	Noble-gas recharge temperature (°C)	Noble-gas recharge temperature 1σ error (°C)	Entrapped air (cubic centimeters at standard temperature and pressure per gram water [cm^3STP/g])	Excess air (cm^3STP/g)	CE model fractionation [F]	Lumped-parameter model[b]	Modeled tracers	SF_6 (parts per trillion by volume)	Tritiogenic ^3He (Tritium units)	^{14}C, corrected final (percent modern carbon)	DIC-young fraction; DIC old fraction (mg/L as $CaCO_3$)	Chi-squared	Dispersion parameter young fraction	Dispersion parameter old fraction	Fraction young water	Mean age young fraction (yr)
Haynesville	HV11	CE	Ne, Ar, Kr, Xe	0.16	18.0	2.1	0.0337	0.0063	0.51	BMM-DM-DM	^3H, SF_6, ^{14}C	0.73	--	89	82; 82	0.06	0.01	0.1	0.3	26
Haynesville	HV12	CE	Ne, Ar, Kr, Xe	0.12	10.2	1.7	0.0337	0.0031	0.73	DM	^{14}C	--	--	3.6	--	--	--	0.1	0	--
Haynesville	HV13	UA	Ne, Ar, Kr, Xe	0.80	11.7	0.5	--	0.0030	--	DM	^{14}C	--	--	37	--	--	--	0.1	0	--
Haynesville	HV14	UA	Ne, Ar, Kr, Xe	0.59	10.7	0.5	--	0.0024	--	DM	^{14}C	--	--	65	--	--	--	0.1	0	--
Haynesville	HV15	UA	Ne, Ar, Kr, Xe	1.02	13.1	0.6	--	0.0027	--	DM	^{14}C	--	--	6.0	--	--	--	0.1	0	--
Haynesville	HV16	CE	Ne, Ar, Kr, Xe	0.43	9.8	1.2	0.0126	0.0043	0.43	DM	^{14}C	--	--	15	--	--	--	0.1	0	--
Haynesville	HV17	UA	Ne, Ar, Kr, Xe	1.58	16.9	0.6	--	0.0036	--	DM	^{14}C	--	--	93	--	--	--	0.1	0	--
Haynesville	HV18	UA	Ne, Ar, Kr	1.00	13.4	0.7	--	0.0029	--	DM	^{14}C	--	--	21	--	--	--	0.1	0	--
Haynesville	HV19	CE	Ne, Ar, Kr, Xe	0.03	17.1	1.5	0.0172	0.0053	0.43	DM	^{14}C	--	--	109	--	--	--	0.1	0	--
Haynesville	HV20	CE	Ne, Ar, Kr, Xe	0.55	16.3	1.7	0.0231	0.0030	0.68	BMM-DM-DM	^3H, SF_6, ^{14}C	0.75	--	120	82;568	0.82	0.01	0.1	0.81	35
Haynesville	HV21	CE	Ne, Ar, Kr, Xe	0.08	18.7	2.4	0.0372	0.0035	0.69	DM	^{14}C	--	--	1	--	--	--	0.1	0	--
Haynesville	HV22	UA	Ne, Ar, Kr	2.15	14.2	0.7	--	0.0026	--	DM	^{14}C	--	--	25	--	--	--	0.1	0	--
Haynesville	HV23	CE	Ne, Ar, Kr, Xe	0.02	13.4	1.3	0.0124	0.0029	0.58	DM	^{14}C	--	--	2.6	--	--	--	0.1	0	--
Haynesville	HV24	CE	Ne, Ar, Kr, Xe	< 0.01	20.6	8.6	0.1008	0.0046	0.68	DM	^{14}C	--	--	48	--	--	--	0.1	0	--
Haynesville	HV25	--	--	--	--	--	--	--	--	DM	^{14}C	--	--	3.4	--	--	--	0.1	0	--
Haynesville	HV26	CE	Ne, Ar, Kr, Xe	0.02	13.8	1.3	0.0134	0.004	0.48	DM	^{14}C	--	--	1.4	--	--	--	0.1	0	--
Haynesville	HV27	UA	Ne, Ar, Kr, Xe	0.89	9.9	0.5	--	0.0025	--	DM	^{14}C	--	--	7.5	--	--	--	0.1	0	--
Haynesville	HV28	UA	Ne, Ar, Kr	1.91	13.4	0.7	--	0.0035	--	DM	^{14}C	--	--	1.6	--	--	--	0.1	0	--
Haynesville	HV29	UA	Ne, Ar, Kr	1.98	10.4	0.6	--	0.0016	--	DM	^{14}C	--	--	53	--	--	--	0.1	0	--
Haynesville	HV30	CE	Ne, Ar, Kr, Xe	0.06	15.6	2.1	0.0356	0.003	0.72	DM	^{14}C	--	--	0.8	--	--	--	0.1	0	--
Haynesville	HVP21	CE	Ne, Ar, Kr, Xe	0.30	17.8	1.7	0.0207	0.0024	0.71	BMM-DM-DM	^3H, SF_6, ^{14}C	0.90	--	119.00	82:82	0.13	0.01	0.1	0.64	31
Haynesville	HVP25	CE	Ne, Ar, Kr, Xe	0.02	14.8	1.6	0.0217	0.0021	0.76	DM	^{14}C	--	--	91.00	--	--	--	0.1	0	--
Haynesville	HVP27	CE	Ne, Ar, Kr, Xe	0.06	7.4	1.2	0.0192	0.0044	0.55	DM	^{14}C	--	--	6.50	--	--	--	0.1	0	--
Haynesville	HVP88	CE	Ne, Ar, Kr, Xe	0.00	14.9	1.3	0.0092	0.003	0.48	DM	^{14}C	--	--	0.6	--	--	--	0.1	0	--
Haynesville	HVP89	UA	Ne, Ar, Kr, Xe	1.06	11.8	0.5	--	0.0026	--	DM	^{14}C	--	--	1.5	--	--	--	0.1	0	--
Haynesville	HVP90	UA	Ne, Ar, Kr, Xe	1.27	10.6	0.5	--	0.0021	--	DM	^{14}C	--	--	16	--	--	--	0.1	0	--
Haynesville	HVP91	UA	Ne, Ar, Xe	0.06	10.6	0.7	--	0.0029	--	DM	^{14}C	--	--	25	--	--	--	0.1	0	--
Haynesville	HVP93	--	--	--	--	--	--	--	--	DM	^{14}C	--	--	78	--	--	--	0.1	0	--
Haynesville	HVP94	UA	Ne, Ar, Kr, Xe	0.38	10.7	0.6	--	0.0104	--	DM	^{14}C	--	--	5.8	--	--	--	0.1	0	--
Haynesville	HVP95	UA	Ne, Ar, Kr, Xe	1.00	10.1	0.5	--	0.0024	--	DM	^{14}C	--	--	14	--	--	--	0.1	0	--
Haynesville	HVP96	CE	Ne, Ar, Kr, Xe	0.01	14.7	1.7	0.0262	0.0040	0.62	DM	^{14}C	--	--	1.5	--	--	--	0.1	0	--
Haynesville	HVP98	UA	Ne, Ar, Kr	0.00	13.4	0.7	--	0.0024	--	DM	^{14}C	--	--	15	--	--	--	0.1	0	--
Haynesville	HVP100	CE	Ne, Ar, Kr, Xe	0.10	14.2	1.4	0.0150	0.0033	0.58	--	--	--	--	--	--	--	--	--	--	--

[a]CE, closed-system equilibration; UA, unfractionated excess air.

[b]BMM-DM-DM, binary mixing model (BMM) composed of dispersion models (DMs) for the young and old fractions of water.

Table S9. Results of recharge temperature, excess air, and groundwater age calculations.

Shale play	Well name	Mean age young fraction 1σ error (yr)	Mean age old fraction (calibrated ^{14}C age, yr)	Mean age old fraction 1σ error (calibrated ^{14}C age, yr)
Eagle Ford	EF1	--	18800	1500
Eagle Ford	EF2	2.4	--	--
Eagle Ford	EF3	--	> 30000	--
Eagle Ford	EF4	--	1000	700
Eagle Ford	EF5	7	8300	1300
Eagle Ford	EF6	--	6500	1200
Eagle Ford	EF7	--	19000	1500
Eagle Ford	EF8	--	> 30000	--
Eagle Ford	EF9	--	6200	1100
Eagle Ford	EF10	--	7400	1100
Eagle Ford	EF11	--	7200	1000
Eagle Ford	EF12	--	> 30000	--
Eagle Ford	EF13	--	14000	1200
Eagle Ford	EF14	--	> 30000	--
Eagle Ford	EF15	--	2700	900
Eagle Ford	EF16	20	12400	1000
Eagle Ford	EF17	--	6300	1000
Eagle Ford	EF18	--	18100	1300
Eagle Ford	EF19	--	5300	1200
Eagle Ford	EF20	--	4400	1200
Eagle Ford	EF21	5	18200	1600
Eagle Ford	EF22	1	11200	1300
Eagle Ford	EF23	--	18300	1400
Eagle Ford	EF24	--	< 1000	500
Eagle Ford	EF25	--	> 30000	--
Eagle Ford	EF26	--	> 30000	--
Eagle Ford	EF27	--	< 1000	500
Eagle Ford	EF28	--	> 30000	--
Eagle Ford	EF29	--	> 30000	--
Eagle Ford	EF30	--	> 30000	--
Eagle Ford	EFP70	--	> 30000	--
Eagle Ford	EFP71	--	> 30000	--
Eagle Ford	EFP72	--	> 30000	--
Eagle Ford	EFP73	--	5900	900
Eagle Ford	EFP74	--	15800	1600
Eagle Ford	EFP75	--	4700	1200
Eagle Ford	EFP76	--	7400	900
Eagle Ford	EFP77	--	< 1000	500
Eagle Ford	EFP78	--	3100	1000
Eagle Ford	EFP79	--	--	--
Eagle Ford	EFP80	--	> 30000	--
Eagle Ford	EFP81	--	--	--

[a]CE, closed-system equilibration; UA, unfractionated excess air.

[b]BMM-DM-DM, binary mixing model (BMM) composed of dispersion models (DMs) for the young and old fractions of water.

Table S9. Results of recharge temperature, excess air, and groundwater age calculations.

Shale play	Well name	Mean age young fraction 1σ error (yr)	Mean age old fraction (calibrated ^{14}C age, yr)	Mean age old fraction 1σ error (calibrated ^{14}C age, yr)
Eagle Ford	EFP83	--	--	--
Fayetteville	FV1	1	< 1000	250
Fayetteville	FV2	1	8100	600
Fayetteville	FV3	1	3100	1400
Fayetteville	FV4	1	1900	1300
Fayetteville	FV5	1	200	200
Fayetteville	FV6	1	6900	500
Fayetteville	FV7	1	300	200
Fayetteville	FV8	--	--	--
Fayetteville	FV9	1.1	8200	2300
Fayetteville	FV10	1	4000	1700
Fayetteville	FV11	1.9	400	300
Fayetteville	FV12	2.4	1300	2900
Fayetteville	FV13	1	290	240
Fayetteville	FV14	1	200	100
Fayetteville	FV15	--	20500	600
Fayetteville	FV16	1.2	--	--
Fayetteville	FV17	1	2800	500
Fayetteville	FV18	4.9	--	--
Fayetteville	FV19	--	11700	500
Fayetteville	FV20	--	2600	500
Fayetteville	FV21	1	3900	3100
Fayetteville	FV22	1	170	50
Fayetteville	FV23	1	1600	600
Fayetteville	FV24	--	> 30,000	--
Fayetteville	FV25	1	170	50
Fayetteville	FV26	2.5	500	600
Fayetteville	FV27	6.7	--	--
Fayetteville	FV28	1	--	--
Fayetteville	FV29	--	--	--
Fayetteville	FV30	1	400	300
Haynesville	HV1	--	20300	1100
Haynesville	HV2	--	14100	1300
Haynesville	HV3	--	> 30000	--
Haynesville	HV4	--	2000	900
Haynesville	HV5	--	15500	1400
Haynesville	HV6	--	2100	900
Haynesville	HV7	--	20600	1300
Haynesville	HV8	--	14600	1500
Haynesville	HV9	9.9	1200	900
Haynesville	HV10	--	3300	1100

[a]CE, closed-system equilibration; UA, unfractionated excess air.

[b]BMM-DM-DM, binary mixing model (BMM) composed of dispersion models (DMs) for the young and old fractions of water.

Table S9. Results of recharge temperature, excess air, and groundwater age calculations.

Shale play	Well name	Mean age young fraction 1σ error (yr)	Mean age old fraction (calibrated ^{14}C age, yr)	Mean age old fraction 1σ error (calibrated ^{14}C age, yr)
Haynesville	HV11	3.2	2300	1600
Haynesville	HV12	--	> 30000	--
Haynesville	HV13	--	10100	1100
Haynesville	HV14	--	3800	1000
Haynesville	HV15	--	> 30000	--
Haynesville	HV16	--	21200	300
Haynesville	HV17	--	900	800
Haynesville	HV18	--	16800	1100
Haynesville	HV19	--	200	500
Haynesville	HV20	1.3	200	200
Haynesville	HV21	--	> 30000	--
Haynesville	HV22	--	14500	500
Haynesville	HV23	--	> 30000	--
Haynesville	HV24	--	7000	1000
Haynesville	HV25	--	> 30000	--
Haynesville	HV26	--	> 30000	--
Haynesville	HV27	--	> 30000	--
Haynesville	HV28	--	> 30000	--
Haynesville	HV29	--	6100	200
Haynesville	HV30	--	> 30000	--
Haynesville	HVP21	2.4	1100	2900
Haynesville	HVP25	--	1200	900
Haynesville	HVP27	--	> 30000	--
Haynesville	HVP88	--	> 30000	--
Haynesville	HVP89	--	> 30000	--
Haynesville	HVP90	--	22000	7300
Haynesville	HVP91	--	14700	900
Haynesville	HVP93	--	1700	1000
Haynesville	HVP94	--	> 30000	--
Haynesville	HVP95	--	21900	1700
Haynesville	HVP96	--	> 30000	--
Haynesville	HVP98	--	21900	4400
Haynesville	HVP100	--	--	--

[a]CE, closed-system equilibration; UA, unfractionated excess air.

[b]BMM-DM-DM, binary mixing model (BMM) composed of dispersion models (DMs) for the young and old fractions of water.

Table S10. Carbon-14 corrections based on NETPATH and other correction models. Corrected carbon-14 concentrations were used in TracerLPM to date groundwater.[41]

			CH_2O		Calcite		Dolomite		CO_2 gas		Methane		NETPATH mineral mass transfer (mmol/kg)[a]													
Modeled (final) well	Initial well	Constraints	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	CH_2O	Calcite	Calcite isotopic exchange, mmol ($\delta^{13}C$) (^{14}C)	Dolomite	Exchange	Goethite	Gypsum	Pyrite	CO_2 gas	Mg/Na exchange	Albite	K-spar	NaCl	Kaolinite
EF1	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	--	--	2	0	-23	100	--	--	--	--	--	0.82459	--	0.01321	3.35496	-0.01389	2.56933	-1.5723	4.1043	--	9.97573	-2.05219
EF2	EF27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		--	--	--
EF3	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-23	0	--	--	2	0	-23	100	-25	0	0.15043	--	--	0.71238	10.44989	-0.00093	12.9614	--	3.10534	--	7.65821	--	80.48979	-3.82915
EF4	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-23	0	2	0	2	0	-23	100	--	--	0.06819	0.67846	--	0.28316	0.13238	--	0.38271	-0.01948	1.39734	--	0.09333	--	1.80058	-0.04667
EF5	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-24	0	1	0	1	0	-24	100	--	--	0.0434	0.92766	--	0.32025	1.05413	--	0.8436	-0.0124	1.21331	--	0.00096	--	1.8517	-0.0005
EF6	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.04599	0.98875	--	0.40254	1.23214	--	0.77332	-0.01582	0.6107	--	--	--	1.58348	-0.00004
EF7	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.02807	-1.35359	--	2.0417	1.9266	--	3.37301	-0.00802	3.59814	--	--	--	1.37285	-0.00003
EF8	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	--	--	0.06856	2.33848	1.0 (0)(0)	--	3.05805	--	0.65798	-0.01959	0.6101	0.04193	0.0002	--	0.80742	--
EF9	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.05688	1.29133	1.0 (0)(0)	0.4519	1.24374	--	0.43043	-0.01625	0.68768	--	--	--	0.75934	-0.00002
EF10	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.03119	1.33715	0.75 (0)(0)	0.43956	1.14076	--	0.35638	-0.00891	0.69806	--	--	--	0.81295	-0.00001
EF11	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.04322	1.47749	1.5 (0)(0)	0.3408	1.55039	--	0.47233	-0.01324	1.43677	--	<0.00001	--	0.33322	--
EF12	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	--	--	--	--	-25	100	--	--	0.00163	--	--	--	8.53889	0.00656	15.53622	--	2.26038	-5.40233	18.86217	--	24.61963	-9.43112
EF13	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0	0	0	0	-25	100	--	--	--	0.27715	4.0 (0)(0)	0.97494	-0.7286	0.00831	0.26318	-0.0289	2.02189	--	0.09843	--	6.49642	-0.04921
EF14	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-24	0	1	0	--	--	-24	100	--	--	0.04893	4.29535	--	--	4.66707	--	0.31465	-0.01398	3.40828	0.06826	0.03934	--	1.68036	-0.01967
EF15	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.04154	-0.4846	1.0 (0)(0)	1.31176	--	--	0.24252	-0.01187	1.5667	0.91337	--	--	0.01429	-0.00004
EF16	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0	0	0	0	-25	100	--	--	--	-2.08698	1.0 (0)(0)	2.27619	--	0.03425	0.82872	-0.05476	1.70941	2.18181	0.00031	--	6.13052	--
EF17	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0	0	0	0	-25	100	--	--	--	-0.34142	1.0 (0)(0)	1.14382	-2.89877	0.02833	0.20112	-0.04892	1.16563	--	0.12842	--	9.29197	-0.06419
EF18	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0	0	0	0	-25	100	--	--	--	-1.87984	1.5 (0)(0)	2.40025	--	0.01331	0.40233	-0.0339	1.89619	2.21412	0.14754	--	2.34611	-0.07376
EF19	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	--	--	0.03965	2.40868	0.5 (0)(0)	--	2.42193	--	0.74359	-0.01133	1.22625	-0.36143	0.00031	--	1.58085	--
EF20	EF27	C, Ca, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0	0	0	0	-25	100	--	--	--	-0.39871	2.5 (0)(0)	1.50626	-2.0724	0.02842	0.32308	-0.04892	1.25372	--	--	--	9.63167	--
EF21	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	--	--	0.07207	2.60076	2.5 (0)(0)	--	3.49911	--	1.92904	-0.02059	1.88471	-0.02112	0.32261	--	7.00761	-0.16122
EF22	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	--	--	0	0	-25	100	-64	0	1.55055	--	--	0.41892	-0.81289	0.03497	--	-0.04945	1.23861	--	2.21388	--	0.1779	-1.10698
EF23	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-23	0	--	--	2	0	-23	100	--	--	3.27931	--	--	1.08335	7.77073	0.85872	7.77147	-0.87561	1.03256	--	--	--	8.73745	-0.00004
EF24	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	--	--	--	--	-25	100	--	--	0.07554	--	--	--	-0.13351	0.11275	--	-0.01353	-0.33783	-0.02592	0.24558	--	0.28213	-0.12271
EF25	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	-66	0	1.76217	5.19829	2.0 (0)(0)	--	5.24836	0.05348	--	-0.07178	3.43517	0.04067	0.00014	--	0.83058	--
EF26	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	-60	0	3.0773	8.4251	0.5 (0)(0)	--	8.25849	0.00551	--	-0.02201	5.90012	-0.08637	--	--	12.86734	-0.00004
EF27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EF28	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-26	0	-1	0	--	--	-26	100	--	--	0.04652	2.40218	--	--	3.52035	--	2.87325	-0.01329	1.76378	-0.41523	--	--	5.67988	-0.00004
EF29	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-26	0	-1	0	-1	0	--	--	--	--	0.74313	0.67247	--	0.15124	--	0.18549	1.2615	-0.19907	--	-0.97666	--	--	16.89462	-0.00004
EF30	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox	-23	0	--	--	--	--	-23	100	--	--	2.30078	--	--	--	1.81365	0.59515	1.73556	-0.61574	-1.14929	0.07486	0.00007	--	--	--
EFP70	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl			0	0	--	--	-25	100	--	--	--	1.0543	1.0 (0)(0)	--	3.78566	-0.01721	3.48463	-0.00123	1.5117	-0.74875	0.00052	--	5.50996	--
EFP71	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	--	--	0.07168	2.40263	1.0 (0)(0)	--	3.17893	--	0.68274	-0.02048	0.76635	0.06156	0.00012	--	1.70227	--
EFP72	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	-43	0	0.9079	4.12942	1.5 (0)(0)	--	4.6685	--	0.43506	-0.0205	3.83306	0.07975	0.04728	--	1.51673	-0.02324
EFP73	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0	0	0	0	-25	100	--	--	--	1.26175	1.5 (0)(0)	0.37786	1.7151	0.03015	0.81577	-0.05057	1.34022	--	--	--	1.05296	-0.00004
EFP74	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	--	--	0.04949	2.32361	2.0 (0)(0)	--	2.31413	--	0.72834	-0.01414	1.22054	-0.38611	0.00028	--	0.93163	--
EFP75	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.0525	1.49162	2.0 (0)(0)	0.5507	0.21636	--	0.5769	-0.015	1.97268	--	--	--	0.32477	-0.00004
EFP76	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.04774	1.46301	2.5 (0)(0)	0.33253	0.18323	--	0.15127	-0.01364	1.41547	--	--	--	0.29083	-0.00004
EFP77	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox	-25	0	0	0	0	0	-25	100	--	--	0.06437	1.49126	2.5 (0)(0)	0.45188	0.21983	--	0.14515	-0.01839	3.28438	--	0.00005	--	--	--
EFP78	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	--	--	-25	100	--	--	0.00248	0.57029	1.0 (0)(0)	--	-0.02511	--	0.71379	-0.00071	1.06748	-0.34485	--	--	2.21521	-0.00004
EFP80	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-25	0	0	0	0	0	-25	100	--	--	0.07074	1.429	2.0 (0)(0)	0.42722	1.52481	--	0.43628	-0.02021	1.50002	--	--	--	0.31911	-0.00004
FV1	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	0	0	--	--	-25	100	--	--	<0.00001	0.468	--	--	--	--	--	--	-2.1686	-0.1489	0.9193	--	--	-0.4595
FV2	FV12	C, Ca, Al, Mg, Na, Si, Redox, Cl	-25	0	0	0	--	--	-25	100	-63	0	1.995	0.2542	--	--	--	--	--	--	-2.023	0.0022	3.94	--	0.398	-1.97
FV3	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	0	0	--	--	-25	100	--	--	0.0045	0.2848	--	--	--	0.01807	--	--	-2.762	-0.1935	0.5688	--	--	-0.2843
FV4	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	--	--	--	--	-25	100	--	--	<0.00001	--	--	--	0.0714	--	--	--	-2.923	0.01	0.1046	0.0071	--	-0.0559
FV5	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	0	0	--	--	-25	100	--	--	0.0095	0.5738	--	--	--	0.03817	--	--	-2.328	-0.0654	0.5121	--	--	-0.2561
FV6	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	0	0	--	--	--	--	--	--	<0.00001	0.9235	--	--	0.7239	--	--	--	--	0.0248	1.44	--	--	-0.7201
FV7	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	--	--	--	--	-25	100	--	--	0.004	--	--	--	0.194	0.01619	--	--	-1.5619	-0.0409	0.1119	0.7884 (Anorthite)	--	-0.8444
FV8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV9	FV12	C, Ca, Al, Mg, Na, Si, Redox, Cl, Fe	-25	0	--	--	--	--	-25	100	--	--	0.01874	--	--	--	-1.2668	0.07498	--	--	-2.7664	-0.3976	1.7611	--	2.2068	-0.8806
FV10	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	0	0	--	--	-25	100	--	--	0.01999	0.1993	--	--	0.0637	0.0799	--	--	-3.167	-0.0561	0.10045	--	--	-0.0503
FV11	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	--	--	--	--	-25	100	--	--	<0.00001	--	--	--	0.1417	--	--	--	-3.0369	0.1497	1.3715	--	--	-0.6851
FV12		RECHARGE WATER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV13	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	--	--	--	--	-25	100	--	--	0.003	--	--	--	-0.3714	0.0122	--	--	-2.346	-0.0474	0.00002	--	--	-0.5153
FV14	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	--	--	--	--	-25	100	--	--	0.00997	--	--	--	-0.2189	0.03988	--	--	-2.194	-0.0183	0.71096	--		-0.3555
FV15	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	-2	0	--	--	-25	100	-68	0	0.9854	3.2853	--	--	3.256	--	--	--	-2.425	-0.0095	--	--	--	-0.00007
FV16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV17	FV12	C, Ca, Al, Mg, Na, Cl, Si, K, Redox	-25	0	--	--	--	--	-25	100	-65	0	0.3742	--	--	--	0.0035	--	--	--	0.3726	-0.1509	5.927	--	2.624	-2.9653
FV18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV19	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	--	--	--	--	-25	100	-73	0	3.1181	--	--	--	0.1735	--	--	--	-2.6736	0.163	3.9698	--	--	-1.9848
FV20	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	0	0	--	--	-25	100	--	--	<0.00001	1.4187	--	--	--	--	--	--	0.2186	-0.7853	2.1235	--	--	-1.0617
FV21	FV12	C, Ca, Al, Mg, Na, Cl, Si, K, Redox	-25	0	0	0	--	--	-25	100	--	--	<0.00001	0.4518	--	--	0.3368	--	--	--	2.2297	-0.424	--	--	0.5512	-0.0162
FV22	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	0	0	--	--	-25	100	--	--	<0.00001	0.4476	--	--	--	--	--	--	-2.148	-0.3408	1.954	--	--	-0.9775
FV23	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	0	0	--	--	-25	100	--	--	<0.00001	0.2761	--	--	--	--	--	--	-2.2908	-0.1121	2.6363	--	--	-1.3182
FV24	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	--	--	--	--	-25	100	--	--	<0.00001	--	--	--	0.05503	--	--	--	-2.1904	0.1042	2.9114	--	--	-1.4531
FV25	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	0	0	--	--	-25	100	--	--	0.0062	0.5343	--	--	0.1608	0.02488	--	--	0.151	-0.02708	--	--	--	-0.00007
FV26	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	--	--	--	--	-25	100	--	--	<0.00001	--	--	--	0.085	--	--	--	-1.324	0.09974	3.2119	--	--	-1.6059
FV27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV29	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-25	0	0	0	--	--	-25	100	--	--	0.02183	0.4235	--	--	0.3902	0.08738	--	--	5.0053	-0.04283	0.00002	--	--	--
FV30	FV12	C, Ca, Al, Mg, Na, Si, Redox	-25	0	0	0	--	--	-25	100	--	--	0.0003	1.9335	--	--	--	0.00125	--	--	3.5769	-0.1902	0.00031	--	--	-0.1763
HV1	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	--	--	--	--	--	--	-25	100	--	--	--	--	--	--	3.26013	-0.11598	3.22235	-0.03306	-0.24442	0.04338	1.25367	--	2.4486	-0.62626
HV2	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.48705	2.80515	--	--	3.65095	--	0.60094	-0.14892	-0.03252	0.12552	0.00004	--	0.5256	--
HV3	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-23	0	2	0	2	0	-23	100	-60	0	1.79181	-8.54018	10 (0)(0)	8.06945	--	--	0.23383	-0.1487	4.00248	8.19187	0.00045	--	0.60582	--
HV4	HV19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HV5	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-23	0	2	0	--	--	-23	100	-62	0	2.02709	3.0866	--	--	3.41717	--	0.2601	-0.14697	1.1348	0.03449	<0.00001	--	2.34822	--
HV6	HV19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HV7	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-23	0	2	0	--	--	-23	100	--	--	0.5187	3.66868	4.5 (0)(0)	--	4.44124	--	0.56478	-0.14892	0.5579	0.09139	0.00007	--	0.24624	--
HV8	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.03675	1.10212	--	--	1.05816	-0.12744	--	-0.02139	-1.23447	0.04187	<0.00001	--	0.25115	
HV9	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-23	0	2	0	--	--	-23	100	--	--	0.10231	0.89562	--	--	0.86604	--	2.07853	-0.02486	2.12359	-1.32768	<0.00001	--	3.36818	--
HV10	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	--	--	--	--	0.76074	0.61475	--	--	-0.28894	0.11121	0.4278	-0.20584	--	-0.26084	0.07186	--	1.03489	-0.03591
HV11	HV19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[a]Positive value for dissolution and negative value for precipitation.
[mmol/kg, millimoles per kilogram of water]

Table S10. Carbon-14 corrections based on NETPATH and other correction models. Corrected carbon-14 concentrations were used in TracerLPM to date groundwater.[41]

			CH_2O		Calcite		Dolomite		CO_2 gas		Methane		NETPATH mineral mass transfer (mmol/kg)[a]													
Modeled (final) well	Initial well	Constraints	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	$\delta^{13}C$	^{14}C	CH_2O	Calcite	Calcite isotopic exchange, mmol ($\delta^{13}C$) (^{14}C)	Dolomite	Exchange	Goethite	Gypsum	Pyrite	CO_2 gas	Mg/Na exchange	Albite	K-spar	NaCl	Kaolinite
HV12	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	0	0	--	--	-25	100	--	--	0.54506	2.28052	1.0 (0)(0)	--	3.64954	--	1.17235	-0.14877	-0.64488	0.10362	0.00166	--	--	--
HV13	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.53567	2.69745	--	--	3.16935	--	0.26604	-0.14912	0.34154	0.11695	0.00024	--	1.5016	--
HV14	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	--	--	--	--	-25	100	--	--	0.72834	--	--	--	0.83837	0.05703	0.62008	-0.20536	-2.04189	0.10515	<0.00001	--	--	--
HV15	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	-71	0	0.69396	2.90911	1.5 (0)(0)	--	3.39592	--	0.27379	-0.1489	0.22354	0.11716	0.00002	--	1.81478	--
HV16	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-23	0	2	0	--	--	-23	100	-59	0	2.43157	3.55762	13 (0)(0)	--	3.99463	--	0.23597	-0.14899	-0.18975	0.10289	--	--	13.50962	0.0001
HV17	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-26	0	-1	0	--	--	-26	100	--	--	0.46629	1.33969	--	--	0.35523	--	1.16622	-0.12912	-0.44871	-0.80721	0.00006	--	1.91714	--
HV18	HV19	C, Ca, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.53322	1.84193	0.5 (0)(0)	--	2.3501	--	0.52349	-0.1486	-0.4089	0.033	--	--	0.45595	--
HV19		RECHARGE WATER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HV20	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HV21	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	-83	0	0.99318	5.05243	--	--	5.10461	--	0.23275	-0.14808	2.4168	-0.13473	<0.00001	--	1.66098	--
HV22	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.48906	0.40833	--	--	0.74542	--	0.29635	-0.1487	-1.76953	0.04023	<0.00001	--	0.4751	--
HV23	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	-75	0	1.19739	6.24439	10 (0)(0)	--	6.68641	--	0.23546	-0.14873	1.43172	0.10713	0.00017	--	10.10357	--
HV24	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.51733	1.10278	--	--	--	--	0.51853	-0.14388	1.62386	-1.05863	2.06206	--	0.50908	-1.03103
HV25	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	-49	0	3.27872	2.67734	3.5 (0)(0)	--	3.08252	--	0.23478	-0.14892	-0.89183	0.08717	0.00014	--	10.99542	--
HV26	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	0	0	-25	100	--	--	0.53754	-1.57297	--	1.17385	--	--	0.29261	-0.14894	-0.77677	1.22899	<0.00001	--	11.89418	--
HV27	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-27	0	-2	0	--	--	-27	100	--	--	0.5449	1.35378	--	--	1.87955	--	0.43005	-0.1489	-1.38359	0.06877	0.00003	--	0.47616	--
HV28	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	-77	0	1.08477	4.57791	2.0 (0)(0)	--	4.86218	--	0.26407	-0.14872	1.78865	0.05455	<0.00001	--	6.14283	--
HV29	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	2	0	--	--	-25	100	-52	0	2.40462	1.55537	16 (0)(0)	--	1.87438	--	0.42956	-0.14817	-0.98287	-0.05419	<0.00001	--	6.05053	--
HV30	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	-75	0	0.77984	5.14017	10 (0)(0)	--	5.55759	--	0.23469	-0.14883	2.59087	0.09828	0.00005	--	6.27367	--
HVP21	HV19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HVP25	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	0	0	0	0	-25	100	--	--	0.37714	0.06042	--	0.07254	-0.20818	--	0.16098	-0.10436	-0.70264	--	0.00001	--		--
HVP27	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.16281	1.42503	--	--	1.77093	--	0.11647	-0.04313	-0.6099	0.12469	0.00005	--	2.57569	--
HVP88	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	--	--	-69	--	5.1749	3.82756	--	--	5.5971	0.64941	1.53334	-0.79846	--	0.12353	0.00011	--	1.71888	--
HVP89	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	--	--	--	--	-25	100	--	--	2.46357	--	--	--	2.36415	0.51209	2.1103	-0.66123	-2.31233	0.13255	0.00019	--	0.10622	--
HVP90	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	0	0	--	--	-25	100	--	--	0.54254	0.56665	0.5 (0)(0)	--	1.23875	--	0.42018	-0.14894	-1.17515	0.12494	<0.00001	--	--	--
HVP91	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	--	--	--	--	-25	100	--	--	0.54219	--	--	--	0.78549	--	0.54389	-0.14884	-0.74631	0.12416	0.65129	--	--	-0.32568
HVP93	HV19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HVP94	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	0	0	--	--	-25	100	--	--	0.54261	1.37497	2.0 (0)(0)	--	2.0253	--	0.45045	-0.14896	-0.27199	0.11107	0.00022	--	--	--
HVP95	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-25	0	0	0	--	--	-25	100	--	--	0.54205	0.78369	0.5 (0)(0)	--	1.3389	--	0.43344	-0.1488	-1.56652	0.10741	0.00023	--	--	--
HVP96	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-25	0	0	0	--	--	-25	100	--	--	0.53645	4.60726	6.0 (0)(0)	--	5.08031	--	0.23534	-0.14899	1.8399	0.12411	0.0001	--	5.23518	--
HVP98	HV19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[a]Positive value for dissolution and negative value for precipitation.
[mmol/kg, millimoles per kilogram of water]

Table S10. Carbon-14 corrections based on NETPATH and other correction models. Corrected carbon-14 concentrations were used in TracerLPM to date groundwater.[41]

						NETPATH carbon-14 correction					Other carbon-14 correction models			TracerLPM input
Modeled (final) well	Initial well	Constraints	SiO_2	Illite	^{14}C measured (pmc)	Ao	$\delta^{13}C$ measured	$\delta^{13}C$ modeled	^{14}C corrected initial	^{14}C corrected final	^{14}C corrected initial	^{14}C corrected final	Correction model	Preferred ^{14}C corrected final
EF1	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-8.21793	--	10.5	76.34	-14.39	-15.2	65.17	16.11	57.6	18.23	Tamers, frxn factor = 1	18
EF2	EF27	--	--	--	88.6	--	--	--	--	--	38.9	227.76	Revised Fontes and Garnier, gas exchange, frxn factor = 1	100
EF3	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-15.53135	--	0.8	76.34	-15.2	-16.6	68.9	1.16	75.3	1.06	Revised Fontes and Garnier, gas exchange, frxn factor = 1	1
EF4	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	54.1	76.34	-14.5	-14.9	60.79	88.99	66.7	81.11	Tamers, frxn factor = 1	89
EF5	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	26.2	76.34	-13.3	-13.9	55.07	47.58	55.5	47.21	Tamers, frxn factor = 1	48
EF6	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.13128	--	23.66	76.34	-13.3	-12.2	45.3	52.23	55.6	42.55	Tamers, frxn factor = 1	52
EF7	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.05951	--	9.1	76.34	-13	-13.4	50.9	17.88	57.9	15.72	Tamers, frxn factor = 1	18
EF8	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.08532	--	0.8	76.34	-9	-8.6	30.15	2.65	31.8	2.52	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	3
EF9	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.01977	--	16.7	76.34	-9.1	-9	32.05	52.11	33.2	50.30	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	52
EF10	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.03643	--	16.4	76.34	-9.5	-9.4	34.44	47.62	34.5	47.54	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	48
EF11	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.07642	--	18.1	76.34	-10.1	-10.2	37.02	48.89	36.6	49.45	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	49
EF12	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-37.8897	--	1.7	76.34	-20.2	-23.1	90.12	1.89	127.7	1.33	Revised Fontes and Garnier, gas exchange, frxn factor = 1	1.3
EF13	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	7.7	76.34	-8.1	-8.2	28.66	26.87	28.9	26.64	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	27
EF14	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0.1	76.34	-11.7	-11.9	49.53	0.20	51.1	0.20	Tamers, frxn factor = 1	0.2
EF15	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.12298	--	28.6	76.34	-10.1	-10.5	38.56	74.17	37.4	76.47	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	74
EF16	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	0.85583	--	9.3	76.34	-7.8	-8.1	29.2	31.85	27.8	33.45	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	33
EF17	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	18	76.34	-9.7	-10.1	36.88	48.81	35.6	50.56	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	51
EF18	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	5.1	76.34	-7.5	-7.8	28.14	18.12	26.9	18.96	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	19
EF19	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.1356	--	23.8	76.34	-11.4	-11.1	41.53	57.31	55.5	42.88	Tamers, frxn factor = 1	57
EF20	EF27	C, Ca, Mg, Na, Si, Fe, S, Redox, Cl	0.10368	--	16	76.34	-7.2	-7.4	25.25	63.37	25.3	63.24	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	63
EF21	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	8.8	76.34	-9.3	-9.1	32.87	26.77	34.2	25.73	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	27
EF22	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-4.61237	--	19.9	76.34	-12.5	-12.9	47.12	42.23	56.8	35.04	Tamers, frxn factor = 1	42
EF23	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.10752	--	5.2	76.34	-15.4	-15.8	27.96	18.60	71.3	7.29	Revised Fontes and Garnier, gas exchange, frxn factor = 1	19
EF24	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.46467		70.5	76.34	-18.3	-19.7	72.69	96.99	76.8	91.80	Revised Fontes and Garnier, gas exchange, frxn factor = 1	97
EF25	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.13665	--	0.2	76.34	-8.1	-8.5	32.08	0.62	28.8	0.69	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	0.6
EF26	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.15415	--	0.5	76.34	-9.3	-9.3	36.37	1.37	34.1	1.47	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	1.4
EF27	--	--	--	--	76.3	--	--	--	--	--	76.5	99.74	Revised Fontes and Garnier, gas exchange, frxn factor = 0	100
EF28	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.0761	--	0.5	76.34	-16.5	-14.2	51.4	0.97	85.7	0.58	Revised Fontes and Garnier, gas exchange, frxn factor = 1	0.6
EF29	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.19271	--	0.2	76.34	-16.2	-16	36.92	0.54	86.8	0.23	Revised Fontes and Garnier, gas exchange, frxn factor = 1	0.5
EF30	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox	-0.16659	--	0.7	76.34	-17.7	-19.6	26.19	2.67	109.4	0.64	Revised Fontes and Garnier, gas exchange, frxn factor = 0	0.6
EFP70	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.13109	--	2	76.34	-12.8	-13.5	51.38	3.89	52.2	3.83	Tamers, frxn factor = 1	3.9
EFP71	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.08173	--	0.4	76.34	-9.1	-8.9	31.8	1.26	32.5	1.23	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	1.3
EFP72	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	--	--	0.5	76.34	-11.2	-11.7	41.32	1.21	50.5	0.99	Tamers, frxn factor = 0	1.2
EFP73	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.0963	--	18	76.34	-9.4	-10.1	37.09	48.53	34.1	52.79	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	53
EFP74	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.03726	--	7	76.34	-8.8	-8.7	30.55	22.91	30.8	22.73	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	23
EFP75	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.15959	--	22	76.34	-10.2	-10.3	36.43	60.39	36.4	60.44	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	60
EFP76	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.13631	--	14	76.34	-8.5	-8.9	30.43	46.01	29.4	47.62	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	46
EFP77	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox	-0.12821	--	64.3	76.34	-11.2	-12.4	43.86	146.60	-2.9	-2,217.24	Revised Fontes and Garnier, gas exchange, frxn factor = 1	100
EFP78	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.13299	--	37	76.34	-14.8	-15.1	51.83	71.39	48	77.08	Revised Fontes and Garnier, gas exchange, frxn factor = 0	71
EFP80	EF27	C, Ca, Al, Mg, Na, Si, Fe, S, Redox, Cl	-0.10298	--	0.9	76.34	-10.2	-9.5	33.49	2.69	37.3	2.41	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	2.7
FV1	FV12	C, Ca, Al, Mg, Na, Si, Redox	-1.6483	--	52.94	47.5	-18.94	-17.3	43.37	122.07	85.8	61.70	Revised Fontes and Garnier, gas exchange, frxn factor = 1	122
FV2	FV12	C, Ca, Al, Mg, Na, Si, Redox, Cl	-7.876	--	26.50	81.4	-15.03	-13.3	55.81	47.49	51.1	51.87	Tamers, frxn factor=1	47
FV3	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-0.9125	--	55.45	81.4	-17.81	-17.7	76.73	72.26	64.1	86.50	Revised Fontes and Garnier, gas exchange, frxn factor = 0	86
FV4	FV12	C, Ca, Al, Mg, Na, Si, Redox	--	--	69.17	81.4	-20.73	-20.4	81.59	84.78	77.4	89.37	Revised Fontes and Garnier, gas exchange, frxn factor = 0	90
FV5	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-0.6329	--	46.71	47.5	-18.56	-17.2	42.32	110.38	62.5	74.74	Revised Fontes and Garnier, gas exchange, frxn factor = 1	110
FV6	FV12	C, Ca, Al, Mg, Na, Si, Redox	-2.768	--	36.29	81.4	-17.55	-18.4	70.31	51.61	54.5	66.58	Revised Fontes and Garnier, gas exchange, frxn factor = 1	52
FV7	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	--	--	49.89	47.5	-19.28	-19.9	47.57	104.88	82.6	60.40	Revised Fontes and Garnier, gas exchange, frxn factor = 1	105
FV8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FV9	FV12	C, Ca, Al, Mg, Na, Si, Redox, Cl, Fe	-3.2248	--	53.75	47.5	-19.03	-18.2	47.57	113.00	88.1	61.01	Revised Fontes and Garnier, gas exchange, frxn factor = 1	61
FV10	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	--	--	70.61	47.5	-19.04	-18.3	45.25	156.03	69.6	101.44	Revised Fontes and Garnier, gas exchange, frxn factor = 0	101
FV11	FV12	C, Ca, Al, Mg, Na, Si, Redox	-2.8059	--	48.68	47.5	-19.04	-17.3	47.86	101.71	94.4	51.57	Revised Fontes and Garnier, gas exchange, frxn factor = 1	102
FV12		RECHARGE WATER	--	--	81.43	81.4	-21.32	--	--	--	80.1	101.66	Revised Fontes and Garnier, gas exchange, frxn factor = 0	102
FV13	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-1.85	--	56.05	47.5	-19.56	-19.3	47.64	117.65	77	72.79	Revised Fontes and Garnier, gas exchange, frxn factor = 1	118
FV14	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-1.0157		57.70	47.5	-20.22	-20	47.5	121.48	68.9	83.75	Revised Fontes and Garnier, gas exchange, frxn factor = 1	121
FV15	FV12	C, Ca, Al, Mg, Na, Si, Redox	-0.1136	--	6.88	81.4	-12.77	-9.7	43.29	15.89	51.1	13.46	Tamers, frxn factor=1	16
FV16	--	--	--	--	109.83	--	--	--	--	--	--	--	--	110
FV17	FV12	C, Ca, Al, Mg, Na, Cl, Si, K, Redox	-11.952	0.0015	35.20	47.5	-21.06	-20.5	47.75	73.72	169	20.83	Revised Fontes and Garnier, gas exchange, frxn factor = 1	74
FV18	--	--	--	--	98.89	--	-21.79	--	--	--	83.2	118.86	Revised Fontes and Garnier, gas exchange, frxn factor = 0	119
FV19	FV12	C, Ca, Al, Mg, Na, Si, Redox	-7.9897	--	15.65	81.4	-9.18	-9.5	48.36	32.35	34.5	45.35	Tamers, frxn factor=1	32
FV20	FV12	C, Ca, Al, Mg, Na, Si, Redox	-4.1626	--	48.63	81.4	-18.43	-17.4	66.52	73.10	79.4	61.25	Revised Fontes and Garnier, gas exchange, frxn factor = 1	73
FV21	FV12	C, Ca, Al, Mg, Na, Cl, Si, K, Redox	0.0912	0.0141	55.66	47.5	-20.43	-21.2	58.7	94.82	76.1	73.14	Revised Fontes and Garnier, gas exchange, frxn factor = 0	95
FV22	FV12	C, Ca, Al, Mg, Na, Si, Redox	-3.896	--	46.72	47.5	-16.88	-17	43.59	107.18	63.6	73.46	Tamers, frxn factor=1	107
FV23	FV12	C, Ca, Al, Mg, Na, Si, Redox	-5.2467	--	40.05	47.5	-16.27	-16.6	45.13	88.74	55.1	72.68	Tamers, frxn factor=1	89
FV24	FV12	C, Ca, Al, Mg, Na, Si, Redox	-5.9577	--	1.82	81.4	-14.45	-17.5	82.07	2.22	50.7	3.59	Tamers, frxn factor=1	2.2
FV25	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-0.04644	--	47.55	47.5	-16.96	-19.7	44.76	106.24	87.6	54.29	Tamers, frxn factor=1	106
FV26	FV12	C, Ca, Al, Mg, Na, Si, Redox	-6.4935	--	46.31	47.5	-19.96	-19.5	47.65	97.18	135	34.30	Revised Fontes and Garnier, gas exchange, frxn factor = 1	97
FV27	--	--	--	--	106.21	--	--	--	--	--	--	--	--	106
FV28	--	--	--	--	91.06	--	--	--	--	--	83.8	108.66	Revised Fontes and Garnier, gas exchange, frxn factor = 0	109
FV29	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-0.04598	--	59.86	47.5	-20.18	-22.2	68.89	86.89	75.4	79.39	Revised Fontes and Garnier, gas exchange, frxn factor = 0	87
FV30	FV12	C, Ca, Al, Mg, Na, Si, Fe, Redox	-0.7956	--	55.46	47.5	-15.64	-18.8	55.94	99.14	50.3	110.26	--	99
HV1	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-3.27961	--	12.75	79.11	-18	-18.9	79.2	16.10	116.9	10.91	Revised Fontes and Garnier, gas exchange, frxn factor = 1	16
HV2	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.82223	--	11.39	79.11	-11.42	-12	41.69	27.32	50.2	22.69	Tamers, frxn factor = 0	27
HV3	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.82282	--	0.16	79.11	-2.2	-3.1	14.19	1.13	5.5	2.91	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	1.1
HV4	HV19	--	--	--	50.51	--	--	--	--	--	64.2	78.68	Revised Fontes and Garnier, gas exchange, frxn factor = 0	79
HV5	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.64416	--	9.84	79.11	-10	-10	40.75	24.15	37.5	26.24	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	24
HV6	HV19	--	--	--	62.76	--	--	--	--	--	80	78.45	Revised Fontes and Garnier, gas exchange, frxn factor = 0	78
HV7	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.80564	--	3.37	79.11	-5.2	-5.7	20.56	16.39	18.2	18.52	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	16
HV8	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.71295	--	14.35	79.11	-12.9	-12.1	58.13	24.69	50.7	28.30	Tamers, frxn factor = 1	25
HV9	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.3204	--	65.41	79.11	-17.2	-17.8	74.03	88.36	60	109.02	Revised Fontes and Garnier, gas exchange, frxn factor = 0	88
HV10	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	--	--	59.51	79.11	-18.1	-17.9	57.58	103.35	85.3	69.77	Revised Fontes and Garnier, gas exchange, frxn factor = 1	70
HV11	HV19	--	--	--	76.60	--	--	--	--	--	86.3	88.76	Revised Fontes and Garnier, gas exchange, frxn factor = 0	89

[a]Positive value for dissolution and negative value for precipitation.

[mmol/kg, millimoles per kilogram of water]

Table S10. Carbon-14 corrections based on NETPATH and other correction models. Corrected carbon-14 concentrations were used in TracerLPM to date groundwater.[41]

						NETPATH carbon-14 correction					Other carbon-14 correction models			TracerLPM input
Modeled (final) well	Initial well	Constraints	SiO_2	Illite	^{14}C measured (pmc)	Ao	$\delta^{13}C$ measured	$\delta^{13}C$ modeled	^{14}C corrected initial	^{14}C corrected final	^{14}C corrected initial	^{14}C corrected final	Correction model	Preferred ^{14}C corrected final
HV12	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-0.80178	--	1.28	79.11	-9.8	-9.9	35.03	3.65	36.7	3.49	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	3.6
HV13	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.82066	--	16.47	79.11	-13	-12.9	44.83	36.74	50.2	32.81	Tamers, frxn factor = 0	37
HV14	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-0.30144	--	40.79	79.11	-17.1	-16.5	62.52	65.24	88	46.35	Revised Fontes and Garnier, gas exchange, frxn factor = 1	65
HV15	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.82812	--	2.03	79.11	-9.1	-9.5	31.94	6.36	33.8	6.01	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	6.0
HV16	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.82183	--	0.52	79.11	-1.4	-1.8	3.47	14.99	2.3	22.61	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	15
HV17	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.32302	--	48.73	79.11	-15.6	-14.8	52.17	93.41	63.8	76.38	Revised Fontes and Garnier, gas exchange, frxn factor = 1	93
HV18	HV19	C, Ca, Mg, Na, Si, Fe, Redox, Cl, S	-0.76501	--	8.89	79.11	-12.1	-12.1	42.35	20.99	50.7	17.53	Tamers, frxn factor = 1	21
HV19		RECHARGE WATER	--	--	79.11	--	--	--	--	--	72.9	108.52	Revised Fontes and Garnier, gas exchange, frxn factor = 0	109
HV20	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	--	--	93.13	--	--	--	--	--	77.3	120.48	Revised Fontes and Garnier, gas exchange, frxn factor = 1	120
HV21	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.77855	--	0.36	79.11	-10.5	-11.6	43.88	0.82	51	0.71	Tamers, frxn factor = 1	1
HV22	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.69548	--	15.18	79.11	-14.6	-14.2	60.42	25.12	70.3	21.59	Revised Fontes and Garnier, gas exchange, frxn factor = 1	25
HV23	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.79344	--	0.33	79.11	-4.2	-4.1	12.78	2.58	13.4	2.46	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	2.6
HV24	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-4.68913	--	43.36	79.11	-17	-18.1	65.5	66.20	91	47.65	Revised Fontes and Garnier, gas exchange, frxn factor = 1	48
HV25	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.82791	--	0.53	79.11	-5.8	-6.2	15.58	3.40	20.3	2.61	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	3.4
HV26	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.81871	--	0.53	79.11	-10.4	-10.9	38.14	1.39	39.2	1.35	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	1.4
HV27	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.75747	--	3.76	79.11	-14.2	-13.2	49.09	7.66	50.4	7.46	Tamers, frxn factor = 0	7.5
HV28	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.64369	--	0.55	79.11	-9.2	-9.2	33.67	1.63	34.3	1.60	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	1.6
HV29	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.79892	--	0.75	79.11	-1.7	-2.3	1.41	53.19	3.9	19.23	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	53
HV30	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.80797	--	0.15	79.11	-5.2	-5.6	18.76	0.80	17.8	0.84	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	0.8
HVP21	HV19	--	--	--	103	--	--	--	--	--	86.4	119.21	Revised Fontes and Garnier, gas exchange, frxn factor = 0	119
HVP25	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-0.22891	--	61.7	79.11	-18.1	-18.1	67.48	91.43	73.2	84.29	Revised Fontes and Garnier, gas exchange, frxn factor = 1	91
HVP27	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.80279	--	3.5	79.11	-14.5	-13.1	54.08	6.47	74.3	4.71	Revised Fontes and Garnier, gas exchange, frxn factor = 0	6.5
HVP88	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.77204	--	0.15	79.11	-11.4	-10.8	22.95	0.65	50.2	0.30	Tamers, frxn factor = 0	0.6
HVP89	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.76577	--	1.5	79.11	-17.1	-18.8	41.42	3.62	99.1	1.51	Revised Fontes and Garnier, gas exchange, frxn factor = 0	1.5
HVP90	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-0.77855		8	79.11	-14.8	-14	51.08	15.66	58.8	13.61	Revised Fontes and Garnier, gas exchange, frxn factor = 1	16
HVP91	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-2.08274	--	17.3	79.11	-19.2	-19.1	68.15	25.39	100.4	17.23	Revised Fontes and Garnier, gas exchange, frxn factor = 1	25
HVP93	HV19	--	--	--	62.8	--	--	--	--	--	80	78.50	Revised Fontes and Garnier, gas exchange, frxn factor = 0	78
HVP94	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-0.77918	--	1.9	79.11	-10.2	-10.1	32.81	5.79	38.2	4.97	Revised Fontes and Garnier, Solid exchange, frxn factor = 1	5.8
HVP95	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, S	-0.75593	--	6.7	79.11	-12	-12.1	47.66	14.06	51	13.14	Tamers, frxn factor = 1	14
HVP96	HV19	C, Ca, Al, Mg, Na, Si, Fe, Redox, Cl, S	-0.81698	--	0.34	79.11	-6.8	-7	23.13	1.47	24.2	1.40	Revised Fontes and Garnier, Solid exchange, frxn factor = 0	1.5
HVP98	HV19	--	--	--	15.2	--	--	--	--	--	101.8	14.93	Revised Fontes and Garnier, gas exchange, frxn factor = 1	15

[a]Positive value for dissolution and negative value for precipitation.
[mmol/kg, millimoles per kilogram of water]