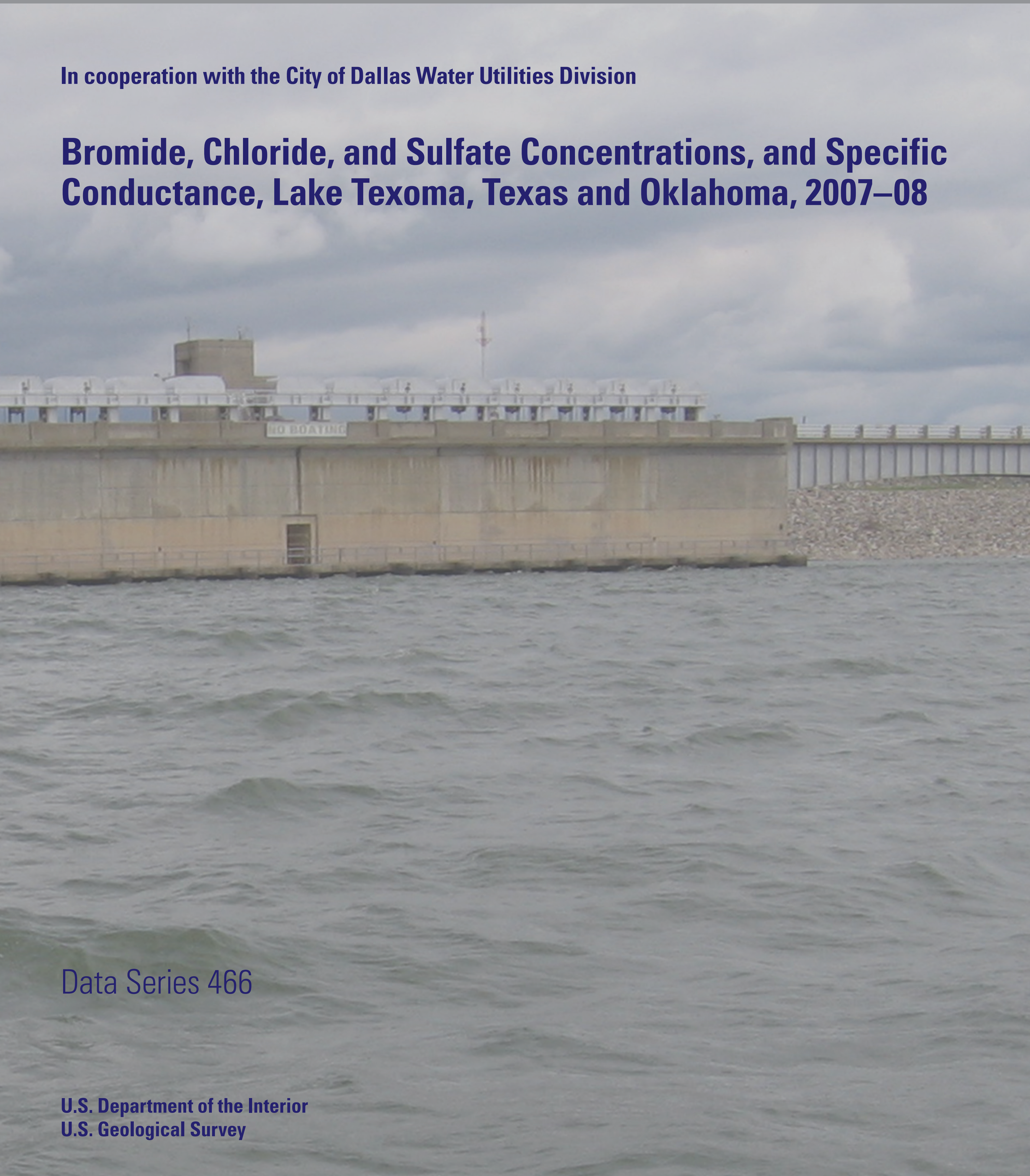
USGS
science for a changing world

In cooperation with the City of Dallas Water Utilities Division

Bromide, Chloride, and Sulfate Concentrations, and Specific Conductance, Lake Texoma, Texas and Oklahoma, 2007–08



Data Series 466

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

Front and back cover: Lake Texoma near Lake Texoma Dam near Denison, Texas (photograph by Dana A. Blanchette, U.S. Geological Survey).

Bromide, Chloride, and Sulfate Concentrations, and Specific Conductance, Lake Texoma, Texas and Oklahoma, 2007–08

By Stanley Baldys III

In cooperation with the City of Dallas Water Utilities Division

Data Series 466

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

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

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2009

This and other USGS information products are available at http://store.usgs.gov/
U.S. Geological Survey
Box 25286, Denver Federal Center
Denver, CO 80225

To learn about the USGS and its information products visit http://www.usgs.gov/
1-888-ASK-USGS

Suggested citation:
Baldys, Stanley, III, 2009, Bromide, chloride, and sulfate concentrations, and specific conductance, Lake Texoma, Texas and Oklahoma, 2007–08: U.S. Geological Survey Data Series 466, 30 p.

Contents

Figures

Tables

Conversion Factors, Datums, and Water-Quality Units

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.4047	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

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

$$°F=(1.8\times°C)+32$$

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

$$°C=(°F-32)/1.8$$

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (μS/cm).

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Water-Quality Units

cfu/100 mL, colony-forming units per 100 milliliters

μS/cm, microsiemens per centimeter at 25 degrees Celsius at 25 °C

mg/L, milligrams per liter

MPN/100 mL, most-probable number per 100 milliliters

psu, practical salinity units

Blank Page

Bromide, Chloride, and Sulfate Concentrations, and Specific Conductance, Lake Texoma, Texas and Oklahoma, 2007–08

By Stanley Baldys III

Abstract

The U.S. Geological Survey, in cooperation with the City of Dallas Water Utilities Division, collected water-quality data from 11 sites on Lake Texoma, a reservoir on the Texas-Oklahoma border, during April 2007–September 2008. At 10 of the sites, physical properties (depth, specific conductance, pH, temperature, dissolved oxygen, and alkalinity) were measured and samples were collected for analysis of selected dissolved constituents (bromide, calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, and sulfate); at one site, only physical properties were measured. The primary constituent of interest was bromide. Bromate can form when ozone is used to disinfect raw water containing bromide, and bromate is a suspected human carcinogen. Chloride and sulfate were of secondary interest. Only the analytical results for bromide, chloride, sulfate, and measured specific conductance are discussed in this report. Median dissolved bromide concentrations ranged from 0.28 to 0.60 milligram per liter. The largest median dissolved bromide concentration (0.60 milligram per liter at site 11) was from the Red River arm of Lake Texoma. Dissolved bromide concentrations generally were larger in the Red River arm of Lake Texoma than in the Washita arm of the lake. Median dissolved chloride concentrations were largest in the Red River arm of Lake Texoma at site 11 (431 milligrams per liter) and smallest at site 8 (122 milligrams per liter) in the Washita arm. At site 11 in the Red River arm, the mean and median chloride concentrations exceeded the secondary maximum contaminant level of 300 milligrams per liter for chloride established by the "Texas Surface Water Quality Standards" for surface-water bodies designated for public water supply use. Median dissolved sulfate concentrations ranged from 182 milligrams per liter at site 4 in the Big Mineral arm to 246 milligrams per liter at site 11 in the Red River arm. None of the mean or median sulfate concentrations exceeded the secondary maximum contaminant level of 300 milligrams per liter. Median specific conductance measurements at sites ranged from 1,120 microsiemens per centimeter at site 8 in the Washita arm to 2,100 microsiemens per centimeter in the Red River arm. The spatial distribution of specific conductance in Lake Texoma was similar to that of bromide and chloride, with larger specific conductance values in the Red River arm compared to those in the Washita arm.

Introduction

Lake Texoma, a reservoir on the Texas-Oklahoma border about 5 miles northwest of Denison, Tex. (fig. 1), provides municipal water supply, hydropower, flood control, and recreational opportunity. The lake was formed by an impoundment of the Red and Washita Rivers in 1944. Lake Texoma has been characterized as slightly saline with salinity (dissolved solids concentration) of 1,000 to 3,000 milligrams per liter (mg/L) (Mabe, 2002). Salinity-related constituents (bromide, chloride, and sulfate in this report) occur naturally in the semiarid Red and Washita River Basins upstream from Lake Texoma because of salt springs. Salinity of the lake could potentially be affected by anthropogenic activities as well. A reverse osmosis plant at Wichita Falls, Tex., began operation in 2008 and will be discharging as much as 3 million gallons per day of brine (dissolved solids concentration more than 35,000 mg/L) into the Wichita River, a major tributary to the Red River upstream from Lake Texoma (Daniel K. Nix, City of Wichita Falls Public Utilities Operations Manager, oral commun., 2009).

Little information is available regarding bromide concentrations in Lake Texoma. Disinfection by-products can form from the naturally occurring bromide in the lake water. Bromide is readily oxidized to bromate when raw water is disinfected for municipal supply using ozone, and bromate is a suspected human carcinogen (U.S. Environmental Protection Agency, 2006). The conversion of bromide to bromate during ozonation is influenced by factors such as the concentration of dissolved bromide, pH of the source water, and reaction time of ozone used to disinfect the water (State of New York, Department of Health, 2006). Bromate concentration is regulated in drinking water by the Texas Commission on Environmental Quality with a maximum contaminant level of 0.01 mg/L (Texas Administrative Code, 2009).

Elevated concentrations of other salinity-related constituents have been measured in Lake Texoma (Atkinson and

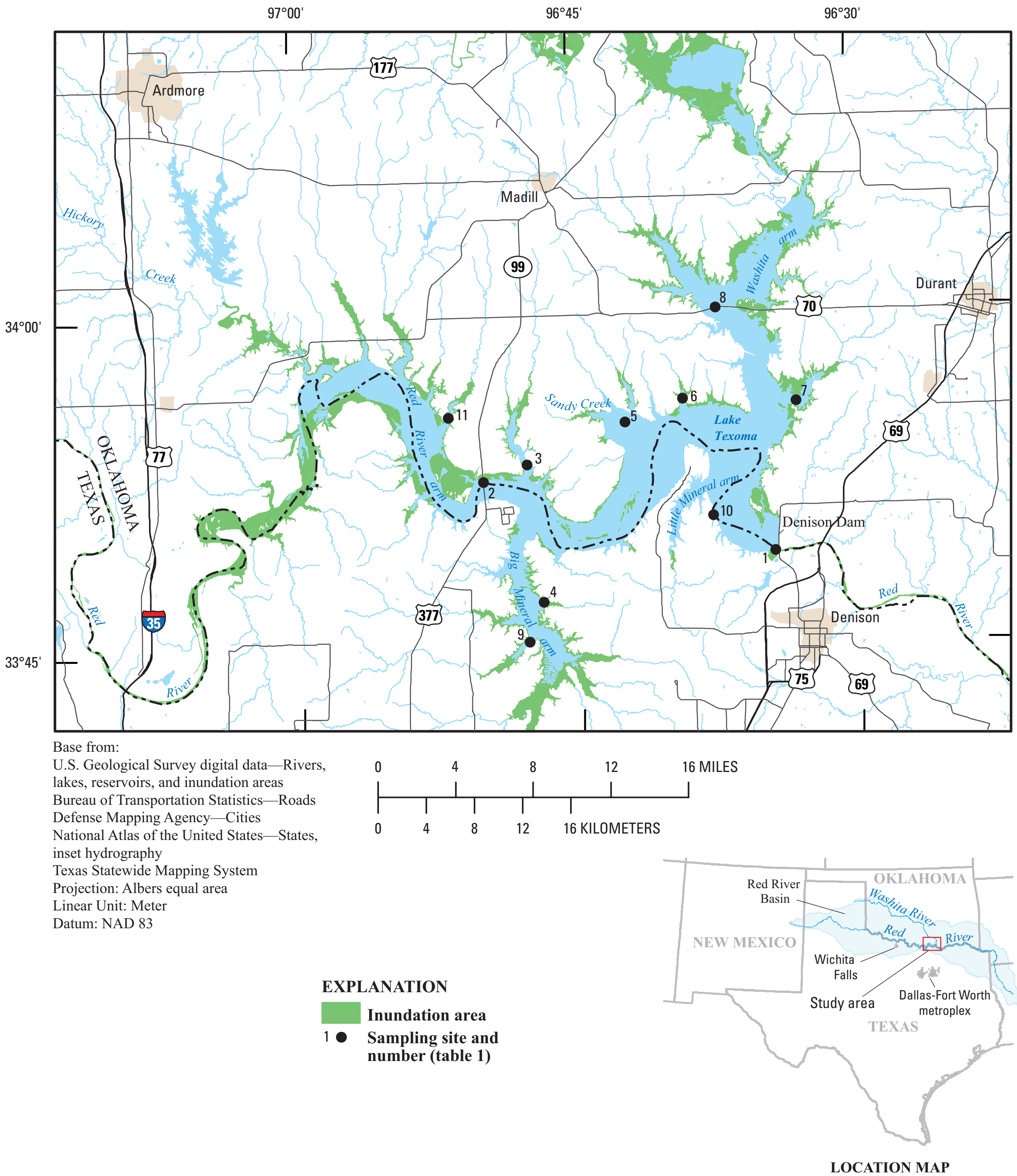


Figure 1. Location of sampling sites on Lake Texoma in Texas and Oklahoma, 2007–08.

others, 1999); for example chloride and sulfate concentrations at times have exceeded applicable secondary maximum contaminant levels of the “Texas Surface Water Quality Standards” for drinking water (Texas Commission on Environmental Quality, 2003). The U.S. Geological Survey (USGS), in cooperation with the City of Dallas Water Utilities Division, sampled and analyzed Lake Texoma water during 2007–08 to characterize the water quality, essentially to document a present-day benchmark of lake water quality.

Purpose and Scope

This report describes bromide, chloride, and sulfate concentrations and specific conductance for Lake Texoma in Texas and Oklahoma during April 2007–September 2008 during six lake surveys. This report also documents the techniques used to collect and analyze water-quality samples during the six lake surveys. Samples were collected at 11 sites. At 10 sites, physical properties (depth, specific conductance, pH, temperature, dissolved oxygen, and alkalinity) were measured and samples were collected for analysis of selected dissolved constituents (bromide, calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, and sulfate); at one site, only physical properties were measured.

The primary constituent of interest was bromide; chloride and sulfate were of secondary interest. Only the analytical results for bromide, chloride, sulfate, and measured specific conductance are discussed in this report. The spatial and temporal variability of bromide, chloride, sulfate, and specific conductance are described using summary statistics and boxplots. Differences in bromide, chloride, and sulfate concentrations and specific conductance measured near the top and bottom of the water column at each site also are discussed. The data were insufficient to compute separate summary statistics for samples collected at the top and bottom of the lake at the various sampling sites. Results for chloride and sulfate are compared to applicable secondary maximum contaminant levels (secondary criteria established by “Texas Surface Water Quality Standards” for surface-water bodies designated for public water supply use [Texas Commission on Environmental Quality, 2003]). A large inflow during July 2007 that resulted in water flowing over the spillway for 11 days provided an opportunity to assess changes in water quality in Lake Texoma caused by a flood.

Description of Study Area

Lake Texoma is formed by Denison Dam and impounds water of the Red and Washita Rivers at their confluence (fig. 1). Lake Texoma is a major water resource for Texas and Oklahoma; the U.S. Army Corps of Engineers (2009) ranks Lake Texoma as the twelfth largest reservoir in the United States in volume. It is also one of the most popular Federal recreation facilities in the country, with more than 6 million visitors annually (U.S. Army Corps of Engineers, 2009).

The surface area of Lake Texoma varies from 89,000 acres (elevation 617.25 feet above NAVD 88) at the top of the normal power-generating pool to 143,000 acres (elevation 640 feet above NAVD 88) at the top of the flood-control pool (U.S. Army Corps of Engineers, 2009). The Red River predominately drains watersheds in Texas, whereas the Washita River predominately drains watersheds in Oklahoma. The combined drainage-basin area of the Red and Washita Rivers is 39,720 square miles, of which 5,936 square miles are noncontributing (U.S. Geological Survey, 2009).

The Red River Basin upstream from Lake Texoma (upper Red River Basin), which includes the Washita River Basin, is characterized by extended periods of drought interrupted by occasional floods (Benke and Cushing, 2005). Average annual rainfall increases appreciably across the basins from about 15 inches near the Texas-New Mexico border to about 38 inches at Denison (National Weather Service Weather Forecast Center, Dallas/Fort Worth, 2009). The land-surface features of the Red River Basin vary from the nearly level prairie and farmland in the western part of the watersheds to gently rolling plains and prairie in the immediate Lake Texoma area.

Salt springs in the upper reaches of the upper Red River Basin discharge saline water to the tributaries to Lake Texoma (Keller and others, 1988). Mabe (2002, p. 7) noted other investigators’ findings that “marine evaporite salt (sodium chloride) deposits in the Red River Basin strongly influence the ionic composition of Lake Texoma (Ground and Groeger, 1994) and make chloride the predominate anion (Atkinson and others, 1999).” Runoff from rainfall on the upper Red River Basin along with discharges from salt springs in the upper reaches of the Red River Basin provides highly variable inflows to Lake Texoma. Benke and Cushing (2005, p. 301) provides a description of the hydrology of the Red River:

> The upper [parts] of all forks [of the Red River] have unpredictable flow. The main stem is subject to extended periods of “no flow” and pooling up as far downstream as Burkburnett, Tex. Downstream [from] the forks it is a perennial, wide, shallow, sand-mud-bed river, with discharge that varies greatly. The Red River main stem can rise rapidly after heavy rains and produce extreme flooding. The water quality of Red River above Lake Texoma reflects the harsh arid country of the Red River Basin and is characterized by extremely high salinity. Tributaries [to the Red River upstream from Lake Texoma] in Oklahoma flow through a large gypsum region, resulting in inputs of sulfate to the river . . . water quality in the inflows to Lake Texoma can vary substantially depending on flow conditions.

Methods

All physical properties were measured at 10-foot increments throughout the water column starting 1 foot below the lake surface until reaching the lake bottom, with the deepest specific conductance recorded at a depth of 1 ft above the lake bed regardless of the depth of the previous point of measurement. All constituent concentrations represent the amount occurring in the dissolved phase. For each site, constituents were analyzed in samples collected near the top of the water column (1 foot below the water surface) and near the bottom of the water column (1 foot above the lake bed). Differences in concentrations near the top and bottom of the water column were compared by subtracting the concentration near the bottom of the water column from the concentration near the top of the water column.

Description of Sampling Sites

Sampling sites (fig. 1; table 1) were selected throughout Lake Texoma by personnel from the City of Dallas Water Utilities Division and the USGS. Site 1 is near the main intake site for the Denison Dam structure where electrical power is generated and water is released downstream. Site 2 is a composite indicator site for water entering Lake Texoma from the Red River on the submerged former thalweg of the Red River under the bridge at U.S. Highway 377. Sites 3–4 and 6–7 are near the mouths of tributaries to Lake Texoma. Site 5 is in a small cove that receives inflow from Sandy Creek, midway between the Red River arm and the Washita arm. Site 8 is in the Washita arm on the submerged former thalweg of the Washita River and the primary indicator of inflow from the Washita River Basin. Site 9 (physical properties only) is a shallow site in the Big Mineral arm of Lake Texoma; depth there was less than 10 feet. Site 10 is near the Little Mineral arm of Lake Texoma. Site 11 is in the western part of Lake Texoma; it is the farthest west of all sites.

Sample Collection

Physical properties (specific conductance, pH, temperature, dissolved oxygen, and alkalinity) were measured at each site using a multiprobe sonde that was calibrated to standards certified by the USGS National Water Quality Laboratory (NWQL) in Denver, Colo. Field measurements were allowed to stabilize before data were recorded. Water depth readings were made using a Secchi disk and tape measure.

Water for samples was withdrawn from Lake Texoma by a centrifugal pump attached to a hose that moved water to a chamber where a multiprobe sonde was located. Discrete samples were withdrawn from an outlet hose attached to the chamber using a peristaltic pump and filtered onsite using a 0.45-micrometer filter. Samples collected for the analyses of calcium, potassium, magnesium, and sodium were preserved by adding nitric acid to reduce the pH to less than 2. All sample-collection methods were in accordance with the “National Field Manual for the Collection of Water-Quality Data” (U.S. Geological Survey, variously dated).

Lake Surveys

Lake Texoma was evaluated for water-quality characteristics during six lake surveys, three of which were completed in spring and summer 2007 and three of which were completed in spring and summer 2008. Samples for the first lake survey in April 2007 were collected and physical properties were measured at sites 1–8; at site 9 only physical properties were measured. After review of the data from the first survey, sites 10 and 11 were added; during the remaining five surveys all sites were sampled and properties were measured except at site 9, where only properties were measured. Most surveys were done in consecutive 2-day periods except for the May 20–23, 2008, survey, which lasted 4 days because of inclement weather (table 1). For sites 1–8, twelve concentrations were obtained for each water-quality constituent, and for sites 11 and 12, ten concentrations for each water-quality constituent.

The six lake surveys were done at pool elevations ranging from 616.5 feet (September 23–24, 2008) to 620.3 feet (June 19–20, 2007) above NAVD 88, close to the normal power-generating pool elevation, 617.25 feet above NAVD 88 (fig. 2). In response to widespread flooding in the Red River Basin during July 2007, inflows to Lake Texoma were large enough to result in water running over the spillway during July 7–17. The peak lake elevation during the study was 640.7 ft above NAVD 88 on July 12, 2007, which occurred between the June and September 2007 lake surveys. All data from the lake surveys, including results for quality-control samples, are in the USGS National Water Information System (NWISWeb) (U.S. Geological Survey, 2009).

Laboratory Analytical Methods

Water samples were sent to the NWQL for analysis. For the constituents of interest, the analytical methods used were ion chromatography for dissolved bromide analysis and inductively coupled plasma with mass spectrophotometry for chloride and sulfate analyses (Fishman and Friedman, 1989; Fishman, 1993).

Quality Assurance

Quality-assurance procedures outlined in the “National Field Manual for the Collection of Water-Quality Data” (U.S. Geological Survey, variously dated) were followed for collecting and processing water-quality samples. Quality-control samples were collected to evaluate potential bias, variability, or contamination introduced during sample collection, processing, or laboratory analysis. Samples of the deionized water used to clean sampling equipment were periodically submitted to the NWQL as field-equipment blanks and analyzed for selected constituents. One field-equipment blank was collected on December 4, 2007, between the September 2007 and May 2008 lake surveys and analyzed for bromide;

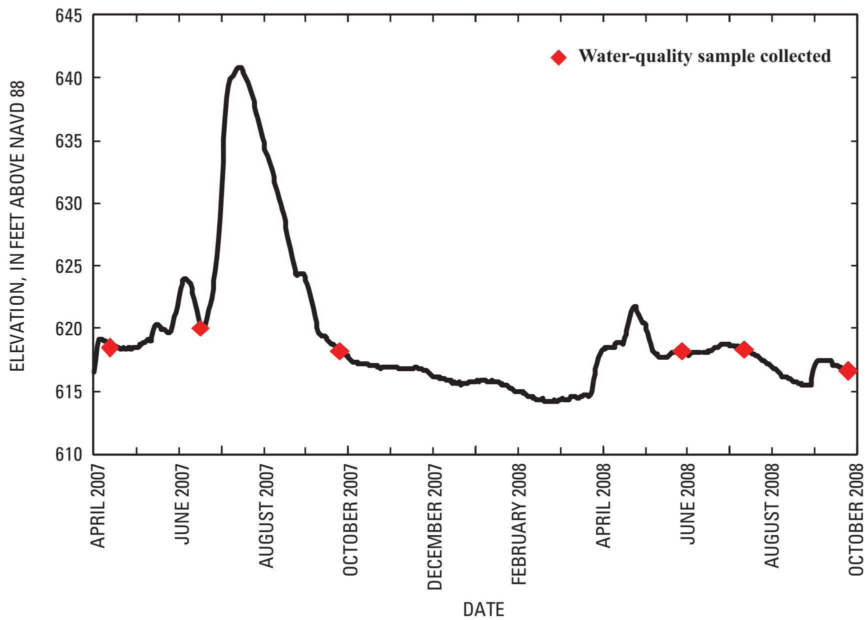


Figure 2. Hydrograph showing daily mean elevation, Lake Texoma in Texas and Oklahoma, April 2007–September 2008.

Table 1. Description of sampling sites on Lake Texoma in Texas and Oklahoma, 2007–08.

[USGS, U.S. Geological Survey; ddmm, degrees minutes]

Sampling site number (fig. 1)	USGS station name	USGS station number	Latitude (ddmm)	Longitude (ddmm)	Reference name	Lake survey[1] in which data collected
1	Lake Texoma near Lake Texoma Dam near Denison, Tex.	334910096342700	33° 49.168'	96° 34.450'	Lake Texoma Dam	1–6
2	Lake Texoma at Highway 377 Bridge near Shay, Okla.	335233096500200	33° 52.555'	96° 50.033'	Highway 377 Bridge	1–6
3	Lake Texoma near Buncombe Creek near Shay, Okla.	335316096474000	33° 53.259'	96° 47.667'	Buncombe Creek	1–6
4	Lake Texoma near Scott Branch near Gordonville, Tex.	334706096465800	33° 47.105'	96° 46.961'	Scott Branch	1–6
5	Lake Texoma near Rock Creek near McBride, Okla.	335504096422100	33° 55.065'	96° 42.358'	Rock Creek	1–6
6	Lake Texoma near McLaughlin Creek near McBride, Okla.	335603096391300	33° 56.042'	96° 39.209'	McLaughin Creek	1–6
7	Lake Texoma near Moore Creek near Platter, Okla.	335550096330700	33° 55.831'	96° 33.115'	Moore Creek	1–6
8	Lake Texoma at Highway 70 Bridge near Little City, Okla.	340005096371800	34° 00.078'	96° 37.308'	Highway 70 Bridge	1–6
9	Lake Texoma near Sandy Creek near Gordonville, Tex.[2]	334521096474700	33° 45.357´	96° 47.787'	Sandy Creek	1–6
10	Lake Texoma at intake structure near Fink, Tex.	335048096374300	33° 50.80'	96° 37.710'	N TX MWD intake	2–6
11	Lake Texoma near tributary near Willis, Okla.	335527096515000	33° 55.45'	96° 51.840'	Red River inflow	2–6

[1] Lake surveys: (1) April 25–26, 2007; (2) June 19–20, 2007; (3) September 26–27, 2007; (4) May 20–23, 2008; (5) July 1–2, 2008; (6) September 23–24, 2008.

[2] Physical properties only at site 9.

the bromide concentration was less than the laboratory reporting level of 0.02 mg/L. Chloride, sulfate, and specific conductance were not analyzed in the December 4, 2007, field-equipment blank. Additional field-equipment blanks were collected on June 19 and July 1, 2008. The field-equipment blank on June 19, 2008, also was analyzed for bromide, and the bromide concentration was less than the laboratory reporting level of 0.02 mg/L. The field-equipment blank collected on July 3, 2008, was analyzed for bromide, chloride, sulfate, and specific conductance. For the July 3, 2008, field-equipment blank, bromide, chloride, and sulfate were all less than their respective laboratory reporting levels of 0.02, 0.12, and 0.18 mg/L, and specific conductance was less than the laboratory reporting level of 8 microsiemens per centimeter at 25 degrees Celsius (µS/cm).

One replicate sample was collected July 1, 2008, at site 7 at a depth of 1 foot below the water surface and was analyzed for the same properties and constituents as the concurrent environmental sample. Bromide, chloride, sulfate, and specific conductance from the replicate and concurrent environmental sample agreed within 5 percent (appendix 1). Major-ion data also were evaluated for each environmental sample to ensure the cation-anion balances were consistently within 5 percent.

Bromide

Bromide concentrations ranged from 0.14 mg/L on June 19, 2007, at site 8 in the Washita arm of the lake to 0.65 mg/L on September 24, 2008, at site 11 in the Red River arm of the lake (table 2; appendix 1). Bromide concentrations in the Red River arm of Lake Texoma generally were larger than bromide concentrations in the Washita arm of Lake Texoma (fig. 3).

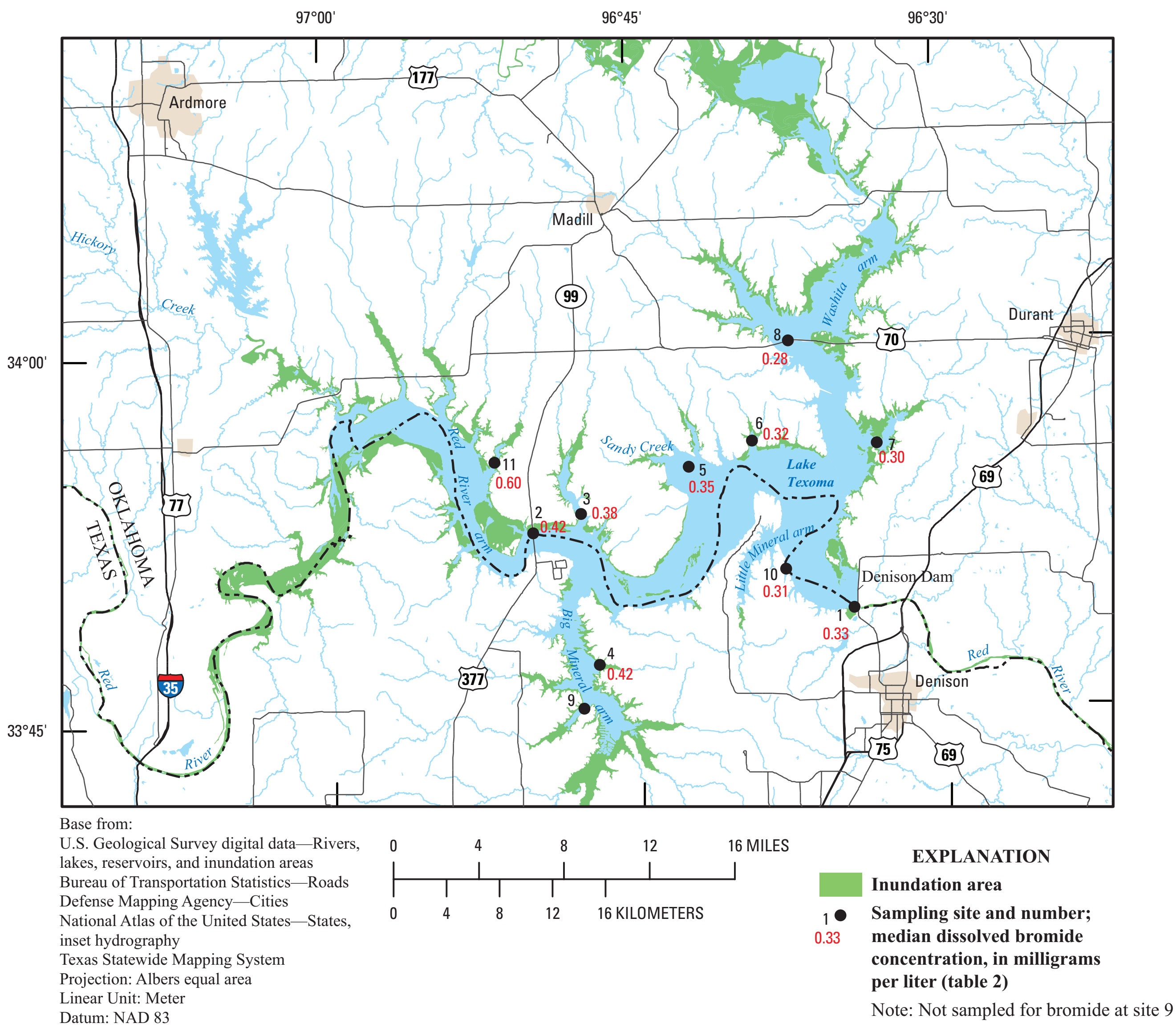


Figure 3. Median bromide concentrations for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

Table 2. Selected statistics for bromide concentrations for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

[In milligrams per liter; --, not applicable]

Sampling site number (fig. 1)	Reference name	Sample size	Maximum	Minimum	Mean	Median
1	Lake Texoma Dam	12	0.47	0.20	0.34	0.33
2	Highway 377 Bridge	12	.58	.32	.43	.42
3	Buncombe Creek	12	.42	.27	.37	.38
4	Scott Branch	12	.47	.16	.36	.42
5	Rock Creek	12	.47	.24	.35	.35
6	McLaughin Creek	12	.47	.21	.32	.32
7	Moore Creek	12	.45	.18	.31	.31
8	Highway 70 Bridge	12	.36	.14	.26	.28
9	Sandy Creek	--	--	--	--	--
10	N TX MWD intake	10	.46	.20	.31	.31
11	Red River inflow	10	.65	.32	.55	.60

The largest median bromide concentration was 0.60 mg/L at site 11, and the second-largest median bromide concentration (0.42 mg/L) was at two sites—site 2 in the submerged former thalweg of the Red River channel under the U.S. Highway 377 bridge and site 4 in the Big Mineral arm of Lake Texoma (fig. 3). The smallest median concentrations of bromide (0.28 to 0.33 mg/L) were at sites 1, 6, 7, 8, and 10 in the eastern part of Lake Texoma. For site 3 where a tributary joins Lake Texoma and site 5 midway between the Red River and Washita arms of the lake, median bromide concentrations were 0.38 and 0.35 mg/L, respectively.

Boxplots show the distribution of bromide concentrations by site in figure 4. Except for two low-range outliers of 0.32 and 0.33 mg/L on June 20, 2007, concentrations of bromide were consistently larger at site 11 compared to those at the other sites. The interquartile range (difference between the 75th and 25th percentile values) was smallest for site 11, indicating that except for the outliers, bromide concentrations at site 11 were less variable compared to those at the other sites.

Concentrations of bromide were smaller for the September 2007 lake survey compared to those for the April and June 2007 lake surveys at the five sites closest to Denison Dam (sites 1, 5, 6, 7, and 10) and at site 8 in the Washita arm of Lake Texoma (appendix 1). The bromide concentrations at the shallow inflow site on the Red River (site 11) on September 26, 2007, after the large inflow in July 2007 were 0.59 mg/L near the top of the water column and 0.56 mg/L near the bottom of the water column. In contrast, the bromide concentrations at site 11 on June 20, 2007, before the large inflow in July were 0.32 mg/L near the top and 0.33 mg/L near the bottom.

Differences in bromide concentrations near the top and bottom of the water column were within a range of -0.05 to +0.05 mg/L in 47 of the 58 pairs of samples collected during the six lake surveys, indicating that the concentration of bromide generally did not vary appreciably with depth (appendix 1). Bromide concentrations near the top and bottom of the water column at sites 2 and 8 were the most variable; of the six pairs of bromide concentrations at each of these sites, three had differences in concentration that exceeded a range of -0.05 to +0.05 mg/L. Of the 58 pairs of sample concentrations near the top and bottom of the water column, there were 11 pairs for which the bromide concentration at the bottom of the water column exceeded the bromide concentration at the top of the water column by an amount greater than 0.05 mg/L. There were no pairs for which the concentration near the bottom of the water column was less than the concentration near the top of the water column by an amount greater than 0.05 mg/L (fig. 3; appendix 1).

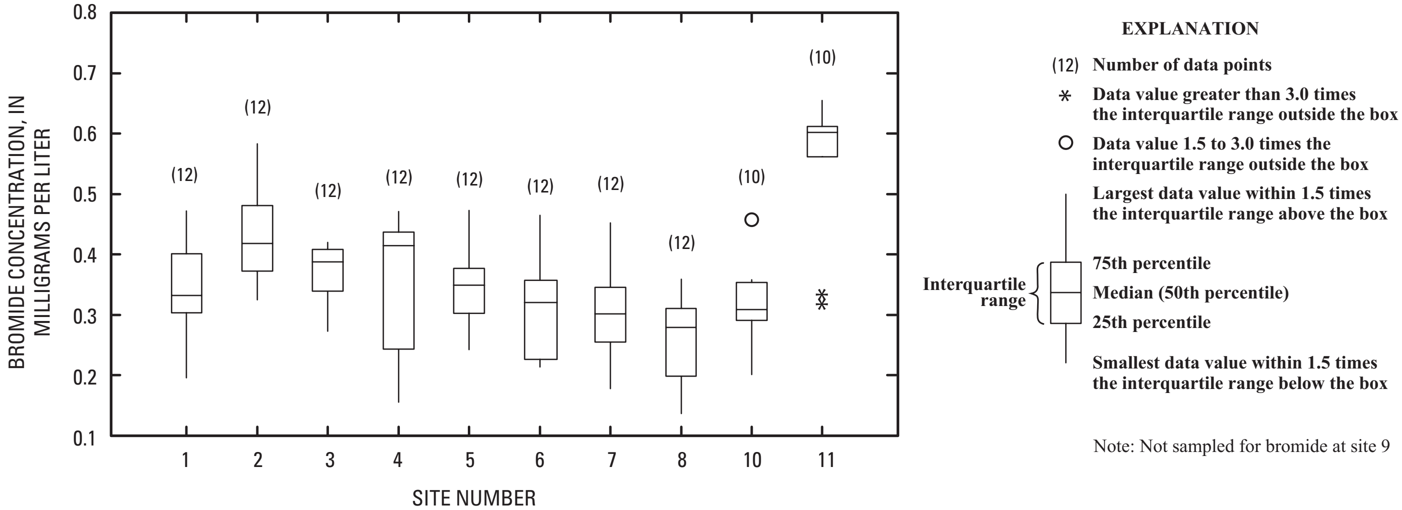


Figure 4. Boxplots showing bromide concentrations by sampling site in Lake Texoma in Texas and Oklahoma, 2007–08.

Chloride

The concentration of chloride ranged from 48.0 mg/L at site 8 in the Washita arm of the lake to 1,070 mg/L at site 11 in the Red River arm of lake (table 3; appendix 1). The smallest and largest median chloride concentrations also were at site 8 (122 mg/L) and at site 11 (431 mg/L), respectively (fig. 5). The second-largest median chloride concentration was at site 2 (278 mg/L). The spatial distribution of median chloride concentrations was similar to the spatial distribution of median bromide concentrations; median chloride concentrations in the Red River arm of Lake Texoma generally were larger than median chloride concentrations in the Washita arm of Lake Texoma (fig. 5).

Boxplots in figure 6 show the distribution of chloride concentrations at each site. Although the interquartile range (difference between the 75th and 25th percentile value) was larger at sites 1, 2, and 5 compared to that for all other sites, the overall range of chloride concentrations was larger at site 11 (266 to 1,070 mg/L). The second-largest range in chloride concentrations was at site 2 (206 to 782 mg/L).

Comparing chloride concentrations before and after the large inflow during July 2007, concentrations were smaller during the September 2007 lake survey compared to those during the June 2007 survey at all sampling sites except at site 11 (appendix 1); this site serves as the primary indicator of inflow from the Red River Basin. At site 11, the mean and median chloride concentrations exceeded the secondary maximum contaminant level of 300 mg/L for chloride established by the "Texas Surface Water Quality Standards" for surface-water bodies designated for public water supply use (Texas Commission on Environmental Quality, 2003). The mean chloride concentration at site 2 also exceeded the secondary maximum contaminant level. None of the mean or median chloride concentrations at the remaining sites exceeded the secondary maximum contaminant level.

Differences in chloride concentrations near the top and bottom of the water column ranged from 41 mg/L at site 8 during the September 2008 survey to -530 mg/L at site 2 also during the September 2008 survey. The chloride concentration at site 2 during the September 2008 survey varied greatly with depth, ranging from 252 mg/L in the sample collected near the top of the water column to 782 mg/L in the sample collected near the bottom of the water column. Differences in chloride concentrations near the top and bottom of the water column were within a range of -30 to +30 mg/L in 44 of the 58 sample pairs, indicating that in general the concentration of chloride did not vary appreciable with depth. Of the 58 sample pairs, there was one pair for which the chloride concentration near the bottom of the water column was less than the concentration near the top of the water column by an amount greater than 30 mg/L. In contrast there were 13 sample pairs for which the chloride concentration near the bottom of the water column exceeded the concentration near the top of the water column by an amount greater than 30 mg/L. Sites 2 and 8 had the most variability; differences in chloride concentrations for four of the six sample pairs at each site exceeded the range of -30 to +30 mg/L (appendix 1).

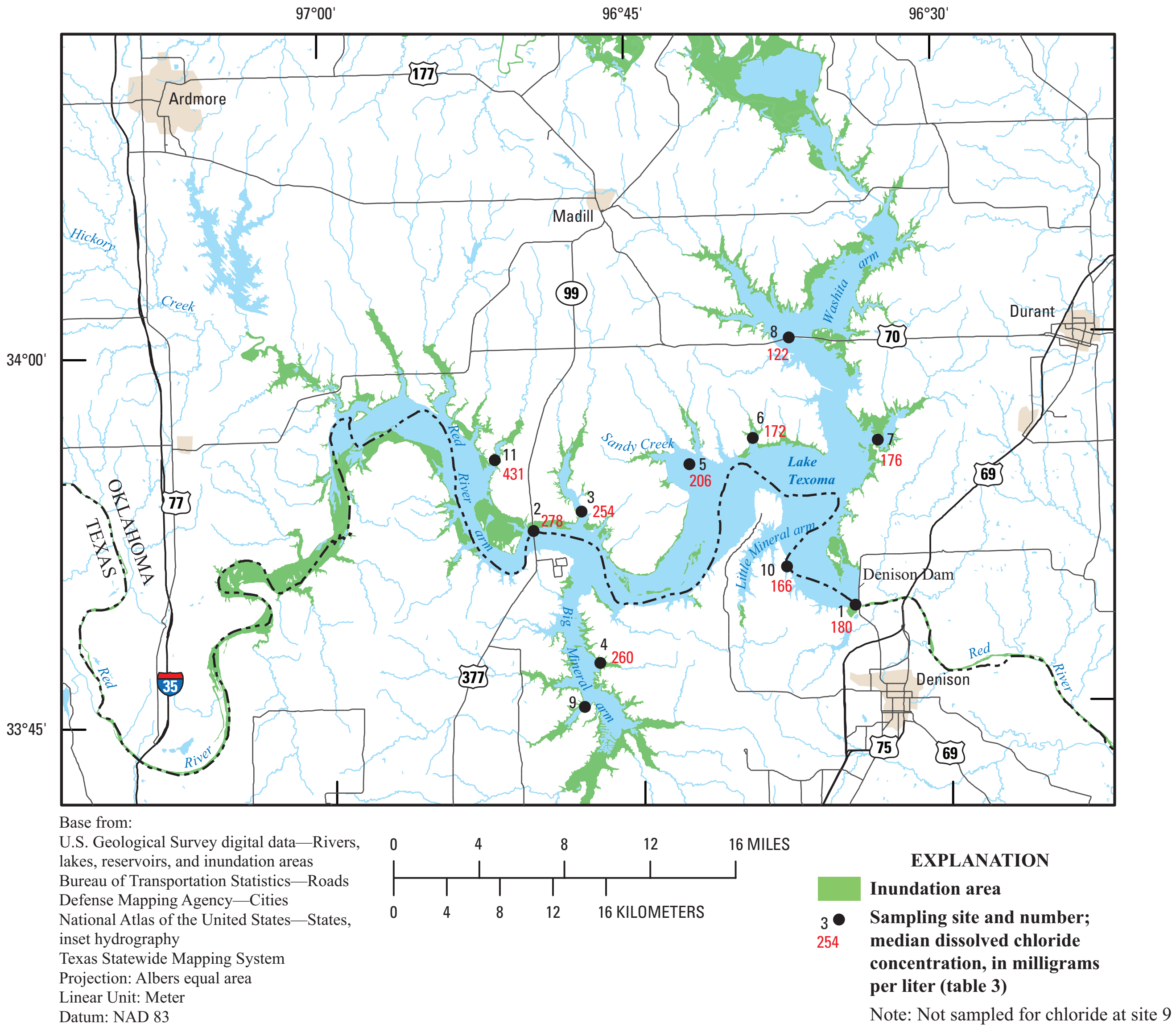


Figure 5. Median chloride concentrations for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

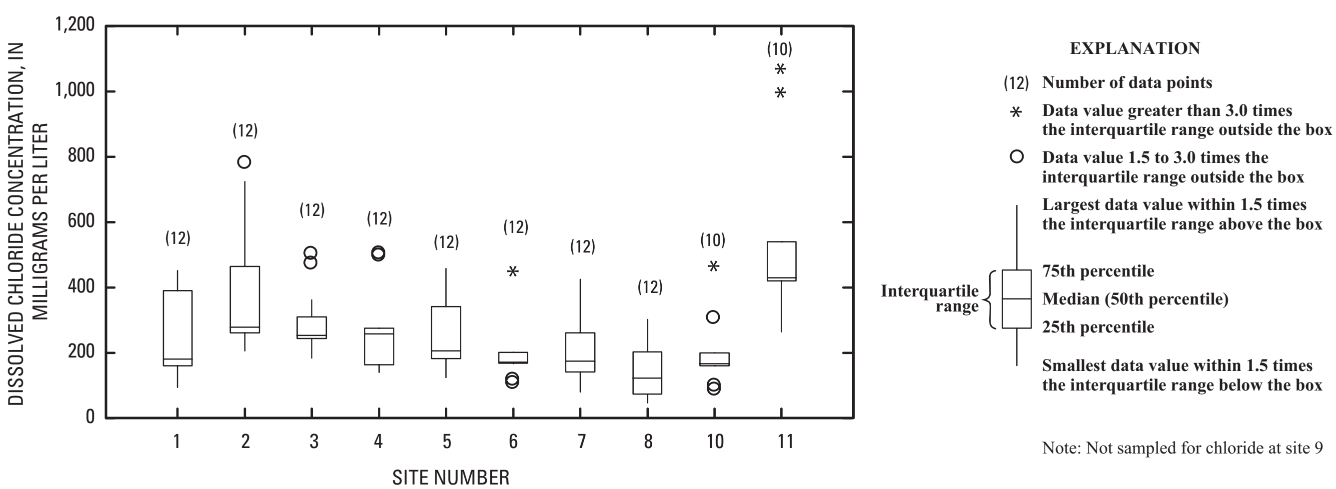


Figure 6. Boxplots showing chloride concentrations by sampling site in Lake Texoma in Texas and Oklahoma, 2007–08.

Table 3. Selected statistics for chloride concentrations for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

[In milligrams per liter; --, not applicable]

Sampling site number (fig. 1)	Reference name	Sample size	Maximum	Minimum	Mean	Median
1	Lake Texoma Dam	12	452	94.8	243	180
2	Highway 377 Bridge	12	782	206	386	278
3	Buncombe Creek	12	500	184	291	254
4	Scott Branch	12	505	141	267	260
5	Rock Creek	12	458	125	253	206
6	McLaughin Creek	12	451	107	214	172
7	Moore Creek	12	426	81.1	209	176
8	Highway 70 Bridge	12	303	48.0	145	122
9	Sandy Creek	--	--	--	--	--
10	N TX MWD intake	10	471	91.6	202	166
11	Red River inflow	10	1,070	266	538	431

Sulfate

The concentration of sulfate ranged from 86.1 mg/L at site 4 in the Big Mineral arm on September 27, 2007, to 494 mg/L at site 11 in the Red River arm on September 23, 2008 (table 4; appendix 1). Median dissolved sulfate concentrations ranged from 182 mg/L at site 4 to 246 mg/L at site 11 (fig. 7). In contrast to the spatial distributions of median bromide and chloride concentrations, for which concentrations were higher in the Red River arm of Lake Texoma than in the Washita arm, the spatial distribution of median sulfate concentrations shows similar concentrations in the Red River and Washita arms.

Boxplots showing the distribution of sulfate concentrations (fig. 8) indicate that overall, sulfate concentrations were slightly larger at site 11 compared to those at other sites, although sulfate concentrations were generally similar at most sites. At seven of the 10 sites where sulfate concentrations were measured, median sulfate concentrations were within a small range from 209 to 216 mg/L.

Comparing sulfate concentrations before and after the large inflow during July 2007, concentrations were smaller during the September 2007 lake survey compared to those during the June 2007 survey at all sampling sites except at site 8 (primary indicator of inflow from the Washita River Basin) and site 11 (farthest west site in the Red River Basin) (appendix 1). None of the mean or median sulfate concentrations exceeded the secondary maximum contaminant level of 300 mg/L for sulfate (Texas Commission on Environmental Quality, 2003).

Differences in sulfate concentrations near the top and bottom of the water column ranged from 31 mg/L at site 8 during the July 2008 lake survey to -169 mg/L at site 2 during the September 2008 lake survey. The sulfate concentration at site 3 during the September 2008 lake survey was 213 mg/L near the top of the water column and 382 mg/L near the bottom of the water column. Similar to the results for chloride concentrations, sulfate concentrations near the top and bottom of the water column differed only slightly, within a range from -30 to +30 mg/L in 44 of the 58 sample pairs. Of the 58 sample pairs, there was one pair for which the sulfate concentration near the bottom of the water column was less than the concentration near the top of the water column by an amount greater than 30 mg/L. In contrast there were 13 sample pairs for which the sulfate concentration near the bottom of the water column exceeded the concentration near the top of the water column by an amount greater than 30 mg/L. Sites 2 and 8 had the most variability; differences in sulfate concentrations for four of the six sample pairs at each site exceeded the range of -30 to +30 mg/L (appendix 1).

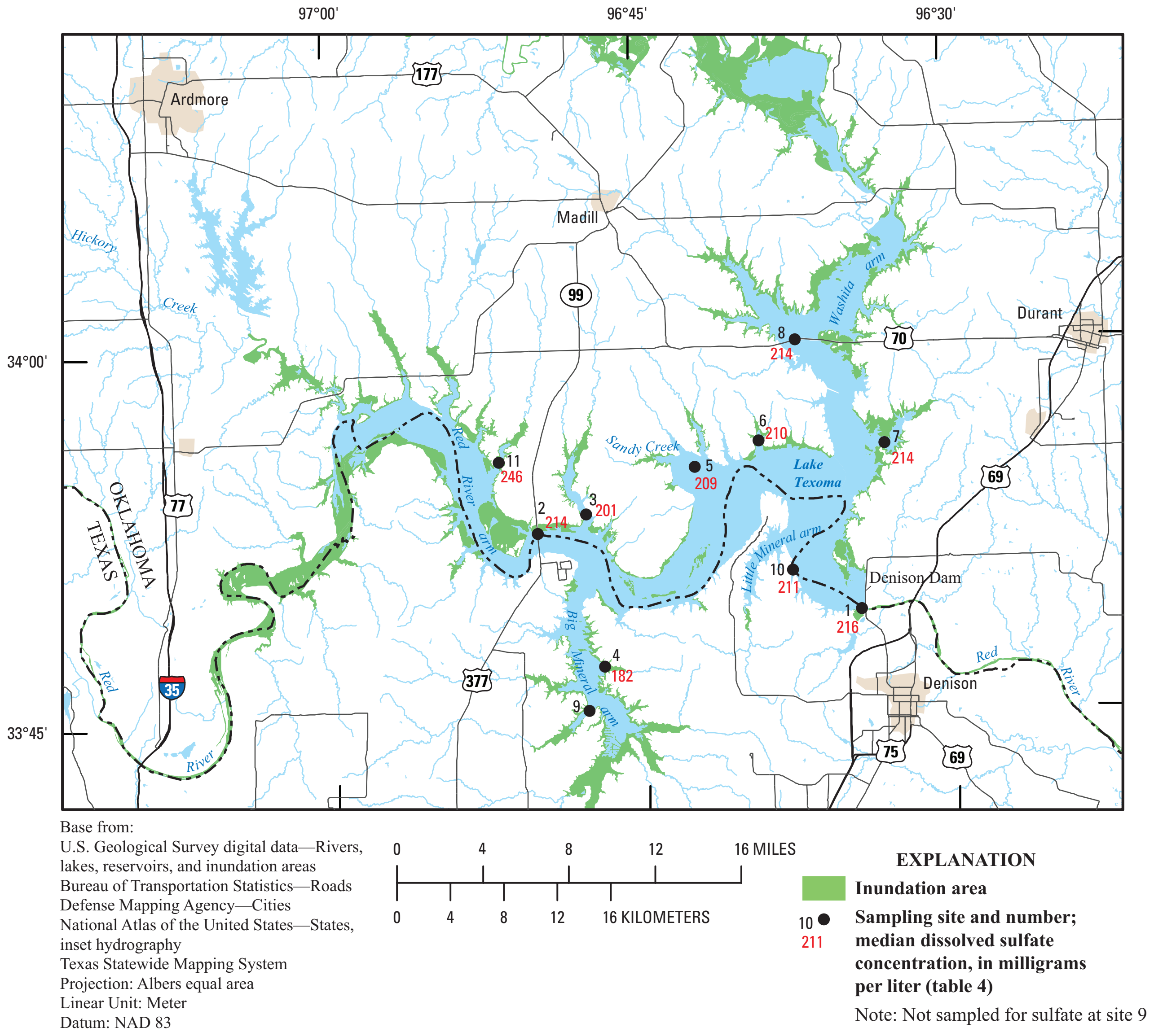


Figure 7. Median sulfate concentrations for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

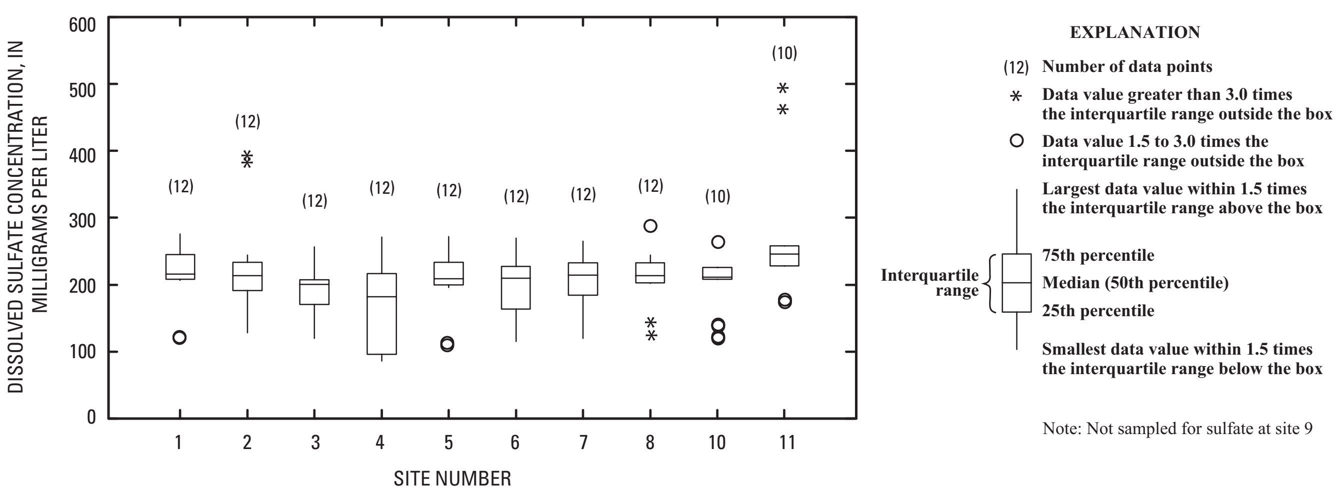


Figure 8. Boxplots showing sulfate concentrations by sampling site in Lake Texoma in Texas and Oklahoma, 2007–08.

Table 4. Selected statistics for sulfate concentrations for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

[In milligrams per liter; --, not applicable]

Sampling site number (fig. 1)	Reference name	Sample size	Maximum	Minimum	Mean	Median
1	Lake Texoma Dam	12	276	121	214	216
2	Highway 377 Bridge	12	391	128	232	214
3	Buncombe Creek	12	256	120	191	201
4	Scott Branch	12	271	86.1	172	182
5	Rock Creek	12	272	110	206	209
6	McLaughin Creek	12	269	115	199	210
7	Moore Creek	12	265	120	206	214
8	Highway 70 Bridge	12	287	124	210	214
9	Sandy Creek	--	--	--	--	--
10	N TX MWD intake	10	265	121	203	211
11	Red River inflow	10	494	172	277	246

Specific Conductance

Specific conductance ranged from 668 µS/cm at site 8 on June 19, 2007, to 4,210 µS/cm at site 11 on September 23, 2008 (table 5; appendix 1). Median specific conductance ranged from 1,120 µS/cm at site 8 to 2,100 µS/cm at site 11 (fig. 9). The spatial distribution of median specific conductance in Lake Texoma was similar to the spatial distribution of bromide and chloride, with larger specific conductance values in the Red River arm compared to those in the Washita arm. Boxplots showing the distribution of specific conductance values (fig. 10) indicate that specific conductance generally was larger at site 11 compared to that at other sites.

Comparing specific conductance values before and after the large inflow during July 2007, specific conductance values were smaller during the September 2007 lake survey compared to those during the June 2007 survey at all sampling sites except at sites 9 and 11. Runoff associated with storms typically has lower specific conductance values compared to base flow (Pilgrim and others, 1979).

Differences in specific conductance near the top and bottom of the water column ranged from 490 µS/cm at site 9 during the May 2008 lake survey to -2,020 µS/cm at site 2 during the September 2008 lake survey. The specific conductance at site 2 during the September 2008 lake survey was 1,430 µS/cm near the top of the water column and 3,450 µS/cm near the bottom of the water column. For most sites, specific conductance measurements remained fairly constant within each vertical profile; 46 of the 64 pairs of specific conductance values near the top and bottom of the water column differed only slightly, between a range of -70 to +70 µS/cm.

Specific conductance values generally increased slightly with depth. Of the 64 pairs of specific conductance values, there was one pair for which the specific conductance value near the bottom of the water column was less than the specific conductance value near the top of the water column by an amount greater than 70 µS/cm. There were 17 pairs of specific conductance values for which the specific conductance near the bottom of the water column exceeded the specific conductance near the top of the water column by an amount greater than 70 µS/cm.

Sites 2 and 8 had the most variability in specific conductance values; differences in specific conductance values near the top and bottom of the water column for four of the six pairs of specific conductance values at each site were greater than 70 µS/cm. Specific conductance varied considerably with depth at some sites on only a few occasions. For example, during the June 2007 lake survey, the mean specific conductance at site 7 was 1,440 µS/cm, and specific conductance near the bottom of the water column was 560 µS/cm greater than the specific conductance near the top of the water column. During the five other lake surveys at site 7, the difference in specific conductance values near the top and bottom of the water column varied between +20 and -50 µS/cm (appendix 1).

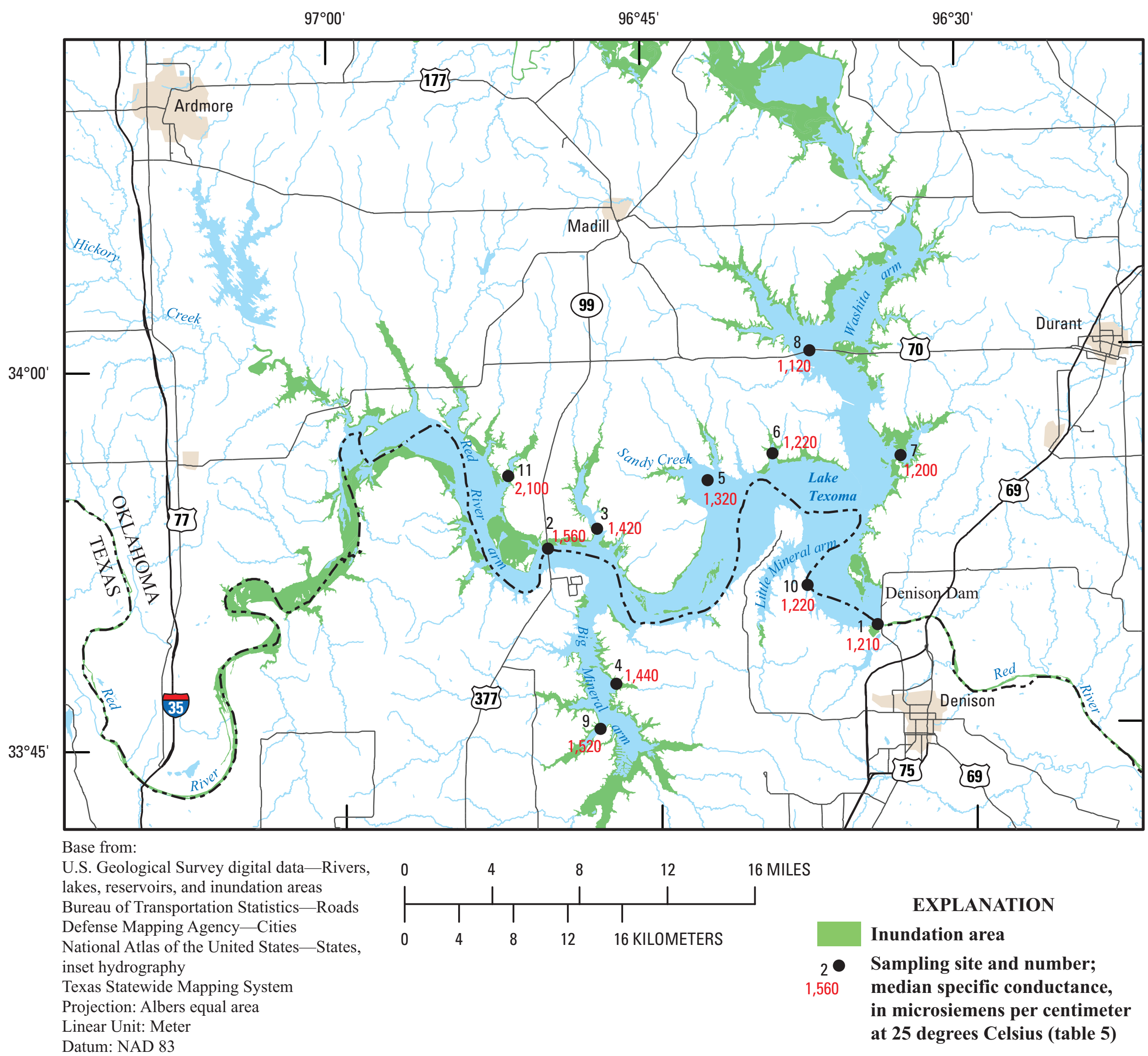


Figure 9. Median specific conductance values for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

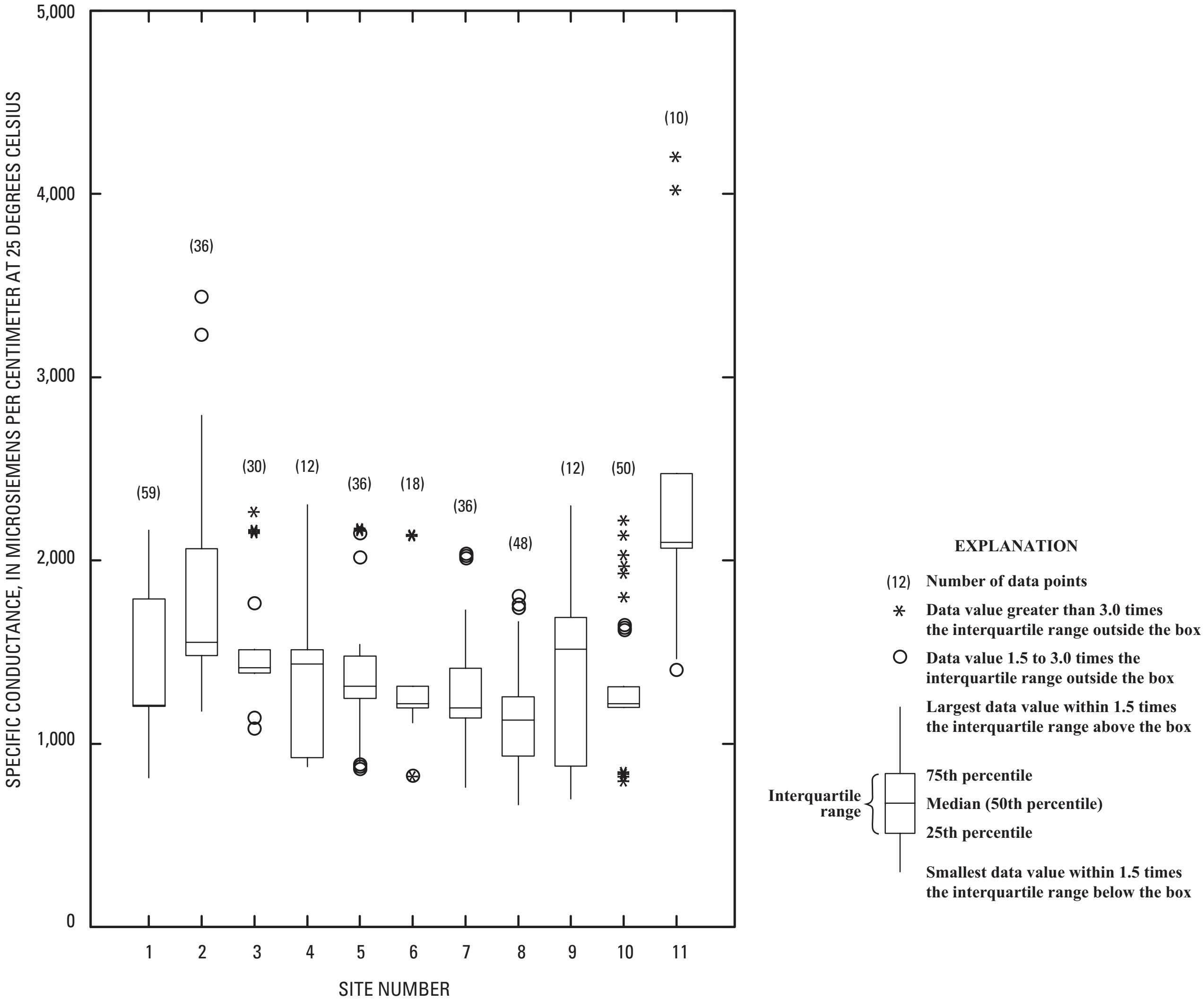


Figure 10. Boxplots showing specific conductance values by sampling site in Lake Texoma in Texas and Oklahoma, 2007–08.

Table 5. Selected statistics for specific conductance values for sampling sites in Lake Texoma in Texas and Oklahoma, 2007–08.

[In microsiemens per centimeter at 25 degrees Celsius]

Sampling site number (fig. 1)	Reference name	Sample size	Maximum	Minimum	Mean	Median
1	Lake Texoma Dam	59	2,170	815	1,420	1,210
2	Highway 377 Bridge	36	3,450	1,180	1,780	1,560
3	Buncombe Creek	30	2,270	1,100	1,520	1,420
4	Scott Branch	12	2,300	874	1,420	1,440
5	Rock Creek	36	2,190	878	1,420	1,320
6	McLaughin Creek	18	2,150	834	1,320	1,220
7	Moore Creek	36	2,050	762	1,310	1,200
8	Highway 70 Bridge	48	1,820	668	1,140	1,120
9	Sandy Creek	12	2,300	699	1,410	1,520
10	N TX MWD intake	50	2,220	810	1,290	1,220
11	Red River inflow	10	4,210	1,420	2,440	2,100

Summary

The U.S. Geological Survey, in cooperation with the City of Dallas Water Utilities Division, collected water-quality data from 11 sites on Lake Texoma, a reservoir on the Texas-Oklahoma border, during April 2007–September 2008. At 10 sites, physical properties (depth, specific conductance, pH, temperature, dissolved oxygen, and alkalinity) were measured and samples were collected for analysis of selected dissolved constituents (bromide, calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, and sulfate); at one site, only physical properties were measured. The primary constituent of interest was bromide. Bromate can form when ozone is used to disinfect raw water containing bromide, and bromate is a suspected human carcinogen. Chloride and sulfate were of secondary interest. Only the analytical results for bromide, chloride, sulfate, and measured specific conductance are discussed in this report.

Physical properties were measured at 10-foot increments throughout the water column at each site. Constituent concentrations were analyzed in samples collected near the top of the water column (1 foot below the water surface) and near the bottom of the water column (1 foot above the lake bed) to assess how water quality varied with depth.

Median dissolved bromide concentrations ranged from 0.28 to 0.60 mg/L. The largest median dissolved bromide concentration (0.60 mg/L at site 11) was from the Red River arm of Lake Texoma. Dissolved bromide concentrations generally were larger in the Red River arm of Lake Texoma than in the Washita arm of the lake. Differences in bromide concentrations from near the top and bottom of the water column were within a range of -0.05 to +0.05 mg/L in 47 of the 58 pairs of samples collected during the six lake surveys, indicating that the concentration of bromide generally did not vary appreciably with depth.

Median dissolved chloride concentrations were largest in the Red River arm of Lake Texoma at site 11 (431 mg/L) and smallest at site 8 (122 mg/L) in the Washita arm of the lake. Differences in chloride concentrations from near the top and bottom of the water column were within a range of -30 to +30 mg/L in 44 of the 58 pairs of samples collected during the six lake surveys, indicating that in general the concentration of chloride did not vary appreciably with depth. At site 11 in the Red River arm, the mean and median chloride concentrations exceeded the secondary maximum contaminant level of 300 mg/L for chloride established by the “Texas Surface Water Quality Standards” for surface-water bodies designated for public water supply use. The mean chloride concentration at site 2 in the Red River arm also exceeded the secondary maximum contaminant level. None of the mean or median chloride concentrations at the remaining sites exceeded the secondary maximum contaminant level.

Median dissolved sulfate concentrations ranged from 182 mg/L at site 4 in the Big Mineral arm to 246 mg/L at site 11 in the Red River arm. In contrast to the spatial distributions of median bromide and chloride concentrations, for which concentrations were higher in the Red River arm than in the Washita arm, the spatial distribution of median sulfate concentrations shows similar concentrations in the Red River and Washita arms. At seven of the 10 sites where sulfate concentrations were measured, the median sulfate concentrations were within a small range, from 209 to 216 mg/L. Similar to the results for chloride, 44 of the 58 pairs of sulfate concentrations from near the top and bottom of the water column differed only slightly, within a range from -30 to +30 mg/L. None of the mean or median sulfate concentrations exceeded the secondary maximum contaminant level of 300 mg/L.

Median specific conductance measurements ranged from 1,120 μS/cm at site 8 in the Washita arm to 2,100 μS/cm at site 11 in the Red River arm. The spatial distribution of median specific conductance in Lake Texoma was similar to the spatial distribution of bromide and chloride, with larger specific conductance values in the Red River arm compared to those in the Washita arm. For most sites, specific conductance measurements remained fairly constant within each vertical profile.

References Cited

Atkinson, S.F., Dickson, K.L., Waller, W.T., Ammann, L., Franks, J., Clyde, T., Gibbs, J., and Rolbiecki, D., 1999, A chemical, physical and biological water-quality survey of Lake Texoma—August 1996–September 1997 final report: Report to U.S. Army Corps of Engineers, Tulsa District, 2,113 p. [Prepared by Environmental Science Program, University of North Texas, Denton, Tex.]

Benke, A.C., and Cushing, C.E., eds., 2005, Rivers of North America: Academic Press, 1,144 p.

Ground, T.A., and Groeger, A.W., 1994, Chemical classification and trophic characteristics of Texas reservoirs: Lake and Reservoir Management, v. 10, p. 189–201.

Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93–125, 217 p.

Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Keller, Jack, Rawson, Jack, Grubb, Hubert, Kramer, Jackson, and Sullivan, Glenn, 1988, Report on the evaluation of the effectiveness of operation of area VIII Red River Chloride Control Project: Red River Chloride Control Project Report, 35 p.

Mabe, J.A., 2002, Water quality mapping on Lake Texoma, USA: Denton, Tex., University of North Texas, Master of

Science Thesis, 141 p., accessed June 11, 2009, at *http://digital.library.unt.edu/data/etd/2002_3/open/meta-dc-3332.tkl*

National Weather Service Weather Forecast Office, Dallas/Fort Worth, Texas, 2009, North Texas weather climate summary: accessed May 8, 2009, at *http://www.srh.noaa.gov/fwd/?n=ntxtrems*

Pilgrim, D.H., Huff, D.D., and Steele, T.D., 1979, Use of specific conductance and contact time relations for separating flow components in storm runoff: Water Resources Research, v. 15, no. 2, p. 329–339, accessed June 4, 2009, at *http://www.agu.org/journals/wr/v015/i002/WR015i002p00329/*.

State of New York, Department of Health, 2006, Information fact sheet—Bromate in drinking water: Troy, N.Y., 2 p., accessed May 2009 at *http://www.health.state.ny.us/environmental/water/drinking/docs/bromate_in_drinking_water.pdf*

Texas Administrative Code, 2009, Drinking water standards governing drinking water quality and reporting requirements for public water systems—Other disinfectant by-products (chlorite and bromate): Title 30, Part 1, Chapter 290, Subchapter F, Rule 290.114, accessed July 6, 2009, at *https://secure.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=290&rl=114*

Texas Commission on Environmental Quality, 2003, Guidance for assessing Texas surface and finished drinking water quality data, 2004: accessed August 11, 2008, at *http://www.tceq.state.tx.us/assets/public/compliance/monops/water/04twqi/04_guidance.pdf*

U.S. Army Corps of Engineers, 2009, History of Denison Dam and Lake Texoma: 16 p., accessed June 5, 2009, at *http://www.swt.usace.army.mil/recreat/laketexoma/webpagetexoma/historical/History%20of%20Lake%20Texoma/2008%20Update%20of%20History%20of%20Lake%20Area.pdf*

U.S. Environmental Protection Agency, 2006, National primary drinking water regulations—Stage 2 disinfectants and disinfection by-product rule: accessed May 2009 at *http://www.epa.gov/OGWDW/disinfection/stage2/*.

U.S. Geological Survey, 2009, National Water Information System (NWISWeb) [for Texas] data available on the World Wide Web: at *http://waterdata.usgs.gov/tx/nwis/nwis*

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9, available online at *http://pubs.water.usgs.gov/twri9A*

Appendix 1—Analytical Results for Bromide, Chloride, and Sulfate Concentrations and for Specific Conductance for all Water-Quality Samples Collected at Lake Texoma in Texas and Oklahoma, 2007–08

Blank Page

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008.

[Differences in constituent concentrations and specific conductance values obtained by subtracting concentration or value at greatest sampling depth at each site for a given sample collection date from concentration or value at 1-foot sampling depth. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not applicable]

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
1	4/25/2007	334910096342700	1	1	0.47	--	445	--	275	--	2,150	--
1	4/25/2007	334910096342700	1	10	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	20	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	30	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	40	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	50	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	60	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	70	--	--	--	--	--	--	2,150	--
1	4/25/2007	334910096342700	1	78	.47	0	452	-7	276	--	2,160	-10
1	4/25/2007	335233096500200	2	1	.40	--	477	--	244	--	2,200	--
1	4/25/2007	335233096500200	2	10	--	--	--	--	--	--	2,210	--
1	4/25/2007	335233096500200	2	20	--	--	--	--	--	--	2,240	--
1	4/25/2007	335233096500200	2	30	--	--	--	--	--	--	2,600	--
1	4/25/2007	335233096500200	2	40	--	--	--	--	--	--	2,790	--
1	4/25/2007	335233096500200	2	47	.58	-.18	724	-247	391	-147	3,240	-1,040
1	4/25/2007	335316096474000	3	1	.41	--	474	--	239	--	2,160	--
1	4/25/2007	335316096474000	3	10	--	--	--	--	--	--	2,170	--
1	4/25/2007	335316096474000	3	20	--	--	--	--	--	--	2,170	--
1	4/25/2007	335316096474000	3	30	--	--	--	--	--	--	2,180	--
1	4/25/2007	335316096474000	3	37	.42	-.01	500	-26	256	-17	2,270	-110
1	4/25/2007	334706096465800	4	1	.47	--	505	--	271	--	2,300	--
1	4/25/2007	334706096465800	4	10	.46	.01	504	1	270	1	2,300	0
1	4/26/2007	335504096422100	5	1	.46	--	454	--	268	--	2,170	--
1	4/26/2007	335504096422100	5	10	--	--	--	--	--	--	2,170	--
1	4/26/2007	335504096422100	5	20	--	--	--	--	--	--	2,170	--
1	4/26/2007	335504096422100	5	30	--	--	--	--	--	--	2,190	--
1	4/26/2007	335504096422100	5	40	--	--	--	--	--	--	2,180	--
1	4/26/2007	335504096422100	5	50	.47	-.01	458	-4	272	-4	2,180	-10
1	4/26/2007	335603096391300	6	1	.46	--	451	--	268	--	2,150	--
1	4/26/2007	335603096391300	6	10	--	--	--	--	--	--	2,140	--
1	4/26/2007	335603096391300	6	19	.47	-.01	447	4	269	--	2,140	10

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
1	4/26/2007	335550096330700	7	1	0.45	--	426	--	265	--	2,050	--
1	4/26/2007	335550096330700	7	10	--	--	--	--	--	--	2,050	--
1	4/26/2007	335550096330700	7	20	--	--	--	--	--	--	2,050	--
1	4/26/2007	335550096330700	7	30	--	--	--	--	--	--	2,040	--
1	4/26/2007	335550096330700	7	40	--	--	--	--	--	--	2,040	--
1	4/26/2007	335550096330700	7	52	.45	0	412	14	264	1	2,030	20
1	4/26/2007	340005096371800	8	1	.30	--	233	--	202	--	1,390	--
1	4/26/2007	340005096371800	8	10	--	--	--	--	--	--	1,390	--
1	4/26/2007	340005096371800	8	20	--	--	--	--	--	--	1,400	--
1	4/26/2007	340005096371800	8	30	--	--	--	--	--	--	1,510	--
1	4/26/2007	340005096371800	8	40	--	--	--	--	--	--	1,820	--
1	4/26/2007	340005096371800	8	50	--	--	--	--	--	--	1,760	--
1	4/26/2007	340005096371800	8	60	--	--	--	--	--	--	1,660	--
1	4/26/2007	340005096371800	8	70	.36	-.06	303	-70	223	-21	1,660	-270
1	4/25/2007	334521096474700	9	1	--	--	--	--	--	--	2,230	--
1	4/25/2007	334521096474700	9	8	--	--	--	--	--	--	2,300	-70

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
2	6/19/2007	334910096342700	1	1	0.34	--	338	--	221	--	1,760	--
2	6/19/2007	334910096342700	1	10	--	--	--	--	--	--	1,780	--
2	6/19/2007	334910096342700	1	20	--	--	--	--	--	--	1,760	--
2	6/19/2007	334910096342700	1	30	--	--	--	--	--	--	1,770	--
2	6/19/2007	334910096342700	1	40	--	--	--	--	--	--	1,790	--
2	6/19/2007	334910096342700	1	50	--	--	--	--	--	--	1,840	--
2	6/19/2007	334910096342700	1	60	--	--	--	--	--	--	1,920	--
2	6/19/2007	334910096342700	1	70	--	--	--	--	--	--	1,910	--
2	6/19/2007	334910096342700	1	80	--	--	--	--	--	--	2,090	--
2	6/19/2007	334910096342700	1	95	.45	-.11	447	-109	262	-41	2,170	-410
2	6/20/2007	335233096500200	2	1	.32	--	276	--	182	--	1,500	--
2	6/20/2007	335233096500200	2	10	--	--	--	--	--	--	1,520	--
2	6/20/2007	335233096500200	2	20	--	--	--	--	--	--	1,530	--
2	6/20/2007	335233096500200	2	30	--	--	--	--	--	--	1,560	--
2	6/20/2007	335233096500200	2	40	--	--	--	--	--	--	1,700	--
2	6/20/2007	335233096500200	2	50	.37	-.05	392	-116	222	-40	1,920	-420
2	6/20/2007	335316096474000	3	1	.27	--	257	--	156	--	1,380	--
2	6/20/2007	335316096474000	3	10	--	--	--	--	--	--	1,380	--
2	6/20/2007	335316096474000	3	20	--	--	--	--	--	--	1,390	--
2	6/20/2007	335316096474000	3	30	--	--	--	--	--	--	1,520	--
2	6/20/2007	335316096474000	3	42	.35	-.08	363	-106	207	-51	1,780	-400
2	6/20/2007	334706096465800	4	1	.16	--	159	--	93.4	--	874	--
2	6/20/2007	334706096465800	4	10	.17	-.01	168	-9	98.3	-4.9	960	-86
2	6/19/2007	335504096422100	5	1	.29	--	264	--	196	--	1,480	--
2	6/19/2007	335504096422100	5	10	--	--	--	--	--	--	1,480	--
2	6/19/2007	335504096422100	5	20	--	--	--	--	--	--	1,480	--
2	6/19/2007	335504096422100	5	30	--	--	--	--	--	--	1,480	--
2	6/19/2007	335504096422100	5	40	--	--	--	--	--	--	1,540	--
2	6/19/2007	335504096422100	5	55	.39	-.1	421	-157	244	-48	2,030	-550
2	6/19/2007	335603096391300	6	1	.21	--	173	--	159	--	1,110	--
2	6/19/2007	335603096391300	6	10	--	--	--	--	--	--	1,240	--
2	6/19/2007	335603096391300	6	21	.23	-.02	202	-29	168	-9	1,240	-130

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
2	6/19/2007	335550096330700	7	1	0.22	--	194	--	157	--	1,170	--
2	6/19/2007	335550096330700	7	10	--	--	--	--	--	--	1,290	--
2	6/19/2007	335550096330700	7	20	--	--	--	--	--	--	1,360	--
2	6/19/2007	335550096330700	7	30	--	--	--	--	--	--	1,460	--
2	6/19/2007	335550096330700	7	40	--	--	--	--	--	--	1,600	--
2	6/19/2007	335550096330700	7	52	.35	-0.13	331	-137	214	-57	1,730	-560
2	6/19/2007	340005096371800	8	1	.14	--	48.5	--	124	--	668	--
2	6/19/2007	340005096371800	8	10	--	--	--	--	--	--	674	--
2	6/19/2007	340005096371800	8	20	--	--	--	--	--	--	678	--
2	6/19/2007	340005096371800	8	30	--	--	--	--	--	--	679	--
2	6/19/2007	340005096371800	8	40	--	--	--	--	--	--	1,160	--
2	6/19/2007	340005096371800	8	50	--	--	--	--	--	--	1,530	--
2	6/19/2007	340005096371800	8	60	--	--	--	--	--	--	1,530	--
2	6/19/2007	340005096371800	8	73	.31	-.17	278	-230	205	-81	1,760	-1,092
2	6/20/2007	334521096474700	9	1	--	--	--	--	--	--	699	--
2	6/20/2007	334521096474700	9	11	--	--	--	--	--	--	699	0
2	6/19/2007	335048096374300	10	1	.32	--	308	--	209	--	1,640	--
2	6/19/2007	335048096374300	10	10	--	--	--	--	--	--	1,640	--
2	6/19/2007	335048096374300	10	20	--	--	--	--	--	--	1,650	--
2	6/19/2007	335048096374300	10	30	--	--	--	--	--	--	1,660	--
2	6/19/2007	335048096374300	10	40	--	--	--	--	--	--	1,800	--
2	6/19/2007	335048096374300	10	50	--	--	--	--	--	--	1,930	--
2	6/19/2007	335048096374300	10	60	--	--	--	--	--	--	1,970	--
2	6/19/2007	335048096374300	10	70	--	--	--	--	--	--	2,040	--
2	6/19/2007	335048096374300	10	80	--	--	--	--	--	--	2,140	--
2	6/19/2007	335048096374300	10	90	.46	-.14	471	-163	265	-56	2,220	-580
2	6/20/2007	335527096515000	11	1	.32	--	266	--	172	--	1,420	--
2	6/20/2007	335527096515000	11	11	.33	-.01	267	--	175	-3	1,460	-40

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
3	9/27/2007	334910096342700	1	1	0.20	--	97.4	--	121	--	820	--
3	9/27/2007	334910096342700	1	10	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	20	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	30	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	40	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	50	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	60	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	70	--	--	--	--	--	--	816	--
3	9/27/2007	334910096342700	1	80	--	--	--	--	--	--	815	--
3	9/27/2007	334910096342700	1	92	.20	0	94.8	2.6	121	0	816	4
3	9/26/2007	335233096500200	2	1	.34	--	206	--	128	--	1,180	--
3	9/26/2007	335233096500200	2	10	--	--	--	--	--	--	1,180	--
3	9/26/2007	335233096500200	2	20	--	--	--	--	--	--	1,180	--
3	9/26/2007	335233096500200	2	30	--	--	--	--	--	--	1,180	--
3	9/26/2007	335233096500200	2	40	--	--	--	--	--	--	1,830	--
3	9/26/2007	335233096500200	2	46	.51	-.17	451	-245	219	-91	2,290	-1,110
3	9/26/2007	335316096474000	3	1	.32	--	184	--	120	--	1,100	--
3	9/26/2007	335316096474000	3	10	--	--	--	--	--	--	1,100	--
3	9/26/2007	335316096474000	3	20	--	--	--	--	--	--	1,100	--
3	9/26/2007	335316096474000	3	30	--	--	--	--	--	--	1,100	--
3	9/26/2007	335316096474000	3	36	.33	-.01	201	-17	127	-7	1,160	-60
3	9/26/2007	334706096465800	4	1	.25	--	142	--	86.9	--	888	--
3	9/26/2007	334706096465800	4	8	.24	.01	141	1	86.1	.8	890	-2
3	9/27/2007	335504096422100	5	1	.24	--	125	--	110	--	878	--
3	9/27/2007	335504096422100	5	10	--	--	--	--	--	--	883	--
3	9/27/2007	335504096422100	5	20	--	--	--	--	--	--	889	--
3	9/27/2007	335504096422100	5	30	--	--	--	--	--	--	894	--
3	9/27/2007	335504096422100	5	40	--	--	--	--	--	--	901	--
3	9/27/2007	335504096422100	5	49	.26	-.02	136	-11	112	-2	929	-51
3	9/27/2007	335603096391300	6	1	.22	--	110	--	115	--	841	--
3	9/27/2007	335603096391300	6	10	--	--	--	--	--	--	841	--
3	9/27/2007	335603096391300	6	19	.22	0	107	3	116	--	834	7

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (μS/cm)	Difference in specific conductance values (μS/cm)
3	9/27/2007	335550096330700	7	1	0.18	--	81.1	--	123	--	768	--
3	9/27/2007	335550096330700	7	10	--	--	--	--	--	--	768	--
3	9/27/2007	335550096330700	7	20	--	--	--	--	--	--	768	--
3	9/27/2007	335550096330700	7	30	--	--	--	--	--	--	768	--
3	9/27/2007	335550096330700	7	40	--	--	--	--	--	--	765	--
3	9/27/2007	335550096330700	7	50	.18	0	81.1	0	120	3	762	6
3	9/27/2007	340005096371800	8	1	.16	--	59.6	--	143	--	740	--
3	9/27/2007	340005096371800	8	10	--	--	--	--	--	--	741	--
3	9/27/2007	340005096371800	8	20	--	--	--	--	--	--	740	--
3	9/27/2007	340005096371800	8	30	--	--	--	--	--	--	742	--
3	9/27/2007	340005096371800	8	40	--	--	--	--	--	--	744	--
3	9/27/2007	340005096371800	8	50	--	--	--	--	--	--	768	--
3	9/27/2007	340005096371800	8	60	--	--	--	--	--	--	867	--
3	9/27/2007	340005096371800	8	70	.16	0	48.0	11.6	203	-60	870	-130
3	9/26/2007	334521096474700	9	1	--	--	--	--	--	--	876	--
3	9/26/2007	334521096474700	9	8	--	--	--	--	--	--	878	-2
3	9/27/2007	335048096374300	10	1	.20	--	94.7	--	121	--	810	--
3	9/27/2007	335048096374300	10	10	--	--	--	--	--	--	811	--
3	9/27/2007	335048096374300	10	20	--	--	--	--	--	--	813	--
3	9/27/2007	335048096374300	10	30	--	--	--	--	--	--	816	--
3	9/27/2007	335048096374300	10	40	--	--	--	--	--	--	819	--
3	9/27/2007	335048096374300	10	50	--	--	--	--	--	--	838	--
3	9/27/2007	335048096374300	10	60	--	--	--	--	--	--	840	--
3	9/27/2007	335048096374300	10	70	--	--	--	--	--	--	850	--
3	9/27/2007	335048096374300	10	80	--	--	--	--	--	--	842	--
3	9/27/2007	335048096374300	10	87	.20	0	91.6	3.1	138	-17	845	-35
3	9/26/2007	335527096515000	11	1	.59	--	532	--	255	--	2,450	--
3	9/26/2007	335527096515000	11	8	.56	.03	540	-8	258	-3	2,470	-20

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
4	5/23/2008	334910096342700	1	1	0.31	--	165	--	212	--	1,200	--
4	5/23/2008	334910096342700	1	10	--	--	--	--	--	--	1,200	--
4	5/23/2008	334910096342700	1	20	--	--	--	--	--	--	1,200	--
4	5/23/2008	334910096342700	1	30	--	--	--	--	--	--	1,210	--
4	5/23/2008	334910096342700	1	40	--	--	--	--	--	--	1,210	--
4	5/23/2008	334910096342700	1	50	--	--	--	--	--	--	1,210	--
4	5/23/2008	334910096342700	1	60	--	--	--	--	--	--	1,210	--
4	5/23/2008	334910096342700	1	70	--	--	--	--	--	--	1,210	--
4	5/23/2008	334910096342700	1	80	--	--	--	--	--	--	1,210	--
4	5/23/2008	334910096342700	1	90	.32	-0.01	166	--	212	0	1,210	-10
4	5/20/2008	335233096500200	2	1	.45	--	280	--	189	--	1,530	--
4	5/20/2008	335233096500200	2	10	--	--	--	--	--	--	1,560	--
4	5/20/2008	335233096500200	2	20	--	--	--	--	--	--	1,580	--
4	5/20/2008	335233096500200	2	30	--	--	--	--	--	--	1,410	--
4	5/20/2008	335233096500200	2	40	--	--	--	--	--	--	1,420	--
4	5/20/2008	335233096500200	2	48	.44	.01	271	9	194	-5	1,480	50
4	5/20/2008	335316096474000	3	1	.40	--	250	--	184	--	1,400	--
4	5/20/2008	335316096474000	3	10	--	--	--	--	--	--	1,420	--
4	5/20/2008	335316096474000	3	20	--	--	--	--	--	--	1,410	--
4	5/20/2008	335316096474000	3	30	--	--	--	--	--	--	1,420	--
4	5/20/2008	335316096474000	3	36	.41	-.01	243	7	186	-2	1,400	0
4	5/20/2008	334706096465800	4	1	.40	--	242	--	171	--	1,360	--
4	5/20/2008	334706096465800	4	8	.40	0	246	-4	173	-2	1,370	-10
4	5/20/2008	335504096422100	5	1	.36	--	206	--	204	--	1,310	--
4	5/20/2008	335504096422100	5	10	--	--	--	--	--	--	1,310	--
4	5/20/2008	335504096422100	5	20	--	--	--	--	--	--	1,290	--
4	5/20/2008	335504096422100	5	30	--	--	--	--	--	--	1,290	--
4	5/20/2008	335504096422100	5	40	--	--	--	--	--	--	1,290	--
4	5/20/2008	335504096422100	5	49	.34	.02	194	12	206	-2	1,310	0
4	5/22/2008	335603096391300	6	1	.33	--	171	--	209	--	1,200	--
4	5/22/2008	335603096391300	6	10	--	--	--	--	--	--	1,200	--
4	5/22/2008	335603096391300	6	20	.33	0	169	2	208	1	1,200	0

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
4	5/22/2008	335550096330700	7	1	0.30	--	145	--	212	--	1,140	--
4	5/22/2008	335550096330700	7	10	--	--	--	--	--	--	1,140	--
4	5/22/2008	335550096330700	7	20	--	--	--	--	--	--	1,140	--
4	5/22/2008	335550096330700	7	30	--	--	--	--	--	--	1,140	--
4	5/22/2008	335550096330700	7	40	--	--	--	--	--	--	1,140	--
4	5/22/2008	335550096330700	7	50	.29	0.01	141	4	212	0	1,140	0
4	5/22/2008	340005096371800	8	1	.24	--	88.0	--	223	--	994	--
4	5/22/2008	340005096371800	8	10	--	--	--	--	--	--	994	--
4	5/22/2008	340005096371800	8	20	--	--	--	--	--	--	1,000	--
4	5/22/2008	340005096371800	8	30	--	--	--	--	--	--	1,030	--
4	5/22/2008	340005096371800	8	40	--	--	--	--	--	--	1,040	--
4	5/22/2008	340005096371800	8	50	--	--	--	--	--	--	1,060	--
4	5/22/2008	340005096371800	8	60	--	--	--	--	--	--	1,060	--
4	5/22/2008	340005096371800	8	70	.26	-.02	112	-24	214	9	1,060	-66
4	5/20/2008	334521096474700	9	1	--	--	--	--	--	--	1,840	--
4	5/20/2008	334521096474700	9	8	--	--	--	--	--	--	1,350	490
4	5/23/2008	335048096374300	10	1	.31	--	164	--	211	--	1,200	--
4	5/23/2008	335048096374300	10	10	--	--	--	--	--	--	1,200	--
4	5/23/2008	335048096374300	10	20	--	--	--	--	--	--	1,200	--
4	5/23/2008	335048096374300	10	30	--	--	--	--	--	--	1,200	--
4	5/23/2008	335048096374300	10	40	--	--	--	--	--	--	1,210	--
4	5/23/2008	335048096374300	10	50	--	--	--	--	--	--	1,220	--
4	5/23/2008	335048096374300	10	60	--	--	--	--	--	--	1,220	--
4	5/23/2008	335048096374300	10	70	--	--	--	--	--	--	1,200	--
4	5/23/2008	335048096374300	10	80	--	--	--	--	--	--	1,210	--
4	5/23/2008	335048096374300	10	89	.31	0	162	2	211	0	1,210	-10
4	5/20/2008	335527096515000	11	1	.60	--	425	--	228	--	2,090	--
4	5/20/2008	335527096515000	11	8	.61	-.01	437	-12	231	-3	2,100	-10

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
5	7/1/2008	334910096342700	1	1	0.31	--	162	--	210	--	1,190	--
5	7/1/2008	334910096342700	1	10	--	--	--	--	--	--	1,190	--
5	7/1/2008	334910096342700	1	20	--	--	--	--	--	--	1,200	--
5	7/1/2008	334910096342700	1	30	--	--	--	--	--	--	1,210	--
5	7/1/2008	334910096342700	1	40	--	--	--	--	--	--	1,210	--
5	7/1/2008	334910096342700	1	50	--	--	--	--	--	--	1,210	--
5	7/1/2008	334910096342700	1	60	--	--	--	--	--	--	1,210	--
5	7/1/2008	334910096342700	1	70	--	--	--	--	--	--	1,210	--
5	7/1/2008	334910096342700	1	80	--	--	--	--	--	--	1,200	--
5	7/1/2008	334910096342700	1	93	.30	0.01	160	2	206	4	1,200	-10
5	7/2/2008	335233096500200	2	1	.44	--	277	--	214	--	1,550	--
5	7/2/2008	335233096500200	2	10	--	--	--	--	--	--	1,560	--
5	7/2/2008	335233096500200	2	20	--	--	--	--	--	--	1,560	--
5	7/2/2008	335233096500200	2	30	--	--	--	--	--	--	1,570	--
5	7/2/2008	335233096500200	2	40	--	--	--	--	--	--	1,500	--
5	7/2/2008	335233096500200	2	47	.39	.05	247	30	205	9	1,480	70
5	7/2/2008	335316096474000	3	1	.41	--	259	--	207	--	1,480	--
5	7/2/2008	335316096474000	3	10	--	--	--	--	--	--	1,500	--
5	7/2/2008	335316096474000	3	20	--	--	--	--	--	--	1,510	--
5	7/2/2008	335316096474000	3	30	--	--	--	--	--	--	1,510	--
5	7/2/2008	335316096474000	3	37	.41	-.02	256	3	205	2	1,490	-10
5	7/2/2008	334706096465800	4	1	.43	--	276	--	191	--	1,510	--
5	7/2/2008	334706096465800	4	10	.43	0	273	3	192	--	1,510	0
5	7/1/2008	335504096422100	5	1	.32	--	175	--	211	--	1,220	--
5	7/1/2008	335504096422100	5	10	--	--	--	--	--	--	1,220	--
5	7/1/2008	335504096422100	5	20	--	--	--	--	--	--	1,230	--
5	7/1/2008	335504096422100	5	30	--	--	--	--	--	--	1,290	--
5	7/1/2008	335504096422100	5	40	--	--	--	--	--	--	1,280	--
5	7/1/2008	335504096422100	5	50	.33	-.01	190	-15	207	4	1,270	-50
5	7/1/2008	335603096391300	6	1	.31	--	170	--	213	--	1,220	--
5	7/1/2008	335603096391300	6	10	--	--	--	--	--	--	1,220	--
5	7/1/2008	335603096391300	6	19	.32	-.01	167	3	211	2	1,210	10

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
5	7/1/2008	335550096330700	7	1	0.29	--	154	--	220	--	1,150	--
5	7/1/2008 (duplicate)	334910096342700	7	1	.30	--	155	--	222	--	1,130	--
5	7/1/2008	335550096330700	7	10	--	--	--	--	--	--	1,150	--
5	7/1/2008	335550096330700	7	20	--	--	--	--	--	--	1,180	--
5	7/1/2008	335550096330700	7	30	--	--	--	--	--	--	1,190	--
5	7/1/2008	335550096330700	7	40	--	--	--	--	--	--	1,200	--
5	7/1/2008	335550096330700	7	52	.31	-0.02	165	-11	215	5	1,200	-50
5	7/1/2008	340005096371800	8	1	.23	--	94.8	--	244	--	1,010	--
5	7/1/2008	340005096371800	8	10	--	--	--	--	--	--	1,010	--
5	7/1/2008	340005096371800	8	20	--	--	--	--	--	--	1,020	--
5	7/1/2008	340005096371800	8	30	--	--	--	--	--	--	1,100	--
5	7/1/2008	340005096371800	8	40	--	--	--	--	--	--	1,150	--
5	7/1/2008	340005096371800	8	50	--	--	--	--	--	--	1,200	--
5	7/1/2008	340005096371800	8	60	--	--	--	--	--	--	1,200	--
5	7/1/2008	340005096371800	8	71	.31	-.08	165	-70	213	31	1,200	-190
5	7/2/2008	334521096474700	9	1	--	--	--	--	--	--	1,520	---
5	7/2/2008	334521096474700	9	7.6	--	--	--	--	--	--	1,520	0
5	7/1/2008	335048096374300	10	1	.30	--	169	--	216	--	1,200	--
5	7/1/2008	335048096374300	10	10	--	--	--	--	--	--	1,240	--
5	7/1/2008	335048096374300	10	20	--	--	--	--	--	--	1,220	--
5	7/1/2008	335048096374300	10	30	--	--	--	--	--	--	1,240	--
5	7/1/2008	335048096374300	10	40	--	--	--	--	--	--	1,220	--
5	7/1/2008	335048096374300	10	50	--	--	--	--	--	--	1,220	--
5	7/1/2008	335048096374300	10	60	--	--	--	--	--	--	1,210	--
5	7/1/2008	335048096374300	10	70	--	--	--	--	--	--	1,210	--
5	7/1/2008	335048096374300	10	80	--	--	--	--	--	--	1,200	--
5	7/1/2008	335048096374300	10	88	.29	.01	164	5	211	5	1,200	0
5	7/2/2008	335527096515000	11	1	.60	--	421	--	246	--	2,070	--
5	7/2/2008	335527096515000	11	8	.60	0	424	-3	246	0	2,070	0

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
6	9/23/2008	334910096342700	1	1	0.35	--	197	--	228	--	1,310	--
6	9/23/2008	334910096342700	1	10	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	20	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	30	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	40	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	50	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	60	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	70	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	80	--	--	--	--	--	--	1,310	--
6	9/23/2008	334910096342700	1	91.5	.35	0	195	2	226	2	1,310	0
6	9/24/2008	335233096500200	2	1	.38	--	252	--	213	--	1,430	--
6	9/24/2008	335233096500200	2	10	--	--	--	--	--	--	1,430	--
6	9/24/2008	335233096500200	2	20	--	--	--	--	--	--	1,500	--
6	9/24/2008	335233096500200	2	30	--	--	--	--	--	--	1,530	--
6	9/24/2008	335233096500200	2	40	--	--	--	--	--	--	2,780	--
6	9/24/2008	335233096500200	2	46	.52	-.14	782	-530	382	-169	3,450	-2,020
6	9/24/2008	335316096474000	3	1	.37	--	247	--	205	--	1,390	--
6	9/24/2008	335316096474000	3	10	--	--	--	--	--	--	1,390	--
6	9/24/2008	335316096474000	3	20	--	--	--	--	--	--	1,390	--
6	9/24/2008	335316096474000	3	30	--	--	--	--	--	--	1,420	--
6	9/24/2008	335316096474000	3	35	.37	0	253	-6	197	8	1,420	-30
6	9/24/2008	334706096465800	4	1	.44	--	274	--	217	--	1,500	--
6	9/24/2008	334706096465800	4	10	.43	.01	276	-2	216	1	1,520	-20
6	9/23/2008	335504096422100	5	1	.36	--	206	--	224	--	1,320	--
6	9/23/2008	335504096422100	5	10	--	--	--	--	--	--	1,320	--
6	9/23/2008	335504096422100	5	20	--	--	--	--	--	--	1,320	--
6	9/23/2008	335504096422100	5	30	--	--	--	--	--	--	1,320	--
6	9/23/2008	335504096422100	5	40	--	--	--	--	--	--	1,330	--
6	9/23/2008	335504096422100	5	49	.36	0	210	-4	221	3	1,340	-20
6	9/23/2008	335603096391300	6	1	.36	--	201	--	228	--	1,310	--
6	9/23/2008	335603096391300	6	10	--	--	--	--	--	--	1,310	--
6	9/23/2008	335603096391300	6	17.5	.35	.01	202	--	227	1	1,310	0

Appendix 1. Analytical results for bromide, chloride, and sulfate concentrations and for specific conductance for all water-quality samples collected at Lake Texoma in Texas and Oklahoma, 2007–2008—Continued.

Lake survey	Sample collection date	USGS station number	Sampling site number (fig. 1)	Sampling depth (feet)	Bromide (mg/L)	Difference in bromide concentrations (mg/L)	Chloride (mg/L)	Difference in chloride concentrations (mg/L)	Sulfate (mg/L)	Difference in sulfate concentrations (mg/L)	Specific conductance (µS/cm)	Difference in specific conductance values (µS/cm)
6	9/23/2008	335550096330700	7	1	0.34	--	188	--	233	--	1,290	--
6	9/23/2008	335550096330700	7	10	--	--	--	--	--	--	1,290	--
6	9/23/2008	335550096330700	7	20	--	--	--	--	--	--	1,280	--
6	9/23/2008	335550096330700	7	30	--	--	--	--	--	--	1,280	--
6	9/23/2008	335550096330700	7	40	--	--	--	--	--	--	1,280	--
6	9/23/2008	335550096330700	7	50	.35	-0.01	186	2	233	0	1,290	0
6	9/23/2008	340005096371800	8	1	.33	--	174	--	243	--	1,260	--
6	9/23/2008	340005096371800	8	10	--	--	--	--	--	--	1,260	--
6	9/23/2008	340005096371800	8	20	--	--	--	--	--	--	1,250	--
6	9/23/2008	340005096371800	8	30	--	--	--	--	--	--	1,250	--
6	9/23/2008	340005096371800	8	40	--	--	--	--	--	--	1,240	--
6	9/23/2008	340005096371800	8	50	--	--	--	--	--	--	1,220	--
6	9/23/2008	340005096371800	8	60	--	--	--	--	--	--	1,220	--
6	9/23/2008	340005096371800	8	69.5	.31	.02	133	41	287	-44	1,220	40
6	9/24/2008	334521096474700	9	1	--	--	--	--	--	--	1,530	--
6	9/24/2008	334521096474700	9	7	--	--	--	--	--	--	1,530	0
6	9/23/2008	335048096374300	10	1	.35	--	197	--	226	--	1,310	--
6	9/23/2008	335048096374300	10	10	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	20	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	30	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	40	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	50	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	60	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	70	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	80	--	--	--	--	--	--	1,310	--
6	9/23/2008	335048096374300	10	86.5	.36	-.01	201	-4	226	0	1,310	0
6	9/24/2008	335527096515000	11	1	.63	--	995	--	463	--	4,030	--
6	9/24/2008	335527096515000	11	6.6	.65	-.02	1,070	-75	494	-31	4,210	-180
				Minimum	.14	-.18	48.0	-530	86.1	-169	668	-2,020
				Maximum	.65	.05	1,070	41	494	31	4,210	490

Publishing support provided by
Lafayette Publishing Service Center

Information regarding water resources in Texas is available at
http://tx.usgs.gov/

Blank Page

USGS

Baldys—Bromide, Chloride, and Sulfate Concentrations, and Specific Conductance, Lake Texoma, Texas and Oklahoma, 2007–08—DS 466

Printed on recycled paper