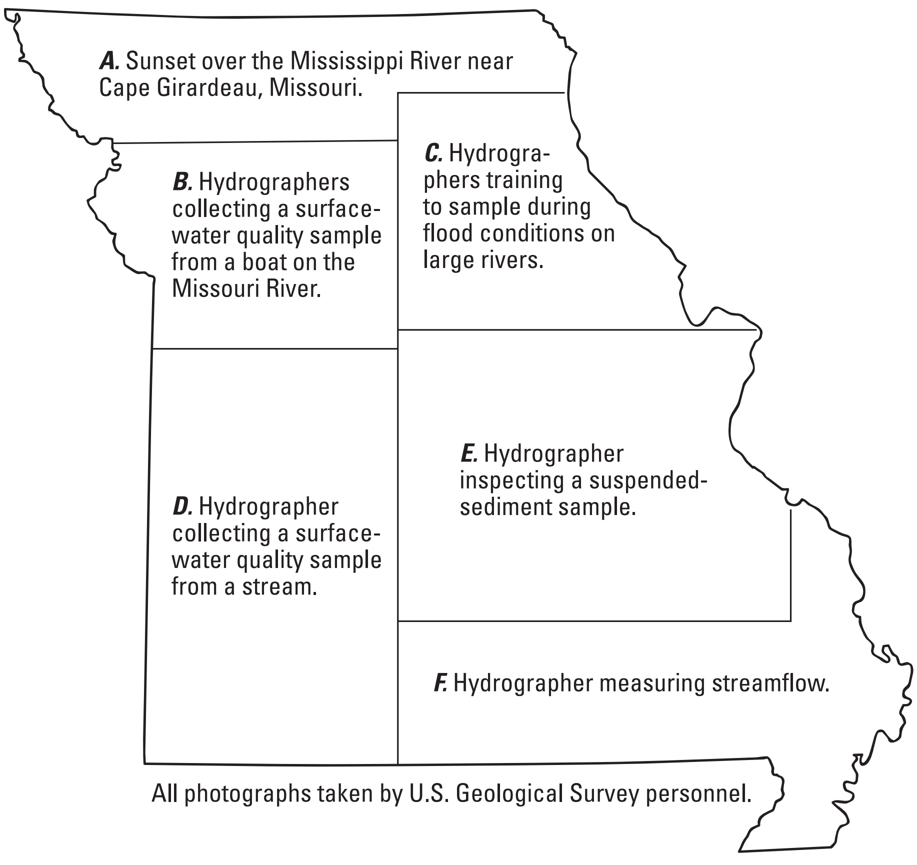
Prepared in cooperation with the Missouri Department of Natural Resources

Quality of Surface Water in Missouri, Water Year 2013

Data Series 886

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



All photographs taken by U.S. Geological Survey personnel.

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By Miya N. Barr and Rachel E. Schneider

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U.S. Department of the Interior
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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

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

$$°F=(1.8×°C)+32$$

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 at 25 °C).

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

Water year in U.S. Geological Survey reports is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 2013, is called the “2013 water year”.

Abreviations

AWQMN	Ambient Water Quality Monitoring Network
CIAT	2-chloro-4-isopropylamino-6-amino-*s*-triazine
CWA	Clean Water Act
DO	Dissolved oxygen
EPTC	S-ethyl dipropylthiocarbamate
LRL	Laboratory reporting level
LT-MDL	Long-term method detection level
MDL	Minimum detection level
MDNR	Missouri Department of Natural Resources
MRL	Minimum reporting level
NASQAN	National Stream Quality Assessment Network
NWIS	National Water Information System
NWISWeb	National Water Information System Web Interface
NWQL	National Water Quality Laboratory
TMDL	Total maximum daily load
USGS	U.S. Geological Survey

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Abstract

The U.S. Geological Survey, in cooperation with the Missouri Department of Natural Resources, designed and operates a series of monitoring stations on streams and springs throughout Missouri known as the Ambient Water-Quality Monitoring Network. During the 2013 water year (October 1, 2012, through September 30, 2013), data were collected at 79 stations—73 Ambient Water-Quality Monitoring Network stations, 4 alternate Ambient Water-Quality Monitoring Network stations, and 2 U.S. Geological Survey National Stream Quality Accounting Network stations. Dissolved oxygen, specific conductance, water temperature, suspended solids, suspended sediment, *Escherichia coli* bacteria, fecal coliform bacteria, dissolved nitrate plus nitrite as nitrogen, total phosphorus, dissolved and total recoverable lead and zinc, and select pesticide compound summaries are presented for 76 of these stations. The stations primarily have been classified into groups corresponding to the physiography of the State, primary land use, or unique station types. In addition, a summary of hydrologic conditions in the State including peak discharges, monthly mean discharges, and 7-day low flow is presented.

Introduction

The Missouri Department of Natural Resources (MDNR) is responsible for the implementation of the Federal Clean Water Act (CWA) in Missouri. Section 305(b) of the CWA requires that each State develop a water-quality monitoring program and periodically report the status of its water quality (U.S. Environmental Protection Agency, 1997). Water-quality status is described in terms of the suitability of the water for various uses, such as drinking, fishing, swimming, and support of aquatic life; these uses formally are defined as "designated uses" in State and Federal Regulations. Section 303(d) of the CWA requires certain waters that do not meet applicable water-quality standards be identified, and total maximum daily loads (TMDLs) be determined for these waters (U.S. Environmental Protection Agency, 1997). Total maximum daily loads establish the maximum amount of an impairing substance that a waterbody can assimilate and still meet the water-quality standards. A TMDL addresses a single pollutant for each waterbody.

Missouri has an area of approximately 69,000 square miles (mi^2) and an estimated population of 6 million people (U.S. Census Bureau, 2013). Within Missouri, there are 24,431 miles (mi) of classified streams that support a variety of uses including wildlife, recreation, agriculture, industry, transportation, and public utilities. An estimated 8,745 mi of streams are adversely affected (impaired) by various physical changes or chemical contaminants to the point that criteria for at least one of the designated uses no longer can be met (Missouri Department of Natural Resources, 2012a). The impairment of about 5,441 mi of assessed streams has been documented by data that meet the requirements of Missouri's 303(d) listing methodology. There also are about 3,304 mi of classified, unassessed streams suspected of nonsupport, for which some data have been collected but the data are not of sufficient quality or quantity to officially rate the stream as impaired. Many of the unassessed streams suspected of nonsupport have been affected or modified by agriculture (Missouri Department of Natural Resources, 2012a).

The U.S. Geological Survey (USGS), in cooperation with the Missouri Department of Natural Resources (MDNR), collects surface-water quality data pertaining to Missouri's water resources each water year (October 1 through September 30). These data, stored and maintained in the USGS National Water Information System (NWIS) database, are collected as part of the Missouri Ambient Water-Quality Monitoring Network (AWQMN) and constitute a source of reliable, impartial, and timely information for developing an enhanced understanding of the State's water resources. To make this information readily available, these data were published annually in the Water-Data Report series from water years 1964 through 2005 (U.S. Geological Survey, 1964–2005). Published data for the 2006 through 2010 water years can be accessed at *http://wdr.water.usgs.gov* (U.S. Geological Survey, 2006–2010). Beginning in the 2011 water year, discrete water-quality data are no longer published annually, but can be accessed on the National Water Information System Web Interface (NWISWeb) at *http://nwis.waterdata.usgs.gov/mo/nwis/qwdata*.

The USGS, in cooperation with the U.S. Army Corps of Engineers, collects suspended-sediment concentration data and various particle-size distribution information on the Missouri and Mississippi Rivers. These data assist with sediment transport and navigable channel assessments along the larger rivers. Sediment samples are collected at seven USGS streamflow-gaging stations within Missouri, but only four stations were used for this report, because these stations also are within the AWQMN and other USGS cooperative stations where additional water-quality information are collected.

The purpose of this report is to summarize surface-water quality data collected by the USGS in cooperation with the MDNR and U.S. Army Corps of Engineers for water year 2013. The annual summary of select constituents provides MDNR with current information to assess the quality of surface water within the State and to ensure the objectives of the AWQMN are being met. This report is one in a series of annual summaries (Otero-Benitez and Davis, 2009a, 2009b; Barr, 2010, 2011, 2012, 2014). Data on the physical characteristics and water-quality constituents in samples collected at 76 surface-water stations are presented in figures and tables. These 76 stations primarily were classified into groups corresponding to the physiography of the State, primary land use, or unique station types.

The Ambient Water-Quality Monitoring Network

The USGS, in cooperation with the MDNR, designed and operates the cooperative AWQMN, which is a series of monitoring stations on streams and springs throughout Missouri. Constituent concentration data from the AWQMN have been used to determine statewide water-quality status and long-term trends (Barr and Davis, 2010) to meet information needs of State agencies involved in water-quality planning and management. The data collected also provide support for the design, implementation, and evaluation of preventive and remediation programs.

The objectives of the AWQMN are to obtain data on the quality and quantity of surface water within the State, provide a historical database of water-quality information that can be used by the State planning and management agencies to make informed decisions about anthropogenic effects (agriculture, mining, urban) on the State's surface waters, and provide for consistent methodology in data collection, laboratory analysis, and data reporting.

The MDNR and the USGS established a fixed-station AWQMN in 1964 with 18 stations, 5 of which are still currently (2014) being sampled. The number of stations within the AWQMN has varied since its inception because of the State's needs. During the 2013 water year, the program consisted of 73 stations. Alternate sampling stations have been established at other streamflow-gaging stations within the area of some primary stations, and were sampled because of drought conditions in the summer months of 2013. Some alternate stations also are primary stations within the AWQMN (table 1). Four stations that are not part of the AWQMN were sampled when the primary stations had no measureable streamflow—Locust Creek near Linneus (06901500), Mussel Fork near Musselfork (06906000), Marais des Cygnes River near Rich Hill (06916665), and South Grand River at Urich (06921600). In addition to the AWQMN stations, water samples are collected by the USGS at two USGS National Stream Quality Accounting Network (NASQAN; a national water-quality sampling network operated by the USGS) stations. From these 79 stations, 76 are included in this report (table 1). Three stations from the AWQMN did not fit in the classes defined for this report and were not included. The three excluded stations were Cuivre River near Troy (05514500) and Lamine River near Pilot Grove (06907300), both located in the Ozark Plateaus border, and Lake Taneycomo at Branson (07053700). Sampling frequency (table 1) is determined by a number of factors, including drainage basin size, potential effects from anthropogenic activities (such as agriculture, mining, and urban), history of chemical change, need for short-term data, and cost. Each of the streams in the AWQMN is classified for one or more designated uses. For specific information on the designated uses applicable to the streams sampled in the AWQMN, refer to Missouri Department of Natural Resources (2012a).

The unique eight-digit number used by the USGS to identify each surface-water station is assigned when a station first is established. The complete eight-digit number for each station includes a two-digit prefix that designates the major river system (05 is the Upper Mississippi River, 06 is the Missouri River, and 07 is the Lower Mississippi River) plus a six-digit downstream-order number. For example, the station number 05587455 indicates the station is located on the Upper Mississippi River ("05"), and the remaining six digits ("587455") locate the station in downstream order. In this system, the station numbers increase downstream along the main stem. A station on a tributary that enters between two main stem stations is assigned a station number between them.

Methods used for collecting and processing representative water-quality samples are presented in detail in the USGS "National Field Manual for the Collection of Water-Quality Data" (U.S. Geological Survey, variously dated). Onsite measurements of dissolved oxygen (DO), specific conductance, and water temperature were collected at each station according to procedures described in Wilde (variously dated). Samples were collected, analyzed for indicator bacteria (*Escherichia coli* [*E. coli*] and fecal coliform), and processed using the membrane filtration procedure described in Myers and others (2014). Methods used by the USGS for collecting and processing representative samples for nutrients, major chemical constituents, trace elements, suspended solids, suspended sediment, and pesticide analysis are presented in detail in U.S. Geological Survey (2006), Guy (1969), and Wilde and others (2004). All chemical analyses were done by the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado, according to procedures described in Patton and Kryskalla (2011), Patton and Truitt (1992), Garabarino and others (2006), Fishman (1993), Sandstrom and others (2001), and Zaugg and others (1995). Suspended-sediment concentrations were computed according to procedures described in Guy (1969).

Table 1. U.S. Geological Survey (USGS) station number, name, drainage area, and sampling frequency of 76 selected stations in Missouri, water year 2013.

[mi², square mile; water year 2013 defined as October 1, 2012 through September 30, 2013; --, not applicable]

USGS station number (figs. 1 and 3)	Station name	Contributing drainage area (mi²)	Water year 2013 sampling frequency	USGS station class (table 2)
05495000	Fox River at Wayland	400	6	DTPL ag
05496000	Wyaconda River above Canton	393	6	DTPL ag
05497150	North Fabius River near Ewing	471	6	DTPL ag
05500000	South Fabius River near Taylor	620	12	DTPL ag
05587455[a]	Mississippi River below Grafton, Illinois	171,300	12	BRMIG
06817700	Nodaway River near Graham	1,520	6	DTPL wi ag
06818000[a]	Missouri River at St. Joseph	426,500	12	BRMOSJ
06821190	Platte River at Sharps Station	2,380	6	DTPL wi ag
06894100	Missouri River at Sibley	426,500	12	BRMOS
06896187	Middle Fork Grand River near Grant City	82.4	6	DTPL ag
06898100[b]	Thompson River at Mount Moriah	891	8[d]	DTPL ag
06898800	Weldon River near Princeton	452	7	DTPL ag
06899580	No Creek near Dunlap	34.0	10	DTPL ag
06899950	Medicine Creek near Harris	192	12	DTPL ag
06900100	Little Medicine Creek near Harris	66.5	12	DTPL ag
06900900	Locust Creek near Unionville	77.5	11	DTPL ag
06901500[b]	Locust Creek near Linneus	550	1	DTPL ag
06902000	Grand River near Sumner	6,880	12	DTPL wi ag
06905500	Chariton River near Prairie Hill	1,870	6	DTPL wi ag
06905725	Mussel Fork near Mystic	24.0	9	DTPL ag
06906000[b]	Mussel Fork near Musselfork	267	3	DTPL ag
06906300	East Fork Little Chariton River near Huntsville	220	6	MINING
06916665[b]	Marais des Cygnes River near Rich Hill	3,250	2	OSPL wi ag
06917630	East Drywood Creek at Prairie State Park	3.38	6	OSPL pr
06918070	Osage River above Schell City	5,410	6	OSPL wi ag
06918600	Little Sac River near Walnut Grove	119	12	OZPLSP ag/fo
06919500	Cedar Creek near Pleasant View	420	12	OZPLSP ag/fo
06921070	Pomme de Terre River near Polk	276	9	OZPLSA fo/ag
06921590	South Grand River at Archie	356	6	OSPL ag
06921600[b]	South Grand River at Urich	670	2	OSPL ag
06921720	Big Creek near Blairstown	414	8	OSPL ag
06923700	Niangua River at Bennett Spring	441	6	OZPLSA fo/ag
06926510	Osage River below St. Thomas	14,580	6	OZPLSA wi fo/ag
06927850	Osage Fork of the Gasconade River near Lebanon	43.6	6	OZPLSA fo/ag
06928440	Roubidoux Spring at Waynesville	--	6	SPRING
06930450	Big Piney River at Devil's Elbow	746	9	OZPLSA fo/ag
06930800	Gasconade River above Jerome	2,570	12	OZPLSA wi fo/ag
06934500[a,c]	Missouri River at Hermann	522,500	14	BRMOH
07014000	Huzzah Creek near Steelville	259	6	OZPLSA fo/ag
07014200	Courtois Creek at Berryman	173	6	OZPLSA fo/ag
07014500	Meramec River near Sullivan	1,475	12	OZPLSA wi fo/ag

Table 1. U.S. Geological Survey (USGS) station number, name, drainage area, and sampling frequency of 76 selected stations in Missouri, water year 2013.—Continued

[mi², square mile; water year 2013 defined as October 1, 2012 through September 30, 2013; --, not applicable]

USGS station number (figs. 1 and 3)	Station name	Contributing drainage area (mi²)	Water year 2013 sampling frequency	USGS station class (table 2)
07016400	Bourbeuse River above Union	808	9	OZPLSA fo/ag
07018100	Big River near Richwoods	735	10	MINING
07019280	Meramec River at Paulina Hills	3,920	11	URBAN wi
07020550	South Fork Saline Creek near Perryville	55.3	6	OZPLSA fo/ag
07021020	Castor River at Greenbriar	423	6	OZPLSA fo/ag
07022000[a,c]	Mississippi River at Thebes, Illinois	713,200	14	BRMIT
07036100	St. Francis River near Saco	664	9	OZPLSA fo/ag
07037300	Big Creek at Sam A. Baker State Park	189	6	OZPLSA fo/ag
07042450	St. Johns Ditch at Henderson Mound	313	7	MIALPL
07046250	Little River Ditches near Rives	1,620	12	MIALPL
07050150	Roaring River Spring at Cassville	--	6	OZPLSP ag/fo
07052152	Wilson Creek near Brookline	51	12	URBAN
07052250	James River near Boaz	462	6	URBAN
07052345	Finley Creek below Riverdale	261	12	OZPLSP ag/fo
07052500	James River at Galena	987	12	URBAN
07052820	Flat Creek below Jenkins	274	12	OZPLSP ag/fo
07053900	Swan Creek near Swan	148	6	OZPLSA fo/ag
07057500	North Fork River near Tecumseh	561	6	OZPLSA fo/ag
07057750	Bryant Creek below Evans	214	6	OZPLSA fo/ag
07061600	Black River below Annapolis	493	8	OZPLSA fo/ag
07066110	Jacks Fork above Two River	425	12	OZPLSA fo/ag
07067500	Big Spring near Van Buren	--	4	SPRING
07068000	Current River at Doniphan	2,040	12	OZPLSA wi fo/ag
07068510	Little Black River below Fairdealing	194	6	OZPLSA fo/ag
07071000	Greer Spring at Greer	--	3	SPRING
07071500	Eleven Point River near Bardley	793	6	OZPLSA fo/ag
07185764	Spring River above Carthage	425	12	OZPLSP ag/fo
07186480	Center Creek near Smithfield	303	9	MINING
07186600	Turkey Creek near Joplin	41.8	9	URBAN
07187000	Shoal Creek above Joplin	427	12	OZPLSP ag/fo
07188653	Big Sugar Creek near Powell	141	12	OZPLSP ag/fo
07188838	Little Sugar Creek near Pineville	195	12	OZPLSP ag/fo
07188885	Indian Creek near Lanagan	239	12	OZPLSP ag/fo
07189000	Elk River near Tiff City	872	12	OZPLSP ag/fo
07189100	Buffalo Creek at Tiff City	60.8	12	OZPLSP ag/fo

[a]Additional water temperature and suspended-sediment samples collected in cooperation with the U.S. Army Corps of Engineers.

[b]Alternate sampling station used during drought conditions at primary Ambient Water-Quality Monitoring Network station. 06898100 is an alternate station for 06899580; 06901500 is alternate station for 06900900; 06906000 is alternate station for 06905725; 06916665 and 06921600 are alternate stations for 06921720.

[c]Stations 06934500 and 07022000 are not part of the Ambient Water-Quality Monitoring Network, but were used in the report. Stations 06934500 and 07022000 are funded by the U.S. Geological Survey National Stream Quality Account Network.

[d]Station 06898100 was sampled as a primary station six times and as an alternate station two times during the 2013 water year.

Laboratory Reporting Conventions

The NWQL uses method reporting conventions (Childress and others, 1999) to establish the minimum concentration for which more than a quantitative measurement can be made. These reporting conventions are the minimum reporting level (MRL), the method detection level (MDL) and the laboratory reporting level (LRL). The MRL is defined by the NWQL as the smallest measured concentration of a substance that can be measured reliably using a given analytical method. The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the concentration is greater than zero. A long-term method detection level (LT-MDL) is a detection level obtained by determining the standard deviation of 24 or more MDL spiked-sample measurements for an extended period of time. The LRL is computed as twice the LT-MDL.

Data Analysis Methods

The distribution of select constituent data was graphically displayed using side-by-side boxplots (box and whiskers distributions; Helsel and Hirsch, 2002). The plots show the center of the data (median, the center line of the boxplot), the variation (interquartile range [25th to 75th percentiles] or the height of the box), the skewness (quartile skew, which is the relative size of the box halves), the spread (upper and lower adjacent values are the vertical lines or whiskers), and the presence or absence of unusual values or outliers (upper and lower detached and outside values). If the median equals the 25th and 75th percentiles, the boxplot is represented by a single horizontal line. Boxplots with censored data (suspended solids, dissolved nitrate plus nitrite as nitrogen, total phosphorus, and dissolved and total recoverable lead and zinc) were modified by making the lower limit of the box equal to the MRL or LT-MDL. For pesticide concentration distributions, censored concentrations (reported as less than the LRL) were included in each distribution as a concentration value equal to the LRL. For some samples, pesticide concentrations are reported as estimated values, which are included in the distribution as a concentration that is plotted below the LRL and above the LT-MDL.

Station Classification for Data Analysis

The stations primarily were classified in groups corresponding to the physiography of the State (fig. 1), primary land use (fig. 2), or unique station types (fig. 1; table 2). The physiography-based groups include the Dissected Till Plains (DTPL) in the north, the Osage Plains (OSPL) in the west, the Mississippi Alluvial Plain (MIALPL) in the southeast, and between them the Ozark Plateaus. The Ozark Plateaus

Table 2. Station classification system.

Classification system is based on physiography of the State, primary and secondary land use, unique station type, and watershed size, as well as a station's representativeness to the general condition of the watershed.

Class (fig. 1)	Description	Number of stations
BRMIG	Big River – Mississippi River below Grafton, Illinois	1
BRMIT	Big River – Mississippi River at Thebes, Illinois	1
BRMOSJ	Big River – Missouri River at St. Joseph, Missouri	1
BRMOS	Big River – Missouri River at Sibley, Missouri	1
BRMOH	Big River – Missouri River at Hermann, Missouri	1
MIALPL	Mississippi Alluvial Plain	2[a]
OZPLSA fo/ag	Ozark Plateaus – Salem Plateau forest and agriculture	18
OZPLSA wi fo/ag	Ozark Plateaus – Salem Plateau watershed indicator, forest and agriculture	4
OZPLSP ag/fo	Ozark Plateaus – Springfield Plateau agriculture and forest	12
DTPL ag	Dissected Till Plains agriculture	14
DTPL wi ag	Dissected Till Plains watershed indicator, agriculture	4
OSPL ag	Osage Plains agriculture	3
OSPL wi ag	Osage Plains watershed indicator, agriculture	2
OSPL pr	Osage Plains prairie	1
SPRING	Springs	3
MINING	Mining	3
URBAN	Urban	4
URBAN wi	Urban watershed indicator	1

[a]One station in this class, Little River Ditches near Rives, Missouri (07046250), has a drainage area greater than 1,000 square miles but is not considered a watershed indicator station because the manmade canals and ditches within its drainage area are not hydrologically connected.

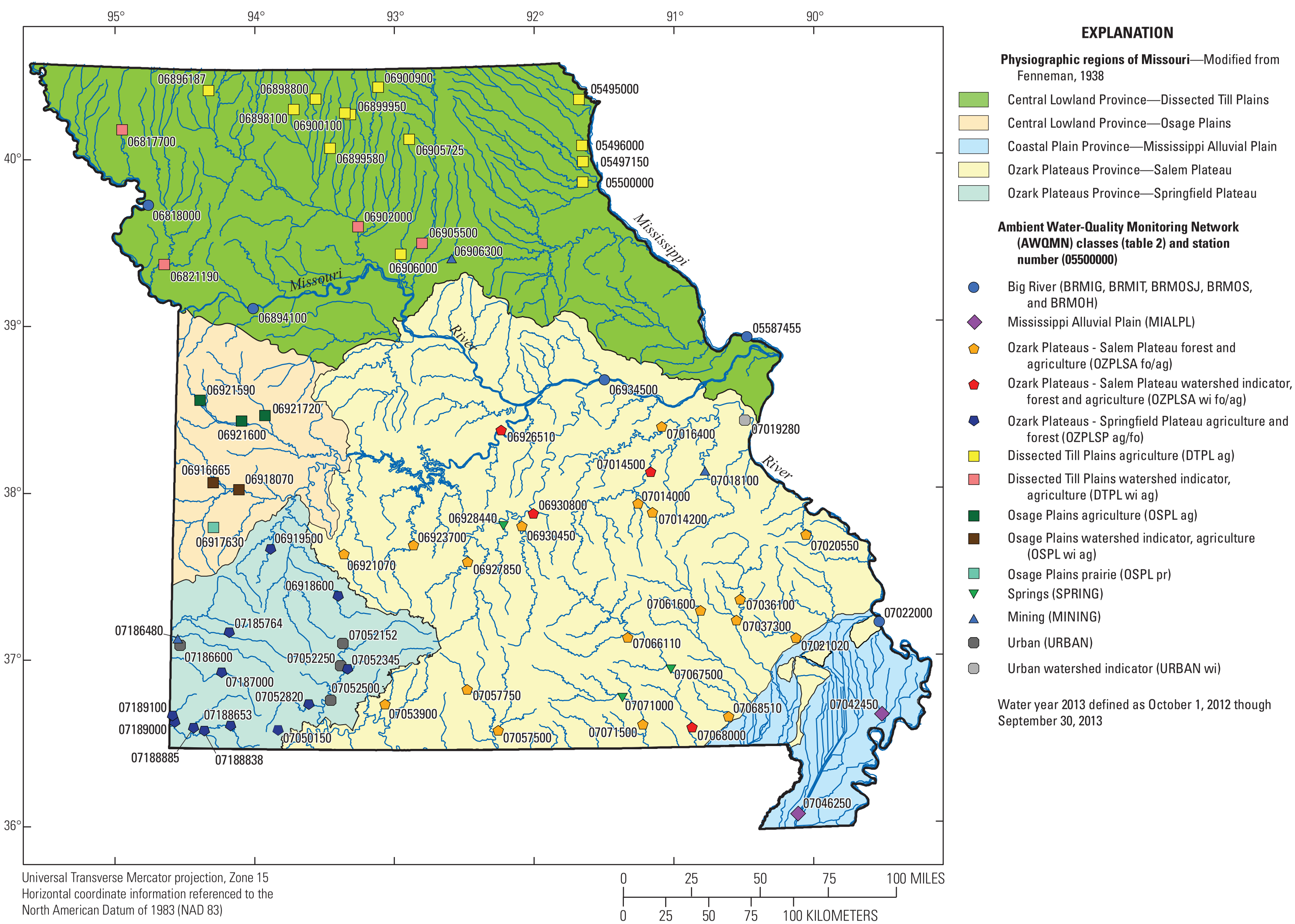


Figure 1. Location and class of selected stations and physiographic regions of Missouri, water year 2013.

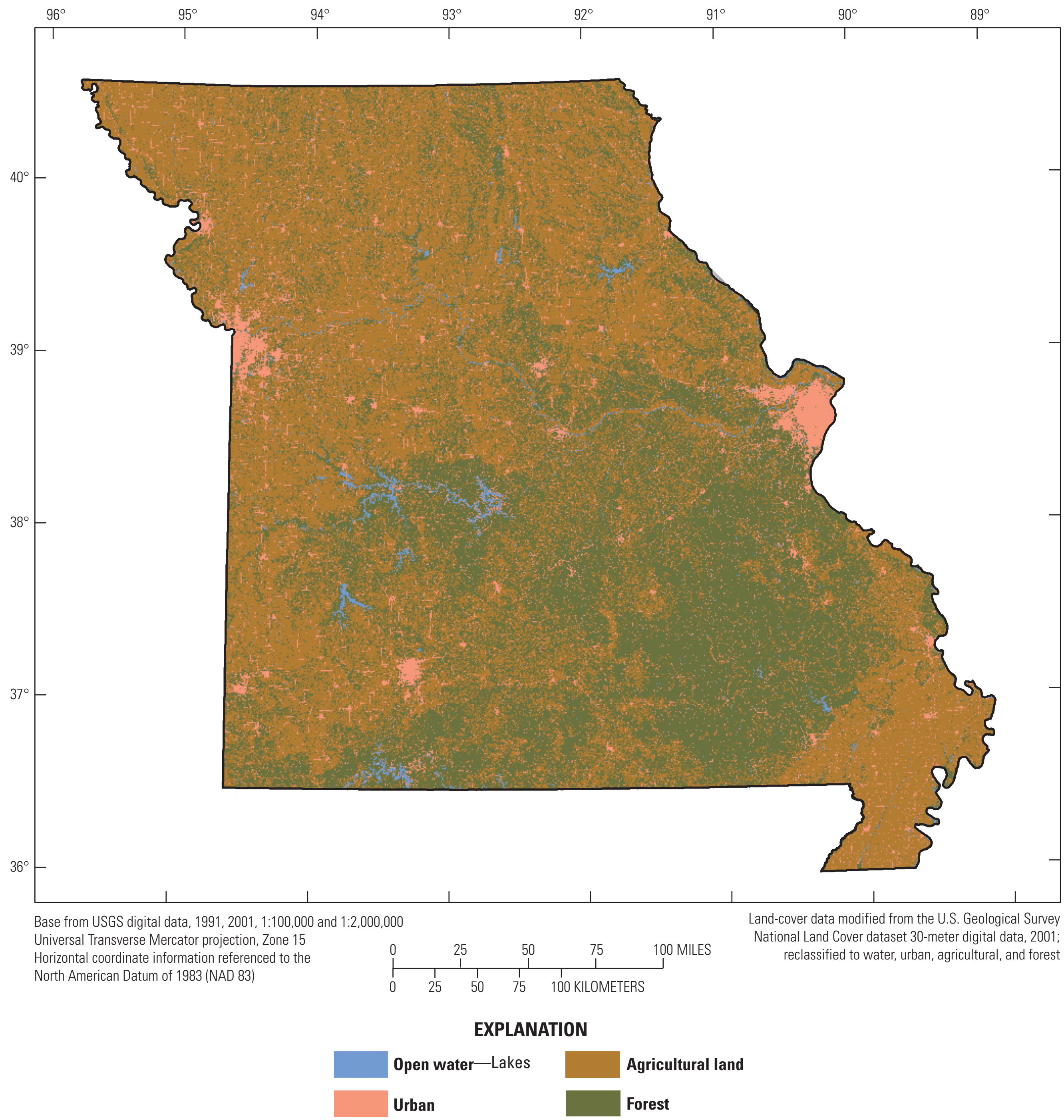


Figure 2. Map showing land use in Missouri.

(Fenneman, 1938) were further subdivided into two distinct groups based on physiographic location—the Salem Plateau (OZPLSA) and the Springfield Plateau (OZPLSP). Land-use groups include mining (MINING) and urban (URBAN) stations, whereas unique station classes refer to springs (SPRING) and the stations located on the Mississippi River (BRMIG and BRMIT) and the Missouri River (BRMOSJ, BRMOS and BRMOH), also referred to in this report as the "Big Rivers stations."

Some additional variability caused by differences in drainage area and land use was observed within physiographic regions; therefore, watershed size and land-use indicators were used to develop a complete set of classes. The land-use indicator provides a subclassification for stations in similar regions with different land uses (fig. 1; table 2). The secondary land-use indicators are watershed indicator stations (wi), which are the most downstream stations in a large watershed, and are defined for the purposes of this report as a drainage

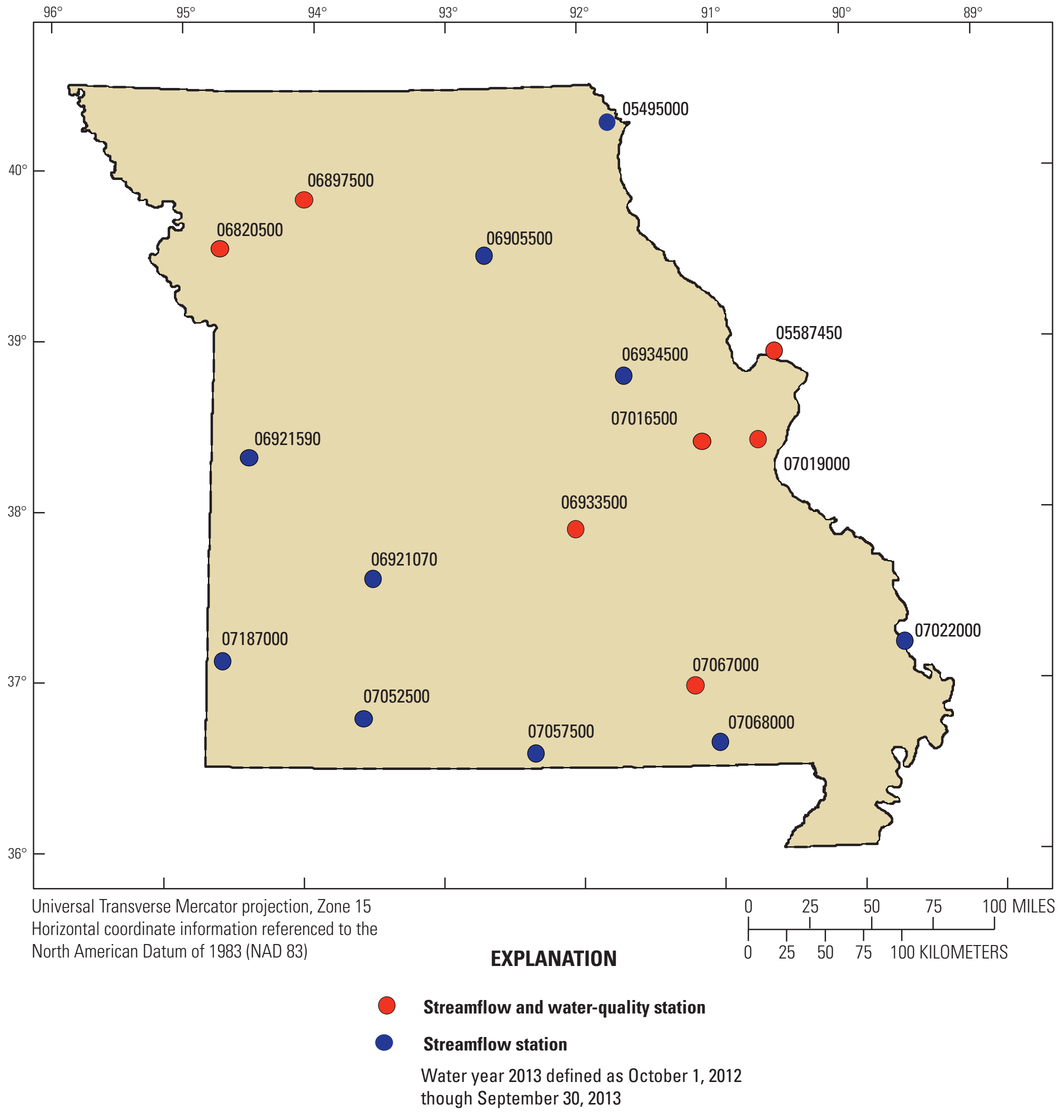


Figure 3. Location of selected streamflow-gaging stations used for summary of hydrologic conditions within Missouri, water year 2013.

area greater than 1,000 mi^2: forest (fo), agricultural (ag), and prairie (pr). Unlike data from land-use indicator sites, observations and analyses from watershed indicator stations can be interpreted as being representative of the general condition of the watershed. In some instances, the agricultural and forest secondary land uses were present; therefore, the convention was to mention them in predominant order. For example, an agriculture and forest (ag/fo) indicator implies that the primary land use of the watershed is agriculture, although a substantial part of the land use is forest.

Hydrologic Conditions

Surface-water streamflow varies seasonally in Missouri and tends to reflect precipitation patterns. During the 2013 water year, the average annual precipitation of the conterminous United States was about 2.03 inches (in.) above the 20th century average. (National Oceanic and Atmospheric Administration, 2013a). Precipitation in Missouri during the 2013 water year ranked above normal with 43.58 in. of total precipitation, whereas the long-term State precipitation average was 40.87 in. (National Oceanic and Atmospheric Administration, 2013b).

The selection of streamflow-gaging stations (hereinafter referred to as “streamgages”) used to describe the variation in hydrologic conditions was based on their geographical distribution across the State and their long period of record. This summary of statewide hydrologic condition data is a legacy of information that was previously provided in the annual Water-Data Reports (U.S. Geological Survey, 1964–2005). Stations used for the hydrologic summary are identified in figure 3.

Six streamgages across the State were selected to determine the 2013 water year monthly mean streamflow

Table 3. Peak discharge for the 2013 water year and select periods of record for selected streamgages.

[2013 water year defined as October 1, 2012 through September 30, 2013; Peak discharge in cubic feet per second]

U.S. Geological Survey station number[a]	Station name (period of record used for statistical summaries in water years)	2013 water year		Long-term period of record	
		Peak discharge	Date	Peak discharge	Date
05495000	Fox River at Wayland, Missouri (1922–2013)	11,900	Apr. 19	26,400	Apr. 22, 1973
05587450	Mississippi River at Grafton, Illinois (1987–2013)	453,000	Apr. 25	598,000	Aug. 1, 1993
06905500	Chariton River near Prairie Hill, Missouri (1929–2013)	35,000	Apr. 18	38,400	July 27, 2008
06933500	Gasconade River at Jerome, Missouri (1903–2013)	138,000	Aug. 7	138,000	Aug. 7, 2013
06934500	Missouri River at Hermann, Missouri (1958–2013)	457,000	June 1	750,000	July 31, 1993
07019000	Meramec River near Eureka, Missouri (1904–2013)	51,100	Mar. 20	145,000	Dec. 6, 1982
07022000	Mississippi River at Thebes, Illinois (1933–2013)	803,000	June 6	996,000	Aug. 7, 1993
07057500	North Fork River near Tecumseh, Missouri (1945–2013)	30,500	Aug. 8	133,000	Nov. 19, 1985
07068000	Current River at Doniphan, Missouri (1921–2013)	33,200	June 3	122,000	Dec. 3, 1982

[a] Stations 05587450, 06933500, and 07019000 are streamflow-gaging stations only and not part of the Ambient Water-Quality Monitoring Network (AWQMN).

Table 4. Seven-day low flow for water year 2013, period of record 7-day low flow, and period of record minimum daily mean flow for selected streamgages in Missouri.

[2013 water year defined as October 1, 2012 through September 30, 2013; Peak discharge in cubic feet per second]

U.S. Geological Survey station number[a]	Station name (period of record in water years)	7-day low flow		Minimum daily mean flow for period of record	
		2013	Period of record	Discharge	Date
05495000	Fox River at Wayland (1922–2013)	0.48	0	0	Several years
06820500	Platte River near Agency (1933–2013)	16	0	0	Several years
06921070	Pomme de Terre river near Polk (1969–2013)	11	0.21	0.17	Aug. 13, 2012
07016500	Bourbeuse River near Union (1921–2013)	50	13	12	Oct. 10, 1956
07067000	Current River at Van Buren (1912–2013)	770	479	476	Oct. 8, 1956
07187000	Shoal Creek above Joplin (1942–2013)	66	16	15	Sept. 7, 1954

[a] Stations 06820500, 07016500, and 07067000 are streamflow-gaging stations only and not part of the Ambient Water-Quality Monitoring Network (AWQMN).

and the long-term median of monthly mean streamflow (fig. 4). Monthly mean streamflow is the arithmetic mean of daily streamflow for a given month. For comparison to the current water year (2013), a historical monthly median was attained from the median of all monthly mean streamflows for the available period of record. Of these six stations, three (05495000, 06921590, and 07052500; table 1, fig. 4) are part of the AWQMN and the remaining three (06897500, 06933500, and 07067000; fig. 4) are streamgages only and are not part of the AWQMN (fig 4). Monthly mean streamflows for the current water year (2013) were lower than the long-term medians for the northern stations (05495000, 06897500, and 06921590) from October through January (fig. 4). The monthly mean streamflows for the three southern stations (06933500, 07052500, and 07067000) were higher than the long-term median for the month of August because of intensive rainfall during a short time period, which caused significant flooding in some basins (fig. 4).

Peak streamflow for the 2013 water year and select periods of record are presented for nine streamgages (fig. 3; table 3). The peak streamflow values presented in table 3 show that there was a peak flow in the long-term period of record for the Gasconade River at Jerome in 2013. The 7-day low flow for the period of record, and the minimum daily mean flow for the 2013 water year are presented for selected stations in table 4.

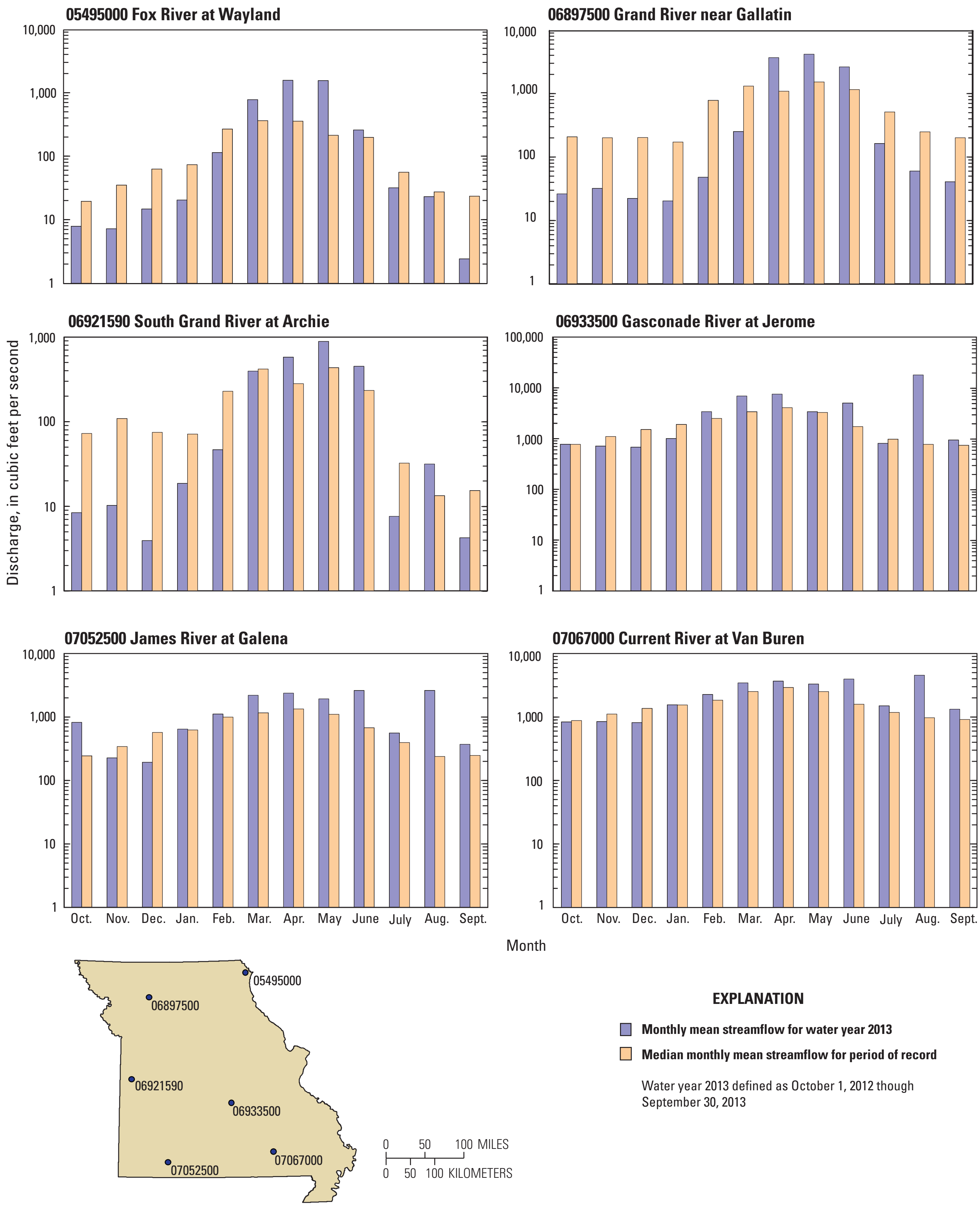


Figure 4. Monthly mean streamflow for water year 2013 and long-term median of monthly mean streamflow at six representative streamgages.

Distribution, Concentration, and Detection Frequency of Select Constituents

The analyses presented in this report include the following constituents: DO, specific conductance, water temperature, suspended solids, suspended sediment, *E. coli* bacteria, fecal coliform bacteria, dissolved nitrate plus nitrite as nitrogen (hereinafter referred to as "nitrate plus nitrite"), total phosphorus, and dissolved and total recoverable lead and zinc. Boxplots of these constituents are presented for the different classes (figs. 5–7). In addition, pesticide data were analyzed from eight stations. Three Big River stations (05587455, 06934500, and 07022000) had pesticide analyses as part of the NASQAN program, which began using a new method of pesticide analyses during the 2013 water year. Many constituents available using the new method were similar to the consituents available with traditional pesticide sampling methods used for the AWQMN stations, but because of the different method, some have different LRLs (fig. 8). Of the 85 pesticide constituents analyzed during the water year, 16 had concentrations larger than their LRL and are presented in this report: 2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT; a degradation product of atrazine), acetochlor, alachlor, atrazine, diazinon, dicrotophos, fipronil, hexazinone, metolachlor, metribuzin, prometon, prometryn, simazine, tebuconazole, tebuthiuron, and terbuthylazine (fig. 8). Missouri water-quality standards are not shown on the graphs because these standards are not applicable to all streams in the AWQMN network. For specific information on Missouri water-quality standards, refer to Missouri Department of Natural Resources (2012b).

Distribution of Physical Properties, Suspended-Solids Concentration, Suspended-Sediment Concentration, and Indicator Bacteria Density

The physical properties analyzed for this report were DO, specific conductance, and water temperature. The median DO, in percent saturation, ranged from 72 to 111 percent (fig. 5). Samples from OSPL wi ag stations had the lowest median DO percent saturation values, whereas samples from URBAN stations had the highest median DO (fig. 5). Median specific conductance values varied substantially among the station classes (fig. 5), ranging from 60 microsiemens per centimeter at 25 degrees Celsius (mS/cm at 25 °C) at the OSPL pr station to 807 mS/cm at 25 °C at the BRMOS station. Median water temperature values ranged from 10.5 to 20.5 degrees Celsius, with the smallest median measured at the BRMIG station and the largest median measured at BRMOH stations (fig. 5). The range in water temperature at the SPRING stations was much smaller than at any other station class.

Suspended solids and suspended sediment are measures of the solid material suspended in the water column. These two measures are not considered directly comparable because of differences in collection and analytical techniques. Suspended-solids concentrations were determined at all stations except BRMIT and BRMOH. Median suspended-solids concentrations varied considerably between all station classes, ranging from 15 to 78 milligrams per liter (mg/L). Samples collected at the OZPL (SA fo/ag, SA wi fo/ag, and SP ag/fo), SPRING, and URBAN stations had median concentrations less than the MRL and data distributions such that boxplots could not be generated. The BRMOS station had the largest median suspended-solids concentrations. Suspended-sediment concentrations were determined only at four Big River stations (fig. 5). The suspended-sediment data used in this report consist of composited cross-sectional concentrations and average cross-sectional concentrations computed from five depth-integrated samples within the cross-section (Edwards and Glysson, 1999). Additional suspended-sediment concentrations from individual depth-integrated samples within cross-sections are available on NWISWeb (*http://nwis.waterdata.usgs.gov/mo/nwis/qwdata*). Median suspended-sediment concentrations ranged from 74 mg/L at BRMIG to 206 mg/L at BRMOSJ (fig. 5).

Median *E. coli* densities ranged from 5 to 1,250 colonies per 100 milliliters, and fecal coliform bacteria densities ranged from 13 to 1,400 (fig. 5). The smallest median densities were in samples collected at SPRING stations, whereas the largest median densities were in samples collected at BRMOS (fig. 5). Median *E. coli* and fecal coliform bacteria densities varied considerably between all station classes.

Distribution of Dissolved Nitrate plus Nitrite and Total Phosphorus Concentrations

Samples were collected at all stations for the analysis of nutrients, including dissolved nitrate plus nitrite and total phosphorus. Median dissolved nitrate plus nitrite and total phosphorus concentrations varied considerably between all station classes (fig. 6), ranging from 0.047 to 3.84 mg/L for nitrate plus nitrite and 0.02 to 0.35 mg/L for total phosphorus. The smallest median dissolved nitrate plus nitrite concentrations were detected at DTPL ag stations, and the largest concentrations were detected in samples collected at URBAN stations (fig. 6). The smallest median total phosphorus concentrations were detected at the OZPLSA (fo/ag and wi fo/ag) and SPRING stations, all of which had median values equal to the LT-MDL, and the largest median concentration was at the BRMIT station (fig. 6).

Distribution of Dissolved and Total Recoverable Lead and Zinc Concentrations

Samples were collected for the analysis of dissolved and total recoverable trace elements, including lead and zinc. No dissolved or total recoverable lead and zinc samples were collected at the BRMIT and BRMOH stations. Median

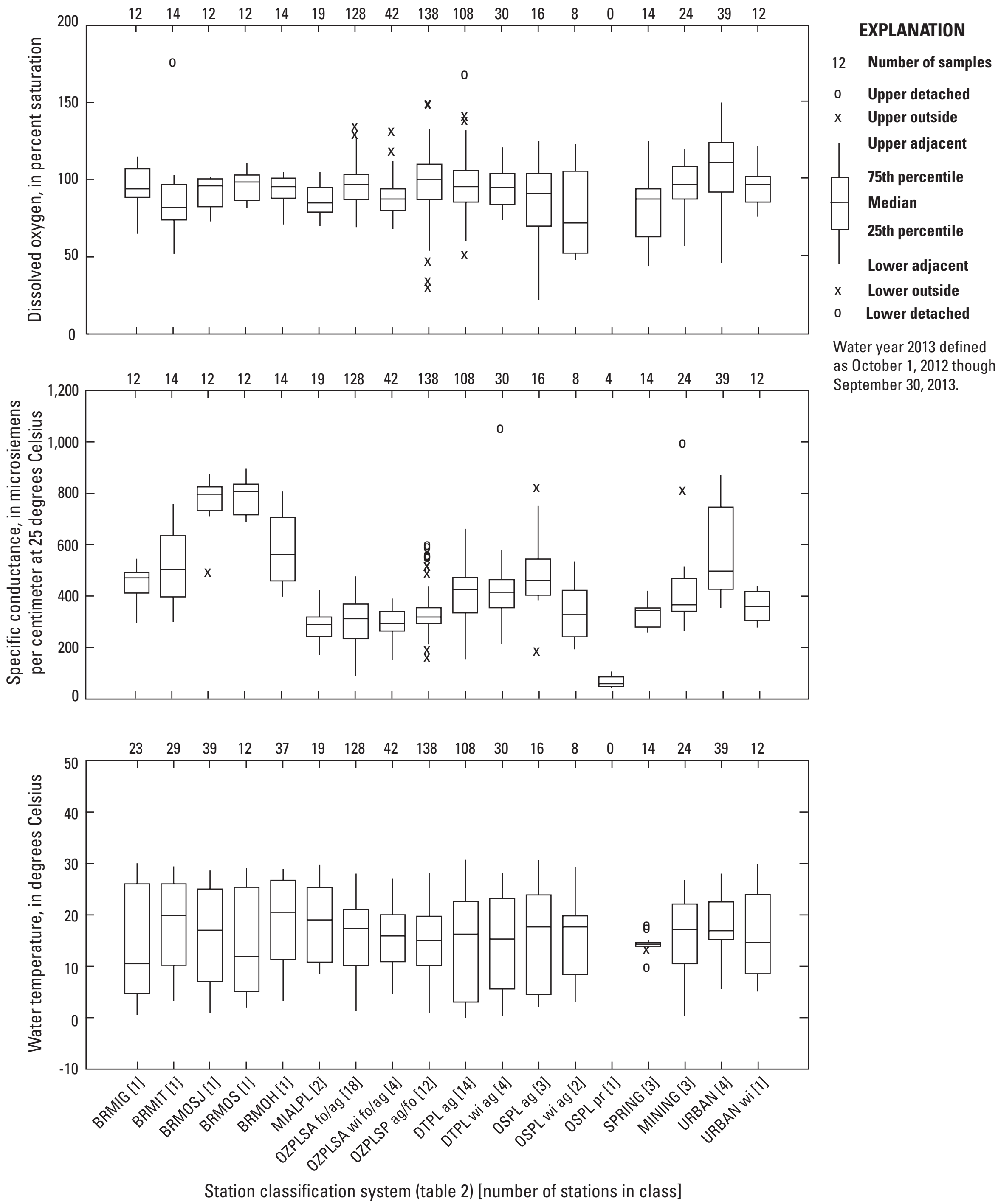


Figure 5. Distribution of physical properties, suspended-solids concentrations, suspended-sediment concentrations, and indicator bacteria densities in samples from 76 stations, water year 2013.

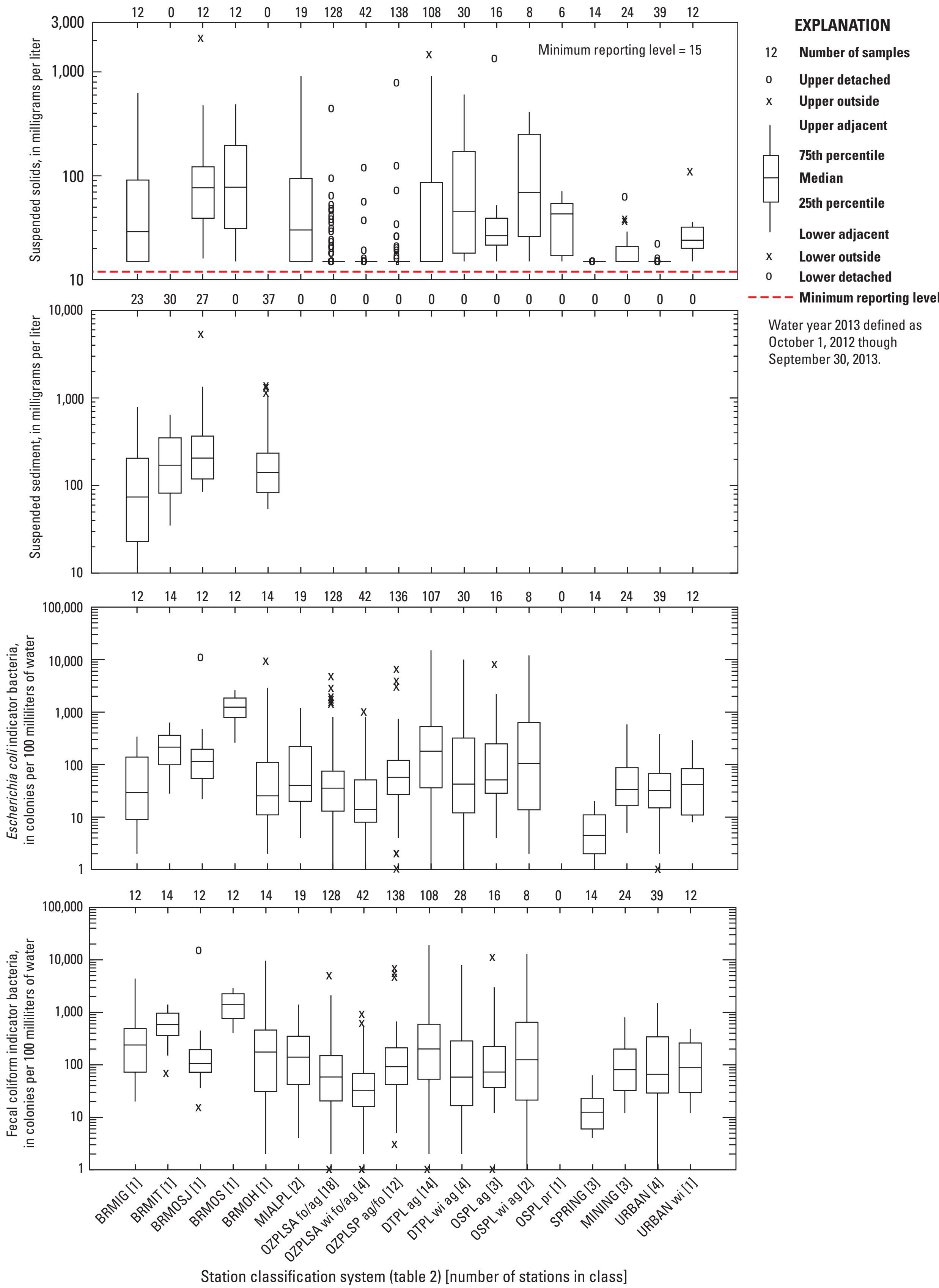


Figure 5. Distribution of physical properties, suspended-solids concentrations, suspended-sediment concentrations, and indicator bacteria densities in samples from 76 stations, water year 2013.–Continued

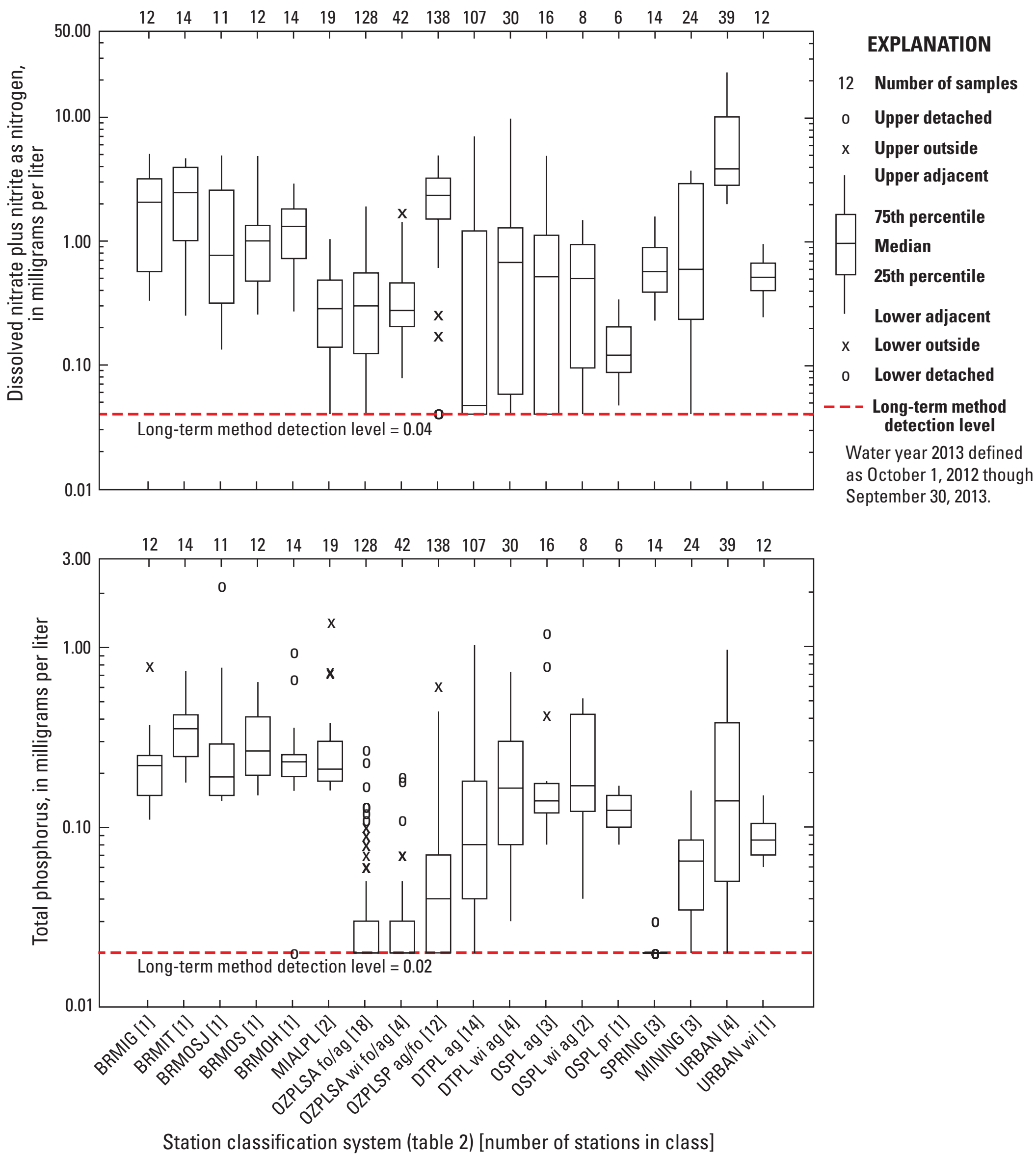


Figure 6. Distribution of dissolved nitrate plus nitrite as nitrogen and total phosphorus concentrations in samples from 76 stations, water year 2013.

concentration ranges were 0.025 to 0.49 micrograms per liter (µg/L) of dissolved lead, 0.075 to 11.9 µg/L of total recoverable lead, 1.4 to 14.6 µg/L of dissolved zinc, and 3.0 to 18.85 µg/L of total recoverable zinc (fig. 7).

The smallest median concentrations of dissolved lead were detected at LT-MDL in samples collected a DTPL ag and OZPLSP ag/fo (fig. 7). Median dissolved zinc concentrations were detected at the LT-MDL for all classes except MINING and URBAN, with URBAN having the highest median concentration. Although large median concentrations of trace elements were detected at the MINING stations, median concentrations of total recoverable lead were largest at the URBAN wi station and at URBAN stations for dissolved zinc. MINING stations had the largest median concentration of total recoverable zinc and dissolved lead.

Concentration and Detection Frequency of Select Pesticides from Selected Stations

Samples for the analysis of dissolved pesticides were collected at eight stations in the AWQMN, including three of the five Big River stations (BRMIG, BRMIT, and BRMOH), both stations in the MIALPL, one DTPL ag station, one OSPL wi ag station, and one URBAN station. Data from 16 compounds detected at concentrations greater than the LRL at 1 or more stations are presented graphically in this report (fig. 8). The most frequently detected pesticides were CIAT, acetochlor, alachlor, atrazine, metolachlor, metribuzin, and simazine. The concentrations for all pesticide compounds analyzed for all stations were less than 1.00 µg/L except atrazine and

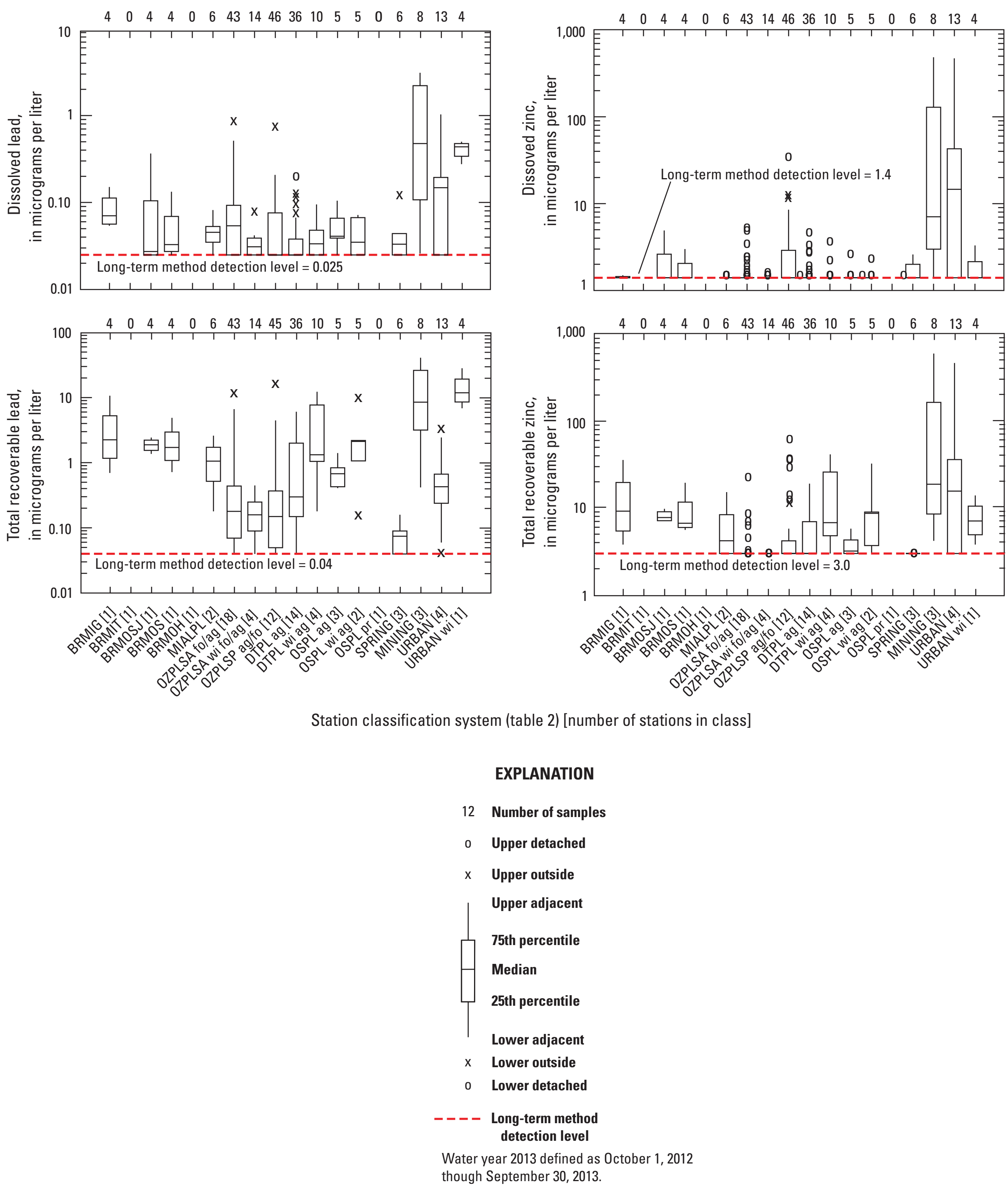
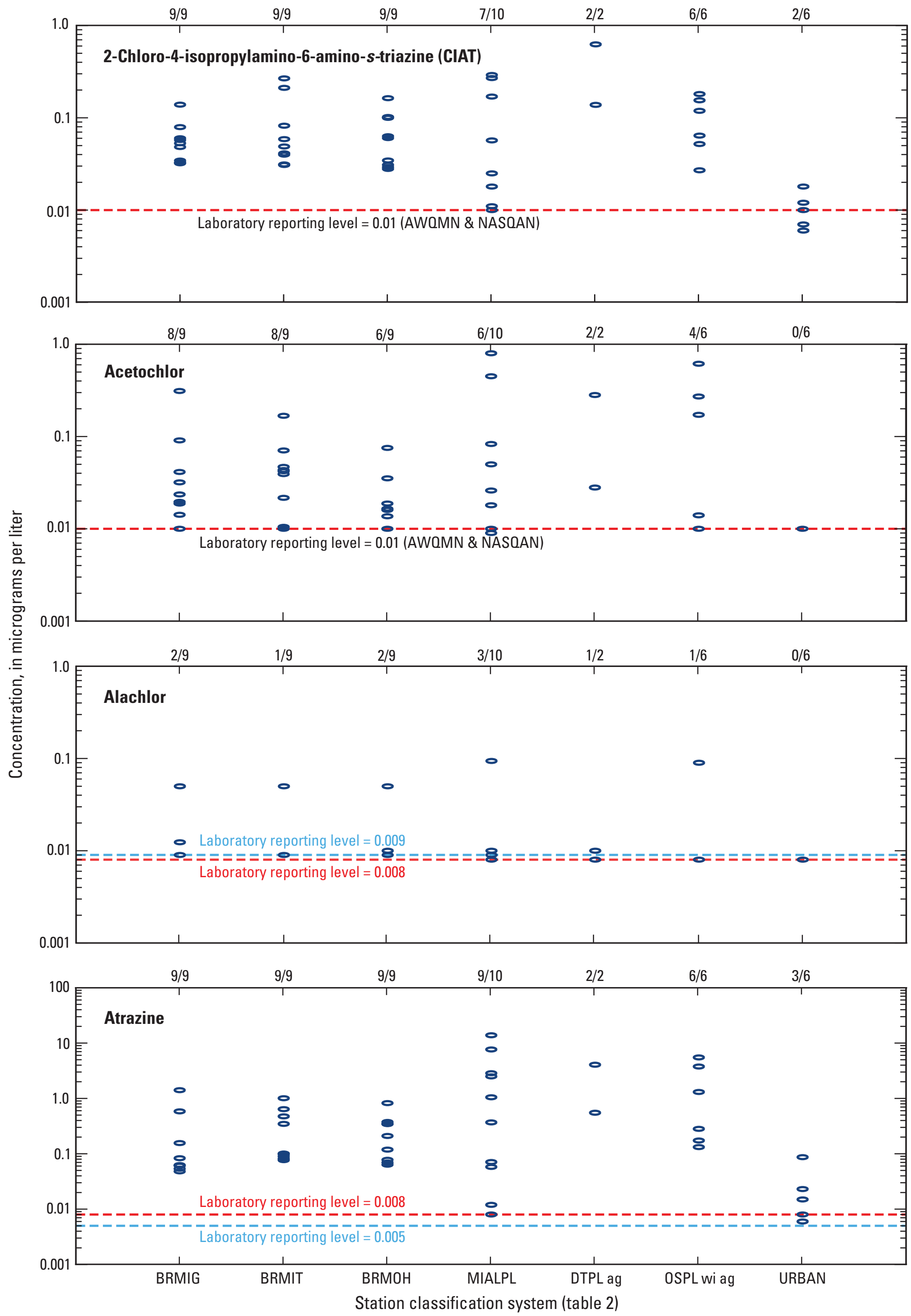


Figure 7. Distribution of dissolved and total recoverable lead and zinc concentrations from 76 stations, water year 2013.



EXPLANATION

Laboratory reporting level (LRL) for Ambient Water-Quality Monitoring Network (AWQMN) collections —Concentrations less than LRL are estimated

Laboratory reporting level (LRL) for U.S. Geological Survey National Stream Quality Account Network (NASQAN) collections —Concentrations less than LRL are estimated

Sample

12/12 **Number of detections/total number of samples**

Water year 2013 defined as October 1, 2012 though September 30, 2013

Figure 8. Detection of select pesticides from selected stations, water year 2013.

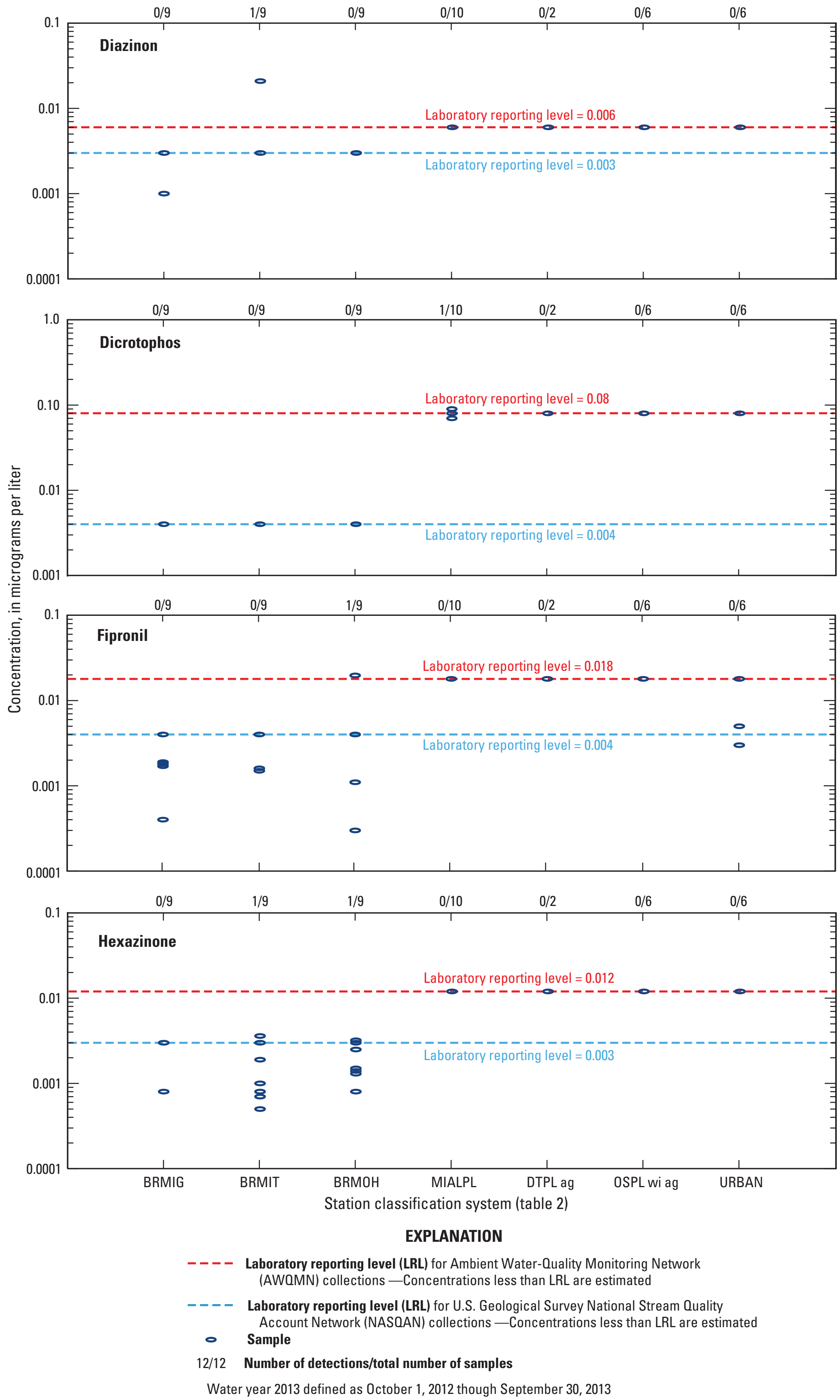


Figure 8. Detection of select pesticides from selected stations, water year 2013.—Continued

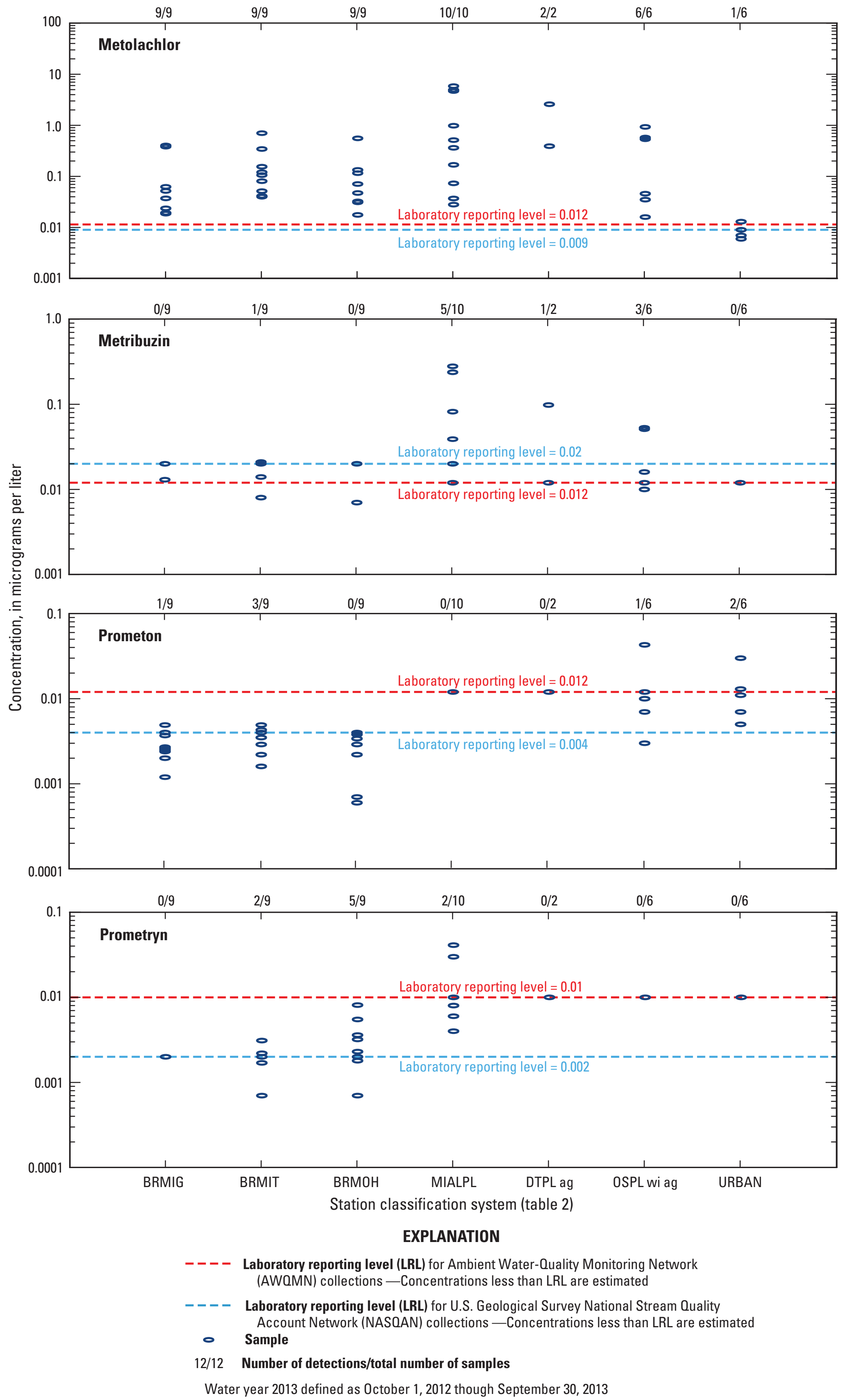


Figure 8. Detection of select pesticides from selected stations, water year 2013.—Continued

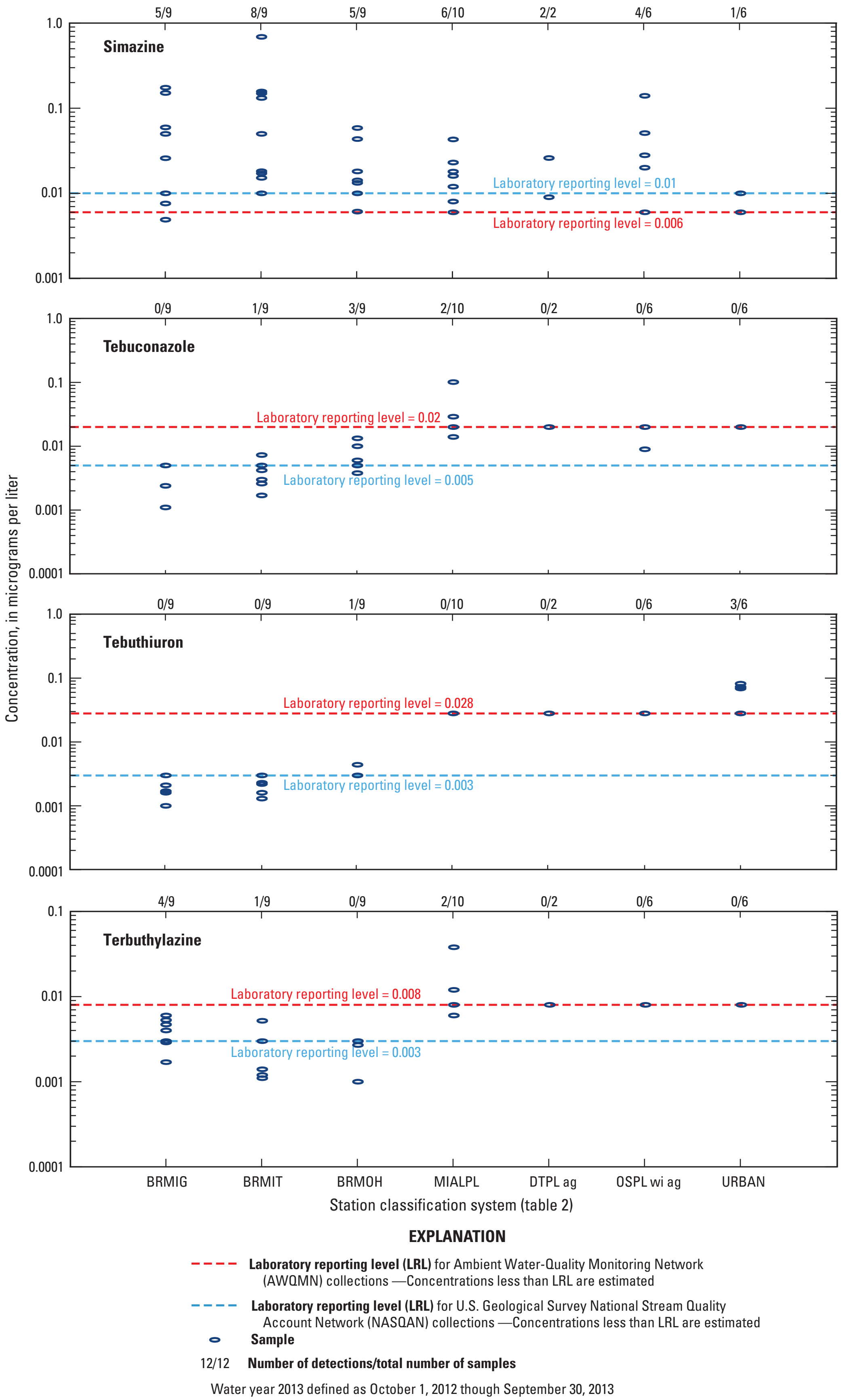


Figure 8. Detection of select pesticides from selected stations, water year 2013.—Continued

metolachlor. Atrazine concentrations ranged from 0.006 to 13.8 µg/L. Metolachlor concentrations ranged from 0.006 to 5.85 µg/L. Of the 16 pesticide compounds with concentrations greater than the LRL, 8 had largest concentrations at the MIALPL stations (fig. 8).

References Cited

Barr, M.N., 2010, Quality of surface water in Missouri, water year 2009: U.S. Geological Survey Open-File Report 2010–1233, 22 p., accessed July 2014 at *http://pubs.usgs.gov/of/2010/1233/*.

Barr, M.N., 2011, Quality of surface water in Missouri, water year 2010: U.S. Geological Survey Data Series 636, 21 p., accessed July 2014 at *http://pubs.usgs.gov/ds/636/*.

Barr, M.N., 2012, Quality of surface water in Missouri, water year 2011: U.S. Geological Survey Data Series 734, 22 p., accessed July 2014 at *http://pubs.usgs.gov/ds/734/*.

Barr, M.N., 2014, Quality of surface water in Missouri, water year 2012: U.S. Geological Survey Data Series 818, 24 p., accessed July 2014 at *http://dx.doi.org/10.3133/ds818.*

Barr, M.N., and Davis, J.V., 2010, Surface-water quality conditions and long-term trends at selected sites within the ambient water-quality monitoring network in Missouri, water years 1993–2008: U.S. Geological Survey Scientific Investigations Report 2010–5078, 42 p.

Childress, C.J.O., Foreman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99–193, 19 p.

Edwards, T.K., and Glysson, G.D., 1999, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C2, accessed August 2014 at *http://pubs.usgs.gov/twri/twri3-c2/*.

Fenneman, N.M., 1938, Physiography of eastern United States: New York, McGraw-Hill Book Co., Inc., 689 p.

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.

Garbarino, J.R., Kanagy, L.K., and Cree, M.E., 2006, Determination of elements in natural-water, biota, sediment and soil samples using collision/reaction cell inductively coupled plasma-mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, chap. B1, 88 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, accessed July 2014 at *http://pubs.usgs.gov/twri/twri5c1/*.

Helsel, D.R., and Hirsch, R.M., 2002, Statistical methods in water resources: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. A3, accessed July 2014 at *http://pubs.usgs.gov/twri/twri4a3/*.

Missouri Department of Natural Resources, 2012a, Missouri water quality report: Section 305(b) Report, accessed July 2014 at *http://www.dnr.mo.gov/env/wpp/docs/2012-305b-report.pdf.*

Missouri Department of Natural Resources, 2012b, Missouri water quality standards—Chapter 7, Water quality: Jefferson City, Missouri, Clean Water Commission, 150 p.

Myers, D.N., Stoeckel, D.M., Bushon, R.N., Francy, D.S., and Brady, A.M.G., 2014, Fecal indicator bacteria (ver. 2.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, section 7.1, accessed August 2014 at *http://pubs.water.usgs.gov/twri9A/*.

National Oceanic and Atmospheric Administration, 2013a, State of the climate—National overview for annual 2013: accessed May 2014 at *http://www.ncdc.noaa.gov/sotc/national/2013/13*.

National Oceanic Atmospheric Administration, 2013b, 2013 Missouri climate summary: National Climatic Data Center database, accessed May 2014 at *http://www.ncdc.noaa.gov/cag/*.

Otero-Benitez, W., and Davis, J.V., 2009a, Quality of surface water in Missouri, water year 2007: U.S. Geological Survey Open-File Report 2009–1096, 19 p., accessed July 2014 at *http://pubs.usgs.gov/of/2009/1096/*.

Otero-Benitez, W., and Davis, J.V., 2009b, Quality of surface water in Missouri, water year 2008; U.S. Geological Survey Open-File Report 2009–1214, 18 p., accessed July 2014 at *http://pubs.usgs.gov/of/2009/1214/*.

Patton, C.J., and Truitt, E.P., 1992, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of total phosphorus by a Kjeldahl digestion method and an automated colorimetric finish that includes dialysis: U.S. Geological Survey Open-File Report 92–146, 39 p.

Patton, C.J., and Kryskalla, J.R., 2011, Colorimetric determination of nitrate plus nitrite in water by enzymatic reduction, automated discrete analyzer methods: U.S. Geological Survey Techniques and Methods, book 5, chap. B8, 48 p.

Sandstrom, M.W., Stroppel, M.E., Foreman, W.T., and Schroeder, M.P., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of moderate-use pesticides and selected degradates in water by C-18 solid-phase extraction and gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01–4098, 70 p.

U.S. Census Bureau, 2013, U.S. population estimates: accessed May 2014 at *http://www.census.gov/*.

U.S. Environmental Protection Agency, 1997, Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic updates: Washington, D.C., Office of Water, EPA–841–B97–002A, [variously paged], accessed July 2014 at *http://www.epa.gov/owow/monitoring/guidelines.html*.

U.S. Geological Survey, 1964–2005, Water resources data—Missouri: [variously paged].

U.S. Geological Survey, 2006, Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, accessed July 2014 at *http://pubs.water.usgs.gov/twri9A4*.

U.S. Geological Survey, 2006–2010, Water resources data for the United States: Water-Data Report, accessed July 2014 at *http://wdr.water.usgs.gov/*.

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, accessed July 2014 at *http://pubs.water.usgs.gov/twri9A*.

Wilde, F.D., ed.,variously dated, Field measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, accessed July 2014 at *http://pubs.water.usgs.gov/twri9A6/*.

Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 2004, with updates through 2009, Processing of water samples (ver. 2.2): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5, accessed May 2013 at *http://pubs.water.usgs.gov/twri9A5/*.

Zaugg, S.D., Sandstrom, M.W., Smith, S.G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography/mass spectrometry with selected-ion monitoring: U.S. Geological Survey Open-File Report 95–181, 49 p.

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