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Science to Support the Understanding of Ohio's Water Resources, 2016–17

Introduction

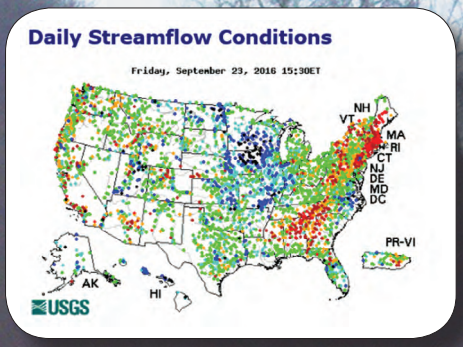
Ohio's water resources support a complex web of human activities and nature—clean and abundant water is needed for drinking, recreation, farming, and industry, as well as for fish and wildlife needs. Although rainfall in normal years can support these activities and needs, occasional floods and droughts can disrupt streamflow, groundwater, water availability, water quality, recreation, and aquatic habitats. Ohio is bordered by the Ohio River and Lake Erie; it has over 44,000 miles of streams and more than 60,000 lakes and ponds (State of Ohio, 1994). Nearly all of the rural population obtains drinking water from groundwater sources.

The U.S. Geological Survey (USGS) works in cooperation with local, State, and other Federal agencies, as well as universities, to furnish decisionmakers, policy makers, USGS scientists, and the general public with reliable scientific information and tools to assist them in management, stewardship, and use of Ohio's natural resources. The diversity of scientific expertise among USGS personnel enables them to carry out large- and small-scale multidisciplinary studies. The USGS is unique among government organizations because it has neither regulatory nor developmental authority—its sole product is impartial, credible, relevant, and timely scientific information, equally accessible and available to everyone. The USGS Ohio Water Science Center provides reliable hydrologic and water-related ecological information to aid in the understanding of the use and management of the Nation's water resources, in general, and Ohio's water resources, in particular. This fact sheet provides an overview of current (2016) or recently completed USGS studies and data activities pertaining to water resources in Ohio. More information regarding projects of the USGS Ohio Water Science Center is available at http://oh.water.usgs.gov/.

Major watersheds within the Ohio River and Lake Erie Basins.

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

Fact Sheet 2016–3087
November 2016



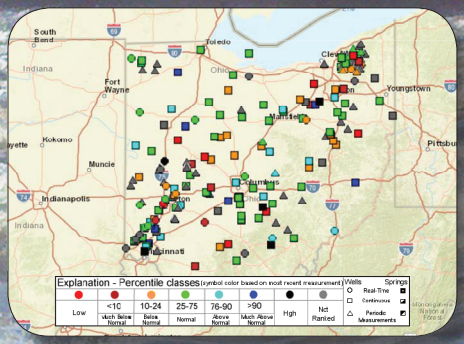
Streamflow Data Available Online

The USGS in Ohio—in cooperation with local, State, and Federal partners—operates about 280 streamgages, about 200 of which are used to compute streamflow. There are about 8,250 USGS streamgages nationwide; many of these gages provide real-time data in 15- to 60-minute increments and typically transmit the data to the Web every hour via satellite. These streamgages provide streamflow information for a wide variety of uses including flood prediction, water management and allocation, engineering design, research, operation of locks and dams, and recreational safety and enjoyment. In addition to these data, field-measurement data, streamflow statistics, and annual peak streamflows from each station are available on the Web through the National Water Information System (NWIS).

http://waterdata.usgs.gov/oh/nwis/rt

For more information, contact Thomas Harris, tharris@usgs.gov.

Image, top left. Daily streamflow conditions in the United States.



Groundwater Data Available Online

State and local agencies in Ohio in cooperation with the USGS collect, research, interpret, and disseminate groundwater data to characterize the groundwater resources of the State. To address these needs, the Ohio Department of Natural Resources (ODNR) and the Miami Conservancy District (MCD) monitor groundwater levels for more than 140 wells throughout Ohio. Personnel from the USGS Ohio Water Science Center and ODNR compile and publish water levels and summary statistics on the Groundwater Watch, National Ground-Water Monitoring Network, and NWIS Web sites.

http://groundwaterwatch.usgs.gov/statemap.asp?sc=39&sa=OH

For more information, contact Robert Darner, radarner@usgs.gov.

Image, second from top, left. Long-Term Groundwater Data Network in Ohio.

Water-Quality Monitoring Network in Ohio

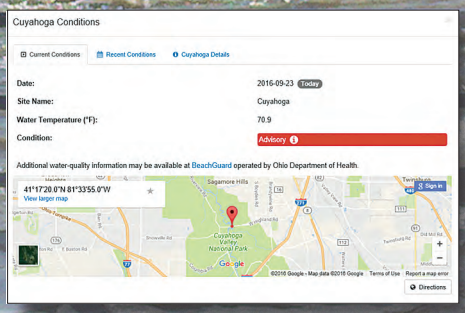
The USGS operates a network of near-real-time water-quality monitoring stations that provide data for temperature, specific conductance, pH, dissolved oxygen, and turbidity of surface water; the data are collected in 15- to 60-minute increments and typically are transmitted to the Web every hour via satellite. These data are needed for decision making regarding drinking water, water treatment, regulatory programs, recreation, healthy ecosystems, and public safety. Data are stored in the NWIS.

http://waterwatch.usgs.gov/wqwatch/

https://waterdata.usgs.gov/oh/nwis/current/?type=quality&group_key=NONE

For more information, contact Kimberly Shaffer, kshaffer@usgs.gov.

Photo, immediate left. Water-quality monitoring site visit at Beaver Creek. Photo by Kimberly H. Shaffer.



Nowcast—Water-Quality Conditions at Beaches and a Recreational River

Local agencies monitor water to measure the concentration of *Escherichia coli* (*E. coli*)—an indicator bacterium found in sewage and other animal wastes—to determine whether the water is safe for contact recreation such as swimming or canoeing. Conventional analytical methods can take 18 to 24 hours to yield results. To improve the timeliness and accuracy of recreational water-quality assessments, quick measurements, such as rainfall or water clarity, can be used to estimate the probability that *E. coli* exceeds safe levels. For example, the Ohio Nowcast has been providing near-real-time beach advisories to the public since 2006 through use of quick measurements and predictive models. In 2016, a new interactive format was introduced for the Ohio Nowcast that allows users to obtain water-quality information for eight Lake Erie beaches and one recreational river site using their computer or mobile device. In a study at 49 Great Lakes beaches, the USGS, in cooperation with many local and State agencies, found that predictive models overall performed better than the conventional methods to assess recreational water quality (Francy and others, 2013).

http://ny.water.usgs.gov/maps/ohnowcast/

For more information, contact Donna Francy, dsfrancy@usgs.gov.

Image, bottom left. Nowcast conditions at Cuyahoga River.

Crest-Stage Streamgage Network in Ohio

Historically, small streams with drainage areas less than 100 square miles have been under represented in regional peak-flow analyses. To help fill this data gap, crest-stage gages were installed during 2001 at 17 sites throughout Ohio to augment the peak-flow records for small-drainage-area streams. After enough annual peaks have been collected at these sites, the statewide flood-frequency analysis can be updated to improve the estimation of peak flows.

http://oh.water.usgs.gov/crest-stage.html

For more information, contact Branden Vonins, blvonins@usgs.gov.

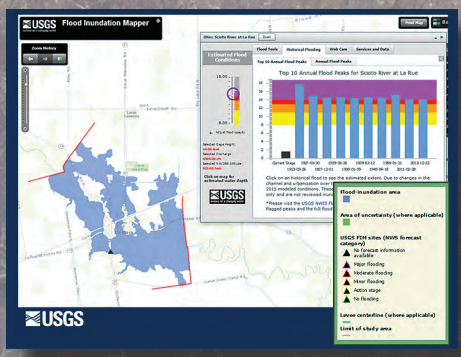
Photo, top right. Crest-stage streamgage in Ohio. Photo by Branden Vonins.

Flood-Studies and Flood-Warning Systems Program

This program employs hydrologic and hydraulic analyses to determine water-surface elevations associated with specific flood magnitudes at several points along a stream channel. The water-surface elevation data are used together with land-surface elevation data to determine and map the corresponding spatial extent of flood inundation. In some cases, libraries of flood-inundation maps are prepared for stream channels near USGS streamgages at which the National Weather Service (NWS) forecasts flood levels. In those cases, the NWS forecasts can be used in advance of flooding through map-based Web applications (for example, see http://wim.usgs.gov/FIMI) to determine areas that are likely to flood at the forecasted levels. These studies and tools serve as a foundation for making science-based decisions to better manage flood risk and efforts to mitigate flood impacts.

http://water.usgs.gov/osw/flood_inundation/

For more information, contact Dave Straub, destraub@usgs.gov.



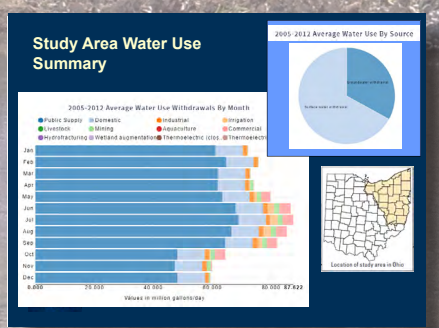
Image, second from top, right. Flood Inundation Mapper output for Scioto River at La Rue.

StreamStats

StreamStats is a Web-based geographic information system (GIS) application that allows users to easily obtain selected low-flow and peak-flow statistics; daily, monthly, and annual streamflow statistics; and basin characteristics for ungaged stream sites in Ohio. Published statistics for gaged sites also can be obtained through the StreamStats application. The StreamStats interface is being revised but still includes an assortment of analytical tools that are useful for water-resources planning and management. A recent addition to Ohio's StreamStats application provides information on average historical water use within basins in the northeast quadrant of Ohio.

http://water.usgs.gov/osw/streamstats/ohio.html

For more information, contact Greg Koltun, gfkoltun@usgs.gov.



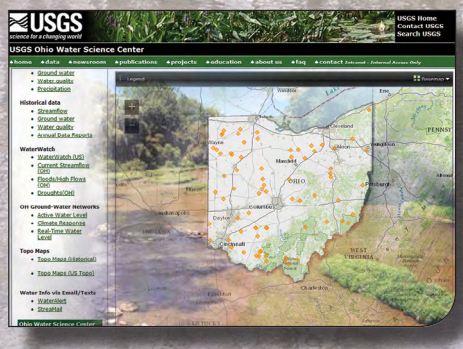
Image, center right. Water-withdrawal data now available from StreamStats for basins in the northeast quadrant of Ohio.

Low-Flow Streamgage Network in Ohio

Data on low-flow characteristics are used by water-resource managers for a variety of purposes, including water-supply planning, making decisions about wastewater-discharge and water withdrawal permits, and evaluating instream-flow requirements. The Ohio Water Science Center collects low-flow data throughout Ohio to expand the base of available information. The Ohio low-flow network consists of both continuous-record streamflow sites and sites where streamflow is measured only during low-flow periods.

http://oh.water.usgs.gov/low-flow_network.html

For more information, contact Joel Metzker, jmetzker@usgs.gov.

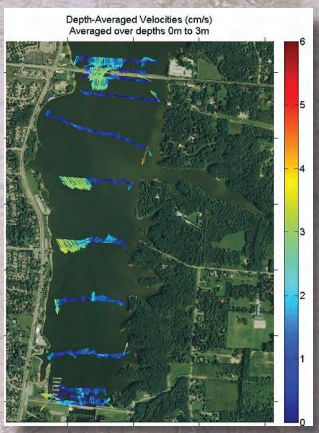


Image, second from bottom, right. Location map of low-flow streamgages.

Synoptic Survey of Hoover Reservoir

The USGS has been working with the City of Columbus to better understand the physical and water-quality characteristics of the lower portion of the Hoover Reservoir near Westerville, Ohio. Specific objectives include measuring and mapping velocity vectors and water-quality parameters of the lower Hoover during separate releases from different withdrawal valves.

For more information, contact Branden Vonins, blvonins@usgs.gov.



Image, bottom right. Depth-averaged velocities at Hoover Reservoir 0 to 3 meters beneath the water surface.

Great Lakes Restoration Initiative (GLRI)

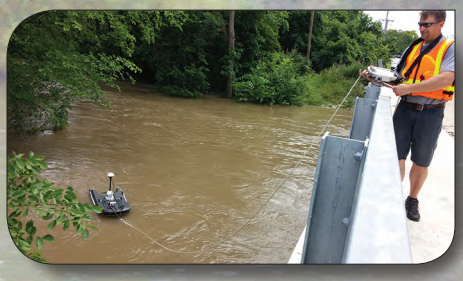
As part of the interagency GLRI effort, the USGS is collecting continuous water-quality monitoring data and nutrient and sediment samples in Ohio at four tributaries to Lake Erie and one edge-of-field monitoring site. The 4 tributaries (Maumee River, Vermilion River, Black River, and Cuyahoga River) are monitored to quantify inputs to Lake Erie and are part of a larger network of 24 regional tributaries to the Great Lakes. The Maumee River Basin is a priority watershed where the USGS is monitoring sediment and nutrients at an edge-of-field site (Eagle Creek waterway 1 near Williamstown), a subsurface-tile site (Eagle Creek tile 1 near Williamstown), and a streamgage (Eagle Creek above Findlay). Data collected at the monitoring sites are used to better understand how differing agricultural practices affect the quantity and quality of runoff water from farms.

https://www.usgs.gov/centers/wisconsin-water-science-center/science/edge-field-monitoring

For more information on the edge-of-field site, contact Carrie Huitger, chuitger@usgs.gov.

For more information on tributary monitoring, contact Erin Bertke, eebertke@usgs.gov.

Photo, top left. Edge of field site. Photo by Carrie Huitger.



Nutrients and Sediment in the Western Lake Erie Basin

Nutrients (nitrogen and phosphorus) are a concern in the Western Lake Erie Basin watersheds in northwestern Ohio. Large inputs of nitrogen and phosphorus compounds into a stream or lake can cause excessive algal growth and may cause taste and odor problems in drinking-water supplies. To better understand the quantity and quality of water from the major tributaries of the Maumee River, nutrient and sediment samples are collected at nine streamgages along the Maumee River and its tributaries. In addition, daily, seasonal, and annual nutrient and sediment loads are estimated for stream reaches at these station locations.

http://arcg.is/21i9CUF

For more information, contact Donna Runkle, dlrunkle@usgs.gov.

Photo, second from top, left. Streamflow measurement at Swan Creek in Toledo. Photo by Donna Runkle.

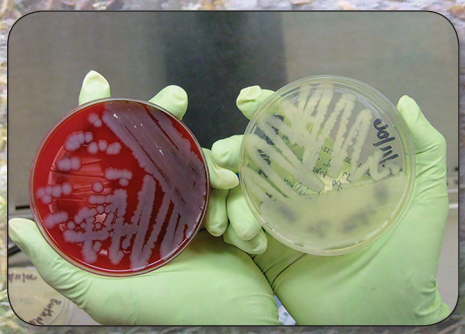
Microbial Source Tracking

The USGS Ohio Water Microbiology Laboratory (OWML) in Columbus has been working with numerous agencies and USGS Water Science Centers to analyze water samples for microbial source tracking (MST) markers using the quantitative polymerase chain reaction (qPCR) method. Results from MST analyses help to characterize the effects of various sources of fecal contamination in a watershed. Currently, water samples can be analyzed for deoxyribonucleic acid (DNA) markers that are associated with humans, cattle and other ruminants, dogs, and waterfowl. In addition to MST marker analyses, other steps are generally taken as part of a multi-tiered approach to source tracking. These steps include conducting sanitary surveys, determining the distributions of bacterial indicators in the watershed, and understanding how hydrologic and meteorological processes affect the distributions of indicators and MST markers.

http://oh.water.usgs.gov/micro_index.htm

For more information, contact Chris Kephart, ckephart@usgs.gov.

Photo, second from bottom, left. Fecal contamination from cattle can be detected by microbial source tracking.



Testing Rapid Detection Methods for Drinking Water and Recreational Waters

Rapid water-quality tests for microorganisms are needed to quickly ensure that water is safe for consumption or recreation. The USGS is testing and optimizing a rapid viability polymerase chain reaction (RV–PCR) method for the detection of viable (living) microorganisms that are potential biological warfare agents. Using a surrogate for *Bacillus anthracis* (the bacterium that causes anthrax), the results from the RV–PCR method are being compared to traditional culture methods. The USGS also has been developing and testing an immunomagnetic method that can provide *E. coli* and enterococci results in 2 hours rather than the conventional 18–24 hours for recreational waters.

http://oh.water.usgs.gov/micro_index.htm

For more information, contact Donna Francy, dsfrancy@usgs.gov.

Photo, bottom, left. Culture of *Bacillus anthracis*.

Modeling Aquatic Species Distributions on the Basis of Physical Habitat and Climate Change

Gap analysis is a coarse-scale assessment of aquatic biodiversity and conservation, the results of which can be used to guide biological field studies and monitoring programs. Potential species distribution models were developed for 130 fish, 70 bivalve, and 17 native crayfish species on the basis of a physical habitat-based classification of the perennial streams in Ohio.

A more recent study has integrated fish-habitat classifications and associated fish-community data with downscaled (regional) climate predictions under different climate-change scenarios to identify vulnerable river systems and to project likely climate-driven changes to important fish species.

http://oh.water.usgs.gov/ohgap.htm

For more information, contact Alex Covert, sacovert@usgs.gov

Photo, top right. Crayfish near stream. Photo by John Tertuliani.

Cyanobacteria and Toxins—Lake Erie and Ohio Inland Lakes

The incidence of cyanobacterial harmful algal blooms (cyanoHABs) and associated toxins has been increasing in frequency and severity worldwide, including the State of Ohio. Microcystins are one of the most frequently detected cyanoHAB toxins in freshwaters. The USGS, in cooperation with partner organizations, is working to develop models to predict microcystin concentrations in rivers and lakes used for recreation and water-supply sources. Samples are analyzed for physical water-quality characteristics, concentrations of nutrients and microcystins, and cyanobacterial gene concentrations, including the presence of toxin genes. In an earlier study of recreational lakes, measures of algal community characteristics (phycocyanin, cyanobacterial biovolume, and cyanobacterial gene concentrations) and pH were strongly correlated with microcystin concentrations; continuous measurements of parameters such as phycocyanin, pH, and temperature over multiple days showed the highest correlations to microcystin concentrations (Francy and others, 2015). Models may be used to focus sample-collection efforts on days when toxins are likely to be elevated, provide near real-time swimming advisories to the public, and help guide drinking-water treatment and intake options.

http://oh.water.usgs.gov/micro_projects_hab_predictions.htm

For more information, contact Donna Francy, dsfrancy@usgs.gov

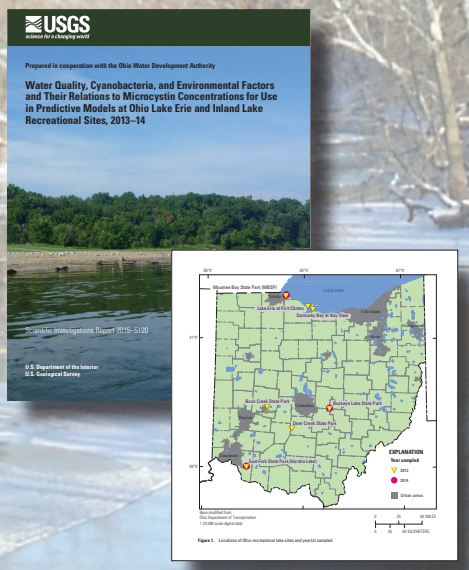


Image set, second from top, right. Recent publication on cyanobacteria, which includes a map of locations in Ohio where recreational lake sites and year(s) are sampled.

Low-Impact Development and Stormwater Control Measures (SCMs)

Low-impact development (LID) is an approach to managing stormwater as near to its source as possible; this is accomplished by minimizing impervious surfaces and promoting more natural infiltration and evapotranspiration than is typically associated with developed areas. Stormwater control measures (SCMs) are engineered attempts to decrease stormwater runoff and associated problems such as increased pollution and flooding in urban areas.

Slavic Village, Cleveland: A groundwater network (19 wells) and weather stations are being used to gather data about two neighborhood block areas to better guide future implementation of SCMs.

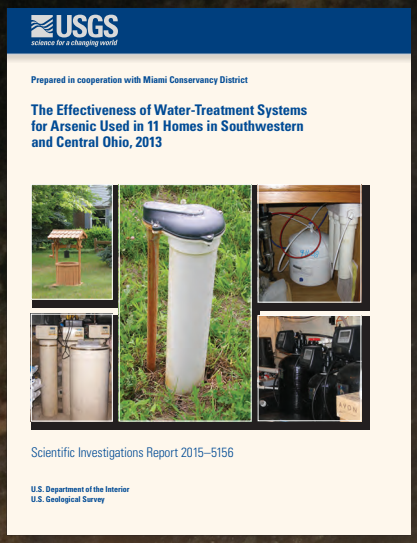
Griggs Reservoir, Columbus: Hydrologic data (meteorological, flow, and groundwater data) are being collected to determine the effectiveness of recently implemented SCMs to reduce stormwater runoff near Griggs Reservoir.

http://oh.water.usgs.gov/bmps.html

For more information, contact Robert Darner, radarner@usgs.gov.

Photo, second from bottom, right. Weather station used in green infrastructure studies, Griggs Reservoir. Photo by Charles Hart.

Photo, bottom, right. Stormwater control measures at Griggs Reservoir. Photo by Rob Darner.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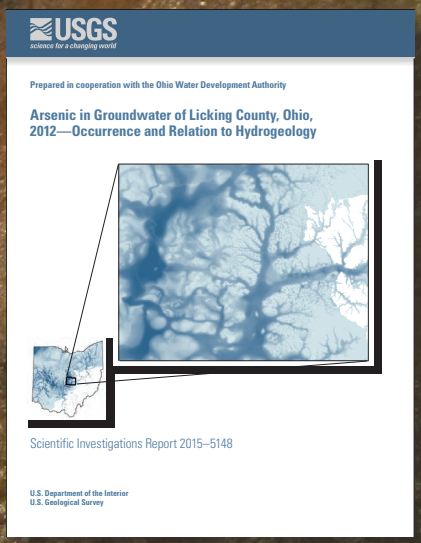
Prepared in cooperation with Miami Conservancy District

The Effectiveness of Water-Treatment Systems for Arsenic Used in 11 Homes in Southwestern and Central Ohio, 2013

Scientific Investigations Report 2015–5156

U.S. Department of the Interior
U.S. Geological Survey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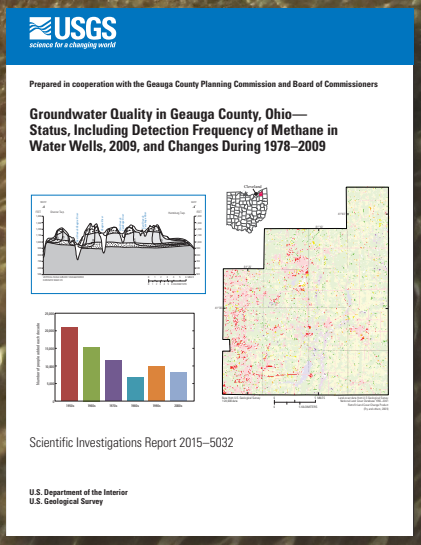
Prepared in cooperation with the Ohio Water Development Authority

Arsenic in Groundwater of Licking County, Ohio, 2012—Occurrence and Relation to Hydrogeology

Scientific Investigations Report 2015–5148

U.S. Department of the Interior
U.S. Geological Survey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Prepared in cooperation with the Geauga County Planning Commission and Board of Commissioners

Groundwater Quality in Geauga County, Ohio—Status, Including Detection Frequency of Methane in Water Wells, 2009, and Changes During 1978–2009

Scientific Investigations Report 2015–5032

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

Arsenic and Methane in Groundwater of Ohio

Arsenic occurs naturally in rocks and soil, and it can be released to groundwater under certain geochemical conditions. Although arsenic is one of the most frequently detected contaminants in Ohio groundwater, most domestic wells are never tested for it, even though long-term exposure to arsenic in drinking water is linked to cancer and other serious health problems (Water Management Association of Ohio, 2016).

A recent study of 168 domestic wells in Licking County found that almost 1 in 8 wells had arsenic concentrations that exceeded the U.S. Environmental Protection Agency Maximum Contaminant Level of 10 parts per billion (Thomas, 2016; U.S Environmental Protection Agency, 2012). Elevated arsenic concentrations were associated with geologic characteristics and geochemical conditions that exist in the western part of the county. The same characteristics exist in other parts of Ohio, and the statewide distribution of these geologic characteristics generally corresponds to areas where elevated arsenic concentrations have been detected in previous studies.

Another recent study investigated the effectiveness of water-treatment methods used to remove arsenic from 11 domestic wells in central and southwestern Ohio. Three types of systems were investigated and the results varied widely, ranging from 2- to 90-percent removal. In general, the effectiveness of arsenic removal was related to the chemical characteristics of the raw water and to maintenance of the treatment equipment (Thomas and Ekberg, 2016).

In parts of southwestern Ohio, a small number of domestic wells with the highest arsenic concentrations also produced methane (Mary Ann Thomas, U.S. Geological Survey, written commun., [October] 2016), a gas that can lead to fire or explosion if it accumulates in enclosed spaces. Methane can occur in groundwater as a result of natural microbial processes or human activities (oil and [or] gas drilling, leaking pipelines, coal mining, landfills, or sewers). The USGS is currently investigating the occurrence and isotopic characteristics of "background" methane found in a range of aquifers across Ohio. This information may be useful in the future to help identify the source of methane detected in wells.

http://arsenicinohiogroundwater.info/

For more information, contact Mary Ann Thomas, mathomas@usgs.gov.

Images top and center, left. Recent publications on Arsenic in Ohio.

Long-Term Water-Level Monitoring Network, Geauga County, Ohio

Residents of Geauga County rely almost exclusively on domestic and public-supply wells tapping groundwater as their source of drinking water. County planners are concerned that steady population growth, in combination with the predominance of groundwater use in the county, will result in water being withdrawn faster than it is recharged. The USGS is monitoring groundwater levels in 30 wells across the county that are open to four widely used aquifers. Knowledge about the magnitude and locations of groundwater declines in the county is needed to assist in planning for continued growth and conservation of groundwater resources.

Another USGS project, which involves monitoring water levels within a network in the vicinity of South Russell, Geauga County, is designed to evaluate whether variations in groundwater levels are caused by residential and commercial development or by annual variations in precipitation.

http://groundwaterwatch.usgs.gov/countymap.asp?sa=OH&cc=055

http://pubs.usgs.gov/sir/2015/5032/ pages 10–11

For more information, contact Martha Jagucki, mjagucki@usgs.gov.

Image, bottom left. Recent publication on groundwater quality in Geauga County.

National Water-Quality Assessment (NAWQA) Program

The program was established in 1991 to provide an understanding of water-quality conditions; whether conditions are getting better or worse over time; and how natural features and human activities affect those conditions. Regional and national assessments are possible because of a consistent study design and uniform methods of data collection and analysis. Monitoring data are integrated with geographic information on hydrological characteristics, land use, and other landscape features in models to extend water-quality understanding to unmonitored areas. Local, State, Tribal, and national stakeholders use NAWQA information to design and implement strategies for managing, protecting, and monitoring water resources in many different hydrologic and land-use settings across the Nation.

Current NAWQA activities at the Ohio Water Science Center

Surface-Water Status and Monitoring Assessment: Long-term data collection at fixed sites supports NAWQA's efforts to identify and understand water-quality trends, estimate loads, and develop large-scale transport models. Ohio surface-water activities include the collection of sediment and water-quality samples from the Maumee River at Waterville (USGS station 04193500). Periodically since 1994, samples have been collected from selected rivers in the Lake Erie Basin and the Great and Little Miami River Basins for the NAWQA Program.

http://waterdata.usgs.gov

For more information, contact Dennis Finnegan, dpfinneg@usgs.gov.

Ecological studies: Habitat, fish, algae, and macroinvertebrate-community data are collected for NAWQA's ecological studies. These types of data for Ohio can be found in the USGS ecological database, BioData.

https://aquatic.biodata.usgs.gov/

For more information, contact Stephanie Janosy, sjanosy@usgs.gov.

Regional Stream-Quality Assessments: Water-resource issues specific to particular areas of the Nation are targeted and assessed, with a focus on water quality and ecological stressors. During summer 2013, the Midwest Stream-Quality Assessment (MSQA) characterized contaminants, nutrients, suspended sediment, and ecological conditions at perennial-stream sites throughout the Midwest, including western Ohio. Similar studies have since been conducted in the Southeast (2014), Pacific Northwest (2015), and in the Northeast (2016).These results will be incorporated into statistical models to determine the effects of stressors on ecological communities and to allow prediction of water-quality conditions in other streams across the region. Additional information and data can be obtained at the following Web site:

http://txpub.usgs.gov/RSQA/

For more information, contact Daniel Button, dtbutton@usgs.gov.

NAWQA groundwater studies: For Ohio, NAWQA groundwater studies include collecting groundwater water-quality samples, measuring water levels, and assessing trends in a glacial aquifer. Three well networks in the glacial aquifer (consisting of both monitoring wells and domestic wells) are being used to collect data in urban areas, agricultural areas, and areas relatively undisturbed by human activities.

http://water.usgs.gov/nawqa/studies/praq/

For more information, contact Mary Ann Thomas, mathomas@usgs.gov.

NAWQA microbiological monitoring of groundwater: The Ohio Water Microbiological Laboratory (OWML) has been analyzing samples of groundwater used as a source for drinking water for total coliforms, *E. coli*, enterococci, F-specific coliphage, somatic coliphage, and aerobic endospores since 2013. Additionally, the OWML is working with NAWQA on a small-scale temporal study in the Edwards-Trinity Enhanced Trends Network in Texas. In addition to the organisms listed above, samples are being analyzed for enteric viruses, *Cryptosporidium*, and *Giardia*.

For more information, contact Rebecca Bushon, rnbushon@usgs.gov.

Photo top right. Treefrog. Photo by Chad Toussant.

Photo, center right. Processing samples for NAWQA. Photo by John Tertuliani.

Photo, bottom right. Water sampling. Photo by Donna Runkle.

Other USGS Resources

Climate and Land-Use Change
https://www2.usgs.gov/climate_landuse/clu_rd/default.asp

Core Science Systems (Mapping)
http://www.usgs.gov/core_science_systems/

Ecosystems
http://www.usgs.gov/ecosystems/

Energy and Minerals
http://www.usgs.gov/energy_minerals/

Environmental Health
http://www.usgs.gov/envirohealth/

Natural Hazards
http://www.usgs.gov/natural_hazards/

Water
http://www.usgs.gov/water/

Ohio Water-Use Program

Every 5 years since 1950, water-use data have been compiled and disseminated in Ohio as part of the USGS National Water-Use Information program. Current water-use categories include public supply, domestic, irrigation, livestock, aquaculture, industry, mining, and thermoelectric power. Water-use data are available by county and 8-digit Hydrologic Unit Codes.

http://waterdata.usgs.gov/oh/nwis/wu
http://oh.water.usgs.gov/water_use.html

For more information, contact Kimberly Shaffer, kshaffer@usgs.gov.

Photo top left. Water activity at science museum. Photo by Kimberly H. Shaffer.

Photo bottom left. Tadpole. Photo by Chad Toussant.

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