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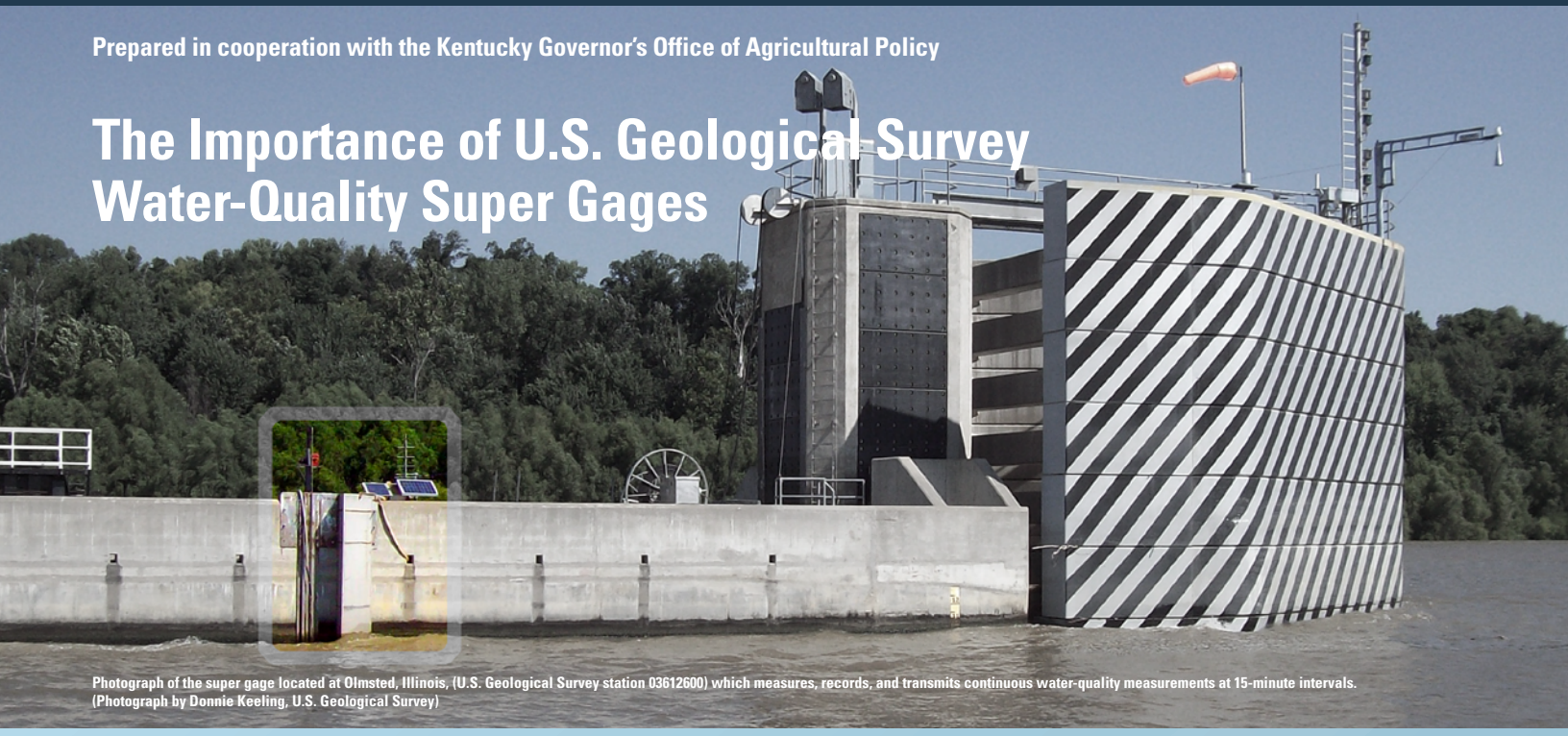
Prepared in cooperation with the Kentucky Governor's Office of Agricultural Policy

The Importance of U.S. Geological Survey Water-Quality Super Gages



Photograph of the super gage located at Olmsted, Illinois, (U.S. Geological Survey station 03612600) which measures, records, and transmits continuous water-quality measurements at 15-minute intervals. (Photograph by Donnie Keeling, U.S. Geological Survey)

What is a U.S. Geological Survey (USGS) Super Gage?

Super gages are an important tool providing real-time, continuous water-quality data at streamgages or groundwater wells. They are designed to address specific water-resource threats such as water-related human health issues including harmful algal blooms, floods, droughts, and hazardous substance spills. In addition, super gages improve our understanding of the effects land-use practices have on critical water resources.

Before the development of super gages, scientists relied on discrete sample collection with subsequent laboratory analysis of the sample to monitor water quality—often requiring days or weeks to obtain results and potentially missing critical peak measurements. A super gage incorporates real-time streamflow or groundwater levels and continuous water-quality measurements with in-stream or groundwater well sample collection for laboratory analysis to ensure accuracy of the real-time data.

What can be Measured at a Super Gage?

Super gages always measure stream stage or measure water levels in groundwater wells. Additional continuous sensors depend upon the type of super gage. There are five types of super gages.

Standard sensors (5)
water temperature
specific conductance (SC)
pH
dissolved oxygen
turbidity

Sediment super gage
turbidity

***E.coli* super gage**
specific conductance
water temperature
turbidity

Nutrient super gage
standard sensors (5)
nitrate plus nitrite
orthophosphate

Harmful Algal Bloom super gage
standard sensors (5)
nutrient sensors
chlorophyll
phycocyanin

What are the Benefits of USGS Super Gage Data?

USGS super gages provide the hydrologic and water-quality information needed to aid in defining, using, and managing our country's invaluable water resources. Super gages provide an immediate, continuous source of well-archived, well-documented, and unbiased water-quality data useful to public and private entities. Some of the ways water-quality data from a USGS super gage network benefits all of us are presented here.

Enhances Ability to Model Nutrient and Sediment Surrogates

Data measured at super gages highlight the usefulness of surrogate regression model techniques in assessing parameters more difficult to measure using typical sampling strategies. A surrogate is a continuous in-stream sensor measurement used to estimate something of greater interest to environmental managers. Super gage data allow the development of surrogates to be modeled and reported in near real-time concentrations and loads (fig.1). Surrogates frequently developed include:

Measured parameter(s)	Surrogate
turbidity	suspended sediment
nitrate plus nitrite	total nitrogen
turbidity and SC	total phosphorus
water temperature, SC, and turbidity	*E. coli*

Assessment of Conservation Practices

Nutrient super gages (those equipped with nitrogen and phosphorus sensors and analyzers) can show both immediate and cumulative effects of conservation practices on water quality in watersheds. Edge-of-field water-quality monitoring helps scientists to understand nutrient pathways from field to stream and nutrient migration response to precipitation. Because there is immediate access to the data (including by the public), farmers can better estimate favorable conditions for applying fertilizers and pesticides so that the products remain on the field and prevent costly losses to runoff.

U.S. Department of the Interior
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Fact Sheet 2020–3019
April 2020

Provides Early Warning for Water Supply and Recreational Activities

Data from super gages can help protect the public by assisting water managers in developing real-time notification systems of changing water-quality conditions that may affect drinking-water treatment and [or] recreational waters. For example, when a fire caused the runoff of thousands of barrels of bourbon into the Kentucky River in July 2019 (Tobin and Kobin, 2019), the super gage data at the Kentucky River at Lockport, Kentucky, documented the effect of that runoff in 15-minute intervals and identified when the river recovered.

Nutrient Reduction Strategy

Super gages improve the estimation of nutrient loads through high-frequency measurements which can be beneficial for targeting and assessing nutrient reduction strategies in a basin. In Kentucky, the USGS super gage data played a key role in developing the Commonwealth's nutrient reduction strategy and documenting the nutrient loads entering and leaving the Commonwealth's major river basins.

Groundwater/Surface Water Interaction

Super gages that have colocated wells equipped to monitor continuous water-quality parameters allow for the assessment of groundwater contributions to streams and rivers. For example, understanding the contribution of legacy nitrate in groundwater to streams is largely unmonitored. This is particularly important in the karst areas of Kentucky and has important management implications because conservation practices cannot affect legacy nitrogen in groundwater.

Why Does My State Need a Super Gage Network?

The lack of enough data for river systems is one of the biggest obstacles to providing the science-based information needed to effectively manage the Nation's rivers and streams (National Research Council, 2007). Since that 2007 report, many nationally funded monitoring networks have either been reduced or eliminated altogether.

Strong partnerships between the USGS and state and local governments are needed to build and tailor monitoring networks that address specific water resource needs important to each state. Strategically placed super gages are one of the most cost-effective measures for addressing threats to water resources; whether it be monitoring impaired streams to ensure compliance with mandated total maximum daily loads of constituents in streams, protecting groundwater resources by continuously monitoring vulnerable areas, or improving understanding of the sources, pathways, and timing of nonpoint source pollutants in the state's rivers, streams, and groundwater.

References

National Research Council, 2007, River science at the U.S. Geological Survey: Washington, DC: The National Academies Press. [Also available at https://doi.org/10.17226/11773.]

Tobin, B., and Kobin, B., 2019, Jim Beam bourbon warehouse crumbles as runoff from fire spills into Kentucky River: The Courier Journal, July 3, 2019, accessed March 2020, at https://www.courier-journal.com/story/news/2019/07/03/jim-beam-bourbon-barrel-warehouses-burn-kentucky/1637073001.

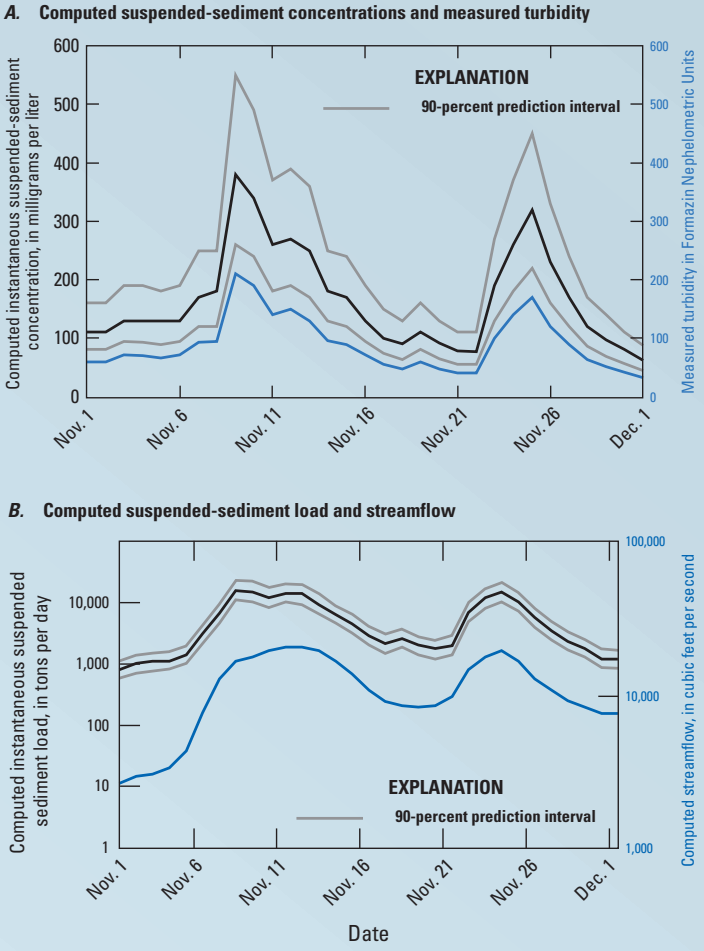

Figure 1. Graph showing, *A*, computed suspended-sediment concentration and meaured turbidity and, *B*, computed suspended-sediment load and streamflow at the White River at Hazleton, Indiana.

How do you Access the Data?

USGS continuous water-quality data and surrogate models are located on the USGS National Real-Time Water Quality website, http://nrtwq.usgs.gov. The website features:

- interactive maps of states with real-time, continuous water-quality monitoring data;
- links to super gages that have surrogate models used to predict water-quality constituent concentrations important to environmental managers; and
- available surrogate model data with plots and tables at https://waterwatch.usgs.gov/wqwatch/?pcode=99999.

By Angela S. Crain

Downstream view of the Kentucky River near the super gage located at Lockport, Kentucky (U.S. Geological Survey station 03290500). (Photograph by Faye Peters, U.S. Geological Survey)

For more information, please contact:

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Or visit the Ohio-Kentucky-Indiana Water Science Center super gage website
https://www.usgs.gov/centers/oki-water

ISSN 2327-6916 (print)
ISSN 2327-6932 (online)
https://doi.gov/10.3133/fs20203019