



USGS Real-Time Water-Quality Data on the Web in 2010

Bradley Garner¹, Andrew Ziegler², Steven Brady², Gerald Feese², and Xiaodong Jian²

April 26, 2010

National Water Quality Monitoring Council

Seventh National Monitoring Conference, Denver, CO

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

¹ USGS Arizona WSC, Tucson, AZ
² USGS Kansas WSC, Lawrence, KS

Outline of Presentation

- Introduction
- NWISWeb
- Web Services
- WaterQualityWatch
- NRTWQ

Introduction

- Real-time Water Quality (RTWQ) produces a lot of data.
- Consider the night sky.
 - Telescopes present manageable slices.
- By analogy, USGS presents useful slices of RTWQ on the Web.



Introduction

- How do we

Present

Explore

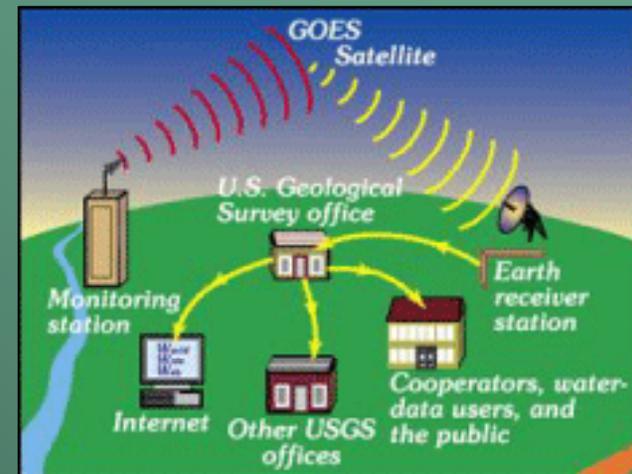
Interpret



Introduction



- RTWQ data start in the field.
- Transmitted over satellite or phone.

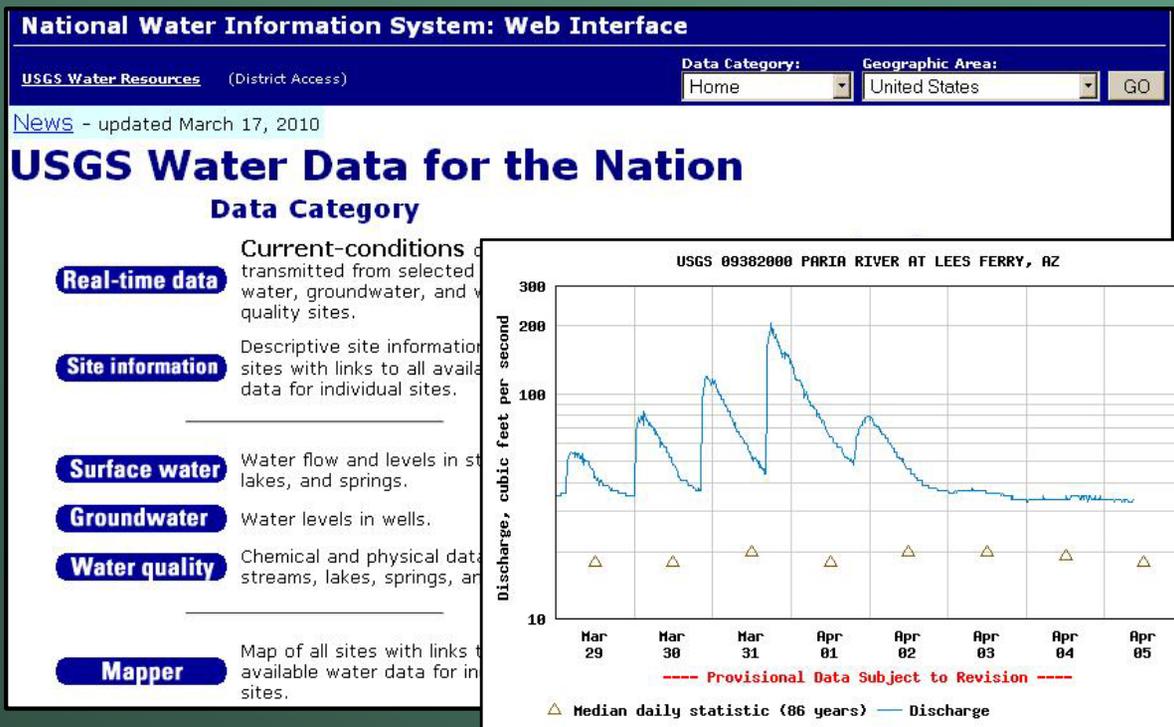


- Available provisionally for Web distribution within minutes of collection.

NWISWeb

waterdata.usgs.gov

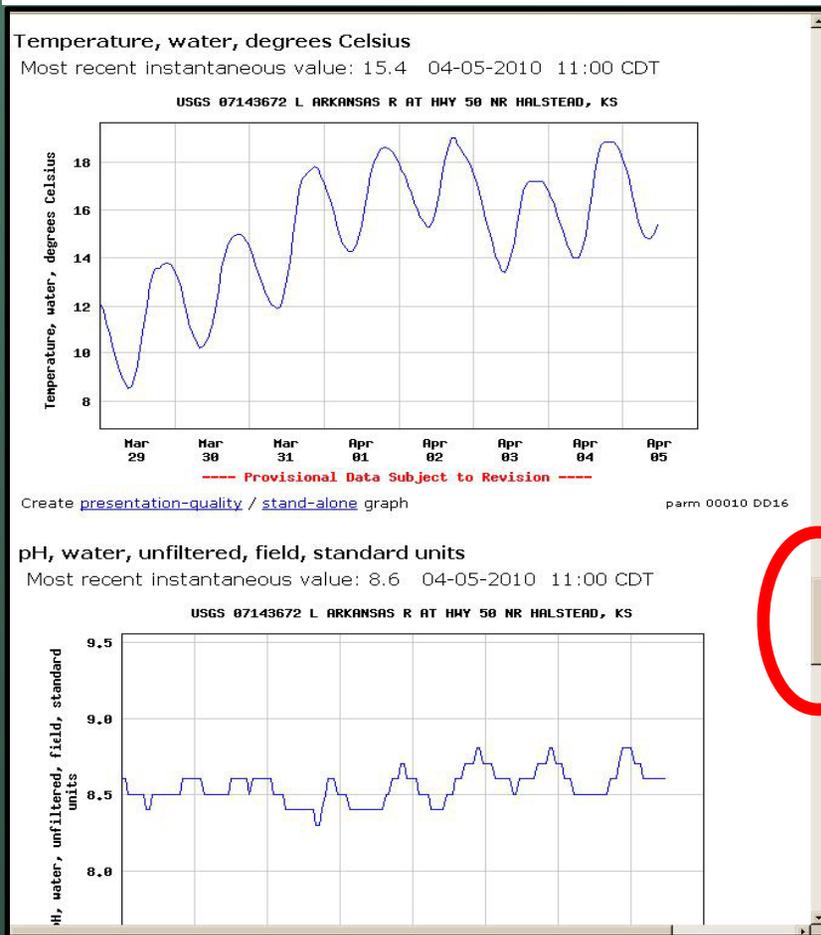
- Online Since 1995 (*early for the Web*)



- Real-time data focuses on discharge.

NWISWeb

waterdata.usgs.gov

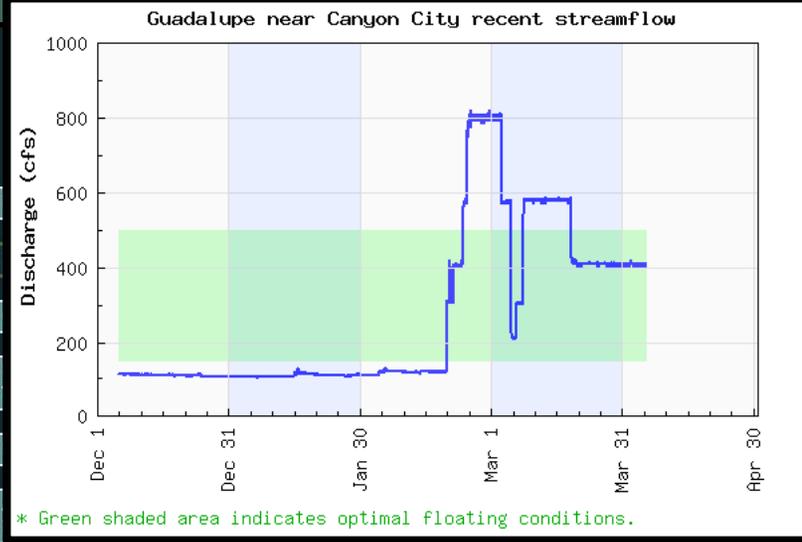


- Station pages with RTWQ are long and cumbersome.
- Hard to explore
- More likely to just get what's needed and move on.

Web Services

waterservices.usgs.gov

- Web-standard WaterML XML
- Computer- and programmer-friendly



```
<timeSeriesResponse xsi:schemaLocation="http://www.cuahsi.org/waterML/1.0/ http://waterservices.usgs.gov/WOF/WaterML-1.0.xsd">
+ <queryInfo></queryInfo>
- <timeSeries name="NWIS Time Series Instantaneous Values">
+ <sourceInfo xsi:type="SiteInfoType"></sourceInfo>
- <variable>
  <variableCode vocabulary="NWISUV">00095</variableCode>
  <variableName>Specific cond at 25C</variableName>
- <variableDescription>
  Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius
  </variableDescription>
  <dataType>Instantaneous</dataType>
  <units unitsType="Flow" unitsAbbreviation="uS/cm @25C"/>
  <NoDataValue>-999999</NoDataValue>
</variable>
- <values count="92">
  <value dateTime="2010-04-04T13:15:00.000-05:00" qualifiers="P">663</value>
  <value dateTime="2010-04-04T13:30:00.000-05:00" qualifiers="P">663</value>
  <value dateTime="2010-04-04T13:45:00.000-05:00" qualifiers="P">663</value>
  <value dateTime="2010-04-04T14:00:00.000-05:00" qualifiers="P">663</value>
</values>
</timeSeriesResponse>
```

- Example: Private website showing USGS data with custom annotations.

Shown for informational purposes only, not an endorsement by USGS.

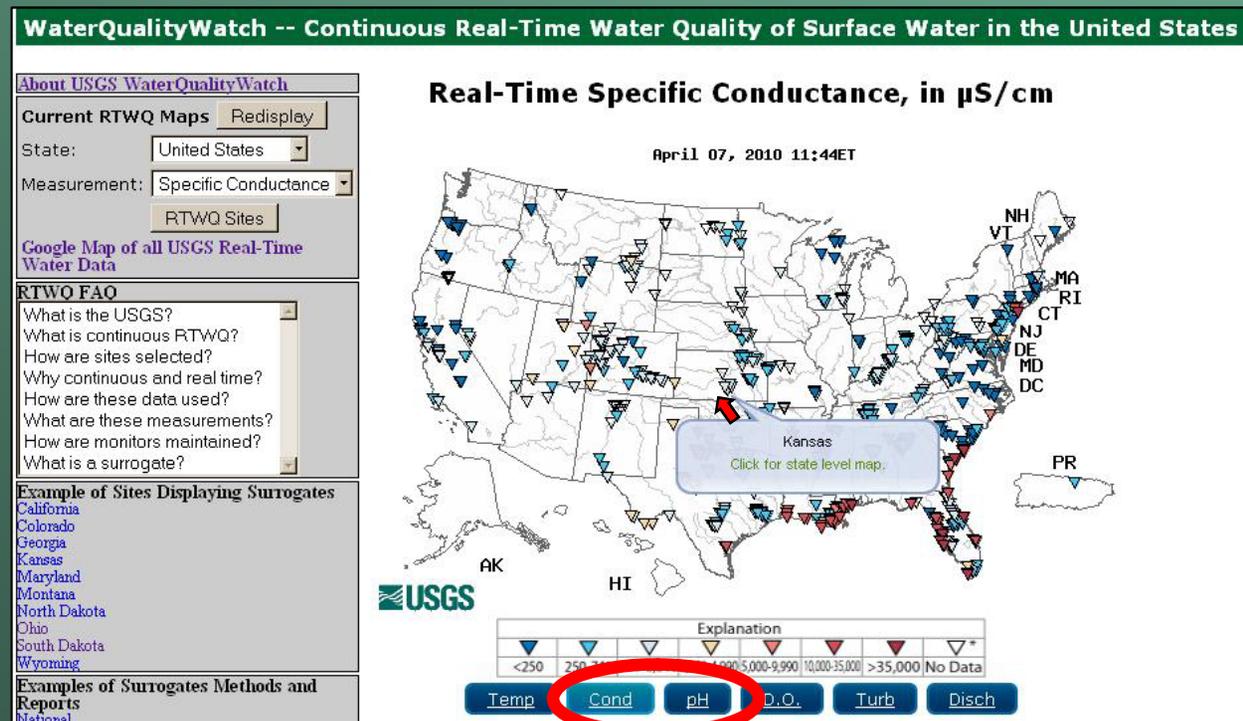
Courtesy of: <http://austinfoattrips.com/>

WaterQualityWatch

waterwatch.usgs.gov/wqwatch

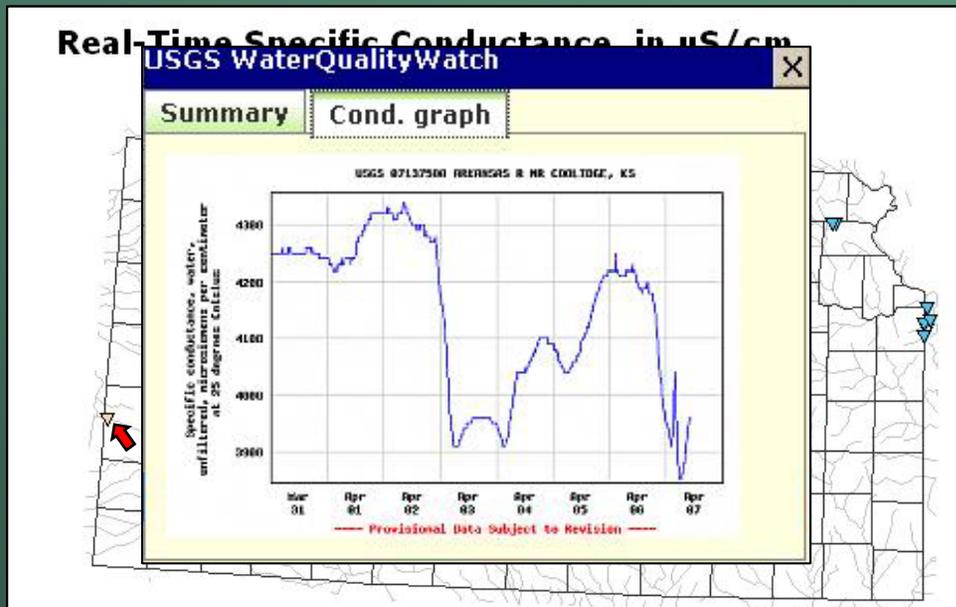
- Clickable map of current conditions
- Clickability invites exploration

- Web 2.0 technology provides smooth operation, across browsers.



WaterQualityWatch

waterwatch.usgs.gov/wqwatch



- State- and station-level detail
- “Pop-in” shows chemograph quickly and shows variability.

- Links to other websites, if more data needed.

National Real-Time Water Quality

nrtwq.usgs.gov



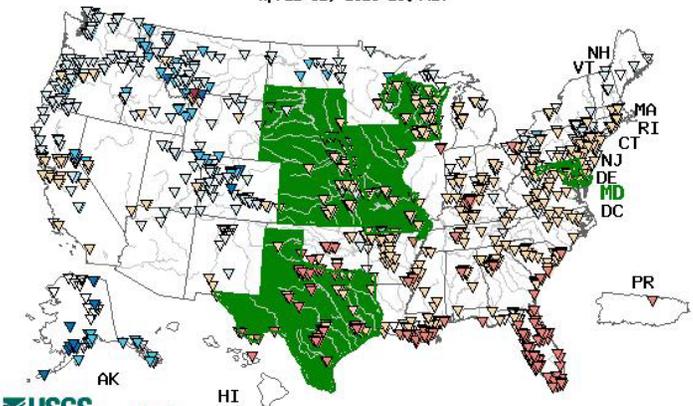
USGS Home
Contact USGS
Search USGS

US Geological Survey Real-Time Water Quality Data For the Nation

NATIONAL REAL-TIME WATER QUALITY

Map of Real-Time Water Temperature, in °C

April 02, 2010 16:44ET





State has continuous computed water-quality data

Explanation						
▼	▼	▼	▼	▼	▼	▼*
<1	1-4.9	5-9.9	10-19.9	20-29.9	30-35	>35
No Data						

Temp

Cond

pH

D.O.

Turb

Disch

Continuous real-time water-quality data are used for decisions regarding drinking water, water treatment, regulatory programs, recreation, and public safety. Sensors in streams typically measure streamflow, water temperature, specific conductance, pH, dissolved oxygen and turbidity. Additionally, these measurements can be used as surrogates to compute real-time concentrations and loads of other water-quality constituents.

Click the Map for Real-Time Water-Quality Data. This Will Either Show:

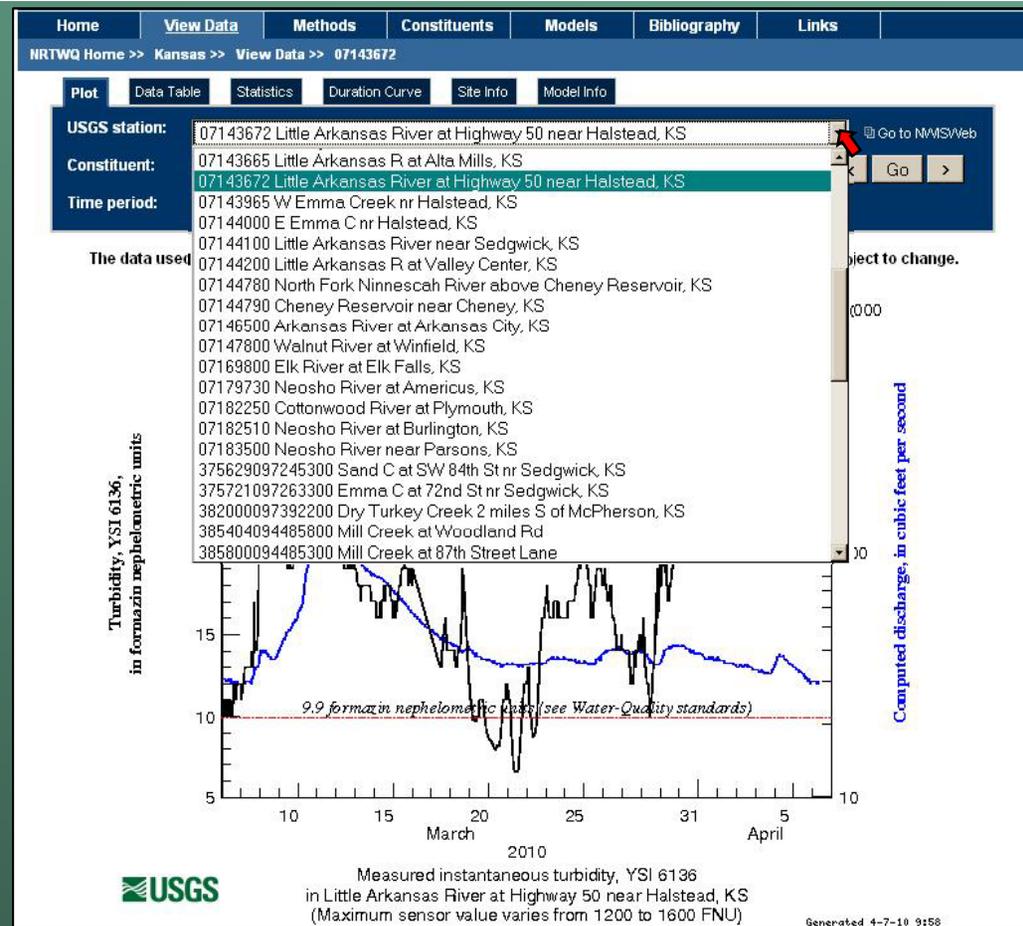
- This National Real-Time Water Quality (NRTWO) website** (currently Iowa, Kansas, Maryland, Missouri, Nebraska, South Dakota, Texas, and Wisconsin) provides hourly **computed** concentrations and loads for sediment, nutrients, bacteria, and many additional constituents; uncertainty values and probabilities for exceeding drinking water or recreational criteria; frequency distribution curves; and all historical hourly in-stream sensor measurements.
- WaterQualityWatch** presents colorful maps of recent hourly measurements of streamflow, water temperature, specific conductance, pH, dissolved oxygen, and turbidity. The most recent 60 days of real-time data also are available for download. Similar to NRTWQ, its data are obtained from the USGS **National Water Information System**.

Vision: Click Anywhere at Anytime

National Real-Time Water Quality

nrtwq.usgs.gov

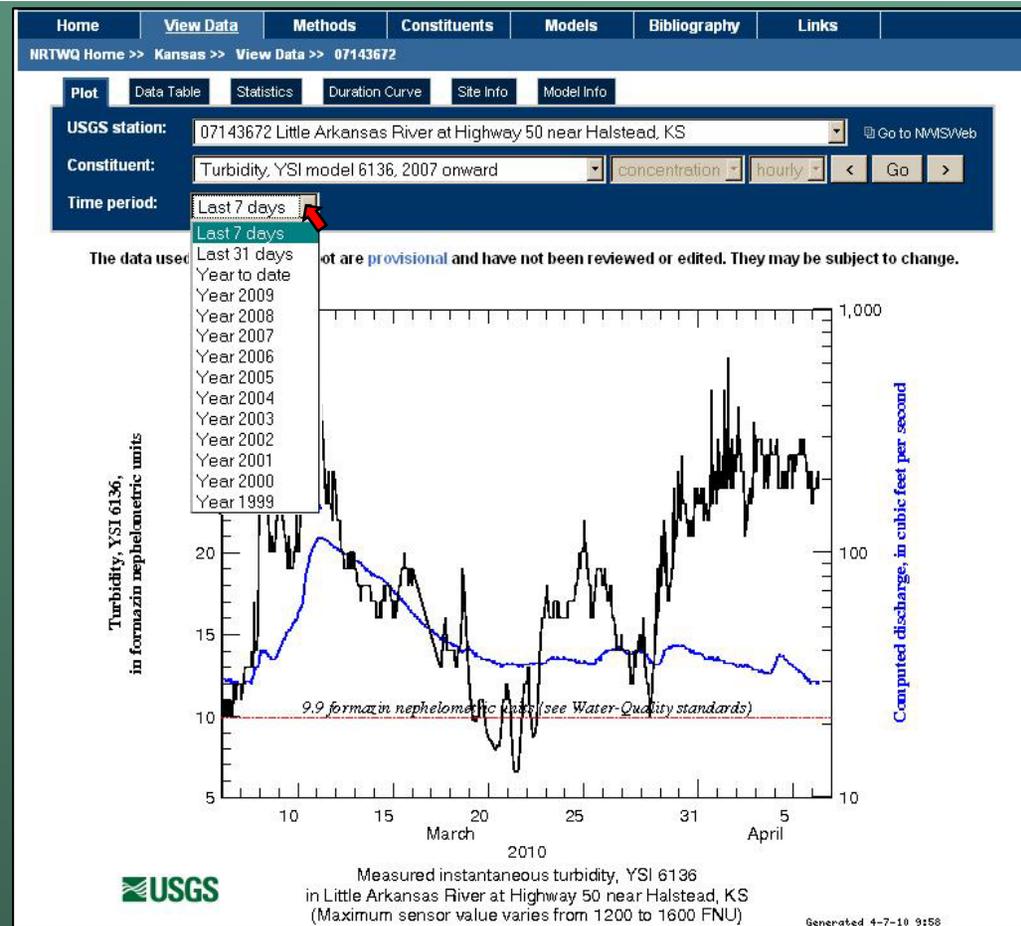
- Time-series graphs
- Multiple data series
- Dropdown boxes allow exploring space, time, and constituent.



National Real-Time Water Quality

nrtwq.usgs.gov

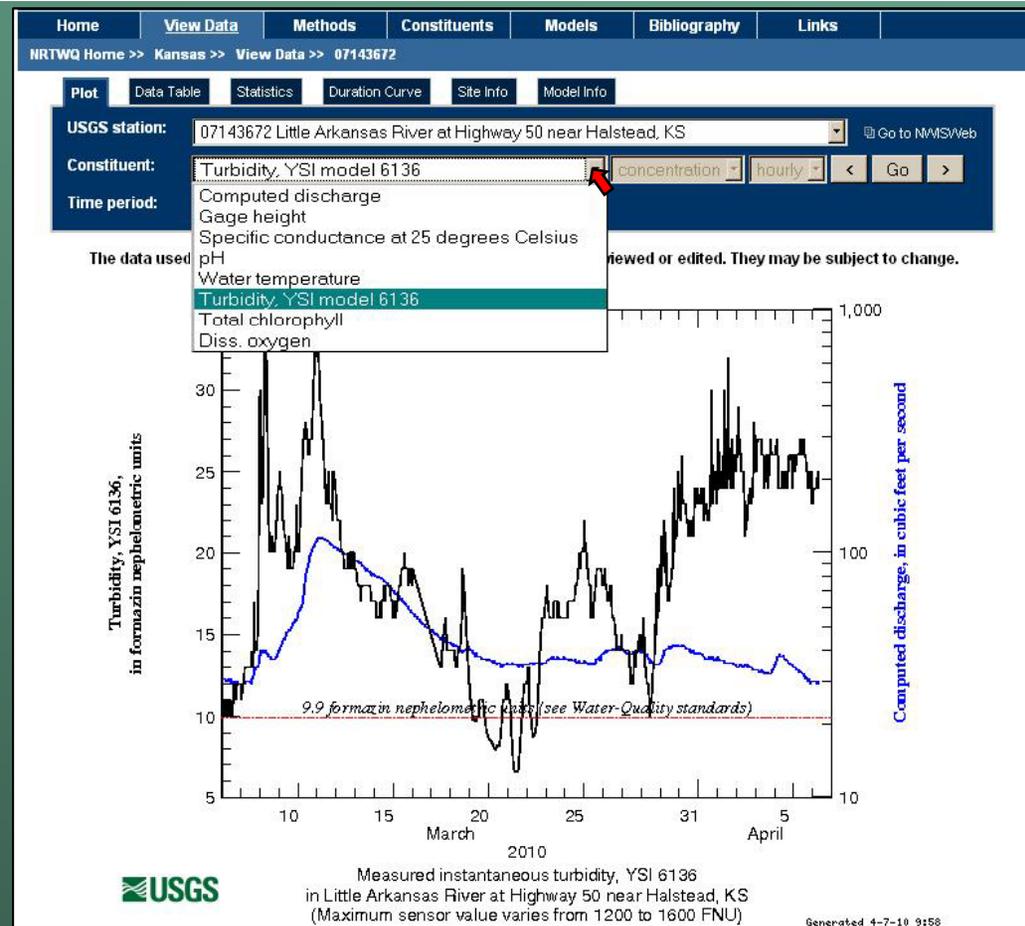
- Time-series graphs
- Multiple data series
- Dropdown boxes allow exploring space, time, and constituent.



National Real-Time Water Quality

nrtwq.usgs.gov

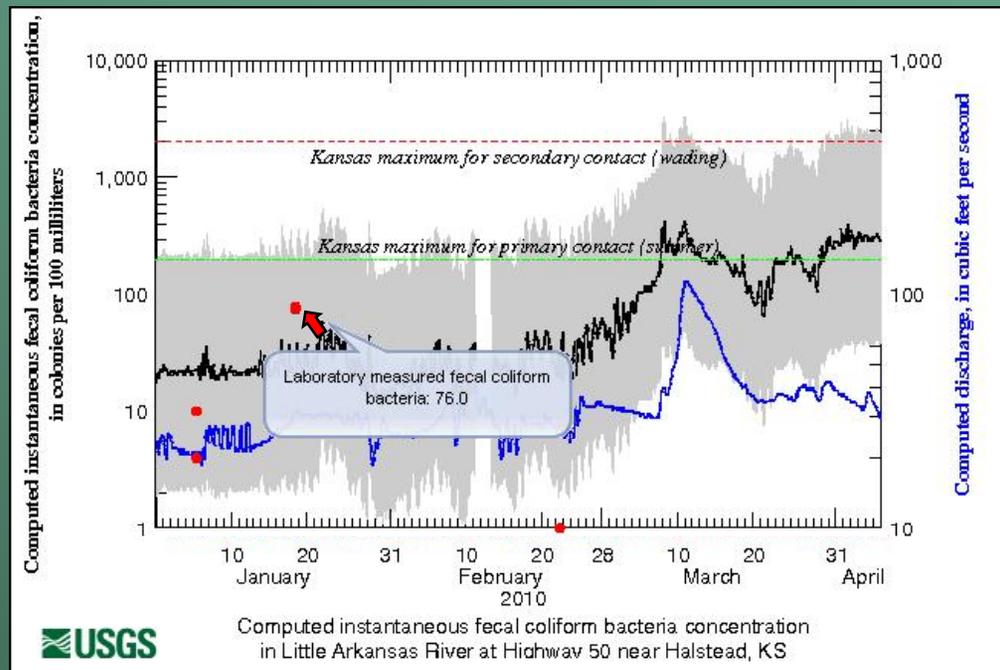
- Time-series graphs
- Multiple data series
- Dropdown boxes allow exploring space, time, and constituent.



National Real-Time Water Quality

nrtwq.usgs.gov

- Model-computed real-time water quality.
- Statistically defined uncertainty in gray.
- Lab-analyzed values as red dots.
- Model form, calibration, and publication source.



$$\log_{10}(\text{FCB}) = 0.572 + 1.13 \log_{10}(\text{TURB})$$

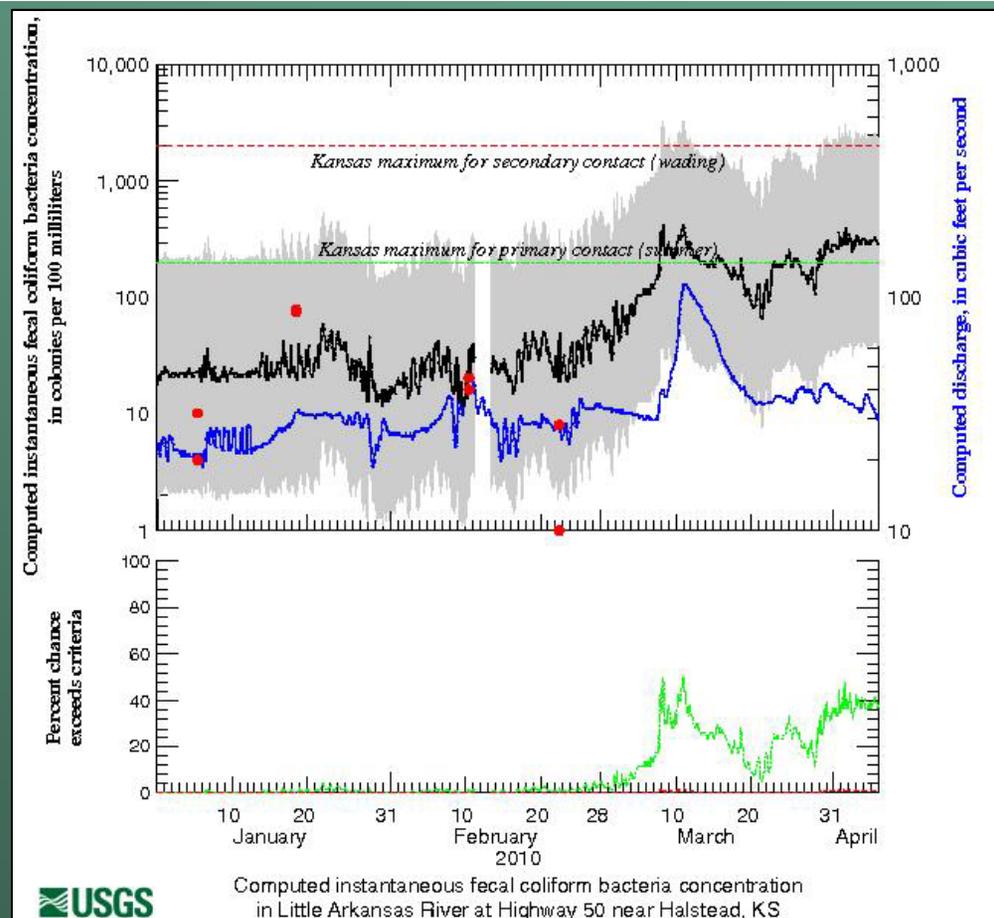
where:

- FCB is computed fecal coliform bacteria, in colonies per 100 milliliters
- TURB is turbidity, YSI model 6136, in formazin nephelometric units

National Real-Time Water Quality

nrtwq.usgs.gov

- WQ standards or criteria shown on graph.
- Computed data show probability of exceeding criteria shown.



National Real-Time Water Quality

nrtwq.usgs.gov

- Duration Curves →
 - Help indicate how frequently WQ standards might be exceeded.

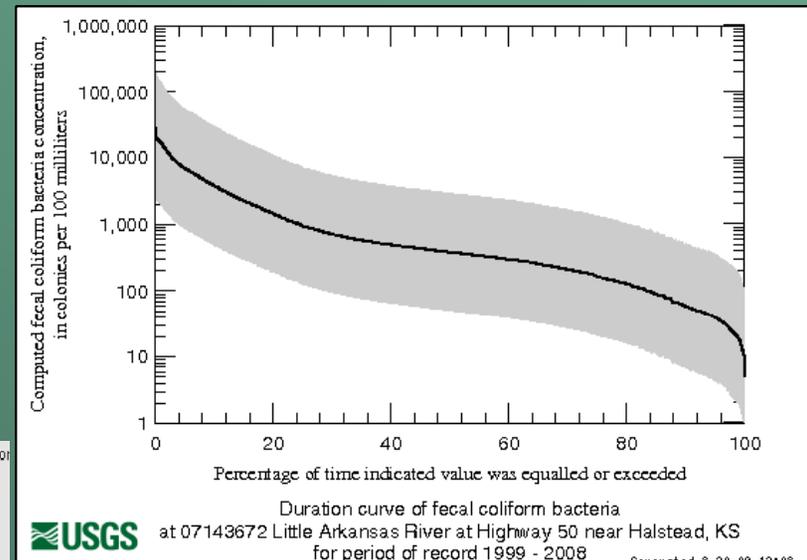
A regression model (Eq 1) also can be expressed in matrix notation (Eq 2; Draper and Smith, 1998). This notation is convenient and concise for explanatory variable, and is used in the section "Quantifying Uncertainty."

$$\underline{Y} = \underline{X}\underline{\beta} + \underline{\varepsilon} \quad (\text{Eq 2})$$

$$\underline{Y} = \begin{bmatrix} SS_1 \\ SS_2 \\ SS_3 \\ \vdots \\ SS_n \end{bmatrix}_{n \times 1} \quad \underline{X} = \begin{bmatrix} 1 & T_1 & Q_1 \\ 1 & T_2 & Q_2 \\ 1 & T_3 & Q_3 \\ \vdots & \vdots & \vdots \\ 1 & T_n & Q_n \end{bmatrix}_{n \times 3} \quad \underline{\beta} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix}_{3 \times 1} \quad \underline{\varepsilon} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \vdots \\ \varepsilon_n \end{bmatrix}_{n \times 1}$$

where

- \underline{Y} is a vector of measurements of the response variable SSC, suspended-sediment concentration,
- \underline{X} is a matrix of all n measurements of the explanatory variables T and Q , turbidity and streamflow,
- $\underline{\beta}$ is a vector of constants calculated by regression analysis, and
- $\underline{\varepsilon}$ is a vector of random errors.



- Documentation
 - Methods
 - Publications

National Real-Time Water Quality

nrtwq.usgs.gov

- Presents information for scientists, regulatory agencies, and the public.
 - Real-time direct-measured values, and all unit values
 - Shows typically rapid changes in water quality
 - Time-dense data improves understanding of water quality
 - Computed estimates of water quality
 - Statistical basis for estimates, including estimated uncertainty
 - Probability of exceeding criteria
 - Frequency distribution/duration curves
-

National Real-Time Water Quality

nrtwq.usgs.gov

- Supported by cooperating agencies who need enhanced presentation and interpretation.
- USGS Water Science Centers provide the access to those interested in next-generation RTWQ on the web
- **Talk to us for more information!**

GS-W_NRTWQ@usgs.gov



nrtwq.usgs.gov

GS-W_NRTWQ@usgs.gov

waterwatch.usgs.gov/wqwatch

waterdata.usgs.gov

waterservices.usgs.gov

