Real-time Water Quality Monitoring: Data errors and comparability

Real-time Water Quality Monitoring Workshop

St. John's, Newfoundland

Richard Wagner

USGS WA WSC

June, 2009

USGS

Key Issues

- Benefits of real-time water quality
- Data objectives
- Computed real-time water quality
- Data comparability and quality assurance

USGS

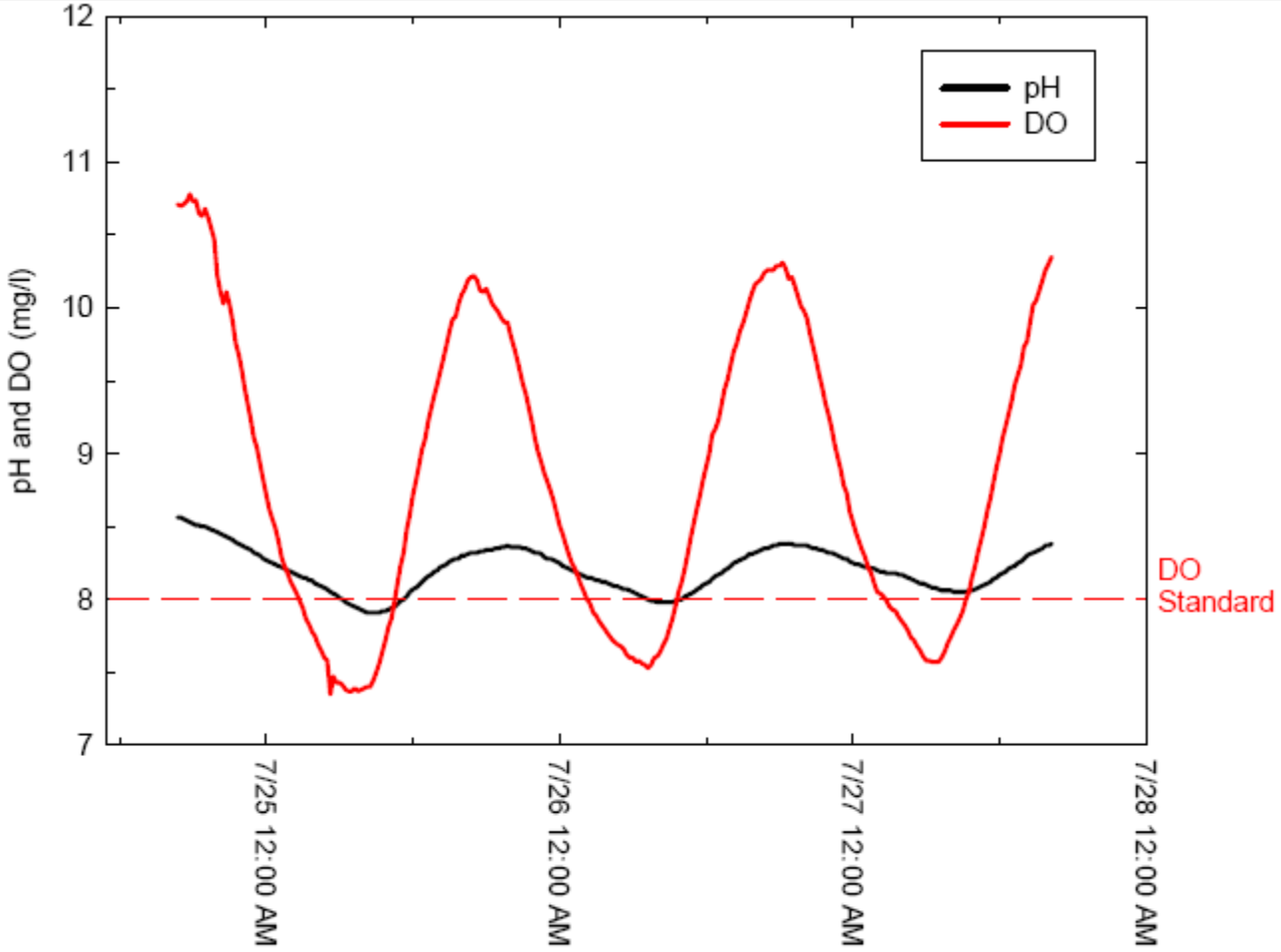

Figure 2. pH and dissolved oxygen in the Yakima River above Horn Rapids Dam (RM 18), July 25-28, 2003. (Source: Washington Department of Ecology)

USGS

Benefits of Real-Time Water Quality

- Improve understanding
- Early notification
- Criteria thresholds
- Monitoring optimization
- Sample collection optimization

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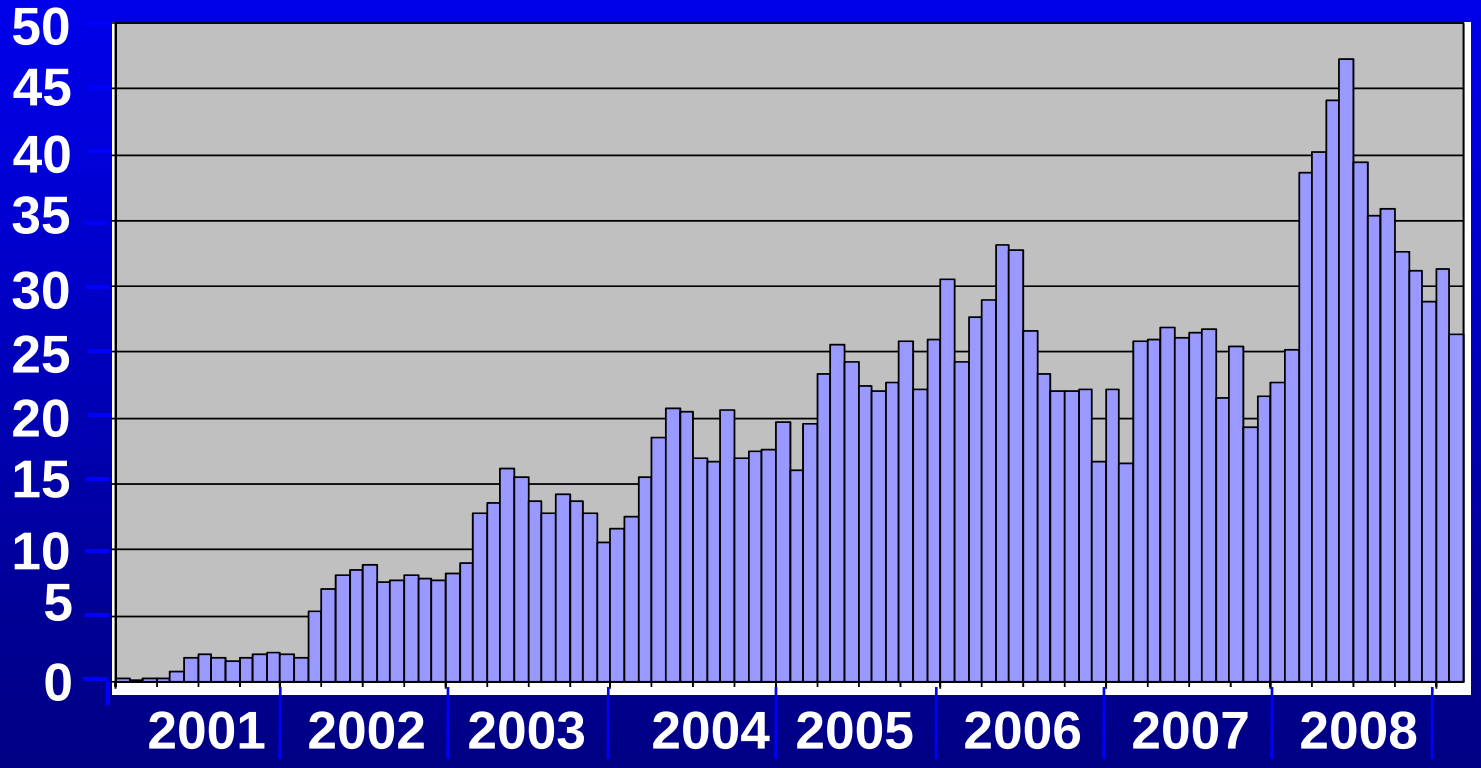
NWISWeb use, in millions of successful page requests per month



USGS

March 19, 2009

USGS NWISWeb Database

Real-time sites	**11,041**
Real-time groundwater	**1,127**
Daily values	**315.1 million**
Groundwater levels	**8.3 million**
Water quality samples	**4.8 million**
Water quality analyses	**87.1 million**
Peak discharges (floods)	**693,000**

USGS

March 19, 2009

USGS NWISWeb Daily Values

Discharge	**205 million**
Stage	**31 million**
Water Levels in Wells	**17 million**
pH	**2 million**
Temperature	**16 million**
Specific Conductance	**7 million**
Other	**32 million**

March 19, 2009

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USGS RTWQ Monitors

Measurement	2006	2009
Temperature	941	1453
Conductance	553	799
pH	242	278
D.O.	294	350
Turbidity	172	268
Other	44	--

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Data Objectives

- Hydrologic and water quality processes
- Seasonal, diurnal, and event-driven fluctuations
- Early warnings
- Estimates of load
- Optimize sample collection

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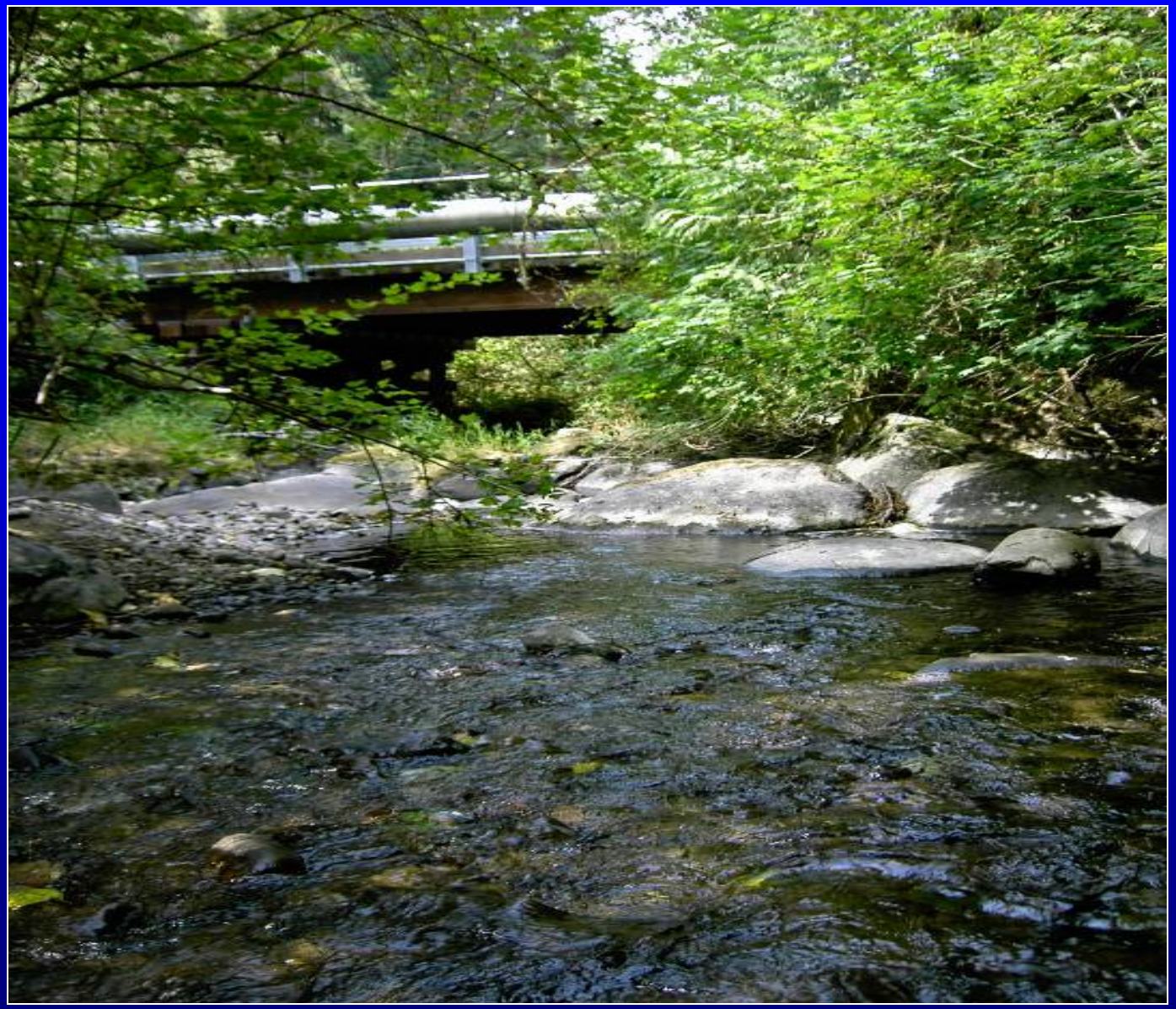
DANGER
WATER QUALITY AND
WEATHER MONITORING STATION
WARNING
U.S. GOVERNMENT PROPERTY
NO TRESPASSING
ENVIRONMENTAL MONITORING
SYSTEMS


USGS



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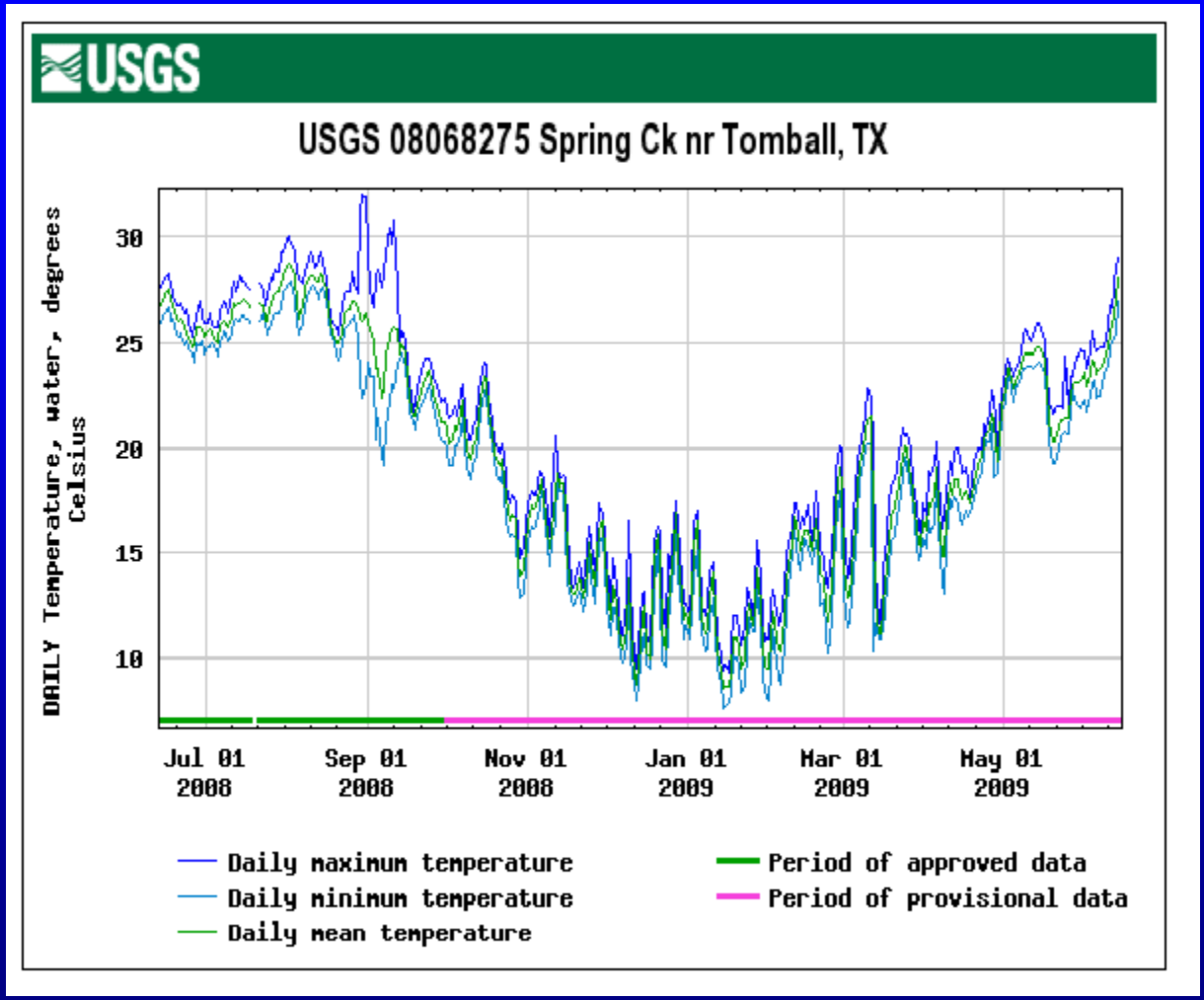
Data Objectives –*Approach*

- **Consider *why* we are monitoring ….**
  - **Objectives?**
  - **Criteria?**
  - **Data reporting?**

USGS

Daily Values



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Computed Real-Time Water Quality

Directly measured	Computed
Gage Height/Stage	Streamflow (discharge)
Specific Conductance	Chloride, alkalinity, fluoride, dissolved solids, sodium, sulfate, nitrate, atrazine
Turbidity	Total suspended solids, suspended sediment, fecal coliform, E. coli, total nitrogen, total nitrogen, total phosphorus, geosmin

USGS

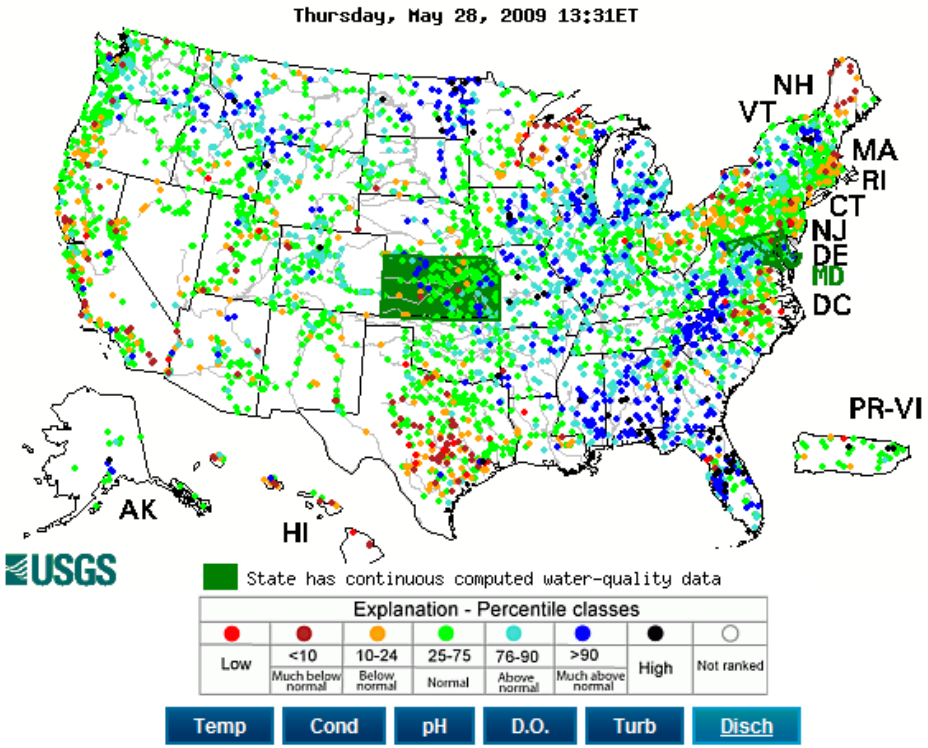
Computed Real-Time Water Quality

- Improve our understanding
- Identify source areas and evaluate trends
- Provide notification of changes in water-quality conditions for water treatment and recreation in real time
- Comparison to water-quality criteria
- Continuously measure water quality in real time like streamflow

USGS

National Real-Time Water Quality

Map of Real-Time Discharge, in cfs



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.

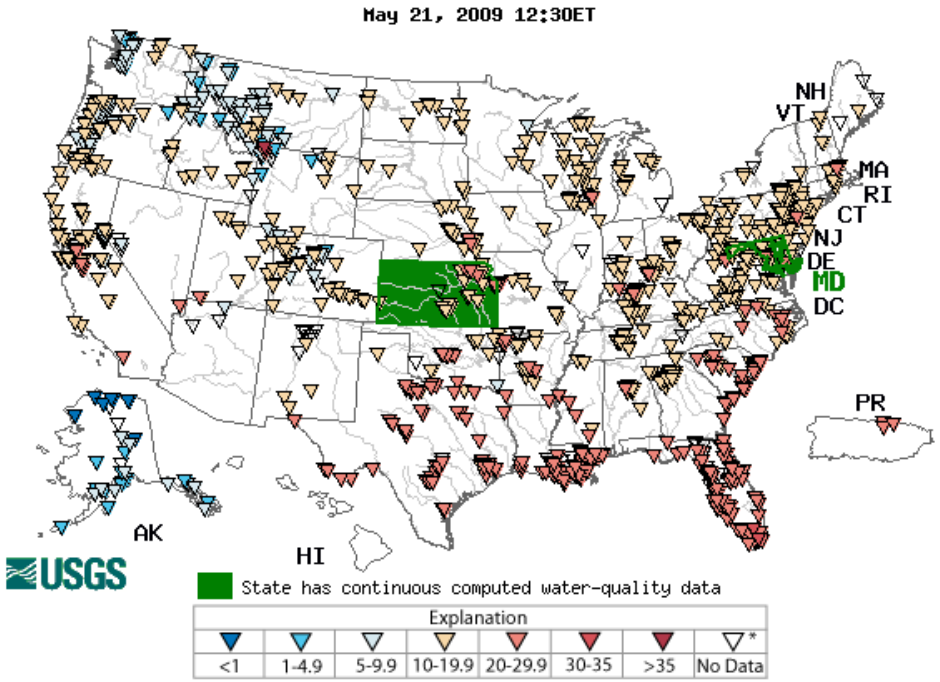
Click the Map for Real-Time Water-Quality Data. This Will Either Show:

1. This National Real-Time Water Quality (NRTWQ) website (currently only Maryland and Kansas) 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.

2. 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.

National Real-Time Water Quality

Map of Real-Time Water Temperature, in °C



Temp | Cond | pH | D.O. | Turb | Disch

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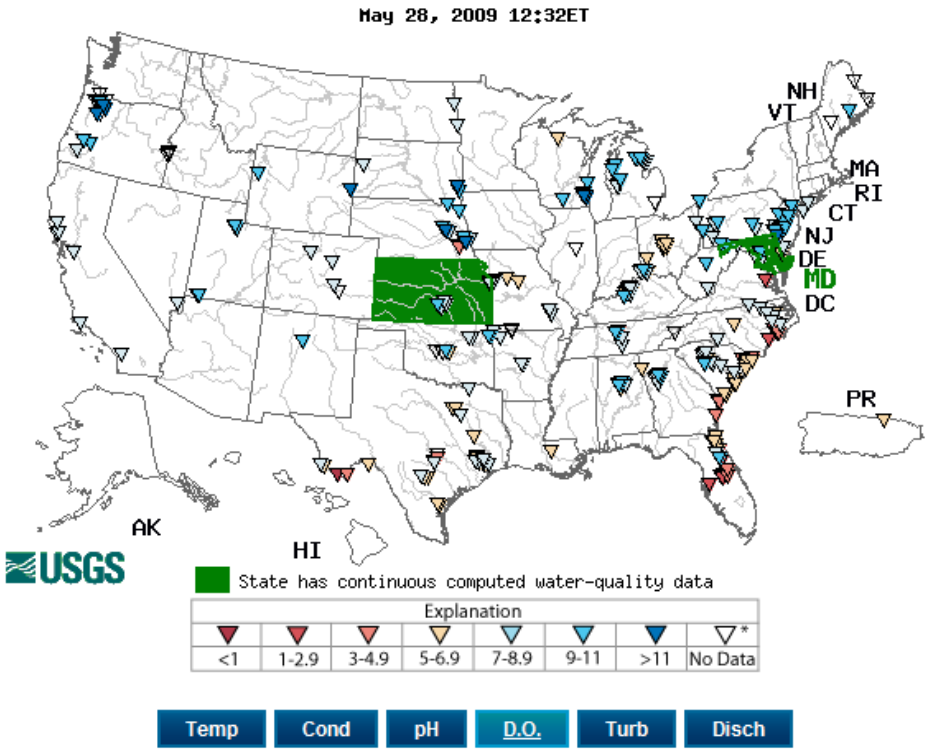
National Real-Time Water Quality

Map of Real-Time Dissolved Oxygen, in mg/L



Temp | Cond | pH | D.O. | Turb | Disch

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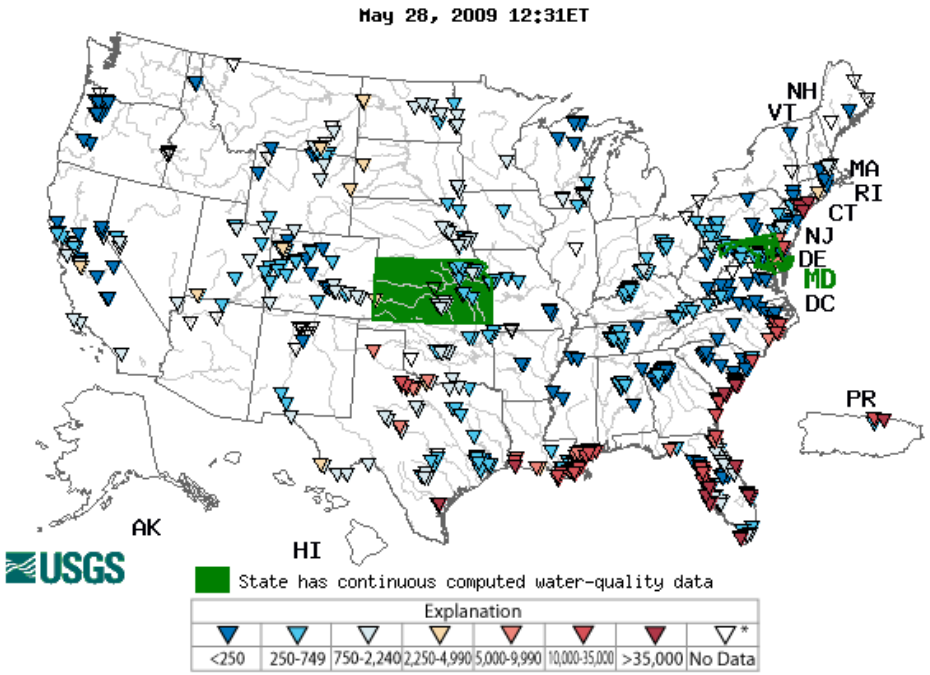
National Real-Time Water Quality

Map of Real-Time Specific Conductance, in µS/cm



Temp | Cond | pH | D.O. | Turb | Disch

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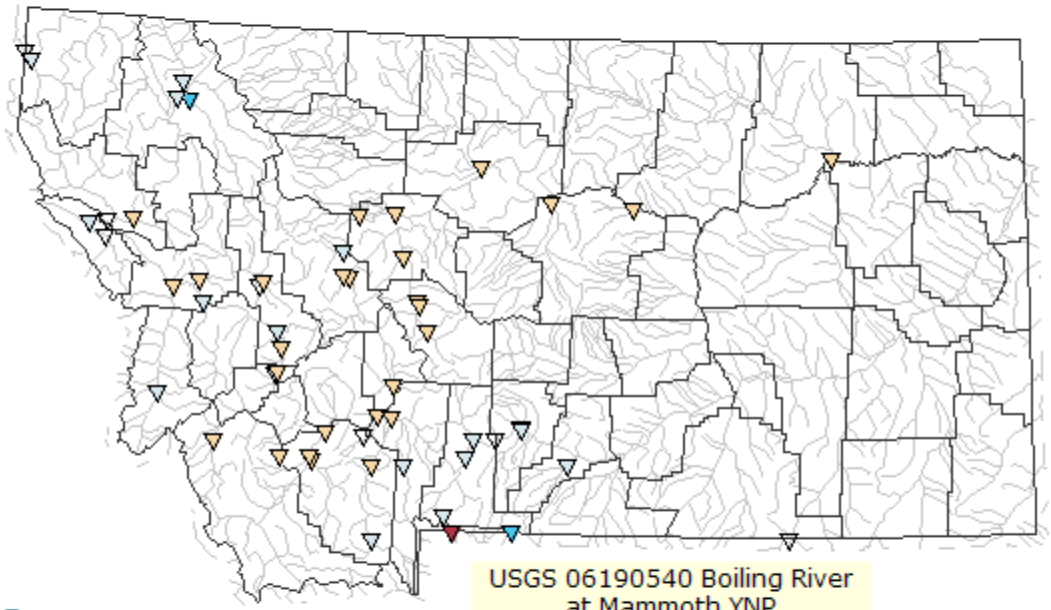
Map of real-time Water Temperature, °C (Montana) click a triangle to view data

May 28, 2009 13:31ET



USGS

USGS 06190540 Boiling River at Mammoth,YNP

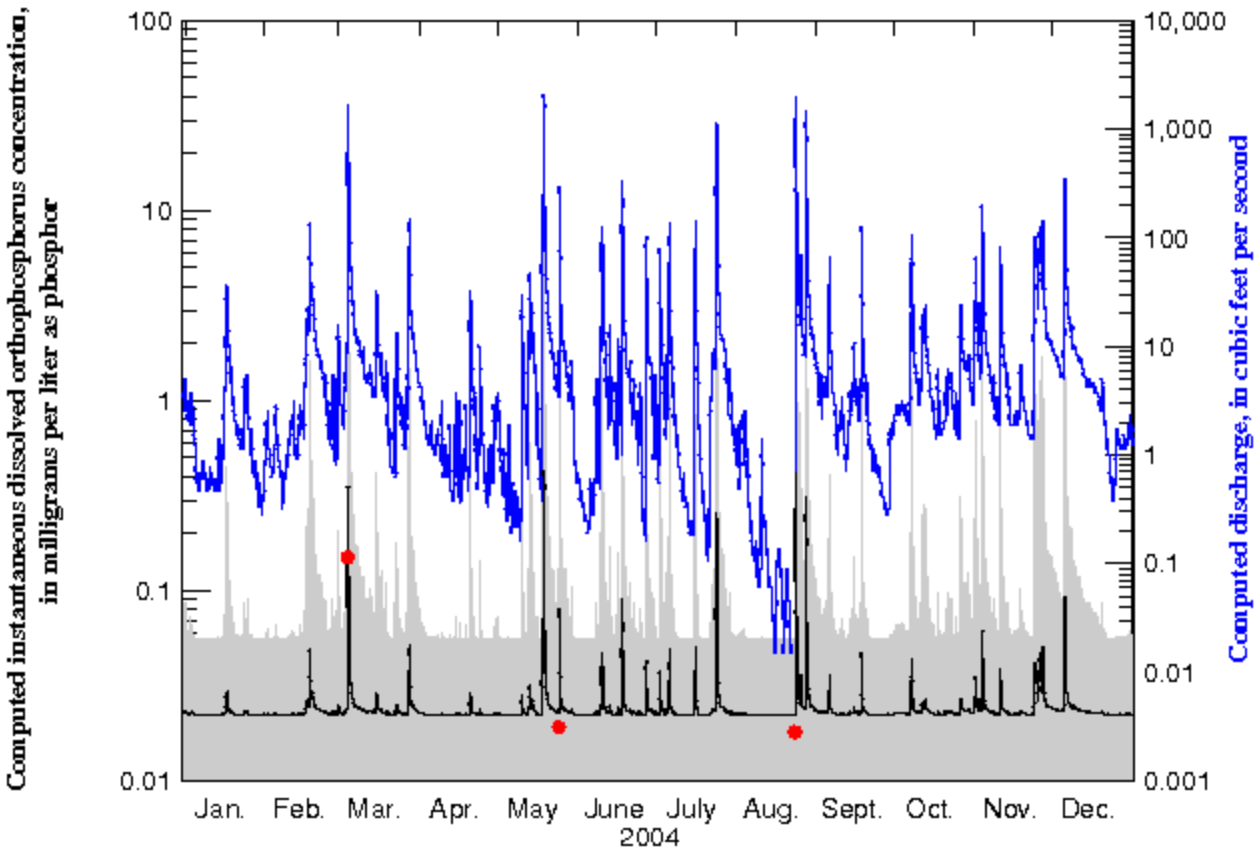
Temperature: 40.0

Date: 2009-05-28 10:15:00

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

*Site operated on a seasonal basis or currently is not operating.
No values are available for the last 6 hours.

The "Real-time" map tracks short-term changes (over several hours) of water quality. Although the general appearance of the map changes very little from one hour to the next, individual sites may change rapidly in response to major rain events or to reservoir releases. The data used to produce this map are provisional.



USGS

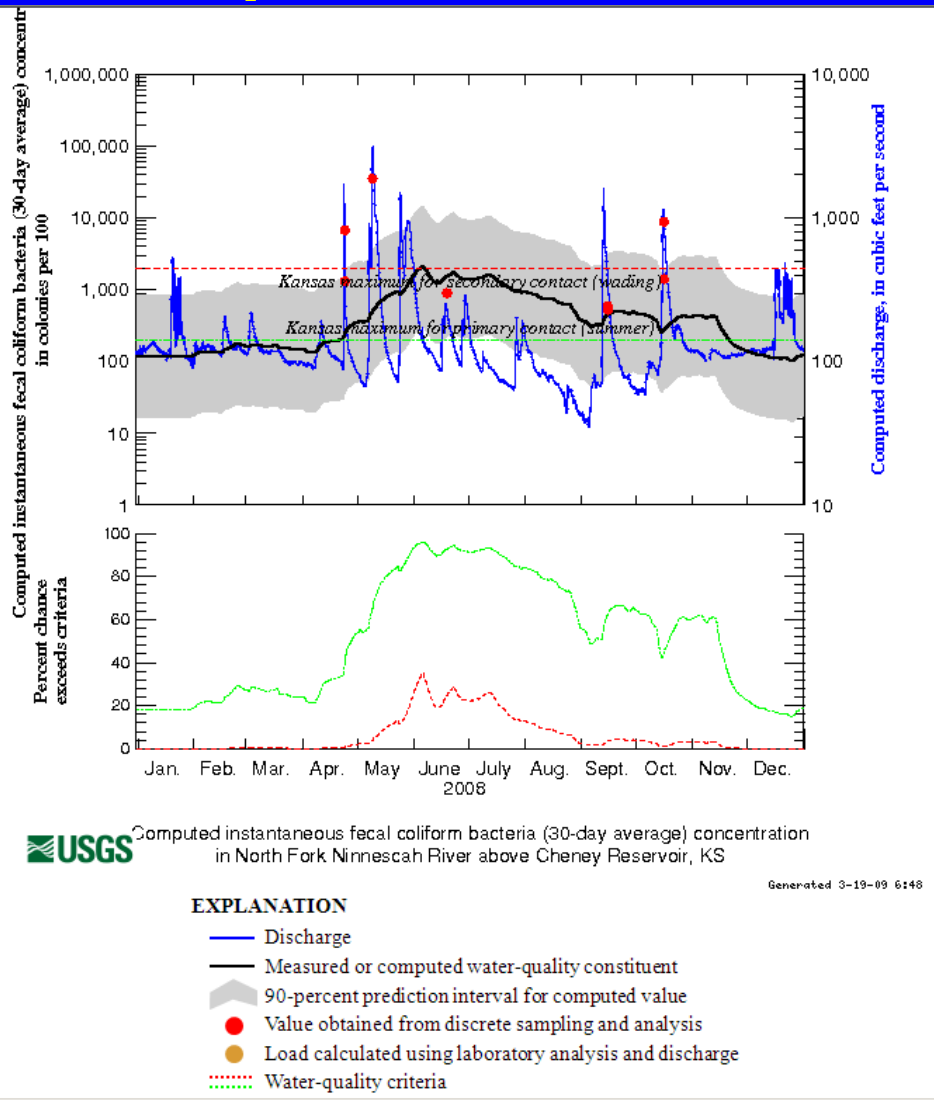
Computed instantaneous dissolved orthophosphorus concentration
in Cedar Creek at Highway 56 at Olathe, KS

Generated 3-21-09 6:51

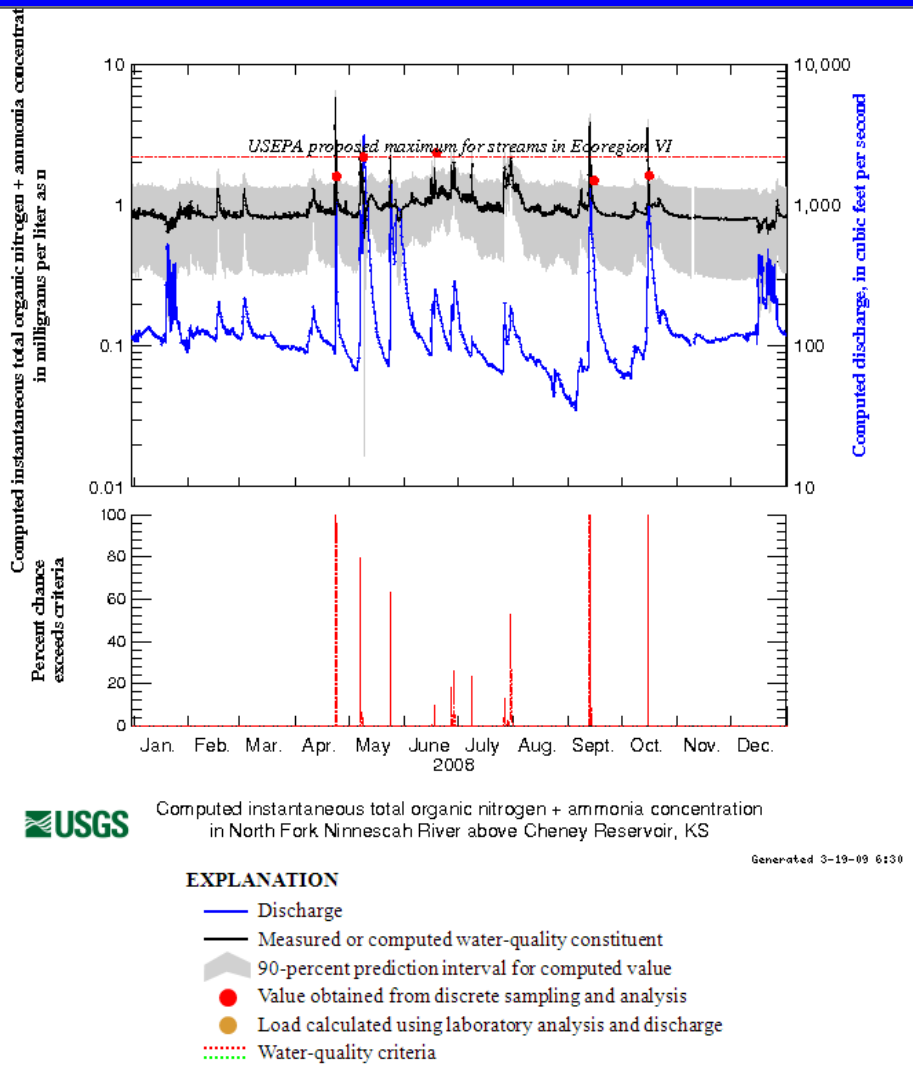
EXPLANATION

- Discharge
- Measured or computed water-quality constituent
- 90-percent prediction interval for computed value
- Value obtained from discrete sampling and analysis
- Load calculated using laboratory analysis and discharge
- Water-quality criteria

Computed bacteria



Computed Nitrogen



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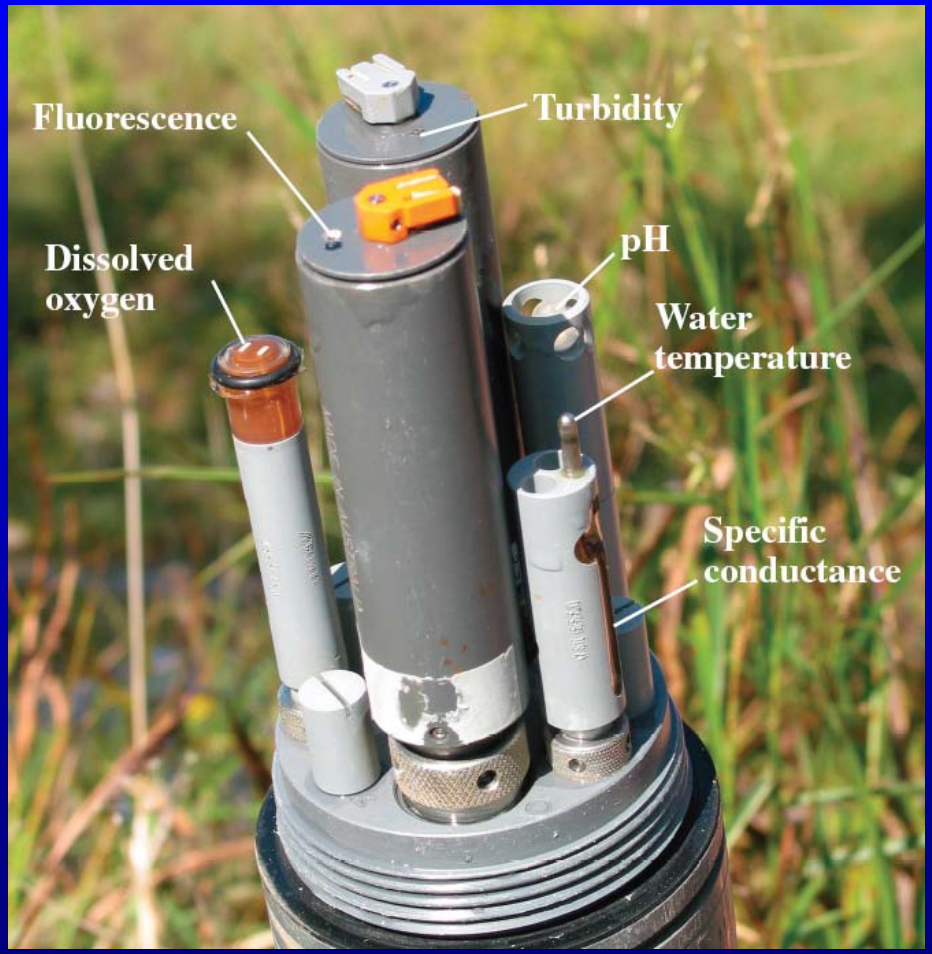
Data Comparability



- Water Temperature
- Turbidity
- Specific Conductance
- Dissolved Oxygen
- Fluorescence

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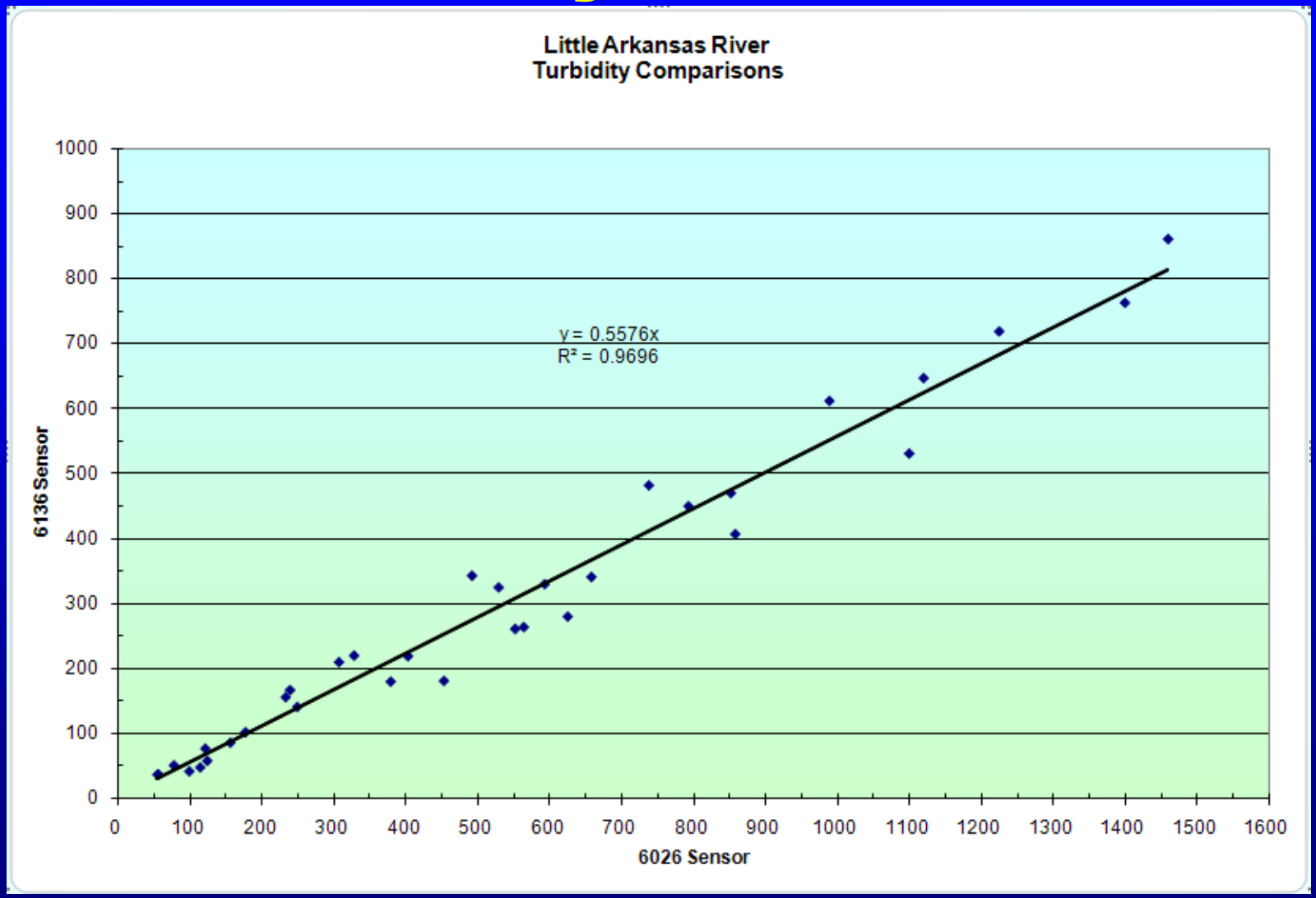
Lab Experiments

USGS
science for a changing world

Turbidity sensors



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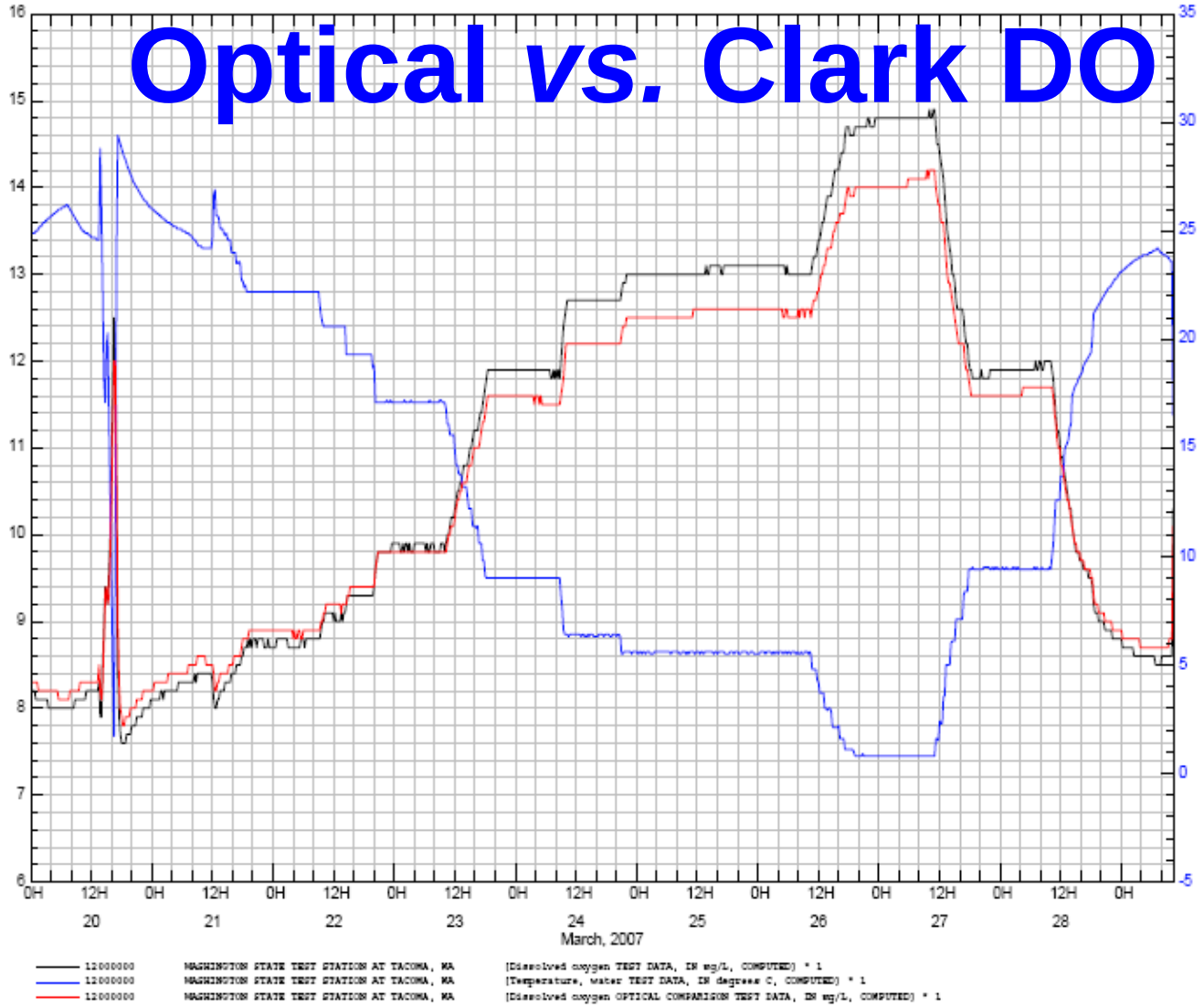
Optical *vs.* Clark DO



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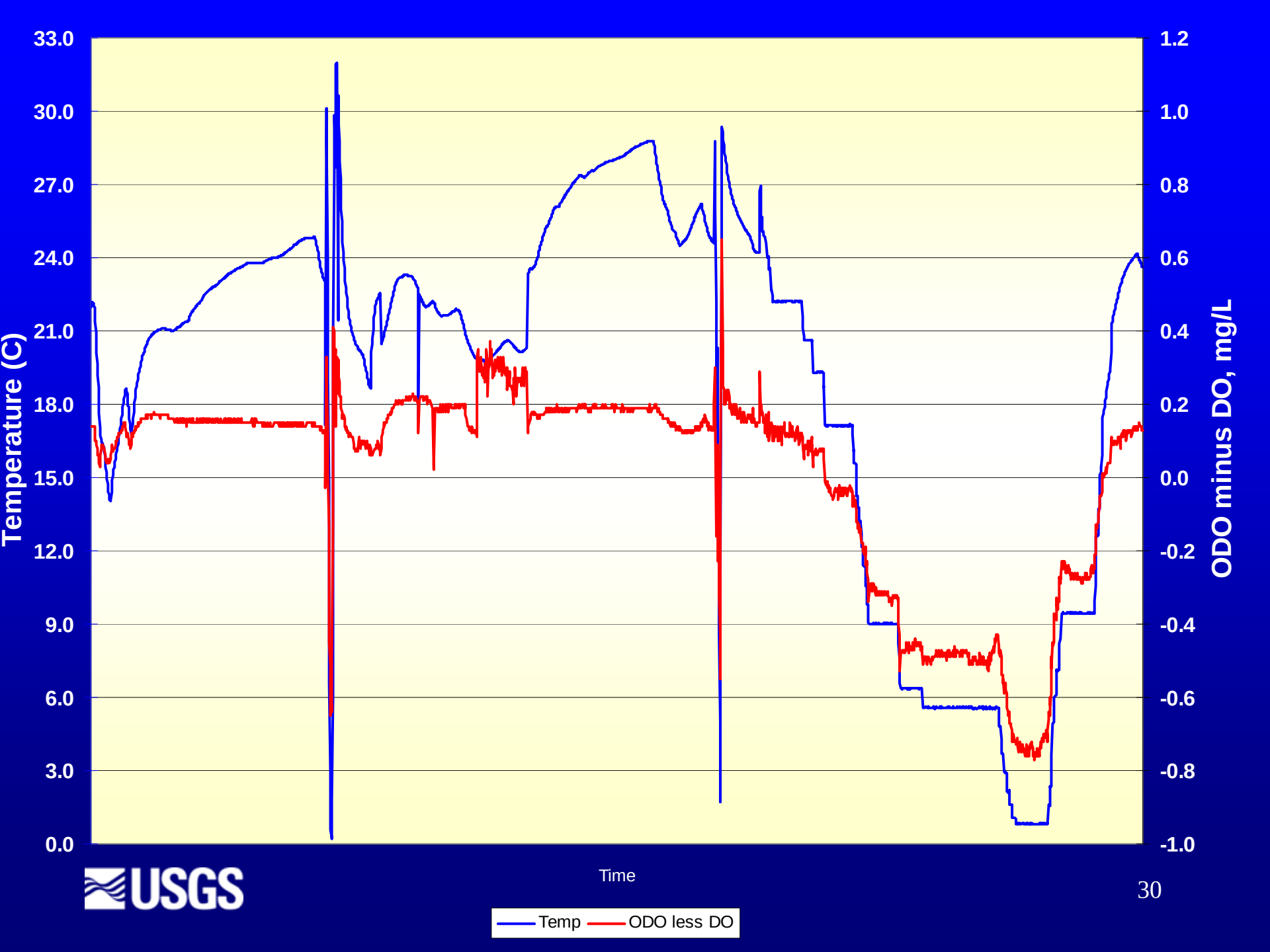
33.0
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0.0
Temperature (C)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
ODO minus DO, mg/L
Time
Temp
ODO less DO

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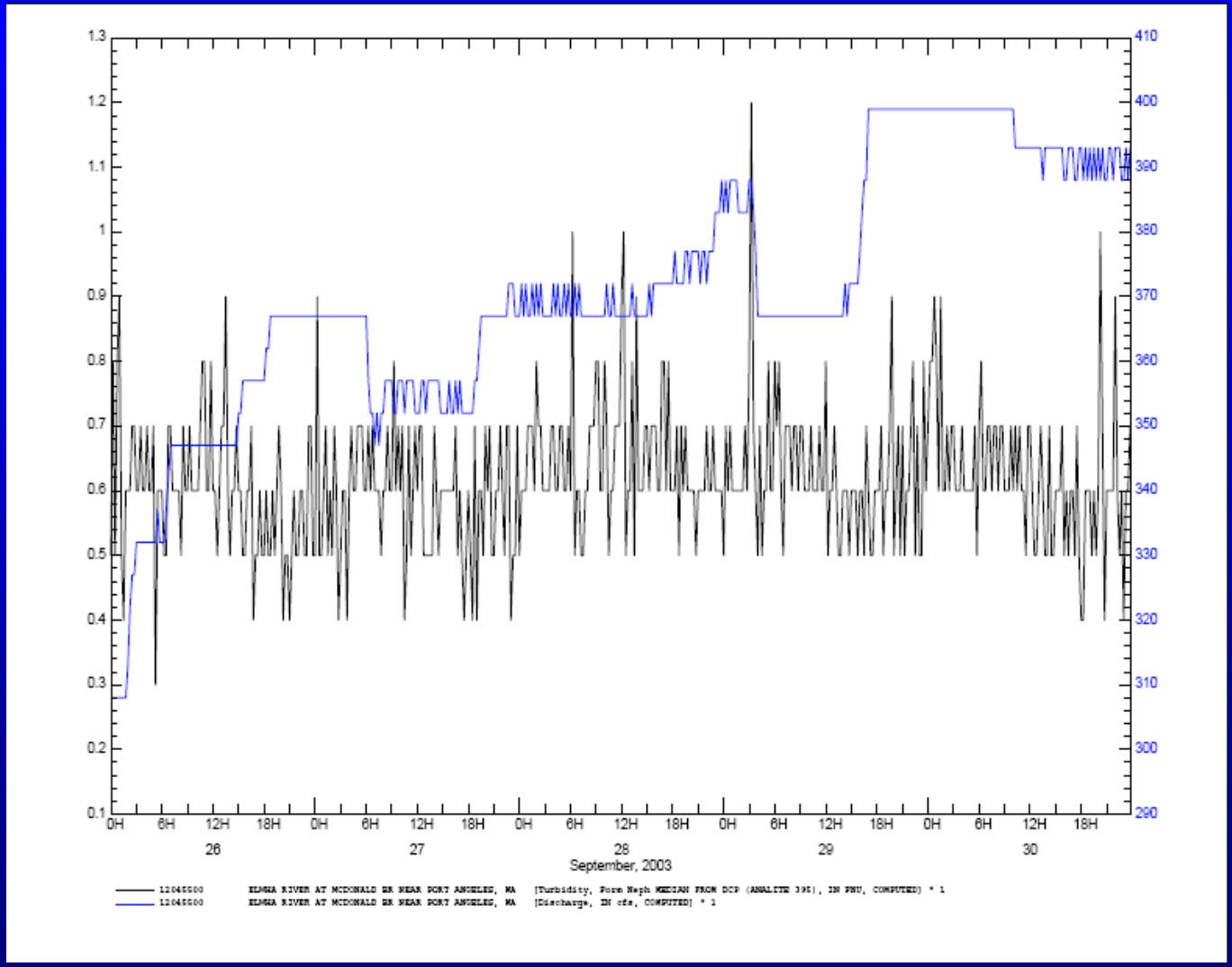
Low-level Turbidity



USGS

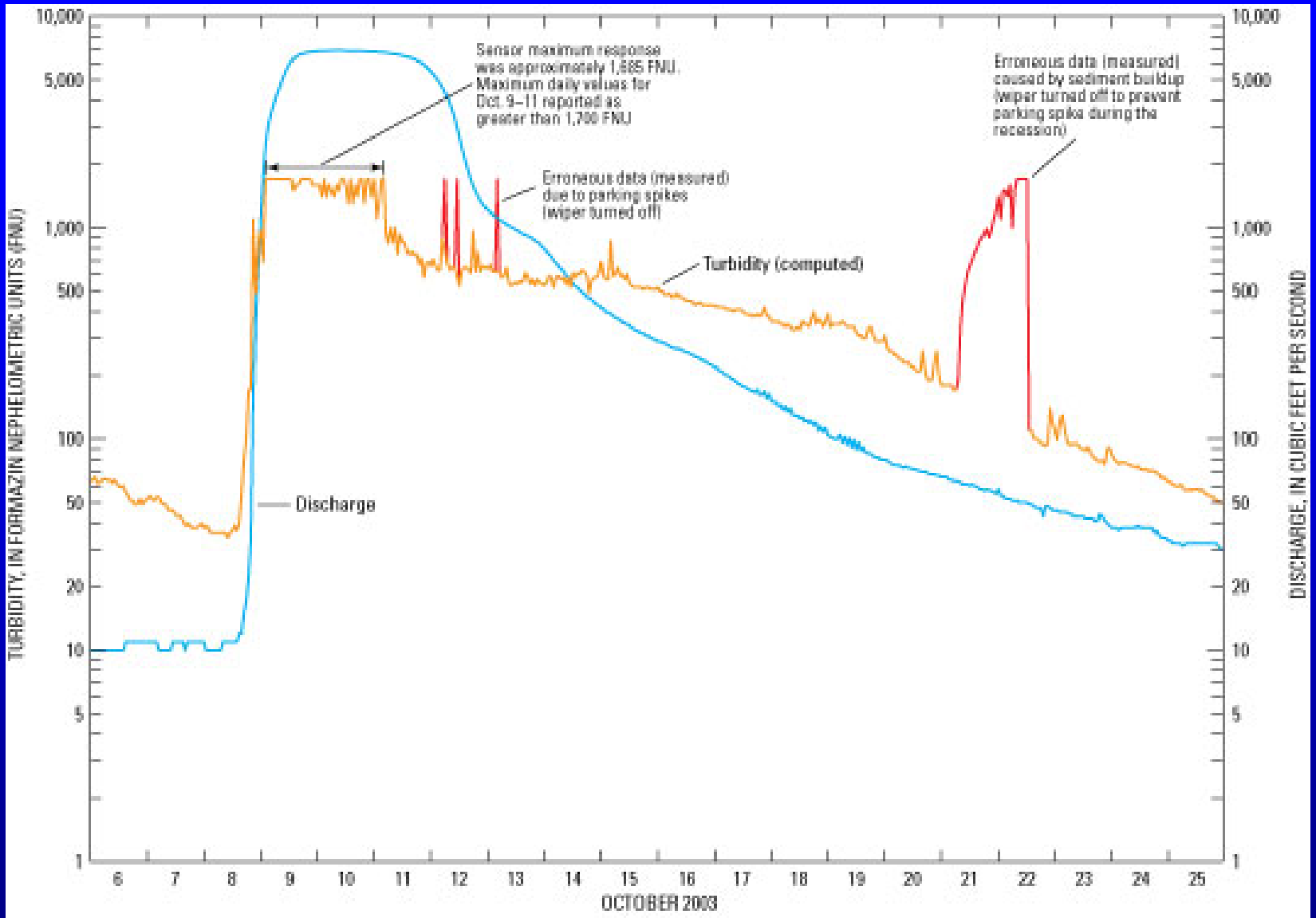


Figure 6. Turbidity values at the Little Arkansas River at Highway 50 near Halstead, Kansas, October 2003.

USGS

Rating Continuous Water-Quality Data

- Assessment of accuracy
- Amount of data recorded and assessment of instrument performance
  - ✓ Excellent
  - ✓ Good
  - ✓ Fair
  - ✓ Poor

USGS

Techniques and Methods

- Book 1, Section D3
- http://pubs.usgs.gov/tm/2006/tm1D3/

National Field Manual

http://water.usgs.gov/owq/FieldManual/

USGS