Water Quality and Streamflow Monitoring near the Ozark National Forest, Scotland, Arkansas

The U.S. Geological Survey (USGS), in cooperation with the U.S. Department of Agriculture Forest Service (USFS), established a real-time continuous water-quality monitor and streamflow gaging station within the upper reaches of the basin of the South Fork of the Little Red River in May 2009.

The USFS administers the Ozark-St. Francis National Forest which consists of lands in and surrounding this watershed. Activities related to the exploration and production of natural gas from the Fayetteville Shale also occur within and surrounding this watershed. To ensure the long term sustainability of the water resources, federal and state agencies are interested in monitoring the conditions before and during natural gas exploration and extraction activities.

The South Fork of the Little Red River is an ecologically important basin because of the presence of two endangered aquatic species. With headwaters in the Ozark National Forest (ONF), this river flows across the state managed lands of the Gulf Mountain Wildlife Management Area (WMA), and ultimately into Greer's Ferry Lake, a public water supply. This monitoring site will provide information useful for assessing any changes to the condition of the water resources within this watershed.
Real-time water quality and streamflow monitoring is occurring at two locations in Van Buren County (fig. 1).

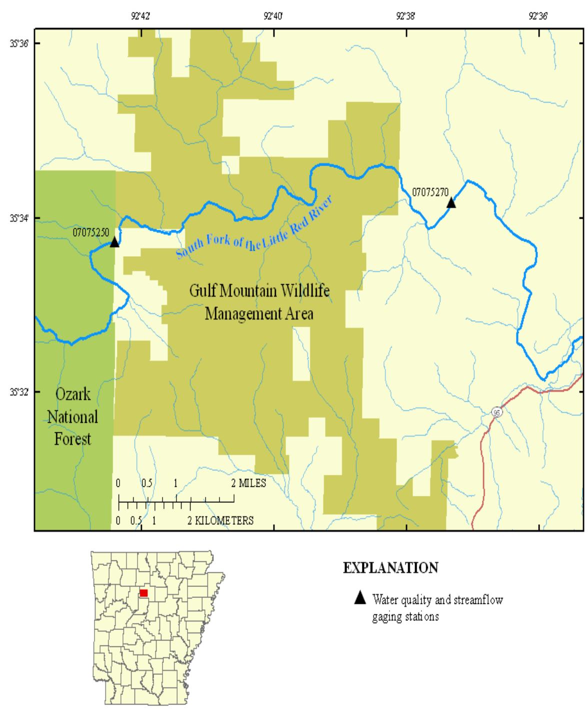

Figure 1. Location of continuous water quality and streamflow gaging station on the South Fork of the Little Red River.

The site, "**07075250** South Fork of Little Red River Upstream of Gulf Mountain Wildlife Management Area, near Scotland, Arkansas" was established with the USFS in June 2009. Another site, "**07075270** South Fork Little Red River near Scotland, Arkansas", is located approximately 8 miles downstream and was established through a formal agreement with the Arkansas Game and Fish Commission in June 2010. These sites complement each other and are designed to provide a comparative suite of water resource parameters for evaluating quantity and quality conditions. These sites are part of a statewide network of stations that the USGS operates in cooperation with numerous federal, state and local partners.

The upstream monitoring site (07075250) has measured temperature, specific conductance, pH, dissolved oxygen, turbidity, stage (water-level), and precipitation data at 15-minute intervals since June 2009 (table 1). Satellite telemetry allows this site to provide near-real time data for display on the internet. Provisional and approved (figures 2-4) data can be viewed by visiting the USGS Arkansas Water Science Center web page (http://ar.water.usgs.gov).

Table 1. Minimum and maximum values (provisional data[1]) for water quality characteristics at 07075250.
[Min, Minimum; Max, Maximum; °C ,degrees Celsius; µS/cm at 25°C, microsiemens per centimeter at 25 degrees Celsius; SU, standard units; mg/L, milligrams per liter; FNU, formazin nephelometric units; <, less than]

2009 Water Year (Partial; June to September)

Characteristics	Reporting Units	Min	Date - Time	Max	Date - Time
Temperature	^{0}C	15.8	06/27 - 1545	29.8	09/30 - 0845
Specific Conductance	µS/cm@25^{0}C	21	07/05 - 2030	42	06/01 - 1030
pH	SU	6.0	09/27 - 1400	7.1	07/10 - 0145
Dissolved Oxygen	mg/L	4.2	09/26 - 1430	9.6	07/16 - 0815
Turbidity	FNU	0.8	07/22 - 0930	270	09/11 - 1630

2010 Water Year (October to September)

Characteristics	Reporting Units	Min	Date - Time	Max	Date - Time
Temperature	^{0}C	<0.5	01/10 - 0745	31.7	08/03 - 1715
Specific Conductance	µS/cm@25^{0}C	17	07/05 - 0530	35	12/24 - 0515
pH	SU	5.9	10/02 - 2300	6.8	08/20 - 0615
Dissolved Oxygen	mg/L	2.6	01/10 - 1030	14.9	07/07 - 0900
Turbidity	FNU	<0.5	10/30 - 0100	530	07/09 - 1015

[1]Minimum and maximum values for the 2009 and 2010 Water Year are not yet published.

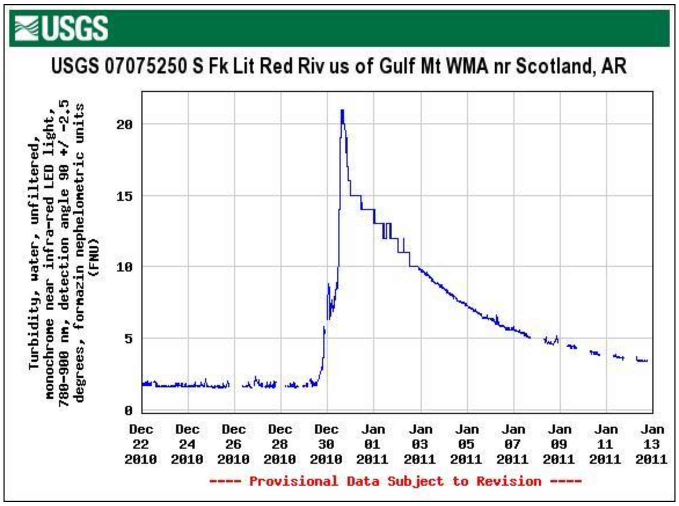

Figure 2. Example showing continuous turbidity values at 07075250.

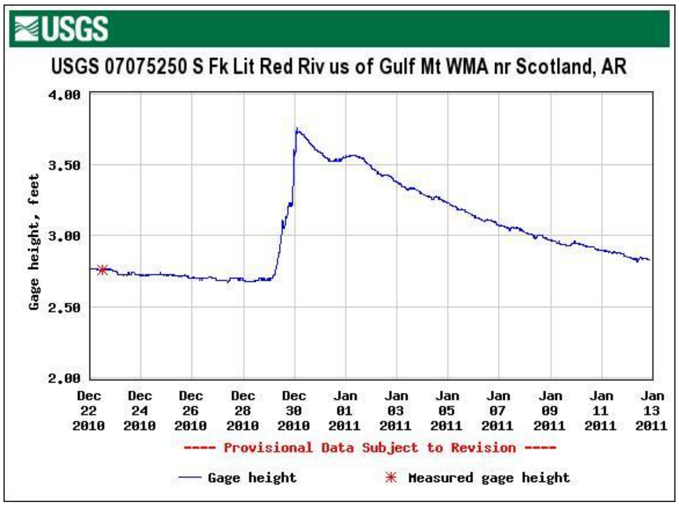

Figure 3. Example of stage hydrograph (gage height) at 07075250.

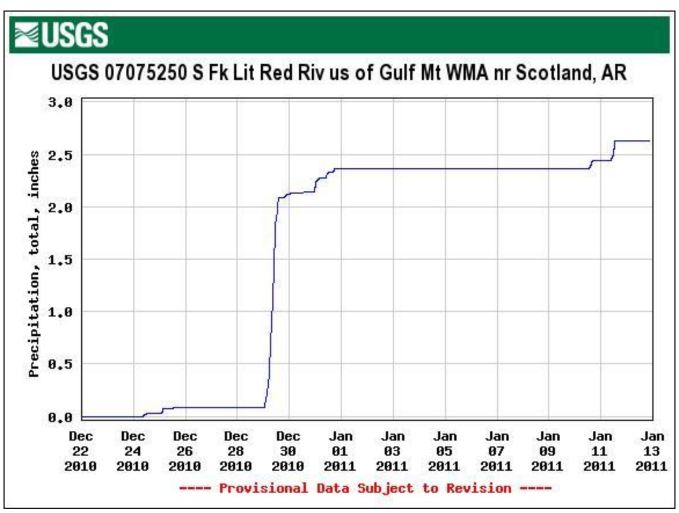

Figure 4. Example of a precipitation accumulation graph showing rainfall amounts at 07075250.

In recent months, the web page that displays water quality data for this station has been accessed more than 500 times.

Operation and maintenance is performed by the USGS and requires physical inspections every 2 to 3 weeks to service the site and collect streamflow measurements (fig. 5). Service is performed according to Wagner et al. (2006); the records remain on file at the AR WCS offices.

Figure 5. a. Continuous water quality monitor and streamflow gaging station site 07075250 gage shelter; b. Continuous water quality monitor; c. USGS hydrologist conducting streamflow measurement; d. Data collection instrumentation inside gaging station.

Streamflow measurements are conducted to establish site specific stage-discharge relationships (table 2), and are performed according to Rantz et al. (1982). Stage-discharge relationships require a full range of flows to be measured.

Table 2. Periodic streamflow measurements collected at 07075250. [feet, ft; cubic feet per second, cfs]

Date	Stage (ft)	Streamflow (cfs)
07/10/2009	2.55	1.23
12/22/2009	3.46	34.6
05/26/2010	3.88	78.4
09/08/2010	2.35	1.35

To measure high flow conditions, a bank operated cableway system was installed to provide for safe operation (fig. 6).

Figure 6. Bank operated cableway installed at the gaging station 07075250.

The standard suite of water-quality parameters are recorded to provide a foundation for a comprehensive evaluation of water-quality conditions. Multi-parameter monitoring is useful for assessing variations over time, for example, increases in stage can be found to coincide with an increase in turbidity (fig. 7). Other relationships can be found to exist such as decreases in specific conductance with increases in flow (fig. 8).

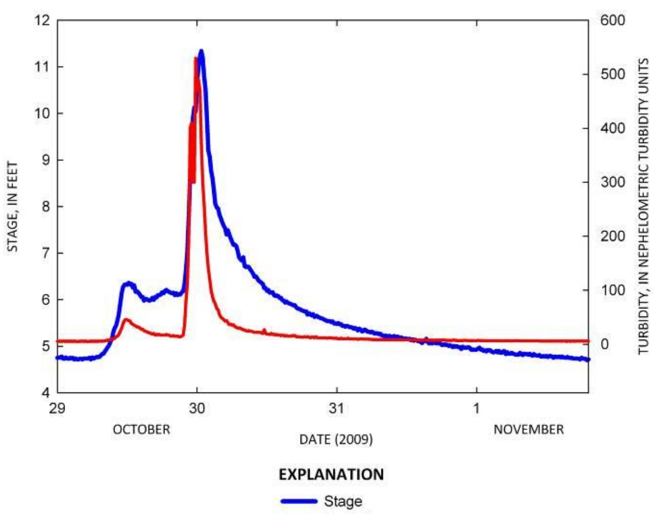

Figure 7. Comparison of stage and turbidity for 07075250.

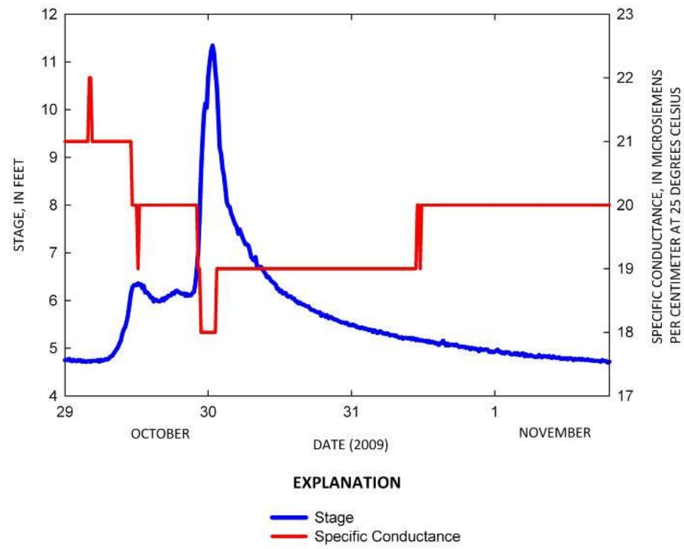

Figure 8. Comparison of stage and specific conductance for 07075250.

Streamflow is important for assessing the quantity, evaluating aquatic habitat, and interpreting water-quality data. Streamflow and rainfall data can also be used to monitor flooding and drought conditions. Through statistical analyses, streamflow data can be used to generate flood-frequency information, and establishing or verifying run-off coefficients for use in other models or analysis.

Continuous data is used to identify changes in water-quality resulting from land-use changes and can also be used to evaluate the effectiveness of best management practices (Rasmussen and others, 2009). Continuous concentration estimates can be used to determine if water-quality criteria are exceeded. Load duration curves can be developed to evaluate the change in duration and magnitude of stream flow run-off constituents.

USGS Monitoring is for Assessment Only

The USGS has no regulatory responsibilities and focuses on evaluating the entire resource, which may be a source of drinking water as well as water used for industry, irrigation, and recreation. USGS water-quality data complement much of the data collected by the States and by the U.S. Environmental Protection Agency, which focus on monitoring for compliance with regulations.

Visit **http://ar.water.usgs.gov** for access to online data and reports, including: current streamflow and rainfall data, streamflow conditions, NWIS Web (National Water Information System) for real-time and historical water data.

For additional information, please contact the Center Director at (501) 228-3600 or by email at dc_ar@usgs.gov

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Selected References

Rantz, S.E, and others, 1982, Measurement and computation of streamflow: Volume 1. Measurement of stage and discharge; Volume 2. Computation of discharge: U.S. Geological Survey Water-Supply Paper 2175, 631 p.

Rasmussen, P.P., Gray, J.R., Glysson, G.D., and Ziegler, A.C. 2009, Guidelines and procedures for computing time-series suspended-sediment concentrations and loads from in-stream turbidity-sensor and streamflow data: U.S. Geological Survey Techniques and Methods book 3, chap. C4, 53 p.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at http://pubs.water.usgs.gov/tm1d3