

Appendix 1.1. Model Archive Summary for Total Dissolved Solids Concentration at U.S. Geological Survey site 07143672, Little Arkansas River at Highway 50 near Halstead, Kansas, during May 1998 through December 2019

This model archive summary summarizes the total dissolved solids model developed to compute hourly or daily total dissolved solids. Model development methods follow U.S. Geological Survey guidance (USGS) from Office of Surface Water/Office of Water Quality Technical Memoranda and USGS Techniques and Methods, book 3, chap. C4 (Rasmussen and others, 2009).

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Site and Model Information

Site Number: 07143672

Site Name: Little Arkansas River at Highway 50 near Halstead, Kansas

Location: Latitude 38°01'43", longitude 97°32'25" referenced to North American Datum of 1927, in NW 1/4 NE 1/4 NE 1/4 sec.28, T.23 S., R.2 W., Harvey County, Kansas, hydrologic unit 11030012.

Equipment: A Sutron Satlink II High Data Rate Collection Platform and a Design Analysis Water Log H350/355 nonsubmersible pressure transducer transfers real-time stage and water-quality data via satellite. The primary reference gage is a Type-A wire-weight gage located on the downstream bridge guardrail. Check-bar elevation is 33.396 feet. The orifice tube is enclosed in 1.25-inch steel conduit trenched into the ground down to the edge of water, where the orifice emerges from the bank and culminates in a 2-inch open-end orifice tethered to a steel fencepost near the left edge of water. Gage height was measured during May 1998 through December 2019. A YSI 6600 water-quality monitor equipped with water temperature, specific conductance, pH, dissolved oxygen, and turbidity (a YSI Model 6026 [December 1998 through December 2006] and YSI Model 6136 [July 2004 through December 2017]) sensors collected data during May 1998 through December 2017. A YSI EXO2 water-quality monitor equipped with water temperature, specific conductance, pH, dissolved oxygen, turbidity, and fluorescent dissolved organic matter sensors collected data during January 2017 through December 2019. A Hach Nitratex monitor collected nitrate data during February 2017 through December 2019.

Date model was developed: June 1, 2020

Model calibration data period: May 12, 1998 through December 10, 2019

Model Data

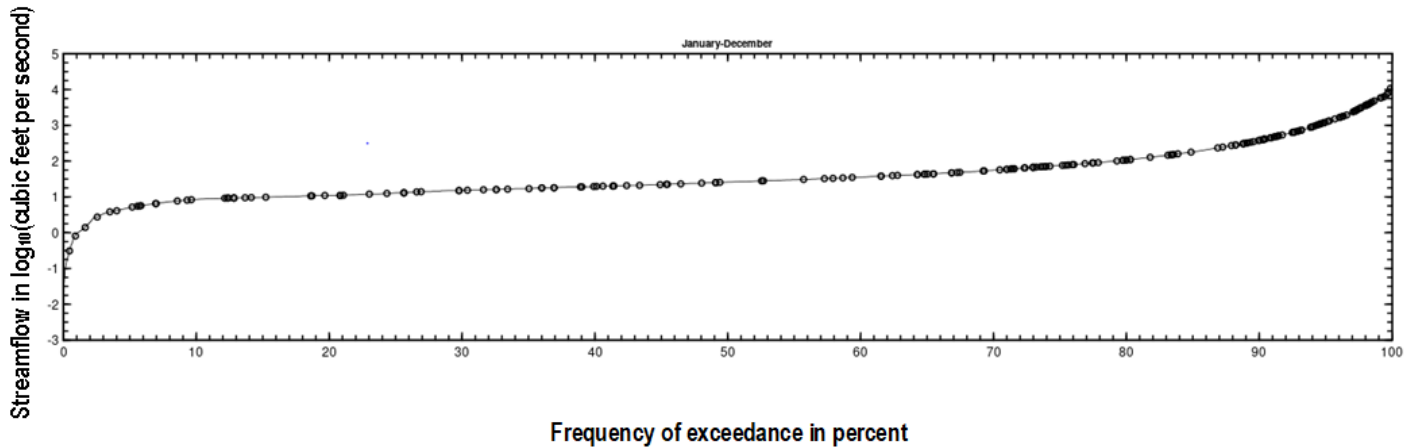
All data were collected using USGS protocols (U.S. Geological Survey, variously dated; Wagner and others, 2006; Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010) and are stored in the National Water Information System (NWIS) database (U.S. Geological Survey, 2021). Explanatory variables were evaluated individually and in combination. Potential explanatory variables included streamflow, water temperature, specific conductance, pH, dissolved oxygen, YSI EXO2 turbidity, nitrate, and fluorescent dissolved organic matter. Seasonal components (sine and cosine variables) also were evaluated as explanatory variables.

The regression model is based on 191 concomitant values of discretely collected total dissolved solids and continuously measured specific conductance during May 1998 through December 2019. Discrete samples were collected over a range of streamflows and specific conductance conditions. No samples had concentrations that were below laboratory detection limits. Summary statistics and the complete model-calibration dataset are provided below. Outliers and influential points were identified using studentized residuals, DFITS, Cook's D (Cook, 1977), and leverage. Outliers in previously published versions of this model (Christensen and others, 2003; Rasmussen and others, 2016) were examined and retained in the dataset if there were no clear issues, explanations, or conditions that would cause a result to be invalid for model calibration. All samples were retained in the dataset.

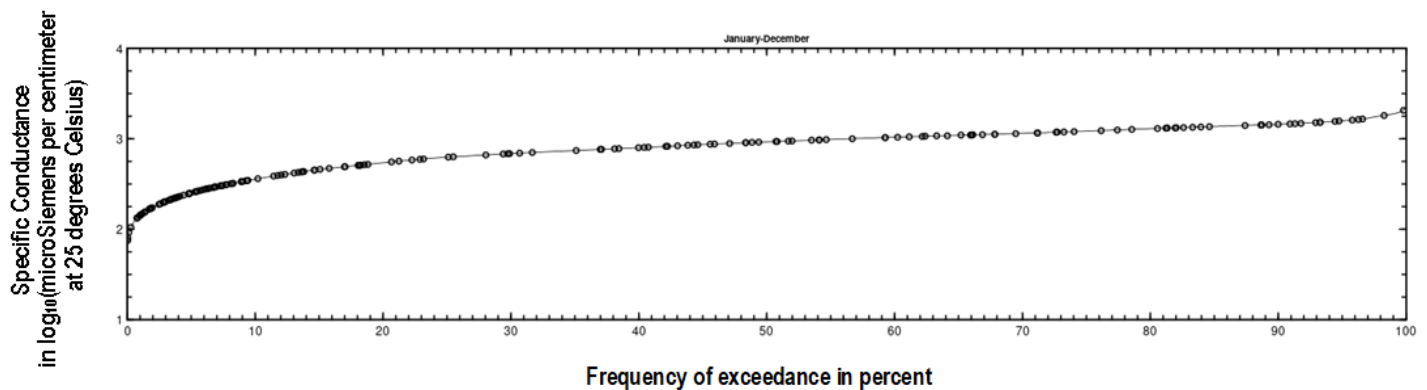
Total Dissolved Solids

Discrete samples were collected from the downstream side of the bridge or instream within 50 feet of the bridge using equal-width-increment, multi-vertical, single vertical or grab-dip methods following U.S. Geological Survey (variously dated) and Rasmussen and others (2014). Discrete samples were collected on a semifixed to event-based schedule ranging from 4 to 13 samples per year with a FISP US DH-95 or D-95 with a Teflon bottle, cap, and nozzle depth-integrating sampler, a DH-81 with a Teflon bottle, cap, and nozzle hand sampler or a grab sample with a Teflon bottle depending on sample location. Samples were analyzed for total dissolved solids by the Wichita Municipal Water and Wastewater Laboratory in Wichita, Kansas, or the USGS National Water Quality Laboratory according to standard methods (American Public Health Association and others, 1995).

Total Dissolved Solids Samples Plotted on Streamflow Duration Curve



Total Dissolved Solids Samples Plotted on Specific Conductance Duration Curve



Continuous Data

Concomitant specific conductance values were time interpolated. If no concomitant continuous data were available within 2 hours of sample collection, the sample was not included in the dataset.

Model Development

Ordinary least squares regression analysis was done using R (version 4.0.0) programming language (R Core Team, 2020) to relate discretely collected total dissolved solids to specific conductance and other continuously measured data. The distribution of residuals was examined for normality and plots of residuals (the difference between the measured and model-calculated values) compared to model-computed total dissolved solids were examined for homoscedasticity (departures from zero did not change substantially over the range of model-calculated values). Previously published explanatory variables were also strongly considered for continuity; however, the best explanatory variable(s) were ultimately selected.

Specific conductance was selected as the best predictor of total dissolved solids based on residual plots, high coefficient of determination (R^2), and low model standard percentage error (MSPE). Specific conductance was positively related to total

dissolved solids because it measures water's capacity to conduct an electrical current and is related to the concentration of ionized substances in water (Hem, 1992).

Model Summary

Summary of final total dissolved solids regression analysis at USGS site number 07143672:

Total dissolved solids-based model:

$$\log_{10}(TDS) = 0.918 \times \log_{10}(SC) + 0.0121$$

where,

\log_{10} = logarithm base 10;

TDS = total dissolved solids, in milligrams per liter (mg/L); and

SC = specific conductance, in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$)

The log-transformed model may be retransformed to original units so that TDS can be calculated directly. The retransformation introduces a bias in the calculated constituent. This bias may be corrected using Duan's bias correction factor (BCF; Duan, 1983). For this model, the calculated BCF is 1.01. The retransformed model, accounting for BCF is:

$$TDS = 1.0385 \times SC^{0.918}$$

Model Statistics, Data, and Plots

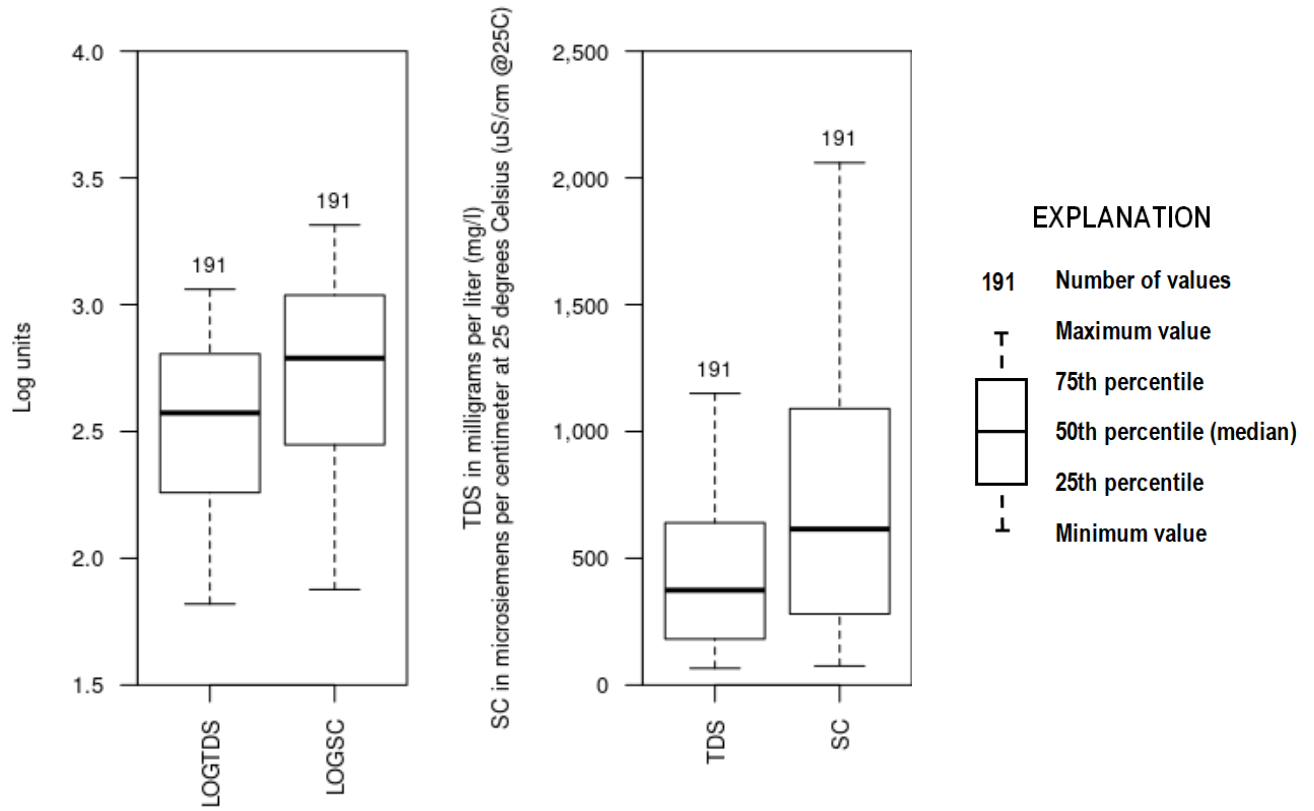
Model

$$\text{LOGTDS} = + 0.918 * \text{LOGSC} + 0.0121$$

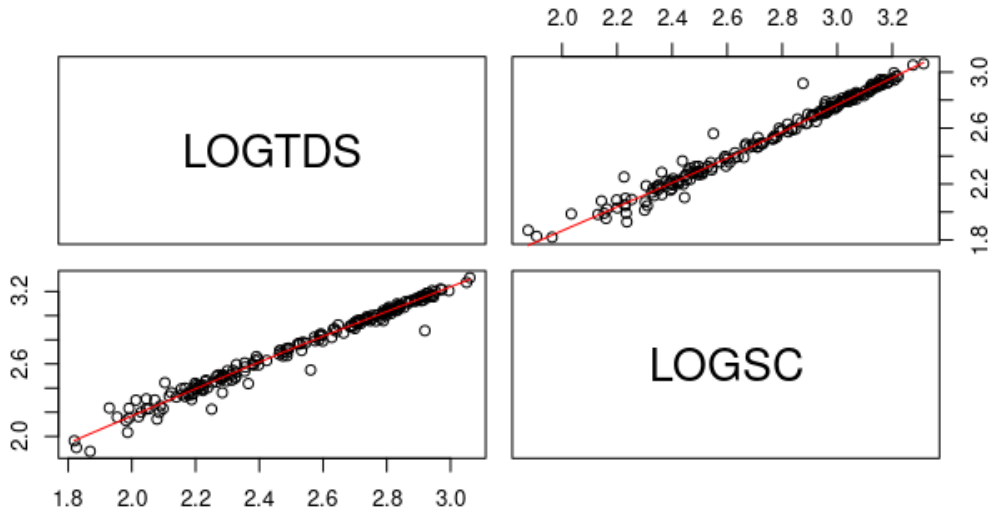
Variable Summary Statistics

	LOGTDS	TDS	LOGSC	SC
Minimum	1.82	66	1.88	75.2
1st Quartile	2.25	179	2.45	279.0
Median	2.57	374	2.79	615.0
Mean	2.53	424	2.74	711.0
3rd Quartile	2.81	641	3.04	1100.0
Maximum	3.06	1150	3.31	2060.0

Box Plots



Exploratory Plots



Basic Model Statistics

Number of Observations	191
Standard error (RMSE)	0.0458
Average Model standard percentage error (MSPE)	10.6
Coefficient of determination (R ²)	0.979
Adjusted Coefficient of Determination (Adj. R ²)	0.979
Bias Correction Factor (BCF)	1.01

Explanatory Variables

	Coefficients	Standard Error	t value	Pr(> t)
(Intercept)	0.0121	0.02720	0.447	6.56e-01
LOGSC	0.9180	0.00985	93.200	5.86e-160

Correlation Matrix

	Intercept	E.vars
Intercept	1.000	-0.992
E.vars	-0.992	1.000

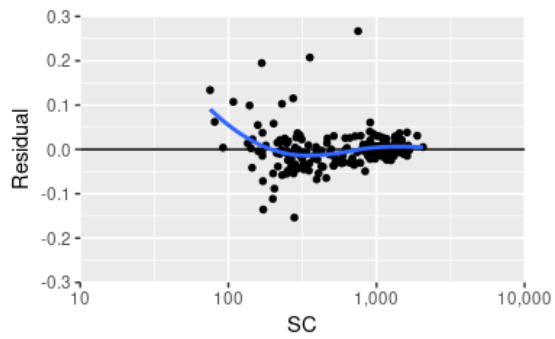
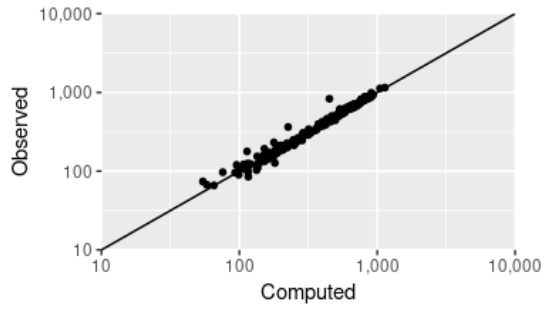
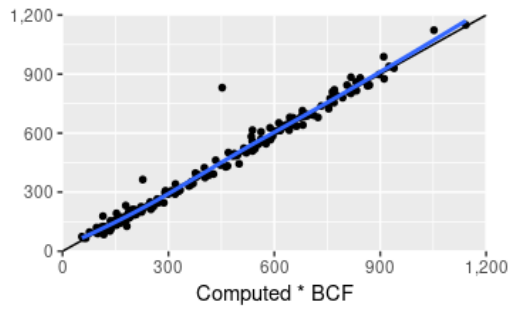
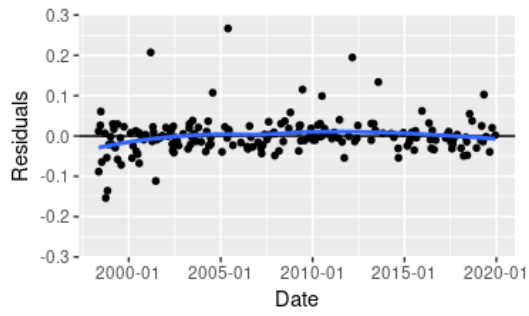
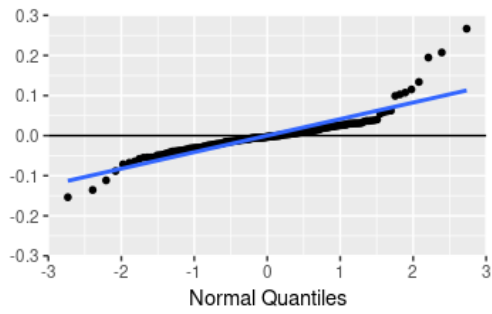
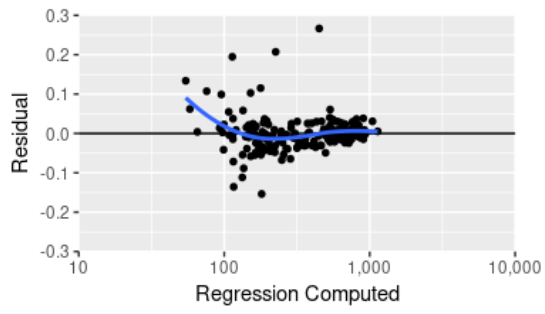
Outlier Test Criteria

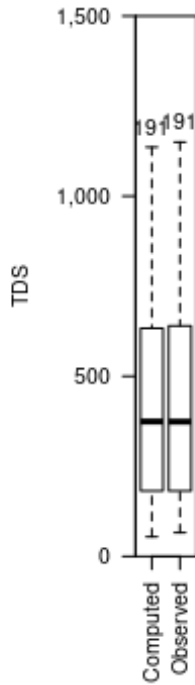
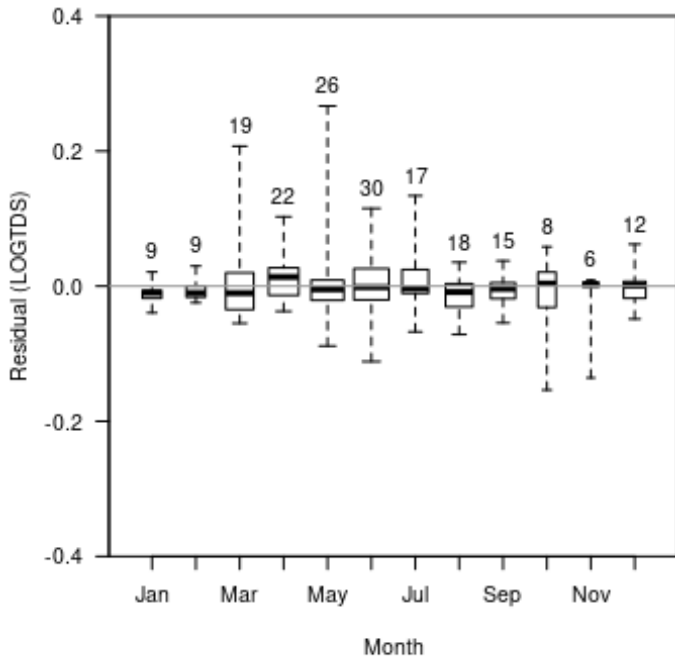
Leverage	Cook's D	DFFITS
0.0314	0.1946	0.2047

Flagged Observations

	LOGTDS	Estimate	Residual	Standard Residual	Studentized Residual	Leverage	Cook's D	DFFITS
5/14/1998 11:40	2.05	2.13	-0.08840	-1.9500	-1.9600	0.01370	0.026300	-0.2310
10/1/1998 11:20	2.10	2.26	-0.15400	-3.3700	-3.4700	0.00921	0.052900	-0.3350
11/6/1998 11:30	1.93	2.07	-0.13600	-2.9900	-3.0600	0.01690	0.077000	-0.4010
8/4/1999 10:35	1.99	2.06	-0.07150	-1.5800	-1.5800	0.01700	0.021500	-0.2080
3/13/2001 11:15	2.56	2.35	0.20700	4.5500	4.8100	0.00687	0.071500	0.4000
6/22/2001 10:35	2.01	2.12	-0.11200	-2.4600	-2.4900	0.01410	0.043200	-0.2980
7/26/2004 10:20	1.99	1.88	0.10700	2.3800	2.4100	0.02820	0.082200	0.4110
5/26/2005 12:00	2.92	2.65	0.26700	5.8500	6.4400	0.00612	0.105000	0.5060
5/25/2007 10:20	1.82	1.82	0.00403	0.0895	0.0893	0.03300	0.000137	0.0165
6/16/2009 10:20	2.37	2.25	0.11500	2.5300	2.5700	0.00942	0.030400	0.2500
7/7/2010 10:00	2.08	1.98	0.09910	2.1900	2.2100	0.02160	0.053000	0.3290
3/1/2012 10:00	2.25	2.06	0.19500	4.2900	4.5100	0.01740	0.163000	0.6000
7/30/2013 10:15	1.87	1.74	0.13400	2.9900	3.0500	0.03960	0.184000	0.6200
12/14/2015 10:35	1.83	1.76	0.06220	1.3800	1.3900	0.03720	0.037000	0.2730
4/29/2019 13:05	2.28	2.18	0.10300	2.2600	2.2900	0.01180	0.030500	0.2500

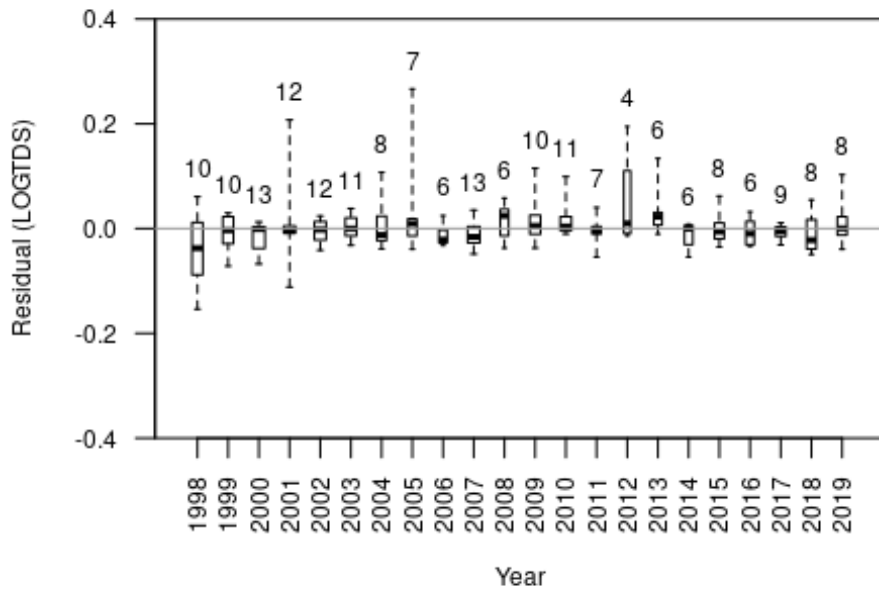
Statistical Plots





EXPLANATION

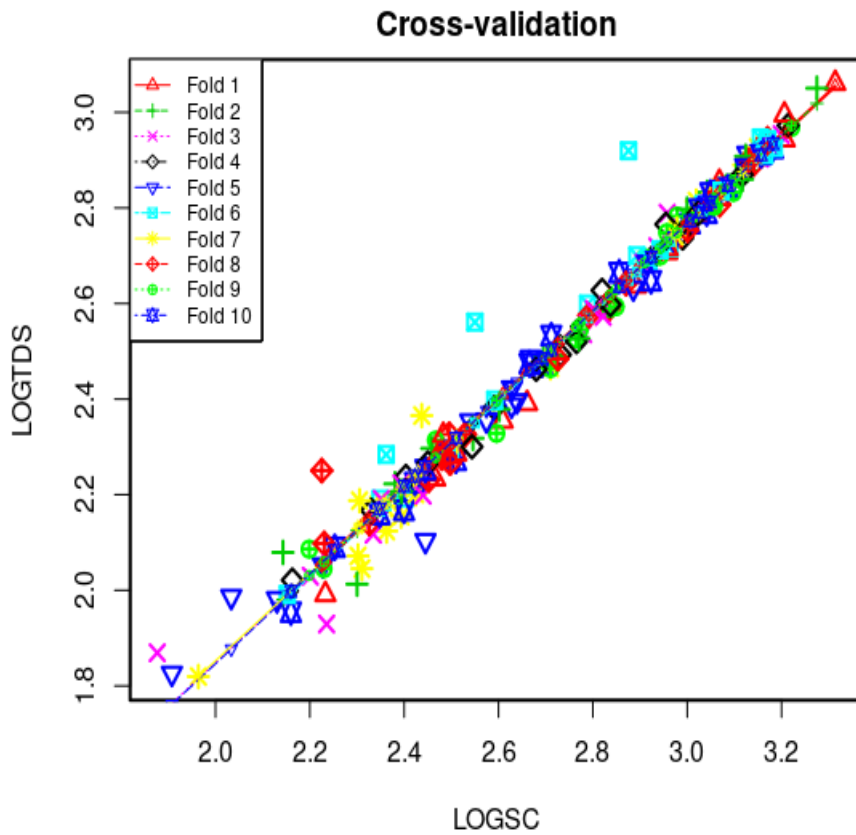
- 191 Number of values
- T Maximum value
- 75th percentile
- 50th percentile (median)
- 25th percentile
- Minimum value



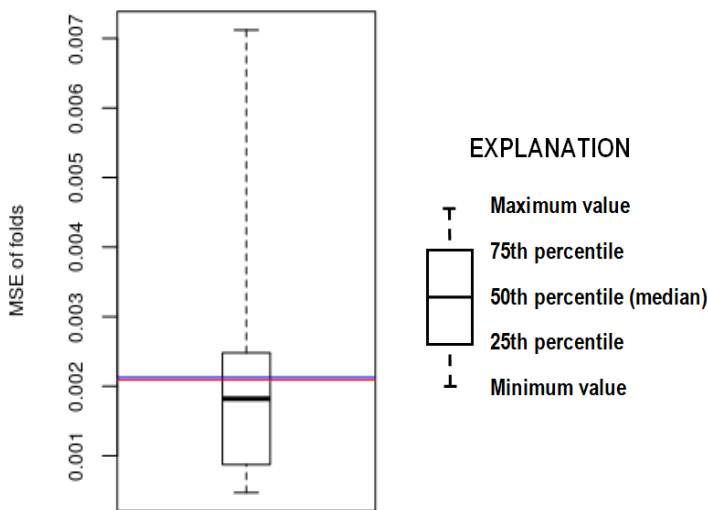
EXPLANATION

- 10 Number of values
- T Maximum value
- 75th percentile
- 50th percentile (median)
- 25th percentile
- Minimum value

Cross Validation



Minimum MSE of folds: 0.000471
Mean MSE of folds: 0.002130
Median MSE of folds: 0.001820
Maximum MSE of folds: 0.007120
(Mean MSE of folds) / (Model MSE): 1.020000



Red line - Model MSE
Blue line - Mean MSE of folds

Model-Calibration Dataset

	Date	LOGTDS	LOGSC	TDS	SC	Computed LOGTDS	Computed TDS	Residual	Normal Quantiles
1	5/12/1998	2.82	3.04	658	1100	2.81	644	0.0117	0.597
2	5/14/1998	2.05	2.31	111	204	2.13	137	-0.0884	-2.08
3	6/15/1998	2.83	3.04	680	1100	2.81	644	0.0264	1.04
4	6/25/1998	2.79	2.96	615	907	2.73	538	0.0607	1.64
5	7/13/1998	2.39	2.66	246	458	2.46	287	-0.0645	-1.82
6	9/14/1998	2.79	3.01	611	1030	2.78	605	0.00674	0.404
7	10/1/1998	2.1	2.45	127	279	2.26	182	-0.154	-2.73
8	10/22/1998	2.35	2.61	226	406	2.41	257	-0.0537	-1.55
9	11/6/1998	1.93	2.24	85	172	2.07	117	-0.136	-2.39
10	12/3/1998	2.74	2.99	546	978	2.76	577	-0.0211	-0.694
11	1/6/1999	2.97	3.22	930	1660	2.97	939	-0.0017	0.0525
12	2/1/1999	2.22	2.42	165	266	2.24	174	-0.0208	-0.678
13	2/19/1999	2.91	3.13	820	1340	2.88	770	0.0298	1.13
14	3/11/1999	2.93	3.16	860	1460	2.92	831	0.0172	0.728
15	4/7/1999	2.54	2.78	344	603	2.57	370	-0.0288	-0.892
16	5/20/1999	2.81	3.02	652	1040	2.78	613	0.0296	1.11
17	5/24/1999	2.12	2.36	133	231	2.18	153	-0.058	-1.75
18	7/19/1999	2.05	2.23	113	169	2.06	115	-0.00477	-0.0787
19	8/4/1999	1.99	2.23	98	171	2.06	116	-0.0715	-1.98
20	9/28/1999	2.02	2.16	105	145	2	100	0.0229	0.912
21	2/8/2000	2.92	3.15	826	1430	2.91	816	0.00764	0.433
22	3/6/2000	2.16	2.39	143	247	2.21	163	-0.0549	-1.7
23	3/27/2000	2.19	2.4	156	252	2.22	166	-0.0243	-0.78
24	5/19/2000	2.89	3.12	776	1320	2.88	758	0.0127	0.629
25	5/30/2000	2.39	2.63	244	424	2.43	268	-0.0379	-1.21
26	6/26/2000	2.27	2.51	187	323	2.32	209	-0.0452	-1.39
27	7/19/2000	2.79	3.01	610	1030	2.78	603	0.00781	0.447
28	7/27/2000	2.33	2.6	213	394	2.4	250	-0.0676	-1.89
29	8/15/2000	2.8	3.03	633	1080	2.8	631	0.00362	0.279
30	9/7/2000	2.81	3.04	647	1110	2.81	647	0.00269	0.225
31	9/25/2000	2.84	3.08	688	1200	2.84	694	-0.000911	0.105
32	10/27/2000	2.38	2.59	241	389	2.39	248	-0.00903	-0.279
33	11/30/2000	2.95	3.2	898	1580	2.95	897	0.00317	0.238
34	3/13/2001	2.56	2.55	364	355	2.35	227	0.207	2.39
35	4/12/2001	2.55	2.77	351	593	2.56	364	-0.0133	-0.433
36	4/26/2001	2.93	3.15	844	1410	2.9	806	0.0226	0.892
37	5/9/2001	2.97	3.21	939	1640	2.96	925	0.00901	0.506
38	6/1/2001	2.77	3.01	585	1010	2.77	595	-0.00515	-0.131
39	6/11/2001	2.2	2.39	159	247	2.21	163	-0.00773	-0.238
40	6/22/2001	2.01	2.3	103	200	2.12	134	-0.112	-2.21
41	7/12/2001	2.75	2.99	556	968	2.75	571	-0.00904	-0.293
42	8/1/2001	2.88	3.13	755	1340	2.88	769	-0.00557	-0.158
43	8/30/2001	2.89	3.14	780	1380	2.9	793	-0.00489	-0.0919
44	9/18/2001	2.03	2.2	107	159	2.03	109	-0.00392	-0.0262
45	10/30/2001	2.81	3.05	645	1110	2.81	648	0.000849	0.185
46	1/9/2002	2.94	3.17	880	1480	2.92	843	0.021	0.835
47	2/20/2002	2.91	3.15	807	1420	2.91	812	-0.000299	0.131
48	4/10/2002	2.9	3.13	793	1350	2.89	775	0.0125	0.613
49	4/22/2002	2.18	2.34	151	221	2.16	147	0.0147	0.694
50	5/14/2002	2.49	2.72	310	526	2.51	326	-0.0198	-0.629
51	5/23/2002	2.47	2.71	292	513	2.5	319	-0.0355	-1.13
52	6/6/2002	2.85	3.07	714	1170	2.83	680	0.024	0.932
53	6/17/2002	1.95	2.16	90	144	2	99.6	-0.0413	-1.33

54	7/9/2002	2.69	2.92	489	830	2.69	496	-0.00347	-0.0131
55	8/20/2002	2.47	2.69	297	493	2.48	307	-0.0119	-0.404
56	9/18/2002	2.81	3.07	641	1170	2.83	681	-0.0237	-0.763
57	12/17/2002	3.06	3.31	1150	2060	3.06	1140	0.00538	0.334
58	3/24/2003	2.32	2.55	208	351	2.35	225	-0.0319	-1.04
59	4/16/2003	2.94	3.17	877	1480	2.92	843	0.0196	0.798
60	4/22/2003	2.66	2.86	462	718	2.63	434	0.0299	1.16
61	5/15/2003	2.29	2.5	193	315	2.31	204	-0.0208	-0.661
62	5/28/2003	2.49	2.7	307	496	2.49	309	9.56E-05	0.171
63	6/10/2003	2.71	2.94	508	862	2.71	513	-0.00206	0.0393
64	6/24/2003	2.99	3.21	988	1610	2.96	910	0.0384	1.47
65	7/30/2003	2.87	3.1	738	1270	2.86	733	0.00564	0.362
66	9/2/2003	2.28	2.48	189	302	2.29	196	-0.0131	-0.418
67	10/15/2003	2.19	2.35	155	223	2.17	148	0.0213	0.854
68	12/11/2003	2.94	3.21	876	1610	2.96	911	-0.0145	-0.521
69	3/9/2004	2.12	2.33	131	216	2.16	144	-0.0386	-1.24
70	3/29/2004	2.84	3.07	693	1170	2.83	680	0.011	0.582
71	4/26/2004	2.95	3.16	884	1430	2.91	817	0.0367	1.36
72	5/13/2004	2.53	2.76	336	581	2.55	358	-0.0245	-0.816
73	5/26/2004	2.71	2.96	509	907	2.73	538	-0.0216	-0.711
74	6/16/2004	2.73	2.97	541	928	2.74	550	-0.00431	-0.0525
75	6/21/2004	2.36	2.57	227	375	2.38	239	-0.0202	-0.645
76	7/26/2004	1.99	2.03	97	108	1.88	76.2	0.107	1.89
77	1/28/2005	2.4	2.64	249	435	2.44	274	-0.0394	-1.27
78	3/25/2005	2.33	2.5	212	313	2.3	202	0.0225	0.873
79	5/11/2005	2.87	3.12	740	1310	2.87	753	-0.00504	-0.105
80	5/26/2005	2.92	2.88	831	751	2.65	452	0.267	2.73
81	6/7/2005	2.35	2.54	226	347	2.34	222	0.00943	0.536
82	6/14/2005	2.17	2.33	147	214	2.15	143	0.0151	0.711
83	8/31/2005	2.38	2.6	239	400	2.4	253	-0.0229	-0.745
84	2/7/2006	2.79	3.04	615	1100	2.81	642	-0.0162	-0.582
85	6/8/2006	2.59	2.83	388	683	2.62	415	-0.0262	-0.835
86	6/26/2006	2.29	2.51	193	324	2.32	209	-0.0321	-1.06
87	7/28/2006	2.22	2.38	167	240	2.2	159	0.0247	0.952
88	8/23/2006	2.42	2.63	265	425	2.43	268	-0.00274	0.0262
89	9/27/2006	2.59	2.84	389	686	2.62	416	-0.027	-0.854
90	1/10/2007	2.8	3.06	636	1140	2.82	664	-0.0159	-0.566
91	1/30/2007	2.72	2.96	520	920	2.73	545	-0.0178	-0.597
92	3/12/2007	2.57	2.82	374	663	2.6	404	-0.0305	-0.952
93	3/21/2007	2.49	2.73	311	538	2.52	333	-0.0274	-0.873
94	3/27/2007	2.23	2.47	171	292	2.28	190	-0.0435	-1.36
95	4/18/2007	2.21	2.42	163	263	2.23	173	-0.0222	-0.728
96	5/25/2007	1.82	1.96	66	92	1.82	65.8	0.00403	0.306
97	7/11/2007	2.14	2.33	138	212	2.15	141	-0.00826	-0.252
98	8/13/2007	2.78	2.98	606	952	2.75	562	0.0353	1.33
99	9/5/2007	2.79	3.02	615	1050	2.79	614	0.00328	0.252
100	11/27/2007	2.81	3.03	641	1080	2.8	631	0.00907	0.521
101	12/4/2007	2.84	3.08	696	1190	2.84	690	0.00588	0.376
102	12/12/2007	2.17	2.4	147	251	2.22	165	-0.0485	-1.47
103	3/4/2008	2.2	2.42	159	266	2.24	174	-0.0372	-1.18
104	4/14/2008	2.53	2.71	341	515	2.5	320	0.0303	1.18
105	5/29/2008	2.28	2.49	192	308	2.3	199	-0.0137	-0.462
106	6/30/2008	2.31	2.47	206	293	2.28	190	0.0368	1.39
107	9/16/2008	2.24	2.4	173	253	2.22	167	0.0186	0.763
108	10/17/2008	2.19	2.31	154	202	2.13	135	0.0583	1.59
109	4/1/2009	2.46	2.71	291	513	2.5	319	-0.0371	-1.16

110	4/6/2009	2.7	2.91	496	813	2.68	486	0.011	0.566
111	4/13/2009	2.6	2.79	397	615	2.57	377	0.0256	0.994
112	4/30/2009	2.3	2.46	198	287	2.27	187	0.0268	1.06
113	5/12/2009	2.23	2.42	168	265	2.24	174	-0.0118	-0.39
114	6/16/2009	2.37	2.44	232	274	2.25	179	0.115	1.98
115	7/30/2009	2.46	2.68	290	478	2.47	299	-0.0107	-0.362
116	11/2/2009	2.28	2.47	191	296	2.28	193	-0.000983	0.0919
117	12/1/2009	2.83	3.05	678	1120	2.81	653	0.0189	0.78
118	12/17/2009	2.9	3.16	802	1430	2.91	817	-0.00556	-0.145
119	1/6/2010	2.92	3.18	840	1520	2.93	864	-0.0098	-0.306
120	1/19/2010	2.93	3.18	847	1520	2.93	864	-0.0062	-0.185
121	2/11/2010	2.91	3.16	815	1430	2.91	820	2.83E-05	0.158
122	2/23/2010	2.84	3.09	691	1230	2.85	712	-0.0102	-0.334
123	4/13/2010	2.91	3.12	809	1330	2.88	765	0.0271	1.08
124	6/1/2010	2.7	2.89	501	782	2.67	470	0.0306	1.24
125	6/15/2010	2.18	2.36	150	228	2.18	151	-0.00138	0.0787
126	7/7/2010	2.08	2.14	120	139	1.98	96.1	0.0991	1.75
127	8/19/2010	2.68	2.91	484	806	2.68	482	0.00393	0.293
128	8/25/2010	2.19	2.35	155	225	2.17	149	0.0184	0.745
129	11/16/2010	2.4	2.59	250	391	2.39	248	0.00553	0.348
130	1/19/2011	2.91	3.16	816	1460	2.92	833	-0.00633	-0.198
131	3/7/2011	2.76	2.98	570	951	2.75	562	0.00882	0.476
132	5/16/2011	2.84	3.09	695	1220	2.85	706	-0.00441	-0.0656
133	6/20/2011	2.77	2.95	583	901	2.73	535	0.0402	1.51
134	8/11/2011	2.05	2.23	111	170	2.06	115	-0.0145	-0.506
135	9/22/2011	2.2	2.44	158	275	2.25	180	-0.0543	-1.59
136	12/21/2011	2.58	2.79	376	619	2.58	379	-5.00E-04	0.118
137	3/1/2012	2.25	2.23	178	168	2.06	114	0.195	2.21
138	4/18/2012	2.29	2.5	196	315	2.31	203	-0.0135	-0.447
139	5/29/2012	2.73	2.97	543	936	2.74	554	-0.00602	-0.171
140	6/18/2012	2.63	2.82	424	660	2.6	402	0.026	1.02
141	3/12/2013	2.93	3.18	844	1530	2.94	869	-0.0104	-0.348
142	3/13/2013	3.05	3.27	1120	1880	3.02	1050	0.0308	1.27
143	4/29/2013	2.8	3	627	999	2.77	588	0.0306	1.21
144	6/3/2013	2.47	2.67	298	463	2.46	290	0.0142	0.678
145	7/30/2013	1.87	1.88	74	75.2	1.74	54.7	0.134	2.08
146	10/30/2013	2.8	3.03	627	1060	2.79	621	0.00694	0.418
147	4/9/2014	2.83	3.06	680	1160	2.83	674	0.00623	0.39
148	6/4/2014	2.69	2.91	485	822	2.69	491	-0.00301	0.0131
149	6/12/2014	1.99	2.15	98	142	1.99	98	0.0026	0.211
150	8/28/2014	2.64	2.89	433	778	2.67	467	-0.0307	-0.973
151	9/4/2014	2.07	2.3	118	201	2.13	135	-0.0543	-1.64
152	12/10/2014	2.89	3.12	773	1330	2.88	763	0.00811	0.462
153	2/25/2015	2.83	3.1	680	1250	2.86	724	-0.0245	-0.798
154	4/7/2015	2.86	3.12	724	1310	2.87	754	-0.015	-0.551
155	4/20/2015	2.31	2.51	205	325	2.32	210	-0.00719	-0.225
156	5/28/2015	2.09	2.25	123	179	2.08	121	0.00893	0.491
157	7/14/2015	2.59	2.85	392	706	2.63	428	-0.0351	-1.11
158	8/6/2015	2.22	2.39	167	247	2.21	163	0.0128	0.645
159	8/27/2015	2.21	2.39	161	248	2.21	164	-0.00418	-0.0393
160	12/14/2015	1.83	1.91	67	80.8	1.76	58.4	0.0622	1.7
161	5/2/2016	2.32	2.48	211	304	2.29	197	0.0321	1.3
162	6/1/2016	2.33	2.53	212	339	2.34	218	-0.00894	-0.265
163	6/16/2016	2.48	2.73	305	532	2.52	329	-0.0308	-0.994
164	7/5/2016	1.98	2.13	96	135	1.97	93.5	0.0138	0.661
165	8/10/2016	2.23	2.45	170	283	2.26	185	-0.0336	-1.08

166	9/12/2016	2.16	2.35	144	223	2.17	148	-0.0101	-0.32
167	3/30/2017	2.25	2.44	179	279	2.26	182	-0.00509	-0.118
168	5/3/2017	2.27	2.45	185	282	2.26	184	0.00418	0.32
169	5/30/2017	2.72	2.94	523	862	2.71	513	0.0108	0.551
170	6/27/2017	2.79	3.02	613	1050	2.79	617	-0.000129	0.145
171	7/12/2017	2.7	2.94	500	876	2.71	521	-0.0148	-0.536
172	8/1/2017	2.52	2.77	331	583	2.55	358	-0.0313	-1.02
173	8/17/2017	2.6	2.84	396	687	2.62	417	-0.0196	-0.613
174	9/5/2017	2.64	2.87	438	742	2.65	447	-0.00644	-0.211
175	11/14/2017	2.59	2.8	387	632	2.58	386	0.00339	0.265
176	1/30/2018	2.63	2.89	429	769	2.66	462	-0.0302	-0.932
177	3/21/2018	2.65	2.92	444	838	2.7	500	-0.0492	-1.51
178	5/1/2018	2.74	2.97	550	943	2.74	557	-0.00308	0
179	5/22/2018	2.75	3	567	1000	2.77	589	-0.0143	-0.491
180	6/2/2018	2.3	2.54	200	350	2.35	224	-0.0478	-1.43
181	7/18/2018	2.09	2.2	122	158	2.03	108	0.0549	1.55
182	9/6/2018	2.1	2.23	125	170	2.06	116	0.0375	1.43
183	12/3/2018	2.53	2.77	336	589	2.56	362	-0.0297	-0.912
184	2/26/2019	2.81	3.05	639	1130	2.82	659	-0.0108	-0.376
185	3/14/2019	2.49	2.67	307	466	2.46	292	0.0249	0.973
186	4/10/2019	2.72	2.96	519	909	2.73	539	-0.014	-0.476
187	4/29/2019	2.28	2.36	192	230	2.18	153	0.103	1.82
188	6/11/2019	2.71	2.94	516	876	2.71	521	-0.00156	0.0656
189	8/21/2019	2.27	2.5	185	314	2.31	203	-0.0395	-1.3
190	10/8/2019	2.75	2.96	560	906	2.73	537	0.0204	0.816
191	12/10/2019	2.84	3.07	685	1180	2.83	685	0.00214	0.198

Definitions

TDS: Total dissolved solids in mg/L (70300)

SC: Specific conductance in $\mu\text{S}/\text{cm}$ @25C (00095)

References Cited

- American Public Health Association, American Water Works Association, and Water Environment Federation, 1995, Standard methods for the examination of water and wastewater (19th ed.): Washington D.C., American Public Health Association, 905 p.
- Christensen, V.G., Ziegler, A.C., Rasmussen P.P., and Jian X., 2003, Continuous real-time water-quality monitoring of Kansas streams, *in* Proceedings of 2003 Spring Specialty Conference on Agricultural Hydrology and Water Quality, Kansas City, Mo., May 12–14, 2003: Middleburg, Va., American Water Resources Association Technical Publication Series No. TPS-03-1, compact disc. [Also available at <https://nrtwq.usgs.gov/ks/methods/christensen2003/>.]
- Cook, D.R., 1977, Detection of influential observation in linear regression: *Technometrics*, v. 19, no. 1, p. 15–18. [Also available at https://www.jstor.org/stable/1268249?seq=4#metadata_info_tab_contents.]
- Duan, N., 1983, Smearing estimate—A nonparametric retransformation method: *Journal of the American Statistical Association*, v. 78, no. 383, p. 605–610. [Also available at <https://doi.org/10.1080/01621459.1983.10478017>.]
- Hem, J.D., 1992, Study and interpretation of chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 3rd ed., 263 p. [Also available at <https://pubs.usgs.gov/wsp/wsp2254/>.]
- R Core Team, 2020, R—A language and environment for statistical computing: Vienna, Austria, R Foundation for Statistical Computing. [Also available at <https://www.r-project.org/>.]
- Rasmussen, P.P., Eslick, P.J., and Ziegler, A.C., 2016, Relations between continuous real-time physical properties and discrete water-quality constituents in the Little Arkansas River, south-central Kansas, 1998–2014: U.S. Geological Survey Open-File Report 2016–1057, 16 p. [Also available at <https://doi.org/10.3133/ofr20161057>.]

- 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. [Also available at <https://doi.org/10.3133/tm3C4>.]
- Rasmussen, T.J., Bennett, T.J., Stone, M.L., Foster, G.M., Graham, J.L., and Putnam, J.E., 2014, Quality-assurance and data-management plan for water-quality activities in the Kansas Water Science Center, 2014: U.S. Geological Survey Open-File Report 2014–1233, 41 p. [Also available at <https://doi.org/10.3133/ofr20141233>.]
- Sauer, V.B., and Turnipseed, D.P., 2010, Stage measurement at gaging stations: U.S. Geological Survey Techniques and Methods, book 3, chap. A7, 45 p. [Also available at <https://doi.org/10.3133/tm3A7>.]
- Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods, book 3, chap. A8, 87 p. [Also available at <https://doi.org/10.3133/tm3A8>.]
- U.S. Geological Survey, 2021, USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed December 8, 2021, at <https://doi.org/10.5066/F7P55KJN>.
- U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9 [variously paged]. [Also available at <https://water.usgs.gov/owq/FieldManual/>.]
- 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, book 1, chap. D3, 96 p. [Also available at <https://doi.org/10.3133/tm1D3>.]