

Appendix 15. Model Archive Summary for Total Phosphorus at U.S. Geological Survey Site 07144780, North Fork Ninnescah River above Cheney Reservoir, Kansas, during January 1, 1999, through December 31, 2019

This model archive summary summarizes the total phosphorus (TP) model developed to compute hourly or daily TP from January 1, 1999, through December 31, 2019. This model is used concomitantly with other models during this period to calculate concentrations when other explanatory variables are not available for the purposes of load and concentration calculations. The methods used follow U.S. Geological Survey (USGS) guidance as referenced in relevant Office of Surface Water/Office of Water Quality Technical Memoranda and USGS Techniques and Methods, book 3, chapter C4 (Rasmussen and others, 2009), and other standard USGS methods (Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010).

Site and Model Information

Site number: 07144780

Site name: North Fork Ninnescah River above Cheney Reservoir, Kansas

Location: Lat 37°51'45", long 98°00'49" referenced to North American Datum of 1927, in NE 1/4 SE 1/4 NE 1/4 sec.19, T.25 S., R.6 W., Reno County, Kans., Hydrologic Unit 11030014, on right bank at upstream side of county highway bridge, 10 miles south of Hutchinson, 18.1 miles upstream from Cheney Dam.

Equipment: A Sutron Satlink 2 High Data Rate Collection Platform and a Design Analysis Water Log H350/355 nonsubmersible pressure transducer transfers real-time stage, precipitation, 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 21.804 feet. The orifice is enclosed in 1 1/4-inch pipe, which runs from the gage house, under the bridge, and along an I-beam where it is attached to the concrete pier closest to the left edge of water.

Date model was developed: April 26, 2019

Model calibration data period: January 26, 1999, to September 28, 2017

Model Data

All data were collected using USGS protocols (U.S. Geological Survey, 2006; Wagner and others, 2006; Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010) and are stored in the National Water Information System (NWIS) database (<https://doi.org/10.5066/F7P55KJN>; U.S. Geological Survey, 2020). Explanatory variables were evaluated individually and in combination. Potential explanatory variables included streamflow, water temperature, specific conductance, pH, dissolved oxygen, and turbidity. Seasonal components (sine and cosine variables) were also evaluated as explanatory variables.

The regression model is based on 118 concomitant values of discretely collected TP samples and continuously measured streamflow during January 26, 1999, through September 28, 2017. Discrete samples were collected over a range of streamflows. Two samples were less than the minimum reporting level (less than [$<$] 0.03 milligram per liter); therefore, a Tobit regression model was developed to compute estimates of NO₃NO₂ using the absolute maximum likelihood estimation approach (Hald, 1949; Cohen, 1950; Tobin, 1958; Helsel and others, 2020). Summary statistics and the complete model-calibration data are provided below. Potential outliers were identified using the methods described in Rasmussen and others (2009). Additionally, outlier test criteria, including leverage and Cook's distance (Cook's D), were used to estimate potential outlier influence on the final Tobit regression model (Cook, 1977). None of the samples in this dataset were deemed outliers or removed from the model calibration dataset. Other data deemed outliers and removed in previously published versions of this model (Stone

and others, 2013) 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.

Total Phosphorus

Discrete samples were collected from the downstream side of the bridge or instream within 50 feet of the bridge using equal-width-increment, multiple vertical, single vertical, or grab methods following U.S. Geological Survey (2006) and Rasmussen and others (2014). Discrete samples were collected on a semifix to event-based schedule ranging from 1 to 16 samples per year with a Federal Interagency Sedimentation Project U.S. 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 TP by the Wichita Municipal Water and Wastewater Laboratory in Wichita, Kans., according to standard methods (American Public Health Association and others, 1995).

Continuous Data

Streamflow data were measured using a nonsubmersible pressure transducer from January 1, 1991, through December 31, 2019. The surrogate data used were time interpolated values from the continuous time series. If the continuous data were not available, the sample was not included in the dataset.

Model Development

Stepwise regression analysis was done using R programming language (R Core Team, 2019) to relate discretely collected TP concentration to streamflow 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 calculated TP were examined for homoscedasticity (departures from zero did not change substantially over the range of model calculated values).

A total of 1.7 percent of the model-calibration dataset consisted of censored results (less than minimum reporting level). Tobit regression models were developed using absolute maximum likelihood estimation methods using the *smwrQW* (v.0.7.9) package in R programming language (R Core Team, 2019).

Streamflow was selected as a good predictor of logarithm base 10 (\log_{10}) (TP) based on residual plots, a higher pseudocoeficient of determination (pseudo- R^2), and relatively low estimated standard residual error (RSE). This model was developed with the sole purpose to fill in gaps of missing data of the primary model for concentration and load estimations.

Model Summary

Summary of final TP regression analysis at USGS site 07144780:

TP-based model:

$$\log_{10}(TP) = 0.327 \times \log_{10}(Q) - 1.468,$$

where,

TP = phosphorus, total, unfiltered, in milligrams per liter as phosphorus, and
 Q = streamflow, in cubic feet per second.

The log-transformed model may be retransformed to original units so that TP 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 1.17. The retransformed model, accounting for BCF, is as follows:

$TP = (Q^{0.327} \times 10^{-1.468}) \times 1.17$

Previous Models

Version	Model Equation	Reference
1.0	$TP = 0.191 \times \log_{10}(Q) - 0.174$	Stone and others (2013)

Model Statistics, Plots and Data

Definitions for terms used in this output can be found at the end of this document.

Model

$\log_{10}(TP) = 0.327 \times \log_{10}(Q) - 1.468$

Computation method: Absolute Maximum Likelihood Estimation (AMLE)

Explanatory Variables

Coefficients:				
	Estimate	Std. Error	z-score	p-value
(Intercept)	-1.468	0.09407	-15.609	0
logQ	0.327	0.03796	8.613	0

Basic Model Statistics

For a detailed definition and explanation of the terms used below, refer to Helsel and others (2020).

Estimated residual standard error (Unbiased) = 0.2593
Number of observations = 118, number censored = 2 (1.7 percent)
Log-likelihood (model) = -10
Log-likelihood (intercept only) = -42.95
Chi-square = 65.9
degrees of freedom = 1
p-value = <0.0001
Computation method: AMLE
Pseudo-R-squared: 0.3906
Akaike Information Criterion: 26
Bayesian Information Criterion: 34.31

Outlier Test Criteria

Leverage	Cook's D
0.02542	0.69727

Flagged Observations

Observations exceeding at least one test criterion						
	logTP	ycen	yhat	resids	leverage	cooksD
26	-0.3665	FALSE	-0.3560	-1.056e-02	0.03010	2.655e-05
36	-0.2366	FALSE	-0.3509	1.143e-01	0.03078	3.183e-03
37	-0.3279	FALSE	-0.2982	-2.972e-02	0.03837	2.726e-04
43	-1.0969	FALSE	-1.1516	5.469e-02	0.05203	1.288e-03

44	-1.5229	TRUE	-1.0464	-5.782e-01	0.03462	9.236e-02
45	-0.3188	FALSE	-0.3467	2.799e-02	0.03133	1.945e-04
47	-0.8861	FALSE	-1.0578	1.718e-01	0.03629	8.573e-03
53	-0.2924	FALSE	-0.3923	9.988e-02	0.02559	2.000e-03
60	-0.7447	FALSE	-0.3243	-4.204e-01	0.03446	4.859e-02
67	-0.8665	FALSE	-1.0910	2.245e-01	0.04145	1.692e-02
69	-1.0410	FALSE	-1.0230	-1.795e-02	0.03134	8.006e-05
76	-0.2933	FALSE	-0.3005	7.233e-03	0.03801	1.598e-05
78	-0.9586	FALSE	-0.9951	3.646e-02	0.02771	2.899e-04
80	-0.3270	FALSE	-0.3261	-8.518e-04	0.03420	1.979e-07
85	-0.3768	FALSE	-0.3767	-7.792e-05	0.02746	1.311e-09
92	-0.4949	FALSE	-0.2420	-2.529e-01	0.04769	2.501e-02
93	-0.4949	FALSE	-0.3704	-1.244e-01	0.02824	3.445e-03
94	-0.4202	FALSE	-0.1882	-2.320e-01	0.05780	2.608e-02
98	-1.3010	FALSE	-1.0451	-2.560e-01	0.03442	1.799e-02
99	-0.7447	FALSE	-1.2317	4.870e-01	0.06826	1.387e-01
102	-1.2218	FALSE	-1.0060	-2.159e-01	0.02909	1.070e-02
107	-0.5229	FALSE	-0.3310	-1.919e-01	0.03351	9.826e-03

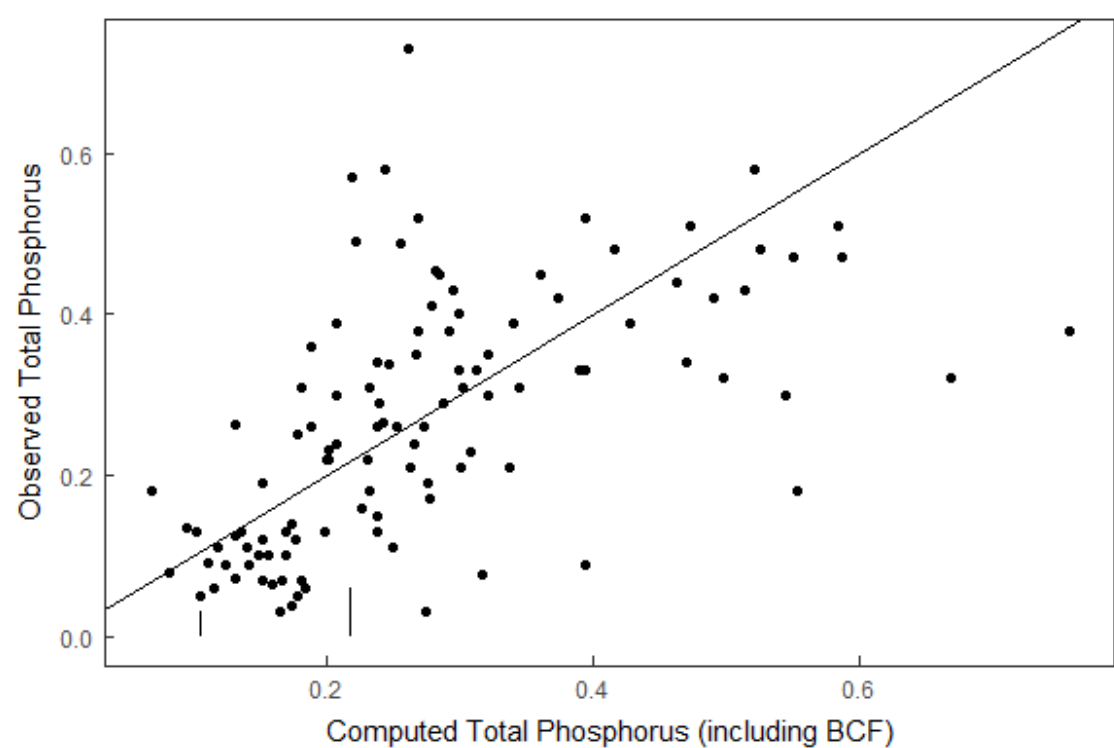
Bias correction factor

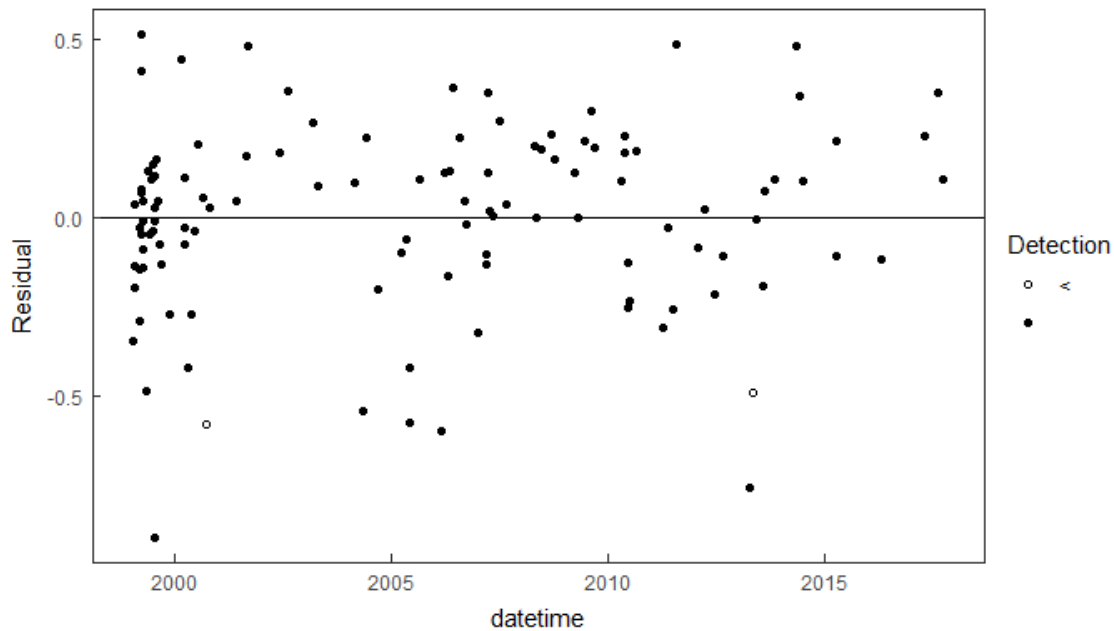
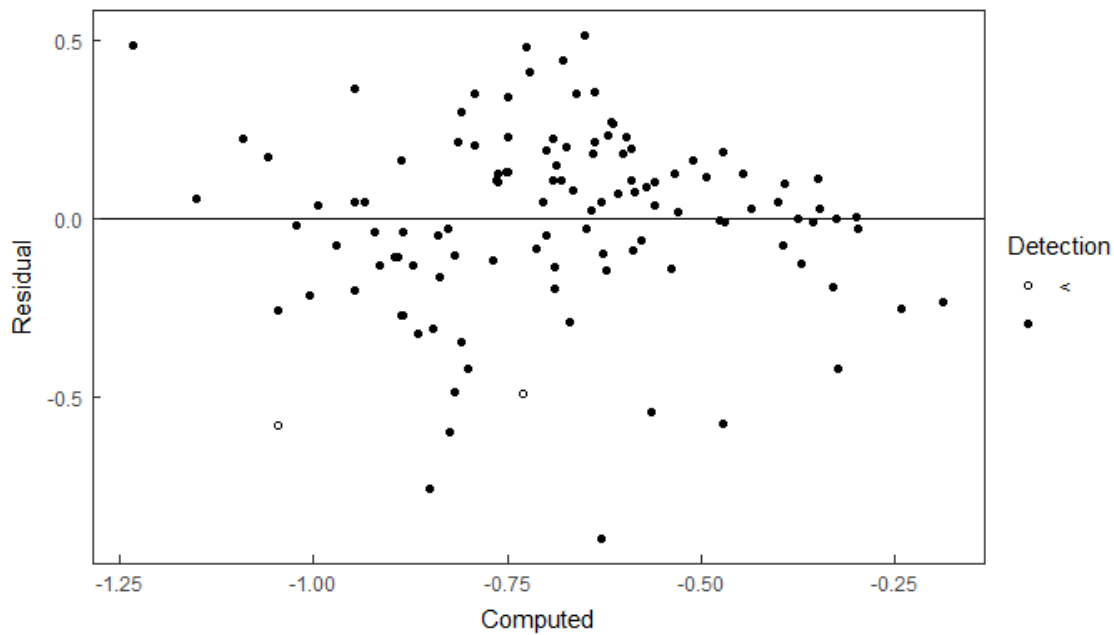
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[1] 1.167094
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95% Confidence Intervals

	2.5 %	97.5 %
(Intercept)	-1.6526707	-1.2839311
logQ	0.2525977	0.4014175

Plots





Variable Summary Statistics

Independent Variable (xvar) - Q

Min.	1st Qu.	Median	Mean	3d Qu.	Max.
5.291	93.750	249.208	673.872	569.625	8,216.570

Standard Deviation

[1] 1177.63

Dependent Variable (yvar) - Total Phosphorus

Min.	1st Qu.	Median	Mean	3d Qu.	Max.
<0.03	0.12	0.255	0.2604	0.38	0.73

Standard Deviation

[1] 0.1586

Model-Calibration Data Set

		datetime	logTP	logQ	Phosphorus	Q	Computed_logTP	Computed_TP	residuals
1	1999-01-26	11:50:00	-1.15	2.017	0.07	104.00	-0.808	0.1814	-3.46e-01
2	1999-01-31	14:25:00	-0.523	2.779	0.3	601.50	-0.559	0.3220	3.66e-02
3	1999-01-31	14:45:00	-0.523	2.778	0.3	599.50	-0.560	0.3217	3.71e-02
4	1999-02-03	10:45:00	-0.824	2.382	0.15	241.00	-0.689	0.2388	-1.35e-01
5	1999-02-03	11:20:00	-0.886	2.381	0.13	240.67	-0.689	0.2387	-1.96e-01
6	1999-03-17	11:40:00	-0.77	2.584	0.17	384.00	-0.623	0.2781	-1.46e-01
7	1999-03-17	12:15:00	-0.77	2.584	0.17	384.00	-0.623	0.2781	-1.46e-01
8	1999-03-18	12:50:00	-0.678	2.507	0.21	321.33	-0.648	0.2623	-2.93e-02
9	1999-03-19	05:30:00	-0.959	2.439	0.11	275.00	-0.670	0.2493	-2.88e-01
10	1999-04-03	04:30:00	-0.31	2.287	0.49	193.50	-0.720	0.2222	4.11e-01
11	1999-04-03	21:10:00	-0.585	2.455	0.26	285.33	-0.665	0.2523	8.04e-02
12	1999-04-04	13:50:00	-0.745	2.349	0.18	223.50	-0.700	0.2330	-4.47e-02
13	1999-04-05	06:25:00	-0.137	2.500	0.73	316.33	-0.650	0.2610	5.14e-01
14	1999-04-06	13:55:00	-0.538	2.632	0.29	428.25	-0.607	0.2882	7.01e-02
15	1999-04-08	12:00:00	-0.658	2.336	0.22	217.00	-0.704	0.2307	4.67e-02
16	1999-04-14	20:25:00	-0.585	2.564	0.26	366.17	-0.630	0.2738	4.49e-02
17	1999-04-15	13:05:00	-0.481	3.049	0.33	1120.00	-0.471	0.3946	-1.03e-02
18	1999-04-16	12:55:00	-0.678	2.843	0.21	696.50	-0.538	0.3378	-1.39e-01
19	1999-04-16	22:20:00	-0.678	2.692	0.21	491.67	-0.588	0.3015	-8.97e-02
20	1999-05-13	10:25:00	-1.3	1.990	0.05	97.75	-0.817	0.1778	-4.84e-01
21	1999-05-24	10:45:00	-0.62	2.199	0.24	158.00	-0.749	0.2080	1.30e-01
22	1999-06-10	12:00:00	-0.886	1.924	0.13	84.00	-0.839	0.1692	-4.70e-02
23	1999-06-25	11:15:00	-0.585	2.375	0.26	237.25	-0.691	0.2376	1.07e-01
24	1999-07-02	10:15:00	-0.538	2.386	0.29	243.25	-0.688	0.2395	1.50e-01
25	1999-07-14	11:20:00	-0.921	1.788	0.12	61.33	-0.883	0.1526	-3.71e-02
26	1999-07-17	13:35:00	-0.367	3.402	0.43	2520.83	-0.356	0.5145	-1.06e-02
27	1999-07-17	23:35:00	-0.409	3.156	0.39	1430.83	-0.436	0.4275	2.75e-02
28	1999-07-18	09:35:00	-0.377	2.979	0.42	952.58	-0.494	0.3743	1.17e-01
29	1999-07-19	07:00:00	-1.52	2.568	0.03	370.00	-0.628	0.2747	-8.94e-01
30	1999-07-29	09:55:00	-0.721	1.778	0.19	60.00	-0.887	0.1515	1.66e-01
31	1999-08-12	10:35:00	-0.886	1.633	0.13	43.00	-0.934	0.1359	4.81e-02
32	1999-08-26	10:50:00	-1.05	1.521	0.09	33.17	-0.971	0.1248	-7.47e-02
33	1999-09-22	11:20:00	-1.05	1.690	0.09	49.00	-0.915	0.1418	-1.30e-01
34	1999-12-02	10:35:00	-1.15	1.787	0.07	61.25	-0.884	0.1526	-2.71e-01
35	2000-02-25	10:40:00	-0.237	2.414	0.58	259.33	-0.679	0.2446	4.42e-01
36	2000-03-23	22:20:00	-0.237	3.417	0.58	2613.33	-0.351	0.5206	1.14e-01
37	2000-03-24	13:50:00	-0.328	3.578	0.47	3786.67	-0.298	0.5877	-2.97e-02
38	2000-03-25	09:05:00	-0.469	3.280	0.34	1905.83	-0.395	0.4695	-7.28e-02
39	2000-04-27	10:45:00	-1.22	2.040	0.06	109.75	-0.801	0.1846	-4.21e-01
40	2000-05-25	10:20:00	-1.15	1.778	0.07	60.00	-0.887	0.1515	-2.68e-01
41	2000-06-21	12:00:00	-0.959	1.672	0.11	47.00	-0.921	0.1399	-3.71e-02
42	2000-07-26	11:50:00	-0.585	2.068	0.26	117.00	-0.792	0.1885	2.07e-01
43	2000-08-29	11:00:00	-1.1	0.968	0.08	9.30	-1.151	0.0824	5.47e-02
44	2000-09-28	10:30:00	<-1.52	1.290	<0.03	19.50	-1.046	0.1049	-5.78e-01
45	2000-10-26	10:50:00	-0.319	3.430	0.48	2690.00	-0.346	0.5255	2.80e-02
46	2001-06-06	11:35:00	-0.357	3.261	0.44	1824.17	-0.402	0.4628	4.54e-02
47	2001-09-04	11:05:00	-0.886	1.255	0.13	18.00	-1.058	0.1022	1.72e-01
48	2001-09-19	10:25:00	-0.244	2.273	0.57	187.33	-0.725	0.2199	4.81e-01
49	2002-06-12	11:10:00	-0.42	2.650	0.38	446.33	-0.602	0.2921	1.82e-01
50	2002-08-14	11:35:00	-0.284	2.539	0.52	346.08	-0.638	0.2688	3.54e-01
51	2003-03-18	12:00:00	-0.347	2.615	0.45	412.00	-0.613	0.2845	2.66e-01
52	2003-04-21	11:30:00	-0.481	2.741	0.33	551.00	-0.572	0.3129	9.04e-02
53	2004-03-05	12:10:00	-0.292	3.290	0.51	1951.67	-0.392	0.4732	9.99e-02
54	2004-05-14	10:35:00	-1.11	2.760	0.078	575.83	-0.565	0.3175	-5.42e-01
55	2004-06-14	09:45:00	-0.469	2.377	0.34	238.00	-0.691	0.2378	2.23e-01
56	2004-09-08	10:25:00	-1.15	1.591	0.071	39.00	-0.948	0.1316	-2.01e-01
57	2005-03-24	10:15:00	-0.721	2.576	0.19	376.75	-0.626	0.2763	-9.53e-02
58	2005-05-16	11:40:00	-0.638	2.721	0.23	526.00	-0.578	0.3082	-5.98e-02
59	2005-06-10	10:55:00	-1.05	3.048	0.09	1116.67	-0.471	0.3942	-5.74e-01
60	2005-06-13	09:25:00	-0.745	3.498	0.18	3150.00	-0.324	0.5534	-4.20e-01
61	2005-08-29	09:35:00	-0.575	2.407	0.266	255.17	-0.681	0.2433	1.06e-01
62	2006-03-02	09:50:00	-1.42	1.967	0.038	92.67	-0.825	0.1747	-5.95e-01
63	2006-03-22	11:30:00	-0.635	2.158	0.232	144.00	-0.762	0.2018	1.28e-01
64	2006-05-01	11:15:00	-1	1.928	0.1	84.75	-0.837	0.1697	-1.62e-01
65	2006-05-12	10:30:00	-0.62	2.192	0.24	155.50	-0.751	0.2069	1.32e-01

66	2006-06-05	10:15:00	-0.582	1.591	0.262	39.00	-0.948	0.1316	3.66e-01
67	2006-07-31	10:30:00	-0.866	1.154	0.136	14.25	-1.091	0.0947	2.25e-01
68	2006-09-07	10:50:00	-0.9	1.591	0.126	39.00	-0.948	0.1316	4.84e-02
69	2006-09-21	10:00:00	-1.04	1.362	0.091	23.00	-1.023	0.1108	-1.80e-02
70	2007-01-09	10:30:00	-1.19	1.845	0.065	70.00	-0.865	0.1594	-3.22e-01
71	2007-03-14	10:20:00	-1	1.824	0.1	66.67	-0.872	0.1569	-1.28e-01
72	2007-03-22	10:00:00	-0.921	1.987	0.12	97.00	-0.818	0.1773	-1.02e-01
73	2007-03-26	10:40:00	-0.311	2.471	0.489	295.67	-0.660	0.2553	3.50e-01
74	2007-03-31	12:30:00	-0.319	3.122	0.48	1325.00	-0.447	0.4169	1.29e-01
75	2007-04-16	12:15:00	-0.51	2.871	0.309	743.50	-0.529	0.3451	1.93e-02
76	2007-05-07	10:30:00	-0.293	3.571	0.509	3725.00	-0.300	0.5846	7.23e-03
77	2007-06-29	10:25:00	-0.344	2.603	0.453	401.00	-0.617	0.2820	2.73e-01
78	2007-09-04	11:25:00	-0.959	1.447	0.11	28.00	-0.995	0.1181	3.65e-02
79	2008-04-24	11:40:00	-0.472	2.426	0.337	266.60	-0.675	0.2468	2.03e-01
80	2008-05-09	11:35:00	-0.327	3.493	0.471	3110.31	-0.326	0.5511	-8.52e-04
81	2008-06-19	09:45:00	-0.509	2.349	0.31	223.23	-0.700	0.2329	1.92e-01
82	2008-09-15	10:55:00	-0.387	2.591	0.41	389.55	-0.621	0.2794	2.34e-01
83	2008-10-16	10:10:00	-0.347	2.928	0.45	848.02	-0.510	0.3603	1.64e-01
84	2009-03-31	11:20:00	-0.409	2.853	0.39	713.40	-0.535	0.3405	1.26e-01
85	2009-04-27	12:15:00	-0.377	3.338	0.42	2178.89	-0.376	0.4905	-7.79e-05
86	2009-06-17	10:40:00	-0.42	2.543	0.38	349.14	-0.636	0.2695	2.17e-01
87	2009-08-20	10:50:00	-0.509	2.014	0.31	103.19	-0.810	0.1809	3.01e-01
88	2009-09-10	11:30:00	-0.397	2.682	0.401	481.29	-0.591	0.2994	1.94e-01
89	2010-04-23	10:00:00	-0.658	2.159	0.22	144.33	-0.762	0.2019	1.05e-01
90	2010-05-17	16:40:00	-0.523	2.197	0.3	157.26	-0.750	0.2077	2.27e-01
91	2010-05-27	10:00:00	-0.456	2.533	0.35	341.23	-0.640	0.2675	1.84e-01
92	2010-06-14	11:30:00	-0.495	3.750	0.32	5625.32	-0.242	0.6689	-2.53e-01
93	2010-06-16	10:15:00	-0.495	3.357	0.32	2277.10	-0.370	0.4977	-1.24e-01
94	2010-07-06	10:30:00	-0.42	3.915	0.38	8216.57	-0.188	0.7571	-2.32e-01
95	2010-08-25	11:00:00	-0.284	3.047	0.52	1114.21	-0.472	0.3939	1.88e-01
96	2011-04-13	10:00:00	-1.15	1.904	0.07	80.15	-0.845	0.1666	-3.09e-01
97	2011-05-23	10:20:00	-0.854	1.965	0.14	92.25	-0.825	0.1744	-2.81e-02
98	2011-06-28	10:00:00	-1.3	1.294	0.05	19.69	-1.045	0.1053	-2.56e-01
99	2011-07-27	11:20:00	-0.745	0.724	0.18	5.29	-1.231	0.0685	4.87e-01
100	2012-02-06	09:45:00	-0.796	2.313	0.16	205.38	-0.712	0.2266	-8.38e-02
101	2012-03-23	10:15:00	-0.62	2.529	0.24	337.76	-0.641	0.2666	2.16e-02
102	2012-06-20	09:15:00	-1.22	1.414	0.06	25.93	-1.006	0.1152	-2.16e-01
103	2012-08-27	09:30:00	-1	1.762	0.1	57.83	-0.892	0.1497	-1.08e-01
104	2013-04-11	10:10:00	<-1.52	1.891	<0.03	77.82	-0.850	0.1650	-7.55e-01
105	2013-05-10	10:00:00	-1.22	2.258	0.06	180.98	-0.730	0.2174	-4.92e-01
106	2013-05-31	10:00:00	-0.481	3.033	0.33	1078.66	-0.476	0.3898	-4.96e-03
107	2013-08-05	10:05:00	-0.523	3.478	0.3	3005.69	-0.331	0.5450	-1.92e-01
108	2013-08-16	08:30:00	-0.509	2.699	0.31	499.95	-0.585	0.3031	7.71e-02
109	2013-10-31	10:00:00	-0.658	2.153	0.22	142.12	-0.764	0.2009	1.07e-01
110	2014-05-13	10:00:00	-0.244	2.272	0.57	186.89	-0.725	0.2197	4.81e-01
111	2014-06-10	10:30:00	-0.409	2.199	0.39	157.96	-0.749	0.2080	3.40e-01
112	2014-07-02	09:10:00	-0.456	2.776	0.35	597.26	-0.560	0.3213	1.05e-01
113	2015-04-08	09:45:00	-1	1.754	0.1	56.75	-0.894	0.1488	-1.05e-01
114	2015-04-14	09:55:00	-0.602	1.999	0.25	99.67	-0.814	0.1789	2.13e-01
115	2016-04-19	10:25:00	-0.886	2.138	0.13	137.55	-0.769	0.1988	-1.17e-01
116	2017-04-20	12:00:00	-0.367	2.666	0.43	463.31	-0.596	0.2957	2.30e-01
117	2017-08-11	11:00:00	-0.444	2.066	0.36	116.31	-0.793	0.1882	3.49e-01
118	2017-09-28	10:30:00	-0.481	2.686	0.33	484.79	-0.590	0.3001	1.09e-01

Definitions

TP: phosphorus, unfiltered, in milligrams per liter as phosphorus (00665)

Q: streamflow, instantaneous, in cubic feet per second (00061)

Leverage: an outlier's measure in the x-direction (Helsel and others, 2020).

p-value: the probability that the independent variable has no effect on the dependent variable (Helsel and others, 2020).

Pseudo-R-squared: pseudocoefficient of determination. An estimation of the proportion of variance in the response variable explained by the model (McKelvey and Zavoina, 1975).

z-score: the estimated coefficient divided by its associated standard error (Helsel and others, 2020).

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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