

**SITE NUMBER**—07144100

**SITE NAME**—Little Arkansas River near Sedgwick

**DATE CREATED**—4/8/2013

**MODEL DEVELOPMENT DATA PERIOD**—5/1/1998 – 9/22/2011

**MODEL-CALIBRATION DATASET**—All data were collected using U.S. Geological Survey (USGS) protocols and are stored in National Water Information System (NWIS) database. The regression model is based on 160 concurrent measurements of specific conductance and calcium samples collected from 05-01-1998 through 09-22-2011. Samples were collected throughout the range of continuously observed hydrologic and specific conductance conditions. Specific conductance values are time-averaged, approved unit values corresponding with the duration of sample collection. Summary statistics and complete model-calibration dataset are provided. No calcium values were deemed outliers.

**MODEL DEVELOPMENT**—Regression analysis was done using S-PLUS, R, and a spreadsheet macro that examined specific conductance as an explanatory variable for estimating calcium. Different combinations of untransformed and  $\log_{10}$ -transformed data were evaluated. Calcium and specific conductance were selected as the best model based on residual plots, model standard percentage error (*MSPE*), adjusted  $R^2$ , prediction error sum of squares (*PRESS*), and Mallows'  $C_p$ . Model spreadsheet is archived and can be found at <http://nrtwq.usgs.gov/ks> for review, and contains all relevant sample data and more in-depth statistical information.

**MODEL SUMMARY**—Summary of final regression analysis for calcium concentration at site number 07144100.

Specific conductance-based model:

$$\log_{10}(Ca) = 1.05 \times \log_{10}(SC) - 1.14,$$

where

$Ca$  = calcium, in milligrams per liter; and

$SC$  = specific conductance, in microsiemens per centimeter at 25 degrees Celsius.

The use of specific conductance as an explanatory variable makes sense both physically and statistically. It makes physical sense because calcium is a major ion that affects the conductivity of water. Specific conductance is a measure of the conductivity of water. This results in a clear correlation between calcium and specific conductance. Specific conductance makes statistical sense as an explanatory variable because it resulted in a model with low Mallows'  $C_p$  and *PRESS* values, and high adjusted  $R^2$  values.

**CALCIUM RECORD**— The record is computed using the regression model in the National Real-Time Water Quality (NRTWQ) website. Data are computed at hourly intervals. The record is complete for the year except as noted. The specific conductance monitor was removed during winter months because of below freezing conditions. A more in-depth description of the water quality record can be found at –

<http://nrtwq.usgs.gov/ks>

**REMARKS**—

- Site location, equipment, and other stream-gaging station information can be found in the Site Information Management System (SIMS).

Computed: Aaron King

Reviewed: Patrick Rasmussen

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Model Form

$$\log(\text{Ca}) = 1.05 * \log(\text{SC}) - 1.14$$

Explanatory variable summary statistics

	log(SC)	SC
Minimum	1.732	54.0
1st Quartile	2.451	283
Median	2.778	600
Mean	2.680	589
3rd Quartile	2.941	872
Maximum	3.126	1340

Notes:

Dependent variable summary statistics

	log(Ca)	Ca
Minimum	0.6758	4.74
1st Quartile	1.409	25.7
Median	1.781	60.4
Mean	1.674	59.5
3rd Quartile	1.957	90.6
Maximum	2.140	138

Notes:

Model Calibration

Basic Data

Number of Measurements:	160
Standard Error:	0.04396
MSPE (Upper)	+10.65
MSPE (Lower)	-9.63
R <sup>2</sup>	0.98
Adj R <sup>2</sup>	0.98
Duan BCF:	1.01

Explanatory Variables

Variable	Value	Standard Error
Intercept	-1.14	0.0307
log(SC)	1.05	0.0114

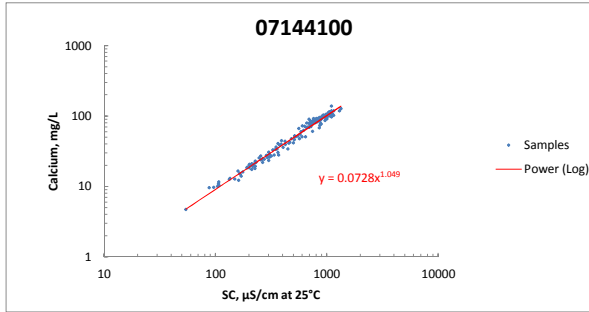
Notes:

Covariance Matrix

	Intercept	log(SC)
Intercept	1	-0.994
log(SC)	-0.994	1

Test Criteria

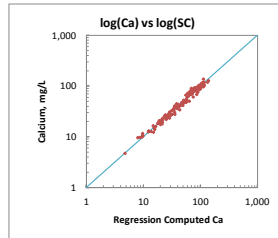
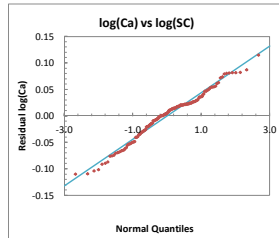
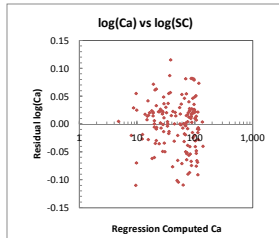
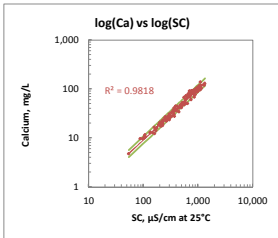
	Leverage	Cook's D	DFITS
	0.0375	0.792	0.224



Observations exceeding at least one test criterion

Observation	Observed log(Ca)	Predicted log(Ca)	Residuals	Standardized Residuals	Studentized Residuals	Leverage	Cook's D	DFITS
13	0.984	0.898	0.0862	2.01	2.03	0.0429	0.0901	0.429
50	0.988	0.940	0.0482	1.12	1.12	0.0390	0.0255	0.226
92	0.676	0.678	-0.00169	-0.0399	-0.0398	0.0666	0.000057	-0.0106
98	1.96	1.84	0.119	2.71	2.77	0.00795	0.0295	0.248
109	1.09	1.18	-0.0909	-2.09	-2.11	0.0210	0.0470	-0.310
143	1.06	0.992	0.0678	1.57	1.58	0.0345	0.0442	0.299
150	2.14	2.05	0.0890	2.04	2.06	0.0149	0.0315	0.254
158	1.83	1.94	-0.106	-2.42	-2.46	0.0104	0.0308	-0.252

Notes:



Date	SC, µS/cm		Calcium, mg/L	log(Ca)	Regression		Normal Quantiles	90% P.I.	
	at 25°C	ft <sup>3</sup> /sec			Computed Ca	Residual log(Ca)		Lower	Upper
5/1/1998	868	729	74.2	1.87	2.94	88.0	-0.074	74.5	104.1
5/6/1998	803	143	85.8	1.93	2.91	81.1	0.024	68.6	95.9
5/11/1998	911	128	97.1	1.99	2.96	92.6	0.021	68.3	109.5
5/27/1998	844	100	87.5	1.94	2.93	85.5	0.010	72.3	101.1
6/16/1998	877	43.5	89.6	1.95	2.94	89.0	0.003	-0.070	75.3
6/24/1998	598	413	50.6	1.70	2.78	59.6	-0.071	-1.51	50.4
7/10/1998	211	1360	17.4	1.24	2.32	20.0	-0.060	-1.20	16.9
7/13/1998	316	243	27.2	1.44	2.50	30.5	-0.050	-0.995	25.8
7/20/1998	558	44.8	66.9	1.83	2.75	82.9	0.000	-0.181	70.1
8/6/1998	819	28.7	82.9	1.92	2.91	89.0	-0.054	-1.13	75.3
9/15/1998	877	14.5	78.6	1.90	2.94	19.0	0.027	0.807	16.1
9/22/1998	201	913	20.2	1.31	2.30	9.89	0.022	0.533	8.4
9/25/1998	88.0	6590	9.63	0.984	1.94	41.6	-0.021	-0.588	35.2
10/5/1998	108	7490	10.4	1.02	2.03	73.3	0.025	0.723	62.0
10/22/1998	425	104	39.7	1.60	2.63	113	0.023	0.606	95.6
12/4/1998	729	222	77.7	1.89	2.86	29.5	-0.051	-1.05	24.9
1/12/1999	1101	113	119	2.08	3.04	107	0.022	0.497	90.1
2/1/1999	306	4676	26.2	1.42	2.49	139	-0.034	-0.786	117.1
2/19/1999	1041	119	112	2.05	3.02	112	0.014	0.165	95.0
3/16/1999	1337	110	128	2.11	3.13	39.5	-0.040	-0.874	33.4
3/23/1999	1095	98.1	116	2.06	3.04	18.9	-0.009	-0.376	16.0
4/7/1999	404	1651	36.0	1.56	2.61	81.0	0.015	0.229	68.5
4/16/1999	200	5410	18.5	1.27	2.30	20.0	0.020	0.376	16.9
5/5/1999	802	239	83.9	1.92	2.90	28.9	0.028	0.829	24.4
5/24/1999	211	1664	20.9	1.32	2.32	20.9	-0.006	-0.277	17.6
6/18/1999	300	410	30.8	1.49	2.48	16.5	-0.014	-0.445	14.0
6/21/1999	220	2223	20.6	1.31	2.34	13.9	-0.035	-0.807	11.7
7/20/1999	176	3521	20.6	1.20	2.25	94.0	0.021	0.462	79.5
8/3/1999	149	4238	12.8	1.11	2.17	20.1	0.018	0.310	17.0
8/19/1999	924	88.8	98.6	1.99	2.97	114	-0.025	-0.625	96.7
9/28/1999	212	1915	20.9	1.32	2.33	27.5	0.000	-0.165	23.2
2/9/2000	1113	84.4	108	2.03	3.05	24.3	-0.006	-0.310	20.5
3/7/2000	286	1151	27.5	1.44	2.46	109	0.023	0.644	92.2
3/28/2000	254	4559	23.9	1.38	2.41	44.8	-0.035	-0.829	37.9
5/19/2000	1064	98.6	115	2.06	3.03	35.4	-0.066	-1.33	29.9
5/31/2000	456	203	41.3	1.62	2.66	34.3	0.000	-0.149	29.0

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6/28/2000	364	1165	30.4	1.48	2.56	75.4	0.055	1.37	63.8	89.1
7/28/2000	353	160	34.3	1.54	2.55	85.7	0.000	-0.133	72.5	101.3
8/16/2000	749	23.5	85.6	1.93	2.87	86.7	0.017	0.277	73.3	102.5
9/8/2000	846	19.1	85.8	1.93	2.93	21.7	0.013	0.133	18.3	25.6
9/25/2000	855	20.9	90.1	1.96	2.93	50.8	0.013	0.149	43.0	60.1
10/26/2000	228	6524	22.3	1.35	2.36	111	-0.030	-0.703	94.2	131.7
11/8/2000	514	82.5	52.4	1.72	2.71	32.5	-0.065	-1.30	27.5	38.5
12/4/2000	1086	46.2	104	2.02	3.04	56.1	-0.069	-1.41	47.5	66.4
3/14/2001	336	1932	28.0	1.45	2.53	100	0.020	0.393	84.7	118.5
4/13/2001	565	415	47.9	1.68	2.75	66.1	0.018	0.343	55.9	78.1
4/26/2001	982	98.2	105	2.02	2.99	28.1	-0.020	-0.569	23.7	33.2
5/8/2001	660	155	68.9	1.84	2.82	8.74	0.047	1.13	7.4	10.3
6/4/2001	292	1050	26.8	1.43	2.47	15.4	-0.001	-0.197	13.1	18.2
6/6/2001	96.0	8962	9.73	0.988	1.98	82.0	0.029	0.852	69.3	96.9
6/23/2001	165	4251	15.4	1.19	2.22	77.1	0.042	1.08	65.2	91.2
7/11/2001	811	49.1	87.6	1.94	2.91	79.6	0.023	0.625	67.3	94.1
8/2/2001	765	24.4	84.9	1.93	2.88	12.5	0.020	0.410	10.6	14.8
8/28/2001	788	31.2	83.9	1.92	2.90	86.5	0.040	1.05	73.1	102.2
9/20/2001	135	4178	13.1	1.12	2.13	106	-0.018	-0.533	90.0	125.8
10/31/2001	853	27.3	94.8	1.98	2.93	113	-0.067	-1.37	95.5	133.5
1/10/2002	1040	36.4	102	2.01	3.02	98.0	-0.053	-1.08	82.9	115.8
2/21/2002	1100	42.0	96.7	1.99	3.04	25.4	-0.015	-0.462	21.4	30.0
4/9/2002	961	93.5	86.8	1.94	2.98	41.3	0.026	0.765	34.9	48.9
4/22/2002	265	1480	24.5	1.39	2.42	37.8	0.024	0.683	32.0	44.7
5/22/2002	422	142	43.9	1.64	2.63	21.5	-0.076	-1.67	18.2	25.4
6/6/2002	388	244	40.0	1.60	2.59	72.4	0.056	1.41	61.2	85.6
6/13/2002	226	5868	18.0	1.26	2.35	72.4	-0.009	-0.393	61.2	85.6
7/9/2002	720	29.6	82.4	1.92	2.86	135	-0.053	-1.10	113.8	159.0
8/15/2002	744	750	60.7	1.78	2.87	28.1	-0.038	-0.852	23.7	33.2
9/19/2002	720	15.2	70.9	1.85	2.86	118	-0.064	-1.26	100.1	139.9
12/18/2002	1300	41.1	119	2.08	3.11	47.2	0.004	-0.055	39.9	55.8
3/20/2003	292	6285	25.7	1.41	2.47	65.6	0.022	0.515	55.5	77.6
4/17/2003	1150	69.9	102	2.01	3.06	102	-0.009	-0.410	86.4	120.7
4/23/2003	642	296	50.8	1.71	2.81	90.8	0.001	-0.118	76.8	107.4
5/14/2003	369	1709	27.9	1.45	2.57	25.4	-0.013	-0.427	21.4	30.0
5/29/2003	479	193	47.6	1.68	2.68	18.2	0.014	0.197	15.4	21.5
6/11/2003	656	96.5	69.0	1.84	2.82	115	-0.031	-0.765	97.3	136.0
6/24/2003	1000	57.0	100	2.00	3.00	20.1	0.011	0.086	17.0	23.7
7/30/2003	894	7.73	91.0	1.96	2.95	102	-0.015	-0.479	86.3	120.6
9/3/2003	265	578	24.6	1.39	2.42	101	0.027	0.786	85.1	118.9
10/14/2003	193	1077	18.8	1.27	2.29	25.4	-0.062	-1.23	21.4	30.0
12/11/2003	1120	46.2	107	2.03	3.05	106	-0.028	-0.683	90.0	125.8
3/9/2004	212	1819	20.6	1.31	2.33	79.6	0.006	0.008	67.3	94.1
3/30/2004	999	292	98.5	1.99	3.00	26.2	-0.030	-0.723	22.1	30.9
4/26/2004	986	50.6	107	2.03	2.99	12.3	0.010	0.070	10.4	14.6
5/13/2004	265	1153	22.0	1.34	2.42	33.8	0.002	-0.102	28.5	39.9
5/26/2004	1040	49.7	99.8	2.00	3.02	21.6	-0.048	-0.945	18.2	25.5
6/16/2004	788	56.1	80.7	1.91	2.90	58.4	0.012	0.118	49.4	69.1
6/22/2004	273	1042	24.4	1.39	2.44	29.4	-0.007	-0.343	24.9	34.7
7/27/2004	133	5855	12.6	1.10	2.12	28.0	-0.027	-0.644	23.7	33.1
1/27/2005	348	172	33.9	1.53	2.54	4.78	-0.004	-0.261	4.0	5.7
3/23/2005	227	5855	19.3	1.29	2.36	35.3	0.063	1.51	29.8	41.7
5/10/2005	587	203	60.1	1.78	2.77	88.5	0.036	0.970	74.8	104.6
5/27/2005	305	743	28.9	1.46	2.48	74.8	0.012	0.102	63.3	88.4
6/6/2005	291	1957	26.3	1.42	2.46	102	-0.049	-0.970	86.4	120.7
6/9/2005	54.0	11797	4.74	0.676	1.73	27.5	0.005	-0.008	23.2	32.5
8/31/2005	363	112	40.8	1.61	2.56	57.3	-0.017	-0.497	48.4	67.7
2/9/2006	872	32.5	96.1	1.98	2.94	75.6	0.019	0.360	64.0	89.4
5/2/2006	743	122	76.8	1.89	2.87	88.6	-0.008	-0.360	74.9	104.7
6/8/2006	1000	25.5	91.2	1.96	3.00	99.4	-0.041	-0.897	84.0	117.5
6/26/2006	286	114	27.8	1.44	2.46	71.1	0.018	0.327	60.1	84.1
7/27/2006	693	3.12	90.6	1.96	2.84	70.1	-0.003	-0.245	59.2	82.8
8/15/2006	658	6.99	79.3	1.90	2.82	15.6	-0.018	-0.515	13.2	18.5
8/23/2006	576	15.2	55.1	1.74	2.76	22.0	-0.001	-0.229	18.6	26.0
9/27/2006	751	6.99	79.0	1.90	2.88	68.8	0.004	-0.023	58.2	81.3
1/10/2007	873	13.8	86.9	1.94	2.94	97.0	0.018	0.294	82.0	114.7
2/5/2007	974	15.2	90.5	1.96	2.99	82.4	0.049	1.20	69.7	97.4
3/12/2007	708	19.1	74.1	1.87	2.85	92.1	0.015	0.245	77.9	108.9
3/21/2007	698	51.0	69.5	1.84	2.84	29.4	-0.050	-1.02	24.9	34.7
3/27/2007	446	164	34.0	1.53	2.65	45.8	-0.031	-0.744	38.7	54.1
4/2/2007	167	2886	15.0	1.18	2.22	20.5	-0.028	-0.664	17.3	24.2
4/18/2007	231	861	21.9	1.34	2.36	34.6	-0.006	-0.294	29.2	40.9
7/11/2007	161	1927	12.3	1.09	2.21	67.0	0.014	0.181	56.7	79.2
8/16/2007	686	59.3	69.5	1.84	2.84	54.4	-0.019	-0.551	46.0	64.3
9/6/2007	952	25.5	101	2.00	2.98	19.1	0.035	0.945	16.1	22.6
11/26/2007	815	28.9	92.2	1.97	2.91	50.5	-0.041	-0.921	42.7	59.7
12/6/2007	906	29.5	95.4	1.98	2.96	24.4	0.046	1.10	20.6	28.8
12/13/2007	300	2740	23.5	1.37	2.48	14.8	0.049	1.16	12.6	17.5
3/6/2008	305	979	26.2	1.42	2.48	23.5	0.036	0.995	19.8	27.7
4/14/2008	465	484	42.6	1.63	2.67	31.6	0.021	0.479	26.7	37.4
5/29/2008	216	2895	19.2	1.28	2.33	78.7	0.061	1.46	66.6	93.0
6/30/2008	356	877	34.1	1.53	2.55	93.7	0.037	1.02	79.2	110.8
8/5/2008	708	24.9	85.6	1.93	2.85	105	0.003	-0.086	89.1	124.6
4/6/2009	669	187	69.2	1.84	2.83	118	-0.001	-0.213	100.1	139.9
4/13/2009	548	851	52.0	1.72	2.74	106	0.030	0.874	90.0	125.8
4/28/2009	202	9190	20.7	1.32	2.31	96.7	0.015	0.213	81.8	114.3
6/16/2009	511	661	46.0	1.66	2.71	102	-0.021	-0.606	86.1	120.4
7/30/2009	255	523	27.1	1.43	2.41	71.5	0.022	0.588	60.5	84.6
9/9/2009	159	3141	16.6	1.22	2.20	61.8	0.008	0.039	52.2	73.0
9/24/2009	246	333	25.5	1.41	2.39	106	0.022	0.569	90.0	125.8
11/3/2009	327	328	33.2	1.52	2.52	33.9	0.030	0.897	28.6	40.0
11/19/2009	780	65.0	90.6	1.96	2.89	15.9	-0.056	-1.16	13.5	18.8
12/1/2009	921	54.7	102	2.01	2.96	21.7	0.026	0.744	18.3	25.6
12/17/2009	1030	58.7	106	2.03	3.01	9.70	0.051	1.23	8.2	11.5
1/6/2010	1150	94.5	118	2.07	3.06	9.80	0.073	1.61	8.3	11.6
1/19/2010	1040	79.7	114	2.06	3.02	18.1	0.007	0.023	15.3	21.4
2/4/2010	949	63.9	100	2.00	2.98	19.2	0.020	0.427	16.2	22.7
2/23/2010	997	69.3	97.1	1.99	3.00	9.51	0.022	0.551	8.0	11.2
3/10/2010	712	547	75.3	1.88	2.85	63.1	0.054	1.30	53.4	74.6
3/11/2010	619	11111	62.9	1.80	2.79	51.9	-0.007	-0.327	43.9	61.3
4/14/2010	1040	52.7	112	2.05	3.02	49.4	-0.075	-1.61	41.7	58.4
4/23/2010	601	228	72.2	1.86	2.78	81.5	0.053	1.26	68.9	96.3
5/13/2010	349	544	36.3	1.56	2.54	97.5	0.004	-0.039	82.5	115.3
6/9/2010	170	2448	14.0	1.15	2.23	95.9	0.016	0.261	81.1	113.4
6/10/2010	228	3345	23.0	1.36	2.36	95.4	0.033	0.921	80.7	112.8
6/13/2010	106	7905	10.9	1.04	2.03	69.3	0.055	1.33	58.6	81.9
6/14/2010	107	15162	11.6	1.06	2.03	90.4	-0.070	-1.46	76.4	106.9
6/15/2010	192	6480	18.4	1.27	2.28	36.6	0.024	0.664	31.0	43.3
6/16/2010	203	4806	20.1	1.30	2.31	38.1	0.072	1.56	32.3	45.1

07144100 - Little Ark near Sedgwick - Calcium

7/6/2010	104	13387	10.0	1.00	2.02	43.8	-0.110	-2.67	37.0	51.8
8/19/2010	632	60.8	71.5	1.85	2.80	35.9	-0.109	-2.33	30.4	42.4
8/25/2010	524	770	51.0	1.71	2.72	86.6	-0.104	-2.14	73.2	102.3
11/16/2010	500	262	41.5	1.62	2.70	64.2	-0.101	-2.01	54.3	75.9
1/19/2011	1100	83.3	138	2.14	3.04	74.9	-0.091	-1.90	63.4	88.6
3/7/2011	759	50.8	91.8	1.96	2.88	28.9	-0.090	-1.81	24.4	34.2
3/16/2011	806	48.0	92.1	1.96	2.91	15.0	-0.087	-1.74	12.7	17.8
4/6/2011	957	37.6	98.5	1.99	2.98	76.5	0.079	1.67	64.7	90.4
4/18/2011	942	32.8	99.5	2.00	2.97	71.1	0.081	1.74	60.1	84.1
5/2/2011	937	28.8	103	2.01	2.97	65.8	0.081	1.81	55.7	77.8
6/7/2011	691	21.9	78.6	1.90	2.84	59.9	0.081	1.90	50.6	70.8
6/21/2011	890	110	77.0	1.89	2.95	7.98	0.082	2.01	6.7	9.4
6/22/2011	854	46.2	68.1	1.83	2.93	55.4	0.082	2.14	46.8	65.5
8/15/2011	376	25.5	38.7	1.59	2.58	113	0.087	2.33	95.5	133.5
9/22/2011	391	42.9	45.0	1.65	2.59	69.5	0.115	2.67	58.8	82.2