

SITE NUMBER—07144100

SITE NAME—Little Ark near Sedgwick

DATE CREATED—3/18/2013

MODEL DEVELOPMENT DATA PERIOD—7/27/2004 – 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 66 concurrent measurements of turbidity and *Escherichia coli* bacteria (*ECB*) samples collected from 07-27-2004 through 09-22-2011. Samples were collected throughout the range of continuously observed hydrologic conditions. Summary statistics and complete model-calibration dataset are provided. No *ECB* values were deemed outliers.

MODEL DEVELOPMENT— Regression analysis was done using S-PLUS, R, and a spreadsheet macro that examined turbidity as an explanatory variable for estimating *ECB*. Different combinations of untransformed and log₁₀-transformed data were evaluated. *ECB* and turbidity 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 Mallow's *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 *ECB* concentration at site number 07144100.

Turbidity-based model:

$$\log_{10}(ECB) = 1.29 \times \log_{10}(Turb) + 0.304 ,$$

where

ECB = *E. coli* bacteria, in colonies per 100 milliliters; and

Turb = turbidity, in formazin nephelometric units.

The use of turbidity as an explanatory variable makes sense both physically and statistically. It makes physical sense because *ECB* are mobilized by the same hydrologic forces that mobilize particles associated with turbidity. In addition, the sediment particles associated with turbidity provide an attachment point for the bacteria and the nutrients that help sustain them. Turbidity makes statistical sense as an explanatory variable because it resulted in a model with low Mallow's *C*_{*p*} and *PRESS* values, and high adjusted *R*² values.

***E. COLI* BACTERIA 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. 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

Model Form

$$\log(\text{ECB}) = 1.29 * \log(\text{Turb}) + 0.304$$

Explanatory variable summary statistics

	<u>log(Turb)</u>	<u>Turb</u>
Minimum	0.5185	3.30
1st Quartile	1.362	23.0
Median	2.146	140
Mean	1.902	193
3rd Quartile	2.394	248
Maximum	3.025	1060

Notes:

Dependent variable summary statistics

	<u>log(ECB)</u>	<u>ECB</u>
Minimum	0.4771	3.00
1st Quartile	1.882	76.3
Median	2.862	730
Mean	2.749	3770
3rd Quartile	3.518	3300
Maximum	4.663	46000

Notes:

Model Calibration

Basic Data

Number of Measurements:	66
Standard Error:	0.5054
MSPE (Upper)	220.18
MSPE (Lower)	68.77
R ²	0.76
Adj R ²	0.76
Duan BCF:	1.85

Explanatory Variables

Variable	Value	Standard Error
Intercept	0.304	0.182
log(Turb)	1.29	0.0900

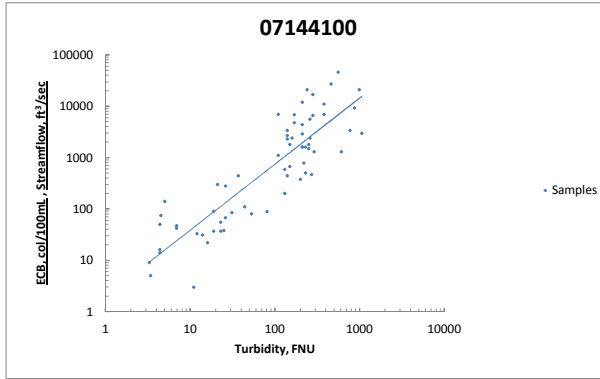
Notes:

Covariance Matrix

	<u>Intercept</u>	<u>log(Turb)</u>
Intercept	1	-0.94
log(Turb)	-0.94	1

Test Criteria

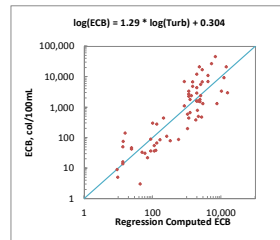
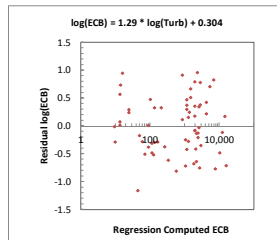
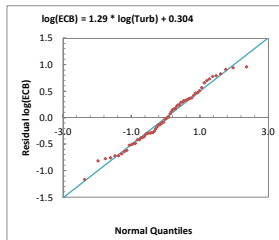
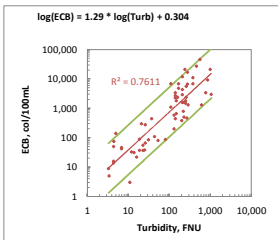
	<u>Leverage</u>	<u>Cook's D</u>	<u>DFITS</u>
	0.0909	0.797	0.348



Observations exceeding at least one test criterion

Observation	<u>Observed log(ECB)</u>	<u>Predicted log(ECB)</u>	<u>Residuals</u>	<u>Standardized Residuals</u>	<u>Studentized Residuals</u>	<u>Leverage</u>	<u>Cook's D</u>	<u>DFITS</u>
5	3.48	4.19	-0.716	-1.46	-1.47	0.0552	0.0621	-0.356
19	2.15	1.20	0.944	1.93	1.97	0.0611	0.121	0.502
39	1.88	1.14	0.731	1.50	1.51	0.0646	0.0774	0.397
41	0.477	1.64	-1.17	-2.35	-2.44	0.0387	0.111	-0.490

Notes:



Date	Turbidity		Streamflow		log(ECB)	log(Turb)	Regression		Normal Quantiles	90% P.I.		90% P.I. Upper
	FNU	ft³/sec	ECB_col/100ml	log(ECB)			Computed	Residual log(ECB)		Lower	Upper	
7/27/2004 0:00	200	5855.211	380	2.58	2.301	1829	-0.6825	-1.283	262.2	12756.5		
1/27/2005 0:00	81	171.9977	88	1.944	1.908	572.2	-0.8131	-1.974	82.0	3990.9		
3/23/2005 0:00	260	5855.211	5600	3.748	2.415	2563	0.3394	0.6254	367.5	17875.9		
5/10/2005 0:00	170	202.7993	6800	3.833	2.23	1484	0.661	1.127	212.8	10350.3		
5/27/2005 0:00	1060	742.6377	3000	3.477	3.025	15610	-0.7164	-1.375	2238.1	108873.5		
6/6/2005 0:00	290	1957.205	1300	3.114	2.462	2949	-0.3558	-0.6254	422.8	20568.1		
6/9/2005 0:00	380	11797.21	11000	4.041	2.58	4175	0.4207	0.8224	598.6	29118.9		
1/10/2007 0:00	6.9	13.75113	42	1.623	0.8388	24.12	0.2409	0.3678	3.5	168.2		
3/12/2007 0:00	23	19.1356	37	1.568	1.362	113.4	-0.4864	-0.9337	16.3	790.9		
3/21/2007 0:00	26	50.95942	280	2.447	1.415	132.8	0.3241	0.58	19.0	926.2		
3/27/2007 0:00	250	163.7947	1800	3.255	2.398	2437	-0.1316	-0.1712	349.4	16997.1		
4/2/2007 0:00	380	2885.551	6900	3.839	2.58	4175	0.2182	0.3276	598.6	29118.9		
4/18/2007 0:00	130	860.577	200	2.301	2.114	1051	-0.7207	-1.48	150.7	7330.3		
5/24/2007 0:00	560	5252.818	46000	4.663	2.748	6874	0.8256	1.604	985.6	47943.4		
5/25/2007 0:00	210	10926.19	2900	3.462	2.322	1948	0.1729	0.2879	279.3	13586.5		
7/11/2007 0:00	210	1927.15	1600	3.204	2.322	1948	-0.08539	-0.0948	279.3	13586.5		
8/16/2007 0:00	26	59.26939	67	1.826	1.415	132.8	-0.297	-0.5357	19.0	926.2		
11/26/2007 0:00	4.4	28.85959	50	1.699	0.6435	13.52	0.5679	1.058	1.9	94.3		
12/6/2007 0:00	5	29.5492	140	2.146	0.699	15.94	0.9437	1.974	2.3	111.2		
12/13/2007 0:00	260	2740.146	2400	3.38	2.415	2563	-0.02855	-0.01893	367.5	17875.9		
3/6/2008 0:00	610	978.7307	1300	3.114	2.785	7672	-0.771	-1.759	1100.0	53509.1		
4/14/2008 0:00	230	483.9471	500	2.699	2.362	2189	-0.6413	-1.201	313.9	15267.4		
5/29/2008 0:00	230	2895.341	1600	3.204	2.362	2189	-0.1362	-0.2098	313.9	15267.4		
6/30/2008 0:00	210	877.0272	1600	3.204	2.322	1948	-0.08539	-0.05683	279.3	13586.5		
8/5/2008 0:00	31	24.88007	85	1.929	1.491	166.4	-0.4925	-0.925	23.9	1160.6		
9/16/2008 0:00	170	1716.205	4800	3.681	2.23	1484	0.5097	0.994	212.8	10350.3		
4/6/2009 0:00	53	187.4148	80	1.903	1.724	331.7	-0.6176	-1.127	47.6	2313.5		
4/13/2009 0:00	140	851.2272	3400	3.531	2.146	1156	0.4684	0.8767	165.7	8062.6		
4/28/2009 0:00	280	9190.134	17000	4.23	2.447	2819	0.7803	1.375	404.2	19661.4		
6/16/2009 0:00	870	661.1681	9300	3.968	2.94	12110	-0.1147	-0.1329	1736.3	84462.4		
7/30/2009 0:00	210	523.1419	4400	3.643	2.322	1948	0.3539	0.6721	279.3	13586.5		
9/9/2009 0:00	210	3141.001	12000	4.079	2.322	1948	0.7897	1.48	279.3	13586.5		
9/24/2009 0:00	770	332.7602	3400	3.531	2.886	10350	-0.4835	-0.8767	1484.0	72187.1		
11/3/2009 0:00	140	328.0811	440	2.643	2.146	1156	-0.4196	-0.8224	165.7	8062.6		
11/19/2009 0:00	6.9	64.97855	47	1.672	0.8388	24.12	0.2898	0.4502	3.5	168.2		
12/1/2009 0:00	4.4	54.68532	14	1.146	0.6435	13.52	0.01504	0.0948	1.9	94.3		
12/17/2009 0:00	3.4	58.69619	5	0.699	0.5315	9.708	-0.2881	-0.4502	1.4	67.7		
1/6/2010 0:00	3.3	94.51012	9	0.9542	0.5185	9.342	-0.01621	0.01893	1.3	65.2		
1/19/2010 0:00	4.5	79.68536	75	1.875	0.6532	13.92	0.7314	1.283	2.0	97.1		
2/4/2010 0:00	4.4	63.90931	16	1.204	0.6435	13.52	0.07303	0.1329	1.9	94.3		
2/23/2010 0:00	11	69.34409	3	0.4771	1.041	43.93	-1.166	-2.363	6.3	306.4		

3/10/2010 0:00	150	546.7842	670	2.826	2.176	1264	-0.2756	-0.3678	181.2	8815.9
4/14/2010 0:00	12	52.73309	33	1.519	1.079	49.13	-0.1728	-0.2487	7.0	342.7
4/23/2010 0:00	110	227.6153	6900	3.839	2.041	848.1	0.9104	1.759	121.6	5915.2
5/13/2010 0:00	460	543.8144	27000	4.431	2.663	5338	0.704	1.201	765.3	37230.4
6/9/2010 0:00	990	2447.953	21000	4.322	2.996	14300	0.1669	0.2487	2050.3	99736.8
6/10/2010 0:00	160	3344.643	2400	3.38	2.204	1373	0.2425	0.4087	196.9	9576.1
6/13/2010 0:00	280	11316.08	6700	3.826	2.447	2819	0.3759	0.7704	404.2	19661.4
6/14/2010 0:00	150	15161.67	1800	3.255	2.176	1264	0.1536	0.2098	181.2	8815.9
6/15/2010 0:00	250	6480.41	1500	3.176	2.398	2437	-0.2108	-0.2879	349.4	16997.1
6/16/2010 0:00	220	4805.951	790	2.898	2.342	2068	-0.4179	-0.7704	296.5	14423.5
7/6/2010 0:00	140	13386.78	2300	3.362	2.146	1156	0.2986	0.4925	165.7	8062.6
8/19/2010 0:00	37	60.75484	440	2.643	1.568	209	0.3234	0.5357	30.0	1457.7
8/25/2010 0:00	240	769.9608	21000	4.322	2.38	2312	0.9582	2.363	331.5	16125.3
11/16/2010 0:00	140	261.8506	2700	3.431	2.146	1156	0.3683	0.7204	165.7	8062.6
1/19/2011 0:00	21	83.29205	300	2.477	1.322	100.9	0.4733	0.9337	14.5	703.7
3/7/2011 0:00	14	50.81632	31	1.491	1.146	59.89	-0.286	-0.4087	8.6	417.7
3/16/2011 0:00	19	48.00769	90	1.954	1.279	88.7	0.00634	0.05683	12.7	618.6
4/6/2011 0:00	16	37.57128	22	1.342	1.204	71.11	-0.5095	-0.994	10.2	496.0
4/18/2011 0:00	19	32.832	37	1.568	1.279	88.7	-0.3797	-0.7204	12.7	618.6
5/2/2011 0:00	25	28.80818	38	1.58	1.398	126.2	-0.5214	-1.058	18.1	880.2
5/16/2011 0:00	23	26.82455	55	1.74	1.362	113.4	-0.3142	-0.58	16.3	790.9
6/7/2011 0:00	44	21.85781	110	2.041	1.643	261.1	-0.3754	-0.6721	37.4	1821.1
6/22/2011 0:00	130	46.17053	590	2.771	2.114	1051	-0.2509	-0.3276	150.7	7330.3
8/15/2011 0:00	270	25.5387	470	2.672	2.431	2691	-0.7577	-1.604	385.8	18768.6
9/22/2011 0:00	110	42.88016	1100	3.041	2.041	848.1	0.113	0.1712	121.6	5915.2