Big Creek Research and Extension Team

University of Arkansas System Division of Agriculture

Quarterly Report – October 1 to December 31, 2016

MONITORING THE SUSTAINABLE MANAGEMENT OF NUTRIENTS ON C&H FARM IN BIG CREEK WATERSHED

Mission of the University of Arkansas System Division of Agriculture

The mission of the **Division of Agriculture** is to advance the stewardship of natural resources and the environment, cultivate the improvement of agriculture and agribusiness, develop leadership skills and productive citizenship among youth and adults, enhance economic security and financial responsibility among the citizens of the state, ensure a safe, nutritious food supply, improve the quality of life in communities across Arkansas, and strengthen Arkansas families.

Dr. Mark J. Cochran
Vice President for Agriculture

Executive Summary

This is the fourth Quarterly Report of 2016 for the Big Creek Research and Extension Team that details activities and progress made from October 1 through December 31, 2016.

1. We continue to collect weekly base flow and periodic stormflow water samples from Big Creek above and below the C&H Farm, along with water from a spring, ephemeral stream, surface runoff sites on Fields 1, 5a, and 12, two interceptor trenches below the slurry holding ponds, and house well for chemical and bacterial analysis.

2. We continue to monitor concentrations of P, N, bacteria, Cl, and electrical conductivity at all sites. This quarter was a comparatively dry period, with only one field runoff sample collected (Field 1; October 13th) and no interceptor trench flow recorded or sampled.

3. Core samples collected by Harbor Environmental and Safety adjacent to the swine slurry holding ponds were split and analyzed by Arkansas Analytical, Little Rock and by the Soil Testing Laboratory, UA System Division of Agriculture. Results of physical, chemical and biological analyses conducted by the Soil Testing Laboratory are presented in this report and do not indicate leakage of slurry from the ponds at the present time. Concentrations of P, N, bacteria, Cl (a conservative and effective tracer), and electrical conductivity showed no increasing trends at the house well. Due to low rainfall during the 4th quarter of 2016, only one flow event occurred at the ephemeral stream, which was sampled (i.e., October 13th).

4. Results of grid-soil sampling of monitored application Fields 1, 5a and 12, which were completed in 2016, are given and compared with results from the similar sampling conducted in 2014. It is evident from the Mehlich-3 P spatial distribution maps that some accumulation of P occurs in certain areas within the surface 0 - 4 inch depth of Fields 1 and 12. These areas are generally located around trees on Fields 1 and 12 (northern boundary of this field), where grazing cattle congregate for shade. In addition, there is an accumulation of Mehlich-3 P (0 – 4 inch depth) in the southwest corner of Field 12 at the gated entrance to the field, where cattle are routinely fed hay. This accumulation was present with the 2014 soil sampling, which was completed prior to any application of swine slurry to the field. Median Mehlich-3 P concentrations for Field 1 were similar for 2014 and 2016 (59 and 57 mg/L, respectively); for 5a decreased from 2014 to 2016 (71 and 37 mg/L, respectively); and increased for Field 12 (50 and 97 mg/L, respectively).

5. Median values of measured physical and chemical properties of the manure slurry in the holding ponds are updated and presented for samples collected between September 2013 and July 2016. Relationships between N, P, and K concentrations and total solids are presented. In addition, the total N:P_2O_5 concentration ratio exponentially decreased with increasing percent soils content. These trends reflect the variation in manure nutrient concentrations between ponds and depth within the ponds. C&H management is aware of these variations and the nutrient management opportunities they present when making decisions regarding: which pond to pump from; whether the pond will be agitated; the depth at which to pump from; and on which field to make the application.

Big Creek Science Team

Andrew Sharpley, Ph.D., TEAM LEADER – Distinguished Professor - Soil science, water quality, soil phosphorus chemistry, agricultural management

Brian Breaker, M.Sc., Surface-Water Specialist, stream flow and constituent collection, analysis, and statistical evaluation of trends.

Kris Brye, Ph.D., Professor - Effects of land application of poultry litter on in-situ nutrient leaching, effects of land use and management practices on soil physical, chemical, and biological properties related to soil quality and sustainability

Mike Daniels, Ph.D., Professor – Extension water quality and nutrient management specialist

Ed Gbur, Ph.D., Professor and Director, Agricultural Statistics Laboratory - Experimental design, linear and generalized linear mixed models, regression, agricultural applications of statistics.

Brian Haggard, Ph.D., Professor - Ecological engineering, environmental soil and water sciences, water quality chemistry, water quality monitoring and modeling, algal nutrient limitation, pollutant transport in aquatic systems

Phil Hays, Ph.D. Ground Water Specialist, U.S. Geological Survey and Research Professor with Geosciences Dept., University of Arkansas, application of stable isotopes and other geochemical indicators in delineating movement and behavior of contaminants in ground-water systems

Tim Kresse, M.Sc., Water Quality Specialist, U.S. Geological Survey, natural geochemical evolution of groundwater and separating these processes from anthropogenic sources of contamination

Mary Savin, Ph.D. - Structure and function of microbial communities in natural and managed ecosystems, microorganisms in nutrient cycling, contaminant degradation

Karl VanDevender, Ph.D. and P.E., Professor - Extension Engineer, Livestock and poultry manure and mortality management, nutrient management planning

Jun Zhu, PhD., Professor - Biological and agricultural engineering, agricultural sustainability, manure treatment technologies

Adam Willis, M.Sc., Newton County Extension Agent - Agriculture

Field Technicians - The Big Creek Research and Extension Team are ably supported by several outstanding and dedicated Program Technicians based in Fayetteville and Little Rock.

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Site 3. Edge-of-field monitoring on Field 12 permitted to receive slurry.

Site 4. Ephemeral stream flow draining a subwatershed containing the production facilities.

Site 5. Spring below Field 1.

Site 6. Big Creek upstream of the C&H Farm operation.

Site 7. Big Creak downstream of the C&H Farm operation.

Site 8. Left Fork downstream of the C&H Farm operation.

Site 9. North interceptor trench below the manure holding ponds.

Site 10. South interceptor trench below the manure holding ponds.

Site 11. House well at animal facility.

Table 1. Location of sampling sites on the Big Creek Research and Extension Team project.

Site description	Latitude	Longitude	Elevation, ft
Field 1	35 55’ 06.42”	93 03’ 38.34”	984
Field 5a	35 56’03.01”	93 04’ 25.85”	778
Field 12	35 54’ 13.57”	93 04’ 04.76”	838
Ephemeral stream	35 55’ 25.89”	93 04’ 14.94”	824
Spring	35 54’ 57.06”	93 03’ 34.64”	977
Big Creek upstream of farm	35 53’ 32.28”	93 04’ 06.38”	857
Big Creek downstream of farm	35 56’ 18.98”	93 04’ 21.81”	769
Left Fork	35 5’”48.04”	93 04” 02.02”	760
Trench 1 (south)	35 55’ 19.24”	93 04’ 23.04”	896
Trench 2 (north)	35 55’ 21.39”	93 04’ 19.93”	883
House well	35 55’ 27.02”	93 04’ 22.71”	915

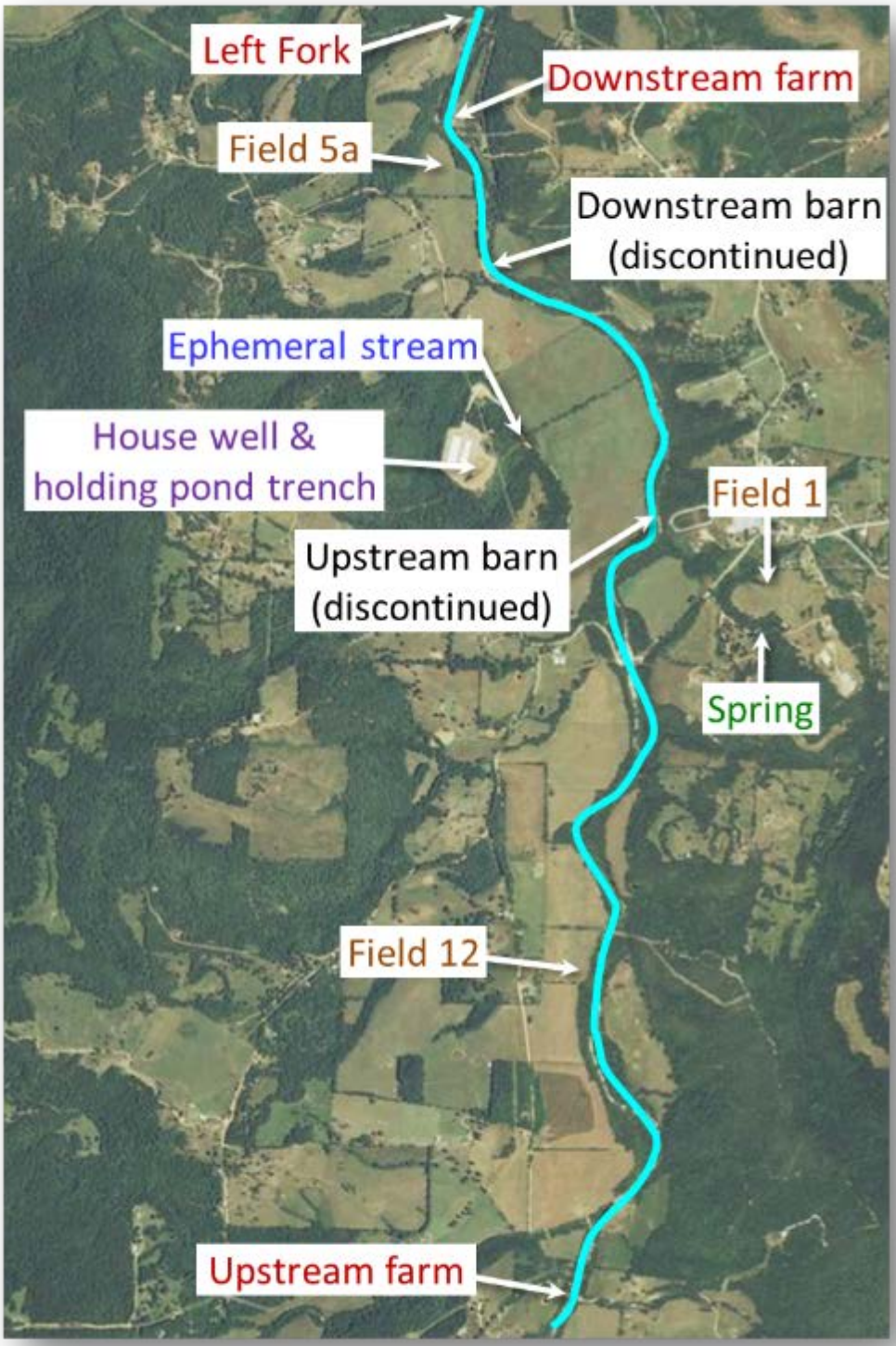


Figure 1. Location of sampling sites for the Big Creek Research and Extension Team project.

Sampling Protocols and Analyses

The following protocols were used to collect, prepare, and analyze all water samples:

1. One-liter acid-washed bottles were used to collect the stream samples for nutrient analyses.
2. Water was collected from just beneath the surface, where the stream was actively moving and well-mixed.
3. The bottle was rinsed with stream water before collecting the sample.
4. Sterilized specimen cups were used to collect samples for bacterial evaluation.
5. Time of collection was noted, and samples placed in a cooler on ice to preserve them until processed and were submitted to the Arkansas Water Resources Center Water Quality Lab on the day of collection for analyses.
6. Analyses included Alkalinity (APHA 2320-B), Ammonia (EPA 351.2), Chloride (EPA 300.0), Dissolved Phosphorus (EPA 365.2), E. coli (APHA 9223-B), Electrical Conductivity (EPA 120.1), Nitrate (EPA 300.0), pH (EPA 150.1), Total Coliforms (APHA 9223-B), Total Dissolved Solids (EPA 160.1), Total Nitrogen (APHA 4500-P J), Total Phosphorus (APHA 4500-P J), and Total Suspended Solids (EPA 160.2). APHA is American Public Health Association from the Wadeable Streams Assessment, Water Chemistry Laboratory Manual http://www.epa.gov/owow/monitoring/wsa/WRS_lab_manual.pdf
7. Prior to collection of a house well water sample, the well is purged and water temperature, pH, and electrical conductivity measured on-site every 30 seconds until all values stabilize (primarily water temperature). At that point a sample of water is collected in a 1-L acid-washed bottle. This method is taken from USGS and EPA well-water sampling protocols. See USGS methods for sampling at https://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf. Specific and detailed guidance on the collected of water quality data can be found in the USGS National Field Manual at file:///U:/Words/C&H%20Farm/Publications/Planning/USGS%20National%20Field%20Mannual_complete%202015.pdf

   The U.S. EPA also recommend that selected water quality parameters can be monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water or source well water. See: http://www.csus.edu/indiv/h/hornert/Geol_210_Summer_2012/Week%202%20readings/Puls%20and%20Barcelona%201996%20Low%20flow%20sampling.pdf and https://in-situ.com/wp-content/uploads/2015/01/Low-Flow-Groundwater-Sampling-Techniques-Improve-Sample-Quality-and-Reduce-Monitoring-Program-Costs-Case-Study.pdf
8. Minimum detection limits (MDLs) for each chemical and biological constituent are listed in Table 1. Some constituent concentrations were reported by the laboratory as less than the MDL but greater than zero. Those values are given in subsequent tables but have less confidence in their accuracy than concentrations above the MDL.
9. Chemical and biological analyses of samples collected from the beginning of 2015 to March 31, 2016 are given in Tables 2, 3, and 4.

Table 2. Minimum detection limits (MDLs) for each chemical and biological constituent.

Constituent	Minimum detection limit [1]
Alkalinity, mg/L as $CaCO_3$	2
Chloride, mg/L	0.093
Dissolved P, mg/L	0.002
Conductivity, uS/cm	1
Ammonia-N, mg/L	0.03
Dissolved organic carbon, mg/L	0.18
E. coli, MPN/100 mL	1
Nitrate-N, mg/L	0.004
pH	0.1
Total coliform, MPN/100 mL	1
Total dissolved solids, mg/L	15.22
Total N, mg/L	0.006
Total P, mg/L	0.012
Total suspended solids, mg/L	6.58

[1] MDL the Minimum Detection Limit of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Further information is available at http://water.usgs.gov/owq/OFR_99-193/detection.html

Big Creek Research and Extension Team Monitoring Data

Nutrients, Sediment, and Bacteria by Date of Sampling

Table 3. Water quality analyses at each sample site since 2016, with those collected since the last report noted. Coliform units are Most Probable Number (MPN) per 100 mL of water.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
			---------- mg/L ----------							-- MPN/100 mL --	
1/5/2016	**1/5/2016**	**Grab sample**									
11:52	15:29	Spring	0.007	0.024	<0.03	0.584	0.63	0.7	1.39	16.0	816.4
13:00	15:29	Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
11:40	15:29	Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
11:30	15:29	Left Fork	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
12:02	15:29	Ephemeral	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
12:13	15:29	Trench 1	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
12:44	15:29	House well	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	**1/25/2016**	**Grab sample**									
11:16	15:25	Spring	0.010	0.022	<0.03	0.565	0.60	0.3	1.27	34.5	1732.9
12:10	15:25	Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
11:00	15:25	Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
10:48	15:25	Left Fork	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:28	15:25	Ephemeral	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
11:42	15:25	House well	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	**2/10/2016**	**Grab sample**									
12:25	15:26	Spring	0.007	0.040	<0.03	0.634	0.80	17.7	2.70	1.0	325.5
11:15	15:26	Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
11:04	15:26	Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
11:29	15:26	Left Fork	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
12:03	15:26	House well	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	**2/24/2016**	**Grab sample**									
11:05	14:45	Spring	0.010	0.052	<0.03	1.102	1.46	2.8	N.S.	209.8	3930.0
12:16	14:45	Upstream	0.014	0.052	<0.03	0.099	0.28	6.1	N.S.	1203.3	7330.0
10:52	14:45	Downstream	0.015	0.058	<0.03	0.142	0.37	8.3	N.S.	1986.3	6500.0
10:38	14:45	Left Fork	0.015	0.088	<0.03	0.249	0.63	15.6	N.S.	2780.0	14390.0
11:15	14:45	Ephemeral	0.010	0.056	<0.03	0.195	0.40	12.8	N.S.	387.3	4870.0
11:36	14:45	Trench 1	0.005	0.014	<0.03	0.345	0.39	2.1	N.S.	<1.0	9070.0
11:53	14:45	House well	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	**3/10/2016**	**Grab sample**									
11:04	15:45	Spring	0.012	0.064	0.11	0.104	0.34	9.5	5.38	285.1	3230.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:13	15:45	Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
10:51	15:45	Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
11:32	15:45	Ephemeral stream	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
10:38	15:45	Left Fork	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
12:03	15:45	House well	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
11:50	15:45	Trench 1	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
11:46	15:45	Trench 2	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
12:41	15:45	Field 12	0.411	0.522	1.17	0.852	4.49	621.5	12.58	410.6	>241920
3/16/2016	**3/16/2016**	**Grab sample**									
11:35	15:05	Spring	0.009	0.036	0.01	0.340	0.44	5.7	3.36	75.4	461.1
12:35	15:05	Upstream	0.008	0.034	<0.03	0.060	0.13	0.4	1.10	52.9	579.4
11:23	15:05	Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
11:50	15:05	Ephemeral stream	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
11:13	15:05	Left Fork	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
12:22	15:05	House well	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
12:01	15:05	Trench 1	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	**3/24/2016**	**Storm sample**									

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:50	15:10	Spring	0.015	0.046	0.06	0.172	0.42	13.1	4.95	N.S.	N.S.
12:50	15:10	Upstream	0.011	0.032	0.06	0.040	0.14	4.5	1.60	N.S.	N.S.
11:35	15:10	Downstream	0.011	0.024	<0.03	0.106	0.20	3.9	1.29	N.S.	N.S.
12:10	15:10	Ephemeral stream	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
11:25	15:10	Left Fork	0.013	0.048	0.09	0.186	0.39	10.7	2.65	N.S.	N.S.
12:34	15:10	House well	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
12:20	15:10	Trench 1	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	**3/31/3016**	**Grab sample**									
11:06	15:10	Spring	0.011	0.034	<0.03	0.319	0.52	7.4	25.32	71.7	1553.1
12:45	15:10	Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
10:45	15:10	Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
11:16	15:10	Ephemeral stream	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
10:33	15:10	Left Fork	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0
11:49	15:10	House well	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
11:40	15:10	Trench 1	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
11:35	15:10	Trench 2	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
12:02	15:10	Field 5a	1.154	1.352	0.27	0.302	1.67	26.5	32.74	24890.0	>241920

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
4/4/2016	**4/4/2016**	**Grab sample**									
11:58	15:20	Spring	0.009	0.028	<0.03	0.324	0.42	7.5	1.57	104.7	866.4
12:50	15:20	Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
11:48	15:20	Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
12:08	15:20	Ephemeral stream	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
11:38	15:20	Left Fork	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
12:35	15:20	House well	0.011	0.018	<0.03	0.466	0.48	0.0	0.94	<1.0	1.0
12:26	15:20	Trench 2	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	>2419.2
4/20/2016	**4/20/2016**	**Grab sample**									
12:02	15:52	Spring	0.005	0.042	<0.03	0.410	0.55	22.4	1.04	3.1	195.6
13:20	15:52	Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
11:42	15:52	Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
12:11	15:52	Ephemeral stream	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
11:30	15:52	Left Fork	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
12:52	15:52	House well	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	**4/28/2016**	**Grab sample**									
11:55	15:17	Spring	0.010	0.024	<0.03	0.455	0.63	12.0	N.S.	25.6	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
13:00	15:17	Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.S.	58.6	648.8
11:30	15:17	Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.S.	36.4	2149.2
12:31	15:17	House well	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
11:25	15:17	Dry Creek	0.010	0.012	<0.03	0.152	0.27	1.0	N.S.	14.8	3050.0
5/2/2016	**5/3/2016**	**Grab sample**									
12:25	08:55	Spring	0.008	0.012	<0.03	0.338	0.36	2.2	5.08	88.2	>2419.2
14:29	08:55	Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
11:43	08:55	Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0
12:38	08:55	Ephemeral stream	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
12:38	08:55	Ephemeral stream	0.008	0.112	0.15	1.794	2.62	61.8	4.07	1046.2	23590.0
11:24	08:55	Left Fork	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
13:27	08:55	House well	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1
5/10/2016	**5/10/2016**	**Grab sample**									
11:15	15:40	Spring	0.008	0.026	<0.03	0.281	0.45	2.9	7.58	410.6	2780.0
12:50	15:40	Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
10:58	15:40	Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
11:28	15:40	Ephemeral stream	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	>2419.2

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:35	15:40	Left Fork	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
12:08	15:40	House well	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
11:55	15:40	Trench 1	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	>2419.2
11:45	15:40	Trench 2	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	>2419.2
12:26	15:40	Field 5a	1.114	1.458	1.69	2.894	6.35	79.9	12.82	22820.0	>2419.2
13:08	15:40	Field 12	0.370	0.666	0.12	0.062	1.03	96.7	6.92	663.0	>2419.2
5/18/2016	**5/18/2016**	**Grab sample**									
11:29	15:20	Spring	0.009	0.024	0.01	0.320	0.51	8.7	2.20	45.7	1413.6
13:08	15:20	Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
11:10	15:20	Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
11:43	15:20	Ephemeral stream	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
10:57	15:20	Left Fork	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
12:50	15:20	House well	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
12:05	15:20	Trench 1	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	**5/26/2016**	**Grab sample**									
11:45	15:30	Spring	0.008	0.020	<0.03	0.219	0.35	6.2	4.15	344.8	3730.0
13:08	15:30	Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
11:30	15:30	Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
12:05	15:30	Ephemeral stream	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	>2419.2
11:20	15:30	Left Fork	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
12:51	15:30	House well	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
12:38	15:30	Trench 1	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
6/2/2016	**6/2/2016**	**Grab sample**									
11:15	14:40	Spring	0.007	0.032	<0.03	0.330	0.47	10.8	2.38	64.1	1986.3
12:26	14:40	Upstream farm	0.007	0.018	<0.03	0.046	0.13	4.1	1.8	224.7	1986.3
11:04	14:40	Downstream farm	0.006	0.018	<0.03	0.106	0.20	1.4	1.8	104.6	3410
11:26	14:40	Ephemeral stream	0.008	0.022	<0.03	0.494	0.63	3.6	2.15	770.1	1986.3
10:52	14:40	Left Fork	0.007	0.022	<0.03	0.117	0.22	1.4	1.40	44.1	1986.3
12:06	14:40	House well	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
11:35	14:40	Trench 1	0.002	0.018	<0.03	0.124	0.30	8.8	3.01	26.5	393.0
6/7/2016	**6/7/2016**	**Grab sample**									
11:25	14:30	Spring	0.011	0.026	<0.03	0.327	0.46	4.6	6.06	140.1	2460.0
12:16	14:30	Upstream farm	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0
11:10	14:30	Downstream farm	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:37	14:30	Ephemeral stream	0.012	0.024	0.01	0.503	0.65	6.9	3.89	2419.2	7980.0
10:50	14:30	Left Fork	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
12:00	14:30	House well	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	**6/15/2016**	**Grab sample**									
11:40	15:00	Spring	0.010	0.016	0.03	0.466	0.65	4.2	0.00	153.9	1553.1
12:40	15:00	Upstream farm	0.007	0.010	<0.03	0.097	0.15	1.6	0.02	69.1	2310.0
11:25	15:00	Downstream farm	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
11:15	15:00	Left Fork	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
12:15	15:00	House well	0.008	0.008	<0.03	0.506	0.59	0.7	0.00	<1.0	<1.0
6/22/2016	**6/22/2016**	**Grab sample**									
10:40	14:35	Spring	0.008	0.012	<0.03	0.532	0.60	1.0	0.00	38.2	1413.6
12:20	14:35	Upstream farm	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5
10:23	14:35	Downstream farm	0.015	0.028	0.04	0.327	0.44	14.9	0.00	46.4	4570.0
10:08	14:35	Left Fork	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
11:38	14:35	House well	0.009	0.008	<0.03	0.545	0.58	0.5	0.00	<1.0	<1.0
6/29/2016	**6/29/2016**	**Grab sample**									
10:53	14:00	Spring	0.009	0.083	0.02	0.487	0.73	43.4	1.10	5.2	648.8

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:37	14:00	Upstream farm	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
10:41	14:00	Downstream farm	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
10:25	14:00	Left Fork	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
11:12	14:00	House well	0.008	0.014	<0.03	0.569	0.56	0.0	0.23	<1.0	<1.0
7/6/2016	**7/6/2016**	**Grab sample**									
6:44	10:16	Spring	0.011	0.027	<0.03	0.465	0.53	9.8	1.15	25.3	4430
7:41	10:16	Upstream farm	0.009	0.023	<0.03	0.221	0.27	5.9	0.66	387.3	12230.0
6:26	10:16	Downstream farm	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
6:08	10:16	Left Fork	0.006	0.020	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7:18	10:16	House well	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	**7/13/2016**	**Grab sample**									
7:53	12:30	Spring	0.003	0.023	<0.03	0.355	0.42	12.3	0.90	71.7	2920
7:33	12:30	Downstream farm	0.006	0.017	<0.03	0.365	0.43	4.3	1.12	129.6	8390.0
7:15	12:30	Left Fork	0.005	0.017	<0.03	0.172	0.29	1.9	0.85	95.9	12360.0
8:34	12:30	House well	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0
7/20/2016	**7/20/2016**	**Grab sample**									
7:56	12:05	Spring	0.006	0.024	<0.03	0.298	0.35	9.4	0.55	N.S.	N.S.

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
7:39	12:05	Downstream farm	0.005	0.024	<0.03	0.356	0.44	5.1	3.93	N.S	N.S.
7:25	12:05	Left Fork	0.005	0.013	<0.03	0.197	0.76	2.3	2.21	N.S.	N.S.
8:30	12:05	House well	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	**7/27/2016**	**Grab sample**									
7:38	14:15	Spring	0.001	0.043	<0.03	0.375	0.46	17.6	2.64	55.6	980.4
7:21	14:15	Downstream farm	0.007	0.027	<0.03	0.423	0.47	2.3	1.62	140.8	17260.0
7:02	14:15	Left Fork	0.004	0.021	<0.03	0.255	0.35	3.6	1.79	920.8	15000.0
8:14	14:15	House well	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
8/3/2016	**8/3/2016**	**Grab sample**									
8:03	12:10	Spring	0.006	0.104	<0.03	0.201	0.49	64.8	7.41	65.7	2920
7:43	12:10	Downstream farm	0.013	0.014	<0.03	0.221	0.29	3.2	3.46	115.3	9320.0
7:28	12:10	Left Fork	0.007	0.016	<0.03	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	**8/16/2016**	**Grab sample**									
10:58	14:50	Spring	0.007	0.027	0.02	0.223	0.39	7.7	9.89	88.2	5380.0
12:16	14:50	Upstream farm	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
10:41	14:50	Downstream farm	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:25	14:50	Ephemeral stream	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
10:28	14:50	Left Fork	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0
11:40	14:50	Trench 1	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
11:50	14:50	Trench 2	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
8/24/2016	**8/24/2016**	**Grab sample**									
11:29	15:30	Spring	0.004	0.046	<0.03	0.477	0.97	29.9	2.99	27.8	5630
12:40	15:30	Upstream farm	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
10:53	15:30	Downstream farm	0.005	0.016	<0.03	0.122	0.22	3.2	0.85	72.8	7030.0
10:40	15:30	Left Fork	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/24/2016	**8/24/2016**	**Storm sample**									
11:03	15:30	Downstream farm	<0.002	0.109	0.01	0.002	0.42	66.9	5.89	156.5	38730.0
12:05	15:30	Trench 1	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
8/30/2016	**8/30/2016**	**Grab sample**									
11:24	14:55	Spring	0.003	0.020	<0.03	0.501	0.58	2.9	3.28	195.6	9090.0
12:35	14:55	Upstream farm	0.003	0.020	<0.03	0.042	0.13	1.7	1.37	102.5	5210.0
11:10	14:55	Downstream farm	0.004	0.020	<0.03	0.116	0.21	1.7	1.19	30.1	5200.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:00	14:55	Left Fork	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
Samples analyzed since the last quarterly report											
9/7/2016	**9/7/2016**	**Grab sample**									
7:58	12:25	Spring	0.003	0.219	0.05	0.514	0.92	142.1	5.37	31.8	18500.0
9:03	12:25	Upstream farm	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
7:38	12:25	Downstream farm	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0
7:23	12:25	Left Fork	0.006	0.021	0.00	0.151	0.24	2.8	1.58	27.5	10170.0
9/15/2016	**9/15/2016**	**Grab sample**									
11:00	14:00	Spring	0.009	0.273	0.00	0.345	0.83	190.9	13.99	ND	ND
11:20	14:00	Upstream farm	0.012	0.011	0.00	0.119	0.21	3.2	6.12	ND	ND
10:45	14:00	Downstream farm	0.014	0.016	0.01	0.312	0.42	2.9	5.38	ND	ND
10:32	14:00	Left Fork	0.011	0.014	0.01	0.132	0.25	2.2	5.35	ND	ND
9/28/2016	**9/28/2016**	**Grab sample**									
11:25	14:25	Spring	0.005	0.043	0.01	0.427	0.62	22.0	2.70	7540.0	7590.0
12:26	14:25	Upstream farm	0.008	0.016	0.01	0.128	0.21	1.0	1.33	9330.0	2310.0
11:12	14:25	Downstream farm	0.011	0.017	0.01	0.293	0.42	1.6	2.15	7120.0	5210.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
11:00	14:25	Left Fork	0.006	0.011	0.02	0.101	0.22	1.8	1.31	2530.0	3410.0
10/5/2016	**10/5/2016**	**Grab sample**									
10:29	15:40	Spring	0.006	0.513	0.01	0.502	1.40	334.8	4.66	36.8	241920.0
12:01	15:40	Upstream farm	0.009	0.020	0.00	0.120	0.25	2.1	2.85	770.1	13170.0
10:07	15:40	Downstream farm	0.014	0.043	0.02	0.413	0.58	29.3	3.00	547.1	11690.0
9:54	15:40	Left Fork	0.009	0.023	0.01	0.130	0.29	2.8	2.38	285.1	17820.0
10/13/2016	**10/13/2016**	**Grab sample**									
10:46	15:45	Spring	0.018	0.272	0.05	0.623	1.36	148.0	6.09	>2419.2	28090.0
12:46	15:45	Upstream farm	0.015	0.026	0.00	0.147	0.28	2.7	2.32	3590.0	46110.0
10:29	15:45	Downstream farm	0.033	0.066	0.02	0.614	0.88	9.6	3.90	4640.0	129970.0
11:03	15:45	Ephemeral stream	0.018	0.047	0.03	1.760	1.97	9.7	5.17	>2419.2	21430.0
10:16	15:45	Left Fork	0.091	0.203	0.04	1.071	1.74	24.2	9.30	14010.0	>241920
12:30	15:45	House well	0.008	0.010	0.01	1.166	1.23	0.6	1.35	<1.0	23.3
10/13/2016	**10/13/2016**	**Storm sample**									
11:15	15:45	Ephemeral stream	0.067	0.213	0.12	2.732	3.83	61.7	11.10	ND	ND
13:10	15:45	Field 1	0.940	1.231	0.13	0.335	2.36	59.0	16.67	ND	ND

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10/20/2016	**10/20/2016**	**Grab sample**									
11:05	15:05	Spring	0.010	0.044	0.00	0.414	0.56	18.9	11.91	461.1	30760.0
12:03	15:05	Upstream farm	0.010	0.021	0.00	0.076	0.13	1.1	4.43	3730.0	16640.0
10:48	15:05	Downstream farm	0.014	0.030	0.03	0.327	0.39	2.1	3.11	387.3	5690.0
10:20	15:05	Left Fork	0.008	0.026	0.01	0.146	0.27	1.3	3.95	33.5	17890.0
11:38	15:05	House well	0.009	0.020	0.02	0.739	0.79	0.1	4.56	<1.0	19.7
10/27/2016	**10/27/2016**	**Grab sample**									
11:05	15:25	Spring	0.007	0.253	0.03	0.265	0.88	161.1	14.84	61.7	13960.0
11:50	15:25	Upstream farm	0.010	0.021	0.00	0.046	0.14	1.1	5.87	517.2	5450.0
10:42	15:25	Downstream farm	0.014	0.021	0.01	0.291	0.36	2.1	7.91	45.5	6440.0
10:27	15:25	Left Fork	0.008	0.016	0.02	0.132	0.26	1.9	7.76	48.8	9340.0
11:30	15:25	House well	0.009	0.010	0.01	0.664	0.74	0.9	8.95	<1.0	5.2
11/03/2016	**11/03/2016**	**Grab sample**									
9:55	14:20	Spring	0.001	0.483	0.03	0.235	0.89	281.7	15.21	3.1	2419.2
11:10	14:20	Upstream farm	0.003	0.031	0.01	0.071	0.20	2.1	6.81	22.6	3010.0
9:36	14:20	Downstream farm	0.008	0.022	0.03	0.388	0.47	1.7	6.07	1732.9	5200.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
9:14	14:20	Left Fork	0.004	0.026	0.03	0.117	0.26	1.5	9.24	33.1	7380.0
10:38	14:20	House well	0.004	0.010	0.02	0.719	0.75	0.4	9.48	1.0	2.0
11/10/2016	**11/10/2016**	**Grab sample**									
10:56	14:00	Spring	0.003	0.104	0.00	0.255	0.50	53.0	3.30	17.1	13760.0
11:33	14:00	Upstream farm	0.011	0.013	0.01	0.073	0.12	1.0	2.29	53.7	>2419.2
10:38	14:00	Downstream farm	0.011	0.021	0.02	0.419	0.48	0.7	2.15	22.6	5040.0
10:18	14:00	Left Fork	0.005	0.013	0.01	0.161	0.23	4.1	2.07	7.4	2560.0
11:10	14:00	House well	0.005	0.009	0.00	0.574	0.68	0.1	2.16	<1.0	1.0
11/17/2016	**11/17/2016**	**Grab sample**									
11:00	13:45	Spring	0.001	0.021	0.00	0.209	0.32	4.9	2.42	2.0	574.8
11:40	13:45	Upstream farm	0.009	0.020	0.00	0.057	0.13	0.6	1.84	58.1	3270.0
10:43	13:45	Downstream farm	0.011	0.020	0.01	0.412	0.49	2.5	1.37	18.5	>2419.2
10:20	13:45	Left Fork	0.005	0.011	0.00	0.195	0.26	0.5	1.77	15.8	2400.0
11:10	13:45	House well	0.006	0.010	0.01	0.660	0.71	0.3	1.57	<1.0	1.0
11/21/2016	**11/21/2016**	**Grab sample**									
10:24	14:15	Spring	0.010	0.313	0.04	0.239	0.87	210.2	4.99	135.4	6770.0
11:15	14:15	Upstream farm	0.010	0.019	0.00	0.125	0.17	1.3	0.68	178.9	3840.0

Time sample collected	Time received @ laboratory	Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic Carbon	E. coli	Total coliform
10:05	14:15	Downstream farm	0.012	0.021	0.01	0.466	0.52	1.3	1.23	26.9	>2419.2
9:40	14:15	Left Fork	0.004	0.011	0.01	0.239	0.31	0.4	3.35	11.9	2419.2
10:40	14:15	House well	0.007	0.011	0.00	0.675	0.75	0.4	1.37	<1.0	<1.0
11/29/2016	**11/29/2016**	**Grab sample**									
11:42	15:15	Spring	0.009	0.100	0.00	0.329	0.68	45.0	8.06	1046.2	13360.0
12:48	15:15	Upstream farm	0.008	0.026	0.01	0.063	0.12	2.1	2.38	235.9	3790.0
11:30	15:15	Downstream farm	0.007	0.027	0.00	0.146	0.23	4.4	2.11	387.3	7380.0
11:20	15:15	Left Fork	0.004	0.014	0.00	0.191	0.28	1.1	1.97	57.6	>2419.2
12:36	15:15	House well	0.004	0.011	0.00	0.598	0.68	0.4	2.67	<1.0	<1.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.
§ N.S. is No Sample.

Nutrients, Sediment, and Bacteria by Date Spring, Upstream, and Downstream Sites

Table 4. Water quality analyses in Big Creek upstream and downstream of the C&H Farm boundary of permitted land application since January 2016, with those collected since the last report noted.

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	mg/L							MPN/100 mL	
1/5/2016									
Upstream	0.008	0.026	<0.03	0.158	0.20	0.5	0.95	67.7	648.8
Downstream	0.011	0.026	<0.03	0.419	0.46	0.1	1.13	40.8	648.8
1/25/2016									
Upstream	0.010	0.022	<0.03	0.068	0.09	1.1	1.52	16.9	290.9
Downstream	0.011	0.022	<0.03	0.213	0.24	0.7	1.29	8.6	365.4
2/10/2016									
Upstream	0.005	0.016	<0.03	0.048	0.11	0.5	1.11	14.5	178.5
Downstream	0.005	0.016	<0.03	0.198	0.24	0.9	0.99	4.1	218.7
2/24/2016									
Upstream	0.014	0.052	<0.03	0.099	0.28	6.1		1203.3	7330.0
Downstream	0.015	0.058	<0.03	0.142	0.37	8.3		1986.3	6500.0
3/10/2016									
Upstream	0.012	0.048	0.13	0.082	0.20	8.6	2.66	770.1	>2419.2
Downstream	0.010	0.044	0.11	0.118	0.25	6.2	2.28	298.7	>2419.2
3/16/2016									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Upstream	0.008	0.034	0.00	0.060	0.13	0.4	1.10	52.9	579.4
Downstream	0.006	0.028	0.01	0.170	0.24	0.9	1.17	81.3	>2419.2
3/24/2016									
Upstream	0.011	0.032	0.06	0.04	0.14	4.5	1.60	N.S.	N.S.
Downstream	0.011	0.024	0.00	0.106	0.20	3.9	1.29	N.S.	N.S.
3/31/2016									
Upstream	0.008	0.042	0.08	0.100	0.22	6.1	2.49	186.0	>2419.2
Downstream	0.011	0.056	0.08	0.156	0.33	12.4	2.67	365.0	>2419.2
4/4/2016									
Upstream	0.008	0.026	<0.03	0.065	0.08	1.7	0.71	8.3	648.8
Downstream	0.010	0.026	<0.03	0.176	0.20	1.9	0.98	77.6	1046.2
4/20/2016									
Upstream	0.003	0.020	<0.03	0.047	0.06	1.9	0.61	185.0	1299.7
Downstream	0.004	0.018	<0.03	0.152	0.20	1.2	0.74	38.4	2920.0
4/28/2016									
Upstream	0.009	0.012	<0.03	0.035	0.12	1.2	N.D.	58.6	648.8
Downstream	0.010	0.012	<0.03	0.154	0.27	1.5	N.D.	36.4	2149.2
5/2/2016									
Upstream	0.006	0.018	<0.03	0.039	0.10	6.7	1.76	185.0	2419.2
Downstream	0.008	0.016	<0.03	0.075	0.16	2.0	1.50	178.9	4720.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016									
Upstream	0.007	0.044	0.01	0.070	0.20	6.1	3.10	613.1	4480.0
Downstream	0.011	0.060	0.01	0.101	0.31	11.6	2.95	1203.3	7490.0
5/18/2016									
Upstream	0.007	0.016	<0.03	0.043	0.13	1.4	1.00	85.5	1299.7
Downstream	0.009	0.020	0.02	0.117	0.25	1.2	0.98	107.1	>2419.2
5/26/2016									
Upstream	0.007	0.030	<0.03	0.056	0.12	4.2	1.56	238.2	5290.0
Downstream	0.009	0.036	<0.03	0.094	0.20	4.6	1.75	547.5	3640.0
6/12/2016									
Upstream	0.007	0.018	0.00	0.046	0.13	4.1	1.8	224.7	1986.3
Downstream	0.006	0.018	0.00	0.106	0.20	1.4	1.8	104.6	3410.0
6/7/2016									
Upstream	0.013	0.018	0.06	0.131	0.14	1.3	2.8	120.1	2720.0
Downstream	0.012	0.018	0.04	0.123	0.19	1.5	1.94	73.8	2980.0
6/15/2016									
Upstream	0.007	0.010	0.00	0.097	0.15	1.6	0.02	69.1	2310.0
Downstream	0.008	0.050	0.05	0.181	0.42	25.4	0.38	33.2	4740.0
6/22/2016									
Upstream	0.008	0.016	0.02	0.237	0.33	2.3	0.20	455.0	547.5

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.015	0.028	0.04	0.327	0.44	14.9	0.00	46.4	4570.0
6/29/2016									
Upstream	0.006	0.029	0.06	0.186	0.34	4.6	0.92	55.4	9888.0
Downstream	0.010	0.021	0.03	0.395	0.47	2.5	0.46	41.3	6310.0
7/6/2016									
Upstream	0.009	0.023	0.00	0.221	0.27	5.9	0.66	387.3	12230.0
Downstream	0.010	0.023	0.01	0.461	0.43	2.1	0.47	39.3	8570.0
8/16/2016									
Upstream	0.009	0.031	0.03	0.089	0.23	4.6	3.14	248.9	9330.0
Downstream	0.011	0.039	0.03	0.161	0.33	8.1	2.94	178.2	17820.0
8/24/2016									
Upstream	0.004	0.014	0.03	0.046	0.14	2.0	1.08	72.3	2620.0
Downstream	0.005	0.016	0.00	0.122	0.22	3.2	0.85	72.8	7030.0
8/30/2016									
Upstream	0.003	0.020	0.00	0.042	0.13	1.7	1.37	102.5	5210.0
Downstream	0.004	0.020	0.00	0.116	0.21	1.7	1.19	30.1	5200.0
9/7/2016									
Upstream	0.007	0.020	0.01	0.113	0.21	1.9	1.89	195.6	5380.0
Downstream	0.008	0.059	0.01	0.265	0.46	25.4	1.39	30.9	4790.0
Samples analyzed since the last Quarterly Report									

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
9/15/2016									
Upstream	0.012	0.011	0.00	0.119	0.21	3.2	6.12	ND	ND
Downstream	0.014	0.016	0.01	0.312	0.42	2.9	5.38	ND	ND
9/28/2016									
Upstream	0.008	0.016	0.01	0.128	0.21	1.0	1.33	9330.0	2310.0
Downstream	0.011	0.017	0.01	0.293	0.42	1.6	2.15	7120.0	5210.0
10/5/2016									
Upstream	0.009	0.020	0.00	0.120	0.25	2.1	2.85	770.1	13170.0
Downstream	0.014	0.043	0.02	0.413	0.58	29.3	3.00	547.1	11690.0
10/13/2016									
Upstream	0.015	0.026	0.00	0.147	0.28	2.7	2.32	3590.0	46110.0
Downstream	0.033	0.066	0.02	0.614	0.88	9.6	3.90	4640.0	129970.0
10/20/2016									
Upstream	0.010	0.021	0.00	0.076	0.13	1.1	4.43	3730.0	16640.0
Downstream	0.014	0.030	0.03	0.327	0.39	2.1	3.11	387.3	5690.0
10/27/2016									
Upstream	0.010	0.021	0.00	0.046	0.14	1.1	5.87	517.2	5450.0
Downstream	0.014	0.021	0.01	0.291	0.36	2.1	7.91	45.5	6440.0
11/3/2016									
Upstream	0.003	0.031	0.01	0.071	0.20	2.1	6.81	22.6	3010.0

Sample location	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
Downstream	0.008	0.022	0.03	0.388	0.47	1.7	6.07	1732.9	5200.0
11/10/2016									
Upstream	0.011	0.013	0.01	0.073	0.12	1.0	2.29	53.7	>2419.2
Downstream	0.011	0.021	0.02	0.419	0.48	0.7	2.15	22.6	5040.0
11/17/2016									
Upstream	0.009	0.020	0.00	0.057	0.13	0.6	1.84	58.1	3270.0
Downstream	0.012	0.020	0.01	0.412	0.49	2.5	1.37	18.5	>2419.2
11/21/2016									
Upstream	0.010	0.019	0.00	0.125	0.17	1.3	0.68	178.9	3840.0
Downstream	0.012	0.021	0.01	0.466	0.52	1.3	1.23	26.9	>2419.2
11/29/2016									
Upstream	0.008	0.026	0.01	0.063	0.12	2.1	2.38	235.9	3790.0
Downstream	0.007	0.027	0.00	0.146	0.23	4.4	2.11	387.3	7380.0

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the Minimum detection limit is given.

§ N.S. is No Sample.

† N.D. is No Data.

Nutrients, Sediment, and Bacteria by Site for Ephemeral Stream, Trenches, Left Fork and Field Runoff

Table 5. Water quality analyses at the ephemeral stream draining the subwatershed containing the production houses and manure holding ponds, and surface runoff from Fields 1, 5a, and 12 since January, 2015, with those collected since the last report noted.

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
	---------- mg/L ----------							--- MPN/100 mL ---	
Ephemeral stream									
1/5/2016	0.007	0.018	<0.03	0.883	1.00	1.2	2.15	32.7	686.7
1/25/2016	0.011	0.030	<0.03	0.762	0.87	9.8	3.10	1.0	816.4
2/24/2016	0.010	0.056	<0.03	0.195	0.40	12.8		387.3	4870.0
3/10/2016	0.006	0.050	0.13	0.918	1.22	26.7	3.12	648.8	8840.0
3/16/2016	0.006	0.022	0.01	0.520	0.54	0.0	1.75	88.0	461.1
3/24/2016	0.010	0.012	<0.03	0.531	0.64	1.3	1.44	N.S.	N.S.
3/31/2016	0.013	0.656	0.68	1.211	3.05	375.0	12.14	16160.0	198630.0
4/4/2016	0.008	0.018	<0.03	0.462	0.48	1.3	1.79	12.0	727.0
4/20/2016	0.008	0.020	<0.03	0.517	0.66	4.1	0.68	44.3	21430.0
5/2/2016	0.007	0.016	<0.03	0.468	0.59	1.7	2.56	118.7	5380.0
5/10/2016	0.195	0.560	0.32	0.649	4.01	1346.7	11.94	579.4	241920.0
5/18/2016	0.008	0.014	<0.03	0.479	0.63	3.0	0.84	34.1	2419.2
5/26/2016	0.052	0.424	0.39	0.858	2.20	350.6	8.58	22470.0	241920..0
6/2/2016	0.008	0.022	0.03	0.494	0.63	3.6	2.15	770.1	1986.3

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
6/7/2016	0.012	0.024	0.01	0.5	0.7	6.9	3.89	2419.2	7980
8/16/2016	0.011	0.023	0.01	1.365	1.59	2.6	2.47	137.6	154945.0
Samples analyzed since the last quarterly report									
10/13/2016 (grab sample)	0.018	0.047	0.03	1.760	1.97	9.7	5.17	>2419.2	21430.0
10/13/2016 (storm sample)	0.067	0.213	0.12	2.732	3.83	61.7	11.10	ND	ND
House well									
1/5/2016	0.008	0.020	<0.03	0.528	0.57	0.9	1.08	<1.0	1.0
1/25/2016	0.012	0.020	<0.03	0.602	0.55	0.5	2.36	<1.0	<1
2/10/2016	0.007	0.014	<0.03	0.542	0.56	0.1	0.63	<1.0	<1.0
2/24/2016	0.010	0.010	<0.03	0.582	0.55	1.3	N.S.	<1.0	<1.0
3/10/2016	0.011	0.020	0.02	0.562	0.59	0.9	1.19	<1.0	<1.0
3/16/2016	0.009	0.022	<0.03	0.550	0.55	0.0	1.55	<1.0	<1
3/24/2016	0.012	0.014	<0.03	0.565	0.65	0.2	2.72	N.S.	N.S.
3/31/2016	0.010	0.018	<0.03	0.556	0.62	0.2	3.93	1.0	26.2
4/4/2016	0.011	0.018	<0.03	0.466	0.48	0.0	0.94	<1.0	1.0
4/20/2016	0.005	0.014	<0.03	0.598	0.50	0.5	0.47	1.0	1.0
4/28/2016	0.011	0.008	<0.03	0.481	0.57	0.3	N.S.	<1.0	<1.0
5/2/2016	0.009	0.016	<0.03	0.551	0.56	0.1	1.94	<1.0	<1

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
5/10/2016	0.009	0.008	<0.03	0.533	0.56	0.5	4.39	<1.0	24.9
5/18/2016	0.009	0.010	<0.03	0.488	0.64	0.4	0.95	<1.0	<1.0
5/26/2016	0.009	0.012	<0.03	0.564	0.57	0.7	0.93	1.0	7.4
6/2/2016	0.008	0.018	<0.03	0.597	0.62	0.7	0.99	<1.0	<1.0
6/7/2016	0.011	0.014	0.03	0.500	0.58	0.1	3.06	<1.0	<1.0
6/15/2016	0.008	0.008	<0.03	0.506	0.59	0.7	0.00	<1.0	<1.0
6/22/2016	0.009	0.008	<0.03	0.545	0.58	0.5	0.00	<1.0	<1.0
6/29/2016	0.008	0.014	<0.03	0.569	0.56	0.0	0.23	<1.0	<1.0
7/6/2016	0.009	0.013	<0.03	0.874	0.96	1.0	0.73	<1.0	13.5
7/13/2016	0.005	0.011	<0.03	0.627	0.63	0.5	0.09	<1.0	<1.0
7/20/2016	0.007	0.009	0.02	0.594	0.70	0.1	0.14	N.S.	N.S.
7/27/2016	0.006	0.010	<0.03	0.650	0.67	0.1	1.41	<1.0	<1.0
Samples analyzed since the last quarterly report									
10/13/2016	0.008	0.010	0.01	1.166	1.23	0.6	1.35	<1.0	23.3
10/13/2016	0.009	0.020	0.02	0.739	0.79	0.1	4.56	<1.0	19.7
10/27/2016	0.009	0.010	0.01	0.664	0.74	0.9	8.95	<1.0	5.2
11/03/2016	0.004	0.010	0.02	0.719	0.75	0.4	9.48	1.0	2.0
11/10/2016	0.005	0.009	0.00	0.574	0.68	0.1	2.16	<1.0	1.0
11/17/2016	0.006	0.010	0.01	0.660	0.71	0.3	1.57	<1.0	1.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
11/21/2016	0.007	0.011	0.00	0.675	0.75	0.4	1.37	<1.0	<1.0
11/29/2016	0.004	0.011	0.00	0.598	0.68	0.4	2.67	<1.0	<1.0
Interceptor Trench 1 (South)									
1/5/2016	0.003	0.016	<0.03	0.243	0.29	0.9	1.11	1.0	209.8
2/24/2016	0.005	0.014	<0.03	0.345	0.39	2.1		<1.0	9070.0
3/10/2016	0.005	0.036	0.10	0.264	0.45	3.5	2.87	2419.2	16690.0
3/16/2016	0.003	0.032	0.02	0.331	0.37	0.0	1.23	101.7	290.9
3/24/2016	0.008	0.016	<0.03	0.208	0.20	2.8	1.33	N.S.	N.S.
3/31/2016	0.004	0.018	<0.03	0.347	0.49	5.5	4.76	4.1	2419.2
5/10/2016	0.002	0.016	<0.03	0.228	0.30	3.9	2.91	13.9	2419.2
5/18/2016	0.006	0.006	<0.03	0.169	0.22	0.1	0.54	2.0	5200.0
5/26/2016	0.008	0.006	<0.03	0.217	0.23	1.4	1.29	1.0	4260.0
6/2/2016	0.002	0.018	0.00	0.124	0.30	8.8	3.01	26.5	393.0
8/16/2016	0.005	0.006	0.02	0.130	0.17	0.2	2.14	93.4	48840.0
8/24/2016	<0.002	0.019	0.03	0.033	0.30	8.3	1.99	21.8	3450.0
Samples analyzed since the last quarterly report									
No flow									
Interceptor Trench 2 (North)									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
2/24/2016	0.005	0.066	0.13	6.298	7.02	9.7	4.27	30.1	18720.0
3/10/2016	0.005	0.054	0.14	1.716	2.35	6.8	6.77	613.1	34480.0
3/31/2016	0.006	0.040	0.06	2.800	3.54	20.9	9.29	7.4	10810.0
4/4/2016	0.004	0.012	<0.03	0.236	0.25	0.0	0.85	1.0	2419.2
5/10/2016	0.002	0.038	<0.03	1.706	2.18	5.2	3.72	38.7	1553.0
8/16/2016	0.004	0.036	0.05	0.344	0.99	1.5	8.98	290.9	198630.0
Samples analyzed since the last quarterly report									
No flow									
Left Fork									
1/5/2016	0.013	0.028	<0.03	0.427	0.48	0.7	1.51	34.1	686.7
1/25/2016	0.010	0.024	<0.03	0.198	0.25	1.0	1.30	21.1	435.2
2/10/2016	0.003	0.012	<0.03	0.175	0.24	0.8	1.15	7.4	209.8
2/24/2016	0.015	0.088	<0.03	0.249	0.63	15.6		2780.0	14390.0
3/10/2016	0.013	0.046	0.01	0.154	0.38	8.7	2.64	367.3	2750.0
3/16/2016	0.009	0.032	<0.03	0.190	0.26	0.3	1.45	35.9	980.4
3/24/2016	0.013	0.048	0.09	0.186	0.39	10.7	2.65		
3/31/2016	0.013	0.056	0.09	0.199	0.40	11.9	2.59	172.0	3640.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
4/4/2016	0.009	0.022	<0.03	0.131	0.17	1.5	0.87	44.8	1119.9
4/20/2016	0.005	0.020	<0.03	0.157	0.21	2.1	0.84	35.0	6160.0
5/2/2016	0.009	0.020	<0.03	0.095	0.20	1.9	2.30	172.6	3640.0
5/10/2016	0.011	0.072	0.02	0.121	0.37	17.2	3.35	980.4	8230.0
5/18/2016	0.010	0.016	0.01	0.139	0.27	1.4	1.54	60.1	2620.0
5/26/2016	0.010	0.048	0.02	0.123	0.24	10.6	2.66	461.1	6890.0
6/2/2016	0.007	0.022	0.00	0.117	0.22	1.4	1.40	44.1	1986.3
6/7/2016	0.009	0.016	0.04	0.124	0.19	0.8	2.08	31.8	3180.0
6/15/2016	0.009	0.012	0.01	0.198	0.29	2.0	0.94	63.1	8860.0
6/22/2016	0.008	0.018	0.05	0.220	0.37	2.1	0.70	37.9	676.0
6/29/2016	0.006	0.023	0.03	0.251	0.35	2.0	0.94	23.5	5200.0
7/6/2016	0.006	0.02	0.04	0.271	0.36	2.7	0.96	248.1	12590.0
7/13/2016	0.005	0.017	0.00	0.172	0.29	1.9	0.85	95.9	12360.0
7/20/2016	0.005	0.013	0.00	0.197	0.76	2.3	2.21		
7/27/2016	0.004	0.021	0.00	0.255	0.35	3.6	1.79	920.8	15000.0
8/3/2016	0.007	0.016	0.00	0.212	0.32	2.4	2.21	101.4	7430.0
8/16/2016	0.012	0.082	0.07	0.118	0.30	19.5	3.64	201.4	14550.0

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
8/24/2016	0.004	0.013	0.00	0.045	0.13	1.5	1.62	43.5	6690.0
8/30/2016	0.005	0.021	0.02	0.157	0.28	2.7	2.00	111.2	17850.0
9/7/2016	0.006	0.021	0.00	0.151	0.24	2.8	1.58	27.5	10170.0
Samples analyzed since the last quarterly report									
9/15/2016	0.011	0.014	0.01	0.132	0.25	2.2	5.35	ND	ND
9/28/2016	0.006	0.011	0.02	0.101	0.22	1.8	1.31	2530.0	3410.0
10/5/2016	0.009	0.023	0.01	0.130	0.29	2.8	2.38	285.1	17820.0
10/13/2016	0.091	0.203	0.04	1.071	1.74	24.2	9.30	14010.0	>241920
10/20/2016	0.008	0.026	0.01	0.146	0.27	1.3	3.95	33.5	17890.0
10/27/2016	0.008	0.016	0.02	0.132	0.26	1.9	7.76	48.8	9340.0
11/03/2016	0.004	0.026	0.03	0.117	0.26	1.5	9.24	33.1	7380.0
11/10/2016	0.005	0.013	0.01	0.161	0.23	4.1	2.07	7.4	2560.0
11/17/2016	0.005	0.011	0.00	0.195	0.26	0.5	1.77	15.8	2400.0
11/21/2016	0.004	0.011	0.01	0.239	0.31	0.4	3.35	11.9	2419.2
11/29/2016	0.004	0.014	0.00	0.191	0.28	1.1	1.97	57.6	>2419.2
Field 1									

Date sample collected	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Total suspended solids	Dissolved Organic C	E. coli	Total coliform
10/13/2016	0.940	1.231	0.13	0.335	2.36	59.0	16.67	ND	ND
Field 5a									
3/31/2016	1.154	1.352	0.27	0.302	1.67	26.5	32.74	N.S.	N.S.
5/10/2016	1.114	1.458	1.69	2.894	6.35	79.9	12.82	N.S.	N.S.
No samples analyzed since the last quarterly report									
Field 12									
3/10/2016	0.411	0.522	1.17	0.852	4.49	621.5	12.58	N.S.	N.S.
5/10/2016	0.370	0.666	0.12	0.062	1.03	96.7	6.92	N.S.	N.S.
No samples analyzed since the last quarterly report									

¶ Values proceeded by '<' were reported by the analytical laboratory as zero and the minimum detection limit is given.

§ N.S. is No Sample. E. coli and total coliform were not measured on surface runoff samples collected by ISCO samplers when sample holding time exceeded the required 8-hour threshold.

† N.D. is No Data.

Water pH, Alkalinity, Chloride, Electrical Conductivity, and Total Dissolved Solids for Several Big Creek Sites

At the beginning of 2015, the pH, alkalinity, chloride concentration, electrical conductivity and total dissolved solids were determined on water samples collected at the upstream and downstream sites, spring, house well, and trenches, to build a data base that will enable to eventually source track the major water source pathways at these sites. These values are given below in Table 6.

Table 6. The pH, Chloride concentration, electrical conducting, and total solids concentration of water samples collected at upstream, downstream, spring, ephemeral stream, house well and trench sites, initiated at the beginning of 2015, with those collected since the last report noted.

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
		------- mg/L ------		µS/cm	mg/L
Upstream					
1/5/2016	7.5	40	1.34	102	62.5
1/25/2016	8.2	46	1.50	115	65.0
2/10/2016	8.6	54	1.69	141	60.0
2/24/2016	7.2	66	1.20	102	97.5
3/10/2016	7.6	38.0	1.268	84.5	60.0
3/16/2016	6.7	38.0	1.252	88.3	52.5
3/24/2016	7.7	46.0	1.825	103.3	56.5
3/31/2016	7.3	30.0	0.933	65.8	235.0
4/4/2016	7.4	40.0	1.163	86.9	55.0
4/20/2016	8.0	58.0	1.405	125.7	65.0
4/29/2016	8.1	66.0	1.373	134.8	72.5
5/3/2016	7.7	38.0	1.150	83.7	52.5
5/10/2016	7.6	32.0	0.914	67.6	57.5
518/2016	8.0	48.0	1.228	102.8	57.5
5/26/2016	7.8	76.0	1.045	78.4	50.0
6/2/2016	7.9	68.0	1.298	105.4	75.0
6/7/2016	8.1	58.0	2.722	128.3	77.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/15/2016	8.3	72.0	1.471	150.3	77.5
6/22/2016	8.1	88.0	1.695	182.3	112.5
6/29/2016	7.4	110.0	2.176	203.0	112.5
7/6/2016	7.5	106.0	1.821	212.0	117.5
8/16/2016	7.7	40.0	1.092	88.1	60.0
8/24/2016	8.3	54.0	1.513	121.7	95.0
8/30/2016	8.2	64.0	1.088	143.3	70.0
9/7/2016	7.9	82.0	1.601	176.0	97.5
Samples analyzed since the last quarterly report					
9/15/2016	8.0	98.0	1.287	206.0	111.1
9/28/2016	8.1	84.0	1.804	217.0	113.3
10/5/2016	7.9	94.0	1.831	230.0	110.0
10/13/2016	7.8		2.540	225.0	242.5
10/20/2016	7.9		2.017	235.0	117.8
10/27/2016	8.0		2.139	299.0	117.5
11/3/2016	7.6		2.330	260.0	
11/10/2016	8.0		2.446	233.0	
11/17/2016	8.0		2.455	272.0	
11/21/2016	8.0		2.314	101.0	
11/29/2016			2.087		
Downstream					
1/5/2016	7.5	60	2.17	158	92.5
1/25/2016	8.0	80	2.00	191	95.0
2/10/2016	8.0	94	2.36	214	102.5
2/22/2016	7.5	80	1.48	156	110.0
3/10/2016	7.3	54.0	1.481	126.1	80.0

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/16/2016	7.1	60.0	1.500	137.6	75.0
3/24/2016	7.3	68.0	1.827	156.8	79.0
3/31/2016	7.3	48.0	1.043	95.9	50.0
4/4/2016	7.4	66.0	1.563	138.6	80.0
4/20/2016	7.3	92.0	1.903	187.0	105.0
4/29/2016	7.7	100.0	2.052	199.1	107.5
5/3/2016	7.8	60.0	1.197	130.5	87.5
5/10/2016	7.6	44.0	0.856	93.5	75.0
518/2016	7.8	74.0	1.482	154.5	82.5
5/26/2016	7.7	34.0	0.941	114.1	72.5
6/2/2016	8.0	48.0	1.447	154.8	100.0
6/7/2016	7.8	88.0	1.698	176.8	97.5
6/15/2016	7.9	108.0	2.525	205.0	115.0
6/22/2016	7.8	120.0	2.406	230.0	145.0
6/29/2016	7.5	132.0	2.971	259.0	322.5
7/6/2016	7.4	136.0	2.960	262.0	157.5
7/13/2016	7.4	130.0	2.549	289.0	137.5
7/20/2016	7.7	138.0	2.726	305.0	145.0
7/27/2016	7.5	134.0	2.599	286.0	150.0
8/3/2016	7.9	144.0	1.845	258.0	137.5
8/16/2016	7.7	60.0	1.255	128.9	82.5
8/24/2016	7.8	84.0	1.368	174.8	97.5
8/24/2016			1.152	122.8	97.5
8/30/2016	7.8	88.0	1.435	193.5	97.5
9/7/2016	7.9	112.0	2.143	240.0	125.0
Samples analyzed since the last quarterly report					
9/15/2016	7.9	126.0	1.918	265.0	137.8

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
9/28/2016	7.8	124.0	2.272	281.0	142.2
10/5/2016	7.8	122.0	2.708	288.0	140.0
10/13/2016	7.6		2.799	264.0	152.5
10/20/2016	7.2		2.791	314.0	157.8
10/27/2016	7.6		2.805	304.0	150.0
11/3/2016	7.2		3.074	313.0	
11/10/2016	7.8		3.330	311.0	
11/17/2016	7.8		3.203	366.0	
11/21/2016	7.8		3.272	139.0	
11/29/2016			2.481		
Spring					
3/10/2016			1.109	359.0	210.0
3/16/2016			2.038	516.0	250.0
3/24/2016			1.939	446.0	214.0
3/31/2016			1.324	414.0	45.0
4/4/2016			1.971	506.0	272.5
4/20/2016			2.111	554.0	300.0
4/29/2016			2.234	522.0	285.0
5/3/2016			1.879	486.0	275.0
5/10/2016			1.190	417.0	245.0
5/18/2016			2.206	493.0	275.0
5/26/2016			1.370	450.0	250.0
6/2/2016			2.111	512.0	285.0
6/7/2016			2.348	503.0	280.0
6/15/2016			2.523	526.0	305.0
6/22/2016			2.659	543.0	322.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
6/29/2016			2.864	545.0	322.5
7/6/2016			2.749	533.0	267.5
7/13/2016			2.661	272.0	292.5
7/20/2016			2.271	594.0	292.5
7/27/2016			2.424	593.0	297.5
8/3/2016			2.151	541.0	280
8/16/2016			1.435	434.0	242.5
8/24/2016			2.644	556.0	312.5
8/30/2016			2.710	604.0	310.0
9/7/2016			2.822	598.0	322.5
Samples analyzed since the last quarterly report					
9/15/2016			2.040	590.0	322.2
9/28/2016			2.785	652.0	328.9
10/5/2016			2.272	644.0	315.0
10/13/2016			1.899	455.0	127.5
10/20/2016	6.9		2.528	674.0	331.1
10/27/2016	7.2		2.525	637.0	315.0
11/3/2016	6.9		2.361	619.0	
11/10/2016	7.2		2.402	605.0	
11/17/2016	7.1		2.367	695.0	
11/21/2016	7.0		2.433	259.0	
11/29/2016			2.472		
Ephemeral Stream					
1/5/2016			2.908	368.0	
1/25/2016			3.454	392.0	
2/24/2016			2.427	264.0	

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
3/10/2016			2.530	288.0	
3/16/2016			2.427	356.0	
3/24/2016			3.467	399.0	
3/31/2016			3.366	153.2	
4/4/2016			2.544	330.0	
4/20/2016			2.758	380.0	
5/2/2016			2.068	329.0	
5/2/2016			2.571	241.0	
5/10/2016			1.617	143.3	
5/18/2016			2.726	360.0	
5/26/2016			2.031	194.5	
6/2/2016			2.733	359.0	
6/7/2016			2.930	344.0	
8/16/2016			3.309	357.0	
Samples analyzed since the last quarterly report					
10/13/2016	7.2		3.546	393.0	225.0
House well					
1/5/2016			4.855	439	215.0
1/25/2016			5.278	462	242.5
2/10/2016			5.273	468	215.0
2/24/2016			5.237	447	242.5
3/10/2016			5.366	458	237.5
3/16/2016			4.993	482	240.0
3/24/2016			5.265	484	219.0
3/31/2016			5.023	409	220.0
4/4/2016			4.735	414	210.0
4/20/2016			5.475	417	227.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
4/28/2016			4.671	417	247.5
5/2/2016			5.316	441	237.5
5/10/2016			5.234	411	237.5
5/18/2016			4.450	420	232.5
5/26/2016			5.649	426	220.0
6/2/2016			5.450	409	182.5
6/7/2016			4.670	416	220.0
6/15/2016			4.394	414	242.5
6/22/2016			5.173	424	260.0
6/29/2016			5.557	432	172.5
7/6/2016			5.811	391	237.5
7/13/2016			5.021	561	220.0
7/20/2016			5.561	447	230.0
7/27/2016			5.230	467	227.5
Samples analyzed since the last quarterly report					
10/13/2016			6.988	476.	245.0
10/20/2016		7.6	6.421	495	244.4
10/27/2016		7.9	6.132	501	142.5
11/3/2016		7.6	5.560	479	
11/10/2016		7.6	5.858	473	
11/17/2016		7.6	5.655	544	
11/21/2016		7.5	5.576	209	
11/29/2016			5.721		
12/14/2016		7.4		411	
Trench 1					
1/5/2016			1.61	161	82.5

Date	pH	Alkalinity	Chloride	Electrical conductivity	Total dissolved solids
2/24/2016			1.16	162	102.5
3/10/2016			1.019	173.7	117.5
3/16/2016			1.451	226.0	120.0
3/24/2016			1.732	229.0	99.0
3/31/2016			1.280	167.9	100.0
5/10/2016			1.122	226.0	130.0
5/19/2016			0.405	196.5	115.0
5/18/2016			1.653	234.0	125.0
5/26/2016			1.421	262.0	142.5
6/2/2016			1.229	320	192.5
8/16/2016			2.051	293	130.0
8/24/2016			1.259	318	170.0
Trench 2					
3/11/2015			1.77	159	140.8
3/19/2015			1.04	168	104.9
3/26/2015			0.78	135	160.9
5/11/2015			0.41	165	88.5
5/26/2015			0.93	284	141.3
12/14/2016			1.00	148	110.0
2/24/2016			0.99	144	122.5
3/10/2016			0.349	106.8	80.0
3/31/2016			0.424	134.5	87.5
4/4/2016			1.4	192.1	107.5
8/16/2016			0.597	219	117.5

Temporal Trends in Phosphorus, Nitrogen, Bacteria, and Chloride in Big Creek Above and Below the C&H Farm

The concentration of dissolved P, total P, nitrate-N, total N, bacteria and chloride in Big Creek above and below the C&H Farm are presented in subsequent figures to show the season / temporal trends in measured concentrations (Figures 5, 6, 7, 8, 9, 10, and 11).

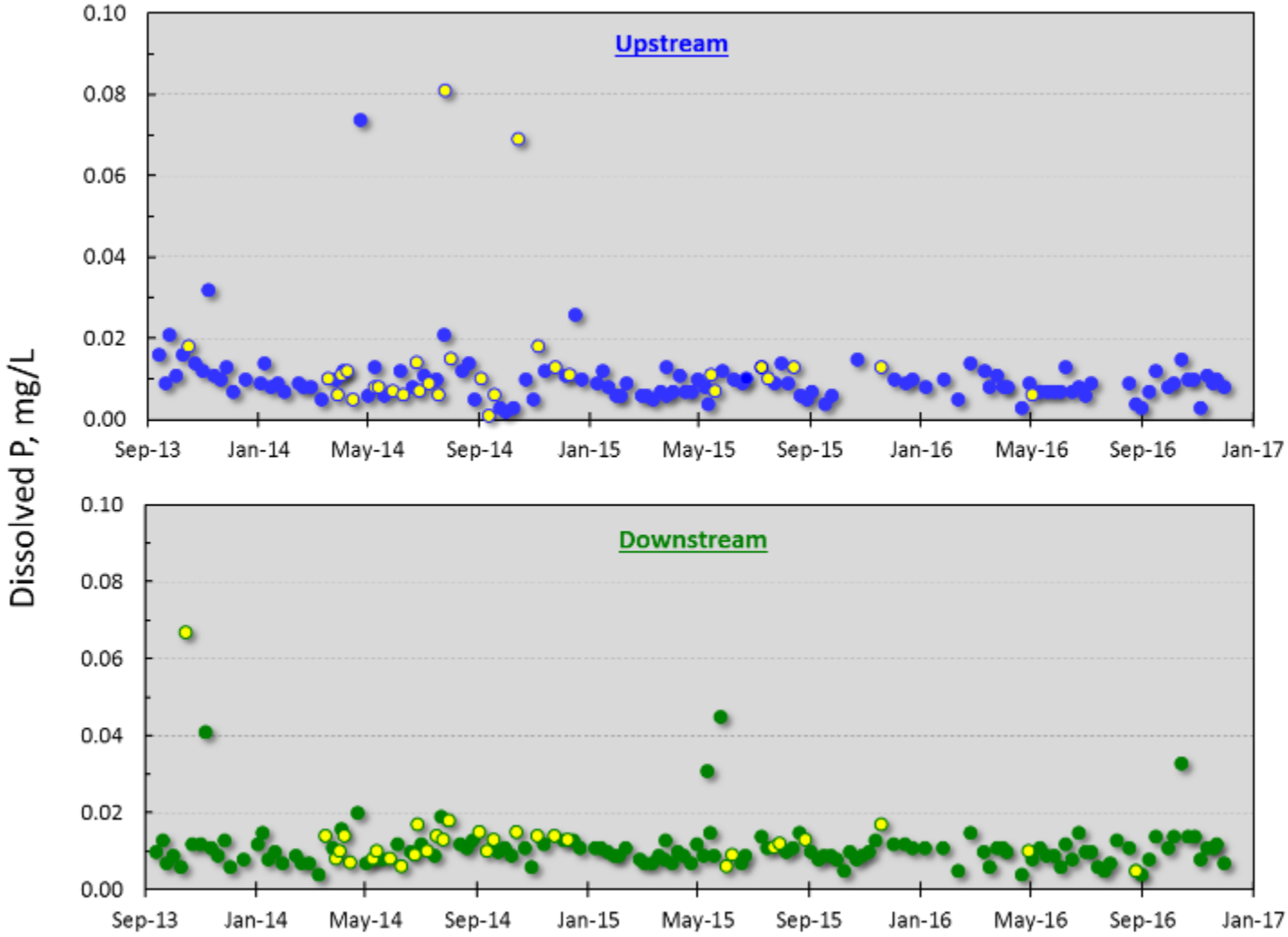


Figure 2. Dissolved P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

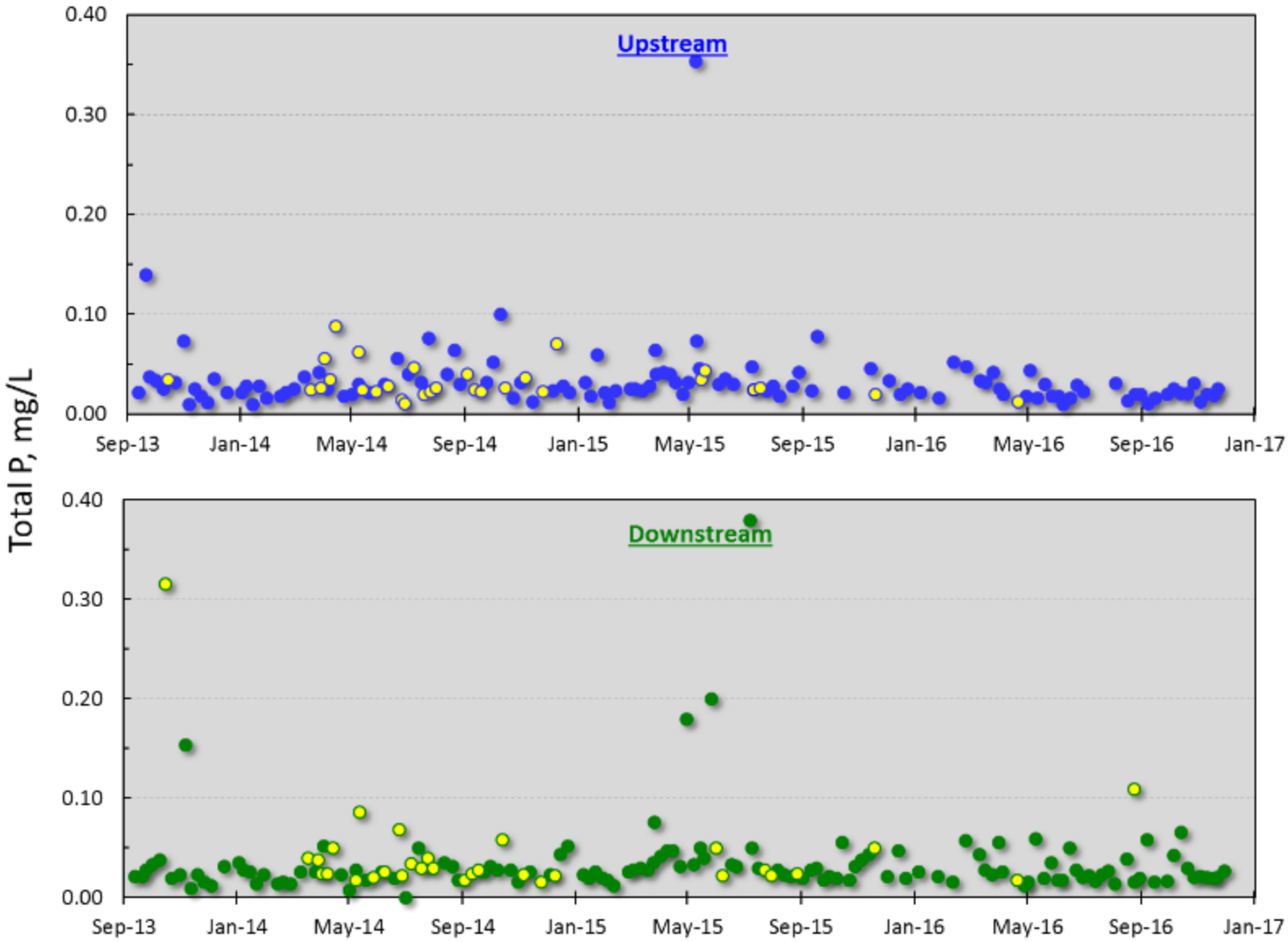


Figure 3. Total P concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

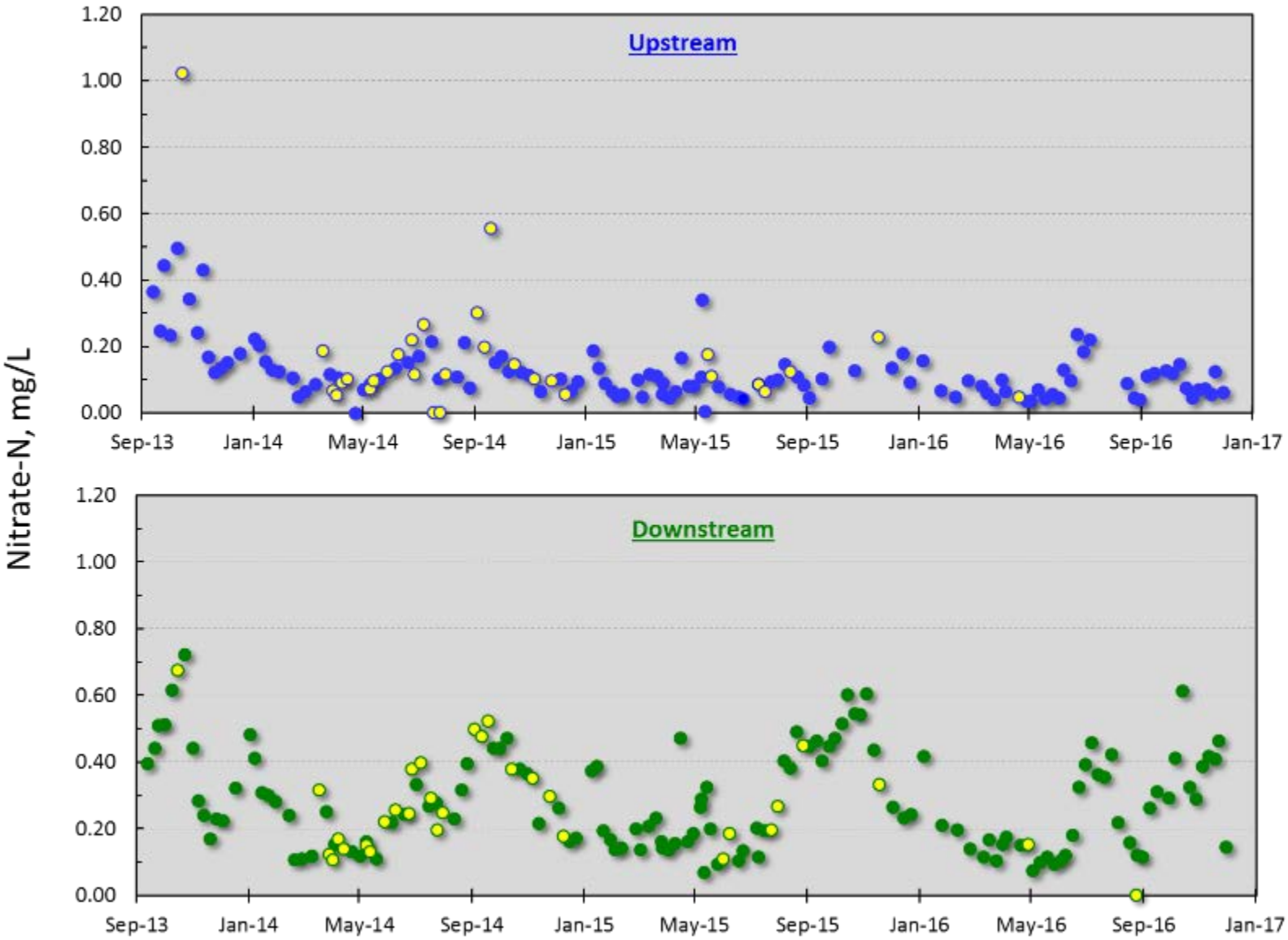


Figure 4. Nitrate-N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

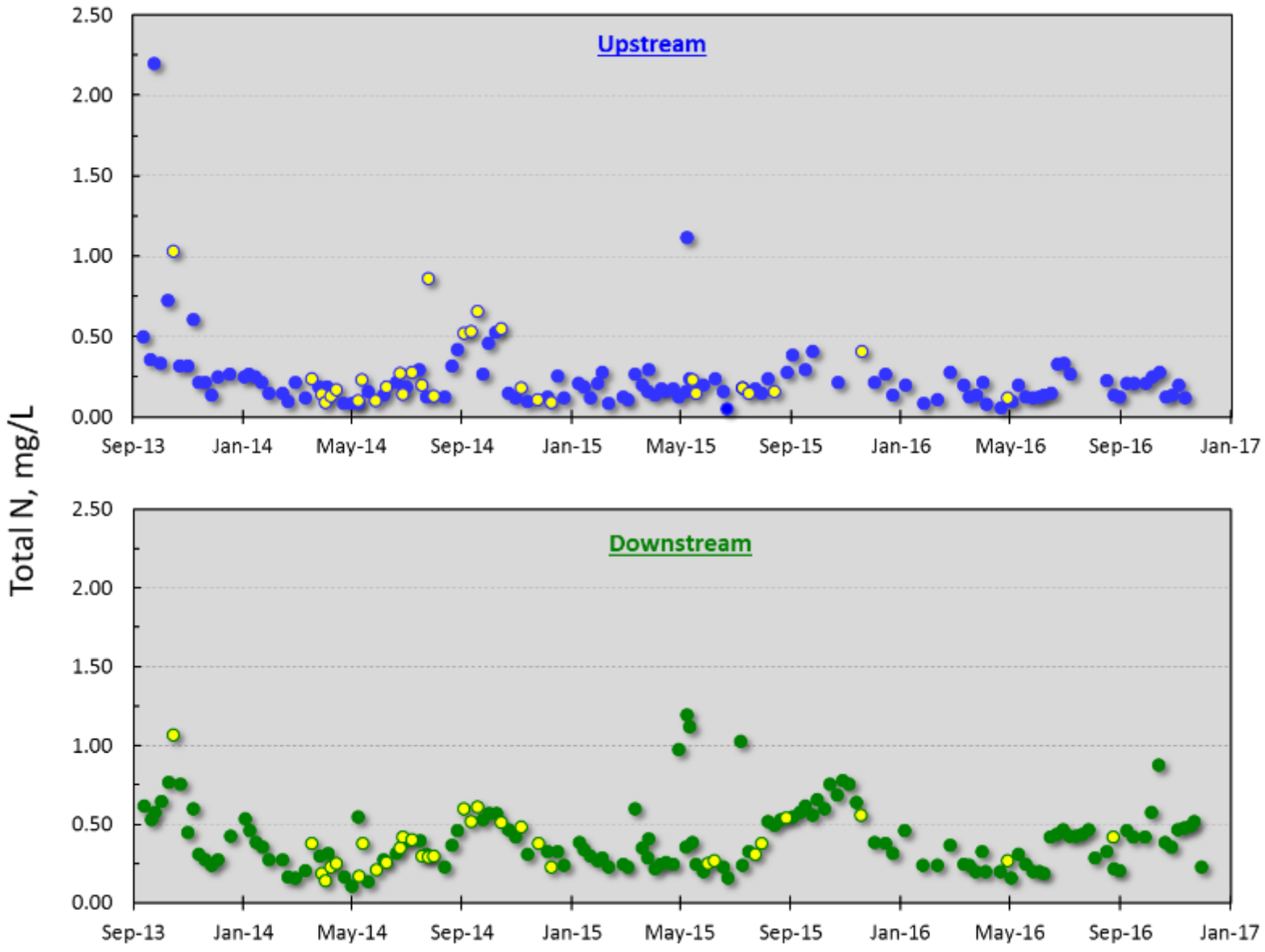


Figure 5. Total N concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

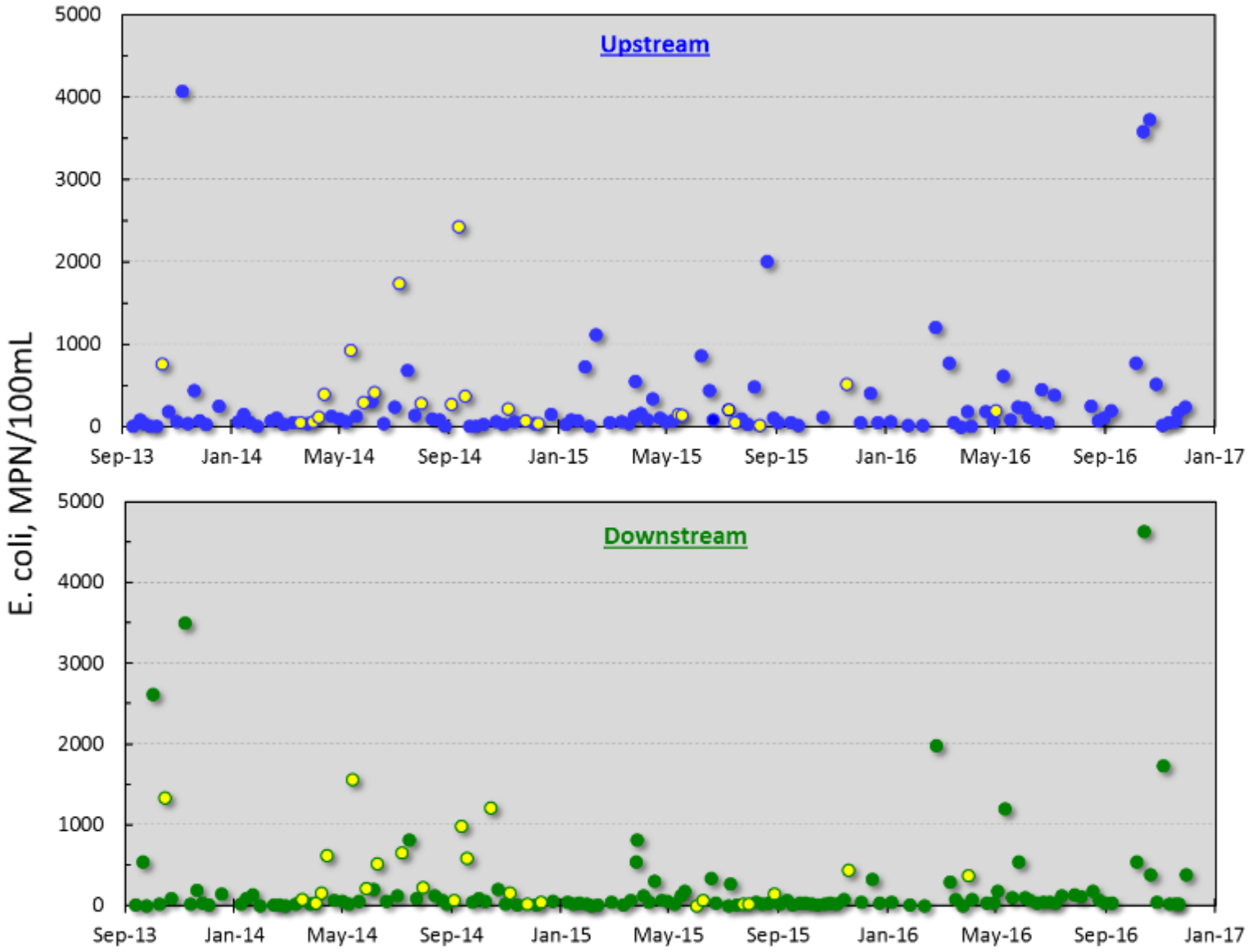


Figure 6. E. coli numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

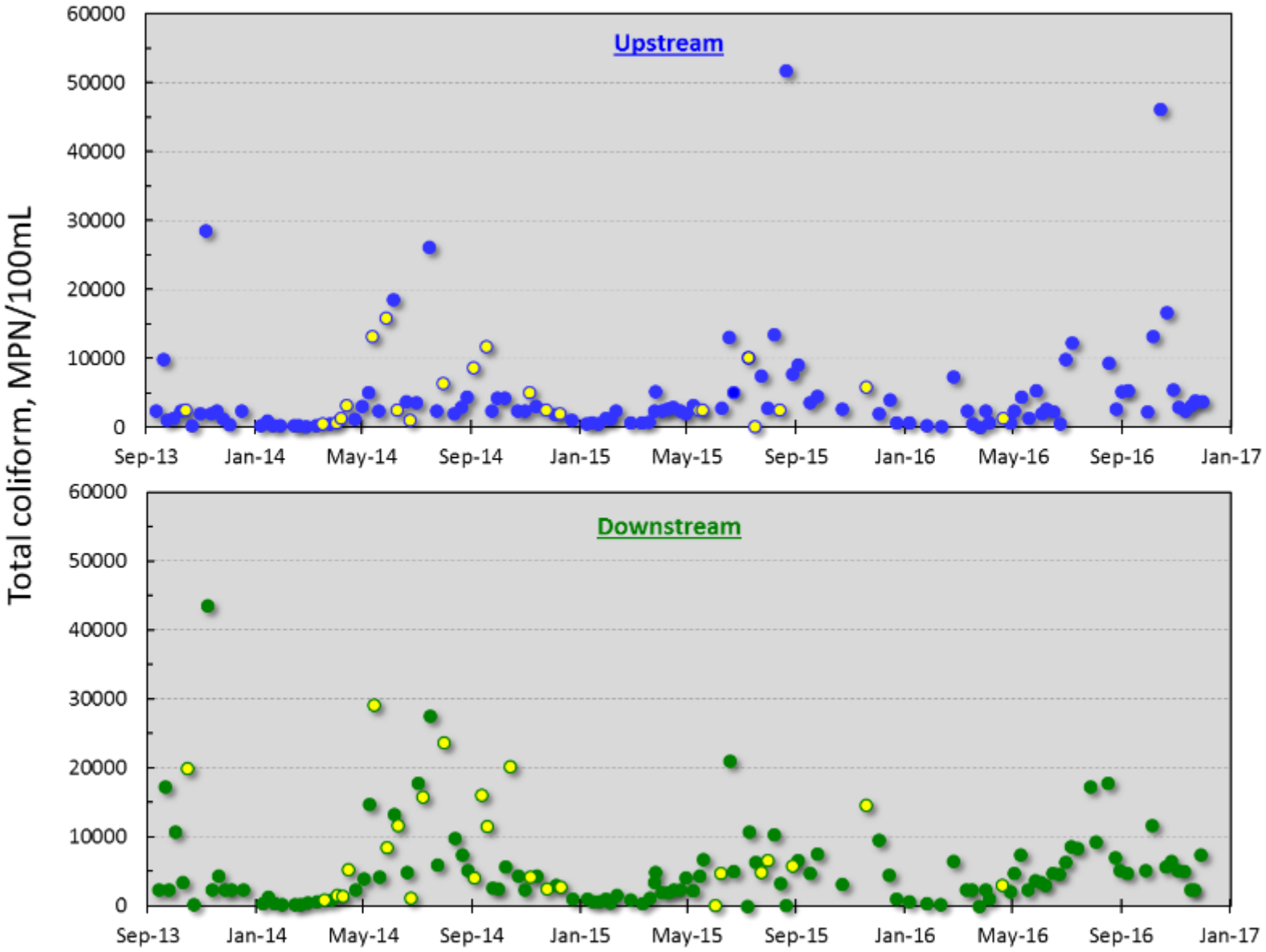


Figure 7. Total coliform numbers at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

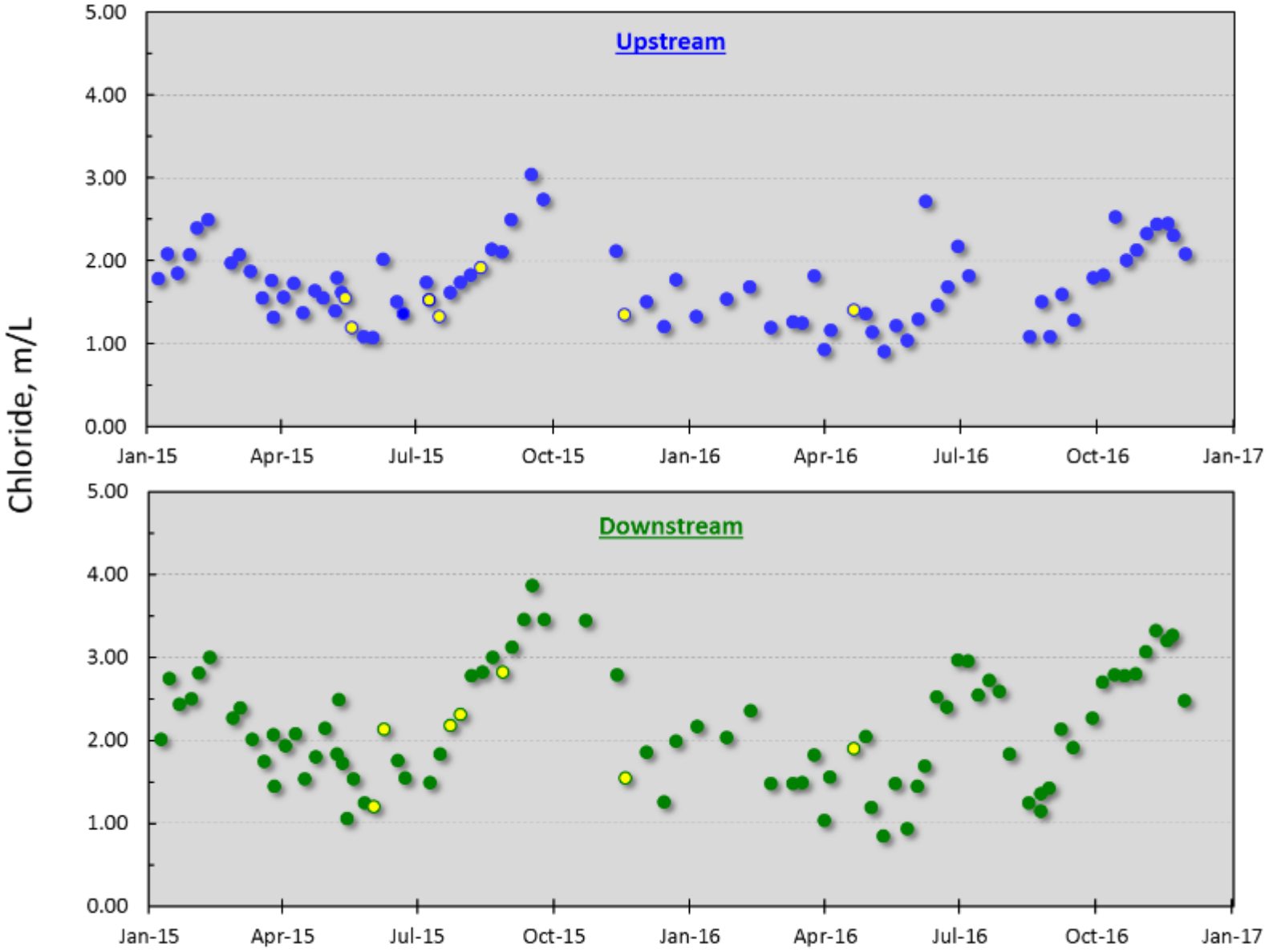


Figure 8. Chloride concentration at the Big Creek monitoring site up- and downstream of the C&H Farm, Newton County, AR.

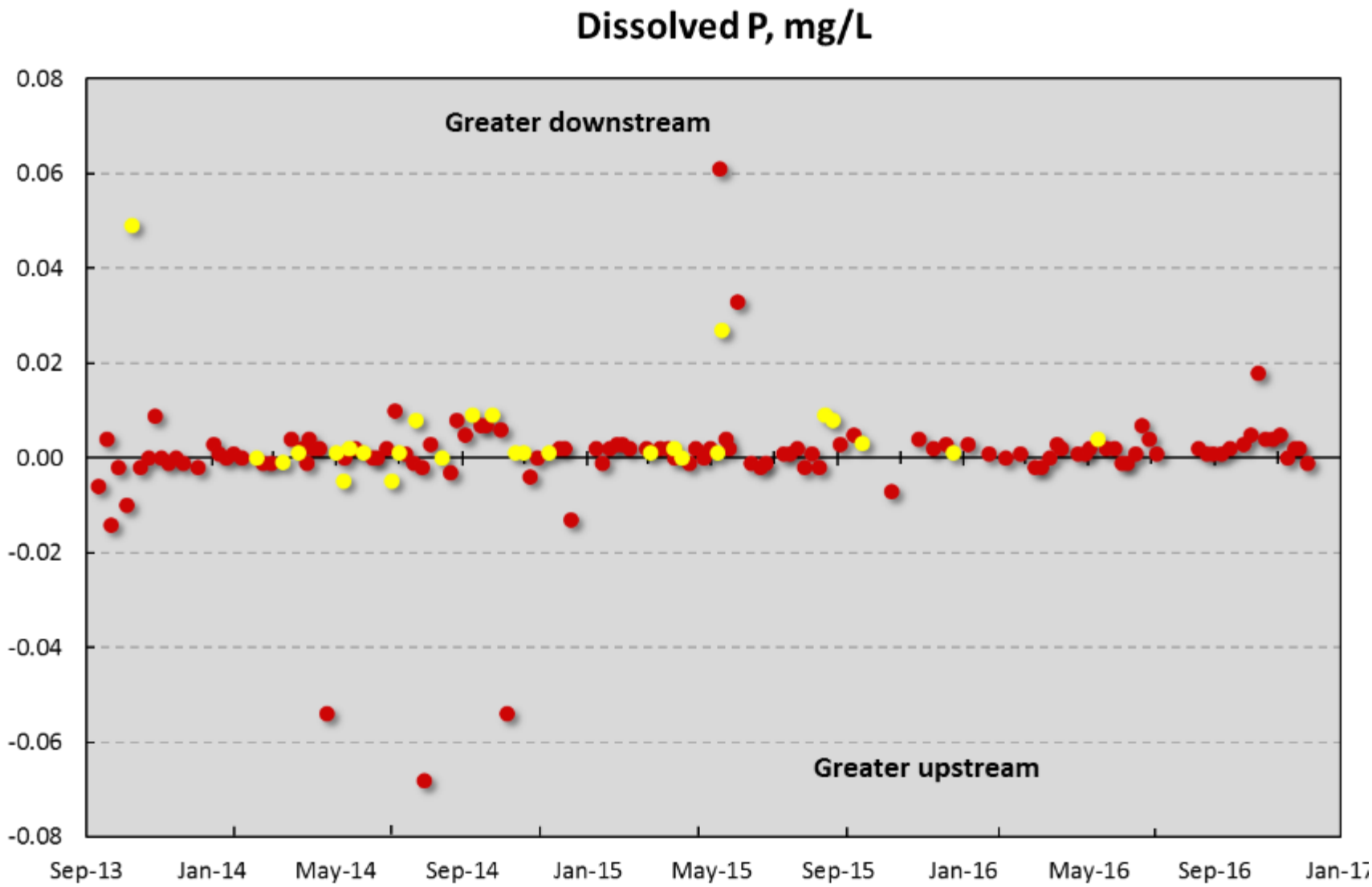


Figure 9. Difference in dissolved P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

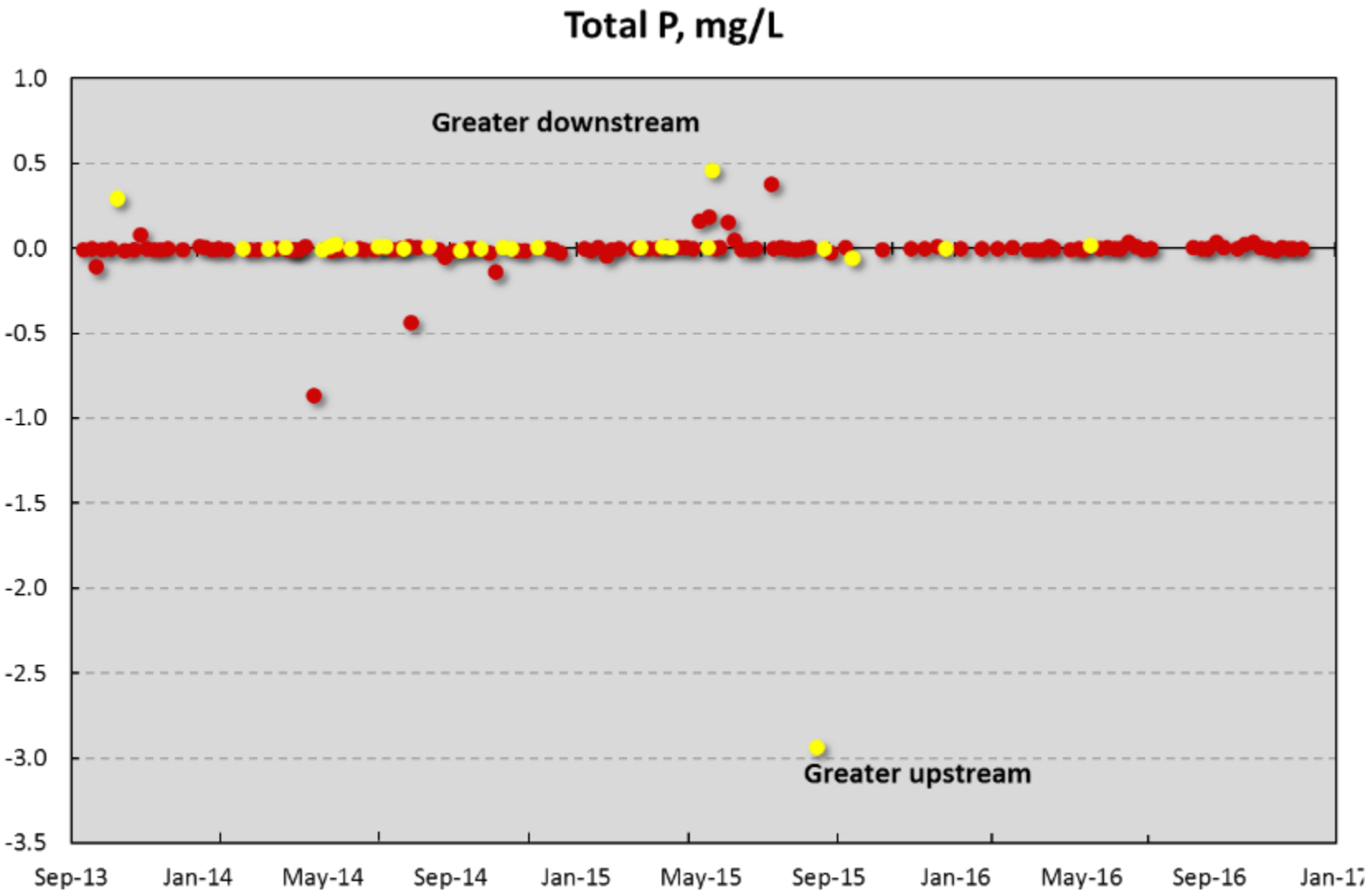


Figure 10. Difference in total P concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

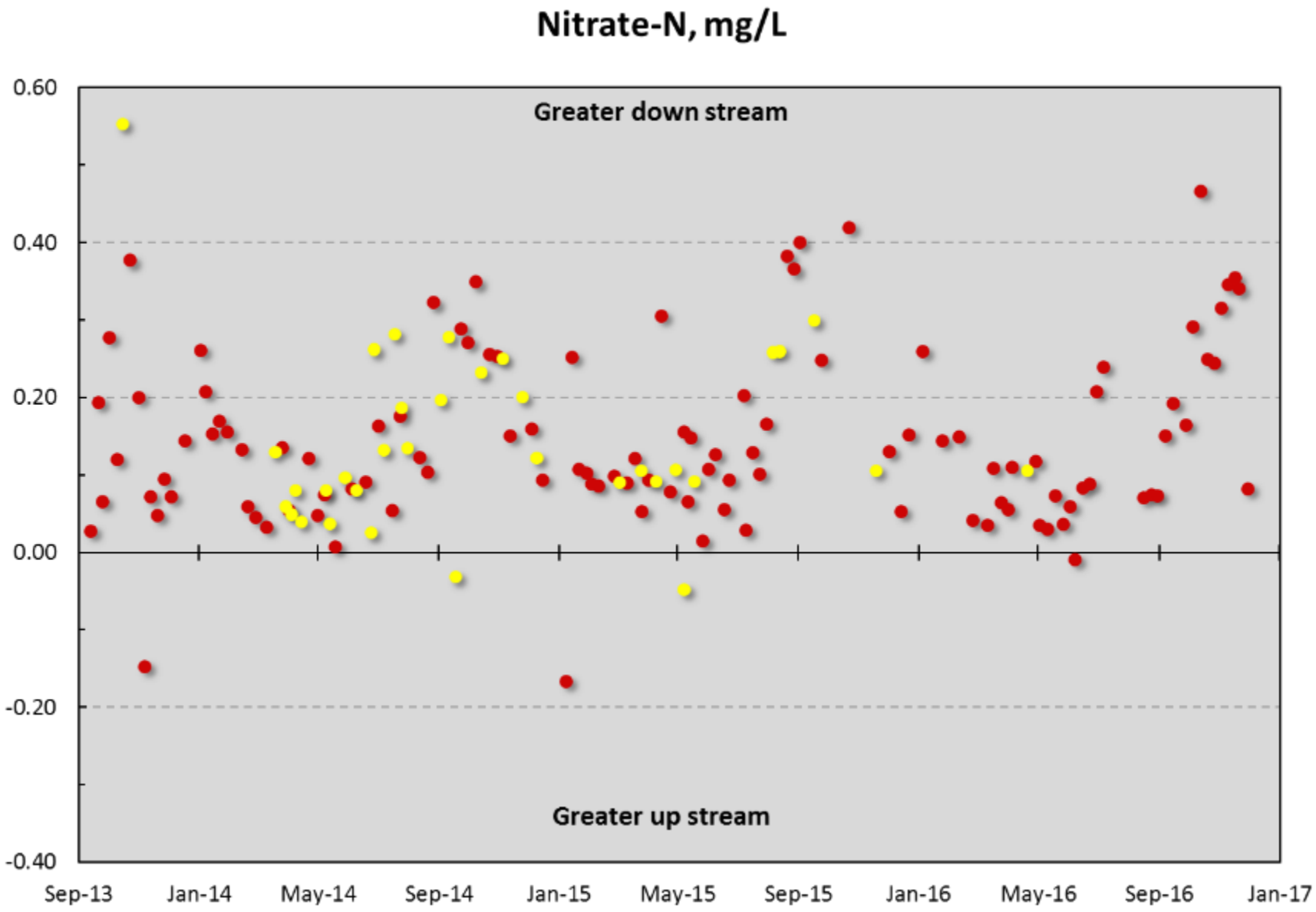


Figure 11. Difference in nitrate-N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

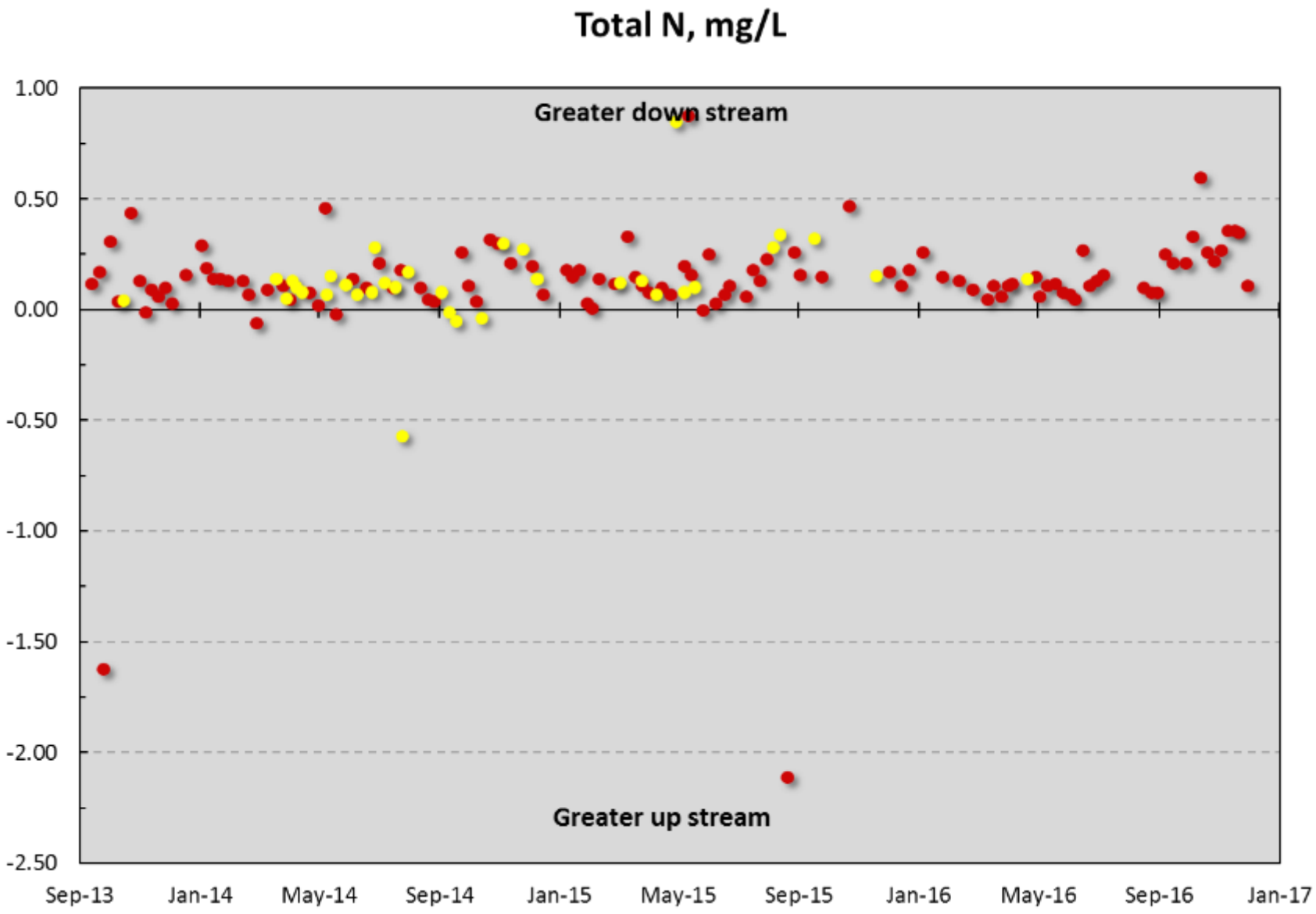


Figure 12. Difference in total N concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

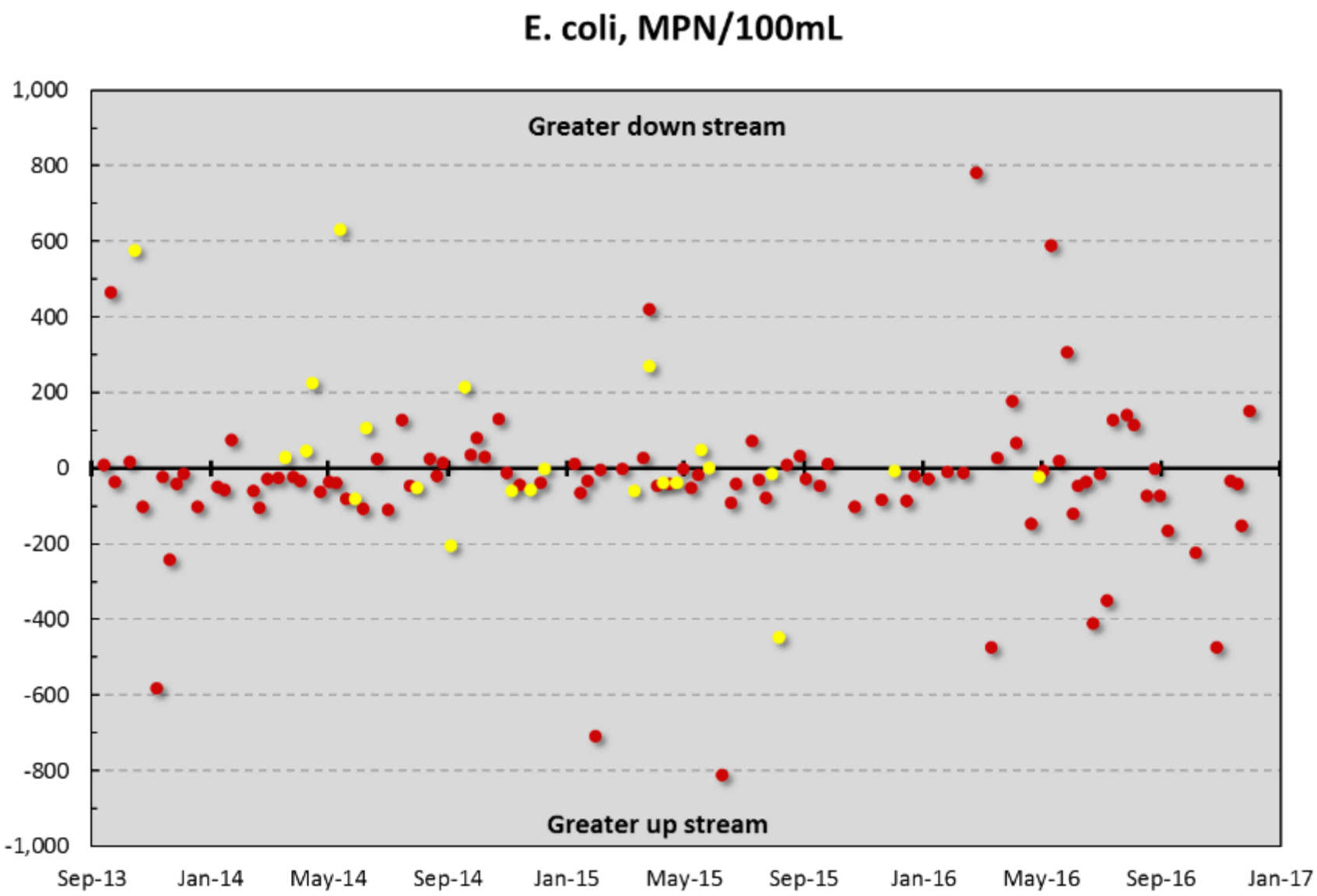


Figure 13. Difference in E. coli numbers in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

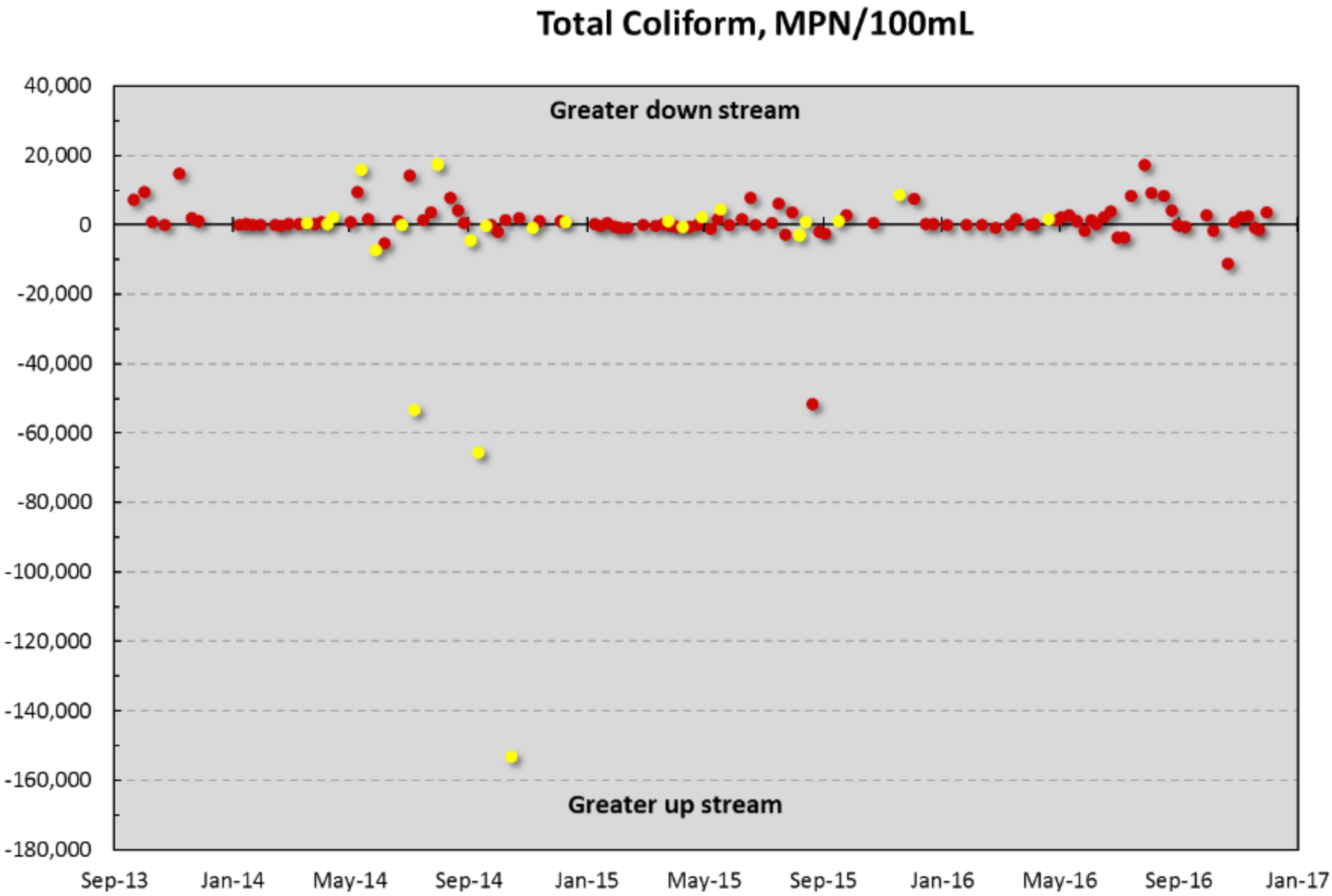


Figure 14. Difference in total coliform numbers in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

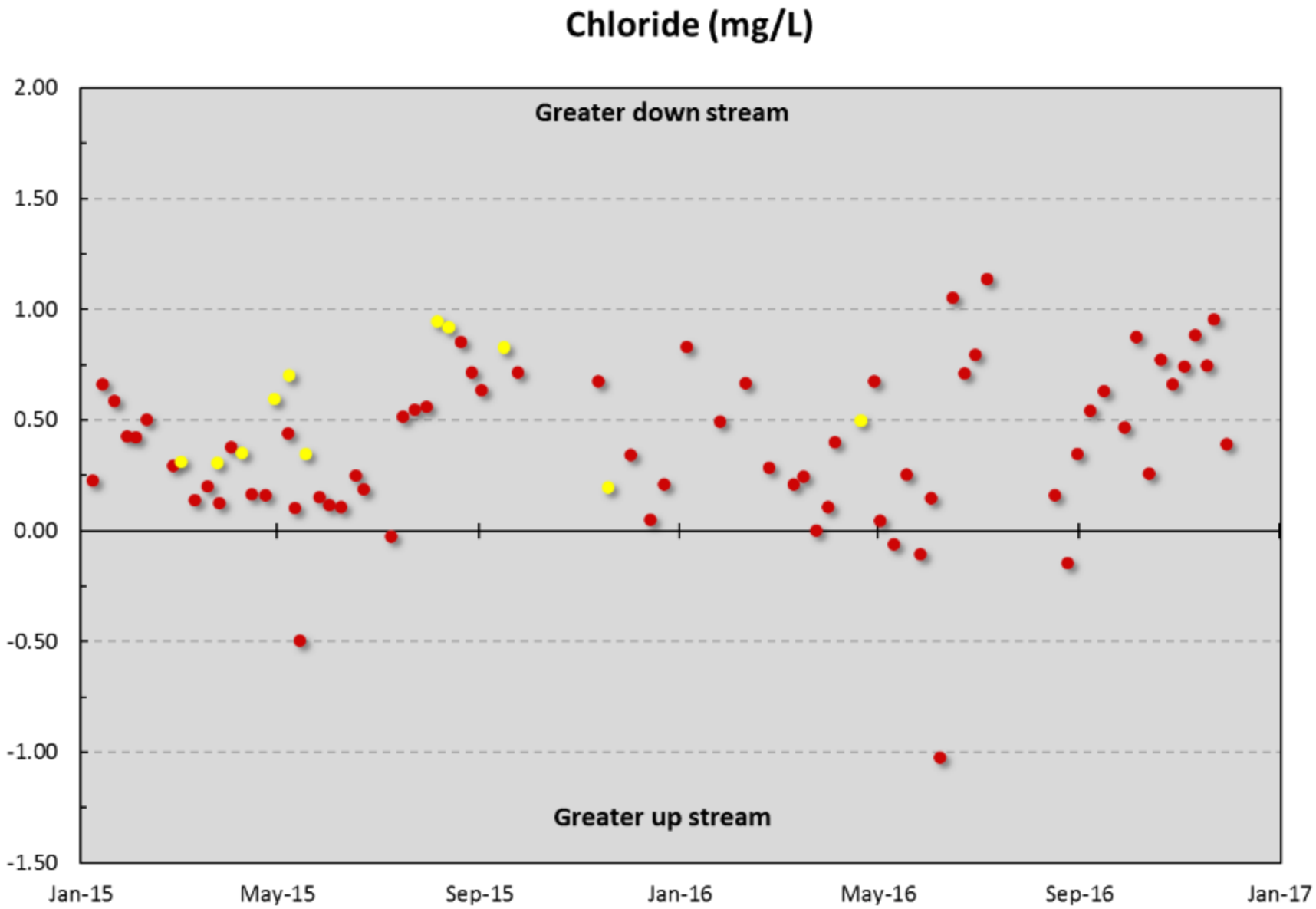


Figure 15. Difference in chloride concentrations in Big Creek up- and downstream of the C&H Farm, Newton County, AR.

Core Sample Analyses

Core samples collected adjacent to the swine slurry holding ponds by Harbor Environmental and Safety were split between Arkansas Analytical, Little Rock, and by the Arkansas Soil Testing and Research Laboratory, Division of Agriculture, University of Arkansas System, Fayetteville, AR. Results of Arkansas Analytical are available at the ADEQ website https://www.adeq.state.ar.us/water/bbri/c-and-h/drilling.aspx#collapseResults. The Soil Testing Laboratory results are presented below. BCRET requested the analyses listed in **Table 1**. **Table 1** also lists methods used and significance of the analyses.

All core samples were dried at 60 ^{o}C and ground to pass through a 2mm sieve. Any material that would not crush (mortar and pestle) to pass the 2mm screen was discarded. All analyses used subsamples from the ground material. Laboratory QA/QC includes among other standard protocols, that with every set of environmental samples digested, a blank, a duplicate, and a North American Proficiency Test Program certified soil sample (http://www.naptprogram.org/) are analyzed and compared. If the check is out of acceptable limits, more than 2.5 times the Mean Absolute Deviation value, the sample is digested again and rerun. The digest and duplicate for this set of core samples all met this analytical criterion.

The shallower core samples at 0.5 and 5 ft below land surface showed sand, silt, and clay contents that varied by less than 20% between the size fractions (**Table 2**). Below 10 feet, core sample data show a dramatic increase in the proportion of clay-sized material; the percent of clay-sized material ranged from 86.9 to 95.1% for the 10, 13.5, and 18.5 foot samples. For the deepest sample collected and analyzed, at 25 feet below surface, clay content was much decreased at 22% with a larger proportion of silt- and sand-sized material (**Table 2**).

Material pH increased with sample depth (**Table 3**), and was greatest in the 25-foot depth sample. The measured pH of 8.72 is consistent with the sample containing limestone with the calcite effectively buffering acidity. Electrical conductivity (inverse of resistivity) of water extracted from the sampled material increased as clay content increased, indicating greater mineral-water interaction with the fine-grained clay. Total N and organic matter content also correlated with clay content (**Table 3**). No consistent trends were observed in the concentration of total dissolved P, nitrate-N plus nitrite-N and ammonium-N with depth of sample collected (**Table 3**). Total C concentration was appreciably greater in the 25-foot sample than the depths above, which likely results from the carbon released from calcium carbonate present in the sample form this depth (note the high Ca concentration of 382,176 mg/L; **Table 4**).

Total elemental analysis revealed the concentrations of P, potassium, magnesium, and sodium were closely related to clay content (R^2 of 0.93, 0.99, 0.97, and 0.83, respectively; **Figure 1**), due to the chemical association of those elements with clay minerals and mineralogy (**Table 4**). Concentrations of zinc, copper, and boron were also closely related to clay content of the core samples (0.89, 0.99, 0.64, respectively; **Figure 1** and **Table 5**). The concentration of calcium was greatest at the 25-foot depth (382,176 mg/kg), where the sample was partly composed of weathered limestone bedrock (**Table 4**).

These values are similar to those reported by Arkansas Analytical on split core samples and reported by Harbor Environmental and Safety on the ADEQ website at (https://www.adeq.state.ar.us/water/bbri/c-and-h/files/ch-farms-drilling-study-report-final-12.1.2016.pdf). Variations in determined analyte concentrations are within inter-laboratory variability and within ranges reported by U.S. Geological Survey as background concentrations (see https://mrdata.usgs.gov/geochemistry/ngs.html and Smith et al., 2013 and 2014) and reported in Table 5-1 of the Harbor report noted above. A comparison of total elemental analyses as determined by Arkansas Analytical and Arkansas Soil Testing and Research Laboratory is presented in **Figures 2 and 3**. Elemental concentrations determined by the two laboratories were statistically similar (at <0.005 probability level) as determined by analysis of variance.

The concentrations of elements extracted by the Mehlich-3 solution, which is used by the majority of State Soil Testing Laboratories in the U.S. to estimate plant-available P and other macro and micro-nutrients, are presented in **Table 5**. Other than the close relationship between clay content of core material and Mehlich-3 extractable potassium and sodium, no consistent trends in concentrations of Mehlich-3 elements were observed with depth of sample (**Table 5**). Notably, Mehlich-3 extractable P (i.e., plant-available P) was appreciably lower than values associated with optimum levels for plant growth (i.e., 30 to 50 mg/kg Mehlich-3 P for cool and warm season grasses, respectively). The Mehlich-3 P concentrations of core samples, which ranged from 0.59 to 4.16 mg/kg are consistent with levels present in pristine or unfertilized, ungrazed soils that have received no external inputs of P (3 - 10 mg/kg Sharpley et al., 2007).

The low levels of Mehlich-3 P in all core samples suggest that the total P concentrations represent P associated with the soil and clay matrix and that no significant input of P-rich swine slurry from the holding ponds in the 0 to 25-foot depth sampled had occurred.

References

Sharpley, A.N., S. Herron, and T.C. Daniel. 2007. Phosphorus-based management challenges and strategies for poultry farming. Journal of Soil and Water Conservation, 62(6):152-153.

Smith, D.B., W.F. Cannon, L.G. Woodruff, F. Solano, J.E. Kilburn, and D.L. Fey. 2013. Geochemical and mineralogical data for soils of the conterminous United States. U.S. Geological Survey Data Series 801. 19 pages. http://pubs.usgs.gov/ds/801/

Smith, D.B., W.F. Cannon, L.G. Woodruff, F. Solano, and K.J. Ellefsen. 2014. Geochemical and mineralogical maps for soils of the conterminous United States. U.S. Geological Survey Open-File Report 2014–1082. 386 pages. http://dx.doi.org/10.3133/ofr20141082.

Table 7. Physical, chemical, and biological analyses conducted by the Soil Testing Laboratory for BCRET. Table

Parameter	Analytical method	Description	Source
Particle size distribution	Hydrometer	Measures amount of sand (2 – 0.05 mm), silt (0.05 – 0.002 mm), and clay (<0.002 mm) sized material in a sample. These size fractions influence material conductivity and chemical reactivity, with clay-sized material being most reactive.	Huluka, G., and Miller, R. 2014. Particle size determination by hydrometer method. *In*: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. p. 180-184. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
pH	Electrode	Determines the sample pH on a 1:2 (volume basis) solid:water slurry, measured by electrode using a Denver Instrument model 220 with an Orion electrode.	Sikora, F.J., and D.E. Kissel. 2014. Soil pH. *In*: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. p. 48-53. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
Electrical conductivity	Electrode	Solid:water 1:2 slurry, measured by electrode on an Oakton 510 series meter.	Wang, J.J., T. Provin, and H. Zhang. 2014. Measurement of soil salinity and sodicity. *In*: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. P.185-193. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
Chloride	Inductively-coupled plasma (ICP)	Solid:water 1:2 extract, Whatman 42 quantitative filter, ICP.	
Total dissolved P / Water extractable manure P		Solid:water 1:10 extract, 0.45 micron filter, ICP.	
Ammonium-N	Colorimetry	Method used for ammonium-nitrogen: 5g soil/15ml 2N KCl, shake for 15 minutes, filtered through Whatman 4 paper; analyzed on a Skalar autoanalyzer using a modified Berthelot reaction. Ammonia is chlorinated to monochloramine which reacts with salicylate to 5-aminosalicylate. After oxidation and oxidative coupling a green complex is formed. The absorption of the formed complex is measured at 660nm.	

Nitrate-N plus Nitrite-N	Colorimetry	Method used for nitrate-nitrogen plus nitrite-nitrogen, same KCl extraction as for ammonium-N, also analyzed on the Skalar using a method based on the cadmium reduction method. The sample is passed through a column containing granulated copper-cadmium to reduce the nitrate to nitrite. The nitrite (originally present plus reduced nitrate) is determined by diazotizing with sulfanilamide and coupling with a-naphthylenediamine dihydrochloride to form a highly colored azo dye which is measured at 540nm.	
Organic matter	Loss on ignition	Loss on ignition is equivalent to organic matter. Gravimetric measure, dried at 120 C for 2 hours to remove water, combusted at 360 C.	Zhang, H., and J.J. Wang. 2014. Loss on ignition method. In: F.J. Sikora and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. p.155-157. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.
Total C and N	Combustion	Total C and N are determined by combustion on an Elementar VarioMax CM.	
Total elemental analysis	Acid digest	Phosphorus, Potassium, Calcium, Magnesium, Sulfur, Sodium, Iron, Manganese, Zinc, Copper, and Boron determined by ICP equipped with cyclonic quartz spray chamber and optimist quartz nebulizer.	EPA 3050b
Mehlich-3 extractable elements	Melich-3 extraction and ICP	Phosphorus, Potassium, Calcium, Magnesium, Sulfur, Sodium, Iron, Manganese, Zinc, Copper, and Boron determined by ICP equipped with cyclonic quartz spray chamber and optimist quartz nebulizer.	Zhang, H., D.H. Hardy, R. Mylavarapu, and J.J. Wang. 2014. Mehlich-3. *In*: Sikora, F.J. and K.P. Moore, editors, Soil test methods from the southeastern United States. Southern Coop. Ser. Bull. 419. Clemson Univ., Clemson, S.C. p. 101-110. Available at http://www.clemson.edu/sera6/MethodsManualFinalSERA6.pdf.

Table 8. Particle-size distribution of the core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	Particle-size distribution †		
		Sand	Silt	Clay
	feet	---------- % ----------		
B-1S-1	0.5	24.2	33.1	42.7
B-1S-2	5	28.3	41.9	29.9
B-1S-3	10	5.1	8.1	86.9
B-1S-4	13.5	2.2	2.8	95.1
B-1S-5	18.5	8.9	1.5	89.7
B-1S-6	25	37.6	40.2	22.2

Table 9. Physio-chemical properties of the core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	pH	Electrical conductivity	Total dissolved P †	Chloride	Nitrate-N plus Nitrite-N	Ammonium-N	Total N	Total C	Organic matter
	feet		µmhos/cm	---------- mg/kg ----------				---------- % ----------		
B-1S-1	0.5	4.71	89	2.12	3.8	16.3	5.8	0.023	0.15	1.52
B-1S-2	5	5.2	62	1.97	3.8	7.2	7.4	0.023	0.20	1.34
B-1S-3	10	7.85	571	2.16	72.6	1.2	3.8	0.047	1.84	2.53
B-1S-4	13.5	7.71	458	3.08	93	0.7	6	0.070	0.20	2.84
B-1S-5	18.5	7.88	770	2.17	251.4	Not enough sample		0.061	0.43	2.25
B-1S-6	25	8.72	183	2.15	99.8	0.3	2.1	0.000	10.13	0.29
B-1S-1 duplicate	0.5	N.A. ‡	N.A.	N.A.	N.A.	17.0	5.5	0.028	0.16	1.92

† Equivalent to Water extractable manure P determined for inclusion in the Arkansas Phosphorus Index nutrient management planning and risk assessment tool. See Sharpley, A.N., P. Moore, K. VanDevender, M. Daniels, W. Delp, B. Haggard, T. Daniel, and A. Baber. 2010. Arkansas Phosphorus Index. Cooperative Extension Service, Division of Agriculture, University of Arkansas. Fact Sheet FSA 9531. 8 pages. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-9531.pdf and Sharpley, A.N., M. Daniels, K. VanDevender, B. Haggard, N. Slaton, and C. West, C. 2010. Using the 2010 Arkansas Phosphorus Index. Cooperative Extension Service, Division of Agriculture, University of Arkansas. Miscellaneous Publication MP487. 17 pages. http://www.uaex.edu/Other_Areas/publications/PDF/MP487.pdf

‡ Not analyzed.

Table 10. Total elemental composition of core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	Total elemental analysis										
		Phosphorus	Potassium	Calcium	Magnesium	Sulfur	Sodium	Iron	Manganese	Zinc	Copper	Boron
	feet	mg/kg										
B-1S-1	0.5	281	1,101	1,262	1,024	62.8	19	49,571	364	33	7.4	12.5
B-1S-2	5	220	879	805	847	53.9	1	31,119	1,745	30	6.2	8.9
B-1S-3	10	1,031	3,488	69,480	3,417	7.2	296	51,696	1,169	273	23.6	12.9
B-1S-4	13.5	929	4,030	7,468	3,844	5.2	308	60,251	1,366	334	26.4	14.2
B-1S-5	18.5	747	3,434	14,752	3,516	0.5	369	50,122	1,620	184	24.6	13.9
B-1S-6	25	56	112	382,176	895	<0.1	105	1,764	227	8	0.5	1.0
B-1S-1 duplicate	0.5	275	1,174	1,228	1,072	67.9	21	45,645	392	36	7.9	12.2

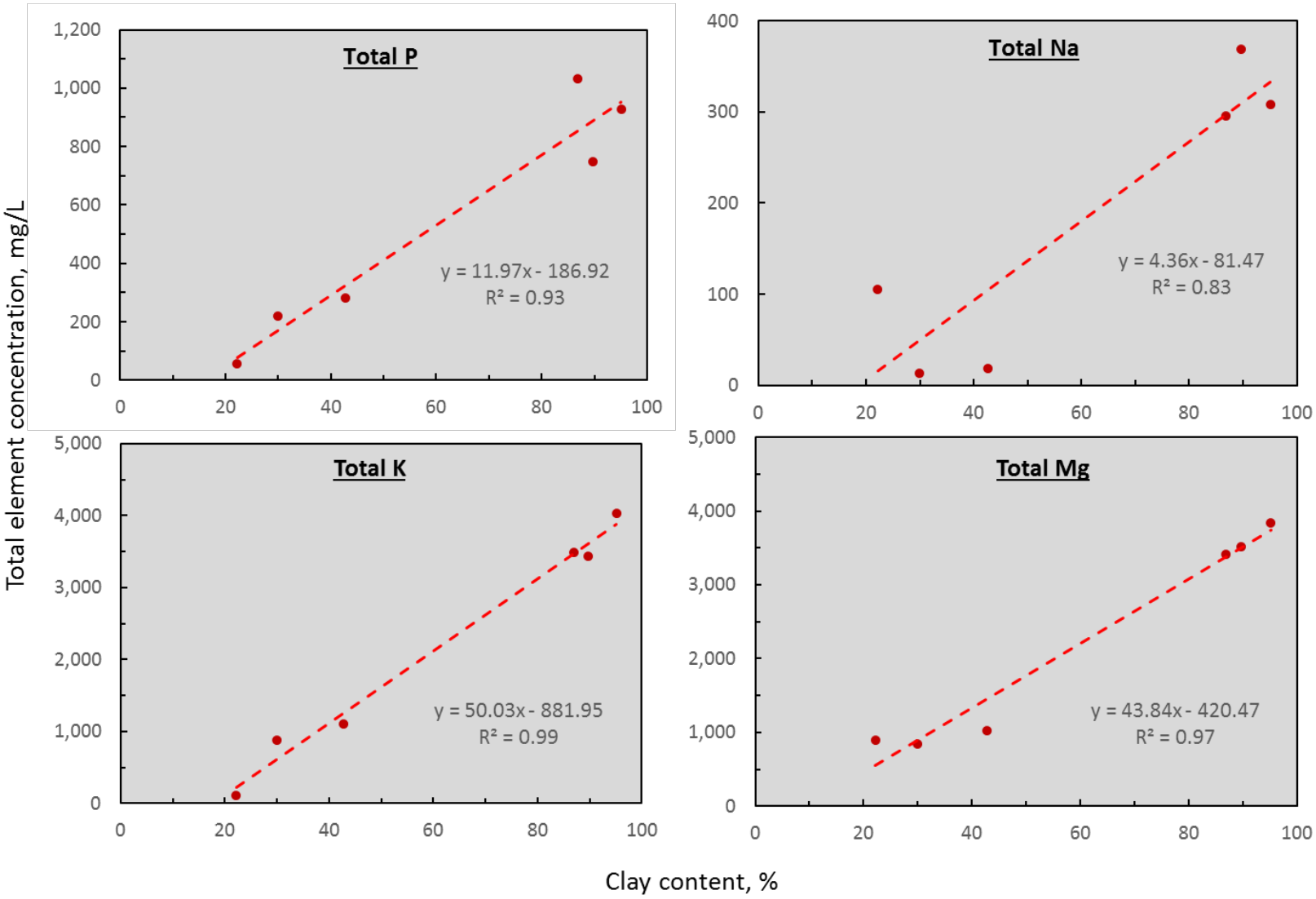


Figure 16. Relationship between total P, Na, K, and Mg concentration and clay content of core samples from the C&H Farm.

Table 11. Mehlich-3 extractable elemental composition of core samples taken from the bore hole drilling at C&H Farm, as determined by the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory, Fayetteville, AR.

Sample ID	Depth	Mehlich-3 extractable elements										
		Phosphorus	Potassium	Calcium	Magnesium	Sulfur	Sodium	Iron	Manganese	Zinc	Copper	Boron
	feet	mg/kg										
B-1S-1	0.5	0.75	87	1390	149	46	7.0	55.4	32.5	0.41	0.30	<0.01
B-1S-2	5	1.09	97	873	112	37.9	7.5	91.9	295.2	0.35	0.35	<0.01
B-1S-3	10	4.16	287	18133	704	3.8	233.4	35.6	39.6	9.95	0.60	<0.01
B-1S-4	13.5	0.84	314	7036	708	1.5	234.9	44.9	44.7	16.2	0.80	<0.01
B-1S-5	18.5	6.07	280	12742	594	3.1	280.2	49.0	81.4	6.66	0.92	<0.01
B-1S-6	25	0.59	14	34332	97	4.0	32.4	9.4	21.8	0.59	0.07	<0.01

Table 12. Relationship between cation exchange capacity, total elemental analysis and clay content of core samples collected from the C&H Farm. Number of samples is 6. Regression equation is Element = Intercept + Slope x Percent Clay.

Element	Intercept	Slope	R^2	Probability
CEC	7.63	-110.3	0.76*	0.0227
Total P	-186.92	11.97	0.93*	0.0017
Total Mg	-420.74	43.84	0.91*	0.0003
Total K	-881.95	50.03	0.99*	<0.0001
Total Na	-81.47	4.36	0.83*	0.0111
Total Zn	-100.25	3.99	0.89*	0.0050
Total Cu	-6.03	0.34	0.99	<0.0001
Total S	91.30	-0.95	0.92*	0.0095
Total Fe	8,694.11	524.85	0.66*	0.0493
Total B	3.10	0.12	0.64	0.0566
Total Ca	218,357.81	-2,276.14	0.25	0.3129
Total Mn	488.61	9.71	0.25	0.3128

* Significance determined by paired *t* test.

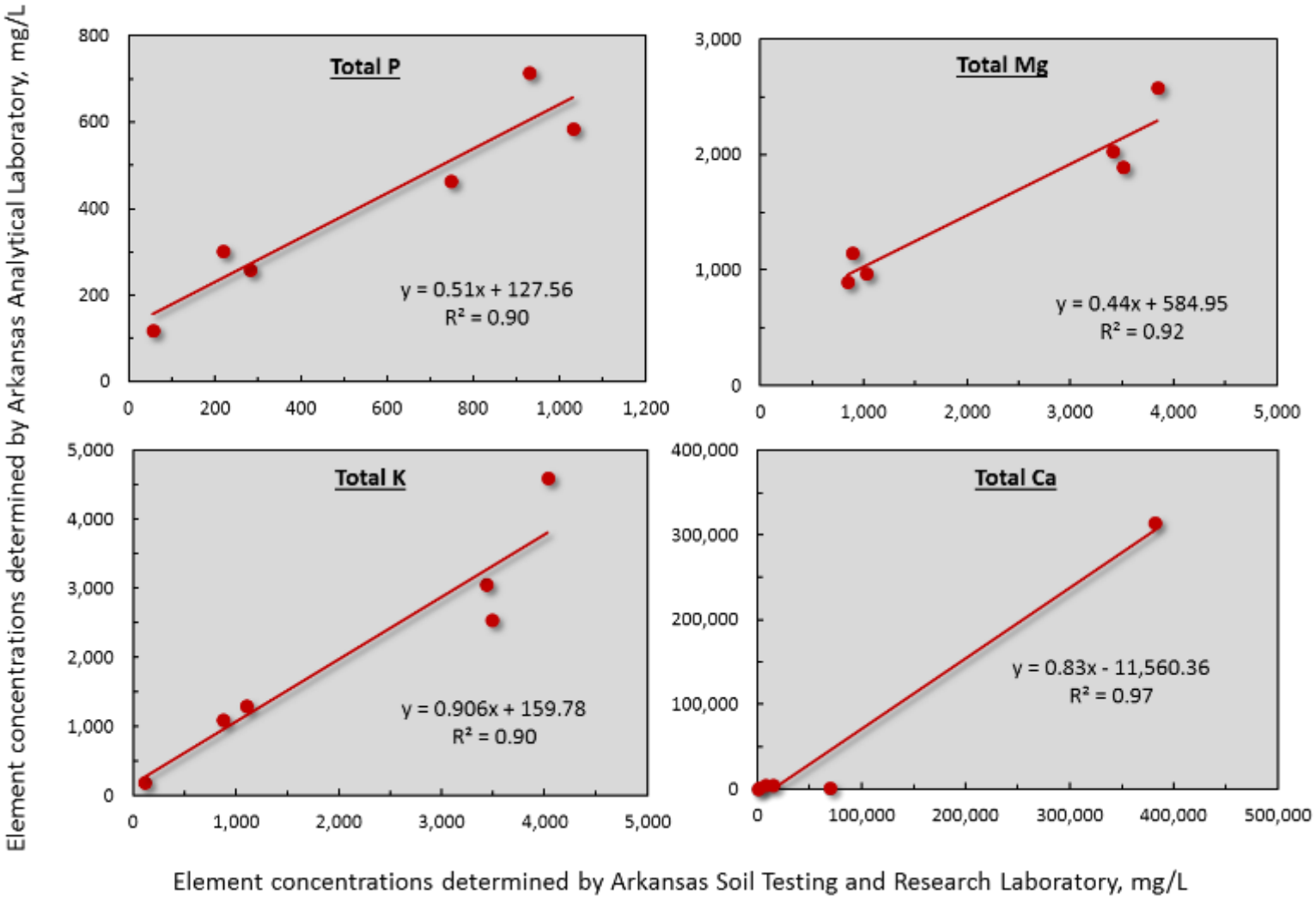


Figure 17. Relationship between total P, Mg, K, and Ca analysis conducted by Arkansas Analytical and the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory of core samples from the C&H Farm.

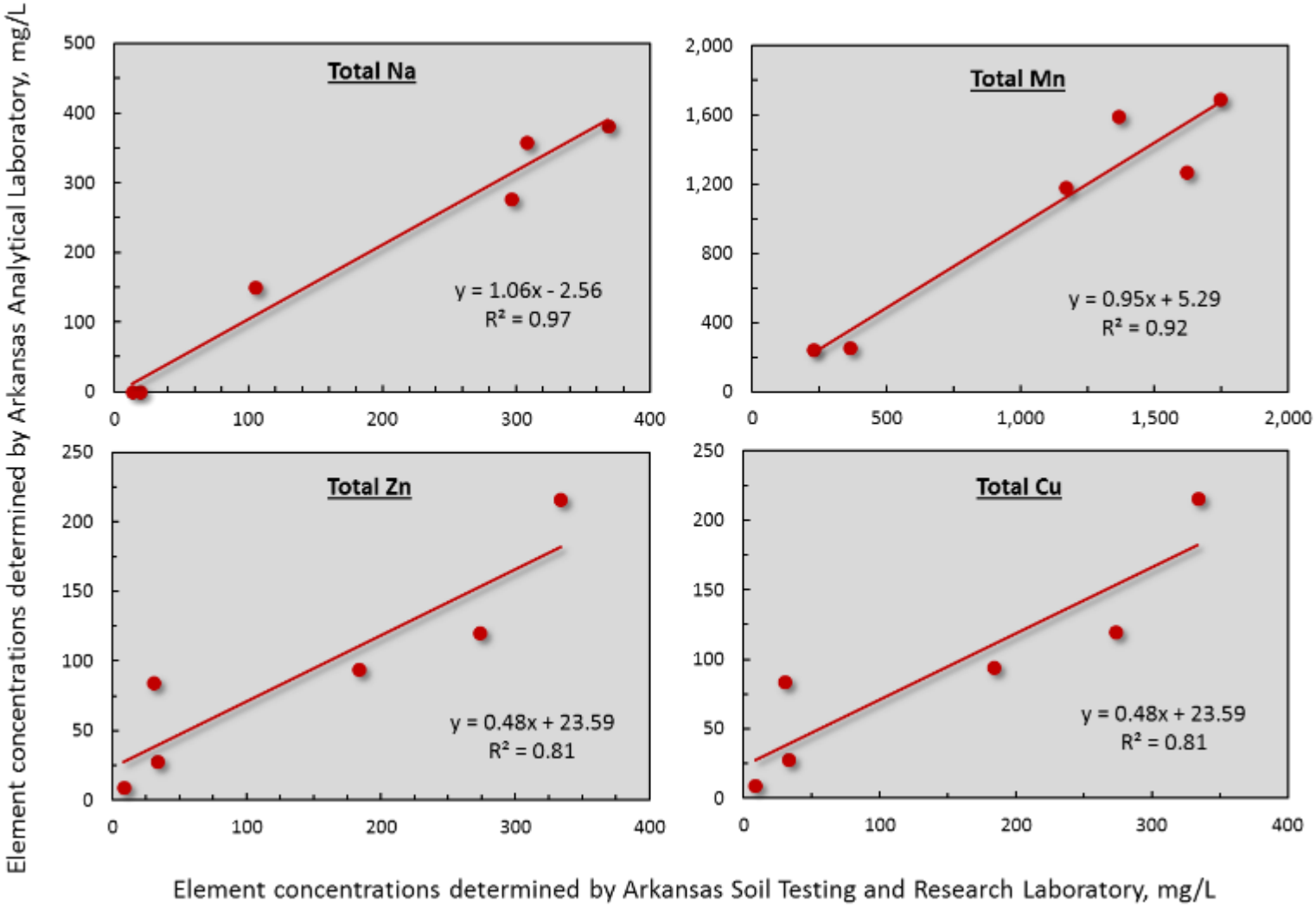


Figure 18. Relationship between total P, Mg, K, and Ca analysis conducted by Arkansas Analytical and the Division of Agriculture University of Arkansas System Soil Testing and Research Laboratory of core samples from the C&H Farm.

Grid-Soil Sampling

BCRET conducted grid-soil sampling of Fields 1, 5a, and 12 in February 2016. A grid network of approximately 0.25 acres was overlain on each field to determine the point of sampling, which were recorded with GPS. Each sample-hole remaining after the soil core was removed was carefully back-filled with commercial top soil. Where rock stopped the core penetrating below a specific layer, no sample was collected beyond that point. This February 2016 sampling is a repeat of the 2014 sampling and was conducted within a 5-foot radius of the original geo-referenced point in order to document any changes in soil composition with time and land management. The results of the 2016 sampling are presented in **Tables 1 to 6**. Unlike the 2014 grid sampling, samples were only collected from the 0 – 4 and 4 – 8 inch depths in February.

The spatial distribution of Mehlich-3 extractable soil P (Mehlich-3 P) only across Fields 1, 5a, and 12 are depicted in **Figures 1 to 3**, for both the 0 – 4 inch and 4 – 8 inch depths. Individual values of the points are noted on the figures. The ranges in Mehlich-3 P concentrations depicted are <25, 25 to 50, 50 – 100, and >100 mg/L, which depict general soil fertility and plant response categories of deficiency levels, optimum levels for cool season grasses, little response to additional P expected for cool and warm season grasses, and no plant growth response expected to added P, respectively.

It is evident from the Mehlich-3 P spatial distribution maps that some accumulation of P occurs in some areas within the surface 0 – 4 inch depth of Fields 1 and 12 (**Figures 1 and 3)**. These areas are generally located around areas of shade on Fields 1 and 12 (northern boundary of this field), where grazing cattle congregate to avoid the sun. On Field 12, the area of Mehlich-3 P greater than 100 mg/kg occurs on the southwest corner of the field and is located at the gated entrance to the field, where cattle are routinely fed hay. Further, individual points with elevated P levels on these fields may be due to cow pats that may no longer be visible at the surface. It should be noted that the accumulation of Mehlich-3 P in the southwest corner of Field 12 also was evident in the 2014 grid soil sampling (**Figure 4**), which was completed January 31, 2014 and that the first application of swine slurry to Field 12 did not occur until April 22, 2014. Thus, in-field spatial variations in Mehlcih-3 P for Field 12 are likely a function of land use and management prior to any swine slurry application. Amounts of swine slurry applied to the permitted fields at the end of December 2013, 2014, and 2015 are presented in **Table 7**.

Data from the 2014 grid-soil sampling are reported in BCRET Quarterly Reports provided for the fourth quarter of 2013 for Field 1 (see http://www.bigcreekresearch.org/project_reports/docs/CH%20Quarterly%20Report%20Oct%20-%20Dec%202013%20Sharpley.pdf), in the second quarter of 2015 for 5a (see http://www.bigcreekresearch.org/project_reports/docs/Quarterly%20Report%20April%20-%20June%202015.pdf), and in first quarter of 2014 for Field 12 (see http://www.bigcreekresearch.org/project_reports/docs/Quarterly%20Report%20Jan%20-%20March%202014.pdf).

Median grid-soil sample concentrations for 0 – 4 inch soil samples collected from Fields 1, 5a, and 12 in 2014 and 2016 are presented in **Table 8**. For Mehlich-3 P, median values for Fields 1 and 5a decreased

slightly from 2014 (59 and 71 mg/L, respectively) to 2016 (57 and 47 mg/L, respectively). For Field 12, however, Mehlich-3 P increased from 50 mg/L in 2014 to 79 mg/L in 2016 (**Table 8**). Differences among all other analytes were not statistically significant at the p <0.05 level (still to verify).

Results of the grid-soil sampling in 2014 and 2016 for Mehlich-3 P are graphically presented in **Figure 4** to more easily compare values. Finally, the difference between 2014 and 2016 grid-soil sampling Mehlich-3 P values for 0 – 4 and 4 – 8 inch samples are given in **Figures 5, 6, and 7**. Too few 4 – 8 inch soil samples were collected on Field 1 to meaningfully represent this field.

We have informed the land owner, who is looking at alternative areas to feed cattle on Field 12, and the owners of C&H Farms have agreed to not spread slurry on this area of the field in order to not contribute to any further increase in surface soil Mehlich-3 P levels. While these areas are not adjacent to the Big Creek river channel, which minimizes the potential for this P to reach the river, management changes are in place to address the accumulation.

Table 13. Soil analyses of 0 to 4 inch samples collected from Field 1, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77294	7.2	49	17	189	9104	111	15	12	38	180	1.8	3.6	1
77296	7.5	49	29	117	9064	107	17	6	26	31	1.7	5.4	0.3
77298	6.8	18	123	176	2895	105	12	12	199	105	1.7	4.8	0.6
77300	7.4	39	32	163	7008	118	15	13	69	178	2	5.1	0.7
77302	6.7	31	65	241	5045	205	16	17	77	224	2.4	9.9	1
77304	6.9	18	77	202	2813	141	14	15	121	182	1.8	6.1	0.5
77307	6.4	16	121	274	2031	183	12	15	147	137	1.6	9.8	0.6
77309	6.7	12	44	241	1552	99	15	12	109	254	1.6	3.9	0.4
77311	6.8	14	89	350	1988	129	14	14	117	172	1.5	6.7	0.5
77313	6.1	15	74	238	2028	129	16	19	145	184	1.6	7.7	0.6
77315	6.1	13	63	245	1602	115	11	17	127	259	1.4	5.3	0.6
77318	6.0	12	45	192	1360	101	14	17	124	277	1.4	4.4	0.4
77320	5.8	13	54	185	1334	142	17	17	106	356	1.4	6.7	0.4
77322	5.3	15	72	590	1311	151	16	21	140	285	1.5	9	0.5
77324	5.2	9	43	77	494	53	7	11	195	66	1	2	0.2
77326	5.7	9	21	60	896	60	10	8	117	25	0.8	1.4	0.2
77328	5.2	10	45	106	776	72	13	12	166	58	1	2.5	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77331	5.2	11	59	151	828	81	13	14	205	90	0.9	3.3	0.4
77333	6.0	12	55	207	1395	93	12	14	147	80	1	4.2	0.6
77335	5.6	10	70	212	870	105	14	13	149	138	1.1	5.2	0.5
77337	6.1	14	85	279	1646	157	12	15	152	169	1.3	7.4	0.6
77339	5.8	18	96	351	2035	178	14	22	160	146	1.3	9.3	0.7
77342	5.5	9	31	176	724	77	11	10	108	148	1.2	2.5	0.4
77343	6.0	12	93	224	1255	148	11	16	137	269	1.7	7	0.5
77345	5.8	12	83	223	1148	96	12	10	143	190	1.5	4.5	0.5
77346	5.7	16	274	165	1927	146	16	20	250	101	12.3	28.6	0.7
77348	6.0	8	31	173	715	76	11	10	109	147	1.2	2.6	0.4
77350	6.4	9	77	206	1037	88	11	8	135	186	1.4	3.9	0.4
77355	6.3	16	130	413	2061	176	10	16	115	273	1.9	9.7	0.6
77357	5.8	16	87	418	1736	202	12	18	131	170	1.6	8.2	0.6
77359	6.3	14	56	154	1769	108	12	13	98	198	1.4	6.2	0.5
77361	5.5	11	109	177	986	177	12	14	149	155	1.5	10.2	0.5
77363	6.2	9	33	104	1075	91	9	8	90	226	1.1	5	0.5
77366	5.1	10	38	123	695	91	8	12	103	65	0.9	3.1	0.3
77368	6.9	13	49	161	1924	81	12	14	104	234	1.4	4.1	0.7
77370	5.1	10	28	98	748	77	16	14	102	390	1.1	2.8	0.4

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77372	5.6	12	115	348	1064	181	11	23	132	297	1.5	7	0.6
77374	6.0	15	126	334	1904	155	17	22	115	340	1.6	9.6	0.7
77376	5.6	14	90	283	1461	159	18	23	153	304	1.6	8.3	0.6
77379	5.4	21	66	378	2463	228	21	24	104	136	1.5	8.1	0.6
77381	5.7	17	103	382	1799	183	19	19	167	113	1.7	8.2	0.7
77383	5.4	14	67	124	1293	178	14	17	110	228	1.5	7.8	0.6
77385	6.0	14	16	85	1960	68	12	13	84	247	1.2	2.5	0.6
77387	5.4	12	51	110	1140	67	11	14	101	168	0.9	3.1	0.4
77390	6.3	22	19	65	3467	59	12	12	75	164	0.9	2.7	0.4
77392	5.0	9	44	69	568	40	14	16	143	75	0.8	2	0.3
77394	5.3	10	29	69	975	82	17	17	115	372	1.2	2.8	0.5
77396	5.4	9	33	60	739	56	13	17	121	374	1.2	3.2	0.4
77398	5.3	12	49	173	1124	78	16	19	105	383	1.2	2.7	0.5
77400	5.8	13	58	318	1361	133	23	19	120	442	1.5	5.8	0.7
77403	6.3	16	74	224	2235	126	16	18	103	295	1.5	6.5	0.7
77405	6.0	24	84	409	3299	226	19	18	80	215	1.4	6	0.7
77407	6.2	13	40	239	1643	108	15	16	128	201	1.1	4.1	0.6
77409	5.5	12	31	119	1102	86	18	14	155	193	0.9	3.2	0.4
77411	5.8	16	19	101	1956	83	17	15	87	364	1	3.3	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77414	4.9	10	36	43	656	34	12	11	115	70	0.5	1.4	0.3
77416	5.6	9	27	40	1005	37	14	14	118	215	0.8	2.1	0.4
77418	4.9	10	20	54	649	65	14	14	108	131	0.6	1.5	0.3
77420	5.8	10	17	148	900	90	16	12	104	283	0.8	1.8	0.4
77422	5.7	13	40	120	1555	93	14	18	106	290	1.2	3.6	0.4
77424	6.1	18	25	146	2516	123	17	16	69	280	1.8	4.5	0.6
77427	5.8	15	26	113	1832	97	13	18	77	222	0.9	2.2	0.3
77429	5.9	12	26	69	1478	65	15	17	103	232	1	3.3	0.3
77431	5.3	10	24	38	950	47	18	17	132	277	0.8	2.5	0.2
77433	6.0	16	22	93	2273	54	14	17	74	234	0.9	2.6	0.4
77435	4.9	9	25	43	528	47	12	13	115	94	0.6	1.5	0.2
77438	4.9	10	25	42	590	56	11	15	115	225	0.8	2	0.3
77440	5.6	12	55	142	1206	123	11	20	109	191	1	3.3	0.4
77442	5.5	14	27	71	1490	85	12	19	86	349	1.5	3.1	0.3
77444	6.5	26	22	181	4371	115	11	18	49	224	1.3	2.6	0.5
77446	5.4	14	28	81	1547	98	10	19	90	291	1.2	4.2	0.3
Mean	5.86	15	57	183	1845	110	14	15	118	209	1.44	5.09	0.49
Median	5.80	13	47	164	1428	99	14	16	115	208	1.30	4.15	0.50
Minimum	4.80	8	16	38	494	34	7	6	26	25	0.50	1.40	0.20

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
Maximum	7.50	49	274	590	9104	228	23	24	250	442	12.30	28.60	1.00
Standard deviation	0.59	8	40	113	1635	47	3	4	37	95	1.36	3.77	0.17
Coefficient of variation, %	10.2	52.5	70.7	61.8	88.6	43.0	21.7	24.6	31.4	45.1	94.7	74.2	34.3

Table 14. Soil analyses of 4 to 8 inch samples collected from Field 1, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77295	7.1	47	11	151	8836	94	27	12	40	130	1.8	4.9	0.7
77297	7.9	48	29	77	9031	84	13	5	22	26	1.4	4.5	0.2
77299	6.8	13	118	136	1911	88	13	11	165	108	1.6	3.8	0.4
77301	7.7	38	18	126	7061	84	20	10	58	216	1.9	4.2	0.6
77303	7.0	34	53	174	5890	192	18	15	69	273	2.4	8.7	1.0
77306	7.1	18	36	133	2893	97	14	11	86	153	1.3	2.9	0.4
77308	6.1	14	83	220	1738	124	24	15	115	120	1.9	5.5	0.4
77310	6.4	9	25	243	1056	84	14	10	114	312	1.3	2.4	0.3
77312	6.6	11	52	278	1431	108	17	13	122	225	1.3	3.7	0.4
77314	6.1	13	54	143	1623	93	12	12	126	166	1.3	5.2	0.5
77316	6.3	10	42	187	1146	78	15	11	112	247	1.2	3.4	0.4
77319	6.3	10	26	115	1236	82	14	11	111	272	1.2	2.7	0.3
77321	6.0	12	17	83	1454	67	18	10	86	364	1.1	3.4	0.3
77323	5.8	11	36	324	1043	88	15	12	111	226	1.2	5.2	0.4
77325	6.5	5	12	51	319	31	10	8	182	37	1.0	1.2	0.2
77327	5.1	9	5	43	596	36	10	8	60	6	0.7	0.6	0.1
77330	5.3	8	24	75	510	45	9	11	132	41	0.9	1.5	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77332	5.0	9	43	112	547	54	11	12	193	80	0.9	2.5	0.4
77334	6.1	9	37	163	1008	70	11	10	123	60	0.9	2.5	0.4
77336	5.7	8	29	128	640	57	12	9	114	118	0.9	2.1	0.3
77338	6.0	10	44	158	1130	103	14	11	114	171	1.1	4.1	0.4
77340	6.0	9	49	193	907	89	9	9	144	107	0.9	3.4	0.5
77344	6.3	7	28	162	750	72	12	8	100	250	1.3	2.5	0.4
77347	5.7	19	27	113	2538	116	10	13	118	298	1.6	3.7	0.7
77349	6.0	8	28	178	806	75	10	8	102	261	1.3	2.6	0.4
77354	6.1	14	119	251	1767	136	12	16	172	207	1.7	8.3	0.6
77356	6.4	13	69	291	1564	128	11	11	95	323	1.6	4.5	0.5
77358	6.0	14	38	279	1763	151	14	15	95	196	1.4	4.5	0.5
77360	6.2	9	24	66	1053	67	15	9	80	163	1.5	3.3	0.3
77362	5.6	7	55	129	497	72	10	8	107	86	1.0	2.9	0.3
77364	6.4	8	22	79	1048	60	11	7	99	221	1.0	3.6	0.5
77367	5.3	7	18	92	412	39	9	7	83	25	0.8	1.0	0.3
77369	6.5	9	21	96	1183	49	12	9	99	228	1.1	2.0	0.4
77371	5.6	7	8	35	554	46	14	8	93	360	1.0	1.4	0.3
77373	6.1	9	51	245	819	123	12	10	101	300	1.2	2.6	0.5
77375	6.3	9	40	147	1056	70	10	8	94	344	1.2	2.7	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77378	5.7	13	26	148	1469	132	21	13	117	362	1.6	6.5	0.5
77380	5.9	29	4	248	4646	115	36	13	43	35	0.8	1.4	0.4
77382	5.8	16	50	214	1746	142	23	13	100	128	1.3	3.2	0.5
77384	5.9	10	41	90	1083	113	17	12	134	249	1.3	4.6	0.5
77386	6.5	16	4	70	2430	29	14	6	68	263	1.0	1.3	0.5
77388	6.1	6	18	32	589	26	11	7	88	84	0.7	1.3	0.4
77391	6.1	17	4	65	2689	20	16	6	69	118	0.8	1.3	0.4
77393	5.0	8	24	32	493	23	12	10	102	46	0.7	1.1	0.3
77395	5.8	8	6	33	721	31	12	7	94	303	1.0	1.2	0.4
77397	4.9	10	12	44	648	36	13	11	99	309	1.0	1.9	0.4
77399	5.4	8	10	149	561	33	12	14	109	330	1.0	1.0	0.3
77402	6.0	9	14	153	993	82	14	8	105	391	1.0	2.3	0.4
77404	6.4	11	16	84	1340	70	20	9	90	310	0.9	2.1	0.4
77406	6.6	32	22	236	5404	141	25	11	49	142	0.9	2.2	0.5
77408	6.0	9	13	124	1047	74	12	9	80	138	0.7	1.5	0.4
77410	5.5	10	10	50	961	55	13	8	85	145	0.7	1.2	0.3
77412	6.3	20	9	110	3113	45	19	12	84	333	1.0	1.9	0.5
77415	5.4	7	7	26	527	21	12	6	75	38	0.4	0.9	0.2
77417	5.6	8	9	26	851	16	9	7	92	186	0.6	1.1	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77419	5.0	11	6	42	857	68	12	8	66	65	0.5	0.8	0.3
77421	5.4	9	4	73	765	62	14	7	107	256	0.6	1.2	0.3
77423	5.7	11	12	65	1138	52	16	9	102	266	0.9	1.6	0.3
77426	5.8	18	13	94	2471	74	17	15	70	293	1.5	2.1	0.4
77428	5.0	20	6	109	2601	54	17	16	53	106	0.6	1.2	0.2
77430	5.8	10	7	37	1045	29	13	10	85	216	0.6	1.1	0.2
77432	5.6	9	14	34	999	31	18	13	108	230	0.8	1.7	0.2
77434	5.9	17	8	76	2627	25	16	12	64	193	0.7	1.6	0.3
77436	4.8	9	6	35	531	36	15	8	60	36	0.4	1.0	0.2
77439	5.1	9	9	35	599	40	12	11	104	211	0.7	1.3	0.2
77441	5.8	9	28	73	846	80	12	14	98	151	0.8	1.7	0.3
77443	5.5	13	13	56	1391	59	14	15	87	351	1.4	1.7	0.2
77445	6.8	24	7	135	4178	53	15	11	40	189	1.0	1.3	0.5
77447	5.8	15	17	69	2181	57	12	17	77	336	1.4	3.0	0.4
Mean	5.98	13	27	121	1759	72	14	10	96	196	1.1	2.7	0.4
Median	6.00	10	21	110	1056	70	13	10	98	207	1.0	2.2	0.4
Minimum	4.80	5	4	26	319	16	9	5	22	6	0.4	0.6	0.1
Maximum	7.90	48	119	324	9031	192	36	17	193	391	2.4	8.7	1.0

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
Standard deviation	0.62	8.8	24	75	1808	37	5	3	32	105	0.4	1.7	0.1
Coefficient of variation, %	10.34	65.5	89	62	103	52	32	27	33	53	35.5	63.7	36.8

Table 15. Soil analyses of 0 to 4 inch samples collected from Field 5a, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77198	4.6	8	49	38	260	28	7	26	114	237	0.5	1.3	0.2
77200	4.4	14	12	77	905	150	12	12	55	37	0.3	0.4	0.1
77202	5.9	19	10	95	2810	42	11	9	104	114	2.1	3.6	0.6
77204	6.7	19	20	94	3068	66	15	12	135	174	2.5	4.9	0.8
77206	5.9	15	16	73	2090	82	10	9	115	179	2.1	3.4	0.4
77208	5.4	14	24	67	1570	87	9	11	132	151	2.2	3.0	0.3
77211	5.5	12	37	58	1147	72	9	10	184	184	1.5	2.9	0.3
77213	5.2	11	33	40	987	55	7	8	164	120	1.0	2.7	0.3
77215	5.7	11	26	39	1212	74	10	8	159	154	1.1	2.8	0.3
77217	5.0	11	50	95	830	99	8	14	86	181	0.6	2.9	0.3
77219	4.6	9	84	36	441	30	11	23	107	264	0.6	1.6	0.2
77222	4.7	9	75	58	525	58	10	20	112	220	0.7	2.1	0.2
77224	5.9	17	29	88	2492	78	14	14	105	123	1.9	4.4	0.6
77226	5.2	11	30	67	980	87	9	13	147	149	1.3	1.7	0.3
77228	5.3	12	65	79	1161	83	11	12	187	189	1.9	2.8	0.3
77230	5.2	13	51	75	1130	85	19	11	196	140	1.3	2.4	0.3
77232	5.7	12	28	39	1287	73	11	9	143	145	1.2	3.4	0.4

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77235	6.3	15	25	52	2198	81	10	11	142	172	1.5	4.1	0.7
77237	4.5	9	61	50	377	37	11	23	112	259	0.7	1.7	0.2
77239	6.3	21	34	150	3177	95	23	14	117	141	2.2	5.7	0.8
77241	5.1	10	47	76	778	85	8	12	174	202	1.5	2.6	0.3
77243	5.4	10	43	57	874	62	8	9	183	173	1.0	2.5	0.3
77246	5.1	11	79	96	945	80	7	11	186	236	2.4	4.2	0.3
77248	5.8	15	21	55	1834	79	7	10	143	158	1.5	4.1	0.5
77250	5.7	16	23	51	1953	91	8	9	138	182	1.5	4.0	0.6
77252	5.5	10	46	62	854	74	8	11	172	240	2.0	3.6	0.3
77254	5.0	11	58	80	841	89	10	12	165	113	0.7	1.7	0.2
77256	5.1	9	33	45	506	71	9	14	165	210	1.1	2.3	0.2
77259	5.7	22	21	103	3059	70	19	18	146	158	2.5	5.2	0.8
77261	5.2	10	49	78	756	93	12	18	178	270	1.7	2.2	0.3
77263	6.0	13	24	73	1785	50	16	11	142	142	1.5	2.4	0.5
77265	5.1	9	45	47	468	67	15	14	171	212	1.4	2.8	0.2
77267	5.0	10	47	84	622	88	8	16	171	209	1.7	2.6	0.3
77270	4.9	10	41	64	626	67	8	15	170	240	2.3	2.5	0.3
77272	5.2	11	39	73	905	83	10	13	136	82	1.5	1.8	0.4
77274	6.7	19	19	87	3128	56	11	12	121	145	2.0	3.5	0.7

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77276	4.7	8	77	40	341	48	7	16	207	134	1.3	2.1	0.3
77278	5.9	11	46	61	1288	110	10	15	140	181	1.9	3.0	0.4
77280	5.2	10	44	84	609	86	7	14	138	110	1.2	2.4	0.3
77283	4.7	8	40	38	358	34	10	15	173	152	1.6	1.6	0.3
77285	4.9	9	39	48	457	57	11	14	165	189	1.8	1.9	0.3
77287	5.1	12	35	100	987	93	10	12	202	134	1.6	2.0	0.3
77289	6.1	13	12	67	1719	27	14	7	131	177	2.4	2.3	0.4
77291	4.9	13	30	73	1027	87	10	16	187	128	1.6	2.1	0.3
Mean	5.36	12	39	68	1258	73	11	13	148	171	1.5	2.8	0.4
Median	5.20	11	37	67	987	78	10	12	146	172	1.5	2.6	0.3
Minimum	4.50	8	10	36	341	27	7	7	86	82	0.6	1.6	0.2
Maximum	6.70	22	84	150	3177	150	23	26	207	270	2.5	5.7	0.8
Standard deviation	0.51	3.3	18	23	771	20	4	4	30	45	0.5	1.0	0.2
Coefficient of variation, %	9.55	26.9	45.6	33.4	61.3	26.8	33.4	28.1	20.0	26.4	34.0	35.0	43.1

Table 16. Soil analyses of 4 to 8 inch samples collected from Field 5a, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77199	4.7	7	22	24	212	16	9	19	108	281	0.5	0.9	0.1
77201	4.2	12	36	60	656	105	10	20	93	151	0.3	0.8	0.2
77203	5.9	19	19	96	2859	72	13	12	115	114	2.1	5.0	0.6
77205	6.3	18	10	83	2760	50	14	8	106	211	2.5	3.4	0.6
77207	6.1	15	8	71	2088	47	10	6	110	185	2.3	2.4	0.4
77210	5.5	17	15	81	2096	65	11	10	139	155	3	2.4	0.4
77212	5.6	11	32	56	1198	42	9	6	152	143	1.8	2.0	0.2
77214	5.5	9	34	37	918	30	7	6	184	111	1.0	2.1	0.2
77216	5.9	10	19	40	1176	42	9	5	137	123	1.2	1.9	0.3
77218	4.9	9	32	50	477	47	8	12	97	246	0.6	1.6	0.2
77220	4.9	8	35	23	358	22	18	13	98	236	0.8	1.2	0.2
77223	4.9	9	26	29	466	24	15	13	100	230	0.8	1.2	0.2
77225	5.8	16	13	68	2016	40	14	9	98	161	1.7	2.9	0.5
77227	5.2	12	18	66	1075	64	8	11	138	114	1.4	1.1	0.3
77229	5.3	13	50	75	1376	50	9	7	154	148	2.0	1.7	0.3
77231	5.5	12	43	72	1218	45	9	7	173	116	1.1	1.3	0.3
77234	5.8	9	21	30	1005	29	8	5	149	119	1.1	2.2	0.3

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77236	6.5	12	18	41	1675	38	10	7	127	128	1.4	3	0.5
77238	4.5	9	37	33	381	21	11	21	104	253	0.8	1.3	0.2
77240	6.6	19	12	116	3024	76	19	8	103	163	2.3	4.1	0.6
77242	5.1	10	30	58	802	56	10	8	156	159	1.6	1.7	0.2
77244	5.7	9	44	53	895	38	8	7	171	134	1.1	1.6	0.2
77247	5.4	10	65	81	1059	45	8	8	178	204	2.9	3.2	0.3
77249	6.0	14	12	58	2010	51	10	7	129	131	1.5	2.4	0.5
77251	6.0	10	17	35	1220	39	7	5	123	134	1.1	2.5	0.4
77253	5.5	10	33	50	936	43	9	7	148	171	2.3	2.4	0.3
77255	5.0	10	65	74	858	57	9	8	144	58	0.8	0.9	0.2
77258	4.9	9	22	42	498	51	9	13	155	174	1.5	1.6	0.2
77260	6.2	17	11	85	2596	40	15	10	123	177	2.5	3.5	0.6
77262	5.1	9	19	50	579	44	17	12	133	138	1.2	1.0	0.2
77264	6.0	13	18	73	1694	34	15	7	138	125	1.3	1.3	0.3
77266	5.2	8	26	38	480	43	9	9	150	222	1.6	2.0	0.2
77268	5.3	8	22	61	664	49	12	12	153	179	2.0	1.3	0.3
77271	5.3	9	24	55	814	44	9	10	165	226	2.6	1.8	0.3
77273	4.8	11	37	73	827	63	12	12	127	64	1.4	1.0	0.5
77275	6.4	16	12	71	2310	29	9	8	120	165	1.9	2.9	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77277	4.7	8	66	32	307	34	6	11	176	143	1.3	1.9	0.2
77279	6.0	10	26	51	1167	88	9	11	130	161	1.6	2.1	0.4
77282	5.0	10	36	72	645	64	16	11	143	90	1.7	1.3	0.3
77284	4.9	9	26	33	471	23	10	10	159	163	1.6	1.3	0.3
77286	4.9	9	21	45	564	31	10	8	137	133	1.6	1.1	0.2
77288	5.1	11	32	99	907	90	13	10	158	102	1.4	1.2	0.3
77290	6.0	14	22	62	1902	50	27	14	141	190	2.3	3.6	0.6
77292	4.8	11	14	72	805	57	12	14	150	96	1.2	1.1	0.3
Mean	5.43	11	27	59	1183	47	11	10	136	157	1.6	2.0	0.3
Median	5.35	10	23	58	927	45	10	10	138	153	1.5	1.8	0.3
Minimum	4.20	7	8	23	212	16	6	5	93	58	0.3	0.8	0.1
Maximum	6.60	19	66	116	3024	105	27	21	184	281	3.0	5.0	0.6
Standard deviation	0.58	3	14	21	749	19	4	4	25	50	0.6	1.0	0.1
Coefficient of variation, %	10.69	28.2	52.7	36.5	63.4	39.6	35.1	37.6	18.0	31.6	40.9	48.1	42.9

Table 17. Soil analyses of 0 to 4 inch samples collected from Field 12, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77102	5.4	11	148	353	961	129	14	15	214	254	1.5	7.4	0.7
77104	5.5	11	190	183	981	112	16	18	211	244	1.6	5.3	0.5
77106	5.3	10	160	183	912	96	18	16	175	238	1.6	4.8	0.4
77108	5.4	10	178	146	795	92	12	15	196	256	1.7	4.1	0.4
77110	5.2	10	172	119	766	78	11	13	206	216	1.4	3.5	0.4
77112	5.8	16	97	129	1830	134	14	15	215	140	2.4	5.3	0.6
77115	5.2	11	193	189	864	113	22	17	215	251	1.6	6.3	0.4
77117	5.1	11	167	185	751	108	16	16	192	247	1.4	4.8	0.3
77119	5.2	11	168	159	883	117	27	16	206	222	1.6	5.9	0.4
77121	5.5	12	73	82	1176	86	15	13	162	156	1.7	3.2	0.4
77123	5.6	12	49	70	1307	104	16	11	157	156	1.5	3.0	0.4
77126	5.4	10	40	63	991	65	9	8	143	123	1.1	2.2	0.2
77128	5.3	9	115	115	661	88	18	15	149	193	1.3	4.1	0.3
77130	4.9	12	186	276	739	103	24	19	185	215	1.5	5.2	0.4
77132	5.7	12	112	101	1297	115	25	16	172	200	1.9	4.7	0.4
77134	5.3	14	123	75	1316	154	26	16	227	216	2.0	7.2	0.5
77136	5.6	14	101	95	1568	162	27	17	204	175	1.8	5.8	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77139	5.3	10	64	48	976	80	9	15	241	174	1.3	3.6	0.3
77141	5.1	11	138	147	772	99	24	22	147	174	1.2	5.3	0.3
77143	5.2	15	103	98	1408	128	27	23	175	169	2.1	4.5	0.5
77145	6.0	13	76	121	1575	135	23	19	163	159	1.4	4.2	0.5
77147	5.5	14	97	107	1333	126	21	18	197	232	1.7	6.5	0.5
77150	5.5	10	81	60	962	80	12	16	255	219	1.4	4.0	0.4
77152	5.5	14	57	109	1479	115	30	19	161	195	1.6	3.9	0.5
77154	5.1	17	123	117	1752	165	24	23	195	138	2.1	6.7	0.5
77156	5.5	13	91	102	1225	109	24	22	153	227	1.8	5.2	0.4
77158	5.3	17	59	91	1848	139	29	20	170	109	2.0	4.3	0.5
77160	5.7	13	79	122	1393	122	23	22	187	201	1.8	5.1	0.5
77163	5.6	12	65	164	1135	111	19	15	183	187	1.4	4.0	0.4
77165	5.9	9	77	94	930	108	21	14	181	161	1.2	4.3	0.4
77167	6.1	11	27	59	1378	107	6	9	163	164	1.3	3.8	0.5
77169	5.8	12	55	59	1386	98	9	12	177	174	1.7	3.9	0.4
77171	5.8	17	65	95	2178	139	31	15	133	90	2.1	5.3	0.7
77174	5.4	16	72	85	1697	141	31	15	143	110	2.3	5.1	0.6
77176	5.9	16	65	109	2099	151	40	14	157	137	2.5	5.2	0.6
77178	5.4	14	76	94	1389	101	27	15	187	162	2.2	4.3	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77180	5.3	14	77	110	1493	121	19	16	192	178	2.4	5.0	0.6
77182	5.5	11	117	79	941	124	23	13	234	202	1.8	7.5	0.6
77184	6.0	17	63	107	2593	75	28	18	136	141	2.3	6.0	1.0
77187	5.3	17	146	245	1791	178	27	19	178	88	2.3	7.0	0.4
77189	5.4	17	117	207	1737	162	20	15	166	94	1.8	5.1	0.5
77191	5.6	15	65	123	1632	142	27	14	161	113	1.8	3.8	0.4
77193	5.3	15	151	315	1326	185	24	18	165	144	1.6	6.9	0.5
77195	5.6	13	82	110	1464	128	22	13	159	143	1.6	5.0	0.4
77470	5.4	10	104	84	845	106	12	16	220	162	1.6	4.2	0.3
Mean	5.48	13	104	129	1301	118	21	16	182	177	1.7	4.9	0.5
Median	5.40	12	97	109	1316	115	22	16	178	174	1.7	5.0	0.4
Minimum	4.90	9	27	48	661	65	6	8	133	88	1.1	2.2	0.2
Maximum	6.10	17	193	353	2593	185	40	23	255	256	2.5	7.5	1.0
Standard deviation	0.27	2	45	66	433	28	7	3	29	47	0.4	1.2	0.1
Coefficient of variation, %	4.88	19.4	43.1	51.6	33.3	23.4	34.6	20.6	15.9	26.4	20.7	24.7	28.7

Table 18. Soil analyses of 4 to 8 inch samples collected from Field 12, collected February 2016.

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
			mg/kg										
77103	5.7	9	107	315	701	96	17	13	158	249	1.3	4.5	0.4
77105	5.6	9	142	97	814	67	16	12	154	170	1.3	2.4	0.3
77107	5.5	10	88	93	847	59	20	12	141	202	1.5	2.1	0.3
77109	5.6	9	118	68	883	65	20	12	163	210	1.7	2.1	0.3
77111	5.7	9	116	77	827	45	14	11	164	149	1.4	1.7	0.4
77114	5.7	15	49	92	1766	104	17	11	153	115	2.4	2.9	0.7
77116	5.6	9	106	107	799	71	17	13	165	203	1.3	2.4	0.4
77118	5.2	10	104	103	723	71	16	13	160	195	1.4	2.3	0.3
77120	5.8	8	73	77	763	47	16	8	131	137	1.2	1.5	0.2
77122	5.7	12	41	66	1356	59	17	10	133	111	1.9	2.0	0.3
77124	6.1	12	25	63	1491	69	15	9	119	115	1.6	1.6	0.4
77127	5.7	10	24	56	1009	48	11	7	106	81	1.1	1.2	0.2
77129	5.4	9	45	66	691	41	18	10	106	127	1.5	1.4	0.2
77131	5.2	10	120	106	756	57	19	14	149	149	1.4	2.4	0.3
77133	5.8	13	60	62	1483	66	25	12	140	143	2.0	2.1	0.4
77135	5.7	13	38	57	1575	73	19	10	146	160	2.0	2.2	0.4
77138	5.7	14	28	64	1639	81	21	14	133	142	1.6	1.8	0.4

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77140	5.8	8	35	32	675	28	9	9	134	94	0.9	1.4	0.2
77142	5.1	9	33	56	653	28	14	16	95	99	0.8	0.9	0.2
77144	5.7	11	47	44	1108	54	20	15	106	92	1.8	1.4	0.3
77146	5.8	13	27	67	1547	83	17	14	115	116	1.4	1.4	0.4
77148	6.0	12	23	54	1472	72	18	12	134	162	1.9	2.1	0.4
77151	5.7	9	45	42	859	43	15	12	157	145	1.2	2.0	0.3
77153	6.2	12	19	57	1567	60	28	14	115	123	1.7	1.2	0.4
77155	5.6	16	50	68	1904	96	23	16	145	121	2.2	2.9	0.5
77157	5.9	10	34	57	1154	44	17	15	103	144	1.5	1.5	0.4
77159	5.6	17	23	65	2111	104	24	18	124	97	2.1	1.9	0.4
77162	5.6	12	26	73	1350	82	20	15	117	114	1.8	1.9	0.3
77164	5.8	12	32	96	1314	81	20	12	132	142	1.8	1.8	0.4
77166	5.5	11	21	67	1072	65	13	11	106	78	1.0	1.2	0.2
77168	6.1	11	27	61	1288	77	7	7	151	125	1.8	3.0	0.4
77170	5.8	12	35	56	1291	46	7	8	133	131	1.8	2.1	0.3
77172	5.9	15	22	65	2202	83	26	11	108	75	1.9	1.9	0.7
77175	5.8	17	19	68	2190	95	28	11	118	86	2.5	1.9	0.5
77177	6.1	17	20	85	2477	97	24	11	132	101	2.6	2.3	0.6
77179	5.7	13	37	72	1516	72	27	11	148	132	2.3	2.6	0.5

Lab Number	pH	CEC	P	K	Ca	Mg	Na	S	Fe	Mn	Cu	Zn	B
77181	5.8	15	28	86	1714	81	16	12	147	141	2.7	2.5	0.6
77183	5.6	10	36	50	962	64	16	9	142	143	1.7	2.6	0.6
77186	6.2	17	17	81	2600	35	29	11	108	113	1.7	2.0	0.6
77188	5.7	16	55	140	1864	117	21	12	145	62	2.1	2.5	0.4
77190	5.7	15	50	122	1810	126	17	11	135	66	1.9	2.2	0.4
77192	5.7	14	30	75	1592	104	16	11	124	88	1.7	1.9	0.4
77194	5.4	13	61	181	1272	131	15	13	137	86	1.5	2.3	0.4
77196	6.0	11	37	68	1381	86	17	8	131	123	1.6	2.3	0.3
77471	5.4	10	64	76	885	60	14	13	156	105	1.7	1.9	0.3
Mean	5.71	12	50	81	1332	72	18	12	134	128	1.7	2.0	0.4
Median	5.70	12	37	68	1314	71	17	12	134	123	1.7	2.0	0.4
Minimum	5.10	8	17	32	653	28	7	7	95	62	0.8	0.9	0.2
Maximum	6.20	17	142	315	2600	131	29	18	165	249	2.7	4.5	0.7
Standard deviation	0.24	3	33	44	509	25	5	2	19	40	0.4	0.6	0.1
Coefficient of variation, %	4.26	22.4	66.1	55.0	38.2	34.1	28.3	20.7	14.2	31.4	25.3	29.8	33.3

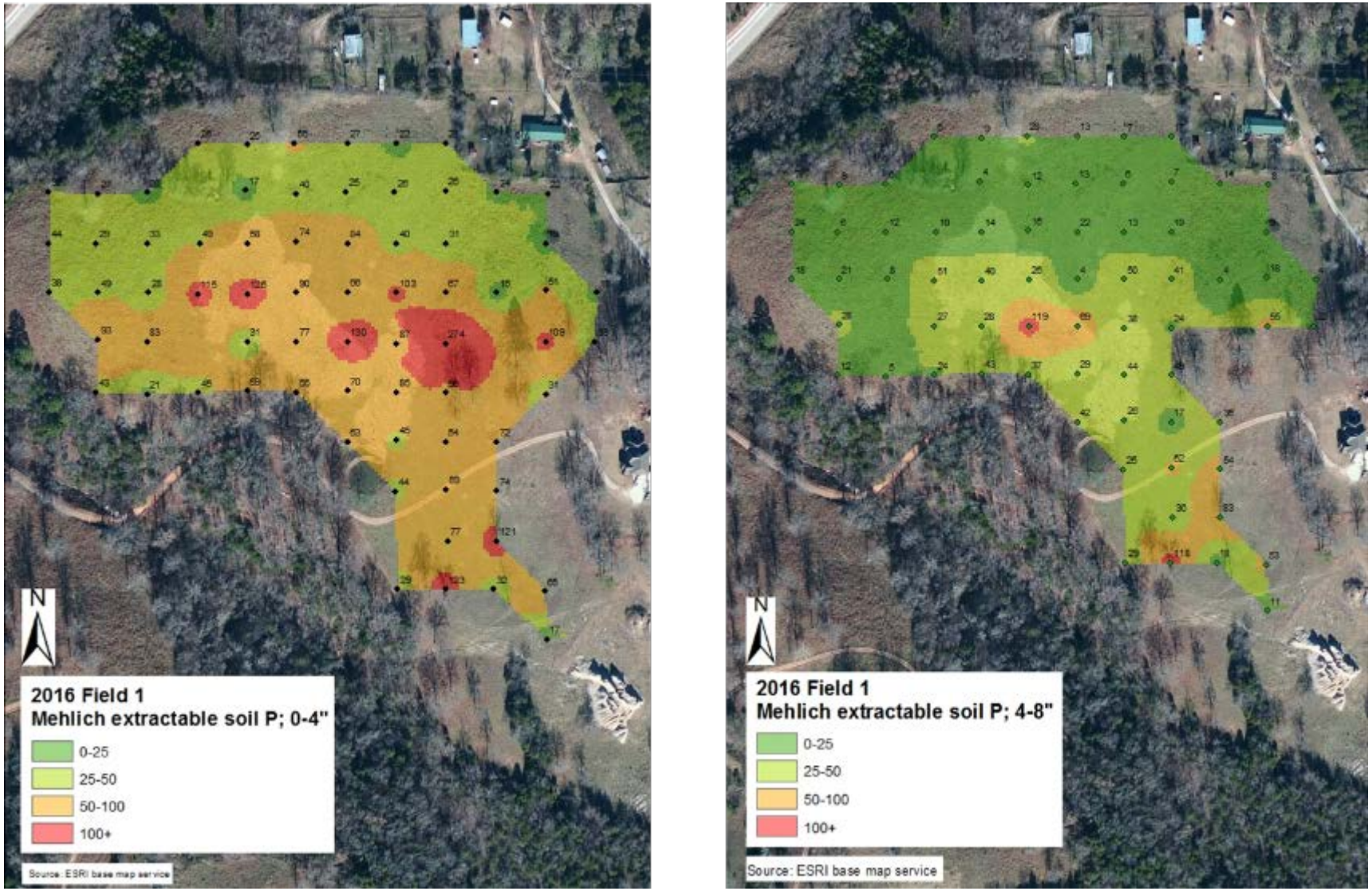


Figure 19. Map of Mehlich-3 extractable soil P in grid-soil sampling of Field 1 for 0 - 4 and 4 – 8 inch samples collected February 2016.

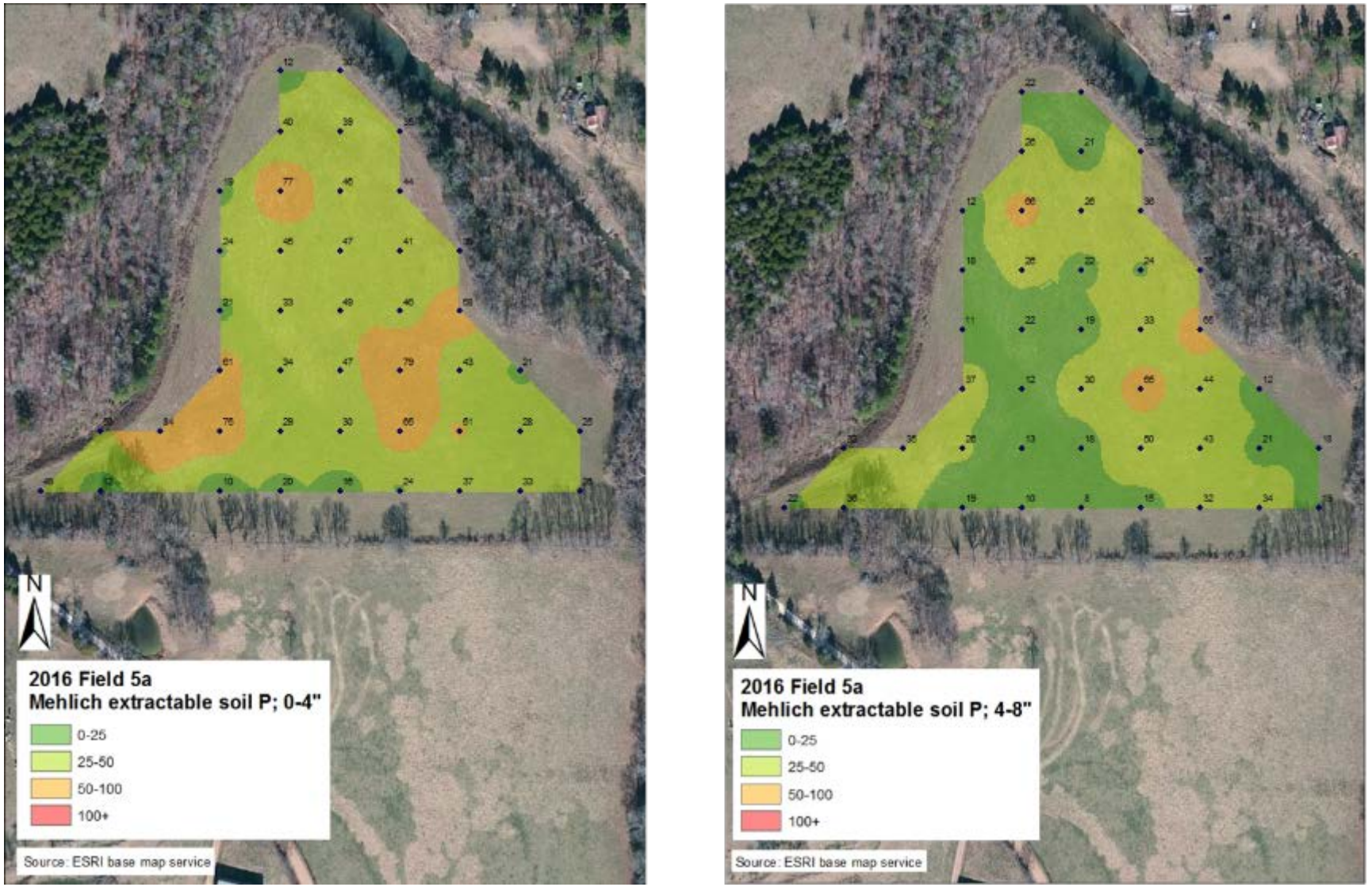


Figure 20. Map of Mehlich-3 extractable soil P in grid-soil sampling of Field 5a for 0 - 4 and 4 – 8 inch samples collected February 2016..

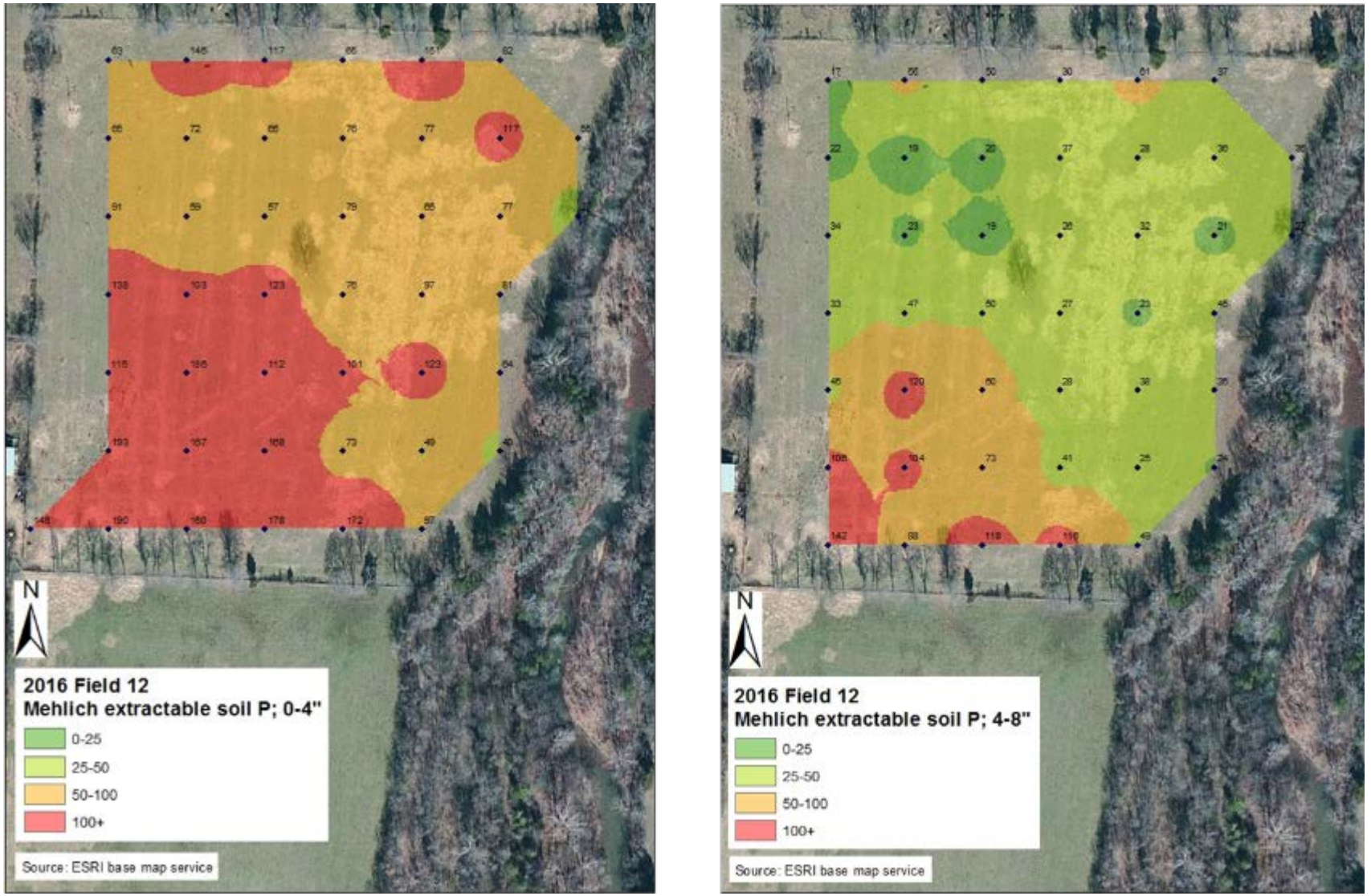


Figure 21. Map of Mehlich-3 extractable soil P in grid-soil sampling of Field 12 for 0 - 4 and 4 – 8 inch samples collected February 2016.

Table 19. Swine slurry applications for 2013, 2014, and 2015 for the C&H Farm operation.

Field	2013 & 2014				2015			
	Gallons applied	Acres	Average gal/acre applied	Average inches applied	Gallons applied	Acres	Average gal/acre applied	Average inches applied
1	46,000	13.0	3,538	0.13	46,000	13.0	3,538	0.13
2	22,600	6.0	3,767	0.14	22,600	6.0	3,767	0.14
3	118,100	27.0	4,374	0.16	118,100	27.0	4,374	0.16
4	28,800	8.5	3,388	0.12	28,800	8.5	3,388	0.12
7	396,200	123.0	3,221	0.12	396,200	123.0	3,221	0.12
8	25,000	9.0	2,778	0.10	25,000	9.0	2,778	0.10
9	103,800	35.0	2,966	0.11	103,800	35.0	2,966	0.11
10	249,200	64.0	3,894	0.14	249,200	64.0	3,894	0.14
11	51,000	17.0	3,000	0.11	51,000	17.0	3,000	0.11
12	48,000	9.9	4,848	0.18	48,000	9.9	4,848	0.18
13	453,550	151.0	3,004	0.11	453,550	151.0	3,004	0.11
14	73,000	23.0	3,174	0.12	73,000	23.0	3,174	0.12
15	434,400	150.0	2,896	0.11	434,400	150.0	2,896	0.11
16	56,000	9.0	6,222	0.23	56,000	9.0	6,222	0.23
17	294,750	105.0	2,807	0.10	294,750	105.0	2,807	0.10

Table 20. Median concentrations (mg/L) of Mehlich-3 extractable elements for 0 to 4 inch soil samples collected in the 2014 and 2016 grid sampling of Fields 1, 5a, and 12 under the C&H Farm operation plan. Parameters followed by the same letter for any given for any given fields are not significantly different between 2014 and 2016 grid-soil samplings, as determined by paired *t* test with a <0.0001 level of probability.

Parameter	Field 1		Field 5a		Field 12	
	2014	2016	2014	2016	2014	2016
No. samples	72	71	33	44	40	45
Phosphorus	54 a	47 a	47 a	37 a	50 b	97 a
Potassium	143 a	164 a	51 a	67 a	68 b	109 a
Calcium	1,591 a	1,428 a	987 a	987 a	1,132 b	1,316 a
Magnesium	107 a	99 a	69 a	78 a	80 b	115 a
Sodium	12 a	14 a	11 a	10 a	10 b	22 a
Sulfur	18 a	16 b	12 a	12 a	14 b	16 a
Iron	109 b	115 a	153 a	146 a	118 b	178 a
Manganese	258 a	208 b	211 a	172 b	156 b	174 a
Copper	0.50 b	1.30 a	1.20 a	1.50 a	1.20 b	1.70 a
Zinc	3.90 a	4.15 a	2.90 a	2.60 b	2.10 b	5.05 a
Boron	0.40 b	0.50 a	0.20 a	0.30 a	0.20 b	0.45 a

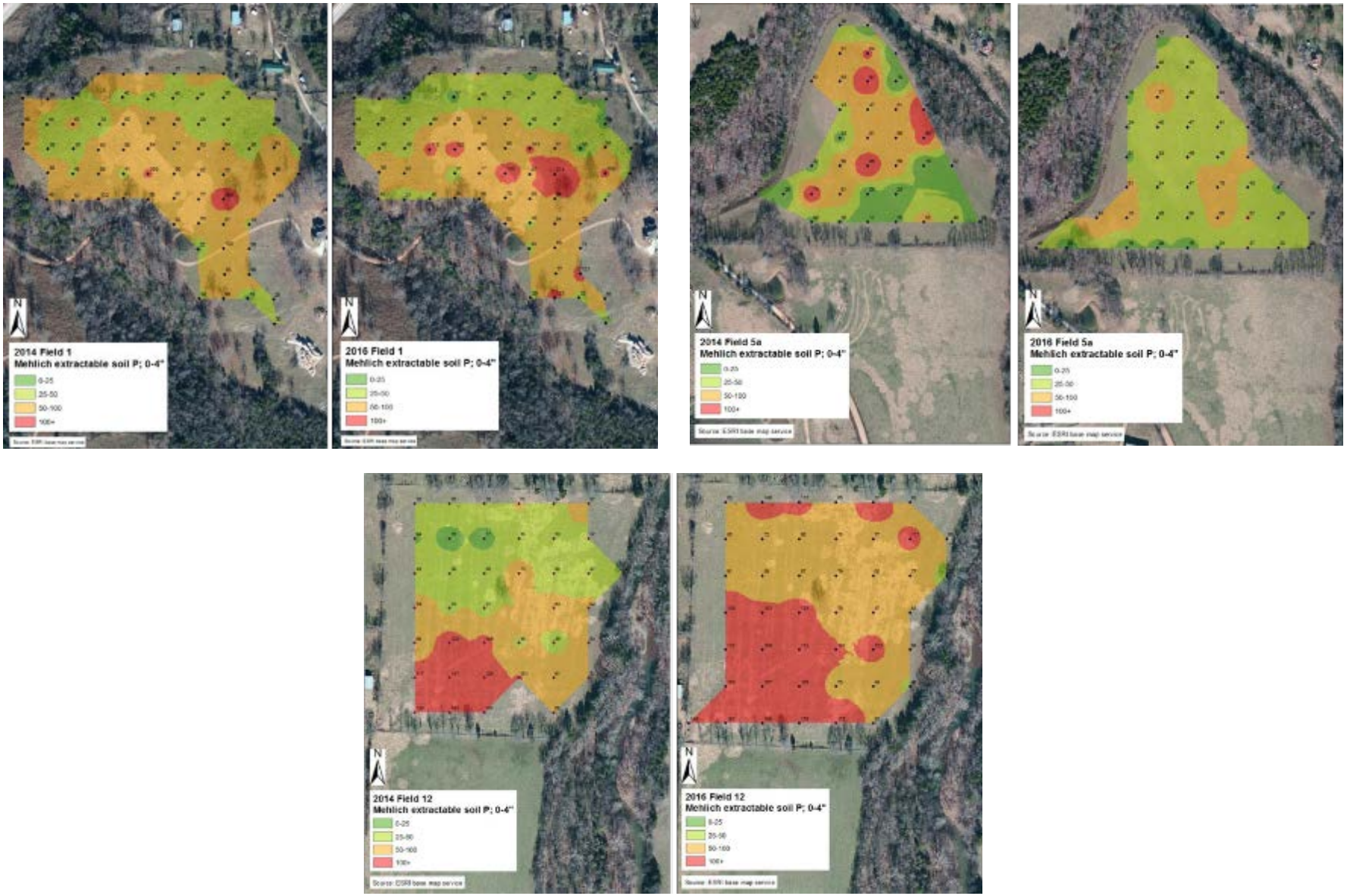


Figure 22. Map of Mehlich-3 extractable soil P in 0 - 4 inch samples for Fields 1, 5a, and 12 collected in 2014 and 2016.

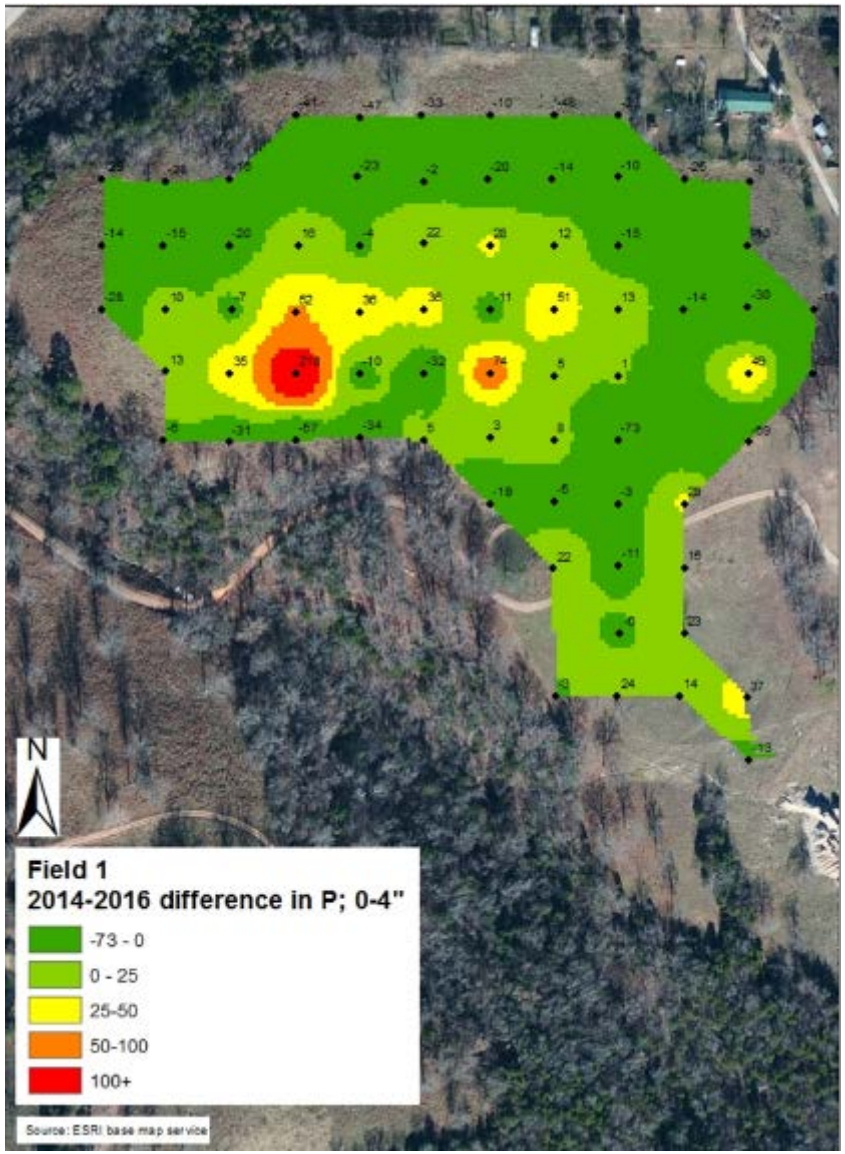
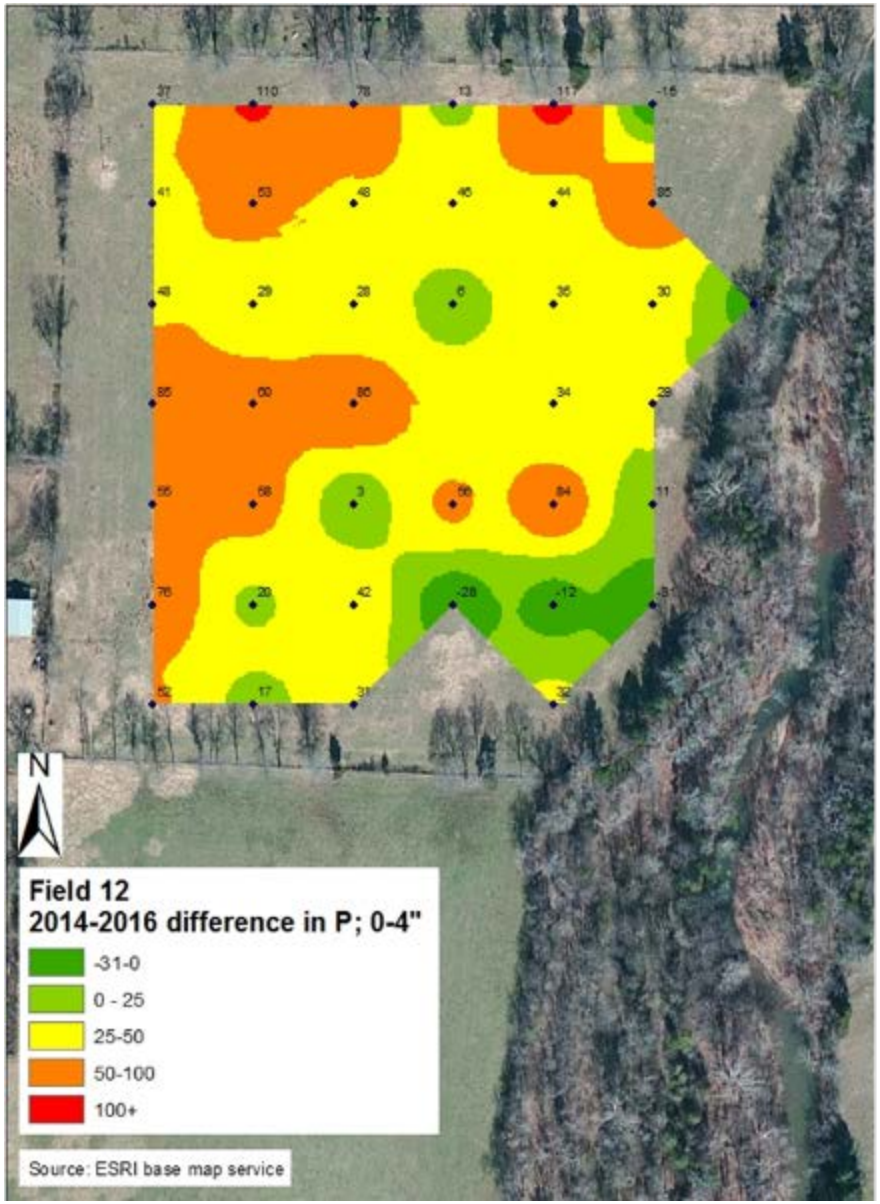


Figure 23. Map of the difference in Mehlich-3 extractable soil P in 0 - 4 inch samples on Field 1 collected in 2014 and 2016.

Figure 24. Map of the difference in Mehlich-3 extractable soil P in 0 - 4 inch samples on Field 5a collected in 2014 and 2016.



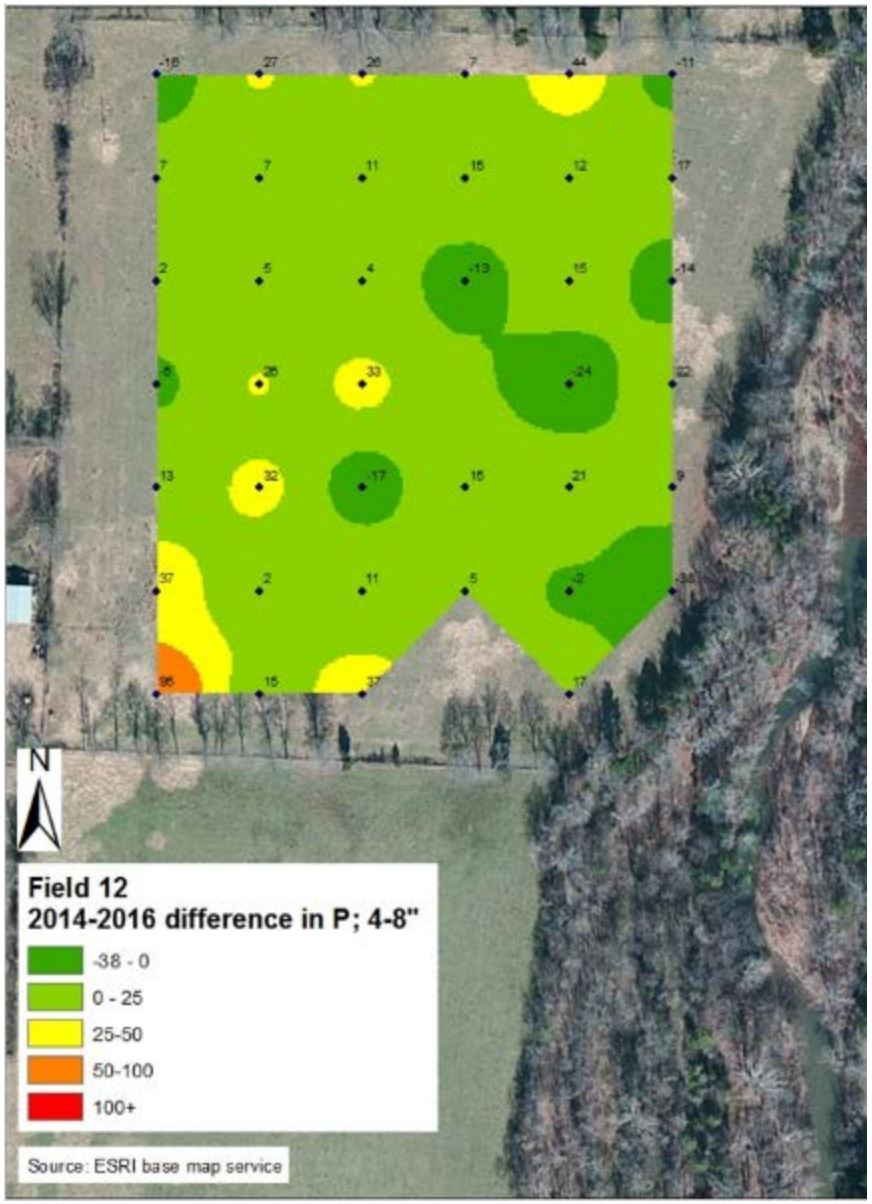


Figure 25. Map of the difference in Mehlich-3 extractable soil P in 0 - 4 inch samples on Field 12 collected in 2014 and 2016.

Manure slurry holding ponds

Measurement of the physical and chemical properties of the manure slurry in the holding ponds have been determined at various times and reported in prior Quarterly Reports. Here, the median values of constituents measured are updated in **Table 1** for samples collected on September 24, 2013; April 10, 2014; October 28, 2014; April 16, 2015; and January 15, May 27, and July 27, 2016.

An increasing linear relationship between total N, total P, total K, and water-extractable P concentrations and the increasing percent solids content of the slurry was observed (**Figure 1**). These nutrient concentrations are selected as they are required by plants for growth and used to determine the nutrient-fertilizer applications from an agronomic perspective. Nitrogen and P are also of interest because of their involvement in eutrophication of waters receiving excess loads of these nutrients. Water-extractable P is of interest due its key role in P Index calculations and determination of acceptable manure application rates. In addition, the total N:P_2O_5 concentration ratio exponentially decreased with increasing percent soils content (**Figure 2**).

These trends reflect the variation in manure nutrient concentrations between ponds and depth within the ponds. C&H Farm management is aware of these variations and the nutrient management opportunities they present when making decisions regarding: which pond to pump from; whether the pond will be agitated; the depth at which to pump from; and which field to make the application. These factors coupled the total number and size of application fields with the frequency in which each field receives a manure application plays a significant role in meeting the crop's nutrient fertility needs, while minimizing soil P accumulation and associated potential P runoff risk.

Table 21. Median concentration of constituent property of manure sampled from the top 6 inches, bottom layer, and profile of holding ponds 1 and 2 on the C&H Farm between September, 2013 and July, 2016.

Property	Pond 1			Pond 2		
	Top 6 inches	Bottom layer	Profile	Top 6 inches	Bottom layer	Profile
pH	7.9	7.5	7.7	8.1	7.9	8.1
Conductivity, µS/cm	13,905	10,710	12,835	10,275	10,475	8,100
Solids, %	0.8	11.9	3.8	0.5	4.3	2.3
Chloride, mg/L	360	409	468	338	409	532
Total N, mg/L	1,692	5,078	2,640	1,213	2,890	1,043
Ammonium-N, mg/L	1,323	1,437	1,150	859	938	536

Nitrate-N, mg/L	0.035	0.035	0.035	0.153	0.035	0.058
Total P, mg/L	180	5,070	1,316	114	458	279
Water-extractable P, mg/L	78	476	194	79	162	89
Total K, mg/L	1,383	1,593	1,416	1,109	1,180	1,073
Total Ca, mg/L	103	6,070	1,218	45	409	193
Total Mg, mg/L	30	2,368	589	6	177	77
Total S, mg/kg	60	1,076	243	23	133	77
Total Fe, mg/L	14	2,290	696	12	1,336	1,397
Total Mn, mg/L	0.6	102	20.5	0.0	9.8	5.4
Total Zn, mg/L	2.6	218	54.7	0.3	18.5	10.0
Total Cu, mg/L	0.5	27.6	7.0	0.0	2.9	1.9
Total Na, mg/L	340	368	349	246	250	314

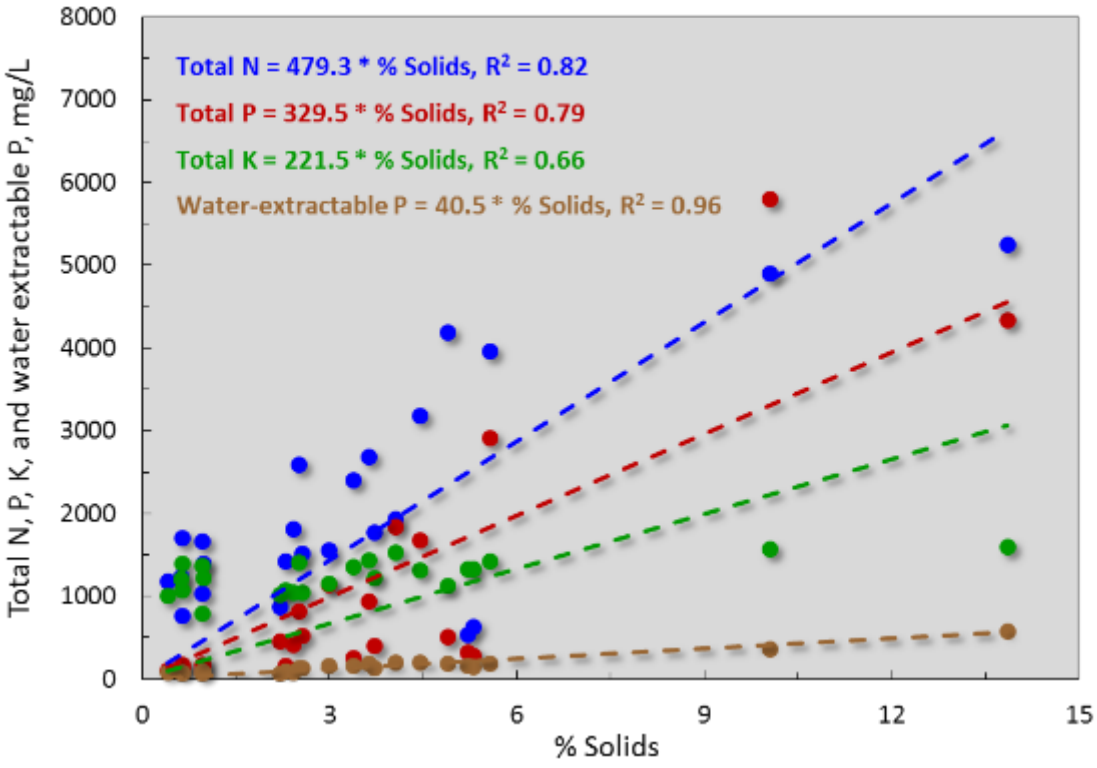


Figure 26. Relationship between total N, P, K and water-extractable P concentration and the percent solids content of swine slurry (all samples collected from ponds 1 and 2) from the C&H Farm operation.

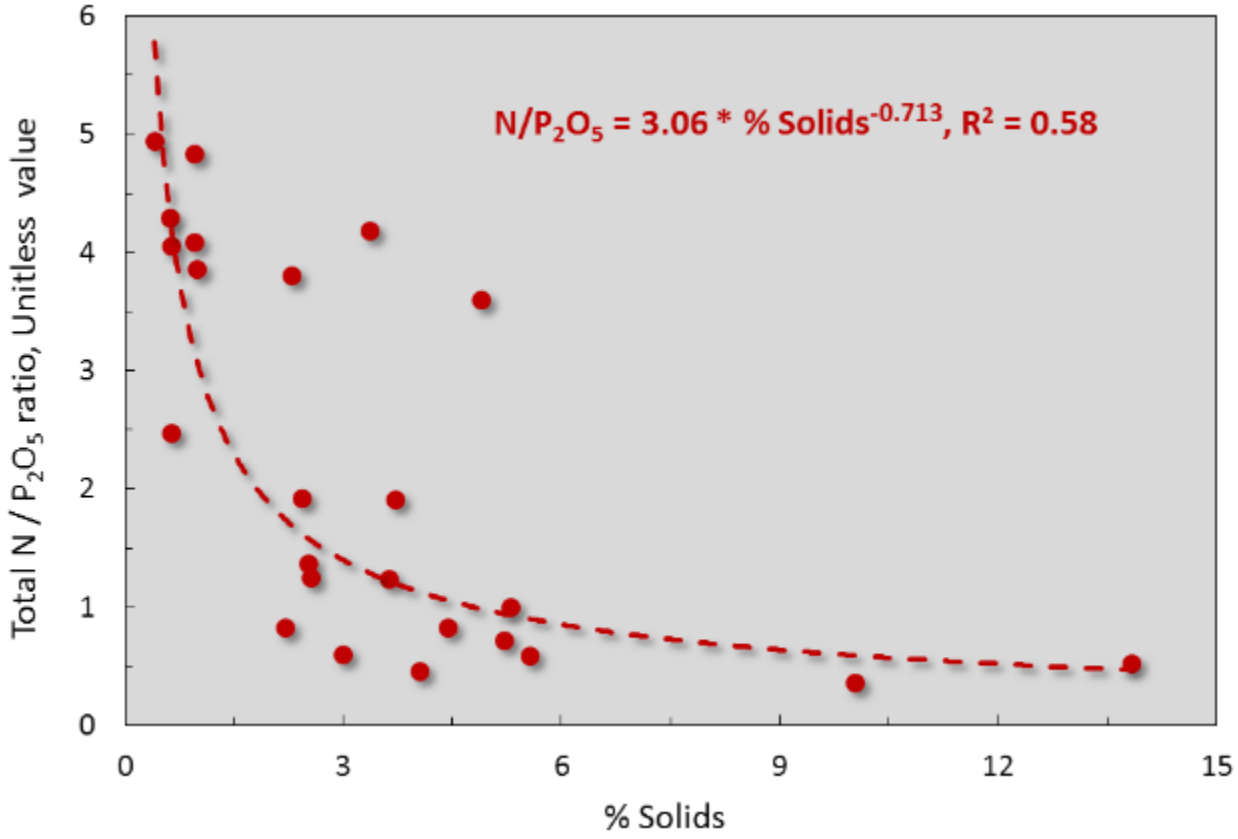


Figure 27. Relationship between the total N and P2O5 concentration ratio and percent solids content of swine slurry (all samples collected from ponds 1 and 2) from the C&H Farm operation.