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Assessment of Groundwater Quality in an Abandoned Feedlot, Henderson County, Kentucky: Data Report

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Abstract

A three-phase project investigated the influence of past and present agricultural practices on groundwater resources in the Western Kentucky Coal Field. Phase II concentrated on past practices, specifically those associated with an abandoned dairy feedlot and an old homestead. Results of phase II analyses are presented in this report.

Introduction

This report is associated with the second phase of a three-phase investigation of the influence of present and past agricultural practices on groundwater resources in the Western Kentucky Coal Field. The phase I report (Beck and others, 2010) concentrated on water and soil quality associated with present agricultural practices (row crop, pasture, etc.). This report presents the results of water-quality analyses for groundwater samples collected from monitoring wells installed in and around a long-abandoned dairy feedlot. In addition to groundwater quality data, data for soil cores collected in and around the abandoned feedlot, monitoring-well construction details, and groundwater elevations are presented. Soil-core data are also presented for cores collected from an old homestead. The abandoned dairy feedlot and old homestead are on a farm in an upland bedrock setting (loess overlying bedrock) in the Western Kentucky Coal Field. Funding for this research was provided by the University of Kentucky's College of Agriculture through the Senate Bill 271 Research and Education Program. Previous reports generated by this research describing water- and soil-quality monitoring at this site were published by the UK College of Agriculture. This report covers work completed during phase II (1998–2001). Phase I (Beck and others, 2010) overlapped with phase II.

Study Site

The abandoned feedlot and old homestead are located on a 540-acre farm (referred to as the Keach farm) in north-central Henderson County, approximately 5 mi west of downtown Henderson (Fig. 1), in the Wilson 7.5-minute quadrangle (Johnson, 1973). The Keach farm is in a typical Western Kentucky Coal Field upland bedrock setting in which moderately thick loess (17 to 35 ft) of Pleistocene age overlies bedrock (shale and channel-fill sandstone) of Pennsylvanian age. Upland bedrock settings in the Western Kentucky Coal Field are characterized by broad ridges with shallow, wide valleys. The two dominant loess-derived soil series are Memphis and Loring. Memphis soils are well drained, whereas Loring soils are well to moderately drained and typically have a fragipan (layer of semiconsolidated soil particles that retard water infiltration) between 26 and 42 in. below the land surface (Converse and Cox, 1967). The locations of the abandoned dairy feedlot and old homestead on the Keach farm are shown in Figure 2.

Soil Core Descriptions

During phase II, 109 soil cores were collected in and around the abandoned dairy feedlot and 14 soil cores were collected from the old homestead. Three rounds of soil cores were collected at the dairy feedlot. During round 1 (May 1998), 46 soil cores were collected on 50-

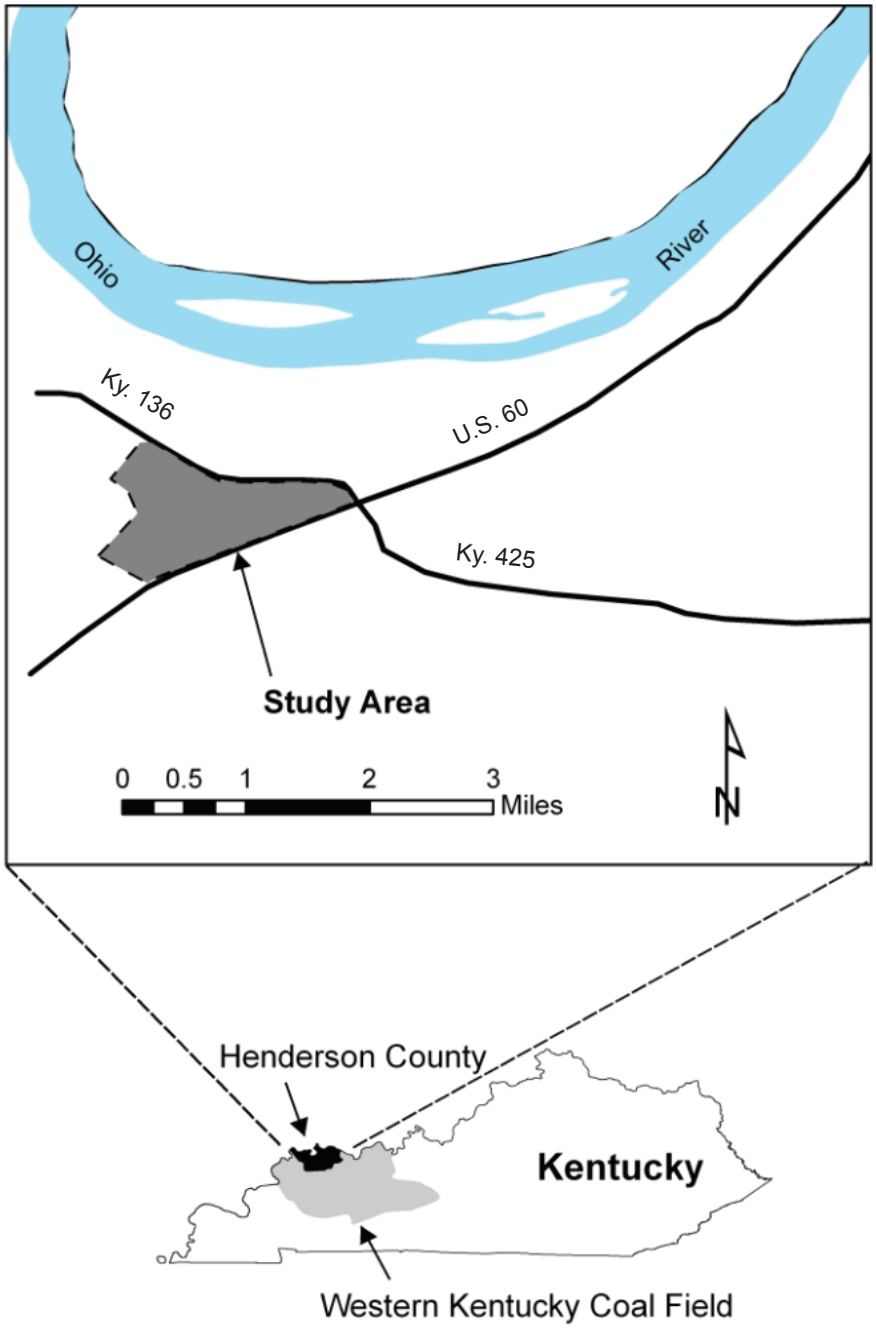

Figure 1. Location of the study site in Henderson County, Kentucky.

ft centers to a depth of 3 ft below land surface (Fig. 3). Cores are identified with R1 (round 1), a row number (1 through 8), and a corresponding letter (A through I) (Fig. 3). Coordinates for round 1 soil cores are presented in Table 1. All coordinates are in decimal degrees and based on the North American datum of 1983 (NAD 83). Elevations were not collected for round 1 soil cores. The second round consisted of 49 cores collected in May 1999 on 100-ft centers in and around the abandoned dairy feedlot to a depth of 8 ft below the land surface (Fig. 4). Round 2 cores are identified as R2 (round 2), 1 through 49 (Fig. 4). Coordinates, surface elevations, and total depth for round 2 soil cores are presented in Table 2. Elevations for these and all cores for which elevations were recorded are in feet above sea level. For round 3 (April 2000), 14 soil cores were collected from the soil surface through the loess until the core tubing was stopped by hard rock (bedrock refusal). These cores were distributed throughout the present farmstead and are identified as R3 (round 3), 1 through 14 (Fig. 5). Co-

Figure 2. Locations of the abandoned dairy feedlot and old homestead on the Keach farm.

ordinates, surface elevations, and total depth for round 3 soil cores are presented in Table 3.

In addition to the three rounds of cores taken at the abandoned dairy feedlot, 14 soil cores were collected from the old homestead in May 1998. Three transects of cores were collected to a depth of 3 ft below the land surface (Fig. 6). Each homestead core is identified with a T, a transect number (1 through 3), and a letter (A through F) (Fig. 6). Coordinates for homestead soil cores are presented in Table 4. Elevations were not recorded.

Soil Core Data

At the time of collection, soil cores were typically subdivided into 1-ft increments and placed in brown paper bags to be transported to a freezer, where the samples remained until they were analyzed. Samples were air-dried and crushed to pass a 2-mm sieve. Soil cores were analyzed in two laboratories. Particle size (silt, clay, sand) and inorganic nitrogen (ammonium and nitrate) analyses were conducted at the Chemical and Physical Edaphology Laboratory of the University of Kentucky Department of Plant and Soil Sciences. Ammonium was not determined for the round 2 soil cores. All other soil analyses (pH, bioavailable phosphorus, potassium, calcium, magnesium, zinc, organic matter, and total nitrogen) were conducted in the University of Kentucky Regulatory Services Laboratory. All analyses were performed in accordance with methods widely accepted in the literature. Table 5 lists the laboratory analyses performed and corresponding methods used.

Particle-size data for soil cores from rounds 1, 2, and 3 are in Appendix A, B, and C, respectively. Particle size was not determined for the old homestead cores. When possible, particle size and chemistry were determined for 1-ft intervals. Missing intervals indicate that samples were not collected, because of inadequate sample volume or cross contamination occurring during coring. Appendices D through G contain chemical data for rounds 1, 2, and 3, and old homestead cores, respectively. Organic matter is calculated as percent carbon multiplied by 1.72, which gives the percentage of organic matter of the soil sample. Analytes are presented as lb/acre or parts per 2 million, and parts per million. To convert lb/acre or parts per 2 million to kg/hectare, multiply by 1.78.

Well Descriptions

Groundwater quality data were collected from seven water wells installed in and around the abandoned dairy feedlot (Fig. 8). All seven wells were installed by a certified water-well driller according to Kentucky water-well regulations (Kentucky Department of Environmental Protection, 1985). Three of the seven wells (DW06, DW07, and DW08) were open borehole. The remaining four wells (DW09, DW10, DW11, and DW12) were constructed using 4-in. PVC screen and surface casing. Well

Figure 3. Locations of soil cores collected during round 1.

names, corresponding AKGWA (Assembled Kentucky Ground Water Database) numbers, coordinates, elevations, total depths, depth to bedrock, and screen or open borehole intervals are presented for each well in Table 6. Coordinates and elevations were determined using GPS equipment. The total drilled depths are reported in feet from ground surface. Detailed well-construction diagrams are shown for each well in Appendix H.

Groundwater Quality Data

Phase II groundwater data were collected from seven water wells between October 1998 and December 2001. Field measurements were pH, specific conductance, temperature, dissolved oxygen, and oxidation-reduction potential, all in accordance with U.S. Geological Survey guidelines for sampling and collecting

Table 1. Coordinates for round 1 soil cores from the abandoned dairy feedlot.

Core ID	*Latitude*	*Longitude*
R1-1A	37.799201	–87.671276
R1-1B	37.799159	–87.671128
R1-1C	37.799107	–87.670966
R1-1D	37.799061	–87.670808
R1-1E	37.799031	–87.670648
R1-1F	37.798965	–87.670495
R1-1G	37.798918	–87.670343
R1-1H	37.798862	–87.670174
R1-2A	37.799335	–87.671214
R1-2B	37.799288	–87.671061
R1-2C	37.799239	–87.670892
R1-2D	37.799185	–87.670734
R1-2E	37.799131	–87.670572
R1-2F	37.799082	–87.670413
R1-2G	37.799035	–87.670255
R1-2H	37.798978	–87.670077
R1-3A	37.799509	–87.671285
R1-3B	37.799453	–87.671122
R1-3C	37.799412	–87.670984
R1-3D	37.799364	–87.670823
R1-3E	37.799313	–87.670660
R1-3F	37.799260	–87.670504
R1-3G	37.799203	–87.670328
R1-3H	37.799152	–87.670159
R1-3I	37.799093	–87.669988
R1-4A	37.799651	–87.671171
R1-4B	37.799587	–87.671069
R1-4C	37.799486	–87.670721
R1-4D	37.799442	–87.670596
R1-4E	37.799385	–87.670429
R1-4F	37.799323	–87.670238
R1-4G	37.799269	–87.670063
R1-4H	37.799209	–87.669895
R1-5A	37.799727	–87.670955
R1-5B	37.799566	–87.670682
R1-5C	37.799520	–87.670549
R1-5D	37.799463	–87.670386
R1-6A	37.799398	–87.670084
R1-6B	37.799382	–87.669961
R1-6C	37.799326	–87.669802
R1-7A	37.799545	–87.669980
R1-7B	37.799407	–87.669709
R1-8A	37.799902	–87.670857
R1-8B	37.799909	–87.670262
R1-8C	37.799615	–87.669977
R1-8D	37.799600	–87.669518

(U.S. Geological Survey, 1980). All wells were purged and sampled using a 2-in.-diameter submersible Grundfos Redi-Flo[1] pump. The pump and tubing were rinsed thoroughly with distilled water between purging and sampling.

Field measurements (specific conductance, pH, temperature, and dissolved oxygen) were recorded using a Horiba U-10 water-quality monitoring system with a flow-through chamber. Oxidation-reduction potential was recorded using an Orion ORP electrode and field meter. Field measurements were recorded after each well was purged and field measurements stabilized. All field instruments were calibrated daily using procedures prescribed by the manufacturers.

All laboratory analyses were performed in accordance with either U.S. Environmental Protection Agency methods or methods widely accepted in the literature. Sample splits were prepared in the field and transported to the laboratory in sterilized bottles. For dissolved-constituent analysis, filtration was performed in the field using high-capacity in-line filters (0.45-µm pore size). If preservation was required by analysis protocol, the samples were preserved at the time of collection and kept at a temperature of 4°C until delivered to the appropriate laboratory.

Water analyses were performed at the Kentucky Geological Survey, Kentucky Division of Environmental Services, Environmental Isotope Laboratory at the University of Waterloo, and the KGS Western Kentucky office. Table 7 lists the analyses performed, methods used, and required sample preservation for the KGS, Division of Environmental Services, and University of Waterloo laboratories. Table 8 presents the same information for the Western Kentucky office laboratory. Because research funding and goals changed during the project, the list of analytes changed also. Therefore, not all analytes listed in Tables 7 and 8 appear throughout the water-quality data tables.

[1]The use of trade or product names is for descriptive purposes only and does not imply endorsement by the Kentucky Geological Survey.

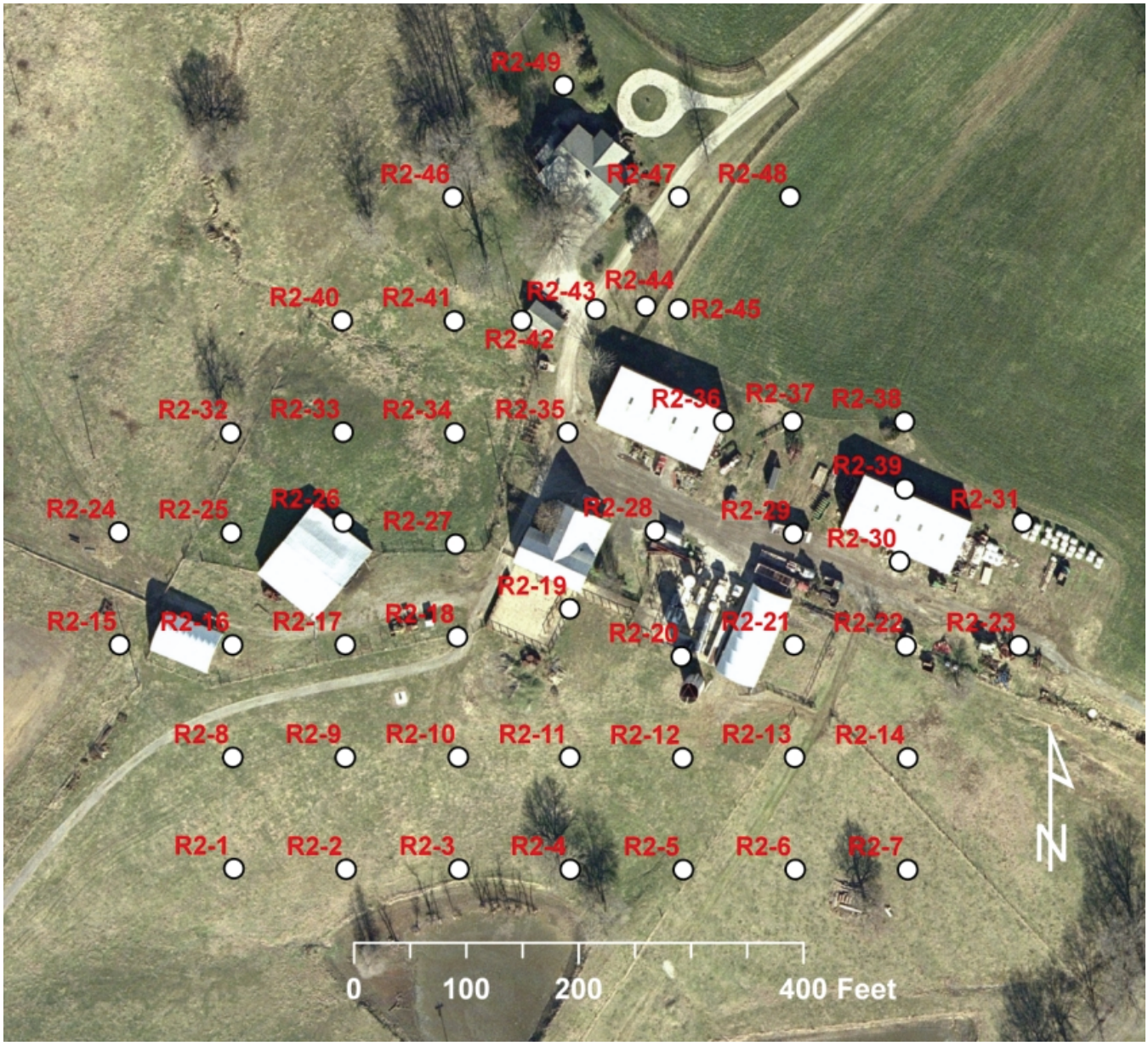

Figure 4. Locations of soil cores collected during round 2.

Groundwater Data Format

Data presented here are associated with wells DW06 through DW12. All data tables are formatted similarly. The "<" symbol indicates a concentration below the indicated method detection limit. Data presented here have been checked for quality, and suspect laboratory results were analyzed again to verify reported values.

Appendix I presents field measurements (pH, specific conductance, dissolved oxygen, temperature, and oxidation-reduction potential) for all wells. Field instruments occasionally encountered problems, and resulting measurements were not included.

Appendix J presents inorganic anion data (chloride, sulfate, fluoride, bromide, and bicarbonate) for all wells. Chloride was analyzed using two different methods, which are identified in Tables 7 and 8. Shaded cells in the chloride and bromide columns indicate that the samples were analyzed using an ion selective electrode.

Appendix K presents nitrate data for all wells. Nitrate samples were analyzed using two different methods, which are identified in Tables 7 and 8. Shaded cells in the nitrate column indicate that the sample was analyzed using an ion selective electrode.

Appendices L and M present total metals and dissolved total metals data, and pesticide data analyzed

Table 2. Coordinates, elevations, and total depths for round 2 soil cores from the abandoned dairy feedlot.

Core ID	*Latitude*	*Longitude*	*Surface Elevation (ft above sea level)*	*Total Depth (in.)*
R2-1	37.798889	–87.671734	426.59	99
R2-2	37.798893	–87.671388	422.00	100
R2-3	37.798899	–87.671041	420.01	96
R2-4	37.798904	–87.670698	419.40	89
R2-5	37.798909	–87.670350	418.07	90
R2-6	37.798915	–87.670005	417.62	98
R2-7	37.798920	–87.669659	416.66	99
R2-8	37.799161	–87.671744	435.68	98
R2-9	37.799167	–87.671398	431.27	94
R2-10	37.799173	–87.671050	429.55	98
R2-11	37.799178	–87.670706	429.00	99
R2-12	37.799182	–87.670359	428.06	98
R2-13	37.799189	–87.670014	426.58	93
R2-14	37.799193	–87.669666	425.98	96
R2-15	37.799431	–87.672100	436.36	98
R2-16	37.799436	–87.671752	437.90	99
R2-17	37.799442	–87.671405	436.76	98
R2-18	37.799467	–87.671060	434.65	95
R2-19	37.799541	–87.670716	434.08	98
R2-20	37.799430	–87.670369	434.68	97
R2-21	37.799464	–87.670023	433.90	95
R2-22	37.799467	–87.669678	432.08	97
R2-23	37.799473	–87.669330	431.71	94
R2-24	37.799706	–87.672109	432.44	99
R2-25	37.799710	–87.671763	433.25	100
R2-26	37.799742	–87.671419	434.36	99
R2-27	37.799693	–87.671071	433.20	99
R2-28	37.799736	–87.670457	435.23	97
R2-29	37.799736	–87.670032	434.89	95
R2-30	37.799673	–87.669703	434.59	97
R2-31	37.799775	–87.669326	432.41	98
R2-32	37.799954	–87.671771	424.24	95
R2-33	37.799961	–87.671425	427.26	98
R2-34	37.799965	–87.671081	422.34	99
R2-35	37.799972	–87.670733	431.86	91
R2-36	37.800006	–87.670253	432.31	99
R2-37	37.800010	–87.670042	430.35	98
R2-38	37.800015	–87.669697	431.59	98
R2-39	37.799851	–87.669691	433.62	100
R2-40	37.800234	–87.671435	415.35	98
R2-41	37.800239	–87.671089	421.60	98

Table 2. Coordinates, elevations, and total depths for round 2 soil cores from the abandoned dairy feedlot.

Core ID	*Latitude*	*Longitude*	*Surface Elevation (ft above sea level)*	*Total Depth (in.)*
R2-42	37.800243	–87.670882	427.90	96
R2-43	37.800275	–87.670654	429.86	95
R2-44	37.800279	–87.670399	427.47	97
R2-45	37.800284	–87.670500	423.81	96
R2-46	37.800541	–87.671101	428.10	97
R2-47	37.800553	–87.670405	428.28	99
R2-48	37.800559	–87.670063	422.64	95
R2-49	37.800820	–87.670767	427.71	94

using enzyme-linked immunosorbent assay (ELISA) for all wells, respectively.

Appendix N presents caffeine and isotope data for all wells. The analyte 1,7-dimethylzanthine is a metabolite of caffeine. Nitrogen ($^{15}N/^{14}N$) and oxygen ($^{18}O/^{16}O$) isotope ratios were analyzed from the groundwater nitrate molecule and are represented as NO_3-$\delta^{15}N$ and NO_3-$\delta^{18}O$, respectively.

Groundwater Elevation Data

Groundwater-level elevations were measured manually during each sampling and periodically between sampling. A downhole electronic water-level indicator measured the depth to water from a consistent measuring point. Groundwater-level elevations for all of the abandoned dairy feedlot wells are shown in Appendix O.

Rain Data

Rainfall data collected between 1998 and 2001 (phase II) are recorded in Appendix R of the phase I report (Beck and others, 2010).

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Figure 5. Locations of soil cores collected during round 3.

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Table 3. Coordinates, elevations, and total depths for round 3 soil cores from the abandoned dairy feedlot				
Core ID	*Latitude*	*Longitude*	*Surface Elevation (ft above sea level)*	*Total Depth (ft)*
R3-1	37.799327	–87.671760	437.35	33.0
R3-2	37.799162	–87.671197	428.66	26.5
R3-3	37.798858	–87.670023	415.22	24.0
R3-4	37.798936	–87.669472	417.94	31.5
R3-5	37.799265	–87.670026	429.24	31.0
R3-6	37.799422	–87.670450	434.29	33.0
R3-7	37.799668	–87.671096	433.77	30.5
R3-8	37.799819	–87.671869	427.10	28.8
R3-9	37.800314	–87.671598	413.12	17.0
R3-10	37.799759	–87.670386	434.35	34.0
R3-11	37.799485	–87.669133	429.78	31.0
R3-12	37.799896	–87.668941	428.09	32.0
R3-13	37.800783	–87.670027	426.49	31.0
R3-14	37.801136	–87.670758	416.12	23.5

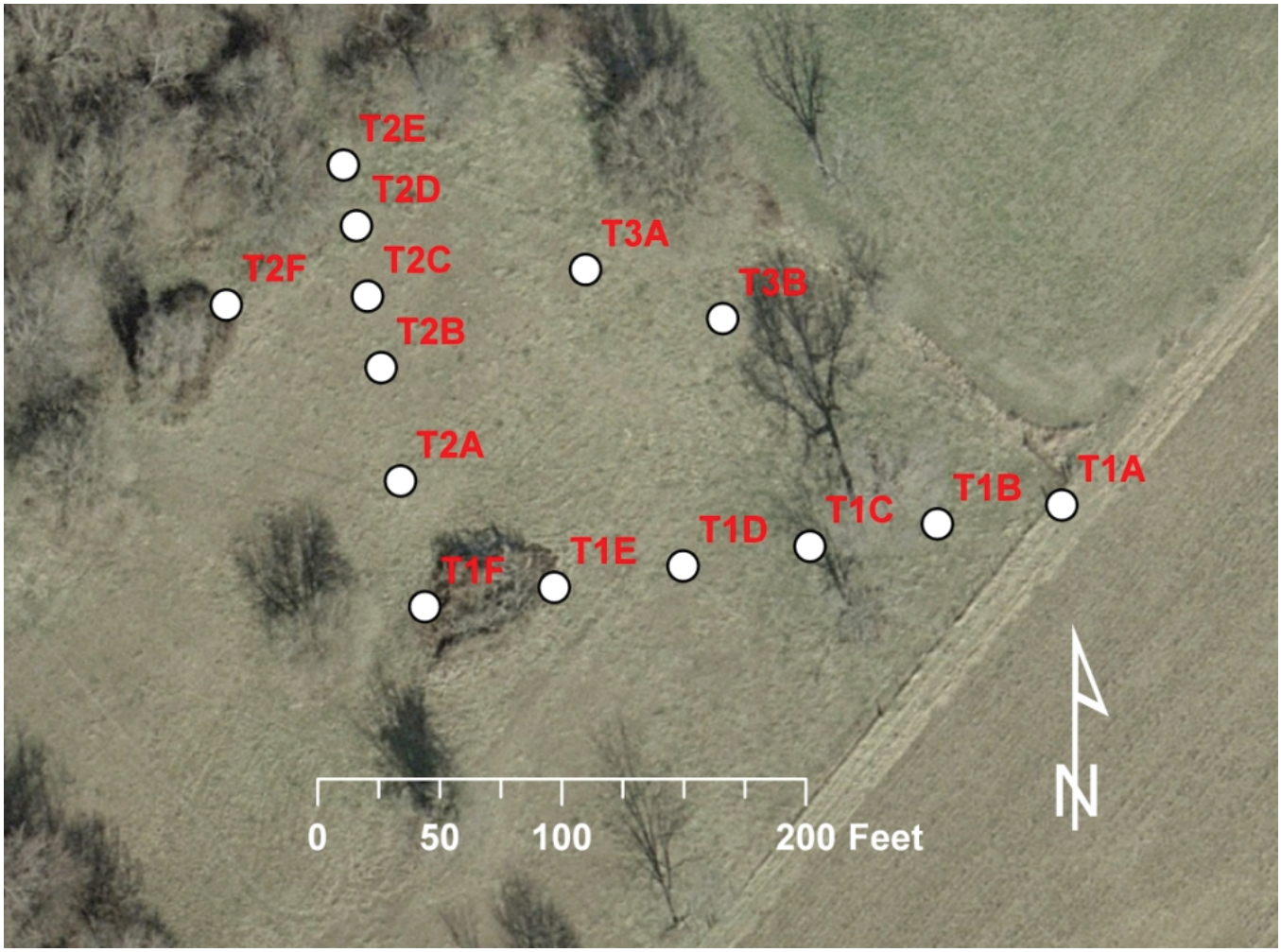

Figure 6. Locations of soil cores collected from the old homestead.

Table 4. Coordinates for the old homestead soil cores.		
Core ID	*Latitude*	*Longitude*
T1A	37.793021	–87.672757
T1B	37.792997	–87.672933
T1C	37.792969	–87.673113
T1D	37.792944	–87.673292
T1E	37.792917	–87.673474
T1F	37.792892	–87.673657
T2A	37.793033	–87.673695
T2B	37.793160	–87.673726
T2C	37.793240	–87.673747
T2D	37.793319	–87.673765
T2E	37.793387	–87.673785
T2F	37.793227	–87.673947
T3A	37.793275	–87.673439
T3B	37.793223	–87.673243

Table 5. Laboratory analytical methods used for soil sampling		
Analyte	*Method*	*Laboratory*
pH	suspension sedimentation and pipette extraction (Gee and Bauder, 1986)	Chemical and Physical Edaphology Laboratory
bioavailable phosphorus, calcium, potassium, magnesium, zinc	glass electrode in a 1:1 soil:water suspension	UK Regulatory Services Laboratory
organic matter and total nitrogen	dry combustion (Bradstreet, 1965; Nelson and Sommers, 1996)	UK Regulatory Services Laboratory
inorganic nitrogen (ammonium and nitrate)	Colorimetry (Technicon Corp., 1965) and Greiss-Hosvay method (Keeney and Nelson, 1982)	Chemical and Physical Edaphology Laboratory

Table 6. Water-well information.							
Well Name	*AKGWA No.*	*Latitude*	*Longitude*	*Surface Elevation (ft above sea level)*	*Total Depth (ft)*	*Depth to Bedrock (ft)*	*Screen or Open Borehole Interval (ft)*
DW06	0004-6993	37.798993	–87.670971	422.85	119.70	26.5	60.23–119.72*
DW07	0004-6994	37.800431	–87.669447	423.94	61.70	32.0	45.00–61.70*
DW08	0004-6995	37.799045	–87.670700	424.21	60.20	27.0	44.35–60.20*
DW09	0005-3553	37.799417	–87.670483	433.67	65.30	33.3	45.30–65.30
DW10	0005-3554	37.799384	–87.671452	436.02	65.75	33.0	45.75–65.75
DW11	0005-3556	37.800072	–87.671798	419.00	52.50	17.8	32.50–52.50
DW12	0005-3557	37.799514	–87.669125	430.34	66.60	31.6	46.60–66.60
*open borehole interval							

Table 7. Analytical methods used in Kentucky Geological Survey, Kentucky Division of Environmental Services, and University of Waterloo laboratories.				
Analyte		*Method*	*Preservative*	*Laboratory*
Total Metals and Total Dissolved Metals:		EPA 200.7 and SW846-6010A, B inductively coupled plasma	filter for dissolved metals, nitric acid, 4°C	Kentucky Geological Survey
aluminum	magnesium			
antimony	manganese			
arsenic	nickel			
barium	phosphorus			
beryllium	potassium			
boron	selenium			
cadmium	silicon			
calcium	silver			
chromium	sodium			
cobalt	strontium			
copper	sulfur			
gold	thallium			
iron	tin			
lead	vanadium			
lithium	zinc			
chloride	bromide	SW846-9056	4°C	Kentucky Geological Survey
sulfate	fluoride			
nitrate				
pesticides		ELISA	4°C	Kentucky Geological Survey
alkalinity		EPA 310.1	4°C	Kentucky Geological Survey
bicarbonate and carbonate		calculated	4°C	Kentucky Geological Survey
caffeine and metabolites		DES 5220 (Kentucky Division of Environmental Services, 2006) DES 6230 (Kentucky Division of Environmental Services, 2005)	4°C	Kentucky Division of Environmental Services
nitrogen 15 and oxygen 18		Flatt and Heemskerk (1997)	filtered, $HgCl_2$	University of Waterloo

Table 8. Analytical methods used in Western Kentucky office laboratory.		
Analyte	*Method*	*Preservative*
chloride	Orion Research Inc. (1996a)	4°C
nitrate	Orion Research Inc. (1996b)	4°C
bromide	Cole Parmer Instrument Co. (no date)	4°C