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Tetra Tech

Date: January 23, 2011

To: Angie Wingfield, Project Manager
Kentucky Division of Conservation
375 Versailles Road
Frankfort KY 40601

RE: Revised Final Close-Out Report for MOA # 0800021058; Contract C9994861-08
Hinkston Creek Watershed Planning and BMP Implementation Project

Dear Ms. Wingfield:

Attached is the Revised Final Close-Out Report for the Hinkston Creek Watershed Planning and BMP Implementation Project. The project period was November 1, 2008 until September 30, 2011. As you know, the primary project activities included:

- One year of water quality monitoring throughout the Hinkston watershed, to update KDOW and other data
- Development of the watershed assessment and management plan, in accordance with KDOW guidelines
- Implementation of a comprehensive public education and outreach program, consisting of newspaper articles, a web site, billboards, and presentations
- Cost share funding for best management practices in the upper portion of the watershed, targeting livestock access to creeks

In closing out this phase of the project, we are pleased to report that the long work of restoring Hinkston Creek has begun. We are confident that our work has helped to improve regional understanding of water quality issues in the watershed and the practices needed to address water quality impairments and threats. We hope to continue this progress as we look down the road to 2012 and the proposed additional work in the Hinkston Creek watershed.

Thanks for you consideration, and your ongoing support. If you need additional information regarding this report, please let me know.

Barry Tonning, Project Manager

Final Closeout Report

Hinkston Creek Watershed Planning and BMP Implementation Project

Grant 08-09 C9994861-08

MOA # 0800021058

November 1, 2008 to September 30, 2011

Submitted to: Kentucky Division of Conservation

Submitted by: Barry Tonning, Tetra Tech

January 23, 2012

A. Title Page

Grant Number: C9994861-08

Title: Hinkston Creek Watershed Plan & BMP Implementation Project

Application #: 08-09

Grant / MOA #: 0800021058

Project Period: November 1, 2008 to September 30, 2011

Submitted By: Barry Tonning, Project Manager

Colville Covered Bridge over Hinkston Creek, Bourbon County

Statement Regarding This Project

The Environmental and Public Protection Cabinet (EPPC) and Tetra Tech do not discriminate on the basis of race, color, national origin, sex, age, religion, or disability. The EPPC and Tetra Tech will provide, on request, reasonable accommodations including auxiliary aids and services necessary to afford an individual with a disability an equal opportunity to participate in all services, programs and activities.

To request materials in an alternative format, contact the Kentucky Division of Water, 14 Reilly Road, Frankfort, KY 40601 or call (502) 564-3410, or contact Tetra Tech at (703) 385-6000 or email barry.tonning@tetratech.com.

Funding for this project was provided in part by a grant from the U.S. Environmental Protection Agency (USEPA) through the Kentucky Division of Water, Nonpoint Source Section and the Kentucky Division of Conservation to Tetra Tech as authorized by the Clean Water Act Amendments of 1987, §319(h) Nonpoint Source Implementation Grant # C9994861-08. Mention of trade names or commercial products, if any, does not constitute endorsement.

This document was printed on recycled paper. It is also available electronically.

B. Acknowledgments

This project, which was funded by the Kentucky Division of Conservation and Division of Water, provided support for development of a watershed-based plan, implementation of best management practices to protect water quality, and outreach to increase awareness and knowledge regarding polluted runoff control measures for Hinkston Creek in east-central Kentucky. The project would not have been possible without the cooperation and support of the Montgomery County Conservation District Supervisors and Faye Ferrell, their office manager, whose wisdom, advice, guidance, and administrative efforts aided greatly in moving the project forward. In addition, project staff recognize the technical and other support provided by Edsel Boyd and Gary McFarland of NRCS, Ron Catchen of the UK Extension Service, Mt. Sterling Mayor Gary Williamson, Montgomery County Judges Executive Floyd Arnold and B.D. Wilson, Steve Lane of the Mt. Sterling Department of Public Works, Troy Wilson of the Montgomery County Road Department, Jamie Vinson of the Mt. Sterling Advocate newspaper, retired NRCS staffer Don Crabtree of Mt. Sterling, and Ramona Hurst of the Bourbon County Conservation District. The US Environmental Protection Agency is also recognized for providing funding for the Hinkston Creek Project through Section 319(h) of the Clean Water Act.

In addition, project staff would like to recognize the efforts of those in the agricultural community who installed new management practices or improved existing ones, including those who participated in the cost share program. Their willingness to implement measures to reduce polluted runoff and protect drainage systems and the stream network are absolutely essential to improving water quality. Finally, the cooperation and support of the people in the Hinkston Creek watershed must be acknowledged and appreciated. We thank them for their interest and involvement in this project, and wish them all the best in the future.

Montgomery County Conservation District Supervisors Shannon White, Barry McCoy, Linda Webb, Faye Ferrell (office manager), Mike Gabbard, Danny McCoy, O.H. Caudill, and Robert Amburgey with creek crossing and watershed signs purchased and installed as part of the Hinkston Creek Watershed Project.

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D. Executive Summary

Hinkston Creek drains 260 square miles of rolling pasture land in the Outer Bluegrass region of Kentucky northeast of Lexington. Hinkston Creek originates in the southern and western portions of Montgomery County, flows through the city of Mt. Sterling, and then proceeds northward between Bourbon and Nicholas counties, flowing through Millersburg and eventually joining with Stoner Creek to form the headwaters of the South Fork of the Licking River in the Ohio River Basin. The watershed is predominantly agricultural, with only four small towns with a combined population of less than 20,000.

Hinkston Creek has been listed as impaired for many years due to poor biological conditions and elevated levels of fecal coliform bacteria, sedimentation, and nutrients linked to low dissolved oxygen and organic enrichment. The Hinkston Creek Project was developed to identify, characterize, and address water quality problems in the watershed by analyzing pollutants and sources, assessing land use/cover and management practices, calculating and apportioning pollutant loads, developing a watershed plan, and implementing portions of the plan based on available resources.

Staff from the Hinkston Creek Project developed a *Quality Assurance Project Plan* (QAPP) and worked with Morehead State University to develop a one-year water quality monitoring program to provide current data on a wide range of conditions to support a watershed assessment. Staff also used the data to develop a watershed management plan, following guidance issued by the Kentucky Division of Water and US EPA, which specifies the management practices needed to address water quality impairments and threats. The plan met the nine key elements identified by both agencies, and was approved by the Division of Water in July 2011.

Because the towns and nearly all of the farms are small – and not subject to NPDES or other water quality regulations – knowledge and use of basic surface water quality protection measures has been somewhat low. As a result, a key part of the Hinkston Creek Project was improving public awareness and knowledge regarding current water quality conditions and the practices needed to address impairments and threats. Project staff addressed the need for improved awareness, education, and outreach through a multi-pronged approach, including weekly newspaper columns that mixed water quality issues with area historical events, a series of billboards featuring positive "thank a farmer" for adopting BMP messages, an informational web site with water quality monitoring and other information, signage installed at watershed boundaries and creek crossings, and presentations to area groups on the watershed and the project.

Finally, the project sponsored a cost share program for agricultural producers interested in implementing plan-based BMPs on land in the upper portion of the watershed. Project staff worked with the Montgomery County Conservation District to identify projects and distribute funds through a process that closely matched the existing Kentucky State Agricultural Cost Share Program. A total of 14 projects were implemented during the summer of 2011, nearly all of which were related to restricting livestock access to the creek and its tributaries through exclusion fencing, controlled crossings, and provision of alternative water sources in area pastures. Project staff plan to expand the outreach, education, and BMP cost share programs into the middle and lower reaches of the watershed during 2012 – 2014.

E. Introduction & Background

Introduction

The Hinkston Creek watershed encompasses 260 square miles of rolling pasture land in the Outer Bluegrass region of Kentucky, located in east-central Kentucky, northeast of Lexington (Tetra Tech, 2011). Hinkston Creek originates in the southern and western portions of Montgomery County, flows through the city of Mt. Sterling, and then proceeds northward along the Bourbon-Nicholas county line to join with Stoner Creek to form the headwaters of the South Fork of the Licking River. The South Fork Licking River then flows generally northward toward Covington, KY to drain into the Licking River, which discharges shortly thereafter into the Ohio River.

The 2010 Integrated Report to Congress (KDOW, 2010) on the *Condition of Water Resources in Kentucky* identified several lengths of waterways within the Hinkston Creek watershed as impaired to some degree for fecal coliform, sedimentation/siltation, and/or nutrient/eutrophication biological indicators. Water bodies designated as impaired are not meeting their designated uses for activities such as fishing, wading, swimming, or use as a domestic water supply.

Project Purpose

In an effort to proactively address the identified waterway impairments and improve water quality, Tetra Tech – with support from the Kentucky Division of Conservation and the Kentucky Division of Water – developed a project to improve outreach and education regarding water quality, produce a Hinkston Creek Watershed Assessment and Management Plan, and provide cost share funding to implement BMPs specified by the plan in the upper portion of the watershed. Tetra Tech selected this project for a variety of reasons: staff working in the watershed were aware of its condition and expressed interest in addressing identified problems; staff have been working with watershed protection and restoration efforts in nearby counties and were encouraged by their progress; Tetra Tech has considerable experience in conducting watershed assessments and developing management plans; the need for basic outreach, awareness, and education services – another area of expertise – was deemed to be critical to success; and the climate for identifying needed management practices and encouraging their implementation was judged as favorable.

Project Objectives and Goals

The overall goal of the project was identify and address impairments in Hinkston Creek and its tributaries. Key objectives supporting the goals were 1) the development of a Watershed-Based Plan addressing EPA's nine key elements; and 2) implementation of selected BMPs for the upper portion of Hinkston Creek. As such, the project sought to identify, characterize, and address KDOW-listed water quality impairments in the upper Hinkston Creek watershed through the following activities:

- Analyzing pollutant types and possible sources in the drainage area
- Assessing land uses, land cover, and land management practices
- Calculating and assigning loads for parameters linked to water quality impairments
- Developing a watershed-based plan to address key stressors and sources
- Implementing portions of the plan through selected demonstration projects
- Supporting the project through targeted awareness, education, and outreach
- Adjusting the approach as appropriate, based on load reductions from BMPs

Other Pertinent Work

Data collected in the past in the upper Hinkston Creek (Licking River Watershed Watch, undated) watershed indicated that it was likely impacted by agriculture, contaminated urban runoff from Mt. Sterling (which is not subject to KPDES stormwater regulations), construction runoff, improper waste disposal, habitat modification, and other uncharacterized nonpoint pollution sources (Gateway District Health Department, 1998; KDOW, 2008). In its *Integrated Report on Water Quality,* the Kentucky Division of Water (2010) listed a segment of Hinkston Creek in Montgomery County (river miles 51.5 to 65.9) as impaired due to poor habitat conditions for warm water aquatic species. Other Hinkston Creek segments in Bourbon and Bath counties (river miles 0 to 12.4; 20.8 to 31.0; 41.8 to 49.1) were also listed as impaired, as well as several minor Hinkston Creek tributaries (e.g., Black's Creek, Grassy Lick Creek, Boone Creek). The causes of impairment included siltation, organic enrichment, and nutrients, among other causes. There are a few minor – mostly stormwater – point source discharges located in the Hinkston Creek watershed, but KY DOW publications list impairments as primarily related to agriculture.

Despite these impairments, there has been no TMDL or watershed plan developed for the Hinkston Creek watershed. The KY DOW has initiated work on a TMDL, according to the 2006 Integrated Report, by collecting data. The primary intent of this project was to conduct the studies needed to determine the nature and extent of the impairments, develop a plan to address them, and implement selected management practices – including education and outreach – as indicated by the studies and cited in the watershed-based plan.

The work conducted in the Hinkston Creek watershed was informed by similar watershed assessment, planning, and management activities conducted by the Strodes Creek Conservancy in Clark County, the Dry Fork Watershed Project in Rowan County, and various projects conducted by the University of Kentucky, the Kentucky Division of Water, Kentucky Division of Conservation, and Tetra Tech. Staff drew on these and other examples in crafting the approach for developing project activities, such as the education/outreach, watershed assessment and management plan, and the BMP cost share program.

F. Materials & Methods

Description of Project Area

The watershed lies northeast of Lexington KY, straddling the Outer Bluegrass physiographic region. Approximately 70 percent of the Hinkston Creek watershed is covered with pasture, hay, and fallow fields and 2 percent is cultivated crops (i.e., 72 percent of the watershed is devoted to agricultural uses). Low intensity development comprises 7 percent of the watershed, while higher intensity development makes up only 0.5 percent of the watershed and is limited to areas in Mount Sterling, Carlisle, Millersburg, and Sharpsburg. Forested land and areas covered by shrubs make up approximately 20 percent of the watershed. Approximately 21,000 people live in the Hinkston Creek watershed. The population is generally located in developed areas and is sparse throughout the remainder of the watershed. Among the permitted dischargers in the watershed are four municipal sewage treatment plants (STP), three are permitted at less than 1 MGD and one, the Mt. Sterling STP, is permitted for over 1 MGD of discharge.

Hinkston Creek is about 70 miles long. In general, the stream network in the watershed consists of a classical dendritic drainage pattern, with primary mainstem tributaries measuring about five miles in length, with secondary tributaries one mile in length. Average land slope lengths range from 500 to around 1,500 feet. Water quality impacts are mostly linked to agricultural practices, with localized heavy impacts on stream reaches in Mt. Sterling, Carlisle, and Millersburg. Tobacco production in the watershed peaked during 1998 – 2002, and has fallen by approximately two-thirds since then, a fairly significant development with ramifications involving sediment runoff from row crop land (probably less), livestock impacts to waterways (probably greater), and regional agricultural economic output (probably less, but partially offset by greater cattle production).

The 2010 Integrated Report to Congress on the Condition of Water Resources in Kentucky identified several lengths of waterways within the Hinkston Creek watershed as impaired to some degree for fecal coliform, sedimentation/siltation, and/or nutrient/eutrophication biological indicators (KDOW, 2010a). Additional information on Hinkston Creek has been collected by other organizations. A survey and mapping program undertaken by the Gateway District Health Department as part of a five-county nonpoint program found widespread erosion along the banks of feeder streams and the creeks themselves, little riparian cover or buffers along waterways, relatively unrestricted cattle access to sensitive bank areas, confined animal feeding operations adjacent to streams, row cropping on erodible lands and riparian areas along waterways, and poor manure management on farms throughout the Hinkston Creek watershed. Macro invertebrate sampling conducted by Gateway District Health Department staff at sites in Hinkston Creek found that sites were mostly devoid of both moderate and high quality organisms (GDHD, 1994, 1995).

Tetra Tech divided the Hinkston Creek watershed into six major subwatersheds, in order to facilitate a finer level of analysis. The watershed and six subwatersheds are shown in Figure 1. Figure 2 shows the impaired waterways.

Figure 1. The Hinkston Creek watershed and major subwatersheds.

Figure 2. Impaired waterbody segments in the Hinkston Creek watershed.

Description of Methods Used to Obtain Results

The processes for conducting the watershed assessment, characterization of stressors and sources, and identification of BMPs for this project were generally consistent with standard practices for developing watershed management plans. Monitoring data collected included the conventional suite of measurable instream parameters (e.g., flow, temperature, dissolved oxygen, pH, conductivity, nitrogen species, total phosphorus, total suspended solids; Tetra Tech, 2009). Pollutant load analyses were processed via the Soil and Water Assessment Tool (SWAT) modeling program.

In addition to the more conventional studies conducted during the project, there were some distinctly different – and somewhat innovative – assessments and activities conducted. A full discussion of these is contained in the *Hinkston Creek Watershed Assessment and Management Plan* (Tetra Tech, 2011); a summary appears below:

<u>Awareness and education</u>. The project awareness and education program was extensive. East central Kentucky has been slow to adopt pasture and grazing practices designed to minimize water quality impacts, such as rotational grazing, managing grass stands, and restricting livestock access to streams. In addition, general land management practices have not included maintenance of stabilized or vegetated ditches and drainage channels (including natural stream corridors), control of sediment runoff from disturbed areas, storage of materials in a manner that reduces polluted runoff, and other practices that prevent nonpoint source pollution. This project included an extensive awareness, education, and outreach component, comprised of more than two dozen newspaper columns developed to create interest in the creek and its history; a web site containing assessment, BMP, and other information; five "thank a farmer" billboards, designed to convey a "positive reinforcement" message regarding BMP adoption; and several dozen permanent "entering the watershed" and stream crossing signs, to constantly remind people about the creek and its drainage area.

<u>Riparian buffer assessment</u>. A riparian buffer assessment and deficiency analysis was produced, using aerial photography to determine canopy cover presence/absence and buffer zone widths. The stream layer used for this analysis was the high resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset (NHD; USGS, 2007). These streams were buffered to create polygons representing riparian buffer areas for this analysis. A 100-foot buffer was created along each side of the mainstem of Hinkston Creek downstream from the Grassy Lick/Hinkston confluence.

A 50-foot buffer was created along each side of Hinkston Creek upstream from the Grassy Lick/Hinkston confluence and along all tributaries within the Hinkston Creek watershed. A Multi-Resolution Land Characteristics Consortium (MRLC) geospatial dataset known as the Landscape Fire and Resource Management (LANDFIRE) map, that provides vegetation and wildland fuel maps was obtained to determine riparian buffer health status (impacted vs. intact). Using methodology from a recent study (Roy et al., 2005), any vegetated layers with less than 30 percent coverage were lumped together with other impacted riparian habitat LULCs (e.g., developed, open space, pasture/hay, etc.). The percent buffer deficiency within each assessment subwatershed was estimated using GIS. The riparian buffer deficiency, at the assessment subwatershed level, ranges from 45 percent to100 percent throughout the Hinkston Creek watershed. The riparian buffer deficiency for the entire watershed is 75 percent.

Onsite wastewater treatment high-risk areas. Onsite wastewater treatment system potential risk to water quality was assessed, via mapping analyses that considered system densities (i.e., number per square mile), system age, and proximity to surface waters. Prioritization was based on level of household density, closeness to streams, and closeness to karst topography (to account for impacts to groundwater).

Publicly serviced areas with centralized wastewater treatment were eliminated from prioritization based on data obtained from the Water Resources Information System, which is supported by the Kentucky's Area Development Districts and KDOW (WRIS, 2010). Household density was calculated for areas outside of public sewer line boundaries that were surrounding the municipalities – within 2 miles of publicly serviced areas in Mount Sterling and within 1 mile of publicly serviced areas for all other municipalities. Household density was not calculated across the entire watershed because septic failure impacts to water quality were assumed to be low in agricultural areas where household density is less than 1 house per acre.

Data for calculating household density was obtained from the U.S. Census Bureau's 2000 Census Block data. Closeness to streams was calculated using the 1:24,000 streams data layer created by the United States Geological Survey (USGS, 2007). Closeness to karst was calculated using a geologic data layer developed by the Kentucky Geological Survey. Only areas having a household density greater than one household per acre were considered and household density, closeness to streams, and closeness to karst geology received equal weights throughout the prioritization process.

Eight census blocks within the Hinkston Creek watershed received prioritization ratings at levels of medium priority (7 blocks) and high priority (1 block). All other census blocks included in the prioritization analysis received ratings of low priority due to low levels of household density (<1 house per acre).

Field assessment of stream channel condition. Project staff identified areas of stream channel erosion, using a modified version of the NRCS (1999) *Stream Visual Assessment Protocol,* focusing on streambank stability, presence of cattle, and riparian vegetation. The method provided a rapid screening procedure composed of three basic protocols, intended to identify stream channels and corridors with 1) significant bank erosion, 2) little or no riparian vegetation, and 3) impacts from heavy livestock use.

Assessment field work was conducted during the November – December period, to make use of the better visibility and lower flow conditions after the leaves had fallen. Field staff has access each reach by vehicle as roadways permit, and then walked each intermittent and perennial channel as far as possible, given access and property constraints. Starting and ending points for each reach assessed were described by latitude and longitude, using a field GPS unit. The length of each reach assessed varied, depending on the overall level of consistency among the three parameters. For example, where a stream reach traverses a pasture and conditions regarding channel erosion, riparian vegetation, and manure presence are somewhat similar, that reach was documented as a single assessment unit or reach. Numeric scores for each parameter were entered into the field report, along with the lat/long information, date, weather conditions, field staff name(s), and any significant observations. Assessment information gathered under the method can be used to better target funding and other support for the implementation of best management practices that reduce nutrient, sediment, and bacteria inputs to Hinkston Creek.

Stream Visual Assessment Reporting Form **Tetra Tech**

Watershed:	Hinkston Creek Watershed		**General Key**
Date:		**Weather:** Clear Cloudy Lt Rain Mod Rain Fog	1 = Very Poor
Staff Name:			3 = Poor
Sub-Wtrshd:			5 = Moderate
Trib Name:			7 = Good
Sub-Trib:			10 = Very Good
USGS Topo:			

Upstream Lat	Upstrm Long	Downstr Lat	Downst Long	Bank Cond	Rip Zone	Manure Pres

Figure 3. Stream visual assessment field form.

Remote sensing analysis of high-risk stream corridors. A broader, desktop analysis of high-risk stream channel areas was also conducted via mapping work that analyzed riparian vegetation (i.e., canopy cover), cattle access points, and property ownership records. The riparian deficiency data described above was overlaid with imagery from the National Agriculture Imagery Program (NAIP), downloaded from the USDA: NRCS Geospatial Data Gateway website. This was used to assess the intensity of impact on riparian areas within the Blacks and Boone Creek watersheds.

The imagery covers all of Bourbon County and was acquired by NAIP during the agricultural growing season in 2010. Reaches within each watershed were visually scanned against the NAIP imagery to assess the land cover context for riparian buffers. Impacted riparian areas were divided into four levels of impact based on stress conditions observable from the aerial imagery, such as proximity of intense tilling and/or grazing to the stream edge, cattle access points, and lack of tree or shrub cover in the riparian buffer. Best professional judgment was used to assign a level of impact to each reach segment according to the definitions of levels of impact.

Cattle access points were visible along some reach segments from the aerial imagery. Evidence of bare stream or pond banks that were within observable pasture boundaries were considered cattle access points. These points were highlighted for both the Blacks and Boone Creek watersheds. To identify landowners who might be approached to discuss field conditions and possible BMP adoption, parcel boundaries were obtained from the Bourbon Counter Property Valuation Administrator. A table identifying high risk areas and parcel owners was developed, and will be used during 2012 to further promote BMP implementation. Figure 4 shows the results of the mapping study.

Figure 4. Level of riparian buffer impact for reaches in the Blacks Creek watershed.

Description of Specialized Material Used in Data Collection

Materials used in this project included those associated with the following major project activity categories: water quality monitoring, watershed plan development, outreach and education, and BMP implementation. The following subsections discuss the equipment and materials used for each.

Water quality monitoring. Field sampling and measurements and collection of laboratory samples was conducted by Tetra Tech staff, scientists from Morehead State University, and/or trained university students. Sampling followed the procedures and protocols outlined in the *Quality Assurance Project Plan for the Hinkston Creek Watershed Project* (Tetra Tech, 2010). At each site, samplers waded into the stream, approaching from a downstream location, to take measurements and samples.

Field measurements were taken with a multi-parameter digital probe in the middle of the stream, below the water surface while standing downstream of the sampling location. Results were recorded immediately on the field forms. Grab samples were taken in a similar manner, taking care not to disturb the area upstream of the sampling location and not to touch or otherwise contaminate the sample container or lid. Field sampling procedures and practices followed the *Kentucky Ambient/Watershed Water Quality Monitoring Standard Operating Procedure Manual* (Kentucky Division of Water, 2005). Laboratory procedures and practices followed Morehead State University Water Testing Laboratory *Quality Assurance Manual* (Morehead State University, 2008). Materials and equipment used for the various parameters analyzed include:

> *Escherichia coli*: EPA-approved, sterile sample containers were distributed to samplers prior to sampling along with a pre-printed Chain of Custody form, sampling instructions, and sample delivery logistics information. The samples were immediately chilled in an ice chest at a temperature of 1° to 4°C for transport back to the microbiology lab. All samples were processed for the assessment of E. coli via membrane filter technique within six hours of collection.
>
> *Total Suspended Solids:* TSS was collected by wading into the center of the stream. The sampler dipped a clean 250-ml or 100-ml polyethylene bottles upstream at approximately mid-depth. The pre-labeled bottle was then be capped. The opened mouth of the container was at all times be upstream of the sample collector, sampling apparatus, and any disturbed sediments.
>
> *Stream Discharge:* A Swoffer Model 2100 and cross-sectional measurements was used to determine discharge each time water quality samples are collected. The neutrally buoyant object method was used to measure velocity in streams that are too shallow or slow for flow meters, too deep and swift to safely wade into, or where working from a bridge is deemed unsafe. In these cases, velocity was measured by timing neutrally buoyant objects as they float through a measured stream reach.

Nutrient Measurements: Water samples were collected using clean, acid washed polyethylene bottles. A total of 500-mL was collected at each site. The field sampler waded to the center of the stream and, while facing upstream, dipped the pre-labeled bottle to mid depth to fill the container completely. If the stream was too deep and/or the velocity was too high for wading, the bottle was attached to a rod and the sample collected as close as possible to the center of the stream. Samples were preserved and stored as outlined in the QAPP.

Other Measurements: Handheld YSI 556 units were used to record temperature, conductivity, pH, and dissolved oxygen at the same time and location that nutrient and bacteria samples were collected. Readings were taken in the middle of the stream, below the water surface, at the head of a riffle or within a run.YSI units were calibrated for pH and DO before and after each use since both instruments tend to require frequent calibration.

Watershed plan development.

The *Soil and Water Assessment Tool* (SWAT) software and modeling program was used to assess pollutant loads. A variety of mapping, database, and other tools were used to produce the watershed assessment and management plan, including:

- A high resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset (NHD; USGS, 2007)
- A Multi-Resolution Land Characteristics Consortium (MRLC) geospatial dataset known as the Landscape Fire and Resource Management (LANDFIRE) map.
- The Water Resources Information System, which is supported by the Kentucky's Area Development Districts and KDOW (WRIS, 2010).
- The U.S. Census Bureau's 2000 Census Block data.
- A geologic data layer developed by the Kentucky Geological Survey.
- The NRCS (1999) *Stream Visual Assessment Protocol.*
- The National Agriculture Imagery Program (NAIP), downloaded from the USDA: NRCS Geospatial Data Gateway website.
- Property records from the Bourbon Counter Property Valuation Administrator.
- The Kentucky Division of Water NPDES discharger database.

Outreach and education.

The outreach and education program, which is described in more detail in the previous section, included newspaper articles, billboards, a web site, and state highway department approved signs at highway bridge creek crossings and on state highways along the perimeter of the watershed.

The signs were purchased from Rocal Inc. of Frankfort, OH, and were standard highway aluminum signs with reflective lettering and borders on a green background (see Figure 5). The full-sized billboards (Figure 6) were rented from Lamar Inc. and Magic Media Inc., and consisted of original project-produced high-resolution photographs of local agricultural scenes and text.

Figure 5. Specifications for the watershed entry and creek crossing signs.

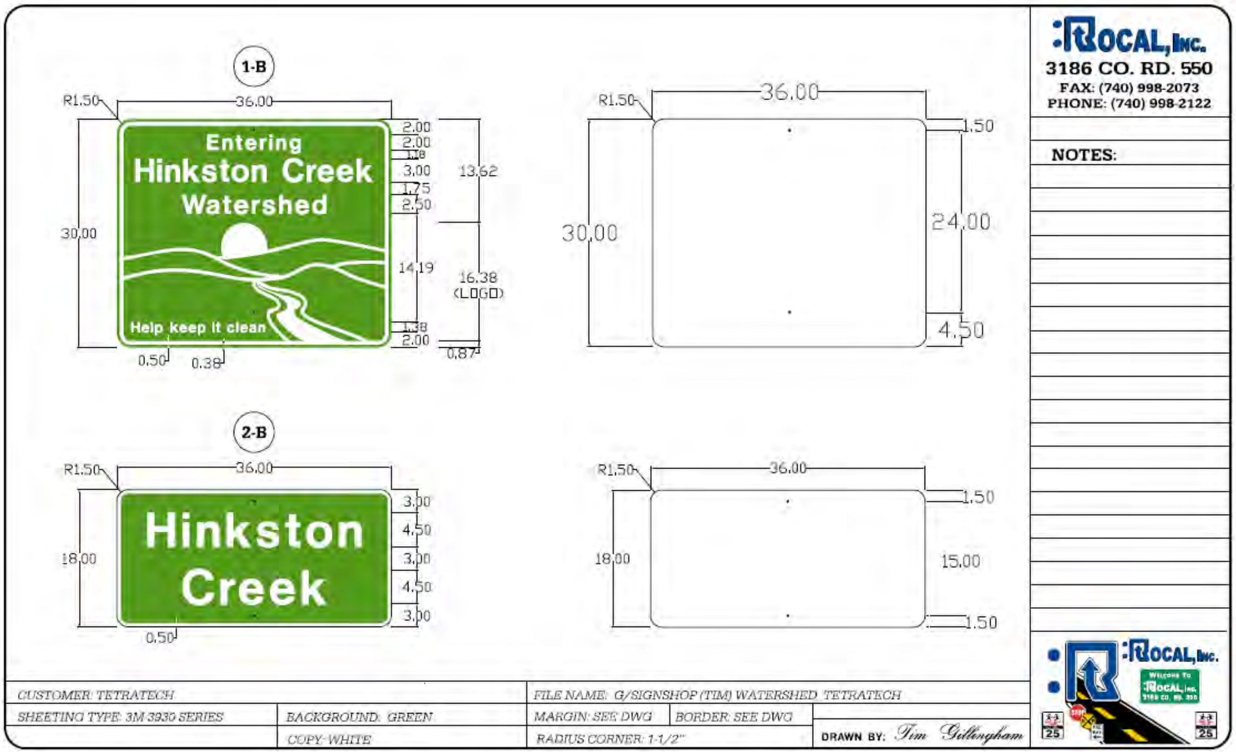


Figure 6. Example of one of the five awareness billboards sponsored by the project.

BMP implementation.

The Hinkston Creek Project directly supported the installation of stream channel livestock restriction fending, alternative water sources at those locations, and heavy use area protection for the watering sites. Specifically, this entailed the construction of 14,128 ft of fence, 5,480 ft of waterline for 6 stock watering tanks, and development of 7 heavy use areas and two stream crossings. Installation of the heavy use areas and stream crossings required several hundred tons of rock and 5 rolls of filter fabric. The fencing work involved use of 6 inch pressure-treated posts and barbed wire or woven wire. Figure 7 illustrates BMP implementation projects installed during the summer of 2011 in the Upper Hinkston Creek watershed.

Figure 7. Examples of riparian fencing and alternative water development BMP projects.

Project-supported BMPs were installed at the following farms in Montgomery County during the project period. It is not known how many other, non-project BMPs were installed due to project outreach and education efforts. The Montgomery County Conservation District handled all project applications, review and approval, and payment authorization.

- Laura Lee Brother — Fencing, Watering Tanks, Stream Crossing
- Ronnie & Earl Donaldson — Fencing, Stream Crossing
- Berkley Mark — Manure Runoff Protection, Watering Tanks
- Allen Prewitt — Fencing, Manure Runoff Protection, Stream Crossing

G. Results & Discussion

This section of the Final Report will primarily discuss the findings of the watershed assessment conducted in association with development of the watershed management plan. Detailed information on the results below are contained in the *Hinkston Creek Watershed Assessment and Management Plan* (Tetra Tech, 2011).

<u>Data collection</u>

Monitoring data used throughout the development of this watershed plan was derived from four sources – the Kentucky Division of Water (KDOW), the Licking River Watershed Watch (LRWW), Morehead State University (MSU) and the United States Geological Survey (USGS). Records for flow, sediment, phosphorus, nitrogen, fecal coliform/bacteria, and dissolved oxygen (DO) were collected. Water quality data from two of the monitoring groups (KDOW and MSU) was combined for analysis because these groups used comparable methods for collection and processing; KDOW data was collected in 2004-2005 and MSU data was collected in 2009-2010. USGS flow data was available for use from 1991-2010. Bacteria data collected by LRWW and MSU were collected in 2006-2010 and 2009-2010, respectively.

Discharge data was obtained for the four STPs located within the Hinkston Creek watershed from the United States Environmental Protection Agency (USEPA) Permit Compliance System (PCS). The data analyzed for this watershed plan were measured between 1989 and 2010. KDOW performs stream assessments to evaluate how well a waterbody is supporting aquatic life. Assessments are performed according to KDOW (2008) and include measures of stream physical characteristics, aquatic habitat, algae, periphyton, macroinvertebrates, and fish. KDOW considered aquatic habitat scores when evaluating use support in the Hinkston Creek watershed.

These data are considered in this watershed plan along with substrate composition and other stream characterization measures. Observations during a single sampling event were recorded at four locations in 1999 and eight locations in 2004. Only one sampling event was recorded for each station, either in 1999 or 2004. Habitat scores were recorded for both years while substrate composition and other physical characteristics were only recorded in 2004.

<u>Nitrogen loads</u>

The KDOW and MSU observations of flow and concentration were used to calculate load. These are in-stream calculations of load, with no separation of point and nonpoint source contributions. These loads were averaged for each monitoring station and then converted to unit-area loads). These values were developed into a plan view map to convey spatial location along with the magnitude of loading. The benchmark unit area load for total nitrogen is 4.1 pounds per acre per year. The headwater portion of Hinkston Creek and Town Branch each result in a unit area load of approximately 10 pounds per acre per year, the highest of the KDOW monitoring period. The MSU data provided a similar unit area loading for the headwater of Hinkston Creek (HKC-12) of 11.4 pounds per acre per year. However, the largest unit area loading from the MSU monitoring was attributed to Blacks Creek at almost 17 pounds per acre per year. Visual assessments for both Blacks Creek and Town Branch indicate heavy livestock pasture operations along the channels, with free cattle access to the streams, which could be linked to elevated TN loading in these reaches. In addition, the MSU data show an increase in the mainstem of unit area loading moving downstream, which suggests elevated nitrogen loading contributions in the lower portion of the drainage area.

Phosphorus loads

KDOW and MSU observations of flow and concentration were used to calculate load. These are in-stream calculations of load, with no separation of point and nonpoint source contributions. These loads were averaged for each monitoring station and then converted to unit-area loads. These values were developed into a plan view map to convey spatial location along with the magnitude of loading, and to convey the relationship to the TP loading benchmark. The benchmark unit area load for total phosphorus is 0.5 pounds per acre per year. Town Branch monitoring stations (05016028 and 05016024) resulted in the highest unit area load of the KDOW monitoring period with loadings of approximately 1.4 and 0.57 pounds per acre per year, respectfully. One location along the mainstem of Hinkston Creek downstream from the City of Mount Sterling (05016027) also exceeded the benchmark value with a loading of approximately 0.57 pounds per acre per year. The largest unit area loading from the MSU monitoring was once again attributed to Blacks Creek (HKC-04) at almost 0.56 pounds per acre per year; all other MSU monitoring stations were below the benchmark value.

Total suspended solids load

KDOW and MSU observations of flow and concentration were used to calculate load. These are instream calculations of load, with no separation of point and nonpoint source contributions. These loads were averaged for each monitoring station and then converted to unit-area loads. These values were developed into a plan view map to convey spatial location along with the magnitude of loading. The monitoring data did not capture storm flow events which should be noted when reviewing the information in this section compared with that in the next section from the SWAT simulation. The results from the SWAT simulation include high flow events. The benchmark unit area load for total suspended solids is 40.8 pounds per acre per year. Town Branch monitoring stations (05016028 and 05016024) resulted in the highest unit area load of the KDOW monitoring period with loadings of approximately 145 and 115 pounds per acre per year, respectively. Additional locations that exceeded the benchmark value during the KDOW monitoring period were the headwater portion of Hinkston Creek (05016020), the Twin Oaks Subdivision/Industrial Park Tributary to Hinkston Creek downstream from the City of Mount Sterling (05016021), and Bennett Branch (05016023). The largest unit area loading from the MSU monitoring was the headwater portion of Hinkston Creek (HKC-12) at approximately 64 pounds per acre per year. The stations located at the mouth of Hinkston Creek (HKC-01) and along Blacks Creek (HKC-04) also exceeded the benchmark value during the MSU monitoring time period. A comparison of the estimated monitoring data loads and the total habitat scores suggests a low correlation between the two except in the Hinkston Headwaters watershed above Mt. Sterling and Town Branch.

Riparian buffer assessment

Perhaps the most revealing and significant analysis conducted for the project was the riparian buffer assessment and deficiency analysis, d, using aerial photography to determine canopy cover presence/absence and buffer zone widths. The stream layer used for this analysis was the high resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset (NHD; USGS, 2007). These streams were buffered to create polygons representing riparian buffer areas for this analysis.

A hypothetical 100-foot buffer was created along each side of the mainstem of Hinkston Creek downstream from the Grassy Lick/Hinkston confluence. A hypothetical 50-foot buffer was created along each side of Hinkston Creek upstream from the Grassy Lick/Hinkston confluence and along all tributaries within the Hinkston Creek watershed. A Multi-Resolution Land

Characteristics Consortium (MRLC) geospatial dataset was obtained to determine riparian buffer health status (impacted vs. intact). Vegetated layers with less than 30 percent coverage were lumped together with other impacted riparian habitat land use/coverages (e.g., developed, open space, pasture/hay, etc.). The percent buffer deficiency within each assessment subwatershed was estimated using GIS. The riparian buffer deficiency, at the assessment subwatershed level, ranges from 45 percent to100 percent throughout the Hinkston Creek watershed. The riparian buffer deficiency for the entire watershed is 75 percent.

<u>BMP cost and benefit analysis</u>

Table 1 presents the results of the cost-benefit analysis by BMP group. Annual loads reduced are provided with the cost-effectiveness ratios (cost per unit load removed) in parentheses. These results are organized by type of pollutant, either 1) surface and cattle sources or 2) bank erosion. The 20-year and annualized costs are provided as both "Full Cost" and "EQIP Cost."
Group 4 is estimated to provide the greatest pollutant load reduction per dollar spent for TSS, TN, and TP from surface runoff and cattle sources. Group 1 is the next most cost-effective group for surface and cattle sources (TSS, TN, TP, and *E. coli*), which is an expected outcome since use exclusion, rotational grazing, and pasture renovation are relatively inexpensive practices. In addition, the act of limiting cattle access to streams should provide a large reduction in pollutant

loading because of the direct nature of this impact. Groups 1 and 4 combined provide a cost-effective approach that could be applied to many properties with interested landowners. Group 1 would be applied to land draining directly to stream reaches with cattle access, and Group 4 would be applied to land draining to ditches that outlet to stream reaches. Rotational grazing could be added to the Group 4 drainage areas, as appropriate, to achieve additional pollutant reduction.

Under load reduction from bank erosion, Group 2 is the only applicable group and therefore direct cost-effectiveness comparisons are not applicable across BMP groups. However, the Group 2 bank stabilization/restoration is estimated to provide a large reduction in loading from bank erosion, and the cost-effectiveness results suggest that a substantial value would be provided by this practice. Although TSS from surface and cattle loading and sediment from bank erosion are different measures, the cost per ton reduced by bank erosion is within the lower range of the surface and cattle loading results for TSS, suggesting that bank stabilization/restoration is among the more cost-effective measures recommended. Stream bank stabilization ($41/ton sediment reduced) may be more cost-effective than Group 4 ($37/ton TSS reduced). A similar cost-effectiveness may be gained for total phosphorus depending on how much bank erosion contributes to instream phosphorus concentrations.

Table 1. BMP load reduction estimates by group (cost per load reduced in parentheses).

Benefit or Cost	Group 1	Group 2	Group 4	Group 5	Total
Load reduction applied to surface and cattle sources					
TSS (tons/year)	4,711 ($151)	2,402 ($270)	3,391 ($37)	37 ($464)	10,541 ($142)
TN (lbs/year)	54,090 ($13)	28,316 ($23)	33,316 ($4)	243 ($71)	115,966 ($13)
TP (lbs/year)	4,420 ($161)	2,066 ($313)	2,010 ($63)	44 ($394)	8,540 ($176)
E. coli (million summer CFU/year)	8.868E+7 ($0.01)	3.383E+7 ($0.02)	NA	NA	1.225E+8 ($0.01)
Load reduction applied to bank erosion					
Sediment (tons/year)	NA	15,668 ($41)	NA	NA	15,668 ($41)
TP (lbs/year)	NA	11,751 ($55)	NA	NA	11,751 ($55)
Cost estimate (Present Value)					
20-Year Full Cost ($)	$14,227,000	$24,064,826	$2,518,000	$345,000	$41,154,826
Annualized Full Cost ($)	$711,350	$1,203,241	$125,900	$17,250	$2,057,741
20-Year EQIP Cost ($)	$11,163,000	$19,209,351	$1,945,000	$345,000	$32,662,351
Annualized EQIP Cost ($)	$558,150	$960,468	$97,250	$1,199,000	$2,814,868

The riparian buffer restoration in Group 2 contributes to the higher cost-effectiveness ratios compared to Groups 1 and 4. Coupled with the bank stabilization/restoration benefits, Group 2 is expected to be a promising strategy. Since buffer restoration will require some removal of land from pasture, fewer landowners will likely be interested in this option, but where implemented, this BMP group will provide reasonable value for the investment. Group 5 was estimated as the least cost-effective BMP group. Urban BMPs are often more expensive per pollutant load removed as they require more structural components and more detailed design than agricultural

BMPs. Due to the anticipated costs, Group 5 BMPs should be targeted in strategic locations where stormwater runoff flow is severely degrading stream channels or causing flooding hazards to residents and property.

Table 3 compares the unit loads under existing conditions and with BMPs for TSS, TN, TP, and *E. coli* to the applicable benchmarks by reporting unit. The percent reduction in load refers to the percent of the total reporting unit load reduced. Cost-effectiveness ratios are also provided by reporting unit across all BMP groups. Cost-effectiveness between the two reporting units is similar. The slight variations are due to differences in loading rate and/or distributions of BMP opportunities. For example, implementation in Grassy Lick is estimated to be more cost-effective for TSS reduction because the TSS unit load is higher and the reporting unit is estimated to have a greater proportion of cost-effective BMPs (i.e., Group 4 compared to Group 5).

Table 2. Unit load estimates and load cost-effectiveness by reporting unit.

Reporting Unit	Existing	Benchmark	With BMPs	% Reduction	Cost per Unit Removed
TSS (tons/acre/year)					
Hinkston Headwaters	0.61	0.02	0.42	30.8%	$160
Grassy Lick	0.67	0.02	0.44	34.0%	$130
TN (lbs/acre/year)					
Hinkston Headwaters	10.20	4.10	7.85	23.0%	$12.9
Grassy Lick	9.68	4.10	7.39	23.6%	$13.0
TP (lbs/acre/year)					
Hinkston Headwaters	0.67	0.50	0.51	24.3%	$185
Grassy Lick	0.63	0.50	0.45	28.0%	$168
E. coli (million summer CFUs/acre/year)					
Hinkston Headwaters	7,070	1,154	4,637.6	34.4%	$0.01
Grassy Lick	7,070	1,154	4,389.0	37.9%	$0.01

[1]Reflects full cost, not EQIP cost share, for all BMPs; ratios based on EQIP costs are about 15 to 25% less than ratios based on full costs.

The recommended BMPs provide substantial progress towards meeting the loading benchmarks. Percent reduction in load ranges from about 23 to 38 percent. The recommended BMPs are estimated to meet the TP loading target. For TSS, TN, and E. coli, additional reduction would likely be needed to achieve the benchmarks. Since these are estimates, the results suggest that the recommended BMPs should provide progress towards addressing impairments, and once BMPs are implemented, conditions in the watershed can be re-assessed to determine actual reductions and where additional improvement is needed. The estimated reduction in bank erosion was not directly applicable to the comparison in the table, because TSS and bank erosion are separate measures. TSS loading, as estimated by SWAT, represents the load delivered to the stream that contributes to suspended sediment concentrations. The bank erosion loading estimates represent sediment delivered to the stream that contributes to both bed load and suspended sediment. Despite these differences, the bank erosion reduction estimates warrant consideration towards meeting the TSS benchmark because bank materials are mostly clays and silts, with small particle sizes easily mobilized by stream flows, and thus likely significant contributors to measured TSS values. Bank erosion is expected to be a major contributor to sediment loading in the watershed, and stabilization/restoration is likely to provide considerable load reduction towards meeting the TSS benchmark for drainage areas where the majority of reaches are restored.

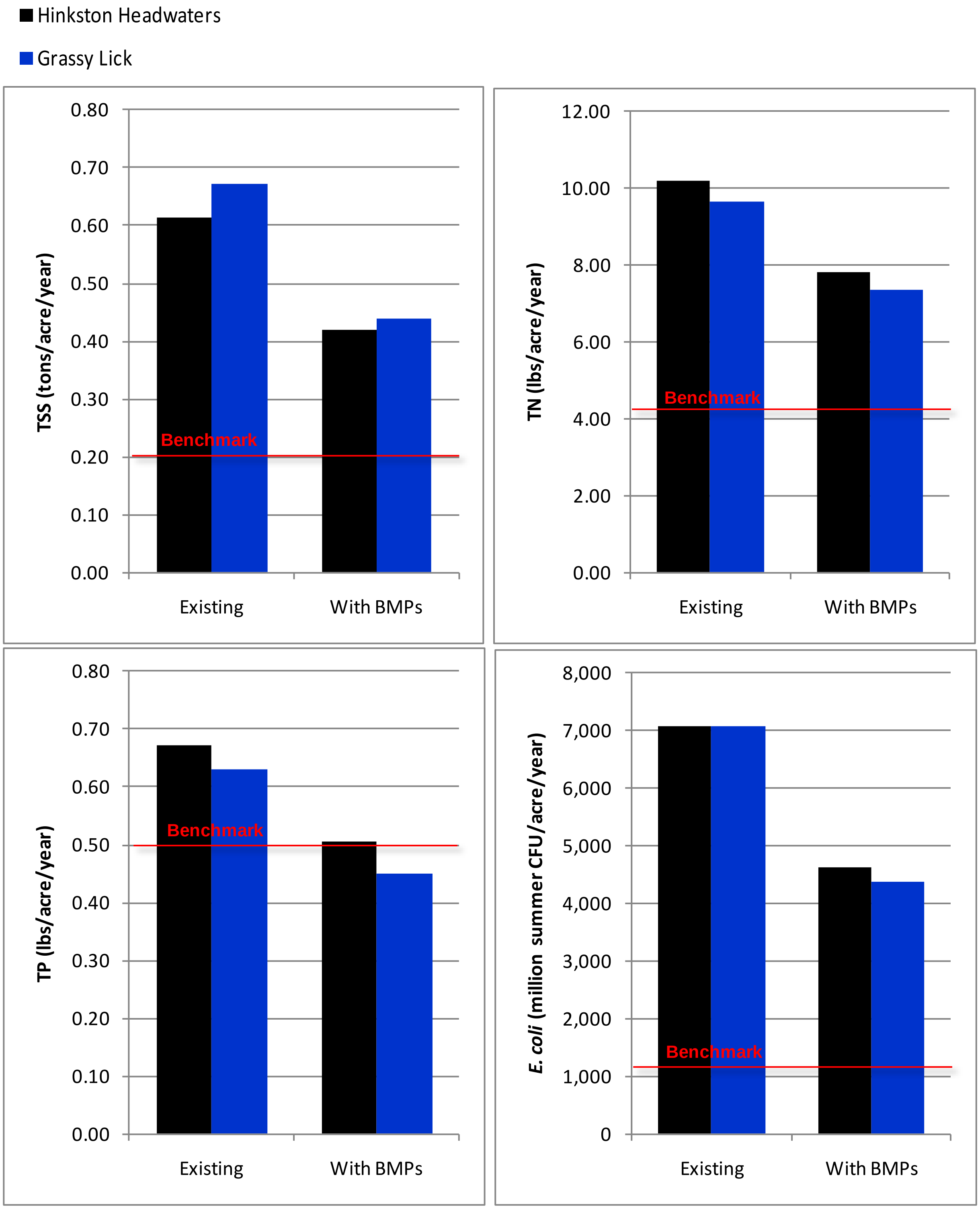


Figure 8. Unit loading rates by reporting unit for existing conditions and recommended BMP implemenation compared to benchmarks.

Recommended BMP implementation actions and time frame

The BMPs recommended for the Hinkston Creek watershed reflect the practices that can best address existing stressors and take advantage of opportunities to improve land management. The BMP groups represent the most likely groupings of BMPs on typical properties within the watershed. The estimated opportunities for these groups were reduced to potentially feasible quantities, and the cost-benefit analysis provided estimates of load reduced and cost as well as measures of cost-effectiveness. The recommended quantities of BMPs, based on the implementation targets are summarized by group in Table 3. The cost-benefit analysis estimated that if these quantities are implemented, annual pollutant load could be reduced by 23 to 38 percent for Hinkston Headwater and Grassy Lick reporting units.

Table 3. Recommended BMP quantities for watershed plan implementation.

BMP Measure	Units	Target Value
Group 1		
Pasture renovation and prescribed grazing	Acres of pasture	7,277
Use exclusion	Miles	47
Group 2		
Pasture renovation and prescribed grazing	Acres of pasture	3,119
Use exclusion, riparian buffer restoration (50-feet), streambank stabilization or restoration	Miles	20
Group 4		
Pasture renovation	Acres of pasture	4,298
Grassed Waterways in Pasture	Miles	33
Grassed Waterways in Row Crop	Miles	3
Group 5		
Urban stormwater retrofits	Acres of impervious drainage area	94

While the recommended BMP groups represent a major effort towards watershed improvement for Hinkston Creek, additional management practices are recommended beyond these BMP groups. On a voluntary basis, it is recommended that owners and managers of industrial and urban areas, as well as construction sites, improve how these areas are managed to protect water quality, stream stability, and other watershed functions. Improved wastewater management is also recommended, with particular focus on investigating potential impacts from the septic tank hot spots identified in the previous section. Plan implementation should involve extensive outreach and education across all sectors to encourage improved management efforts. The following list summarizes the overall actions recommended for watershed plan implementation:

- Improved management of agricultural land (BMP groups 1-4)
- Installation of urban retrofit BMPs (BMP Group 5)
- Improved stormwater management for industrial and urban areas
- Improved management of construction sites
- Improved wastewater management
- Outreach and education supporting all of the above

The targeted quantities for implementation are specified for the entire area of the two reporting units Hinkston Headwaters and Grassy Lick. The Phase 2 prioritization indicated that implementation should begin first in upstream of Calk Road, along the mainstem of Grassy Lick Creek, and along Town and Bennett Branches. Then, efforts should be focused along the Hinkston Creek mainstem second, and the remaining reaches third. Since it is uncertain how many interested property owners exist within these priority areas, this order should be used as guidance during implementation with the intent of achieving the recommended quantities across the entire two reporting units, regardless of priority area. As noted above, these recommendations reflect a starting point or snapshot in time.

In the future, as new BMPs or technologies become available, other BMPs may be substituted for these core BMPs recommended, or if some BMPs on the menu prove more difficult and others easier to implement than anticipated, the targeted participation rate can be adjusted. A 20-year timeframe is recommended for implementing the recommended BMP quantities in the Grassy Lick and Hinkston Headwater reporting units. Table 5 summarizes BMP opportunities. On an annual basis, implementation progress should be reviewed to evaluate effectiveness and determine whether or not adjustments in the approach are required. Tracking against interim annual and 5-year implementation targets is recommended. A more detailed outline of implementation actions and schedule is provided in Chapter 7 of the watershed plan.

Table 4. Preliminary BMP opportunities in the various subwatersheds of Hinkston Creek.

			BMP Groups 1, 2, and 3				BMP Group 4		BMP Group 5
			Pasture Renovation and Prescribed Grazing	Use Exclusion	50-foot Riparian Buffer and Bank Rest.	100-foot Riparian Buffer and Bank Rest.	Grassed Waterways		Urban Area Retrofit BMPs
Reporting Unit	Approx. Number of Pasture Land Owners	Approx. Number of Row Crop Land Owners	Area (acres)	Length (feet)	Length (feet)	Length (feet)	Length in pasture (feet)	Length in row crops (feet)	Impervious Drainage Area (acres)
Hinkston Headwaters	266	4	14,008	339,208	339,145	62	1,252,092	17,173	5,964
Grassy Lick Creek	280	5	14,967	377,060	376,989	71	1,317,405	22,911	481
Hinkston Mid-Reach	653	10	36,281	956,137	876,834	79,303	3,067,422	47,448	9
Somerset Creek	180	5	9,863	272,423	272,423	0	844,314	24,015	27
Big Brushy Creek	208	4	11,031	288,172	288,122	50	978,889	17,926	1,594
Lower Hinkston	352	11	19,262	445,150	415,790	29,359	1,656,222	53,349	431
Watershed Total	1,940	39	105,412	2,678,149	2,569,303	108,846	9,116,344	182,822	8,506

<u>Initial BMP implementation load reductions</u>

The first project-supported BMPs were installed during the summer and early fall of 2011. Other BMPs not supported by the project have also been installed or adopted, but project staff do not have any data regarding these efforts, which were likely the result of project outreach, education, and other efforts. In terms of pollutant load reductions from the project-supported BMPs, the following data were reported (see Table 5).

Table 5. Project supported BMP names and locations.

BMP with units	Lat/Long of BMP	Name of 12 digit HUC	12 digit HUC Number	Watershed Area (Acres)
Livestock Exclusion Fencing On Stream– LL Brother Farm (4,092 ft)	Latitude = 38.0258, Longitude = -83.9974	Hinkston Creek	05100102010	560
Livestock Watering Tanks – LL Brother Farm (2 stock tanks)	Latitude = 38.0258, Longitude = -83.9974	Hinkston Creek	05100102010	560
Heavy Use Area Protection – LL Brother Farm (2 stock pads)	Latitude = 38.0258, Longitude = -83.9974	Hinkston Creek	05100102010	560
Livestock Exclusion Fencing On Stream – Donaldson Farm (7,900 ft)	Latitude = 38.1522, Longitude = -83.9550	Hinkston Creek	05100102010	1,200
Controlled Stream Crossing – Donaldson Farm (1 crossing)	Latitude = 38.1522, Longitude = -83.9550	Hinkston Creek	05100102010	1,200
Livestock Watering Tanks – B Mark Farm (2 stock tanks)	Latitude = 38.1176, Longitude = -84.0492	Hinkston Creek	05100102010	1,350
Heavy Use Area Protection – B Mark Farm (2 stock pads)	Latitude = 38.1176, Longitude = -84.0492	Hinkston Creek	05100102010	1,350
Livestock Exclusion Fencing On Stream – AB Prewitt Farm (2,136 ft)	Latitude = 38.1213, Longitude = -84.0188	Hinkston Creek	05100102010	5,760
Livestock Watering Tanks – AB Prewitt Farm (2 stock tanks)	Latitude = 38.1213, Longitude = -84.0188	Hinkston Creek	05100102010	5,760
Controlled Stream Crossing – AB Prewitt Farm (1 crossing)	Latitude = 38.1213, Longitude = -84.0188	Hinkston Creek	05100102010	5,760
Heavy Use Area Protection – AB Prewitt Farm (6 stock pads)	Latitude = 38.1213, Longitude = -84.0188	Hinkston Creek	05100102010	5,760

Table 6. Pollutant load reduction estimates linked to project supported BMPs.

Name of 12-digit HUC	Calculation Method Or Model Used	Pollutant Type	Current Year Estimate	Units
Hinkston Creek	SWAT methods from Plan*	Nitrogen	11,518	Pounds
Hinkston Creek	SWAT methods from Plan*	Phosphorus	886	Pounds
Hinkston Creek	SWAT methods from Plan*	Sediment	2,364,000	Pounds

** 1,100 tons of sediment per stream mile lost pre-BMP (livestock exclusion fencing); 54% load reduction achieved with BMP.*

H. Conclusions

This section presents general conclusions and recommendations and the status of the project's success measures, as listed in the original memorandum of agreement. The project achieved nearly all of its objectives, but was affected by minor scheduling issues, as noted below.

General conclusions

- When working in watersheds with fairly obvious problems that can be addressed by a relatively small group of landowners, land managers, or other target audiences, it's more efficient to work with them directly and discreetly than to engage lots of other parties that may not bring much to the table in terms of BMP implementation. Hinkston Creek project staff worked through an existing organization, the Montgomery County Conservation District, with excellent relationships with the farmers and landowners who needed to be engaged. This helped to focus efforts and staff time on the target audience that could actually adopt and/or implement BMPs.

- BMP implementation through cost-share programs can be handled efficiently and effectively by existing organizations with the staff and administrative capacity to collect and process applications, conduct application reviews, issue approvals, and generate cost reimbursements. The local conservation district has past experience in dealing with on-farm cost share expenditure through the Kentucky Soil Erosion and Water Quality Cost Share Program, which provides funding for implementation of farm water quality plans.

- Remote sensing tools – such as GIS mapping, aerial photography analysis, and other tools – can help to identify areas with inadequate riparian vegetation, livestock concentrations near streams, and poor pasture grass stand management. Such tools, in combination with other database layers (e.g., sewer collection line maps, subdivision developments) can also help to identify areas that might need improved onsite wastewater treatment system management.

- Public education and outreach programs that link history to area waterbodies can create interest in the waterbody as a historical, cultural, and economic resource. The weekly newspaper columns on the early development and history of the Hinkston Creek region, archived at www.hinkstoncreek.org, resulted in widespread positive perceptions of the creek, and served as a vehicle for delivering important water quality protection / restoration information (e.g., increasing natural buffers near streams, controlling erosion, addressing polluted runoff sources).

- The use of billboards with positive reinforcement messages regarding key agricultural practices that protect water quality provides a workable venue for disseminating BMP information. The "thank a farmer" billboards installed in the Hinkston Creek watershed during 2010 – 2011 helped to "create buzz" and interest in water quality BMPs, such as vegetated riparian buffers, grassed swales, pasture management, and seeding/mulching for bare areas.

Status of project success measures

Administrative: Fulfill 319 grant requirements.

1) Submit annual report by December of each year

Annual reports were submitted as indicated in project schedule.

2) Submit three hard copies and one electronic copy of the Final Report and three hard copies and one electronic copy of all products

Final Report objective will be completed with this submittal.

3) Submit drafts and/or copies of educational materials to be used in project workshops or educational activities

Drafts were submitted as they were developed. Slides used in near-term educational presentations were attached to previous Milestone Progress Reports.

Objective #1: Convene watershed management team to oversee project activities.

1) Contact project supporters and stakeholders, circulate information on upcoming meetings

Contacted project supporters and stakeholders to report progress, seek guidance, and request assistance as needed throughout the project period.

2) Meet with project stakeholders and supporters for orientation on goal, objectives, & activities

SIGNS INSTALLED TO IMPROVE AWARENESS - Hinkston Creek will be getting new signs installed to improve awareness of the creek. Hinkston Creek is the focal point of a Kentucky Division of Conservation project to improve water quality.

Bourbon County Conservation District Sponsoring Watershed Signs

The Bourbon County Conservation District is sponsoring the placement of bridge crossing and "entering watershed" signs in the Hinkston Creek drainage area in the eastern part of the county.

The signs are being installed to improve awareness of the creek, which marks the boundary between Bourbon and Nicholas counties. Hinkston Creek is the focus of a Kentucky Division of Conservation project to improve water quality by reducing sediment, bacteria, and nitrogen runoff during heavy rain storms.

Part of the project involves additional cost share funding for farmers in the Hinkston watershed who want to stabilize stream banks with vegetation, restrict cattle access to the creek with fencing, and install new water lines and stock tanks.

Efforts are underway to secure the cost share funds in early 2012, to supplement the existing State Cost Share Program.

Producers can receive up to 75% of the support needed to install streamside fencing, stock tanks, and water lines, and more if there is an economic need and the farm is located in the Boone or Blacks creek drainage areas. These two creeks, which drain into Hinkston, are particularly affected by sediment, bacteria, and other runoff issues.

Higher levels of sediment in Kentucky creeks has been linked to heavy pasture grazing and stream bank erosion, which can be aggravated by livestock access and removal of trees, shrubs, and other vegetation along the banks.

Banks can recover naturally within a few years if livestock access is controlled and water is provided away from the stream. Cleaner water for livestock also helps to reduce cattle illnesses and improves weight gain.

More information on the project is available at www.hinkstoncreek.org.

Met with staff of the Montgomery County Conservation Board quarterly to discuss the watershed assessment, plan, and BMP cost share program. Provided reports to other stakeholders (Mt. Sterling City Council, Montgomery County Fiscal Court, Bourbon County Conservation District) semiannually at their regularly scheduled meetings.

3) Finalize arrangements for office space, phone, computer access, and etc. for project manager

Office space, phone, computer access, and other support was provided throughout the project period as indicated.

4) Identify or hire project manager, begin to organize tasks and data needed for studies

Project manager was identified as indicated, and remained with the project throughout the entire project period.

5) Meet with KY Division of Water staff and other agency partners on project schedule & tasks

Met with Kentucky Division of Conservation and Division of Water staff quarterly.

6) Meet with US Army Corps of Engineers regarding integration of project with flood studies

Met with US ACE representatives twice during the project period, to discuss their flood studies and recommendations. The watershed management plan has detailed information on this topic.

7) Meet with Little Mount Trail Commission to discuss project planning and coordination

Met with and coordinated with the Trail Commission throughout the project period. The project manager served on the board of the Trail Commission throughout the project, and was instrumental in securing support for paving the first half-mile of trail in the vicinity of Hinkston Creek during late 2011.

8) Meet with City of Mt. Sterling and Montgomery County Fiscal Court to coordinate tasks

Met with city council and fiscal court semiannually. Both entities supported the project, and both provided key labor, equipment, and other support in erecting the "entering watershed" and "creek crossing" signs purchased by the project.

9) Meet with Montgomery County Extension Service, NRCS, Cattlemen's Association on tasks

Worked with the county extension office and NRCS staff in developing the watershed assessment and watershed management plan, particularly the BMP section. Did not meet directly with the Cattlemen's Association, but did work with various members on the BMP implementation effort.

10) Coordinate with technical staff on data needed for modeling loads and BMP effectiveness

Tetra Tech technical staff completed all watershed assessment, pollutant load modeling, and BMP effectiveness studies for the project. This information is presented in detail in the watershed management plan.

11) Finalize monitoring plan and begin gathering N, P, and pathogen water quality, geomorphic, and other data needed to support planning

All monitoring, watershed assessment, and modeling work described in the project funding application was completed. Tetra Tech identified 12 mainstem and tributary monitoring sites, and worked with the Morehead State University Ecology Lab to collect samples monthly during 2010 – 2011. Additionally, project staff:

- Identified and delineated six reporting subwatersheds throughout the larger Hinkston Creek watershed, which will be used to focus and refine pollutant loading and BMP data.
- Identified and delineated the focus area for initial BMP implementation – the watershed segment upstream from the confluence of the Aaron's Run / Grassy Lick / Somerset subwatershed, just downstream of the KY 11 bridge.
- Developed initial runs of nutrient outputs per acre for the initial project focus area (see above).
- Collected additional data on the Mt. Sterling, Millersburg, and Carlisle wastewater treatment plants for incorporation into the watershed model
- Completed data collection on the source water protection areas and issues related to the Millersburg, Carlisle, and Cynthiana drinking water intakes.
- Completed data collection on agricultural practices from county ag and natural resource professionals, for use in refining the BMP approaches regarding livestock and pasture management.
- Completed the GIS project file by retrieving hydrologic boundaries, counties, reaches, water quality stations, flow stations, topography, land cover, impervious cover, point source locations.
- During the previous reporting periods, completed these tasks:
- Delineated the Hinkston Creek watershed with consideration of water quality stations, flow stations, point sources, and connectivity.
- Geo-processed the 2001 NLCD land cover based on the delineations.
- Geo-processed the 2001 NLCD impervious cover based on the delineations.
- Geo-processed a vegetated riparian buffer analysis, and produced map.
- Gathered USGS flow data, LRWW water quality data, 2004-2005 KDOW monitoring data, 2009-2010 Hinkston Creek Project data, and DMR point source data; processed and developed these data elements into WRDB project files.
- Created plan view figures for the watershed management plan.
- Analyzed the data to assess loading at various locations in the Hinkston watershed.
- Developed a draft watershed assessment report, which discusses and summarizes the various data and geo-processing. The discussion includes

consideration of the various components. The draft assessment report includes plan view figures, data figures, and data tables.

- Completed the draft watershed plan, and submitted to KDOC and KDOW for review.
- Completed modified Stream Visual Assessment Protocol for selected reaches
- Finalized riparian buffer deficiency analysis.
- Finalized septic tank prioritization analysis.
- Analyzed and documented land use/land cover data, including watershed imperviousness.
- Analyzed the observed data through plots and statistical summaries for concentration.
- Reviewed and summarized habitat data for report.
- Continued to analyze flow, precipitation, and water quality data.
- Updated WRDB project files to include additional point source data and MSU monitoring data.
- Developed and calibrated a SWAT model for a 10-year simulation period. The simulated parameters include flow, TN, TP, and TSS.
- Appended the weather forcing files for SWAT (precipitation and temperature) to include month of September, 2010.
- Calibrated the SWAT watershed model for flow at the Hinkston Creek near Carlisle, KY USGS gauge.
- Calibrated the SWAT model at all KDOW and MSU station locations for TN, TP, and TSS.
- Performed a LOADEST based regression load calculation at MSU/KDOW co-locations for TN, TP, and TSS.
- The observed data were used to calculate loads for TN, TP, TSS, and E. Coli. The loads were statistically summarized. Unit area loads were calculated at the monitoring stations.
- Benchmark concentrations were developed and proposed to KDOW. Approved by KDOW.
- Researched data on BMP load reduction estimates and cost data.
- Prioritized reporting units within the study area for management efforts and BMP implementation.
- Prioritized septic areas within the study area for assessing potential water disturbances and to recommend areas for future bacteria monitoring.
- Developed a watershed inventory on the reporting unit level consisting of land cover, impervious surface, point source and non-point source water disturbances, and geology/soils/topography to be used for examining potential relationships between these and the observed water quality.

12) Complete data gathering for modeling loads and BMPs; meet with team to discuss plan

All data gathering (see number 11 above for details) was completed as discussed.

Objective #2: Develop nutrient and sediment analyses and a watershed-based plan for Hinkston Creek

1) Identify causes & sources of pollution; quantify existing pollutant loads by source(s)

This objective was completed, with findings incorporated into the watershed plan. Analyses indicate that there are some reaches with elevated levels of nutrients and bacteria, especially during high flow (high runoff) conditions. A detailed analysis of the causes and sources of pollution, accompanied by a complete pollutant load analysis, is being included in the watershed plan.

2) Estimate load reductions needed from relevant and appropriate best management practices

Calculations of existing pollutant loads and load reductions needed were completed, and are included in the watershed plan. The plan was completed and submitted to KDOW and KDOW in April 2011. KDOW and KDOC approved the plan on July 27, after revisions were made in response to comments from both agencies.

3) Describe management measures and note critical areas for siting them

The initial list of management practices was refined, and the final list was completed and submitted to KDOC, which approved the list of BMPs for cost share on May 5. The list is based on current load analyses and future load reduction needs, as well as resource professionals' input and available data (i.e., land use/cover, water quality data, windshield surveys to ground-truth desktop analyses). The selected BMPs, which are included in Appendix 2 of this report and summarized on the project web site at www.hinkstoncreek.org, include streambank stabilization, improved pasture management, livestock exclusion fencing, urban runoff controls, and other measures indicated by the water quality data and land use/cover/management practices observed in the watershed.


Hinkston Creek: A living legacy and link to the past and future

Barry Tonning

With the public water system in operation by December 1901, threats from cholera and other communicable diseases began to subside. However, the dramatic increase in water use—a phenomenon still evident today when "city water" is extended to areas with smaller septic systems designed for cisterns—caused new problems. Homes that might have used less than a few dozen gallons of water per day for dishes, laundry, bathing and drinking were now using a hundred gallons or more ... and all that water had to go somewhere.

Within a few years, the drainage of waste water from homes and businesses into yards, street, gutters, swales and Hinkston Creek itself became almost unbearable, especially in the summertime. In 1909, after a 629 to 50 affirmative vote, the city council authorized a $50,000 bond issue for the construction of public sewers. The Charles E. Collins engineering firm from Philadelphia was contracted to design the system. The survey crew arriving in Mt. Sterling no doubt found an almost ideal topography for building a gravity-flow sewerage system. Streets were laid out in a simple rectangular grid overlaid upon gently rolling hills that drained naturally down toward Hinkston Creek. The old plan sheets for the original sewer system are frayed and cracked, with a few brown stains, but are still very legible.

Printed on blue oil-cloth paper, the plans show 10- to 12-inch sewer main pipes on North Maysville, Locust and East High streets, with 8-inch laterals down the side streets and 6-inch service lines to the homes and businesses. The lay of the land provided pipe slopes/grades of around one percent in flatter areas and 10 to 14 percent on the steeper hills.

The March 23, 1910, edition of the Mt. Sterling Advocate reported that the firm of Paul Kershner of Dayton, Ohio, had been hired to build the sewer system, which featured gravity-flow clay piping laid down the streets in the area between Hinkston Creek and Hinkston Pike, bounded on the east by Willow and the west by Antwerp. The entire network of laterals and mains was designed to bring the sewage to the intersection of Hinkston Creek and Main Street, where a 20-inch cast iron pipe emptied into a 36-inch siphon 12 feet below ground level. The siphon pulled the wastewater under the creek and sent it farther down East Main, to a location in the floodplain just behind what is now Giovanni's. Here, the engineers placed a large septic tank, measuring about 100 feet long and 25 feet wide and probably around 6 to 8 feet in depth. As is the case with septic systems today, the tank functioned to trap settleable solids and floatable material.

After about 24 hours of detention time, the clarified effluent emerged from the tank via a perforated pipe at the north end and flowed underground toward Hinkston Creek, where effluent that was not soaked up by the surrounding soil would be discharged—downstream from town.

After the initial survey work was completed and the construction drawings were produced, work on the system began. The Kershner company brought in a gang of 40 Italian laborers to dig the trenches and lay the pipe. The April 20, 1910, Advocate reported that the Italians "arrived on Monday night, and are quartered in the east part of town ... the largest man in town is Mr. Sullivan, the time-keeper for the firm," who was "over six feet tall and weighs about 380 pounds." Excavation began at the septic tank location, and continued through the summer. There were some delays, caused by the need to remove an unexpectedly large amount of rock for the 10-inch piping, along with the usual difficulties of trenching in the middle of streets busy with traffic from horses, carriages, wagons and even an occasional automobile. The lack of basic safety measures we take for granted today—orange cones and mesh fencing around pits and trenches—was of course only a gleam in the government's eye a hundred years ago ... and the results were predictable. The Aug. 17 Advocate reported that George Richardson, a farmer living on land owned by G.A. McCormick, filed a lawsuit against the city for $3,000 for personal injuries suffered after falling into an open sewer line ditch on East Main Street.

Another problem was encouraging property owners to pay the fee and tap on to the new sewer system. In the July 6, 1910, paper, Mt. Sterling Mayor W.A. Samuels advised property owners to "make taps while the sewer is being constructed," because "if done now, such work will be under the direct supervision of the Sewer Engineer, and at less cost than can possibly be done hereafter." The mayor warned that after the system was built, all new taps into the sewer line would have to be inspected, which would entail additional cost. For those properties downtown, the mayor served notice that "it has been definitely determined that the streets of the business portion of the City will be paved in the near future and no sewer, gas or water connections will be permitted to be made for a period of five years thereafter."

A boxed advertisement next to the mayor's entreaties in that edition of the Advocate, placed by the Mt. Sterling Water, Light and Ice Co., pushed things along from another angle. Under the heading "Make Your Tap Now," the company noted that "Now that Mt. Sterling has a modern sanitary sewer system, you have no excuse for not installing that BATHROOM and KITCHEN SINK, which you have been wanting for so long. Make housekeeping a PLEASURE instead of a GRIND by giving your wife these conveniences."

The sewer system was completed in November 1910, exactly 100 years ago. And while the septic tank system for large-scale municipal sewage treatment would prove to be inadequate in later years, housekeeping did indeed improve—along with the condition of the streets and gutters of the Little Mountain Town on the banks of Hinkston Creek.

This article is one in a series written by Barry Tonning, a local resident and employee of Tetra Tech, an environmental engineering and consulting firm that works on water resource issues across the U.S.

4) Estimate technical and financial assistance needed to implement the BMPs

The section of the watershed plan that addresses this project milestone was completed. The final estimates are documented in the plan.

5) Develop an outreach and education component to support BMP implementation and adoption

This objective was completed. The following activities are noted:

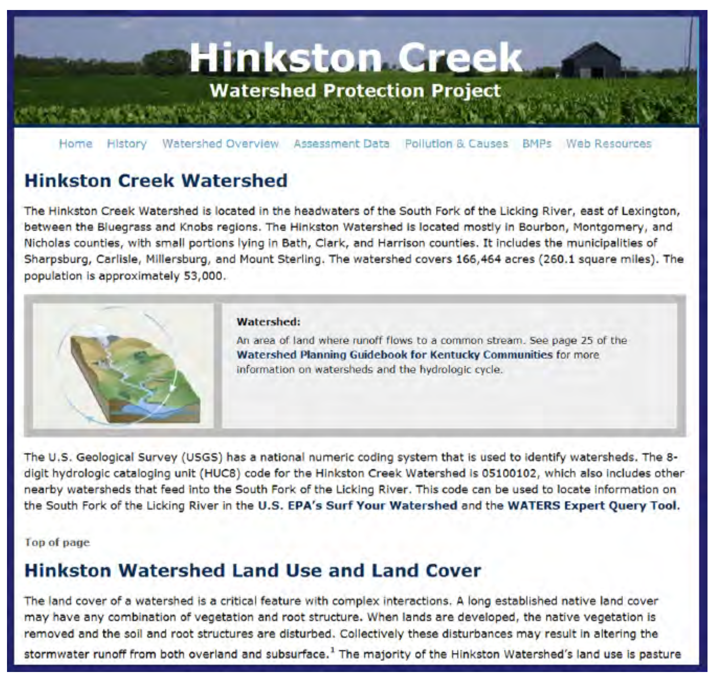
- Installed 9 “thank a farmer” billboards during the project period, in Carlisle, Mt. Sterling, and Paris.

- Installed 24 stream crossing signs and six “entering watershed signs” in March and April, 2011.

- Installed the five “Thank A Farmer” billboards in the Mt. Sterling area, which provide positive reinforcement for addressing polluted runoff, maintaining riparian buffer vegetation, managing pastures for water quality protection, and general soil and water conservation practices.

- Published 23 Hinkston Creek awareness and outreach columns in the Mt. Sterling Advocate, highlighting historical activities in the area and their effects on the creek and water quality, such as industrial spills near the creek, the development of sewage treatment systems, livestock effects, and other issues.

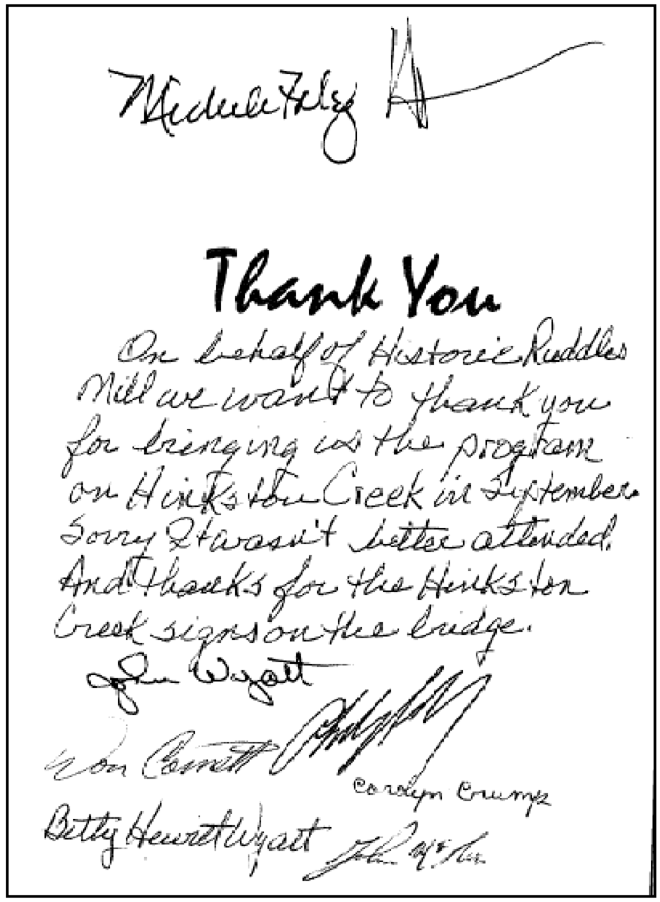
- Completed development of the HinkstonCreek.org web site, with photographs, information on agricultural practices, maps of impaired waters and other features, the newspaper columns, BMP summaries, and other information. Final watershed plan assessment and BMP information was also added.



- Completed presentations to the Montgomery County Conservation District (5), Bourbon County Conservation District (3), Nicholas County Conservation

District, Ruddell's Mill Community Group, Mt. Sterling City Council, Montgomery County Fiscal Court, and Kentucky Water Resources Research Institute.

- Produced and published 26 awareness-building articles on Hinkston Creek in the Mt. Sterling Advocate, focusing on the historic role of the creek in the settling and development of the area.



Thank You

On behalf of Historic Ruddles Mill we want to thank you for bringing us the program on Hinkston Creek in September. Sorry it wasn't better attended. And thanks for the Hinkston Creek signs on the bridge.

Betty Hewitt Wyatt

6) Develop a project schedule for identifying BMP support sources and facilitating implementation

Work was completed on this milestone, via discussions with local resource professionals, as documented in the watershed plan.

7) Describe interim, measurable milestones for ascertaining progress toward BMP implementation

Work was completed on this milestone, via discussions with local resource professionals. The interim milestones are documented in the watershed plan, which was completed in April.

8) Identify indicators to measure progress, such as programmatic and water quality measures

Work was completed on this milestone. Indicators are documented in the watershed plan.

9) Develop an approach to track BMP implementation and overall project progress

Work was complete on this milestone. BMP implementation tracking is addressed in the watershed plan.

10) Use information collected for the plan to calculate and allocate loadings

This activity was completed. Final details are reported in the watershed management plan.

11) Submit watershed-based plan to KY DOW for review

The draft watershed plan was been completed, and sent to KDOC and KDOW for review. Comments were received in June, with responses submitted on June 28. The final plan was approved by KDOW and KDOC on July 27.

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
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Leonard K. Peters
Secretary

R. Bruce Scott
Commissioner

Sandra L. Gruzesky
Director

July 27, 2011

KY Division of Conservation
Attn: Angie Wingfield, NPS Program Coordinator
375 Versailles Road
Frankfort, KY 40601

RE: Project 2008-09 - The Hinkston Creek Watershed Assessment and Management Plan

Dear Ms. Wingfield:

The Division of Water has conducted a thorough review of the Hinkston Creek Watershed Plan. We are pleased to notify you that the plan has been accepted for implementation by the Division. Please remember that Tetra Tech, Inc. must develop and submit a BMP Implementation Plan to the Division of Conservation for approval prior to any implementation of that watershed plan.

Please extend our appreciation to Barry Tonning and Greg Sousa for their time and effort put forth in developing the Hinkston Creek Watershed Plan. If you have any questions pertaining to this correspondence, please contact me at (502) 564-3410.

Sincerely,

E-Signed by James_Roe
VERIFY authenticity with ApproveIt
James L. Roe

James L. Roe, Supervisor
Nonpoint Source and Basin Team Section

JLR
cc: Deb Day, NPS Grant Administrator, Grants Management Section
2008-09 Project File

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12) Ensure that any TMDLs developed by KY DOW and watershed-based plan are consistent

Not applicable – there are no TMDLs established in the watershed.

13) Meet with project team to review the watershed plan and discuss implementation

This activity was completed. Project staff stayed in touch with the Montgomery County Conservation District staff via phone and email, and met with the Montgomery and Bourbon County Conservation District Boards as needed.

Objective #3: Identify key BMPs cited in the watershed plan for implementation support

1) Convene project team and other interested parties to discuss BMPs identified as needed

This activity was completed; BMPs are identified and discussed in detail in the watershed plan.

2) Develop criteria for evaluating BMPs, based on pollutant removal capacity, cost, acceptability, etc.

Work was completed on this milestone, via discussions with local resource professionals. To assist in BMP selection and targeting, Tetra Tech developed an adaptation of the NRCS *Stream Visual Assessment Protocol* to identify stream reaches impacted by 1) eroded channel banks; 2) poor riparian vegetative cover; and 3) heavy cattle impacts to the channel.

3) Appoint committee to rank BMPs in terms of effectiveness, cost, and other identified factors

This activity has been completed. The Montgomery County Soil and Water Conservation District Board provided the input for this task, assisted by the NRCS District Conservationist in Montgomery County. Final procedures were discussed and agreed to in May, 2011.

4) Distribute BMP ranking list to the project team for review & decisions regarding cost-share

This activity has been completed. The BMP ranking list was submitted to the Montgomery County Conservation Board in May, and approved by KDOC.

5) Select BMPs for cost-share funding with grant resources; discuss decisions with land owners

This activity has been completed. The list of BMPs and implementation sites was developed in May and approved by the Montgomery County Conservation District and KDOC.

6) Identify final list of BMPs to be supported with grant funds; finalize plans for installation/adoption; develop BMP Implementation Plan for KY DOW review and approval

Hinkston Creek Project staff had received approval for the final list of BMP cost share funding applicants from the KY Division of Conservation on May 5th. The following projects were approved, with implementation of the BMPs completed during the summer and early fall of 2011:

- Laura Lee Brother — Fencing, Watering Tanks, Stream Crossing
- Ronnie & Earl Donaldson — Fencing, Stream Crossing
- Berkley Mark — Manure Runoff Protection, Watering Tanks
- Allen Prewitt — Fencing, Manure Runoff Protection, Stream Crossing

The Hinkston Creek Project directly supported the installation of stream channel livestock restriction fending, alternative water sources at those locations, and heavy use area protection for the watering sites. Specifically, this entailed the construction of 14,128 ft of fence, 5,480 ft of waterline for 6 stock watering tanks, and development of 7 heavy use areas and two stream crossings. Installation of the heavy use areas and stream crossings required several hundred tons of rock and 5 rolls of filter fabric. The fencing work involved use of 6 inch pressure-treated posts and barbed wire or woven wire.

7) Develop tracking plan for BMPs to be installed with grant funding support

This activity was completed. BMPs will be tracked by project staff.

8) Secure any needed permits for BMP installation; develop agreements; install BMPs as planned

This activity was completed.

9) Monitor BMPs for 24 months after installation, according to plan developed above; submit annual report with load reduction calculations throughout project duration.

This activity is underway.

Objective #4: Close out project and complete needed reports; forward findings to KY DOW

1) Collect all project meeting notes, data, financial and other reports, and other information

All project files are available for review.

2) Meet with project team to review activities and list accomplishments and conclusions

Work on this task was completed.

3) Conduct closeout meeting with KY Division of Water staff; review closeout procedures

Pending submission of Final Report.

4) Submit Final Report on all project activities, including financial and other data

Completed, with this submittal.

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J. Appendices

Appendix A. Financial and Administrative Closeout

1. Application Outputs

The following outputs were generated by the project during 2009 – 2011:

- HinkstonCreek.org web site, with information on the watershed, monitoring data, the watershed management plan, historical information on the area related to the creek, top 5 BMPs, technical and other information on BMP types/costs/etc., and project related information (November 2010).

- 26 weekly newspaper columns on Hinkston Creek, and how it related to the historical, cultural, and economic development of the Gateway Area. The columns contain information on BMPs, flooding issues, how development alters stream corridors, agricultural topics, industrial issues, and other relevant topics (Summer 2010 – Spring 2011).

- Five "Thank A Farmer" billboards, with positive messages promoting agricultural best management practices, installed in the watershed (September 2010).

- 26 "entering watershed" and 9 "creek crossing" signs, formatted and installed in accordance with Kentucky Transportation Cabinet specifications and permitting requirements (February 2011).

- Watershed assessment and watershed management plan, as described and discussed in this Final Report (June 2011)

- Adapted "Stream Visual Survey Assessment Procedures" based on the NRCS protocols, and application of the procedures to stream channels in Montgomery County (see maps in this report; September 2010).

- Advanced GIS analysis of riparian buffer deficiencies, cattle access points along the stream channel, and high-risk septic system areas, summarized in this report (February 2010 – September 2011).

- Installation of cost-shared BMPs, at the following locations (Summer, 2011):

✓ Laura Lee Brother	Fencing, Watering Tanks, Stream Crossing
✓ Ronnie & Earl Donaldson	Fencing, Stream Crossing
✓ Berkley Mark	Manure Runoff Protection, Watering Tanks
✓ Allen Prewitt	Fencing, Manure Runoff Protection, Stream Crossing

The Hinkston Creek Project directly supported the installation of stream channel livestock restriction fending, alternative water sources at those locations, and heavy use area protection for the watering sites. Specifically, this entailed the construction of 14,128 ft of fence, 5,480 ft of waterline for 6 stock watering tanks, and development of 7 heavy use areas and two stream crossings. Installation of the heavy use areas and stream crossings required several hundred tons of rock and 5 rolls of filter fabric. The fencing work involved use of 6 inch pressure-treated posts and barbed wire or woven wire.

Table 7. Final milestones and schedule for the Hinkston Creek Watershed Project

Milestone Description	Actual Begin Date	Actual Completion Date
***Administrative: Fulfill 319 grant requirements*.**		
1) Submit annual report by December of each year	12/1/09	12/31/11
2) Submit three hard copies and one electronic copy of the Final Report and three hard copies and one electronic copy of all products	9/1/11	12/31/11
3) Submit drafts and/or copies of educational materials to be used in project workshops or educational activities	As needed	As needed
Objective #1: Convene watershed management team to oversee project activities.		
1) Contact project supporters and stakeholders, circulate information on upcoming meeting	11/1/08	9/30/11
2) Meet with project stakeholders and supporters for orientation on goal, objectives, & activities	Quarterly	9/30/11
3) Finalize arrangements for office space, phone, computer access, and etc. for project manager	As needed	12/1/09
4) Identify or hire project manager, begin to organize tasks and data needed for studies	12/1/08	12/31/09
5) Meet with KY Division of Water staff and other agency partners on project schedule & tasks	2/1/08	As needed during project
6) Meet with US Army Corps of Engineers regarding integration of project with flood studies	2/1/09	4/1/09

Milestone Description	Actual Begin Date	Actual Completion Date
7) Meet with Little Mount Trail Commission to discuss project planning and coordination	2/1/09	As needed during project
8) Meet with City of Mt. Sterling and Montgomery County Fiscal Court to coordinate tasks	2/1/09	As needed during project
9) Meet with Montgomery County Extension Service, NRCS, Cattlemen's Association on tasks	8/1/09	As needed during project
10) Coordinate with technical staff on data needed for modeling loads and BMP effectiveness	9/1/09	12/31/10
11) Finalize monitoring plan and begin gathering N, P, and pathogen water quality, geomorphic, and other data needed to support planning	8/1/09	11/1/09
10) Complete data gathering for modeling loads and BMPs; meet with team to discuss plan	11/1/09	11/1/10
Objective #2: Develop nutrient & sediment analyses & watershed-based plan for Hinkston Creek		
1) Identify causes & sources of pollution; quantify existing pollutant loads by source(s)	12/1/09	12/31/10
2) Estimate load reductions needed from relevant and appropriate best management practices	12/1/09	12/31/10
3) Describe management measures and note critical areas for siting them	12/1/09	2/1/11
4) Estimate technical and financial assistance needed to implement the BMPs	12/1/09	4/1/11
5) Develop an outreach and education component to support BMP implementation and adoption	12/1/09	12/31/10
6) Develop a project schedule for identifying BMP support sources and facilitating implementation	12/1/09	3/1/11
7) Describe interim, measurable milestones for ascertaining progress toward BMP implementation	12/1/09	4/1/11
8) Identify indicators to measure progress, such as programmatic and water quality measures	12/1/09	4/1/11
9) Develop an approach to track BMP implementation and overall project progress	4/1/10	5/1/11
10) Use information collected for the plan to calculate and allocate loadings	As available	5/1/11
11) Submit watershed-based plan to KY DOW for review	9/1/10	5/1/11

Milestone Description	Actual Begin Date	Actual Completion Date
12) Ensure that any TMDLs developed by KY DOW and watershed-based plan are consistent	9/1/10	As needed
13) Meet with project team to review the watershed plan and discuss implementation	10/1/10	5/1/11
Objective #3: Identify key BMPs cited in the watershed plan for implementation support		
1) Convene project team and other interested parties to discuss BMPs identified as needed	As needed	As needed
2) Develop criteria for evaluating BMPs, based on pollutant removal capacity, cost, acceptability, etc.	5/1/10	4/1/10
3) Appoint committee to rank BMPs in terms of effectiveness, cost, and other identified factors	4/1/10	12/1/10
4) Distribute BMP ranking list to the project team for review & decisions regarding cost-share	6/1/10	6/1/11
5) Select BMPs for cost-share funding with grant resources; discuss decisions with land owners	As appropriate	6/15/11
6) Identify final list of BMPs to be supported with grant funds; finalize plans for installation/adoption; develop BMP Implementation Plan for KY DOW review and approval	4/1/10	7/1/11
7) Develop tracking plan for BMPs to be installed with grant funding support	4/1/10	6/15/11
8) Secure any needed permits for BMP installation; develop agreements; install BMPs as planned	6/1/10	6/1/11
9) Monitor BMPs for 24 months after installation, according to plan developed above; submit annual report with load reduction calculations throughout project duration.	As needed	As needed
Objective #4: Close out project and complete needed reports; forward findings to KY DOW		
1) Collect all project meeting notes, data, financial and other reports, and other information	Throughout project	9/30/11
2) Meet with project team to review activities and list accomplishments and conclusions	Quarterly	9/15/11
3) Conduct closeout meeting with KY Division of Water staff; review closeout procedures	9/1/11	Pending
4) Submit Final Report on all project activities, including financial and other data	9/15/11	12/31/11

2. Budget Summary

This section lists and discusses all fiscal aspects of the Hinkston Creek Watershed Planning and BMP Implementation Project. Below is the original detailed budget, from the project application.

Table 8. Original and actual Hinkston Creek Project budgets.

Cost Category	BMP Implemen -tation	Project Mgmnt	Education, Training, Outreach	Monitoring	Technical Assistance	Other	Original Budget Totals	Actual Project Costs
Personnel	$11,500	$24,500	$52,500	$28,500	$133,500	$0	$250,500	337,690.37
Supplies	$2,500	$2,000	$2,000	$1,500	$2,500	$0	$10,500	407.99
Equipment	$1,000	$1,000	$0	$0	$1,000	$0	$3,000	0.00
Travel	$1,700	$1,300	$4,000	$1,400	$1,600	$0	$10,000	465.70
Contractual	$433,340	$6,000	$6,000	$3,500	$4,500	$0	$453,340	356,664.83
Operating Costs	$3,000	$7,500	$4,500	$3,000	$22,000	$0	$40,000	63,854.88
Other	$40,000	$0	$0	$0	$0	$0	$40,000	48,256.23
TOTAL	$493,040	$42,300	$69,000	$37,900	$165,100	$0	807,340	807,340.00

Tetra Tech was reimbursed $484,404. All dollars were spent; there were no excess project funds to reallocate.
This project did generate overmatch provided by project supporters. This overmatch was not posted to the Grant.

Discussion of the Budget Summary

Personnel includes all project staff, both staff paid under the grant and staff paid by separate, non-federal sources that supported project activities. All personnel support and related costs (e.g., benefits, taxes, administration, fees, etc.) are included under the personnel line item. Personnel costs are focused mostly on technical assistance: these are the costs involving watershed monitoring, assessment, modeling studies, land use / land cover analyses, BMP research and selection, and other technical tasks related to the watershed-based plan and BMP selection. All of the 319(h) expenditures for personnel consisted of staff salary support for Tetra Tech personnel that worked directly on the project.

A little over half of the 319(h) personnel costs were related to development of the watershed based plan, including the watershed assessment, land use/cover analysis, riparian buffer deficiency mapping, septic system risk area targeting, monitoring data analyses, wastewater treatment plant discharge studies, and the identification of priority areas for cattle management practices on Black's and Boone's creeks. The remaining 319(h) personnel funds supported the project director over the three-year grant period, development of the web site and newspaper articles, and implementation of the outreach and education program, which included creation and execution of the billboard component and the "creek crossing" and "entering watershed" signs.

Non-319(h) personnel contributions to the project were largely matching support from those engaging in the education and outreach programs and professional services related to the "fee in lieu of" mitigation (FILO) project, which included geomorphological and biological assessments, channel design, flow studies, and other professional services supporting the Kinniconick Creek restoration effort. Other non-319(h) personnel contributions included in-kind monitoring support from Morehead State University, installation of the "entering watershed" and "creek crossing" signs in Montgomery County (by personnel from the City of Mt. Sterling and county road crews), and other miscellaneous in-kind personnel support. Miscellaneous support included assessments conducted under the adapted stream visual assessment protocol in Montgomery County (see maps in this report).

It should be noted that some of the non-319(h) professional services supporting the fee-in-lieu-of mitigation work is listed under the "personnel" category, but could also be listed under the "contractual" line item. A comparison of the original project budget to the actual expenditures indicates a discrepancy in the "contractual" section, which is largely tied to listing some of the FILO support as "personnel" rather than "contractual." Also, no credit was claimed by the project for any time spent by KY Division of Water or Division of Conservation personnel – including the various site visits and the May 2011 field trip to the project by KDOW, and no time was credited for support provided by members of the Montgomery County Conservation District. These contributions represent undocumented overmatch in those cases where KDOW and KDOC personnel were not being supported through federal funding.

Supplies included miscellaneous office or other supplies. Total supplies were slightly over $400 for the three years.

Equipment costs in the original budget included a laptop computer and laser multi-purpose color printer/copier for the project manager. However, it was not necessary to purchase these items. They were provided by Tetra Tech, and included under the "operating costs" budget. As a result, no equipment was purchased using grant funds.

Travel included miscellaneous travel to various locations within the watershed, such as to stressor source and BMP sites and travel to pick up or access project materials, information, or other travel incidental to the project. Budget-supported travel expenditures were held to less than $500.

Contractual services included professional, labor, and other services related to the following project tasks:

- Collection of monthly water quality monitoring data at 12 sites along the Hinkston Creek mainstem and tributaries during 2009-2010
- Acquisition of large-format digital photographs of various BMPs in the watershed, for the five project-related billboards installed during 2010-2011
- Contracts for installation and maintenance of the five project billboards
- Professional services related to assessment and design work for the FILO project
- Work performed by the Montgomery County Conservation District to solicit BMP cost share operators and to select, approve, and share costs of project-related BMPs
- Work performed by the BMP cost share cooperators to install and maintain project-related BMPs during 2011
- Installation of "creek crossing" and "entering watershed" signs in Bath, Nicholas, and Bourbon counties – Montgomery County signs were installed by local government

Operating costs included costs for staff management, miscellaneous costs associated with BMP selection and implementation, education/training/outreach, and provision of technical assistance to land owners and/or land managers in the watershed. Operating costs also included phone access, long distance calls, internet service, utilities, use of office space, use of office equipment (i.e., projector, facsimile machine, expenses related to presentations, and other expenses incidental to project operation. There was no matching support under this category.

Other was originally intended to include the use of city-owned easements along the banks of Hinkston Creek to install stabilization measures for severely eroded areas to reduce sediment loading, and establishment of riparian vegetation to provide streambank stability. Expenditures in this category included the non-federal match supplied by the fee-in-lieu-of (FILO) mitigation project on Kinniconick Creek. Section 319(h) funding covered the cost of the "entering watershed" and "creek crossing" signs, hardware, and shipping.

3. Equipment Summary

There was no equipment purchased with grant funds.

4. Special Grant Conditions

There were no special grant conditions associated with this project.

Appendix B. QAPP for Water Quality Monitoring

Quality Assurance Project Plan

for the

Hinkston Creek Watershed Project

East Central Kentucky

April 14, 2010 Final Amended Version

Submitted by:

Barry Tonning, Project Manager

Tetra Tech

Quality Assurance Project Plan available at KDOW and KDOW; incorporated by reference.

Appendix C. Best Management Practices Implementation Plan

Implementation Plan

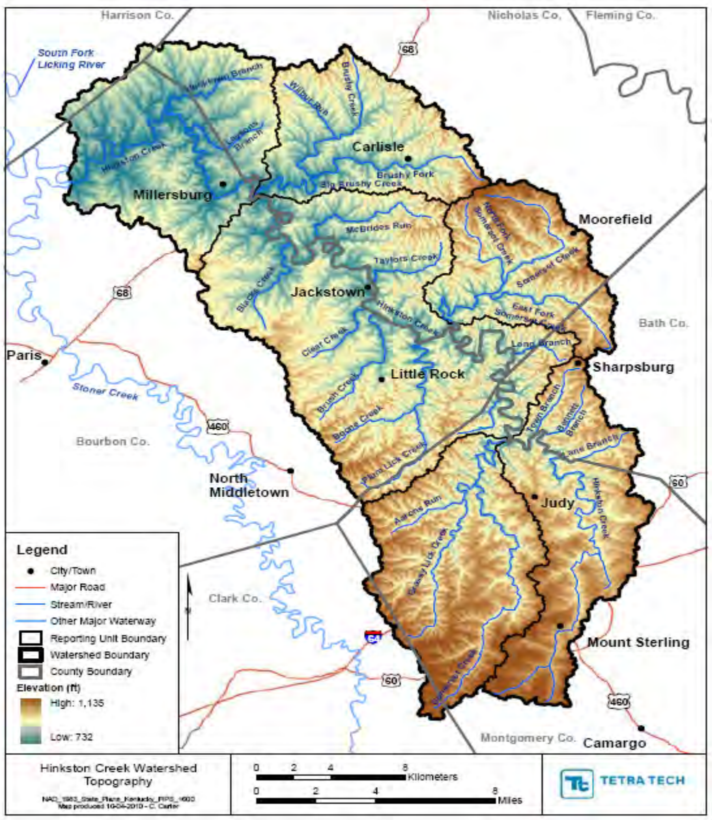
for selected

Best Management Practices

in the

Upper Hinkston Creek Watershed in

Montgomery County, Kentucky



Hinkston Creek Watershed Project

February 11, 2011

Relevant elements of the BMP Implementation Plan were incorporated into the Watershed Plan. The stand-alone document is on file with KDOW and KDOW, and is incorporated by reference.

Appendix D. Hinkston Creek Watershed-Based Plan

Hinkston Creek Watershed Assessment and Management Plan

Prepared for:

Kentucky Energy and Environment Cabinet
Department for Natural Resources
Division of Conservation
Frankfort, Kentucky

Prepared by:

TETRA TECH

3200 Chapel Hill-Nelson Hwy, Ste 105
PO Box 14409
Research Triangle Park, NC 27709

June 29, 2011

Watershed-based plan is available at KDOW and KDOW, and is incorporated by reference

Appendix E. Stream Visual Assessment Protocol, Adapted for KY

Rapid Assessment Method for

Hinkston Creek Mainstem and Tributaries

Adapted by Tetra Tech From The

Stream Visual Assessment Protocol

USDA NRCS, 1998

Summary

This assessment method is proposed for use in the upper portion of the Hinkston Creek watershed, which lies along the eastern edge of the Outer Bluegrass Region in Kentucky. The method described in this document is a rapid screening procedure composed of three basic protocols, intended to identify stream channels and corridors with 1) significant bank erosion, 2) little or no riparian vegetation, and 3) impacts from heavy livestock use. Assessment information gathered under the method described below will be used to better target funding and other support for the implementation of best management practices that reduce nutrient, sediment, and bacteria inputs to Hinkston Creek.

Background

Parameters for characterizing these three channel/corridor conditions were developed by the U.S. Department of Agriculture's Natural Resources Conservation Service in 1998, as part of the *Stream Visual Assessment Protocol*. (USDA NRCS, 1998). The *Stream Visual Assessment Protocol* (SVAP) includes a total of 15 parameters, and provides a basic level of stream health evaluation. It has been successfully applied by conservationists with little biological or hydrological training. It is intended to be conducted with landowners, and incorporates talking points for the field assessor to use during the assessment.

SVAP is the first level in a four-part hierarchy of assessment protocols, which also includes the NRCS *Water Quality Indicators Guide*, the NRCS *Stream Ecological Assessment Field Handbook*, and an intensive bioassessment protocol used by state agencies. The SVAP provides an assessment based primarily on physical conditions within the assessment area, and may not detect some resource problems caused by factors located beyond the area being assessed. The use of higher tier methods is required to more fully assess the ecological condition and to detect problems originating elsewhere in the watershed.

For the most part, SVAP was created to help landowners and resource managers evaluate basic conditions related to stream health. Streams are complex ecosystems in which several biological, physical, and chemical processes interact. The SVAP protocol notes that changes in any one characteristic or process have cascading effects throughout the system and result in changes to many aspects of the system. Often several factors can combine to cause profound changes. For example, increased nutrient loads alone might not cause a change to a forested stream. But when combined with tree removal and channel widening, the result is to shift the energy dynamics from an aquatic biological community based on leaf litter inputs to one based on algae and macrophytes. The resulting chemical changes caused by algal photosynthesis and respiration and elevated temperatures may further contribute to a completely different biological community.

On file with KDOC and KDOW; incorporated by reference.