Cane Run and Royal Spring Watershed-Based Plan Implementation Project: Final Report 2013

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Submitted By:

University of Kentucky
College of Agriculture
Biosystems and Agricultural Engineering
116 C.E. Barnhart Building
Lexington, KY 40546-0276
(859) 218-4327

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- Lexington-Fayette Urban County Government
- Lexmark International
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EXECUTIVE SUMMARY

In Federal Fiscal Year (FFY) 2008, the University of Kentucky's College of Agriculture, Food, and the Environment was awarded a United States Environmental Protection Agency (US EPA) 319(h) grant to implement a watershed-based plan (WBP) for the Cane Run Watershed.

The purpose of the project was to improve and protect the overall water quality of the watershed so that the Cane Run can be removed from the 303(d) list of impaired waters. The project goals included implementing the WBP, revising the plan as necessary, and measuring implementation progress. An information and education component was also included.

Through work with two primary stakeholders, 27 agricultural and 16 urban BMPs were implemented in the Cane Run Watershed. In addition, a large section of the Cane Run and a small tributary were restored to mitigate stream bank erosion. Utilizing effective communication strategies, project managers were able to demonstrate the benefits of BMP implementation and effectively change future land management approaches by the stakeholders.

Education and outreach efforts integrated all levels of watershed stakeholders, including farm-level laborers, K-12 and post-secondary students, land managers, and the general public. Watershed tours, BMP signage, community events, electronic media, and written materials were used to transfer BMP technical information as well as communicate project progress.

The overall success of the project is attributed to partnerships, effective communication, and momentum built through years of work in the Cane Run. Although this project successfully implemented many BMPs, additional BMP implementation is needed to further remediate the Cane Run watershed.

I. INTRODUCTION AND BACKGROUND

This project continued the work of a previously awarded U.S. Environmental Protection Agency (EPA) 319(h) grant (*Cane Run and Royal Spring Watershed Based Plan Project*). The previous grant was awarded in the Federal Fiscal Year (FFY) 2006 to the University of Kentucky to develop a watershed-based plan (WBP) for the Cane Run and Royal Spring Watershed. The 2006 project also developed pathogen and nutrient total maximum daily loads (TMDLs) and began implementing best management practices (BMPs) to reduce, remediate, and prevent the effects of nonpoint source pollution in the watershed. The broad project goals of the current 319(h) grant, awarded in FFY 2008, were to implement the WBP developed during the 2006 project and educate watershed stakeholders.

Beginning in 1998, a portion of the Cane Run in Fayette County was classified on the Clean Water Act Section 303(d) list of impaired waters. The listed causes for impairment at the time included organic enrichment, low dissolved oxygen, and bacteria coming from urban runoff and storm sewers. By 2010, all 17.4 miles of the Cane Run had been listed on the 303(d) list and included impairment by sediment. In addition, three unnamed tributaries of Cane Run, which total 4.5 miles in Fayette County and 3.5 miles in Scott County, and the Royal Spring itself, which totals 0.7 miles in Scott County had been added to the 303(d) list.

The purpose of the Cane Run and Royal Spring Watershed-Based Plan Implementation Project was to improve and protect the overall water quality of the watershed so that the Cane Run and Royal Spring meet their designated uses and can subsequently be removed from the 303(d) list of impaired waters. The project goals included implementing the WBP, measuring implementation progress, and refining BMPs to improve the Cane Run watershed.

Project objectives corresponding to project goals are as follows:

Goal #1: Implement WBP and revise WBP as necessary
Objectives:
- Improve water quality by implementing management strategies as directed by the WBP.
- Continue an information/education (I/E) component to support public participation and build management capacity related to adopted management measures.

Goal #2: Measure implementation progress and make adjustments to the WBP or refine BMPs
Objective:
- Develop an evaluation framework.

II. MATERIALS & METHODS

A) WATERSHED DESCRIPTION

The Cane Run and Royal Spring Watershed (HUC 12: 051002050804) is located within Fayette and Scott Counties in central Kentucky (Figure 1). The upper portion of the watershed, located within Fayette County, drains highly urbanized areas of Lexington and a portion of the watershed in Scott County drains the southern part of Georgetown. The rest of the watershed is predominantly agricultural. The 7.5 minute quadrangle maps on which Cane Run can be found are Centerville, Georgetown, Lexington East, and Lexington West. Cane Run contributes to the Kentucky River Watershed (HUC 8: 05100205). Interstate highways I-64 and I-75 traverse the watershed.

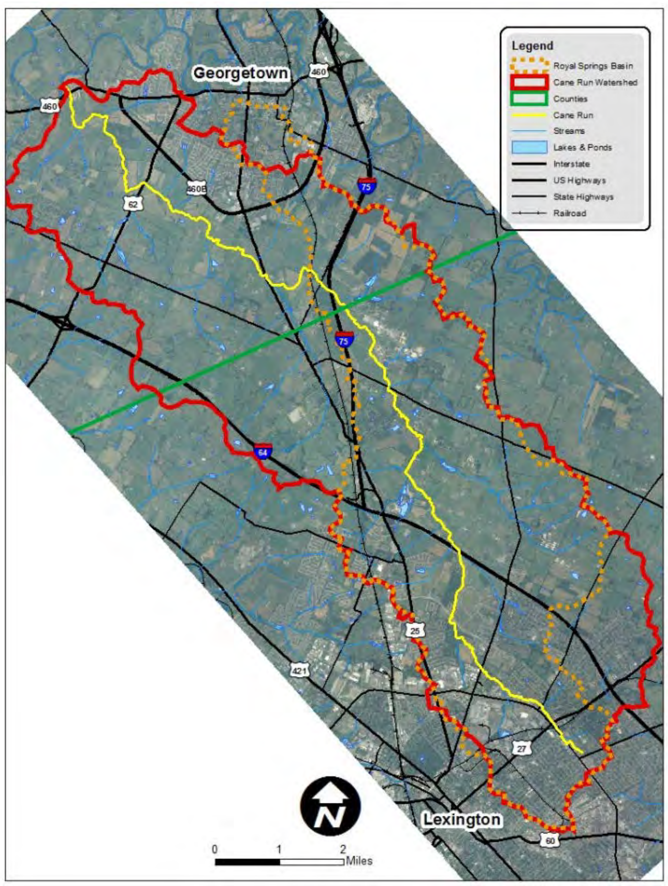


Figure 1. 2010 aerial imagery of the Cane Run watershed and surrounding areas

Hydrology

Cane Run is a fourth order stream that originates in central Fayette County and flows north to discharge into the North Elkhorn Creek 44.3 km (27.5 miles) upstream of its confluence with the Elkhorn Creek. Elkhorn Creek carries the runoff from the county northwest to discharge into the Kentucky River.

The main stem of Cane Run is approximately 28 km (17.4 mi.) long and drains an area of 117.6 km^2 (29,064 acres). The average gradient is 2.34 m/km (12.4 feet/mile). Elevations for Cane Run range from 297 m (975 feet) above mean sea level (MSL) in the headwaters in Lexington to 232 m (760 feet) above MSL at the confluence with the North Elkhorn Creek. Like most small watersheds, many of the tributary streams are intermittent.

Catchment Delineation

The Cane Run watershed can be split into 10 subwatersheds, or catchments as shown in Figure 2. The delineation of catchments within the watershed was accomplished using National Hydrology Data (NHD), which is based on a 10-meter digital elevation map (DEM) characterization of the watershed. This division allows for analysis of both point and nonpoint sources within each subwatershed.

The Cane Run Watershed Project (CRWP) and the Kentucky Water Resources Research Institute (KWRRI) have both divided the Cane Run watershed into catchments, or subwatersheds, but each organization has used different labeling schemes. The catchments presented in the WBPare numbered 1-10. The subwatersheds presented in the bacteria and nutrient TMDLs authored by KWRRI are numbered L1-L6, U1-U8, and K1-K3, with L representing the lower watershed, U representing the upper watershed, and K representing additional karst systems within the watershed (Figure 2). The equivalencies between the labeling schemes can be found in **Error! Reference source not found.**.

Table 1. CRWP and KWRRI catchment equivalencies

Cane Run Watershed Project Catchment Number	KWRRI TMDL Subwatershed Number(s)
1	K1, K2, U4
2	L6
3	L5, U8
4	L2, L3, L4
5	L1
6	U6
7	U7
8	U3, U5
9	U2
10	U1
--	K3

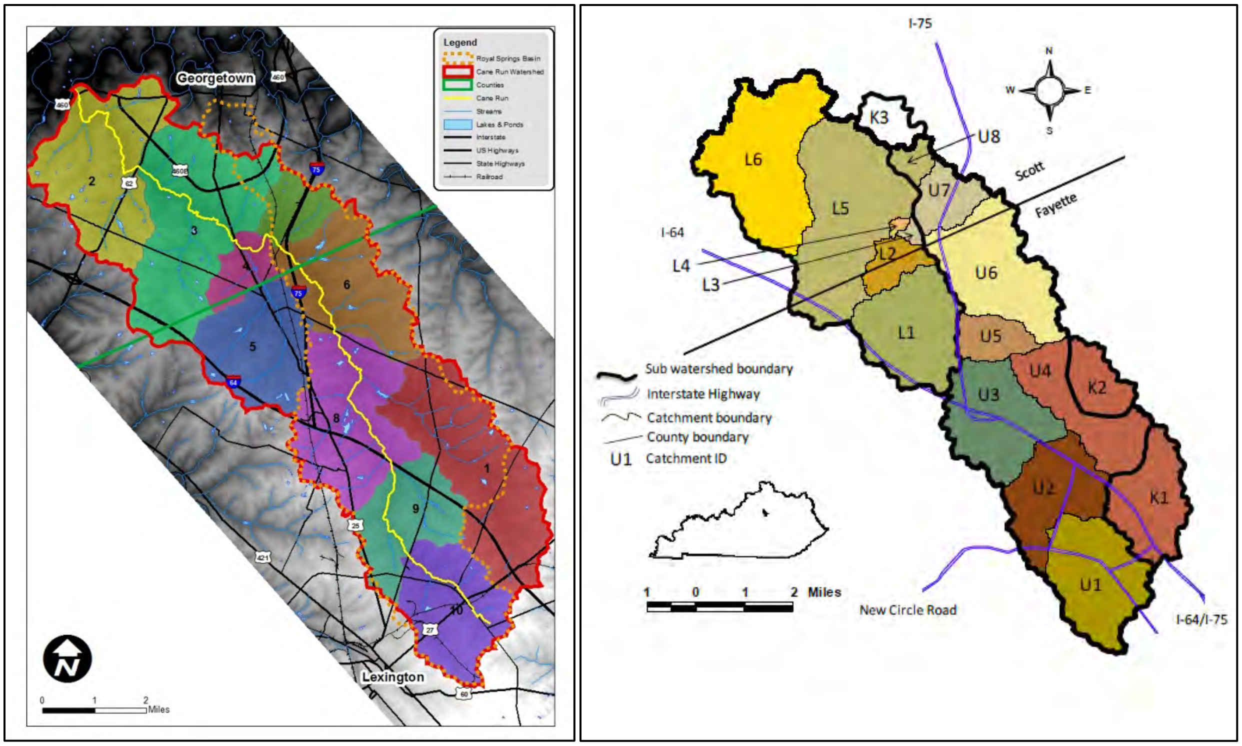


Figure 2. Cane Run Watershed Project catchments and KWRRI catchments

Geology

The Cane Run watershed is located within the Inner Bluegrass physiographic region. The area is underlain with the Lexington limestone formation of the Ordovician age. The Lexington formation is a thin-bedded shaley phosphatic limestone. The Tanglewood member is exposed in the largest area of the basin and is likely responsible for contributing phosphorus to ground water and surface water. Karst features such as sinkholes and springs dominate the geology. There are moderate amounts of shale and alluvium deposits in the region (U.S. Department of Agriculture, 1978). The relief of the Cane Run watershed ranges from nearly level to gently rolling and undulating hills (U.S. Department of Agriculture, 1978).

Large swallets, like the one shown in Figure 3, are present in portions of the watershed and drain the surface flow to the groundwater system (Figure 4). The Royal Spring groundwater basin (located near Georgetown, KY) and the upper Cane Run surface water basin overlap considerably. At baseflow conditions, a series of swallets within the stream channel of Cane Run divert all water to the Royal Spring. As a result, the gauging station at Cane Run near Bonerail (ID# 03288200) records no flow during these periods. Flow data is only available during high flow periods as surface runoff reaches the Cane Run.

Figure 3. Typical karst conduits within the Cane Run

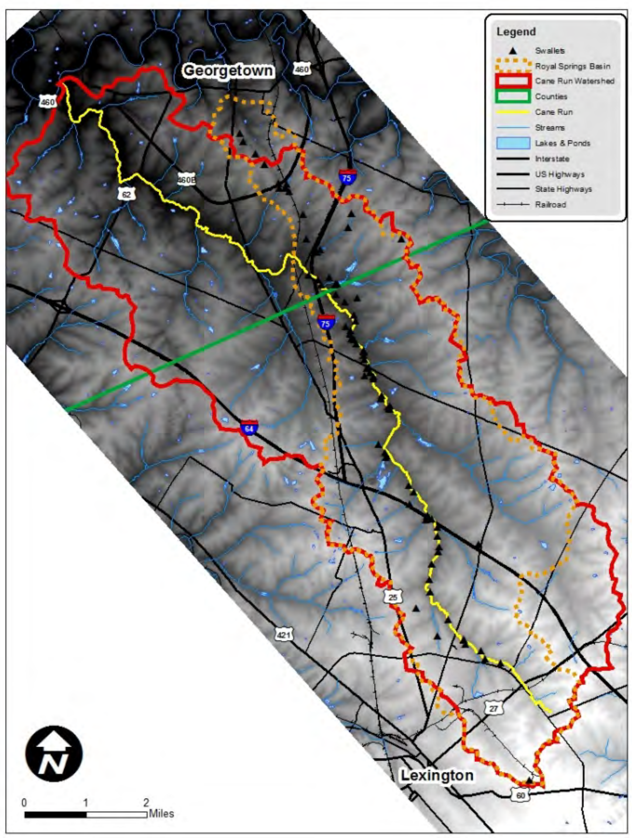


Figure 4. Known swallets within the Cane Run Watershed that divert to the Royal Spring

Soils

Level to strongly sloping silt loam and silty clay loam soils dominate the Cane Run Watershed. The area is comprised mostly of the Maury, McAfee, and Lowell soil series (Figure 5). The Maury series are deep, well-drained soils formed from weathered phosphatic limestone. Permeability for this series is moderate to moderately rapid. The McAfee soil series are moderately deep to deep, well-drained soils formed from weathered phosphatic limestone. Permeability for this series is moderate to moderately low. The Lowell series are deep, well-drained to moderately-drained soils formed from weathered interbedded limestone and calcareous shale. Permeability for this series is moderate to moderately low (U.S. Department of Agriculture, 1978).

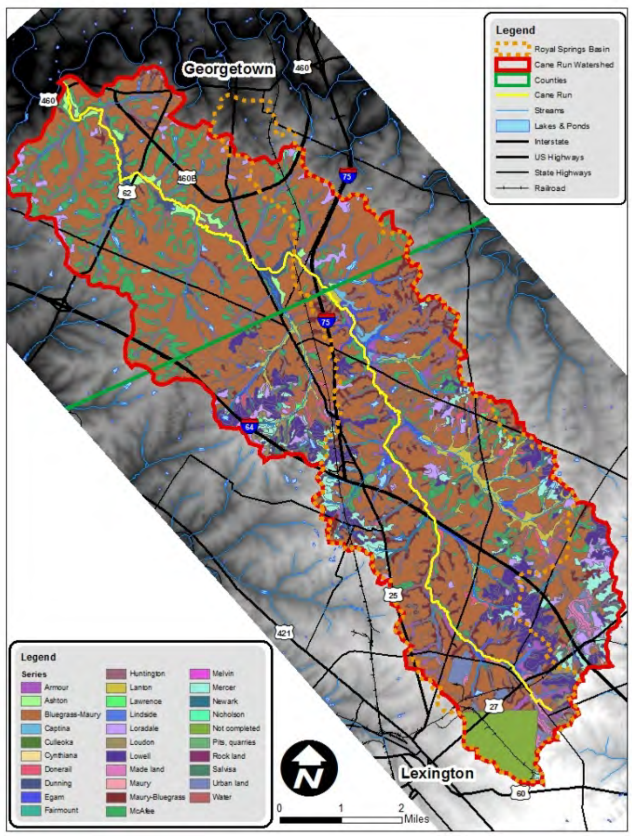


Figure 5. Soil series within the Cane Run Watershed

Land Use

The land in the Cane Run watershed, with its phosphorus rich soils, is conducive to agricultural use. Approximately 67% of the watershed consists of land in agricultural production, and about 29% of the watershed is developed (Figure 6). The developed area ranges from residential to commercial and industrial tracts, and much of this developed land is impervious (Figure 6). About 10% of the entire watershed is impervious surface.

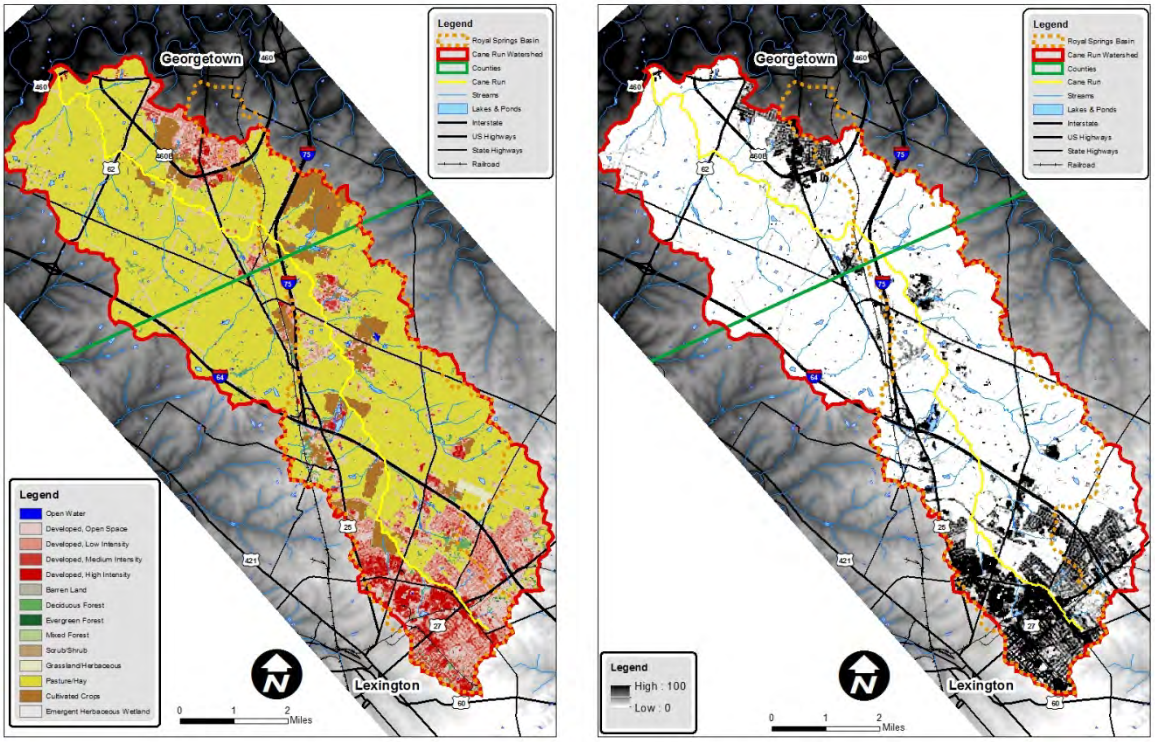


Figure 6. Land cover and impervious surface in the Cane Run Watershed

Stakeholders

The Cane Run Watershed has a unique group of stakeholders (Figure 7). The upper reaches of the watershed begin on the northern edge of Lexington, which makes the Lexington-Fayette Urban County Government (LFUCG) a key stakeholder in the improvement of water quality within the watershed. The EPA, Kentucky Division of Water (KDOW), and LFUCG have finalized a Consent Decree that will require LFUCG to remediate existing stormwater and sanitary sewer deficiencies and enhance the quality of the surface and ground water that exits the city. The LFUCG also controls a portion of the UK Coldstream Research Park where streamside management can be incorporated (the University of Kentucky (UK) farms and maintains the rest of the research park).

Another key stakeholder in the Cane Run Watershed is Lexmark International, which owns a significant portion of land on the northern urban fringe of Lexington at the junction of a large tributary to the Cane Run. Lexmark is an active participant with the Cane Run Council and continues to work to improve the quality of water that flows out of their property.

The Cane Run also flows through the University of Kentucky's Agricultural Experiment Station, which is the largest single landowner in the watershed. This makes the University of Kentucky another major stakeholder in the success of this project. University administrators have agreed to make the Experiment Station a working model of BMPs for streams, which will directly improve water quality and serve as an example for nearby producers, which could encourage a more broad application of water quality BMPs.

The second largest landowner in the Cane Run Watershed is the Kentucky Horse Park, whose managers worked with the Cane Run Watershed Project to protect water quality in preparation for the FEI World Equestrian Games and continue to work to protect water quality on their property.

Other large landowners in the watershed include Marriott Griffin Gate Resort, Barton Brothers Farms, Kentucky River Properties, and Vulcan Materials. Georgetown Water Supply has also been very vocal in their support for the restoration efforts.

Because of the differences between and within the urban and rural landscapes, the karstic linkage between surface water and groundwater, and the diversity of landowners within the watershed, a significant level of coordination among stakeholders, watershed managers, and planners has been necessary to identify and implement BMPs on a watershed scale.

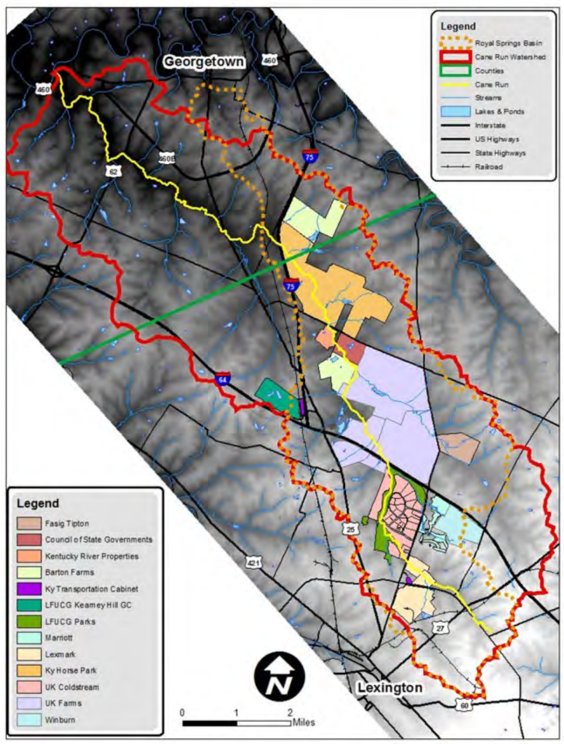


Figure 7. Cane Run cooperators

B) BEST MANAGEMENT PRACTICE IMPLEMENTATION

1. *Project Areas*

Best Management Practice implementation took place at the University of Kentucky's (UK) Agriculture Experiment Station and the Kentucky Horse Park, the two largest landowners in the Cane Run Watershed, respectively.

University of Kentucky's Agriculture Experiment Station

The University of Kentucky's Agriculture Experiment Station (2,011 acres) is located within Catchments 8 (1,172 acres), 1 (699 acres), and 9 (140 acres) and is bordered by Interstate-75/64, KY-922, and KY 1973 (Figure 8). Catchments 1 and 9 flow toward Catchment 8, which comprises the largest portion of the farm. Best Management Practice implementation was targeted at areas within Catchments 8 and 9 on the farm. The land use is predominately pasture/hay but developed, cultivated crop, and deciduous forest areas are also present (Figure 9). Although a few possible point sources of pollution are present on the farm (Class V injection wells), most of the pollution that occurs on the farm is from nonpoint sources such as agricultural runoff and erosion.

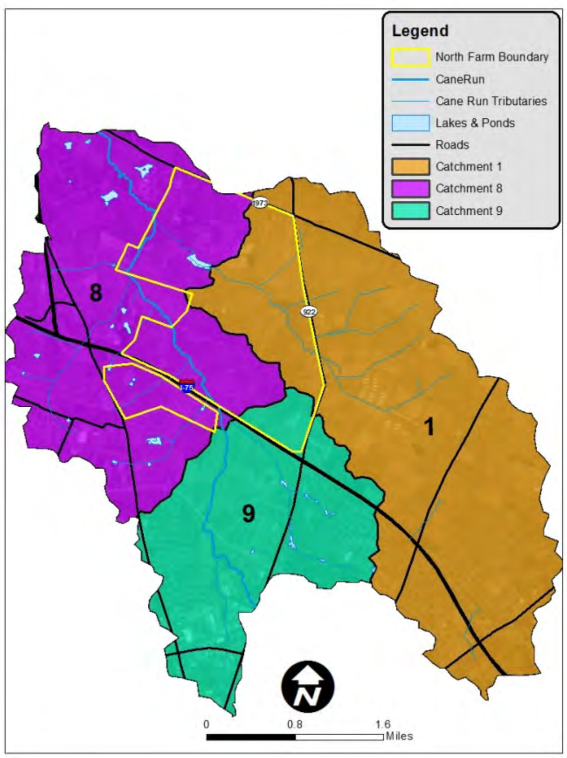


Figure 8. Cane Run Catchments in UK's Agriculture Experiment Station

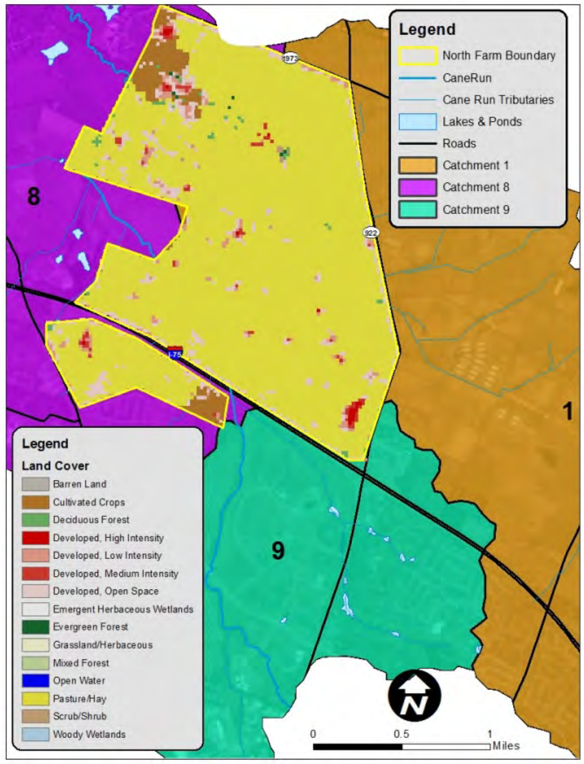


Figure 9. Land cover at UK's Agriculture Experiment Station

Kentucky Horse Park

The Kentucky Horse Park (1,497 acres) is located within Catchments 6 (1,439 acres), 7 (33 acres), and 8 (25 acres) and is bordered by Interstate-75 and KY-1973 (Figure 10). The land cover is predominately pasture/hay but there is a large concentration of developed area in the center of the park; areas of cultivated crops and deciduous forest are also scattered throughout the park (Figure 11). The stream section passing through the Horse Park runs through the entrance area, where many of the swallets that connect to the Royal Spring conduit are located. The lower portion of this stream section is located where the Royal Spring conduit diverges away from the Cane Run. This entire reach is significant, as flood flows pass quickly through the channel. In 2010 the Horse Park served as one of the most visited facilities within the Cane Run Watershed, making the Horse Park a unique opportunity to educate thousands of Kentuckians and guests as to the steps and innovative measures the watershed project has taken to restore Cane Run.

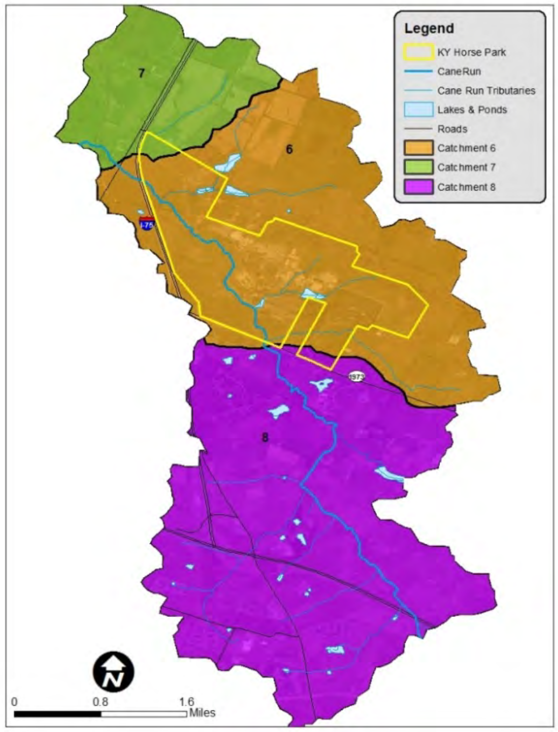


Figure 10. Cane Run Catchments in the Kentucky Horse Park

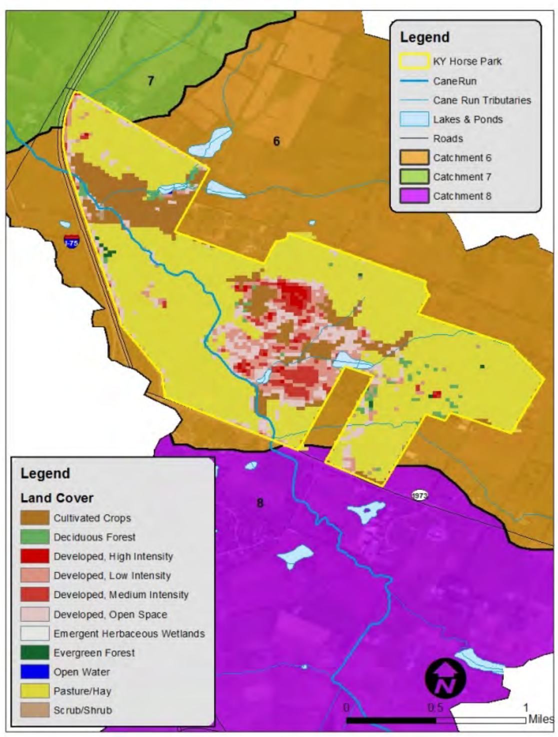


Figure 11. Land cover at the Kentucky Horse Park

2. *Methods*

BMPs were selected based on current land uses, pollutant sources, pollutant load reduction effectiveness, and the overall aptitude for them to be installed and maintained with the highest level of project participation and support.

3. *Materials*

No specialized materials were used for BMP implementation.

C) EDUCATION AND OUTREACH

1. *Project Areas*

Education and outreach activities were focused in the BMP implementation areas mentioned above as well as Northern Elementary, Winburn Middle, and Bryan Station High school.

2. *Methods*

The project employed a variety of education and outreach methods to educate the community about the Cane Run Watershed, water quality of central Kentucky in general, and what people can do to improve conditions in the watershed. These methods included public events, Cane Run Watershed Council meetings, watershed tours, formal presentations, student volunteer opportunities, primary and secondary school projects, workshops, and coordination with other agencies working in the Cane Run watershed.

Activities conducted with public school groups met one or more of the following Kentucky Core Academic Standards (KDE, 2010):

Elementary

- Science – Big Idea: The Earth and the Universe (Earth/Space Science). Students will use senses and scientific tools (e.g., hand lens/magnifier, metric ruler, balance, etc.) to observe, describe and classify earth materials (solid rocks, soils, water and air) using their physical properties.
- Science – Big Idea: Unity and Diversity (Biological Science). Students will ask questions that can be investigated, plan and conduct 'fair tests,' and communicate (e.g., write, draw, speak, multi-media) findings to others.
- Science – Big Idea: Interdependence (Unifying Concepts). Students will describe how changes in an environment might affect plants' and animals' ability to survive.
- Social Studies – Big Idea: Geography. Students will develop an understanding of patterns on the Earth's surface using a variety of geographic tools (e.g., maps, globes, charts, graphs): 1. Locate and describe familiar places at school and the community; 2. Create maps that identify the relative location of familiar places and objects (e.g., school, neighborhood); and 3. Identify major landforms (e.g., continents, mountain ranges) and major bodies of water (e.g., oceans, rivers).
- Vocational Studies – Big Idea: Consumer Decisions; Students will describe consumer actions (reusing, reducing, recycling) and identify ways these actions impact the environment (e.g., conserving resources, reducing pollution, reducing solid waste).

Middle

- Science – Big Idea: Interdependence (Unifying Concepts); Grade 7: Students will research and investigate environmental situations where small changes may have large impacts in both living and non-living components of systems; research and discuss environmental impacts of actions (human or non-human) which necessitate choosing between undesirable alternatives; design and conduct investigations of changes to abiotic and biotic factors in ecosystems, document and communicate observations, procedures, results and conclusions.
- Science – Big Idea: Interdependence (Unifying Concepts); Grade 8: Students will evaluate the risks and benefits of human actions affecting the environment and identify which populations will be harmed or helped. Use a variety of data/ sources to support or defend a position related to a proposed action, both orally and in writing. Analyze the validity of other arguments; and, identify examples of human actions that have had unintended environmental consequences.
- Social Studies – Big Idea: Geography; Grades 6, 7, and 8: Students will demonstrate an understanding of patterns on the Earth's surface, using a variety of geographic tools (e.g., maps, globes, charts, graphs, satellite images); and investigate interactions among human activities and the physical environment in the present day.
- Vocational Studies – Big Idea: Consumer Decisions; Students will evaluate ways consumer actions (reusing, reducing, recycling) influence the use of resources and impact the environment.

High

- Science – Big Idea: Interdependence (Unifying Concepts); Students will explore ways to eradicate or lessen environmental problems caused by human interaction (e.g., examine programs for habitat restoration or wildlife protection, automotive/industrial emissions standards); investigate changes in ecosystems and propose potential solutions to problems by documenting and communicating solutions to others through multi-media presentations; and explore the causes, consequences and possible solutions to persistent, contemporary and emerging global issues relating to environmental quality.
- Social Studies – Big Idea: Geography; Students will use a variety of geographic tools; investigate regions of the Earth's surface using information from print and non-print sources; and investigate interactions among human activities and the physical environment in the modern world and United States.
- Vocational Studies – Big Idea: Consumer Decisions; Students will evaluate consumer actions (e.g., reuse, reduce, recycle, choosing renewable energy sources, using biodegradable packaging materials, composting) and analyze how these actions impact the environment.

3. Materials

The project team used personal communication, email, brochures, a project website (http://www.bae.uky.edu/CaneRun/), social media (Facebook), PowerPoint presentations, and informational poster boards, models, and displays for the education and outreach efforts of this project.

III. RESULTS AND DISCUSSION

A) BEST MANAGEMENT PRACTICE IMPLEMENTATION

A total of 27 agricultural and 16 urban BMPs that were recommended by the WBP were implemented in the Cane Run Watershed during the course of this project. In addition, a large section (1,400 feet) of the Cane Run and a small tributary were restored at the Kentucky Horse Park (KHP). Several other riparian restoration projects also took place. Agriculture BMPs installed in the Cane Run watershed included streambank fencing, heavy use area protection, a waste storage facility, rotational grazing, and alternative water systems. Urban BMPs installed during the project included a rain garden, bioswales, settling basin, bioretention pond, denitrifying mulch berm, stormwater diversion, storm drain inlet protection, and a recreational trail walkway.

The vast majority of BMPs installed throughout this project were funded by the Kentucky 319(h) program (60% share) and SB-271 funding (40% share). Grant money from this project provided funding for the following BMPs:

Agriculture

- Alternative Water System – Four automatic watering facilities were installed at the KHP
- Fence-Containment – 5,150 linear feet of new fencing was installed along riparian areas
- Heavy Use Area (HUA) Protection – Nearly one acre of HUA traffic pads were installed
- Pesticide Handling – 3,200 pounds of pesticides were removed from UK's Agriculture Experiment Station (AES)
- Rotational Grazing – A 27.5 acre field was subdivided to create a rotational grazing system
- Waste Storage Facility – A 2,000 square feet waste storage facility (covered) was installed at the KHP

Urban

- Bioretention Pond – A 220 linear foot bioretention pond was installed to help treat stormwater
- Bioswale – Three bioswales were installed to help treat stormwater at the KHP
- Rain Garden – A 110 linear foot rain garden was installed to capture runoff from denuded paddock
- Recreational Trail Walkway – A 1,200 linear foot trail was established along riparian area at the KHP
- Settling Basin – A 80 linear foot settling basin was installed to capture gravel from parking lot
- Other – Increased elevation in two ponds to make water cooler to decrease algae bloom
- Other – Dredged 570 linear feet of a pond of sediment and stabilized banks
- Other – Installed a denitrifying mulch berm to treat horse much runoff
- Storm Drain Inlet Protection – Installed a pervious concrete storm drain frame to filter sediment
- Stormwater Diversion – 2,400 linear feet of land was contoured to improve stormwater diversion

Stream Restoration

- The unnamed tributary to Cane Run at the KHP was restored to reduce stream bank erosion and improve riparian buffer. Bankfull benches were constructed along approximately 1,200 linear feet of the Cane Run and 200 linear feet of a tributary. Toe rock was installed along approximately 185 linear feet of stream.
- Filled two headcuts

Riparian Restoration

- Planted trees, shrubs, and flowers along 8,440 linear feet of riparian area
- Planted trees along 2,600 linear feet of riparian area
- Established no-mow zones (filter strip) along 51,200 linear feet of riparian area

Funding from the UK's College of Agriculture, Food, and the Environment (CAFE) went toward the following BMPs:

- Heavy Use Area (HUA) Protection – 4,230 square feet of HUA traffic pads were installed under shade structures
- Other – 40 hay huts were purchased in place of roll-bale feeding

Table 2 gives a summary of all BMPs implemented, and Figures 12-13 show the locations of these BMPs. A narrative description, divided by project area, describing the BMPs follows.

Table 2. Best management practices implemented in the Cane Run Watershed[1]

Implemented BMP	Estimated Load Reduction[2]				Estimated Effectiveness[3]				Geographic Location		Project Site
	Nitrogen	Bacteria	Sediment	Phosphorus	Nitrogen	Bacteria	Sediment	Phosphorus	Latitude (N)	Longitude (W)	
Bioretention Systems (rain garden, bioswales, and bioretention pond)	49%[z]	70%[lk]	65%[lk]	76%[z]	M	M	M	H[e]	38.150156	84.518503	KHP
									38.152572	84.516522	
									38.152569	84.516514	
									38.156078	84.524942	
									38.155431	84.519447	
Diversion	45%	N/A	70%[i]	U	L	M	M	L[e]	38.155140	84.519391	KHP
									38.155025	84.519190	
									38.154458	84.515776	
									38.153052	84.515812	
									38.150349	84.525097	
Fence	54%	N/A	90%	81%[j]	M	N/A	H	M[e]	38.148426	84.528045	UK Farm & KHP
									38.147583	84.527767	
									38.150250	84.518374	
									38.150767	84.517534	
									38.154890	84.523007	
									38.154492	84.523283	
									38.154764	84.520618	
									38.155341	84.519907	
Filter Strip	70%	70%	65%	75%[k]	M	M	M	M[e]	38.155230	84.519718	UK Farm & KHP
									38.149708	84.519697	
									38.145189	38.145189	
									38.113873	84.504886	
									38.106961	84.499404	
									38.107702	84.514909	
									38.115578	84.485816	

Heavy Use Area Protection	U	U	U	U	L-M	L-M	L-M	L-M[a]	38.154543 38.150307 38.149723 38.155612 38.106957 38.112635 38.120507 38.107473 38.112162	84.530764 84.525358 84.525483 84.520859 84.489458 84.486109 84.487749 84.488442 84.499156	UK Farm & KHP
Prescribed Grazing (Rotational Grazing)	70%	70%	65%	75%[k]	L-H	L-H	L-H	L-H[a]	38.110151	84.499097	UK Farm
Recreation Trail Walkway	N/A	N/A	U	N/A	N/A	N/A	L-H[a]	N/A	38.145012 38.145227	84.511781 84.508264	
Riparian Buffer	68%	60%	80%	42%[ajp]	M	H	M	M[e]	38.124700 38.113873 38.145189 38.149708	84.500900 84.504886 38.145189 84.519697	UK Farm & KHP
Riprap (filled headcuts)	U	U	U	U	N/A	N/A	H[t]	N/A	38.150217 38.154839	84.517350 84.518878	KHP
Storm Drain Inlet Protection	U	U	U	U	N/A	N/A	L[t]	N/A	38.153064	84.514564	KHP
Stream Habitat Improvement and Management	68%	60%	80%	40%[ajp]	M	M	H	M[e]	38.150369 38.149708	84.516203 84.519697	KHP
Streambank Protection	68%	60%	80%	42%[ajp]	M	M	H	M[e]	38.150369 38.149708	84.516203 84.519697	KHP
Waste Storage Facility	65%	90%	70%	60%[i]	H	H	H	H[e]	38.155384	84.517437	KHP
Water & Sediment Control Basin	U	U	70%[r]	U	M	L	H	M[e]	38.155179	84.519661	KHP

Watering Facility	54%	U	90%	81%[j]	M	M	H	M[e]	38.153927	84.518693	KHP
									38.153606	84.517923	
									38.153023	84.518327	
									38.153352	84.519092	
Key: L Low**, M** Medium**, H** High**, N/A** Not Applicable**, U** Unknown											

[1]The studies referenced in this table can be found in the Literature Cited section at the end of this report.

[2]Estimated Load Reduction: provides a gross estimate of practice effectiveness as reported in research literature. The actual effectiveness of a practice will depend exclusively on site-specific variables such as soil type, topography, climate, and production system.

[3]Effectiveness: Adapted from USDA Agriculture Information Bulletin No. 598 and NRCS conservation practice physical effects (CPPE) documents. NOTE: Because of the general nature of these documents, there may be situations and sites where practices will not perform as indicated.

Figure 12. Best management practices implemented at UK's Agriculture Experiment Station

Figure 13. Best management practices implemented at the Kentucky Horse Park

1. *University of Kentucky Experiment Station*

Hay Huts

Although the use of hay huts in not considered an agricultural BMP, water quality can still potentially benefit from their use. Prior to the use hay huts, roll bales of hay were unrolled in the paddock and would create a feeding area that could be as long as 150 linear feet (Figure 14). Horse congregation along this 150 linear foot strip could potentially create a muddy area as large as 2,100 square feet. By using hay huts, the feeding area is concentrated to around the hut and thus limits the size of the area that becomes denuded, approximately 100 square feet (Figure 15). Approximately forty hay huts have been purchased by UK's CAFE, which could be limiting the amount of denuded pasture by as much as 80,000 square feet.

Figure 14. Mud creation due to roll-bale feeding

Figure 15. Less mud creation due to use of hay huts

Heavy Use Area Protection

Heavy use area (HUA) protection was installed under 4 large permanent shade structures (1,410 square feet each) with funding from UK's CAFE (Figure 16). A HUA was also installed in the paddock that was recently altered to create a rotational grazing system using 319(h) funds (Figures 17). Without a HUA, horses congregating in these areas will create mud, increase soil compaction, eliminate desired vegetation, and lead to increased weed infestation. The runoff from these compacted, denuded areas can also pollute nearby surface water bodies. The purpose of a dry lot is to provide a hardened area for the traffic associated with obtaining water and feed or seeking shelter and to eliminate many of the negative impacts that livestock have on water quality.

Figure 16. Heavy use areas were installed under 4 permanent shade structures with UK CAFE funds

Figure 17. A HUA was installed in the paddock that was recently altered to create a rotational grazing system

No-Mow Zone (Filter Strip)

No-mow zones are areas adjacent to water bodies where mowing is prohibited. These riparian areas were previously mowed to the water's edge (Figure 18). The installation of a no-mow zone allows vegetation, including plants in the seed bank, to grow and create a vegetative buffer between pollutants such as sediment, nutrients, and bacteria and the water (Figure 19). These buffers are approximately 50 feet wide on each side of the water body. During the FFY 2006 project, no-mow zones were established along all streams and water bodies on the farm, with the exception of several small stream sections and Lake Mildred. During this project (FFY 2008), these final areas were delineated as no-mow zones; all streams and water bodies on the entire farm are now protected. Signs are posted to designate no-mow zones areas—these signs also help describe the practices to users and visitors of the farm. As a result of this stewardship, populations of riparian flora such as Great Blue Lobelia (*Lobelia siphilitica*), Swamp Milkweed (*Asclepias incarnate*), sedges, Woodland Sunflower (*Helianthus divaricatus*), and Arrow Arum (*Peltandra*) are returning.

Figure 18. Example of riparian area before the installation of the no-mow zone policy

Figure 19. Example of riparian area after the installation of the no-mow zone policy

Pesticide Management

Pesticides are necessary to the research, extension, and teaching missions of the Experiment Station. The FFY 2006 project established several pesticide management practices, including a regular pick-up of unusable or unneeded pesticides, fertilizers, or other toxic wastes. In 2013, 3,702 pounds of toxic wastes were removed from the farm to be properly disposed of, which reduces the risk of accidental discharge into water resources (Table 3).

Table 3. Toxic wastes removed from UK Experiment Station

Pesticide Pick-Up at UK Experiment Station			
Date	**Item Description**	**Quantity**	**Unit Wt./Vol.**
10/22/2013	UN2810 Toxic Liquids, Organic (Diazinon, Malathion)	3600	pounds
10/22/2013	UN2996, Waste Organochlorine Pesticides, Liquid , Toxic	100	pounds
10/22/2013	UN2757, Waste Carbamate pesticides, Solid, Toxic	2	pounds

Riparian Planting

Two large riparian areas were planted with native trees, scrubs, or wildflowers. The area within the recently established no-mow zone around Lake Mildred was planted with riparian species such as Black-eyed Susan (*Rudbeckia hirta*), River Birch (*Betula nigra)*, Swamp White Oak (*Quercus bicolor*), Prairie Switchgrass (*Panicum virgatum*), Little Bluestem (*Schizachyrium scoparium*), Purple Coneflower (*Echinacea purpurea)*, and Bee Balm (*Monarda didyma*). Forestry students at UK planted 400 native trees along both banks of the southern section of the Cane Run on the farm (Figure 20). Tree mats were used to control competition to help ensure the trees' survival. Tree species planted included Willow Oak (*Quercus phellos*), Bur Oak (*Quercus macrocarpa*), Swamp Chestnut Oak (*Quercus michauxii*), and River Birch (*Betula nigra*). The plantings will eventually help shade the water bodies, provide canopy and forage for wildlife, and filter pollutants.

Figure 20. Forestry students planted 400 native trees along both banks of the Cane Run on UK's AES

2. Kentucky Horse Park

Alternative Water Systems

The KHP had four automatic watering fountains that were poorly sited, not properly working, and were not placed on a HUA. The areas surrounding the water facility were denuded and causing other erosion issues in the paddock due to leaking (Figure 21). There were several similar instances of this throughout the park. The worst four fountains were replaced and properly sited within the paddock on a heavy use surface (Figure 22). Horse park staff were trained on how to properly site and develop a HUA in the process so future fountains can be replaced with water quality in mind.

Figure 21. A dilapidated watering fountain that was poorly sited and not placed on a proper HUA

Figure 22. A new, properly sited watering fountain placed on a HUA

Bioretention Pond

A 220 linear foot bioretention pond was installed below an impervious area where horse wash racks and uncovered manure piles are located and labeled with educational signage (Figure 23). The bioretention pond is engineered to filter the runoff of sediment and nutrients.

Figure 23. A bioretention pond was installed below an impervious area where horse wash racks and uncovered manure piles are located and labeled with education signage

Bioswale

Three bioswales were installed in ditches where stormwater discharges from a point source and designated with educational signage (Figures 24-25). The purpose of the bioswales is to slow the velocity of the discharge to minimize bank erosion and filter pollutants from the stormwater. Bioswales were planted with species such as Black-eyed Susan, Prairie Switchgrass, Little Bluestem, Purple Coneflower, Goldenrod, and Bee Balm, which are known for their ability to assimilate pollutants.

Figure 24. A bioswale and educational signage installed in a stormwater ditch.

Figure 25. A bioswale and educational signage installed in a stormwater ditch.

Denitrifying Mulch Berm

A pond adjacent to the Alltech Arena was receiving a large amount of runoff that was primarily horse muck runoff. Thus, the pond was high in nutrients and experiencing algae blooms. A denitrifying mulch berm, or "bark-bed" was installed beside the pond where runoff was entering. The combination of this berm and other pond work led to the elimination of the algae bloom.

Heavy Use Area Protection

Heavy use areas (HUAs) were installed under and outside the entrance of two run-in sheds (Figure 26), in the paddock used for trail horses (Figures 27), and along a highly eroded section of the horse trail (Figure 28). All of these areas were completely denuded and experiencing excessive erosion, especially the trail horse paddock (Figure 29). The trail horse paddock is 9,672 square feet and typically contains between 20-25 horses (Figure 30). A paddock with this concentration of animals is prone to muddy conditions; contributing further to the trail horse paddock's issues is its location downhill of another denuded area containing two large gullies flowing toward it (Figure 31). Relocating the pasture was considered but was not feasible for KHP staff who utilized the paddock. As an alternative, the paddock was filled with a HUA and storm water was diverted around the paddock.

Figure 26. One of two HUAs installed outside of a run-in shed

Figure 27. Large HUA installed in trail horse paddock

Figure 28. A highly erodible section of the visitor horse trail was paved with soil cement

Figure 29. A denuded and highly erodible paddock used for trail horses

Figure 30. Trail horse paddock is highly concentrated with 20-25 horses

Figure 31. Large gullies flowing toward trail horse paddock

Pond Work

Two ponds located in the northwest part of the KHP were receiving large amounts of runoff from uncovered manure piles, which were contributing excess nutrients to the ponds. The excess nutrients in the ponds caused algae blooms to cover the surface of the water. To combat this issue, a denitrifying mulch berm was installed at the runoff's entrance point to the ponds and the ponds' depths were increased in effort to lower the water temperature, which helps prevent algae blooms.

A larger pond in the center of the KHP had become a milky color due to the large amount of sand runoff that was entering the pond (Figure 32). The pond essentially acts as settling basin for sand and sediment. The amount of sand and sediment that had deposited was so great that the pond's depth had decreased significantly, thus increasing the water temperature, making it inhospitable to aquatic life and causing algae blooms. In addition, the pond bank had begun to erode in certain areas, making it difficult for native ducks to access the pond. The pond was drained and dredged to remove the large amount of sand and sediment, restoring the pond's capacity to collect sand and sediment and reduce the amount that leaves the pond and enters the Cane Run. Banks were stabilized and a vegetative buffer was established to facilitate duck use and deter invasive Canada geese.

Figure 32. Sand runoff and deposition in this pond resulted in shallow water depth, higher water temperatures, and algae blooms .

Rain Garden

A 110 foot long rain garden was installed below a partially denuded paddock at the KHP (Figure 33). The paddock has a moderate slope and lacks a sufficient amount of vegetation to slow the velocity of runoff. Prior to the rain garden's installation, runoff would flow over a pedestrian sidewalk and enter a tributary of the Cane Run—carrying sediment and nutrients. The rain garden was filled with native plants such as wild bergamot (*Monarda fistulosa*), cardinal flower (*Lobelia cardinalis*), and blue flag iris (*Iris versicolor*) and designated with educational signage (Figures 34). Runoff is now captured and filtered within the rain garden. However, during large rain events water breaches the berm and overflows from the rain garden. The size of the rain garden was limited to the space that was available, but ideally the rain garden should be larger for the amount of runoff that it receives.

Figure 33. A rain garden was installed to filter runoff from the uphill, partially denuded paddock

Figure 34. The rain garden was filled with native plants and labeled with educational signage

Riparian Planting & Recreational Trail Walkway

A riparian area and recreational walking trail were established along approximately 1,200 linear feet of an unnamed tributary at the KHP campground. The riparian area was planted with large and small trees, shrubs, grasses, and flowers (Figure 35). The walking trail pathway is covered in mulch to provide a pervious surface. The riparian area is now a great place to educate visitors about water quality.

Figure 35. Established a riparian area and recreational trail walkway with educational signage

Settling Basin

An 80 foot long settling basin was installed in a gravel parking lot at the KHP and labeled with educational signage (Figure 36). Prior to the settling basin's installation, runoff from the parking lot was carrying gravel offsite into the stream channel (Figure 37). The settling basin filters the runoff so the gravel can be collected and reapplied to the parking lot. Storm water diversion was also installed in the parking lot to direct runoff toward the settling basin.

Figure 36. A settling basin was installed in a gravel parking lot at the KHP and labeled with educational signage

Figure 37. Prior to the settling basin's installation, runoff from the parking lot was carrying gravel offsite into the stream channel

Storm Drain Inlet Protection

A small parking lot at the KHP that is primarily used for heavy equipment is located downhill of several sand arenas where erosion is prevalent. A single storm drain receives the vast majority of this sand/sediment runoff. A pervious concrete frame was installed around the storm drain inlet to filter sand and sediment from the runoff (Figure 38). A grate covered in a wire mesh was installed above the pervious concrete frame to filter excess runoff during large rain events.

Figure 38. A pervious concrete frame was installed around the storm drain inlet to filter the sand and sediment from runoff and topped with a grate covered in a wire mesh.

Stormwater Diversion

Four stormwater diversion projects were conducted at the KHP. The first project site is in the same gravel parking lot where the settling basin and bioretention pond are located. Concrete curbs were installed around the perimeter of the parking lot to direct runoff toward the settling basin (Figure 39). Previously, runoff from the lot was creating gullies and carrying gravel offsite and depositing in the stream channel.

Two of the other project sites were located around sand arenas. Both arenas were receiving large amounts of uphill runoff that would carry sand off the arenas. The uphill runoff source was target and redirected around the arenas toward a stormwater outlet. The size of the arenas were also reduced to limit the amount of sand surface area.

The fourth project site is located in the trail horse paddock where the large HUA was installed. Previously, runoff would flow through large gullies into the paddock. Water was diverted to flow through a designated channel along the side of paddock.

Figure 39. Concrete curbs were installed around the perimeter of the parking lot to direct runoff toward the settling basin

Stream Restoration

A large stream restoration project was conducted along 1,400 linear feet of an unnamed tributary of the Cane Run. The tributary was experiencing stream bank erosion in multiple locations due to the lack of floodplain access; concentrated flow subsequently resulted in a large gulley (Figure 40). A floodplain was created to allow excess water from large rain events to escape from the stream channel, thus limiting gulley creation (Figure 41). Stream banks were stabilized with toe rock in various sections (Figure 42). Pools and riffles were also created to slow velocity and create habitat for macroinvertebrates and other aquatic life (Figure 43). The riparian area will also be planted in Spring 2014 to provide shading, increased stream bank stabilization, and to create a vegetative filter.

Figure 40. A section of an unnamed tributary lacked floodplain access and concentrated flow resulted in gulley formation.

Figure 41. A floodplain was created to allow excess water from large rain events to escape from the stream channel, thus limiting streambank erosion

Figure 42. Stream banks were stabilized with toe rock in various sections

Figure 43. Pools and riffles were created to slow velocity and create habitat for macroinvertebrates and other aquatic life

Waste Storage Facility

A 2,000 square feet waste storage facility was constructed at the Kentucky Horse Park (Figure 44). Prior to building the structure, manure was piled at the end of barns, uncovered (Figure 45). Signage was installed at the end of barns to inform visitors of the new manure storage location.

Figure 44. A waste storage facility was constructed to provide a designated, covered storage area

Figure 45. Prior to building the waste storage structure, manure was piled at the end of barns, uncovered

B. EDUCATION AND OUTREACH

The Cane Run Watershed Council was established during the FFY 2006 Cane Run project. The council is comprised of watershed partners and stakeholders, as well as those interested in watershed assessment and restoration and provides a public forum for discussion related to the Cane Run watershed. Project staff maintained an email listserv of council members and coordinated three Cane Run Watershed Council meetings (October 11, 2012; May 13, 2013; and December 2, 1013). University of Kentucky project staff reported BMP implementation progress at each meeting and needs in the watershed were discussed. A public discussion of the Coldstream Park Supplemental Environmental Project (SEP) was held in conjunction with the December 2, 2013 Council meeting.

In effort to share the progress and successes of the project, staff provided multiple tours of the BMP implementation areas, with audiences including primary and secondary students, college students (Agroecology and Forestry Capstone), local citizens (via watershed restoration course at UK Arboretum) and state agency staff. In addition, two professional presentations were made for watershed, technical, and outreach professionals (National Outreach Scholarship Conference in Tuscaloosa, AL and Kentucky Water Resources Research Institute in Lexington, KY) detailing project work in the Cane Run watershed. Further, project staff worked with Co-Media, Inc. to finalize a Cane Run documentary *Water Above, Water Below*, which aired on Kentucky Educational Television (KET) channels in October 2013.

Partnership efforts in the Cane Run Watershed that began with the FFY 2006 project continued to be fruitful during this project. Our partners in Scott County recognized the importance of the Cane Run WBP. At their request project staff cooperated with the Georgetown-Scott County Planning Commission to represent Cane Run watershed restoration interests and provide background information to the US-25 Small Area Study Advisory Committee as they developed land use maps and policies for the area. UK project staff attended planning meetings and provided a Cane Run watershed display board and brochures for the US-25 Small Area Study public meetings. Project staff also collaborated with Lexington-Fayette Urban County Government officials and Bluegrass GreenSource to plan watershed outreach in the Cane Run, including events to be held in May 2014.

To facilitate community involvement, project staff provided two student volunteer opportunities in the Cane Run; Transylvania University students conducted a stream cleanup and UK Fusion students conducted storm drain stenciling (Figure 46), both in the Green Acres neighborhood. Project staff also cooperated with other UK professionals to offer a public rain garden workshop (including installation) at the Kentucky Horse Park. In addition, project staff developed and installed educational signage adjacent to BMP implementation areas. Signs were enhanced with birdhouses and brochure holders, which contained brochures on the Cane Run Watershed and Streamside Management for Horse Owners (previously developed in FFY 2006 Cane Run Project).

Finally, project staff worked collaboratively with additional UK professionals on a concurrent U.S. EPA Urban Waters grant project that focused educational efforts in the urban headwaters of the Cane Run watershed. As part of the Urban Waters project, UK staff made visits to three local schools (Northern Elementary, Winburn Middle, and Bryan Station High School) and led students on watershed investigations, including visits to BMP implementation sites at UK's Agricultural Experiment Station and the KY Horse Park. Students created maps and written reports of their findings. A community event (Hot Chocolate and Cool Watersheds) was held December 11, 2012 at the Coldstream Research Office during which Bryan Station High School students presented their interpretations of the Cane Run project and Lexington-Fayette Urban County Government officials presented restoration plans for the Coldstream Park SEP (Figure 47). As a final phase of the 319(h)/Urban Waters project collaboration, students' work showcasing how the Cane Run watershed impacts their lives will be displayed at the Living Arts and Science Center in February 2014 as part of the Gallery Hop art exhibition.

Figure 46. UK Fusion students stenciling storm drains in the Green Acres neighborhood.

Figure 47. Student work and discussion of Coldstream SEP at the Hot Chocolate and Cool Watersheds social.

IV. CONCLUSION

This project accomplished its primary goal of implementing components of the WBP. The FFY 2006 project began BMP implementation and established approximately 10 of the 50 recommended BMPs in the WBP (appendix B). During the FFY 2008 project, an additional 14 unique recommended BMPs (43 in total) were implemented—making approximately half of the recommended BMPs in the WBP implemented throughout the Cane Run Watershed.

Initially, project attention was focused on implementing BMPs on private horse farms where horse manure was essentially being managed as an open dump. However, it was nearly impossible to implement BMPs on private land for two reasons. First, federal policy changes made it impossible to work with the USDA-NRCS to install covered manure stack pads on private lands within the time frame of our project. Updates and revisions to the USDA-NRCS Practice Code 590 created a situation in which the NRCS was not able to assist unless the operation had a comprehensive nutrient management plan (CNMP), which our private landowner partners did not. It would have taken approximately 1.5 years for the operations to obtain a CNMP, using a certified technical service provider (TSP) to develop the CNMP, before design and construction could begin on covered manure stack pads. This means it would have taken approximately 2.5 years to get BMPs on the ground and we did not have time to wait. Secondly, the University of Kentucky administratively opposed issuing a reimbursement check to a private landowner (horse farm owners) for BMP installation compensation.

Luckily, two primary watershed stakeholders (the University of Kentucky College of Agriculture's Experiment Station (AES), and the Kentucky Horse Park (KHP)) control large parcels of public land containing the Cane Run and its tributaries. BMP implementation on these properties was accomplished using a top-down/bottom-up approach. We contacted the top-tier management of these institutions and gained access to the unit managers controlling day-to-day tasks. We decided that the best approach was not to solve all of the pollution issues that might have existed from a particular practice, but to demonstrate management concepts for improving or enhancing water quality.

For example, the AES practiced winter feeding in floodplains. These practices lead to a tremendous amount of mud and erosion being generated from animal and vehicular traffic. The volume of mud, erosion, and wasted feed was tremendously reduced by implementing heavy use area pads (HUAs), using controlled feeding structures, and changing the location of winter feeding sites. However, the adoption of these practices was not enthusiastically embraced. In fact, numerous unit managers were adamantly opposed to practice suggestions because they thought that it would not work for their animals, management style, etc. Adoption of the practices was accomplished by implementing test projects to convey a management concept to the unit managers that savings could be realized on numerous levels (e.g. less mud, less wasted feed, less pasture destruction, less pasture renovation costs, less labor needed to feed animals, more feed available for animal maintenance and warmth) if they would merely adopt the practice.

Once the unit managers realized the benefit, it was easy for them to adopt the practice in other locations and for them to consider other practices we suggested. Meanwhile, water quality was enhanced throughout the area. This principle of demonstrating how land management practices should be adapted to include BMP concepts was conducted and implemented on the AES and KHP for various practices (e.g. location and construction of livestock watering fountains, location of gates and fences, fencing off streams, management of vegetation in pastures, rotational grazing, location of feeding sites). An unforeseen benefit to implementing BMPs in this manner was the availability of farm-level laborers to assist in the physical installation of the practices. These individuals were educated about management concepts and served as on-the-ground educators to their co-workers as they installed the practices and they will carry this knowledge forward in their future work. Signage installed at the BMP implementation sites further enhanced the educational experience.

Another huge obstacle to BMP implementation was the opposition to change anything based on an outdated cultural system or lack of knowledge in a subject area. Upper level managers were frequently resistant to alterations in streamside management because of what they perceived their clientele expected (i.e. managing in traditional ways) and sometimes used this as a justification against change. For example, managers supported the mowing of riparian areas up to the water's edge, as well as the idea of dredging and straightening streams to allow water to move through the area faster and take up less land. Suggestions of reduced mowing, restored vegetation, and rehabilitation of eroded streambanks using natural channel design concepts were not well received, as they believed this decreased landscape aesthetics. However, through negotiations with clientele groups and upper-level managers, we were able to implement BMPs that satisfied everyone, saved money and time, and improved water quality. Furthermore, by the end of the project, land managers were identifying new areas in which to eliminate mowing due to lessons learned from our BMP implementation. These areas are becoming reforested by passive restoration (no-mow zones) and effectively breaking a cycle of traditional management that had been utilized for the last 60 years.

The project's second goal, measuring implementation progress and making adjustments to the WBP, was not accomplished. Due to contractor schedules, KHP events, permitting obligations, and unseasonable weather, the majority of the BMPs were not completely installed until near the end of the project (September-December, 2013), making monitoring efforts impossible. Adding the list of implemented BMPs was the only update that could have been made to the WBP. While keeping a comprehensive and updated list of implemented BMPs is important, the project team thought this update should not be made until the BMP effectiveness can be determined.

Nearing the end of this project we began to think about what we would or should have done differently to make the project more successful or more efficient. The short answer is nothing. We believe the key to the success of this project could be attributed to the team that we assembled. Our team is hard working and passionate, and we worked tirelessly to implement water quality BMPs and change the hearts and minds of stakeholders in the watershed. We believe that our hard work paid off in that we were able to install practices on the ground that will make a difference. We developed education and outreach materials that addressed important issues. We reached out not only to the land-controlling stakeholders within the watershed, but also to the visitors frequenting the AES and KHP. In addition, we suggested new BMP technologies to the KY Ag Water Quality Authority that later became an adopted practice in the KY Ag Water Quality Act.

Two major themes of this project are communication and partnerships. We capitalized on the partnerships developed during the FFY 2006 Cane Run project and developed them further through communication and education. We made some friends and changed the thinking of some folks along the way. Some folks did not want to change practices and were going to be extremely happy when the project was over and they could go back to doing the same old practices, but, in general, we made positive changes that will last into the future.

In the future, project staff will continue to conduct Cane Run Watershed Council meetings and will continue to provide guidance on stakeholders' projects within the watershed. Additionally, the project staff would like to continue BMP implementation efforts. A tremendous amount of knowledge has been gained about this watershed over the course of these projects, and the momentum exists to make dramatic, positive changes to water quality in the Cane Run. Continued implementation of the WBP is essential for long-lasting positive change in this watershed.

V. LITERATURE CITED

Kentucky Department of Education. 2010. Kentucky Core Academic Standards. http://education.ky.gov/curriculum/docs/Documents/POS%20with%20CCS%20for%20public%20review.pdf. Accessed January 2, 2014.

List of Studies cited in Table 10:

- [a]http://www.nrcs.usda.gov/technical/standards/nhcp.html
- [e]http://ohioline.osu.edu/aex-fact/0464.html
- [i]http://www.epa.gov/owow/nps/MMGI/Chapter2/table209.gif
- [j]http://ohioline.osu.edu/ls-fact/0004.html
- [k]http://www.epa.gov/owow/nps/MMGI/Chapter2/table201.gif
- [l]http://www.epa.gov/owow/nps/MMGI/Chapter7/table709.gif m
- [p]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=82&minmeasure=5 (Table 1)
- [r]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=57&minmeasure=4
- [t]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/
- [z]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=72&minmeasure=5

APPENDICES

Appendix A: Financial and Administrative Closeout

1) **Application Outputs**

	Milestone Status	Expected Begin	Expected Completion	Actual Begin	Actual Completed
	General Grant Requirements				
1	Submit all draft materials to KDOW for review and approval	Duration of Project			
2	Submit advanced written notice on all workshops, demonstrations, and/or field days to KDOW	Duration of Project			
3	Submit quarterly invoices and project progress reports	Duration of Project			
4	Submit annual report to KDOW during each year of the project	Nov-12	Nov-13	Dec-13	Dec-13
5	Submit two hard copies and one electronic of the final report and all products produced by this project	Dec-13	Dec-13	Dec-13	Jan-14
	Watershed Based Plan				
6	Update Cane Run Watershed Based Plan to reflect implementation activities	Duration of Project		Oct-11	Oct-11
	Watershed Based Plan Implementation				
7	Meet with stakeholders to prioritize best management practice implementation	Duration of Project		Jan-12	Dec-13
8	Develop a schedule for implementing best management practices as directed by the BMP Implementation Plan	Jun-12	Dec-12	Jun-12	Sep-13
9	Implement riparian corridor restoration along selected stream sections	Sep-12	Dec-13	May-13	Dec-13
10	Implement agricultural and urban best management practices	Jun-12	Dec-13	Feb-13	Dec-13
	Education and Outreach				
11	Develop educational materials related to watershed restoration efforts	Duration of Project		Oct-11	Dec-13
12	Submit all education and outreach materials to KDOW for review and approval	Duration of Project		Oct-11	Oct-13
13	Conduct workshops and tours for watershed professionals, agricultural producers, and student groups	Duration of Project		Oct-11	Sep-13
14	Conduct community-based science projects with local schools	Oct-11	Dec-13	Oct-11	Nov-13
15	Conduct quarterly Cane Run Watershed Council meetings and facilitate activities of the watershed council	Oct-11	Dec-13	Oct-11	Dec-13
16	Distribute educational materials to watershed stakeholders	Oct-11	Dec-13	Oct-11	Nov-13

2) **Budget Summary**

Original Budget Summary

	BMP Implementation	Project Management	Education, Training, or Outreach	Monitoring	Technical Assistance	Other	TOTAL
Personnel	22,000	65,000	35,000	0	5,000	0	127,000
Supplies	5,000	22,000	50,000	0	0	0	77,000
Equipment	0	0	0	0	0	0	0
Travel	1,800	1,200	0	0	0	0	3,000
Contractual	368,983	0	0	0	25,000	0	393,983
Operating Costs	103,423	22,932	22,100	0	7,800	0	156,255
Other	0	0	0	0	0	0	0
TOTAL	501,206	111,132	107,100	0	37,800	0	757,238

Original Detailed Budget

Budget Categories (itemize all categories)	Section 319(h)	Non-Federal Match	TOTAL
Personnel	31,000	96,000	127,000
Supplies	53,900	23,100	77,000
Equipment	0	0	0
Travel	3,000	0	3,000
Contractual	272,690	121,293	393,983
Operating Costs	93,753	62,502	156,255
Other	0	0	0
TOTAL	454,343	302,895	757,238
	60%	40%	100%

First Budget Summary Revision

	BMP Implementation	Project Management	Education, Training, or Outreach	Monitoring	Technical Assistance	Other	TOTAL
Personnel	22,000	65,000	35,000	0	5,000	0	127,000
Supplies	5,000	22,000	50,000	0	0	0	77,000
Equipment	0	0	0	0	0	0	0
Travel	1,800	1,200	0	0	0	0	3,000
Contractual	368,983	0	0	0	25,000	0	393,983
Operating Costs	103,423	22,932	22,100	0	7,800	0	156,255
Other	0	0	0	0	0	0	0
TOTAL	501,206	111,132	107,100	0	37,800	0	757,238

First Detailed Budget Revision

Budget Categories (itemize all categories)	Section 319(h)	Non-Federal Match	TOTAL
Personnel	31,000	36,000	127,000
Supplies	53,900	23,100	77,000
Equipment	0	0	0
Travel	3,000	0	3,000
Contractual	272,690	181,293	393,983
Operating Costs	93,753	62,502	156,255
Other	0	0	0
TOTAL	454,343	302,895	757,238
	60%	40%	100%

Second Budget Summary Revision

	BMP Implementation	Project Management	Education, Training, or Outreach	Monitoring	Technical Assistance	Other	TOTAL
Personnel	10,000	31,238	17,500	0	2,500	0	61,238
Supplies	72,680	30,800	5000	0	0	0	108,480
Equipment	0	0	0	0	0	0	0
Travel	0	569	0	0	0	0	569
Contractual	405,696	0	0	0	25,000	0	430,696
Operating Costs	103,423	22,932	22,100	0	7,800	0	156,255
Other	0	0	0	0	0	0	0
TOTAL	501,206	111,132	107,100	0	37,800	0	757,238

Second Detailed Budget Revision

Budget Categories (itemize all categories)	Section 319(h)	Non-Federal Match	TOTAL
Personnel	22,919	38,319	61,238
Supplies	19,339	89,141	108,480
Equipment	0	0	0
Travel	569	0	569
Contractual	317,763	112,933	430,696
Operating Costs	93,753	62,502	156,255
Other	0	0	0
TOTAL	454,343	302,895	757,238
	60%	40%	100%

3) Equipment Summary

No equipment costs greater than $5,000 were purchased.

4) Special Grant Conditions

There were no special grant conditions placed on this project by the USEPA.

Appendix B: BMP Implementation Plan

Cane Run and Royal Spring BMP Implementation Plan

I. Eligible Best Management Practices

Best management practices (BMPs) that have been identified as appropriate and/or suitable for the Cane Run watershed are listed by practice name (and NRCS Code - if applicable) as follows:

Practice Name (NRCS)	**Practice Code (NRCS)**
Agricultural Management Measures	
Agrichemical Handling Facility	309
Animal Mortality Facility	316
Composting Facility	317
Conservation Cover	327
Constructed Wetland	656
Diversion	362
Fence – Containment	382
Field Border	386
Filter Strip	393
Grade Stabilization Structure	410
Grassed Waterway	412
Heavy Use Area Protection	561
Manure Transfer	634
Nutrient Management	590
Obstruction Removal	500
Open Channel	582
Pasture and Hayland Planting	512
Pest Management	595
Prescribed Grazing	528
Recreation Area Improvement	562
Recreation Trail Walkway	568
Riparian Forest Buffer	391

Roof Runoff Structure	558
Shallow Water Development and Management	646
Sinkhole Protection	725
Silvopasture establishment	381
Spring Development	574
Stream Crossing	578
Stream Habitat Improvement and Management	395
Streambank Protection	580
Structure for Water Control	587
Use Exclusion	472
Vegetated Treatment Area	635
Waste Storage Facility	313
Water and Sediment Control Basin	638
Watering Facility	614

Urban Management Measures

Practice Name

Bioretention systems (Rain gardens)

Conservation Easements

Constructed wetland

Detention Ponds

Downspouts to Grassed Areas and Rain Barrels

Floatables Control

Interpretative Signs (Education and Outreach)

Modular and Porous Pavement

Sand and Organic Filters

Septic Tank Owner Education and Assistance

Swales (bermed and bioretention)

Urban Forestry

Vegetated Filter Strips

Wet Ponds / Extended Detention Basins

Tables were created to identify several key parameters and characteristics of each BMP. These tables are intended to serve as the primary reference point for more specific information about the practices recommended in the Implementation Plan. The attached tables (1 and 2) list the following categories for each BMP:

- BMP Name and NRCS code (when applicable)
- BMP Description
- Potential Pollutant Sources
- Pollutant that the BMP could remediate
- Estimated Load Reduction*
- Effectiveness*
- Permits or Easements Required
- Potential Funding or Technical Support Sources*
- Estimated Installation Cost
- Estimated Operations and Maintenance Cost
- Life (years)
- Comments
- References

Notes

* Estimated Load Reduction: provides a gross estimate of practice effectiveness as reported in research literature. The actual effectiveness of a practice will depend exclusively on site-specific variables such as soil type, crop rotation, topography, tillage, and harvesting methods.

* Effectiveness: This value was based on USDA Agriculture Information Bulletin No. 598, NRCS conservation practice physical effects (CPPE) documents, or EPA information. Because of the general nature of these sources, there may be situations and sites where practices will not perform as indicated.

* Potential Funding or Technical Support Sources: financial assistance programs, participants and further details are listed in UK Extension publication FOR-94 "*Financial Assistance Guide for Conservation Practices in Kentucky*".

II. Description of the BMP Selection Process

The goal of this project is coordinate watershed efforts and resources to maximize improvements in water quality. Additional benefits will include wildlife habitat restoration, stormwater runoff reduction, an increase in soil infiltration and potentially a reduction in storm surge and increased base flow volumes of water in the stream. Because the Cane Run and its watershed is a highly diverse and dynamic system, it will require a variety of BMPs to meet water quality goals.

The BMPs listed in this section were selected because of current land uses, pollutant sources, pollutant load reduction effectiveness and the overall aptitude for them to be installed and maintained with the highest level of project participation and support. Most of these BMPs are already familiar to both the project team and stakeholders. Several are either already being implemented in the watershed or are planned to be implemented by other property owners.

III. Targeting Selected BMPs

The single overriding aspect to water quality enhancement of the Cane Run Watershed is the linkage between the karst geology (Royal Spring) and the surface stream (Cane Run Creek). Sinkholes and swallets located throughout the upper watershed transmit water directly to the conduit systems associated with the Royal Spring. Only during high flow periods is flow available as surface runoff in many reaches of Cane Run. The largest historical difference in the watershed's upper reaches is the increase in impervious areas such as parking lots, buildings, and homes. The lack of large groundwater recharge areas in the headwaters of the watershed limits the amount of base flow in many stream segments, dramatically reducing aquatic habitats.

In addition to physical characteristics of the watershed, there are many projects and partnerships already underway that will also guide BMP Implementation efforts. The Upper Cane Run Watershed is unique in not only its geology, but by the few, large, public landowners. These include University of Kentucky's Agricultural Experiment Station (the largest single landowner on the stream), the Kentucky Horse Park (the second largest landowner on the stream), LFUCG, and Lexmark International. Other large landowners include Marriott Griffin Gate Resort, Barton Brothers Farms, Kentucky River Properties, and Vulcan Materials. In addition, Georgetown Water Supply has been very vocal in their support for the restoration efforts.

The scope of the Royal Spring aquifer lies within Catchments 10, 9, 8, 6 and 1 of the Cane Run Watershed. For each catchment, BMPs were selected that most effectively address the primary pollutants and suspected sources, land use, property owner and/or stakeholder acceptance and sources of potential funding as well as technical and community support.

There are situations where this project can not address water quality issues because of the continued Consent Decree litigation between the Lexington – Fayette Urban County Government (LFUCG), US EPA and Kentucky Division of Water. Certain locations and practices will be ineligible for this project due to the Consent Decree. Furthermore, two Supplemental Environmental Programs (SEPs) were added to the Consent Decree settlement which will provide funding for "Green" infrastructure and stream habitat restoration within the watershed. Although BMPs in the headwater catchments 10 & 9 will have a greater influence on downstream areas, some may not be addressed by project funds based on their inclusion in the Consent Decree.

IV. Financial Plan of Action

The Cane Run and Royal Spring Watershed Based Plan will serve as a guidebook for project participants both as individuals and as a coordinated team. The intent of the project is to maximize restoration potential throughout the watershed. One aspect of this includes compiling watershed funding or technical assistance and identifying areas that may not receive funding or support otherwise. In addition, project participants intend to use the Plan for developing additional funding sources by demonstrating a comprehensive strategy for water quality management. Detailed technical and financial assistance needs are outlined in chapter VI of the WBP. Cost information as supplied by EPA and NRCS is included in Table 2.

V. Description of the Maintenance Agreement with Landowner

One aspect that makes the Cane Run watershed very unique is the small number of very large landowners along the stream. In addition, most of this land is public property and has the support of both local and State agencies. For each BMP, an Operation and Maintenance (O&M) Plan will be developed. At a minimum, the plan shall specify that the treated areas and associated practices are to be inspected annually and after significant storm events to identify repair and maintenance needs. The O&M plan will describe the level of repairs needed to maintain the effectiveness and useful life of the practice. The O&M Plan will be reviewed with the landowner or operator. The purpose is to assure the BMP will be able to function or operate as intended for the expected life of the practice. In addition, this agreement will address how the BMP will be monitored, repaired or maintained.

VI. Description of Notification Process

The Kentucky Division of Water, NPS Section Technical Advisor (TA) assigned to the Cane Run project will be advised of the selected BMP at least one week before implementation begins. This may take the form of either a letter or an electronic notification to the TA describing the BMP, the location where the BMP will be installed and the expected date of implementation.

VII. Assurance Statement

The Kentucky Agriculture Water Quality Act (KRS 224.71-100 through 224.71-140) was enacted by the 1994 General Assembly to guide the state's agriculture industry in its efforts to address environmental issues. The KY Agricultural Water Quality Plan (KY AWQP) was developed as a result of this Act. The KY AWQP is an effort to produce a practical, flexible, coordinated natural resources management system that protects the waters of the Commonwealth and complies with applicable government rules and regulations. It is based on pollution prevention through the use of Best Management Practices (BMPs). KRS 224.71 defines BMPs as the most effective, practical, and economical means of reducing and preventing water pollution. BMPs establish minimum acceptable quality levels for planning, siting, designing, installing, operating, and maintaining agriculture and silviculture facilities and operations. BMP's used as a part of the Cane Run Watershed Based Plan will conform to guidelines identified in the KY AWQP as well as all local, state, and Federal guidelines. In addition to compliance with KY AWQP, all selected BMPs have been cross referenced with NRCS technical standards and will be implemented accordingly.

Table 1. BMP Pollution Removal Effectiveness

BMP Name and NRCS Code	BMP Description	Pollutant Source	Impairment	Estimated Load Reduction*	Effectiveness*
Agrichemical Handling Facility (309)	A structure with an impervious surface that provides an environmentally safe area for storing, mixing, loading, and cleaning up on-farm agrichemicals and equipment.	Fertilizers Fertilizers Pesticides	Nitrogen Phosphorous Toxic Chemicals	Chemical and Nutrient Spills and Leaching Prevented	Substantial improvement to surface and groundwater quality [a]
Animal Mortality Facility (316)	An on-farm facility for the treatment or disposal of livestock and poultry carcasses. (composting method supported)	Animal Carcasses	Nitrogen Phosphorous Pathogens	40% 10% * (when compared to burial)[c]	Slight to moderate improvement to surface and groundwater quality[a]
Composting Facility (317)	A facility to process raw manure or other raw organic by-products into biologically stable organic material.	Animal Waste	Nitrogen Phosphorus Pathogens		Slight to moderate improvement to surface and groundwater quality [a]
Conservation Cover (327)	Establishing and maintaining permanent vegetative cover	Fertilizers * * Fertilizers	Nitrogen Pathogens Sediment Phosphorous	70% * 65% 75% [d]	Medium Low Medium Medium[e]
Constructed Wetland (small or large with synthetic liner) (656)	A constructed shallow water ecosystem designed to simulate natural wetlands.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	44% 77% 77% 50%[f]	High Medium High Medium[e]
Diversion (362)	A channel constructed across the slope generally with a supporting ridge on the lower side.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	45% - 70%[i]	Low Medium Medium Low[e]

Fence (Containment) (382)	A constructed barrier to animals or people.	Livestock Livestock Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	54% - 90% 81%[j]	Medium * High Medium[e]
Field Border (386)	A strip of permanent vegetation established at the edge or around the perimeter of a field.	Livestock, Fertilizers Livestock, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	70% * 65% 75% [d]	Medium Medium Medium Medium[e]
Filter Strip (393)	A strip or area of herbaceous vegetation that removes contaminants from overland flow.	Livestock, Fertilizers Livestock, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	70% 70[l] 65% 75%[k]	Medium Medium Medium Medium[e]
Grade Stabilization Structure (410)	A structure to control the grade and head cutting in natural or artificial channels	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	10% - 35% 30%[k]	Low * Medium Low[e]
Grassed Waterway (412)	A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet.	Livestock, Fertilizers Livestock Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	38% - 81% 29%[m]	Medium Low Medium Medium[e]
Heavy Use Area Protection (561)	The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, by surfacing with suitable materials, and/or by installing needed structures.	* * Exposed Soil Exposed Soil	Nitrogen Pathogens Sediment Phosphorous		Slight to moderate improvement to surface water quality for all impairments[a]
Manure Transfer (634)	A manure conveyance system using structures, conduits, or equipment. (to be used in conjunction with waste management system)	Livestock Livestock Livestock Livestock	Nitrogen Pathogens Sediment Phosphorous	80% 85% 60% 90%[n]	High High Medium High[e]

Nutrient Management (590)	Managing the amount, sources, placement, form and timing of the application of nutrients and soil amendments.	Livestock, Fertilizers Livestock, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	15% - - 35%[o]	High Low Low High[e]
Obstruction Removal (500)	Removal and disposal of unwanted, unsightly or hazardous buildings, structures, vegetation, landscape features, and other materials.	Underground Storage Tanks Invasive Species Hazardous Materials Solid waste Structures	Petroleum * Toxic Chemicals Pathogens	N/A	N/A
Open Channel (582)	Constructing or improving a channel either natural or artificial, in which water flows with a free surface.	Exposed Soil	Sediment Stream bank Erosion	N/A	Moderate to substantial improvement in channel stabilization and ability to transport sediment[a]
Pasture and Hayland Planting (512)	Establishing introduced or native forage species.	Livestock, Fertilizers Livestock Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	70% 70% 65% 75%[k]	Medium Medium Medium Medium[e]
Pest Management (595)	Utilizing environmentally sensitive prevention, avoidance, monitoring and suppression strategies, to manage weeds, insects, diseases, animals and other organisms (including invasive and non-invasive species), that directly or indirectly cause damage or annoyance.	Pesticides	Toxic Chemicals	N/A	High[e]
Prescribed Grazing (528)	The controlled harvest of vegetation with grazing or browsing animals.	Livestock Livestock Exposed Soil Exposed Soil	Nitrogen Pathogens Sediment Phosphorous	70% 70% 65% 75%[k]	Slight to substantial improvement for all impairments[a]

Recreation Area Improvement (562)	Establishing grasses, legumes, vines, shrubs, trees, or other plants or selectively reducing stand density and trimming woody plants to improve an area for recreation	Exposed soil, Compaction	Sediment	N/A	Slight to substantial improvement for sediment deposition[a]
Recreation Trail Walkway (568)	A pathway for pedestrian, equestrian, bicycle and other off-road modes of travel through or to recreation resources.	Exposed soil, Compaction	Sediment	N/A	Slight to Substantial Improvement for Sediment Deposition[a]
Riparian Forest Buffer (391)	An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	68% 60% 80% 42%[a j p]	Medium Medium High Medium[e]
Roof Runoff Structure (558)	Structures that collect, control, and transport precipitation from roofs. (to be used in conjunction with a run-off management system)	Livestock, Fertilizers Livestock, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	45% * * 70%[i]	High High High High[e]
Shallow Water Development and Management (646)	The inundation of lands to provide habitat for fish and/or wildlife.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	44% 77% 77% 50%[f]	Slight to moderate improvement for all impairments[a]
Sinkhole Protection (725)	Protection of sinkholes or areas of internal drainage (sinkhole watersheds) which deliver runoff waters to a groundwater system and/or pose a threat to public safety.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	* 90%[q] * *	High High High High[e]

Silvopasture Establishment (381)	An agroforestry application establishing a combination of trees or shrubs and compatible forages on the same acreage. (This practice may be used to provide shade for livestock and may be used in conjunction with Fence and Use Exclusion.)	Livestock, Fertilizers Livestock Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	Load reductions will come in the form of reduced amount of livestock in surface waters.	Substantial improvement in reducing wind and sheet erosion. Moderate improvement in the reduction of excess nutrients to surface waters. [a]
Spring Development (574)	Utilizing springs and seeps to provide water for conservation need.	Livestock, Fertilizers Livestock, Septic, Wildlife Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	54% * 90% 81%[j]	Medium * High High[e]
Stream Crossing (578)	A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles.	* * Exposed Soil Exposed Soil	Nitrogen Pathogens Sediment Phosphorous	* * 50%[j] *	* * Medium[e] *
Stream Habitat Improvement and Management (395)	Maintain, improve or restore physical, chemical and biological functions of a stream, and its associated riparian zone, necessary for meeting the life history requirements of desired aquatic species.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	68% 60% 80% 40% [a j p]	Medium Medium High Medium[e]
Stream bank Protection (580)	Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	68% 60% 80% 42% [a j p]	Medium Medium High Medium[e]

Structure for Water Control (587)	A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation or measures water.	Livestock, Fertilizers Livestock, SSOs, Septic Exposed Soil , Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	10% * 35% 30%[k]	Low Low Medium Low [e]
Use Exclusion (472)	Excluding animals, people or vehicles from an area.	Livestock Livestock Exposed Soil Exposed Soil	Nitrogen Pathogens Sediment Phosphorous	54% * 90% 81%[j]	Medium * High Medium[e]
Vegetated Treatment Area (635)	An area of permanent vegetation used for agricultural wastewater treatment. (Typically used in conjunction with compost, animal mortality, and waste facilities.)	Livestock, Fertilizers Livestock Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	70% [d] 55%[n] 60%[n] 85%[n]	High High High High[e]
Waste Storage Facility (313)	A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.	Livestock, Fertilizers Livestock Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	65% 90% 70% 60%[i]	High High High High[e]
Water and Sediment Control Basin (638)	An earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and a water detention basin.	Livestock, Fertilizers Livestock, SSOs, pets Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	* * 70%[r] *	Medium Low High Medium[e]
Watering Facility (614)	A device (tank, trough, or other watertight container) for providing animal access to water.	Livestock Livestock Exposed Soil Exposed Soil	Nitrogen Pathogens Sediment Phosphorous	54% * 90% 81%[j]	Medium Medium High Medium[e]

Bioretention Systems **(Rain Gardens)**	Bioretention is a practice to treat stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. The method combines physical filtering and adsorption with biological processes and typically includes the use of native plants, such as in rain gardens.	Fertilizers, Stormwater SSOs, Septic Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	49%[z] 70%[1 k] 65%[1 k] 76%[z]	Medium Medium Medium High [e]
Conservation Easements	Voluntary agreements that allow individuals or groups to limit the type or amount of development on their property, can cover all or just a portion of a property, and can either be permanent or temporary	N/A	N/A	N/A	N/A
Constructed Wetland	The term "constructed wetland" can apply to a wetland which is constructed to mitigate impacts to a natural wetland (per a Corps of Engineers permit), or a wetland which is constructed as part of a wastewater treatment system.	See BMP 6 in Agricultural	See BMP 6	See BMP 6	See BMP 6
Detention Ponds	A detention pond is a traditional stormwater quantity control device that is designed for peak discharge control, designed to completely drain after the design storm passes.	Fertilizers, Stormwater SSOs, Septic Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	31% * 61% 19%[y]	Detention ponds are not as effective at removing soluble nutrients, but can provide some nutrient removal through sediment capture. [y]

Downspouts to Grassed Areas and Rain Barrels	Discharging downspouts from roofs onto grassed yards, or collecting in a reservoir for slow release.	Livestock, Fertilizers Livestock, Septic Exposed Soil Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	45% * * 70%[i]	High High High High[e]
Floatables Control	Manufactured filtering technologies that include: • Baffles • Screens and trash racks • Catch basin modifications • Netting • Containment booms • Skimmer vessels	Stormwater SSOs, Septic Stormwater Stormwater Litter	Nitrogen Pathogens Sediment Phosphorous Solid Waste	Pollutant Removal Dependent Upon Technology Chosen	Efficiency of practice is highly variable Depending on proper selection and maintenance. Potential to remove a high amount of solid waste entering surface and groundwater.[aa]
Interpretive Signs	Signage posted to identify and explain BMPs.	N/A	N/A	N/A	Increase awareness and education Improve BMP performance
Modular and Porous Pavement	Modular pavement consists of strong structural materials, typically concrete, having regularly interspersed void spaces that are filled with pervious materials such as sand, gravel, or sod. Porous pavement is a permeable pavement surface, often built with an underlying stone reservoir.	Stormwater SSOs, Septic, Straight Pipes Vehicles, Stormwater Exposed Soil, Stormwater	Nitrogen Pathogens Sediment Phosphorous	82.5% * 88.5% 65%[s t]	High * High Medium[s t]
Sand and Organic Filters	Stormwater filters are a diverse group of techniques with each using some sort of filtering media such as sand, soil, gravel, peat, compost, or vegetation. Designed with a filter bed and an outlet to the stormwater drainage system or a receiving stream	Fertilizers, Stormwater SSOs, Septic Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	45.5% 55% 77.5% 62.5%[bb]	Medium Medium High Medium[bb]

Septic Tank Owner Education and Assistance	Provide education materials and financial and technical assistance for septic tank maintenance and or repair.	N/A	N/A	N/A	Increase awareness and education Improve BMP performance
Swales (bermed and bioretention)	Typically vegetated parabolic or trapezoidal channels with a large width to depth ratio	See BMP 12 in Agricultural BMPs	See BMP 12 in Agricultural BMPs	See BMP 12 in Agricultural BMPs	See BMP 12 in Agricultural BMPs
Urban Forestry	The study of trees and forests located in and around towns and cities, including street trees and urban forests	Fertilizers, Stormwater SSOs, Septic , Pets Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	* * * *	A 2009 study done by the USDA Center for Urban Forest Research states the most significant impact of an urban forestry program is a reduction in stormwater runoff and found that an average tree can intercept 2,380 gallons of rain per year.[u]
Vegetated Filter Strips	Use of vegetation to filter out sediment and other pollutants from stormwater runoff, relies upon sheet flow across the entire width of the vegetated area	Fertilizers, Stormwater SSOs, Septic , Pets Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	20% * 84% 40%[w]	Low * High Medium[e]
Wet Ponds/Extended Detention Basins	A basin which has a permanent pool, placed outside the receiving stream except when a pond is designed as a regional detention pond.	Fertilizers, Stormwater SSOs, Septic , Pets Exposed Soil, Stormwater Exposed Soil, Fertilizers	Nitrogen Pathogens Sediment Phosphorous	31% 65% 67% 48%[cc]	Low High High Medium[e]

***BMP Name and NRCS Code:** BMPs are listed in alphabetical order by practice name, with agricultural practices first followed by urban management measures.

*** Estimated Load Reduction:** provides a gross estimate of practice effectiveness as reported in research literature. The actual effectiveness of a practice will depend exclusively on site-specific variables such as soil type, topography, climate, and production system.

*** Effectiveness:** Abstracted from USDA Agriculture Information Bulletin No. 598 and NRCS conservation practice physical effects (CPPE) documents[a]. NOTE: Because of the general nature of these documents, there may be situations and sites where practices will not perform as indicated.

Table 2. Estimated BMP Installation and Maintenance Costs

BMP Name and NRCS Code*	Easements Required	Potential Funding or Technical Support*	Estimated Installation Cost	Maintenance and Operations Cost (Per Year)	Life Span (years)	Comments
Agrichemical Handling Facility (309)	No	NRCS KY Ag Water Quality Authority UK	\$28.64/Square foot[b]	\$1.45/Square foot	10 to 15	Cost estimate based off of NRCS cost data for Vermont, so prices will vary according to local pricing.
Animal Mortality Facility (316)	Potentially	NRCS KY Ag Water Quality Authority UK	\$1.35/Square foot[b]	\$0.12/Square foot	10 to 15	Cost estimate based off of NRCS cost data for Vermont, so prices will vary according to local pricing.
Composting Facility (317)	Yes	NRCS Thoroughbred RC&D UK	\$3.90/Square foot[b]	\$0.20/Square foot	15	Cost estimate based off of NRCS cost data for Vermont, so prices will vary according to local pricing. Insufficient data was found on load reductions but they will vary according to amount of waste generated and on site application methods
Conservation Cover (327)	Potentially	NRCS KY Soil and Water Quality Cost Share Program UK	\$368.50/Acre[b]	\$18.68/Acre	10	Cost estimate based off of NRCS cost data for Vermont, so prices will vary according to local pricing.
Constructed Wetland (small or large with synthetic liner) (656)	Yes	LFUCG NRCS UK KDFWR	Small-\$1,455.25/Each[g] Large-\$29, 593.99/Acre[h]	Small- \$7.39 Large- \$20.39	Small-20 Large-15	SMALL-based on 30'x40' vernal pond with liner, T. Biebighauser 2002. LARGE- based on KY NRCS Cost Data for code 646<3 acres plus costs for liner and geotextile based on material costs for vernal pond with liner, T. Biebighauser 2002. Estimated O/M Cost and Life based on NRCS 646-Ephemeral Pool.

Diversion (362)	Yes	UK NRCS KDF KY Soil Erosion and Water Quality	$2.54/Linear foot[h]	$0.03	10	
Fence (Containment) (382)	Yes	UK NRCS KDF KY Soil Erosion and Water Quality	$2.77/Linear Foot[h]	$0.03	20	Estimated Load Reduction and Effectiveness based on - Use Exclusion (NRCS Code 472). These practices are typically combined.
Field Border (386)	No	UK NRCS KDF KY Soil Erosion and Water Quality	Same as Conservation Cover (# 5)	Same as conservation cover (#5)	10	
Filter Strip (393)	No	UK NRCS KDF KY Soil Erosion and Water Quality	$406.40/Acre[h]	$68.99	10	
Grade Stabilization Structure (410)	Potentially	NRCS KY Soil Erosion and Water Quality UK	$2380.74/Each[h]	$23.11	15	
Grassed Waterway (412)	Potentially	UK NRCS KY Soil Erosion and Water Quality	$4,929.59/Acre[h]	$47.86	10	Estimated Load Reductions based on EPA averages for Grassed Swale. Effectiveness based on NRCS practice.

Heavy Use Area Protection (561)	Yes	UK NRCS KY Soil Erosion and Water Quality KY Ag Water Quality Authority	$1.43/Square Foot[h]	$0.01	10	EPA has a minimum amount of information for integrated runoff management systems which include heavy use protection areas available at http://www.epa.gov/nps/MMGI/Chapter2/ch2-2b1.html
Manure Transfer (634)	Yes	NRCS KY Ag Water Quality Authority	Cost is variable based on type of waste management system utilized. Expected costs must take manure hauling, loading, and containment facilities into consideration.			
Nutrient Management (590)	Yes	NRCS UK KY Ag Water Quality Authority	$1,662.40/Each[h]	$0.00	1	
Obstruction Removal (500)	No	UK NRCS	This practice involves removing a broad range of obstructions; cost is extremely variable based on site specific conditions. Expected costs must take equipment and labor into consideration.			This practice can be used to help remove invasive species as well as unwanted and improperly handled agrichemicals.
Open Channel (582)	Potentially	NRCS KY Ag Water Quality Authority UK	Cost for this practice varies widely depending on site. Maintenance of BMP and its effect on downstream water quality and quantity should be considered.			
Pasture and Hayland Planting (512)	Potentially	NRCS KDFWR UK	$478.48/Acre[h]	$15.50	10	Estimated Load Reduction based on EPA averages for Filter Strip (BMP 10). Effectiveness based on NRCS information.

Pest Management (595)	Yes		143.85/Acre[h]	$0.00	N/A	This practice can be used to help remove invasive species.
Prescribed Grazing (528)	No	NRCS KY Ag Water Quality Authority UK	$12.55/Acre[h]	Cost estimate for first year	N/A	
Recreation Area Improvement (562)	Yes	LFUCG NRCS UK KDFWR KDF Lexmark	Medium Biodiversity- $357.60/Acre[h]	$68.99	N/A	Cost estimate based on Riparian Forest Buffer (Medium Biodiversity), but will vary with site needs and conditions.
Recreation Trail Walkway (568)	Yes	LFUCG NRCS UK KDFWR KDF Legacy Center	Cost Estimates will vary based on site specific needs and conditions.	N/A	N/A	
Riparian Forest Buffer (391)	No	NRCS UK KDF KDFWS	Low Biodiversity- $65.28/Acre Medium Biodiversity- $357.60/Acre High Biodiversity- $826.26/Acre[h]	$68.99 (all scenarios)	10 to 15	LOW-Estimated Load Reduction and Effectiveness is based on Filter Strip MEDIUM-Effectiveness based on NRCS Conservation Practices Physical Effects.
Roof Runoff Structure (558)	No	NRCS Private Landowner UK KY Ag Water Quality Authority	$8.01/Foot	0.43/Foot	15	

Shallow Water Development and Management (646)	Yes	NRCS Private Landowner UK KY Ag Water Quality Authority	Small- $1,455.25/Each[g] Large-$29, 593.99/Acre[h]	Small- $7.39 Large- $20.39	10 to 15	Estimated Load reductions and cost estimates based on Constructed wetland (# 6)
Sinkhole Protection (725)	Yes	NRCS KDFWR KGS KY Ag Water Quality Authority UK	$ 3, 407.06/Each[h]	$97.19	15	Effectiveness and costs based on cumulative results of combined practices (Diversion, Access Control, Fence, Riparian Buffer.). May also include Rock Filter, Nutrient Management, Filter Strip, etc.
Silvopasture Establishment (381)	Potentially	NRCS Private Landowner UK KY Ag Water Quality Authority KDF	$411.83/Acre[h]			Cost is the same for practice 612, Tree/Shrub Establishment.
Spring Development (574)	Yes	KY Geologic Survey UK NRCS KDFWR KDF	$1,213.81/Each[h]	$11.79	10	
Stream Crossing (578)	Potentially	NRCS KDFWR KGS KY Ag Water Quality Authority UK	$2,308.87/Each[h]	$22.42	10	
Stream Habitat Improvement and Management (395)	Yes	NRCS KDFWR UK	$100.00/Linear Foot[h]	$68.99	15	Nutrient Estimated Load Reduction and Operations/Maintenance Cost based on Riparian Buffer.

Stream bank Protection (580)	Potentially	NRCS KDFWR UK	$52.40/Linear foot[h]	$0.51	20	Estimated Load Reductions are based on Riparian Buffer. Stream bank Protection typically combines Access Control, Riparian Buffer, and/or Stream Crossing..
Structure for Water Control (587)	No	UK NRCS Private Landowners	$2,380.74/Each[h]	$23.11	15	Estimated Load Reductions and Cost are based on Grade Stabilization structure.
Use Exclusion (472)	No	Thoroughbred RD&D NRCS KY Ag Water Quality Authority UK	$90.00/Acre[h]	$0.00	10	Price of practice is based on forgone income from acreage excluded on typical KY -CRP rental rates of bottomland soils. Typically implemented with BMP 3 - Fence (NRCS Code 382).
Vegetated Treatment Area (635)	No	UK NRCS Private Landowners KY Ag Water Quality Authority	$267.27/Each[h]			
Waste Storage Facility (313)	No	NRCS Fasig Tipton UK	$9,805.67/Each[h]	$95.20		
Water and Sediment Control Basin (638)	Yes	UK NRCS Private Landowners KY Ag Water Quality Authority	$1901.34/Each[h]	$18.46	10	

Watering Facility (614)	No	UK NRCS Private Landowners KY Ag Water Quality Authority	$2431.61/Foot[h]	$23.60	20	
Bioretention Systems **(Rain Gardens)**	Yes	Bluegrass PRIDE Bluegrass Rain Garden Alliance Neighborhood Associations LFUCG	$2,239.00/ERU[z] (1 Stormwater ERU = 2,500 Ft^2)	167.93 (Maintenance = 7.5 % of construction cost)	10	$Cost = 7.30\ Volume^{0.99}$ $Cost = 7.30 * (2{,}500\ Sq\ Ft \times 0.13\ Ft)^{0.99}$ 0.13 Ft = 1.6" = 1 year storm event (LFUCG design storm)
Conservation Easements	Yes	Private Landowners LFUCG Neighborhood Associations UK Bluegrass Partnership	N/A	N/A	Varies	
Constructed Wetland	Yes	LFCUG KDFWR UK KY Transportation Cabinet	See BMP 6 in Agricultural BMPs	See BMP 6 in Agricultural BMPs	See BMP 6 in Agricultural BMPs	
Detention Ponds	Yes	Businesses KY Dept Of Transportation UK	$41,600/Each (for a one acre one foot pond)[y]	Annual Inspection, Planting, Monitoring, and Sediment Removal Need to Be Taken into Consideration	10	

Downspouts to Grassed Areas and Rain Barrels	Yes	Private Landowner UK LFCUG Bluegrass PRIDE	Rain Barrels can run anywhere from $30-130. $8.01/Foot for piping and additional materials[h]	0.43/Foot	15	Cost and Effectiveness were based on NRCS data for Roof Run Off Structure.
Floatables Control	Yes	LFCUG Bluegrass PRIDE	Cost will vary depending on location.[aa]			Floatable / Trash control will be addressed in the LFUCG Consent Decree.
Interpretive Signs	Yes	UK Friends of Cane Run Bluegrass Partnership Bluegrass PRIDE	Cost depends on size sign and number created			
Modular and Porous Pavement	Yes	Businesses KY Dept Of Transportation KYHP UK	$16,250.00/ER[st] (1 Stormwater ERU = 2,500 Ft^2)	$200.00	10	Cost = $6.50 per Ft2 Estimated Load Reductions and Maintenance Costs based on EPA averages. Installation Cost based on averages provided by Kentucky Ready Mix Concrete Association.
Sand and Organic Filters	Yes	LFCUG CDP Engineers Businesses	$1625.00/ERU[bb] (1 Stormwater ERU = 2,500 Ft2)	$160.00	10	2,500 Ft^2 x 0.13 = 325 Ft^3 325 Ft^3 @ $5 per Ft^3 = $1,625.00
Septic Tank Owner Education and Assistance	No	UK	N/A	N/A	N/A	
Swales (bermed and bioretention)	Yes	LFCUG CDP Engineers Businesses UK	See BMP 12 in Agricultural BMPs	See BMP 12 in Agricultural BMPs		

Urban Forestry	Yes	LFCUG Reforest the Bluegrass UK KDF KDFWR	$328.00/Each	$20.00	40	Installation and Maintenance Cost based on USDA averages. Urban forests can act as natural stormwater management areas by filtering particulate matter, pollutants, some nutrients, sediments, and pesticides, as well as absorbing surface runoff water.[v]
Vegetated Filter Strips	Yes	UK Businesses LFCUG Bluegrass Partnership KDFWR	$21,500./Acre[h]	$350.00	10	Estimated Load Reduction based on 150 Ft filter strip. Installation and Maintenance Costs based on EPA averages.
Wet Ponds/ Extended Detention Basins	Yes	UK Businesses LFCUG	$45,700/Acre[cc]	$1828.00 EPA avg. of 4% of construction cost	10	Effectiveness based on NRCS agricultural BMP for water quality (Grassed Waterway).

***BMP Name and NRCS Code:** BMPs are listed in alphabetical order by practice name, with agricultural practices first followed by urban management measures.

*** Potential Funding or Technical Support Sources:** financial assistance programs, participants and further details are listed in UK Extension publication FOR-94 "Financial Assistance Guide for Conservation Practices in Kentucky" http://www.ca.uky.edu/agc/pubs/for/for94/for94.htm

VIII. Complete List of Studies referenced in Tables 1 and 2

[a]http://www.nrcs.usda.gov/technical/standards/nhcp.html (CPPE Docs for individual practices found here.)

[b] http://www.vt.nrcs.usda.gov/technical/Average_Cost_Lists/Practice_Payment_Scenarios.html

[c]http://archive.chesapeakebay.net/pubs/calendar/TSWG_10-06-08_Handout_4_9157.pdf

[d]http://www.epa.gov/nps/agmm/chap4c.pdf (Table 4c-1)

[e]http://ohioline.osu.edu/aex-fact/0464.html

[f]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=74&minmeasure=5 (Table 2)

[g]http://www.fs.fed.us/r8/boone/documents/resources/vernal.pdf

[h]http://efotg.nrcs.usda.gov/references/public/KY/FINAL_Copy_of_2009_EQIP_Toolkit_Payment_Schedule_07_21_09.xls

[i]http://www.epa.gov/owow/nps/MMGI/Chapter2/table209.gif

[j]http://ohioline.osu.edu/ls-fact/0004.html

[k]http://www.epa.gov/owow/nps/MMGI/Chapter2/table201.gif

[l]http://www.epa.gov/owow/nps/MMGI/Chapter7/table709.gif

[m]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5

[n]http://www.epa.gov/nps/agmm/chap4d.pdf (table 4D-6)

[o]http://www.epa.gov/owow/nps/MMGI/Chapter2/table214.gif

[p]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=82&minmeasure=5 (Table 1)

[q]D. G. Boyer "Assessment of a sinkhole filter for removing agricultural contaminants" Journal of Soil and Water Conservation Vol. 63, Issue 1 pp 47-52. 2008.

[r]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=57&minmeasure=4

[s]http://www.epa.gov/npdes/pubs/porouspa.pdf

[t]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=71&minmeasure=5

[u]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=84&minmeasure=5

[v]http://www.na.fs.fed.us/urban/treespayusback/vol1/Midwest%20Community%20Tree%20Guide%20final.pdf

[w]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=76&minmeasure=5

[x]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5

[y]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=67&minmeasure=5

[z]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=72&minmeasure=5

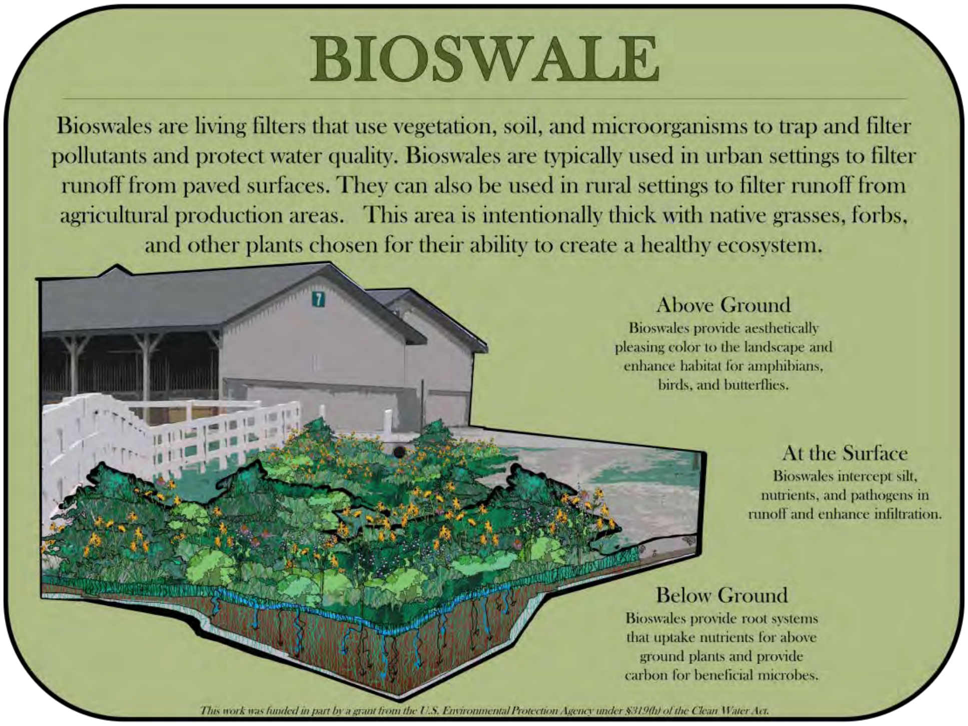
[aa]http://www.epa.gov/npdes/pubs/floatctrl.pdf

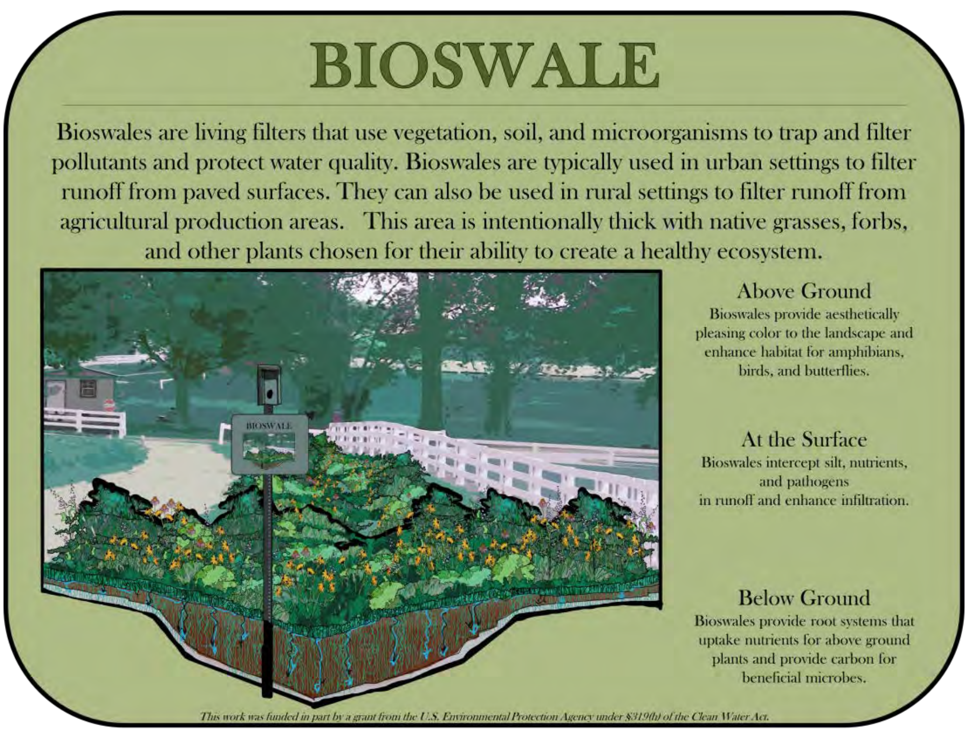
[bb]http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=73&minmeasure=5

[cc] http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=68&minmeasure=5

Appendix C: Education Materials

1) Educational Signage





BIOSWALE

Bioswales are living filters that use vegetation, soil, and microorganisms to trap and filter pollutants and protect water quality. Bioswales are typically used in urban settings to filter runoff from paved surfaces. They can also be used in rural settings to filter runoff from agricultural production areas.   This area is intentionally thick with native grasses, forbs, and other plants chosen for their ability to create a healthy ecosystem.

Above Ground

Bioswales provide aesthetically pleasing color to the landscape and enhance habitat for amphibians, birds, and butterflies.

At the Surface

Bioswales intercept silt, nutrients, and pathogens in runoff and enhance infiltration.

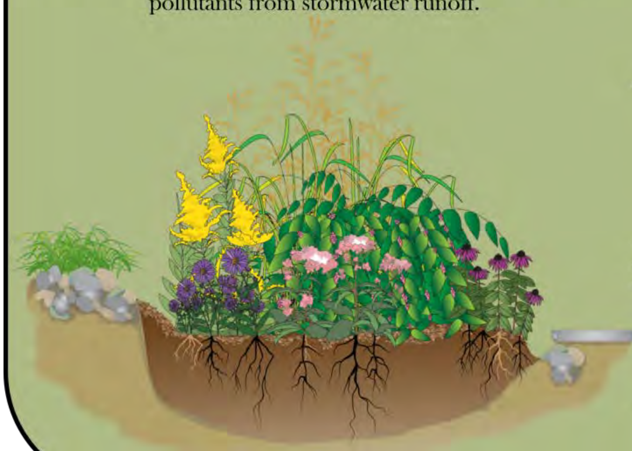
Below Ground

Bioswales provide root systems that uptake nutrients for above ground plants and provide carbon for beneficial microbes.

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act.

RAIN GARDEN

Rain gardens are intentionally planted in low-lying, soggy areas. These gardens use native vegetation, soil, mulch, and an earthern berm to keep water clean by filtering out pollutants from stormwater runoff.



Plants

Biodiverse plants are chosen for their deep root systems, adaptation to wet and dry cycles, and aesthetically pleasing appearance.

Mulch

Hardwood mulch is used to minimize weeds and maintain moisture in the garden.

Berm

The earthern berm is designed to hold water in the garden.

Soil

The soil helps filter pathogens, pesticides, and excess nutrients before it can move to nearby streams where they can be harmful to the ecosystem.

Roots

Deep roots break up the soil to allow water to more easily infiltrate into the soil. Extensive root systems prevent soil erosion and minimize weeds.

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act.

WETLAND

Wetlands are areas that remain saturated or ponded with water for enough of the year that the local area supports vegetation, soils, and wildlife that are unique to these "wet" areas. Wetlands are important because they clean water, help control flooding, stabilize streambanks, recharge the groundwater resources that are important for drinking water, and provide unique habitat for wildlife and vegetation.

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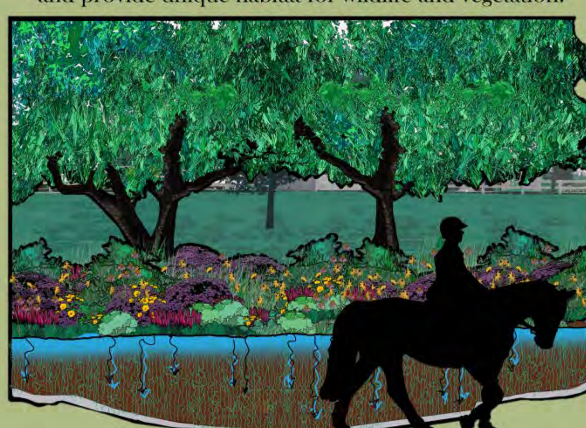

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act.

SETTLING BASIN

Settling basins remove solids from runoff before it enters surface waters. Any gravels collected in the basin will be reapplied to the parking lot thus saving money while protecting water quality. This project was a joint effort between the University of Kentucky and the Kentucky Horse Park Foundation.

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act.

BIORETENTION BASIN

Bioretention basins are soil and plant-based filtration structures that collect stormwater runoff and remove pollutants and sediments through a variety of natural processes such as filtration and plant uptake. This bioretention basin was constructed to treat the runoff from the main horse washing station. This project was a joint effort between the University of Kentucky and the Kentucky Horse Park Foundation.

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act.

Appendix D: Articles

Kentucky Horse Park and UK partner to improve important Kentucky watershed

Amanda Gumbert

The Kentucky Horse Park Foundation and the University of Kentucky College of Agriculture, Food and Environment partnered in 2013 to make substantial improvements to the Cane Run Watershed, an important water resource for the region that is also currently on Kentucky's 303(d) list of impaired streams.

The collaboration is part of a longer-running project that began in 2006 and funded in part by a $1.8 million grant from the U.S. Environmental Protection Agency to UK. In turn, $260,000 was given by UK to the Kentucky Horse Park Foundation in March 2013, with plans to increase that to $465,000, according to the project lead, Stephen Higgins, PhD, director of environmental compliance for UK's Agricultural Experiment Station.

"The partnership between UK and the Kentucky Horse Park is yet further evidence of the park's commitment to the environment and our determination to be a positive example for other equestrian facilities. This project, in addition to being the right thing to do for our land and our water, has also had a number of good practical effects, including much better drainage, both in the barn areas and around the rings," said John Nicholson, Kentucky Horse Park Executive Director. "Dr. Higgins has been super to work with and he has made a lasting contribution for the Horse Park. We are all grateful to the Kentucky Horse Park Foundation for being the vehicle that allowed this great endeavor to move forward."

"Our latest work has been on installing all-weather surfaces on riding trails to reduce erosion and increase horse and rider safety. We have also constructed a covered manure stack pad to store the muck out of the weather," Higgins said. "We have fenced off riparian areas (the interface between land and a river or stream) and moved watering fountains to locations that are better for water quality. Other projects include bioswales (landscape elements designed to remove silt and pollution from surface runoff water), dredging the sediment from the pond, projects to reduce the sediment load, rain gardens, settling basins to capture eroded stone, and a wetland."

ABOVE: New landscaping, Covered muck storage and dredging the Pond are all part of the Cane Run Watershed Project.

The public awareness and educational component is also an important part of the scope of the project, he said, offering opportunities for education about environment and water issues to visitors.

PROJECT WEBSITE:
http://www.bae.uky.edu/CaneRun/

Holly Wiemers, MA, is communications director for UK Ag Equine Programs. ◆

THIRD ANNUAL GOODGIVING GUIDE CHALLENGE

The Kentucky Horse Park Foundation is excited to announce that we have been selected for the third year in a row to participate in the GoodGiving Guide Challenge, organized by Smiley Pete Publishing and the Blue Grass Community Foundation.

Last year, the GoodGiving Guide Challenge raised $429,842 for 68 local charities, and their goal is to raise over $1 million in 2013. The Challenge will run from November 1, through December 31, 2013, promoting incentives to donate to your favorite charities. All donations must be made through GoodGivingGuide.net to qualify during the contest. We welcome you to show your support for the KHPF this holiday season! Follow the campaign on Facebook (facebook.com/khpfoundation), twitter (khpfoundation@khpfoundation) and through our emails. ◆