Hancock Creek Watershed Plan

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Hancock Creek Watershed Plan
Chapter 1: Introduction

The Hancock Creek Watershed Plan (WP) outlines all point and nonpoint pollution sources in the watershed, quantifies the pollution coming from each source, and makes recommendations for Best Management Practices (BMPs) to improve water quality in Hancock Creek.

A. Watershed

Hancock Creek is a tributary of Strodes Creek and located in the Licking River Basin. The Hancock Creek watershed is a 12.96 square mile (8,295 acres) area located in Clark County.

Figure 1.1 Location of Hancock Creek Watershed within the Strodes Creek Watershed, Clark County, Kentucky. Source: Clark County Geographic Information Systems, 2008.

Hancock Creek is a diverse watershed that is subject to substantial change in the future. Currently, the watershed has the potential to receive pollution from such sources as septic tanks, package sewage treatment plants, agricultural land, subdivision development, commercial and industrial businesses, sewage lift stations, permitted discharges, and runoff from Interstate 64. Approximately 8,744 housing units have been approved for development in the future. Their inclusion to the landscape has the potential to impact water quality from the runoff from an increased number of impervious surfaces as well as nonpoint source pollution stemming from lawn care and maintenance, increased sedimentation from construction, and household pet waste to name a few.

B. Goals

An initial community roundtable was held in February 2008 to discern how area residents see and use the creek. These survey results can be seen in Appendix A (page 80). The Hancock Creek Watershed Planning Team adopted the following statement as its goal, “The Team will work to preserve, protect, enhance, and restore the watershed by identifying pollution problems and their potential sources, and creating a plan that reduces current pollutant loads and protects the watershed for the future.” In addition to this general goal to guide planning efforts, the team identified several specific, preliminary goals and possible strategies for the watershed plan. They are as follows:

1. Protect water quality where it is good; improve it where needed.
   Possible strategies:
   a. Work with regulatory agencies when needed to achieve the goal of improving water quality.
   b. Work with other agencies to improve and restore stream conditions.
   c. Partner with rain garden project “Bluegrass 2010 by 2010” to encourage rain garden use in watershed.
   d. Partner with Bluegrass Pride to create a rain barrel program to encourage rain barrel use in the watershed.
   e. Conduct workshops and educational programs on the benefit of rain gardens and rain barrels and how to install them.

2. Educate the community on watershed issues to raise environmental awareness and create continuous lines of communication surrounding watershed issues.
   Possible strategies:
   a. Have an advocate for water quality for planning decisions.
   b. Discuss stormwater management issues with facilities in the watershed.
   c. Present mini-workshops on growth readiness to developers, planners, and others.
   d. Create an environmental resources section at the County Public Library.
   e. Distribute information and brochures on water quality issues such as proper septic system maintenance, household hazardous waste, and nutrient loading from fertilizers and pesticides, etc.

3. Examine and recommend updates to local codes and ordinances to support low impact development and redevelopment and other practices that will improve water quality.
   Possible strategies:
   a. Use Center for Watershed Protection’s Codes and Ordinances Worksheet to examine how well the area’s ordinances work to protect water quality.
   b. Encourage the county and city to use water quality modeling in making planning decisions.
   c. Possible involvement in Growth Readiness pilot program that brings adjacent local governments together to examine codes and ordinances in order to plan for sustainable growth.

    d. Encourage the creation of an enforcement/monitoring program to ensure that, during and after development, peak stormwater flows do not exceed pre-development peak flows, in terms of quantity, quality, and volume.

4. Protect and manage the watershed's soils and natural vegetation to prevent erosion. Possible strategies:
    a. Encourage the use of native plants that are adapted to local soil and weather conditions when re-vegetating disturbed areas.
    b. Work with county to encourage the enforcement of erosion control plans for all development within the watershed.
    c. Minimize the clearing of vegetation and disturbance of soils.

These goals and strategies have been refined and added to as the planning process developed.

C. Partners and Stakeholders

The watershed planning effort was funded in part by a grant from the U.S. Environmental Protection Agency under 319(h) of the Clean Water Act through the Kentucky Division of Water to the Kentucky Waterways Alliance. The Strodes Creek Conservancy and the Kentucky Waterways Alliance sponsored the watershed planning effort. The following are the primary contacts for these organizations:

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The following people and groups were asked to participate in the watershed planning process: all residents of the watershed, Winchester City Council members, Clark County Fiscal Court members, Verna Hills Neighborhood Association, Yorktowne Neighborhood Association, Kentucky American Water Company, a representative from East Kentucky Power Cooperative, Inc., local developers, Winchester Municipal Utilities, the Licking River Basin Coordinator, and City of Winchester Planning and Public Works personnel.

Hancock Creek Watershed Based Plan
Chapter 2: Look around

Watershed Inventory

General Watershed Description

The watershed of concern is Hancock Creek in Winchester, Clark County, Kentucky. Hancock Creek is a tributary to Strodes Creek in the Licking River Basin. The watershed is 12.96 square miles (8,295 acres). It has several diverse land uses including agricultural activity, residential development, and state and interstate highway activity. Approximately 928 homes are located in the watershed.

Water Resources

Watershed Boundary- The hydrologic unit code (HUC) used to identify Hancock Creek is 05100102030020. This 14-digit code is part of the Hydrologic Unit system that is a standardized watershed classification system developed by US Geologic Service. HUCs are watershed boundaries organized by size. The Hancock Creek watershed is a fairly small watershed. Its HUC has 14 digits to indicate its small size. Other watersheds comparable in size will also have a 14-digit number; it is like an address for the watershed. Bigger watersheds have smaller HUC numbers. HUCs of a certain size class are often referred to by the number of digits in their HUC. Hancock Creek is a HUC-14 while Strodes Creek, a bigger watershed, is a HUC-11.

Hydrology

The Hancock Creek watershed lies in Clark County at the boundary between the Inner and Outer Bluegrass Regions of Central Kentucky. The creek drains 8,300 acres of mostly pasture (79%) and crop land (6%), with developed areas accounting for only about 4% of the total drainage area (see Figure 2.1).

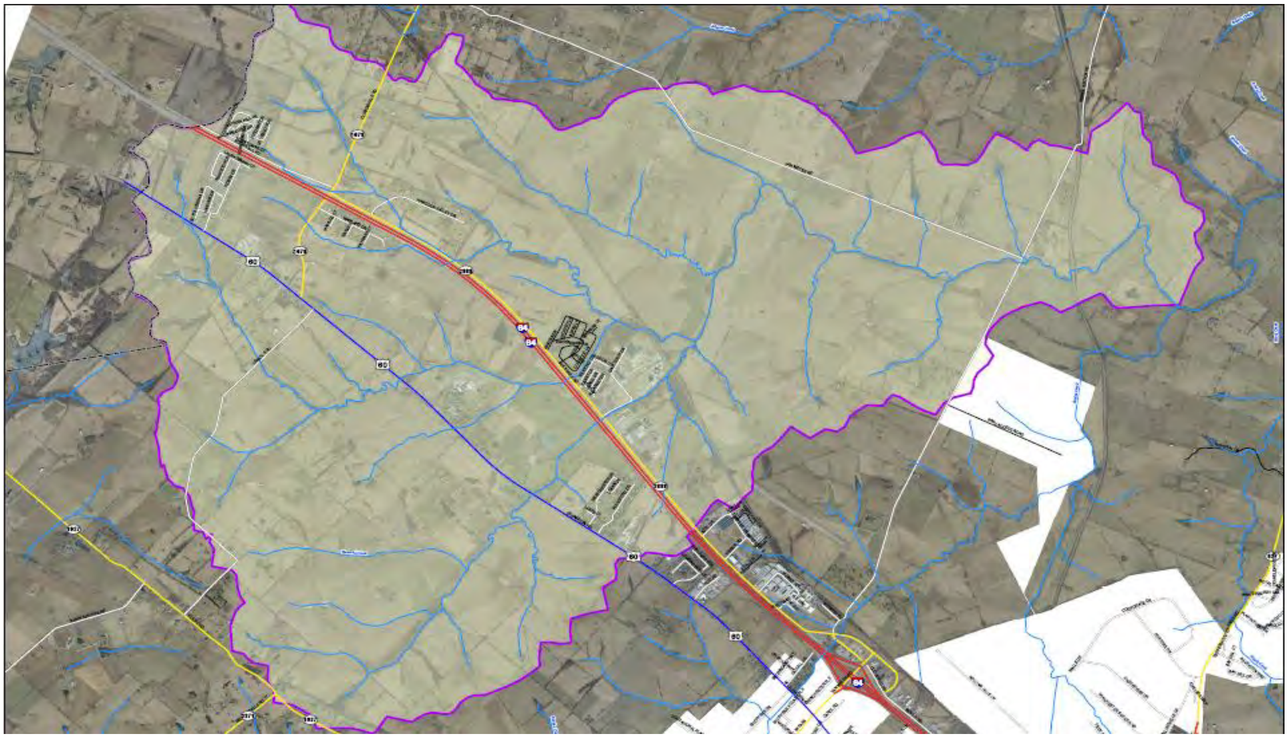


Figure 2.1. Hancock Creek Watershed, showing mostly rectangular to dendritic drainage pattern. Source: Clark County Geographic Information Systems, 2008.

Runoff from pasture land in the watershed is assessed as moderate to moderately rapid due to soil compaction related to cattle grazing and equipment use throughout the drainage area. Stream discharge (flow) on Hancock Creek has been determined through modeling by the US Geologic Survey. The modeled mean annual flow at the confluence of Hancock and Strodes Creek is 16 cubic feet per second (cfs) with low flows at or near zero during the dry season (Walker 2008). The presence of limestone at or near the surface in the Hancock Creek watershed and the general karst topography indicates close interaction between surface waters and shallow groundwater (see Figure 2.2 below).

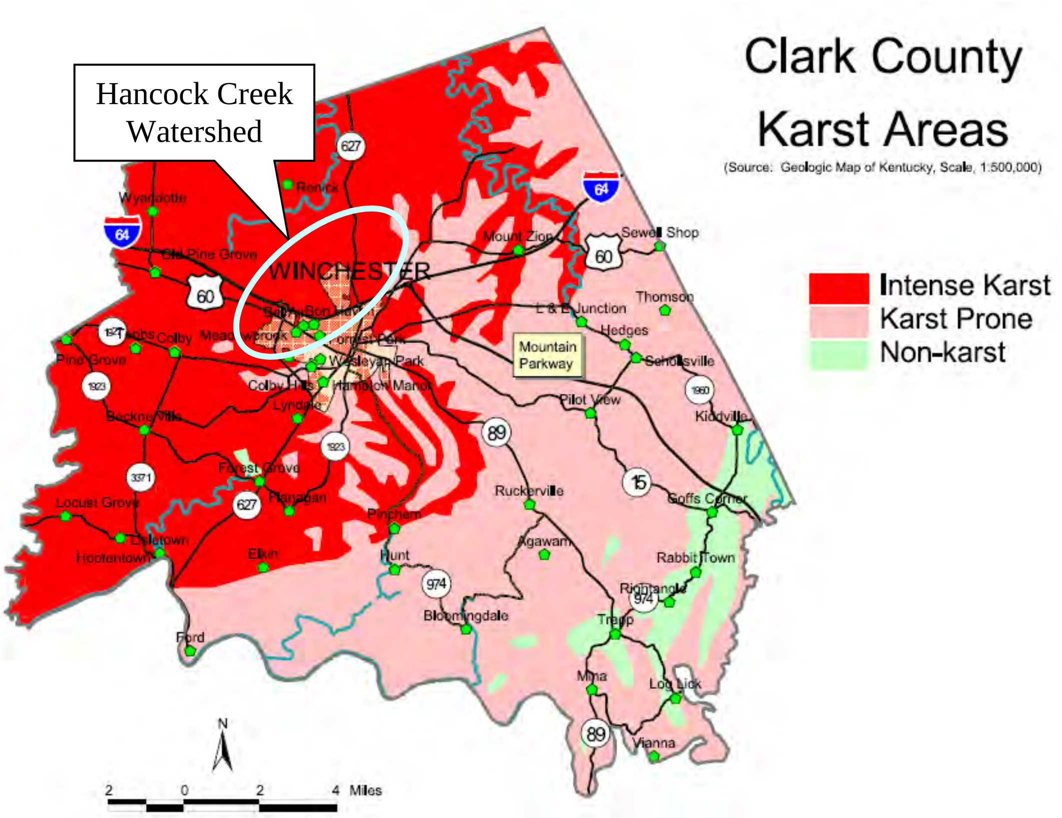


Figure 2.2. Karst areas in Clark County, Kentucky. Source: Kentucky Geological Survey, 2008.

<u>Climate and precipitation</u>

The climate of Clark County is temperate and moist. Winters are fairly short, and there are only a few days when temperatures are extremely low. Summers are long, but periods of excessive heat are short. Frequent changes of temperature occur in all seasons. Precipitation is fairly evenly distributed throughout the year. See Appendix B for climate and precipitation details.

Precipitation has an impact on Hancock Creek water quality and quantity. Sediment (soil) is the biggest water pollutant in Kentucky. When it rains, the water washes away soil and debris sitting on the surface into the stream. Oil and gasoline, fertilizer, pet waste, or agricultural by-products can get washed away by the rain into the stream and act as pollution. For this reason, how much water runs off after a rain or snow melt is very important.

Ground-Surface Water Interactions

The Hancock Creek area in Clark County is a large expanse of Karst topography. The area is considered to be intensely occupied by Karst topography (see Figure 2.2). Karst is a topographic terrain formed on carbonate rocks such as limestone, dolomite, and gypsum. Karst topography is characterized by the presence of sinkholes, caves, springs, sinking streams, and a subsurface drainage network. Where these landforms are abundant and well-developed, the karst terrain is termed mature or intensely karst. Where these landforms are less abundant and thinner beds of carbonate rocks are present, the areas may be termed karst prone. Non karst areas are generally developed on shalestones, sandstones, and siltstones. Non karst areas will not have the features of sinkholes, springs, or sinking streams. Any land surface underlain by weathered carbonate rocks, such as limestone or dolomite, has the potential for rapid groundwater movement through channels in bedrock (conduits). This rapid water movement makes any karst terrain sensitive to pollution, whether well-developed karst features are present or not. Leaky sewer collection lines, sinkhole dumps, and runoff from feedlots, barnyards, and septic systems can contaminate groundwater by entering the subsurface conduit system through sinkholes and sinking streams.

Flooding

For a stream or river to swell after heavy rain or snow is a natural phenomenon. The area immediately surrounding a waterway (the "floodplain") is prone to flooding. Also affecting that rate and frequency of flooding is the amount of impervious surface (a surface that does not permit passage or infiltration) in a community. If a tract of forest is turned into a shopping center, for example, all the rain that would have fallen on that forest parcel and either infiltrated into the soil or stayed on the site will now run off the roof and parking lot of the shopping center and continue running down stream. This swells the waterway downstream even more and carries pollutants from the land into the water. With more development and impervious surfaces, there is more and more run-off and flooding. This is something that is happening in communities across the U.S. Storm water runoff, as it is called, is considered a nonpoint source pollution.

The term "100-year flood," is used to describe the recurrence interval of floods. The 100-year recurrence interval means that a flood of that magnitude has a one percent chance of occurring in any given year. In other words, the chances that a river will flow as high as the 100-year flood stage this year is 1 in 100. Statistically, each year begins with the same 1-percent chance that a 100-year event will occur (USGS). So a 50 year flood is a big flood while a 2 year flood would be a fairly small flood. The yearly average flow of Hancock Creek at the point that it flows into Strodes Creek is 16 cfs. During a two year flood flows are approximately 900 cfs, and a 50 year flood flow approaches 2,800 cfs.

Flooding in the Hancock watershed is an issue mostly in a few downstream reaches where industrial developments were sited prior to the establishments of setbacks or floodplain restrictions (see Figure 2.3). The upper tributaries lie mostly in agricultural lands, where flooding is less of a problem. A visual assessment indicates that many areas of the stream and its tributaries were channelized and drained with subsurface drain tiles and/or surface ditches. The natural floodplain in many reaches has been eliminated. Channel slope is mostly flat, with gradients along most reaches at less than one percent. Channelization and urbanization exacerbate flooding downstream. Work could be done in the lower channel to recreate a floodplain and re-establish some channel meanders (Walker, Quisenberry personal communication, 2008).

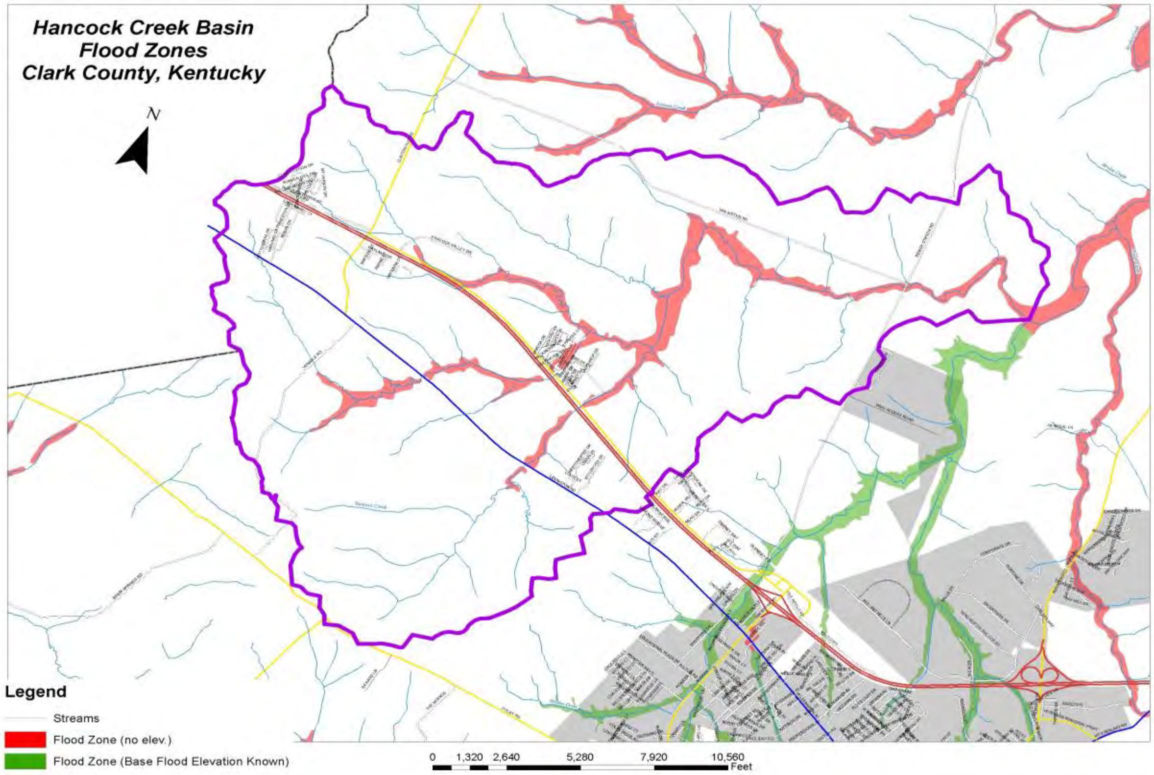


Figure 2.3. Floodplain of Hancock Creek Watershed. Source: Clark County Geographic Information Systems, 2008.

Water Supply

The Kentucky Division of Water (KDOW) water withdrawal program governs all withdrawals of water greater than 10,000 gallons per day from any surface, spring or groundwater source, with the exception of water required for domestic purposes (needs for one household); agricultural withdrawals, including irrigation; steam-powered electrical generating plants whose retail rates are regulated by the Kentucky Public Service Commission or for which facilities a certificate of environmental compatibility from such commission is required by law; or injection underground in conjunction with operations for the production of oil and gas. According to KDOW, there are no permitted water withdrawals greater than 10,000 gallons/day for commercial or public water supply, and no smaller withdrawals known in the Hancock Creek watershed.

Watershed Management Activities

Source Water Protection Plans, Wellhead Protection Program, and Groundwater Protection Plans

According to the KDOW Drinking Water Branch, there are no source water protection plans in the Hancock Creek watershed (see Appendix B for locations of protection plans in the surrounding area). Wellhead Protection Plans are used to assist communities that rely on groundwater as their public water source. According to KDOW Groundwater Section personnel, there are no wellhead protection areas in the Hancock Creek watershed.

Groundwater Protection Plans (GPPs) are required for anyone engaged in activities that have the potential to pollute groundwater. The KDOW Groundwater Section personnel reported that two groundwater protection plans (GPPs) had been filed in their office for the Hancock Creek watershed. The GPPs were for Verna Hills Subdivision WWTP and the Yorktowne Mobile Home Park WWTP. There may be other facilities in the watershed area that need a GPP.

For more information on what types of facilities require GPPs or guidance on how to write a plan, visit the Groundwater Section of the KDOW website. It is part of this watershed-based plan to implement education and awareness campaigns on the need for groundwater protection and active GPPs.

Past and Current Watershed Plans

The Strodes Creek Conservancy (SCC), which works in the Hancock Creek watershed, has projects underway and provides water quality education in the watershed. Much of the information gathered for the Strodes Creek watershed has been used in this watershed plan. However, a formal water quality plan has not been developed for the Hancock Creek watershed or a hydrologic unit code that contains the Hancock Creek watershed. Nonetheless, the information collected by the SCC is very valuable to the current watershed plan and will be considered during the development of this plan.

Wastewater Authorities

Winchester Municipal Utilities (WMU) recently upgraded the Strodes Creek Wastewater Treatment Plant to accommodate the 20 year growth needs of the community. WMU is currently updating the "201 Plan" which is the document required by the KDOW under Section 201 of the Clean Water Act, to evaluate growth projections, collection systems, and treatment needs. Additionally, there are four private waste water treatment plants that operate in the watershed: Rockwell Village is owned / operated by Kentucky American Water in Lexington. Verna Hills is owned / operated by the Verna Hills Neighborhood Association. Yorktowne is owned / operated by the Yorktowne Mobile Home Neighborhood Association, and East Kentucky Power owned / operated by East Kentucky Power.

Agricultural Water Quality Plans

There are 250 Agricultural Water Quality Plans on file in the Clark County Conservation District Office, indicating an overall compliance with the program (Clark County Conservation District , April 2009). The Agriculture Water Quality Act requires all landowners/land users with 10 or more acres that are being used for agriculture or silviculture (forestry) operations to develop and implement a water quality plan based upon guidance from the Kentucky Agriculture Water Quality Plan. The goal of the act is to protect surface and groundwater resources from pollution as a result of agriculture and silviculture activities. For more information about developing a water quality plan, visit the following websites: http://www.conservation.ky.gov/programs/kawqa/ and http://warehouse.ca.uky.edu/AWQP2000/index.html

Special Land Use Planning

The Hancock Creek watershed has several planning and zoning ordinances to which all who operate in the watershed must adhere. According to the Code of Ordinance for the City of Winchester, an ordinance entitled, “Flood Damage Prevention,” is in place. The purpose of this ordinance is to promote the public health, safety and general welfare, and to minimize public and private losses due to flood conditions in specific areas. As part of Subdivision Regulations for Clark County, a regulation entitled, “Plans Required for the Control of Erosion and Sedimentation,” is in place and requires submittal of an erosion and sediment control plan to be submitted with the development plan. Lastly, the

Winchester/Clark County Comprehensive Plan helps guide the future growth and development of the community, including the land area of Hancock Creek. The Hancock Creek watershed will have increased residential growth over the next decade. Approximately 8,744 housing units have been approved by the Winchester-Clark County Commission.

Regulatory Status of Waterways

TMDL Reports

A Total Maximum Daily Load (TMDL) report is a document put together by the Kentucky Division of Water (KDOW) when a stream has been determined “impaired.” An impaired stream is one that is not meeting water quality standards for pollution (nutrients or fecal matter). A Total Maximum Daily Load is the amount of pollution a stream can receive before violating pollution standard limits.

Data for nutrient and organic enrichment TMDL were collected by KDOW in 2004 as part of the Strodes Creek TMDL study. The TMDL for these pollutants will not be developed until KDOW promulgates the nutrient and organic enrichment criteria. The pathogen data have been collected by the Strodes Creek Conservancy project and are currently being used by KDOW to develop the pathogen TMDL. No date of completion is available. As a result of the data collected for Hancock by KDOW in the Strodes Creek assessment and the data collected by the Strodes Creek Conservancy, Hancock has been labeled an impaired stream, but not TMDL has yet been created for it. Also, it does not appear on the list of impaired streams, but this is an error.

Designated Uses

According to KDOW, all unassessed waters in Kentucky are labeled as “High Quality” waters. High quality waters have the following designated uses: primary contact recreation, secondary contact recreation, fish consumption, warm water aquatic habitat, and domestic water supply. Hancock Creek is designated as warm water aquatic habitat, and generally meets all criteria limits associated with that use designation.

Water Quality Data

Water quality in the Hancock Creek drainage area includes physical, chemical, and biological parameters which are influenced by environmental factors (e.g., climate, geology, soils, topography) and land uses, land cover, and land management practices. Hancock Creek lies along the eastern portion of the Inner Bluegrass ecoregion, a weakly dissected agricultural plain containing extensive karst, intermittent streams, and expanding urban-suburban areas that originally developed near major springs. The region is underlain by Middle Ordovician Lexington Limestone and overlaid with fertile phosphatic soils which may contribute to elevated phosphorus concentrations in surface waters. Land uses include pastured cattle, some row crops (mostly tobacco), and residential and commercial development in the upper and middle reaches of the Hancock Creek drainage area, along US 60 and the I-64 frontage road (Rockwell Road). The mainstem of the creek from near the mouth to Van Meter Road is largely fenced off from cattle, and the banks are generally vegetated. The lower portion of the creek – adjacent to the confluence with Strodes Creek – is not vegetated. Tributaries to Hancock experience more cattle grazing and cattle access to stream channels than the mainstem, resulting in soil compaction and stream channel enlargement through bank erosion. As is typical of Inner Bluegrass streams, agriculture also contributes sediment, nutrients, pesticides, and pathogens to surface water, and algal blooms and low concentrations of dissolved oxygen can occur where the riparian tree canopy has been removed.

Wastewater discharges from small package sewage treatment plants and runoff from commercial and industrial areas increase runoff and overall flow volumes and pollutant loading to Hancock Creek and its tributaries, though the impacts are variable.

Impaired Streams

According to the 2008 Integrated Report to Congress, segments of Hancock Creek are listed as impaired for nonsupport for Warm Water Aquatic Habitat (WAH) due to pH, nutrients, biological indicators, and specific conductance) and nonsupport for Primary and Secondary Contact Recreation PCR SCR due to pH and bacteria.

Special Use Waters

Hancock Creek is not listed as a special use water.

Water Quality Data

Biology

As noted, Hancock Creek drains a mostly pasture-dominated agricultural area, with some commercial and residential development in highly concentrated locations in the upper and middle reaches. Hancock Creek joins Strodes Creek just north of Winchester, a stream known in the past for black bass and good water quality. However, Strodes Creek today is listed by KDOW as impaired for primary contact recreation and only partially supports aquatic life. Causes of impairment for Strodes Creek include pathogens, nutrients, siltation, and organic enrichment. The sources of these causes were listed as municipal point sources, highways/roads, agriculture, construction, urban stormwater, and habitat modification.

Bacteria concentrations have been assessed in the Hancock Creek watershed since at least 1999. Bacteria in waterways can be from animal or human sources. It is difficult to determine which source is contaminating a stream, but both can be harmful. Overall bacteria loads serve as an important indicator of stream condition. The Licking River Watershed Watch group samples four sites in the Hancock Creek drainage area three times annually (near Memorial Day, July 4th, and Labor Day). These data report bacteria counts ranging from 300 to more than 14,000 colony-forming units (cfus) per 100 milliliters of stream water sampled during 2001 to 2004. A review of these data indicate that the highest bacteria concentrations appear to be occurring during wet weather (i.e., the May sampling period), but elevated numbers during the drier sampling periods (July and September) indicate bacteria loadings from either upstream wastewater treatment plants, livestock in the stream channels, or both.

Habitat and biological surveys along Hancock Creek were conducted by KDOW in April of 2004, and again in April 2005. In terms of habitat quality, stations assessed exhibited higher scores for channel flow status, lack of channel alteration, and velocity/depth regime. Lower scores were logged for streambank stability, bank vegetative protection, embeddedness, and epifaunal substrate/cover. Fine sediments were dominant in the channel substrate, with fines composing 35-50 percent of the stream bottom material at all habitat survey sites during 2004-2005. Aggregate scores for biota collected by KDOW during 2004 and 2005 were in the poor ranges, with Macroinvertebrate Biological Index (MBI) scores between 26 and 36 (note: scores below 38 are generally considered to be poor). The overall lack of instream habitat and bank vegetation probably contributes to the low MBI scores by 1) limiting the amount and extent of instream habitat structure and refugia, and 2) increasing runoff and stream velocities during heavy storm “flushing” events. The presence of high percentages of fines (i.e., 35 to 50 percent of substrate) indicate upland and/or stream bank erosion and poor habitat conditions for macroinvertebrates.

Geomorphology

Geomorphology is the study of landforms and the processes that shape them. This would include, for example, a hillside adjacent to Hancock Creek. The slope of that hill and the way the sediment erodes after a rain or wind event and then deposits on the streambank would all be geomorphic factors that affect the watershed. Because sediment can be a source of pollution and because highly eroded stream banks become channelized, the geomorphology of a waterway is important to overall water quality and quantity.

No data on stream geomorphology were found for Hancock Creek, but a visual assessment of several reaches conducted by Tetra Tech during 2008 found bedrock controlled stream segments with deposits of fine material of variable depths and moderate-to-heavy bank erosion in pastures. Erosion was also observed in areas with residential and/or commercial development. Channel widening is obvious in many of these areas, as higher flows resulting from greater runoff from compacted soils and/or impervious surfaces erode stream banks to increase channel cross-sectional area. Historical channel relocations have taken place on the lower section of the mainstem, based on field observations (Walker personal communication, 2008).

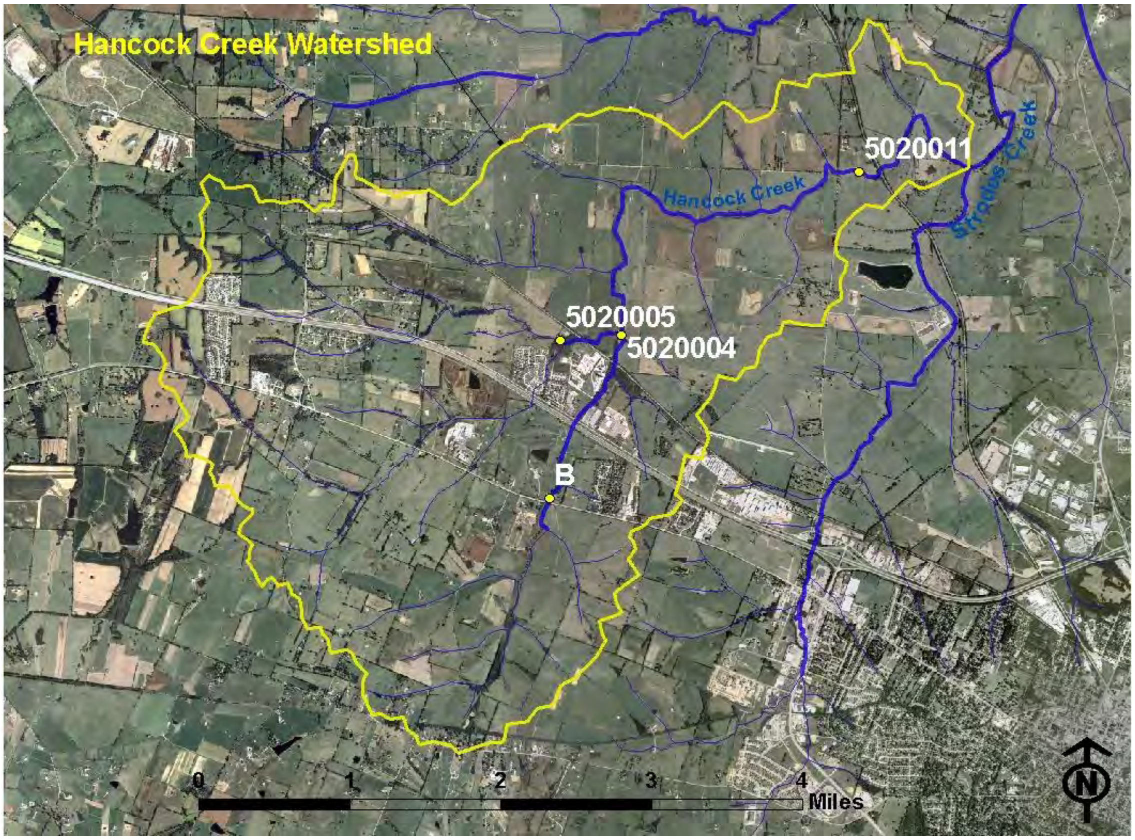


Figure 2.4. Water quality sampling locations in the Hancock Creek watershed. Source: Tetra Tech, 2008.

Chemical Parameters

The Kentucky Division of Water and the Strodes Creek Conservancy collected water quality samples at three locations in the Hancock Creek watershed from 2005 to 2008 (see Figure 2.4). A volunteer monitoring group, the Licking River Watershed Watch, has also collected water quality samples on Hancock Creek. Parameters assessed include a wide variety of parameters like temperature, flow, nitrogen, total phosphorus, total suspended solids, dissolved oxygen and others. These types of data help explain how healthy the water is for human contact and other wildlife. For example, if the dissolved oxygen is low, that may mean that the water is too warm due to lack of healthy riparian trees and shrubs to shade the water. Or if total phosphorus is too high, this can be an indicator of leaky sewer or septic lines in the area. Collecting and interpreting these data can explain what is happening in the watershed. See Appendix B for Licking River Watershed Watch sampling sites in the Hancock Creek watershed.

Hancock Creek shows slightly elevated dissolved solids and phosphorus concentrations. These data come from KDOW sampling done as part of the TMDL in 2004. Elevated phosphorus levels are not uncommon in the eastern part of the Bluegrass due to the limestone in the area. According to the 305(b) Report to Congress, Hancock Creek has impairments due to pH and specific conductance as well. Hancock Creek is designated as warm water aquatic habitat (WAH). As mentioned earlier in this chapter, segments of Hancock Creek will be listed as impaired for nonsupport for WAH due to pH specific conductance and nonsupport for Primary and Secondary Contact Recreation PCR SCR due to pH. It should be noted that warm weather stream sampling in the watershed has found low dissolved oxygen (DO) concentrations on occasion. For example, during July of 2002, samplers logged a DO reading of 3.4 mg/l, which is below the WAH criterion of 4.0 mg/l. Low DO concentrations are likely caused by slow summertime flows and warm temperatures unmitigated by streamside tree canopy cover. These conditions – riparian areas devoid of trees or vegetation other than grass, coupled with stream bank erosion and livestock access to the channel – represent significant threats to Hancock Creek in much of the watershed. The Strodes Creek Conservancy is interested in determining the causes of the aforementioned impairments and hopes to involve more detailed data collection to determine the source(s) of these contaminants.

The chemical, physical, and biological monitoring conducted on Hancock Creek indicates that stream conditions are fair to poor overall, with likely high bacteria concentrations and stream channel erosion occurring during wet weather. Bacteria concentrations in the creek might also be related to inconsistent performance of one or more of the four small wastewater treatment plants in the watershed, though monitoring reports filed by those facilities do not indicate problems with effluent disinfection. Below is a list of the four plants, with key information regarding flow patterns and performance for 2007:

- Rockwell Village: 20-50k gallons/day, 2007 sanction list, better performance in late 2007
- Verna Hills: 20-200k gallons/day, some ammonia spikes
- Yorktowne: 40-350k gallons/day, some bacteria spikes
- East KY Power: 2-3k gallons/day, some ammonia spikes
- Strodes Creek Conservancy is already sampling below Verna Hills and Rockwell.

Verna Hills is a newer sampling site, while Rockwell has been sampled for several years. According to the Discharge Monitoring Reports filed by the treatment plant operators, the flow through the treatment plants varies greatly over time. The treatment plants do not sample at a set time and day, but once a month at their own discretion.

In terms of stream channel issues, it should be noted that the mainstem of Hancock Creek is fenced off from cattle and fairly vegetated for most of its length. Small sections – especially along the tributaries and the lowermost portion of the creek at the confluence with Strodes Creek – do remain unfenced with degraded streambeds. It is believed that the lack of riparian vegetative and tree canopy cover, unrestricted livestock access to the stream network, and heavy grazing of riparian and upland pastures by mostly cattle on some sections of Hancock Creek and most of its tributaries contribute to increased runoff, higher stream flows, elevated loadings of bacteria and sediment, and lowered dissolved oxygen during low summertime flows. While there are some reaches of the creek that display excellent riparian vegetative cover, many areas are relatively devoid of all vegetation except grasses (see Figures 2.5-2.8 below).

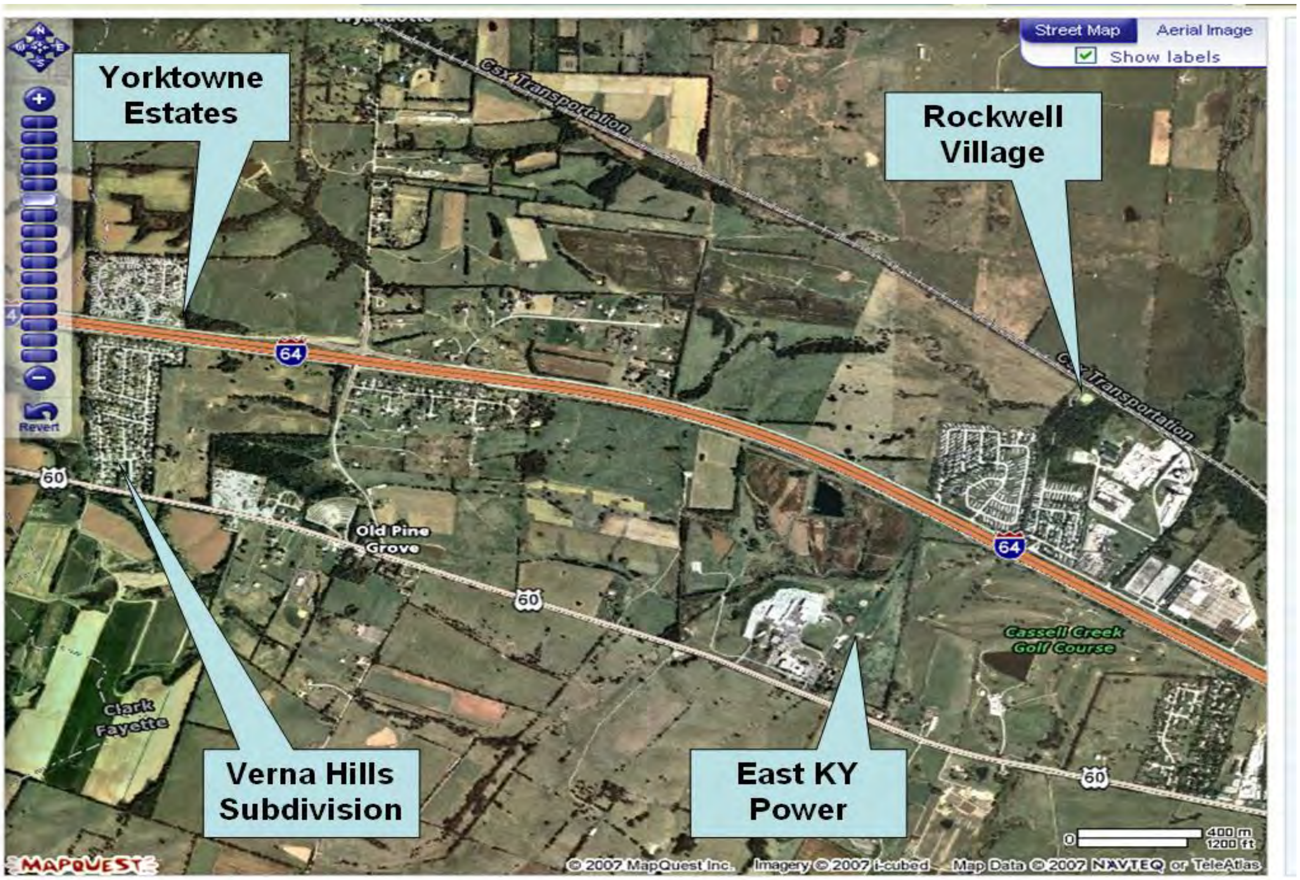


Figure 2.5. Location of wastewater treatment plants in the Hancock Creek watershed. Source: Tetra Tech, 2008.

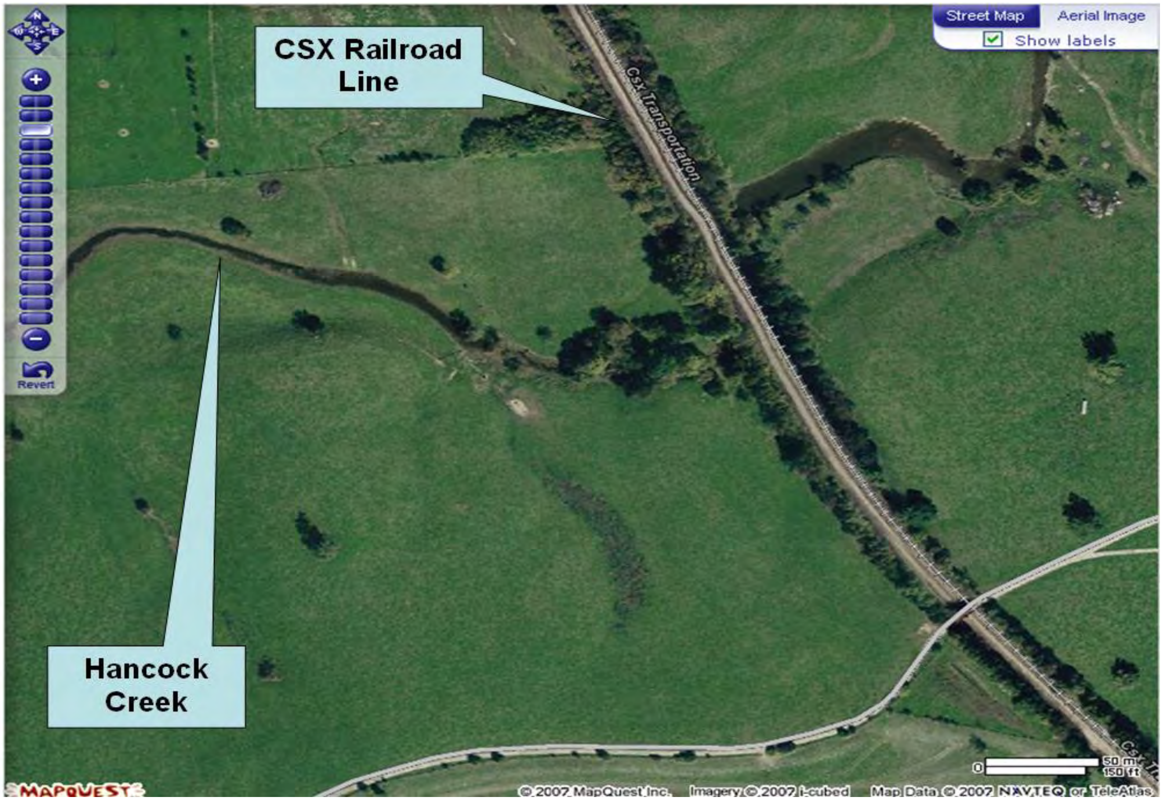


Figure 2.6. Section of Hancock Creek near confluence with Strodes Creek showing lack of vegetative cover along channel typical of most stream reaches in the watershed. Source: Tetra Tech, 2008.

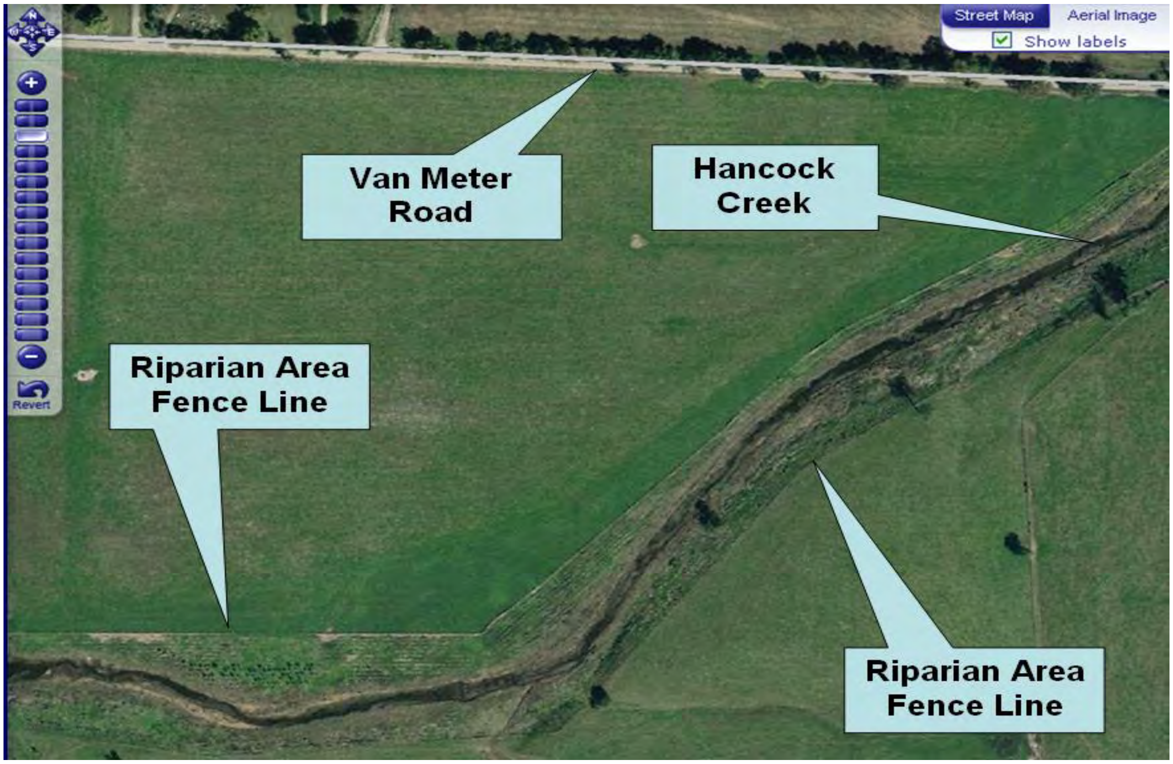


Figure 2.7. Section of Hancock Creek near mouth improved with riparian cattle exclusion fencing and tree plantings. Source: Tetra Tech, 2008.

Figure 2.8. Upland tributary of Hancock Creek, north of I-64 at the Fayette County line, with intact riparian tree canopy. Source: Tetra Tech, 2008.

Water Quality Data Gaps

Given the generally moderate to good water quality data, and analytical findings that most water quality problems stem from lack of riparian vegetation, livestock access, and streambank erosion, the primary data gaps relate to the lack of reach-specific information on these three parameters. Collection of these data for individual stream reaches could be accomplished via the NRCS *Stream Visual Assessment Protocol*, which describes a procedure for rating these and other parameters without testing equipment or laboratory costs. Because the entire Hancock Creek watershed is relatively small – about 13 square miles, it is recommended that the mainstem and tributary streams be assessed using the NRCS SVAP. Assessments could be done from public roads or right-of-ways for the most part, but there are some stream segments on private land that are not visible from public vantage points. Completing assessments of these and other segments could be facilitated by county or state agricultural and/or soil conservation staff, in conjunction with the Strodes Creek Conservancy.

Assessing Hancock Creek and its tributaries via the NRCS SVAP would yield a map of the mainstem and tributaries with information on stream bank erosion, livestock access, riparian vegetation, and other parameters for each stream reach. The information could be used to create a prioritized list of sites targeted for bank stabilization, livestock fencing, alternate water source, or other projects. Educational opportunities associated with these data would help to familiarize area livestock producers and land managers with relatively simple and low-cost or cost-shared approaches for improving water quality and pasture management.

Another major area of data needs relates to the four small wastewater treatment plants that serve residences and businesses in the Hancock Creek watershed. Due to high bacteria concentrations at some monitoring stations, performance of these treatment plants may need closer supervision and more frequent effluent sampling. Random sampling would help provide a more complete data set. Also, sampling below the Yorktowne wastewater treatment plant outfall is advisable. A review of monthly Discharge Monitoring Reports submitted by the four facilities revealed some excursions regarding approved effluent concentrations for various parameters, and widely ranging discharge rates for each of the treatment facilities. Data on effluent quality – and a water conservation program for treatment plant users – might help to further illuminate any water quality problems associated with treatment plant operation. In some locations, it is unclear if the pathogens originate from cattle or the treatment plants. The Strodes Creek Conservancy plans to partner with agencies capable of handling samples that will differentiate between human and livestock waste.

2.2.2 Natural Features of Your Watershed

Geology and Topography

The Hancock Creek watershed lies in the Inner Bluegrass region of the state. The HC watershed is characterized by gently rolling terrain and a thick, fertile, residual soil. Because of this, the land is not significantly constrained by topographic features for development or agricultural practices. The geologic formations that underlie the area are limestone of the Cynthiana formation, which are prone to the formation of sinkholes. Sinkholes are one of the end results of the interaction of limestone and water. As storm water (or groundwater) seeps through a limestone formation it dissolves the stone, forming underground voids that may fill with groundwater or may become dry caves. However, as groundwater levels fluctuate or other conditions occur, the soil above these natural voids subsides into the void – creating a sinkhole. Many human activities and man-made products can affect the quantity and quality of groundwater. Some of these activities include fertilizers, pesticides, septic tanks, municipal sewage systems, garbage dumps, water wells, and surface spills. Fertilizers used extensively on agricultural crops contain nitrogen, potassium, and phosphorus. The latter two do not appear to move into the groundwater system, but nitrogen does in the form of nitrates. Although there has been little evidence of significant contamination of groundwater by pesticides, they can enter the groundwater by infiltrating through soils or through cracks in poorly maintained wells. When septic systems are used to take care of household waste, system failures can introduce excessive amounts of nitrates and bacteria into the soil which can filter into the groundwater system. Where municipal sewage systems treat household and other urban-generated wastes, old sewage lines break and leak nitrates and bacteria to the groundwater system. Garbage dumps can be a major source of groundwater contamination. Solid waste in such dumps contain food, paper, plastics, metals and toxic materials such as lead, mercury, cadmium, poisons, and pesticides. Waste dumps threaten groundwater because rain and moisture wash out or leach metals and organic material from the waste. Poorly constructed and abandoned water wells allow contaminated surface water to reenter the groundwater system (Carigan, April 2009). Except for those areas with where sinkholes occur, the HC watershed is drained by surface streams.

Soils

The Hancock Creek watershed consists primarily of the Hampshire-Mercer soil association. These soils are closely associated with the Hampshire, Mercer, Salvisa, Maury, Hagerstown, McAfee, Loradale, and Eden soils. These soils have a wide range of variability in terms of erodibility, fertility, and ability to manage residential sewage waste. The predominant soils found in the watershed are undulating, deep or moderately deep, well drained or moderately well drained, medium textured, fertile soils of uplands or from material weathered from limestone and calcareous shale. All of the soils, except the Eden soil, are considered fair to good as a suitable source of topsoil.

Soil associations and subsurface geology (depth to bedrock for example) are key elements in determining the suitability of an area for waste disposal via septic tank systems. The suitability of a specific site for waste disposal is determined in large part by three factors, soil texture and structure, the depth to bedrock, and the size of the site. Soil texture and structure determine how quickly or slowly water will drain. Depth to bedrock will be a partial indicator of the capacity of a site to dissipate a given volume of wastewater. If the depth, as measured from the surface soil is very shallow, the site may have insufficient area in which a drain field can properly function. Finally, size of site is also an indicator of whether there is sufficient area for disposal purposes. Data maintained by the Clark County Health Department indicates that approximately 5-10 septic tank systems are reported to fail each year in this watershed. However, the tank failures may not be a product of the soil's ability to manage sewage waste but instead from the size of the site or lack of maintenance performed on individual systems.

The majority of the soils in this area of the county do not present any serious risks to Hancock Creek in terms of erodibility and ability to manage sewage waste from septic systems. With proper conservation practices in place (filter strips, cover crops, etc.), the soil should be an asset to the area for farming with its fertility, deep soil profile, and ability to drain. Except for a few areas of exception, septic systems should function properly in this watershed. To ensure their functionality, it is important for installers to size the tank properly and for homeowners to maintain their systems (United States Department of Agriculture Soil Conservation Service, January 1989).

Riparian Ecosystem

One-third of the mainstem (in the upper and lower reaches only) and much of the tributaries exhibit severely degraded riparian zones or plants densely established along the banks of streams or any waterway. Specifically, the streambanks east of Van Meter Road to the confluence of Strodes Creek have few or no trees, shrubs, or herbaceous vegetation besides pasture grasses. A number of stream segments in the watershed have been trampled by cattle. When livestock trample stream banks, the soil is left unprotected and may collapse, increasing erosion. Substrate in these areas is mostly fine sediment, with significant warming of the water and low dissolved oxygen during the summer due to the lack of shade. The lack of riparian vegetation along most reaches of tributaries to Hancock along with heavy grazing along stream banks in these areas prevents natural re-emergence of a vegetated stream bank, which would shade the channel, stabilize stream banks, and provide habitat and seed stock for further natural stabilization. In addition, much of the stream channels have been channelized or straightened. Channelization usually results in shorter and steeper streams, which then cause faster stream flows and increased erosion (usually eroding the bed downward and outward, and cutting banks). Channelization also reduces the ability of the stream to slow floods and absorb flood damage. Meanders help slow flowing waters. A channelization project may target the faster removal of water, but the removal of water in this manner can not only adversely affect adjacent wetlands, but the stream itself. During drier periods of the year, wetlands tend to slowly release water into streams, helping maintain flows.

The mainstem of Hancock Creek supports riparian vegetation in many areas and is not severely degraded like many of the tributaries. In fact, much of the mainstem streambank is fenced off from cattle and will likely improve due to landowners diligence towards streamside tree planting and agricultural fencing. A few intact forested riparian areas can be found in scattered locations in the watershed. These consist largely of hardwood trees (oak, ash, hickory, poplar), shrubs, and some grasses, though no comprehensive survey of these areas are known to exist. A review of aerial photographs maintained by online mapping and data servers indicates that these intact riparian areas are isolated, fragmented, and limited in their extent (see maps in the *Water Quality Data* section of this report).

Flora and Fauna

The flora and fauna found in the Hancock Creek watershed is fairly uniform since much of the landscape is similar. However, the flora and fauna found in Clark County can be quite diverse since Clark County has a variety of landscapes ranging from meadows to palisades to Appalachian foothills. The following table, which represents findings from the Kentucky State Nature Preserves Commission (KSNPC), indicates that there a number of endangered, threatened, sensitive, or historical plant and animal species in Clark County. In addition, three natural communities, acidic mesophytic forest, limestone slope glade, and moist limestone cliff are listed on the Clark County Report of Endangered, Threatened, and Special Concern Plants, Animals, and Natural Communities by the KSNPC. A list of species specific to the Hancock Creek watershed is not available.

Table 2.1 Summary of the number of each floral and faunal group listed as endangered, threatened, sensitive or historical in Clark County. Source: KSNPC, 2009.

Group	Endangered	Threatened	Sensitive	Historical
Vascular Plants	3	8	1	1
Freshwater Mussels			1	
Crustaceans			1	
Insects				1
Breeding Birds		2	2	
Mammals		1	2	

Approximately 80% of the watershed is in pasture and hay fields. The streams that provide water, food, and habitat for the flora and fauna of the watershed have been degraded along portions of Hancock Creek and its tributaries. A number of stream segments in the watershed have been trampled by cattle. When livestock trample stream banks, the soil is left unprotected and may collapse, increasing erosion. The streams have also been channelized or straightened in much of the watershed. The effects of channelization, through changes in habitat and water flow patterns and duration, can alter the number of plant and animal species present in a stream. Plant species can be affected by changes in the quantity and timing of flooding (either annually or seasonally) and changes in the amount of sediment in flows, which can alter the overall plant community. Plant community changes can adversely impact the quality of the areas that parallel stream banks. When plants are affected, changes can occur in the animal species in the area that use plants for food, cover, and resting. Water quality changes can affect species. Increased sediments in a waterbody can smother benthic (bottom-dwelling) organisms and limit light penetration, which reduces plant production and disrupts the aquatic food chain. Turbidity from bed and bank erosion can impact species that are less tolerant to sediment instream flows. (http://www.epa.gov/region7/wetlands/pdf/ChannelizationFS04-Final.pdf).

A report by the Kentucky State Natural Preserves Commission (KSNPC, 2007) lists a number of wildlife species that are extremely dependent on healthy riparian ecosystems for survival. Examples of these species include *Cryptobrandrus alleganiensis* (Eastern Hellbender), *Mustela nivalis* (Least Weasel), *Juncus articulatus* (Jointed Rush), *Cypripedium kentuckiense* (Kentucky Ladyslipper), and *Ranunculus ambigens* (Waterplantain Spearwort) (EPA Region 7, February 2005).

2.2.3 Human Activities Affecting Water Resource Quality

Point Sources of Pollution
All discharges to waters of the commonwealth require a permit through the Kentucky Pollutant Discharge Elimination System (KPDES). The goal of this permit is to protect the quality and beneficial uses of the Commonwealth of Kentucky's water resources from pollution resulting from a variety of sources. The various types of permits issued through the KPDES program include concentrated animal feeding operations (CAFOs), combined sewer overflows (CSOs), individual residences, Kentucky Inter-System Operational Permit (KISOP), mining, municipal and industrial, no discharge operational permits, oil and gas, pretreatment, and stormwater. However, only municipal and industrial, individual residences, and stormwater permits have been granted in the Hancock Creek watershed.

Municipal and Industrial
DOW reviews and approves all permit applications for municipalities and industries, as well as all domestic or sanitary wastewater treatment facilities. The following entities have a municipal and industrial KPDES permit: Verna Hills Subdivision, Yorktowne Mobile Estates Association, East Kentucky Power Cooperative HQ, and Rockwell Village Mobile Home Park. Bacteria concentrations in the creek may be related to inconsistent performance of one or more of these four small wastewater treatment plants in the watershed, though monitoring reports filed by those facilities do not indicate problems with effluent disinfection. Below is a list of the four plants, what they discharge, and key information regarding flow patterns and performance for 2007:

Rockwell Village: treated domestic wastewater and industrial waste that does not receive pretreatment from Quality Manufacturing, Inc., JennMar, Inc., and Southern States Cooperative, Inc., 20-50k gallons/day, 2007 sanction list, better performance in late 2007
Verna Hills: treated domestic wastewater, 20-200k gallons/day, some ammonia spikes
Yorktowne: treated domestic wastewater, 40-350k gallons/day, some bacteria spikes
East KY Power: treated domestic wastewater, 2-3k gallons/day, some ammonia spikes

Individual Residences
The KDOW's KPDES branch reviews and approves construction and discharge permits for individual home residences. The treatment systems that serve the residences under this permit must include extended aeration plus sand filtration plus disinfection technologies.

Stormwater

The goal of this permit is to protect the quality and beneficial uses of the Commonwealth of Kentucky's water resources from pollution resulting from storm water runoff from construction activities. To achieve this goal, the permit requires operators to plan and implement appropriate and adequate erosion prevention measures, sediment controls measures, and other site management practices necessary to manage storm water runoff during the construction period. These practices are aimed primarily at controlling erosion and sediment transport, but also include controls, including good housekeeping practices, aimed at other pollutants such as construction chemicals and solid waste (e.g., litter). As used in this permit, the terms "Construction and Construction-related activities" include all clearing, grading, excavation, and stockpiling activities that will result in the disturbance of one or more acres of land area.

According to the KDOW, there is one stormwater discharge permit in the Hancock Creek watershed. It belongs to Winchester Municipal Utilities. The permit was given for a water line extension project. The waterline has been installed and work appears to be completed on the project. However, the permit is still open in the KDOW database.

Combined Sewer Systems and Overflows and Municipal Storm Separate Sewer Systems

The Hancock Creek watershed is not covered by a Municipal Storm Separate Sewer System (MS4). While the City of Winchester is covered by an MS4, it does not extend to the entire county.

Regulations and Programs for Wetlands and In-Stream Construction and Disturbance

Section 404 of the Clean Water Act (CWA) establishes a program to regulate the discharge of dredged and fill material into waters of the United States. The term includes such waters as rivers, lakes, streams and most wetlands. Regulated activities include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports) and conversion of wetlands to uplands for farming and forestry. Section 404(f) of the CWA exempts some activities from regulation under Section 404. These activities include many ongoing farming, ranching, and silviculture practices. In order to be exempt, the activities cannot be associated with bringing a wetland into agricultural production or converting an agricultural wetland to a non-wetland area.

In the past, stream channel alterations have caused significant damage to the integrity of the stream and the aquatic life they support and a large number of our wetlands have been drained for agriculture and land development. Because of this, programs under sections 401 and 404 of the CWA have been put in place. The basic premise of the programs is that no discharge of dredged or fill material can be permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. In other words, when one applies for a permit, it must shown that they have: 1. Taken steps to avoid wetland/stream impacts where practicable, 2. minimized potential impacts to wetlands/streams, 3. provided compensation for any remaining, unavoidable impacts, 4. thorough activities to restore or create wetlands/streams (Kentucky Division of Water, June 12, 2008).

Nonpoint Sources of Pollution

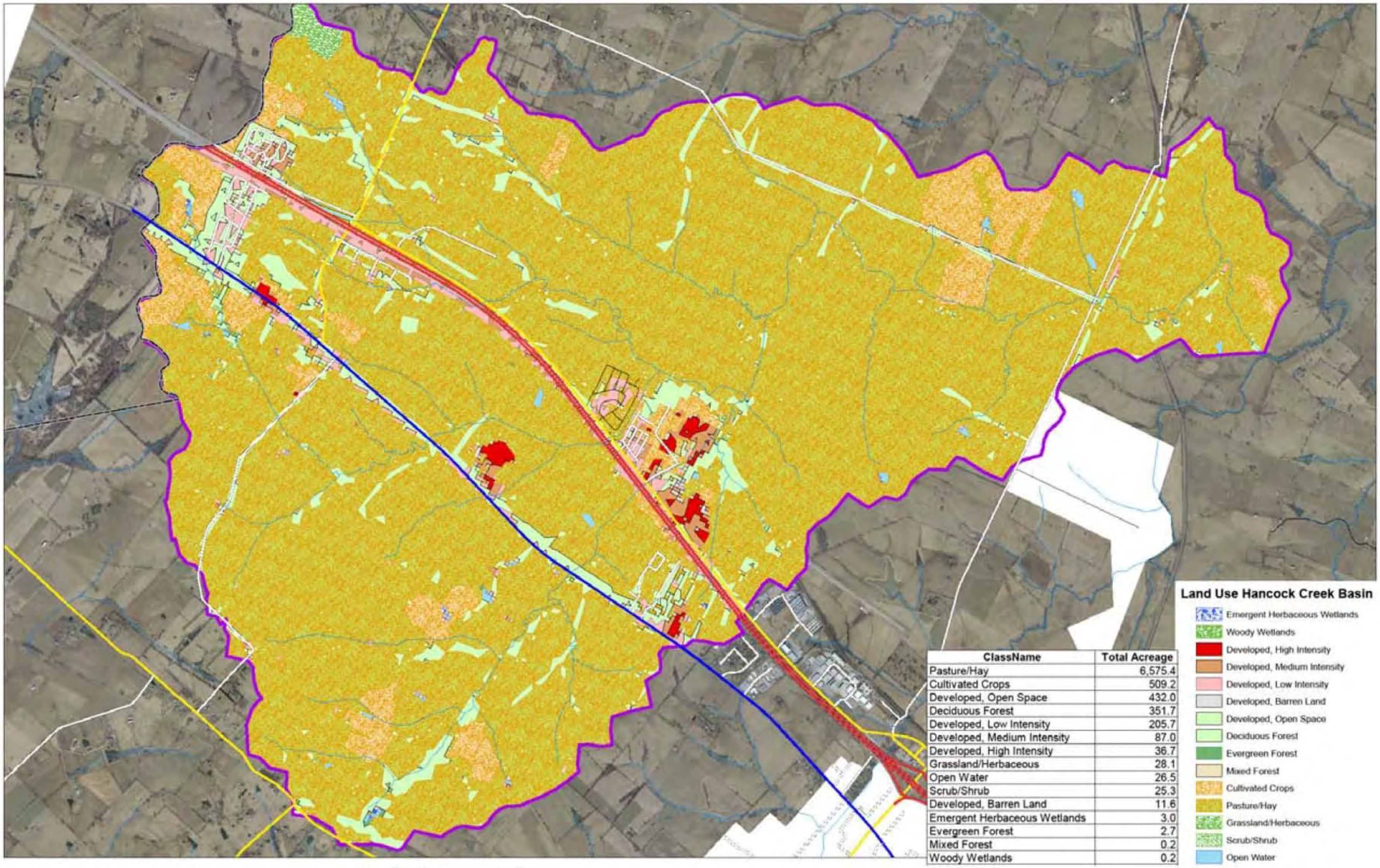
Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources, such as those found in the Hancock Creek watershed. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, and even our underground sources of drinking water. These pollutants include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- Oil, grease, and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks;
- Salt from irrigation practices and acid drainage from abandoned mines;
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

The effects of nonpoint source pollutants on waters vary. However, these pollutants can have harmful effects on drinking water supplies, recreation, fisheries, and wildlife. The nonpoint source pollutants of concern in Hancock Creek are siltation, nutrients, bacteria, and low dissolved oxygen. The sources of those pollutants will be identified in chapter 3. Unfortunately, we all play a part in causing nonpoint source pollution, often without realizing it. Each individual can play an important role in preventing nonpoint source pollution by using conservation practices and changing everyday habits that impact water quality.

Land Use

The Hancock Creek watershed is quite diverse with multiple land uses (see Figure 2.9). The primary land use in the area is agricultural. A significant amount of acreage in the watershed is approved for development. The area is approved for 8,744 new housing units. A hodgepodge of other land uses are present, including single family residential, utility facilities, industrial areas, public/semi public areas, and commercial areas. In addition to these land uses, it should be noted that Interstate-64 and Highway 60 run through the watershed. Because of the diversity of land uses in the watershed, potential sources of nonpoint source (runoff) pollution are abundant. Water is most likely being degraded from runoff coming from livestock pastures and cropland, home septic systems, and highway runoff.



ClassName	Total Acreage
Pasture/Hay	6,575.4
Cultivated Crops	509.2
Developed, Open Space	432.0
Deciduous Forest	351.7
Developed, Low Intensity	205.7
Developed, Medium Intensity	87.0
Developed, High Intensity	36.7
Grassland/Herbaceous	28.1
Open Water	26.5
Scrub/Shrub	25.3
Developed, Barren Land	11.6
Emergent Herbaceous Wetlands	3.0
Evergreen Forest	2.7
Mixed Forest	0.2
Woody Wetlands	0.2

Figure 2.9: Land Use Map of Hancock Creek Watershed

Source: Clark County Geographic Information Systems, 2008.

Impervious surfaces

Impervious surfaces are mainly artificial structures--such as pavements (roads, sidewalks, driveways and parking lots) that are covered by impenetrable materials such as asphalt, concrete, brick, and stone--and rooftops. Soils compacted by urban development are also highly impervious.

Impervious surfaces are an environmental concern because, with their construction, a chain of events is initiated that modifies urban air and water resources:

- The pavement materials seal the soil surface, eliminating rainwater infiltration and natural groundwater recharge. Since the water is not being infiltrated into the soil, it gets transported to a nearby creek or retention basin. When the water surges into a creek during a rain event, the stream banks can be scoured and left without sufficient vegetation to control erosion and the stream bed can be altered which can degrade habitat for aquatic life.
- The runoff from the paved area carries with it pollutants that may include fertilizers; bacteria from pet waste; gasoline, motor oil, and heavy metals from vehicles; high sediment loads from stream bed erosion and construction sites, and waste such as cigarette butts, 6-pack holders and plastic bags carried by surges of stormwater.
- Impervious surfaces collect solar heat. When the heat is released, it raises air temperatures, producing urban "heat islands", and increasing energy consumption in buildings. The warm runoff from impervious surfaces reduces dissolved oxygen in stream water, which is tough on aquatic life.
- Impervious pavements deprive tree roots of aeration, eliminating the "urban forest" and the canopy shade that would otherwise lower temperatures in the urban setting. Because impervious surfaces impact living vegetation, they reduce ecological productivity, and interrupt atmospheric carbon cycling.

Less than one percent of the HC watershed is covered by impervious surfaces. See Figure 2.10 for the impervious surfaces of Clark County. While that isn’t a lot at the present time, consider this: while urban areas cover only 3 percent of the U.S., it is estimated that their runoff is the primary source of pollution in 13 percent of rivers, 18 percent of lakes and 32 percent of estuaries. Now consider the dramatic increase in impervious surfaces to take place in the near future once the approved developments become part of the landscape (Cappiello, October 16, 2008).

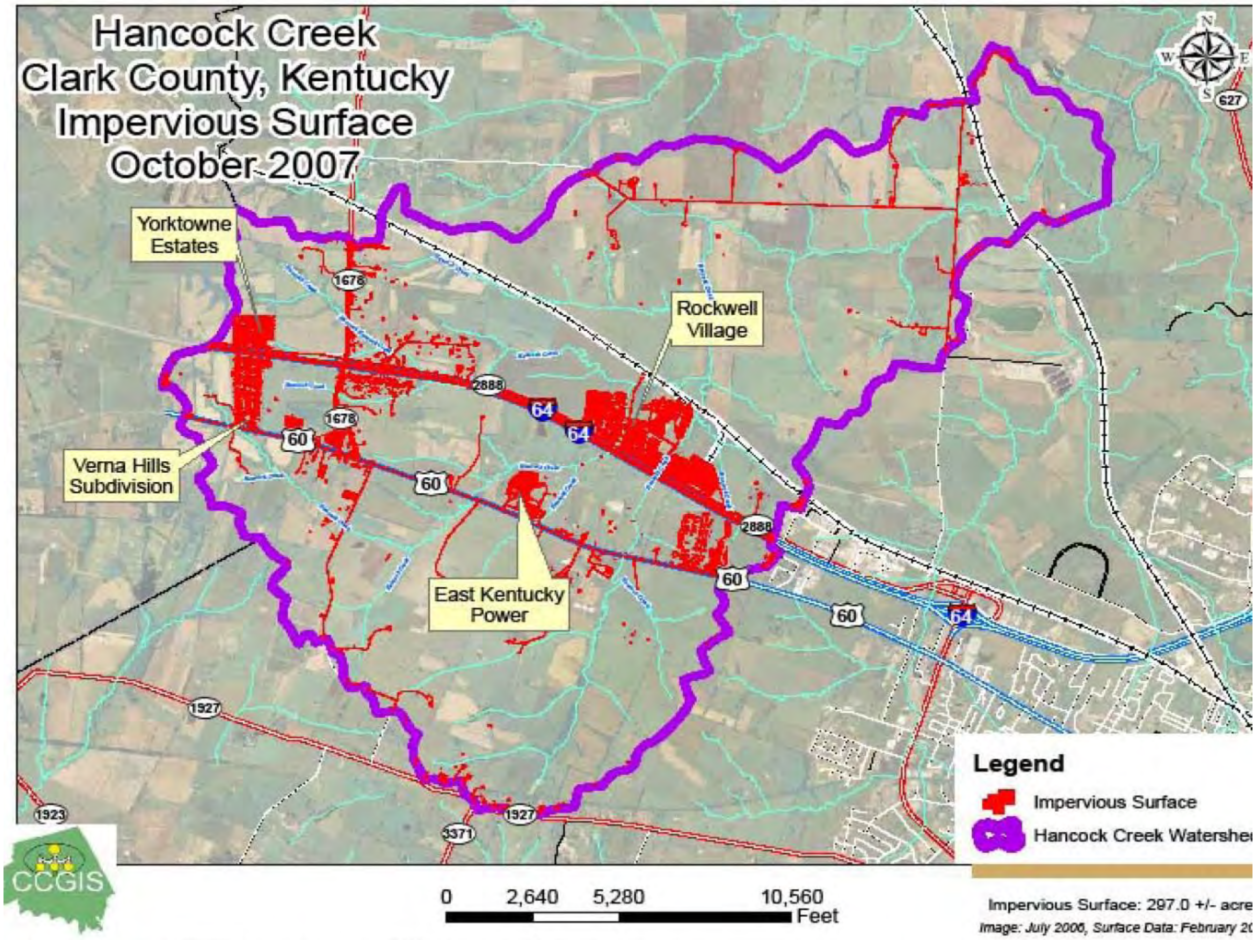


Figure 2.10: Impervious Surfaces in Clark County, Kentucky

Source: Clark County Geographic Information Systems, 2008.

At the present time, regulations and/or ordinances that consider impervious surfaces in planned developments do not exist.

However, the Hancock Creek Watershed Team developed a number of goals that would address impervious surfaces including:

- Use of the Center for Watershed Protection’s Codes and Ordinances Worksheet to examine how well the area’s ordinances work to protect water quality.
- The encouragement of the county and city to use water quality modeling in making planning decisions.
- Encourage the creation of an enforcement/monitoring program to ensure that, during and after development, peak stormwater flows do not exceed pre-development peak flows, in terms of quantity, quality, and volume.

Unsewered Areas

The vast majority of homes and businesses within the Hancock Creek watershed treat wastewater by using onsite wastewater systems or package sewage treatment plants. Two entities, an industrial plant which once housed Rockwell International, and the Treehaven Trailer Park, use wastewater collection lines to send their waste to the Strodes Creek Wastewater Treatment Plant. Efforts are underway by Winchester Municipal Utilities to install wastewater collection lines on the eastern edge of the watershed. These new lines will pick up the East Kentucky Power, Inc. package sewage treatment plant, all new development and surrounding homesteads. The SCC has implemented an onsite wastewater program which financially assists homeowners with pumping their septic tanks and making repairs, as needed. To date, the program has been marginally successful with approximately twenty-five percent of the households participating in the program.

According to AGR-167, the most ideal soil areas for septic systems are those that are gently sloping, thick, of good structure, and permeable with water tables located deep in the profile. Soil color should be uniform reddish-brown, reddish, yellow-brown, or yellowish and should not have gray spots within three feet of the surface. The gray colors often indicate drainage problems. The soil texture should be neither too sandy nor too clayey, and homeowners should maintain their systems (see Appendix B for a soils map of the area). In general, the predominant soils of this area fit this description although the presence of fragipans and clay soils can be found deep in the soil profile (Thom).

2.2.4. Demographics and Social Issues

According to the Claritas 2008 Data for Census, the total population of the Hancock Creek watershed is 2,942 persons, with a population density of 208.19 persons per square mile. Most housing in the watershed consists of single family units (55%). Mobile homes were the second most common housing type with 433 units (36%). The housing and a more suburban lifestyle is likely to become more commonplace in the watershed as the new housing developments slated for construction are established (Claritas, 2008).

2.3 Plan for Collecting More Data

The SCC continues to sample five sites within the watershed bimonthly during the recreation season. Beginning in the 2009 recreation season, they will add several additional sites including a site below the Yorktowne package sewage treatment plant. The SCC is working with the KDOW to conduct biological sampling on several stream segments in the watershed. In addition, members of the Licking River Water Watch (LRWW) sample two sites at three intervals during the recreation season. SCC will also consider methods for collecting data on streambank erosion, and the possibility of using this information for a public awareness campaign.

2.4 Summary and Conclusions

Problems of the Watershed
Healthy Streams and Healthy Areas of Your Watershed
Areas and Streams with Challenges

Hancock Creek and its tributaries are moderately to somewhat severely degraded due to poor instream habitat quality, lack of riparian vegetation, and periodically high bacteria levels. Causes of these conditions include:

- Rapid runoff from pastures with compacted soils and developed areas
- Stream bank instability caused by elevated flows and poor riparian vegetation

- Removal of riparian vegetation through mowing, clearing, or livestock grazing
- Livestock access to stream banks and the stream channel
- Overloaded or inconsistent performance from wastewater plants
- Stormwater runoff from commercial and industrial facilities
- Leaking or failed septic systems

Although the problems are widespread, they are generally moderate in scope and severity and can be addressed through conventional programs, such as riparian fencing, targeted stream bank stabilization, development of alternate livestock watering sources, and education programs for land and facility managers (e.g., stormwater permit managers for industrial/commercial facilities). Three of the wastewater treatment plants in the area – all except for East Kentucky Power – require at least some level of improvement or expansion. For example, the Rockwell Village treatment plant requires general lagoon, piping, chlorinator, and discharge structure improvements. Verna Hills would be improved by a stair-stepped wetland tertiary treatment system developed to handle final effluent polishing. Yorktowne may need expansion or a significant reduction in average daily flow loads.

There are some intact and relatively stable areas in the watershed, lying mostly in the upper tributary zones and the lower mainstem, where restoration of riparian vegetation is underway. These areas can be readily observed from aerial photographs and online map servers, and serve as reference reaches for restoration of riparian vegetation and stabilization of stream banks.

Areas and tributaries with challenges include the lower part of the mainstem of Hancock Creek and most of the tributary reaches in areas of heavily grazed pasture lands. In addition, stream reaches draining developed areas (e.g., Rockwell Village, Verna Hills, Yorktowne Estates, Cassell Creek Golf Course, and the industrial and commercial facilities on Rockwell Road) appear to be somewhat degraded and in need of stream bank stabilization.

Hancock Creek Watershed Plan
Chapter 3: Analysis of Impairments

The Kentucky Division of Water (KDOW) made a preliminary determination in early 2009 that two reaches of Hancock Creek are impaired, due to nonsupport of biological, habitat, and physicochemical parameters. This determination was made based on data collected by the KDOW Nonpoint Source Pollution and Total Maximum Daily Load programs in 2004, 2005, and 2006. In addition to the KDOW determination of nonsupport for certain reaches in the Hancock Creek watershed, there are several factors that indicate water quality is below average, and may be declining:

- Hancock Creek is a major tributary to Strodes Creek, which is listed as impaired for bacteria, nutrients, siltation, and organic enrichment linked to agriculture, construction, urban stormwater, habitat modification, highways/roads, and municipal point sources – all of which exist in the Hancock drainage area.

- Water quality data collected by KDOW, the Strodes Creek Conservancy, Licking River Watershed Watch, Northern Kentucky University, and others generally indicate lower water quality during wet weather periods, possibly linked to polluted runoff and some erosion of sections of the stream channel and smaller tributaries in heavily grazed pastures. Bacteria concentrations during high stream flows often exceed water quality criteria limits.

- Visible stream bank conditions – mostly in the tributaries – indicate channel instability, such as newly exposed roots in areas of fresh bank scouring and lack of vegetation along channel banks.

- Instream water samples collected downstream from some wastewater treatment plant discharge locations show elevated concentrations of bacteria on occasion, possibly indicating inconsistent treatment plant performance which could be linked to a number of issues (e.g., treatment plant overloading during surge periods, poor functioning of the chlorinator, etc.).

- Residential and other construction in the watershed occurring, apparently without appropriate or adequate construction phase and post-construction stormwater controls.

Hancock Creek is included in the Stoner Creek watershed water quality model to be developed by EPA in 2010 (KDOW March 22, 2010). The model will support development of TMDLs for those parameters listed as contributing to nonsupport (impairments) on Hancock Creek. Pathogen TMDLs will be developed for the Hancock Creek watershed by KDOW as a portion of the larger Stoner Creek pathogen TMDL document slated for public notice in 2010.

This section briefly reviews water quality and other data collected previously by the organizations listed above. No new data were collected for this analysis; however, aerial photography and windshield visual surveys were conducted during 2008 to observe channel conditions, construction projects, facilities subject to KPDES stormwater and wastewater discharge permit requirements, and general land management practices.

A. Analytical Methods

The analysis conducted for this section is based on a variety of water quality data collected by trained volunteers and professional staff from KDOW. The analysis consisted of collecting and organizing the data, displaying it via parameter-specific graphs which plot pollutant concentrations against time, and comparing it to rainfall amounts (where possible) and numeric water quality, if criteria exist for the parameter.

In addition, a modeling exercise was conducted using the US EPA *Spreadsheet Tool for Estimating Pollutant Loads* (STEPL), which was developed to provide general estimates of nutrients and sediments in watersheds without overly complex issues (e.g., contaminated sediments, large and numerous wastewater dischargers, legacy hotspots, etc.). The information used in the STEPL analysis was derived from the US Census of Agriculture, published by the US Department of Agriculture; the STEPL online data server; input from local agricultural contacts; and mapping data provided by the Kentucky Division of Water (Tetra Tech Inc., 2009 and USDA 2007). All charts and graphs of Hancock Creek data that appear in this chapter were created by Tetra Tech Inc. for this project unless otherwise indicated.

1. Comparison of Water Quality Data to Water Quality Standards

As noted above, portions of Hancock Creek are likely to be formally listed as impaired in the 2009 update to the KDOW Integrated Report to Congress on Water Quality. Data for nutrient and organic enrichment were collected for three stations in the Hancock Creek watershed by the KDOW in 2004. The Strodes Creek TMDL for these pollutants will not be developed until KDOW promulgates the nutrient and organic enrichment criteria. Pathogen data has been collected by the Strodes Creek Conservancy project and is currently being used by the KDOW to develop the pathogen TMDL. No date of completion is available. Because Hancock feeds into Strodes Creek, it will be the subject of TMDLs developed for impairments along Strodes Creek, which has been assessed by the KDOW from Hoods Creek to Green Creek. It was found to be nonsupporting overall, with nonsupport for fishing and partial support for aquatic life. Physical/chemical indications were supporting.

Specifically, Strodes Creek is listed as impaired between milepoints 2.7 and 19.3 downstream from Clark County in Bourbon County, a total segment length of 16.6 miles. Impaired uses include warm water aquatic habitat (partial support) and primary contact recreation (nonsupport). Pollutants linked to impairments include nutrients and related eutrophication, conditions linked to degradation of biological indicators, sediment and siltation, organic enrichment (possibly from sewage), and fecal coliform. Suspected sources of the impairments/pollutants include agriculture, habitat modification (other than hydromodification), highways, roads, bridges, new construction, municipal point sources, and urban stormwater.

As the data summarized below indicate, Hancock Creek is also degraded due to poor support for aquatic life, with physical and chemical parameters generally good during colder, drier weather but declining during the summer and after rain storms. Specific beneficial uses for Hancock Creek include primary contact recreation, secondary contact recreation, fish consumption, warm water aquatic habitat, and domestic water supply. Narrative water quality criteria include provisions that surface waters shall not be aesthetically or otherwise degraded by substances that:

- Settle to form objectionable deposits;

- Float as debris, scum, oil, or other matter to form a nuisance;
- Produce objectionable color, odor, taste, or turbidity;
- Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, or fish and other aquatic life;
- Produce undesirable aquatic life or result in the dominance of nuisance species; or
- Cause fish flesh tainting.

Numeric water quality criteria for Hancock Creek include the parameters listed in the following tables. Values for the parameters are included in the tables, along with some of the averaging periods and recurrence intervals that comprise these regulatory targets.

Table 3.1 Numeric Criteria: Warmwater Aquatic Habitat, Primary/Secondary Contact Recreation.

Parameter	Values
Dissolved Oxygen	5.0 mg/l Daily Average; 4.0 mg/l Instantaneous
pH	6.0 – 9.0 Standard Units
Temperature	89° F Instantaneous; 84° F 30-Day Summer Average (31.7° and 28.9° C, respectively)
Total Dissolved Solids	No adverse effects on indigenous aquatic community
Total Suspended Solids	No adverse effects on indigenous aquatic community
Settleable Solids	No adverse effects on indigenous aquatic community
Ammonia	< 0.05 mg/l after mixing
Fecal Coliform (Primary Contact Recreation)	200 CFU / 100 ml geometric mean for 5 samples over 30 days, 5/1 – 10/31. 20% of samples must not exceed 400 CFUs.
Escherichia Coli (Primary Contact Recreation)	130 CFU / 100 ml geometric mean for 5 samples over 30 days, 5/1 – 10/31. 20% of samples must not exceed 240 CFUs.
Fecal Coliform (Secondary Contact Recreation)	1000 CFU / 100 ml geometric mean for 5 samples over 30 days, year-round 20% of samples must not exceed 2000 CFUs.

Source: Kentucky Water Quality Standards, 2008.

Table 3.2 Numeric Criteria for Other Key Water Quality Parameters in Surface Waters.

Parameter	**CAS1 #**	**Acute Condition Limit**	**Chronic Condition Limit**
Aldrin	309002	3.0	
alpha-Endosulfan	959988	0.22	0.056
Arsenic	7440382	340	150
Beta-Endosulfan	33213659	0.22	0.056
Cadmium	7440439	e(1.0166 (ln Hard*)-3.924)	e(0.7409 (ln Hard*)- 4.719)
Chlordane	57749	2.4	0.0043
Chloride	16887006	1,200,000	600,000
Chloropyrifos	2921882	0.083	0.041
Chromium (III)	16065831	e(0.8190 (ln Hard*)+ 3.7256)	e(0.8190 (ln Hard*)+ 0.6848)
Chromium (VI)	18540299	16	11

Copper	7440508	e(0.9422 (ln Hard*)- 1.700)	e(0.8545 (ln Hard*)- 1.702)
Cyanide, Free	57125	22	5.2
Demeton	8065483		0.1
Dieldrin	60571	0.24	0.056
Endrin	72208	0.086	0.036
gamma-BHC (Lindane)	58899	0.95	
Guthion	86500		0.01
Heptachlor	76448	0.52	0.0038
Heptachlor epoxide	1024573	0.52	0.0038
Iron6	7439896	4,000	1,000
Lead	7439921	e(1.273 (ln Hard*)- 1.460)	e(1.273 (ln Hard*)- 4.705)
Malathion	121755		0.1
Mercury	7439976	1.7	0.91
Methoxychlor	72435		0.03
Mirex	2385855		0.001
Nickel	7440020	e(0.8460 (ln Hard*)+ 2.255)	e(0.8460 (ln Hard*)+ 0.0584)
Parathion	56382	0.065	0.013
Pentachlorophenol	87865	e(1.005 (pH)-4.869)	e(1.005 (pH)-5.134)
Phthalate esters	N/A		3
Polychlorinated Biphenyls (PCBs)	N/A		0.0014
Selenium	7782492	20	5.0
Silver	7440224	e(1.72 (ln Hard*)-6 .59)	
Hydrogen Sulfide, Undissociated	7783064		2.0
Toxaphene	8001352	0.73	0.0002
Zinc	7440666	e(0.8473 (ln Hard*)+ 0.884)	e(0.8473 (ln Hard*)+ 0.884)
4,4’-DDT	50293	1.1	0.001

Source: Kentucky Water Quality Standards, 2008.

1CAS = Chemical Abstracts Service.

3Metal concentrations shall be total recoverable metals to be measured in an unfiltered sample, unless it can be demonstrated to the satisfaction of the cabinet that a more appropriate analytical technique is available that provides a measurement of that portion of the metal present which causes toxicity to aquatic life.

6The chronic criterion for iron shall not exceed three and five tenths (3.5) mg/l if aquatic life has not been shown to be adversely affected.

**Hard = Hardness as mg/l CaCO3.*

Besides the legally enforceable numeric and narrative criteria, the Kentucky Division of Water has also collected data on some of the relatively undegraded, unimpaired streams in the Bluegrass Region. The table below lists these parameters.

Table 3.3 Mean Parameter Concentrations from Reference Reaches in the Bluegrass Bioregion.

pH	8.06 SU		Arsenic	0.002 mg/L
DO	9.06 mg/L		Barium	0.021 mg/L
Specific Conductance	457.6 µmhos		Cadmium	0.001 mg/L
Temperature	17.6 °C		Calcium	66.56 mg/L
Ammonia	0.044 mg/L		Chromium	0.001 mg/L
Nitrate+Nitrite	0.656 mg/L		Copper	0.001 mg/L
TKN	0.320 mg/L		Iron	0.535 mg/L
Total Phosphorus	0.132 mg/L		Lead	0.002 mg/L
Hardness	224.3 mg/L		Magnesium	13.19 mg/L
Alkalinity	194.8 mg/L		Manganese	0.115 mg/L

Acidity	4.71 mg/L		Mercury	0.00005 mg/L
TDS	290.2 mg/L		Nickel	0.016 mg/L
TSS	9.82 mg/L		Potassium	3.54 mg/L
Chloride	10.6 mg/L		Selenium	0.002 mg/L
Fluoride	0.227 mg/L		Silver	0.0046 mg/L
Sulfate	47.3 mg/L		Sodium	8.91 mg/L
TOC	3.04 mg/L		Zinc	0.023 mg/L
Aluminum	0.356 mg/L			

Note: Aluminum thru Zinc above based on only 8 samples/ parameter. Source: Kentucky Division of Water, 2008.

Data have been collected on Hancock Creek by several entities over the past ten years. The data reviewed in this section were provided by the Strodes Creek Conservancy, the Kentucky Division of Water, and the national STORET computerized database maintained by the U.S. Environmental Protection Agency. Data found on STORET were collected by personnel from Northern Kentucky University, according to STORET records.

Data collected by the KDOW Nonpoint Source and TMDL programs are graphed and summarized below, followed by other data collected by the Strodes Creek Conservancy and the Licking River Watershed Watch. Red lines on the graphs in the following section indicate numeric water quality criteria; it should be noted that not all parameters have such criteria established. Ammonia values indicated are for the un-ionized form. In general, the data indicate possible sewage treatment plant impacts on the creek, as well as polluted runoff effects following rain storms.

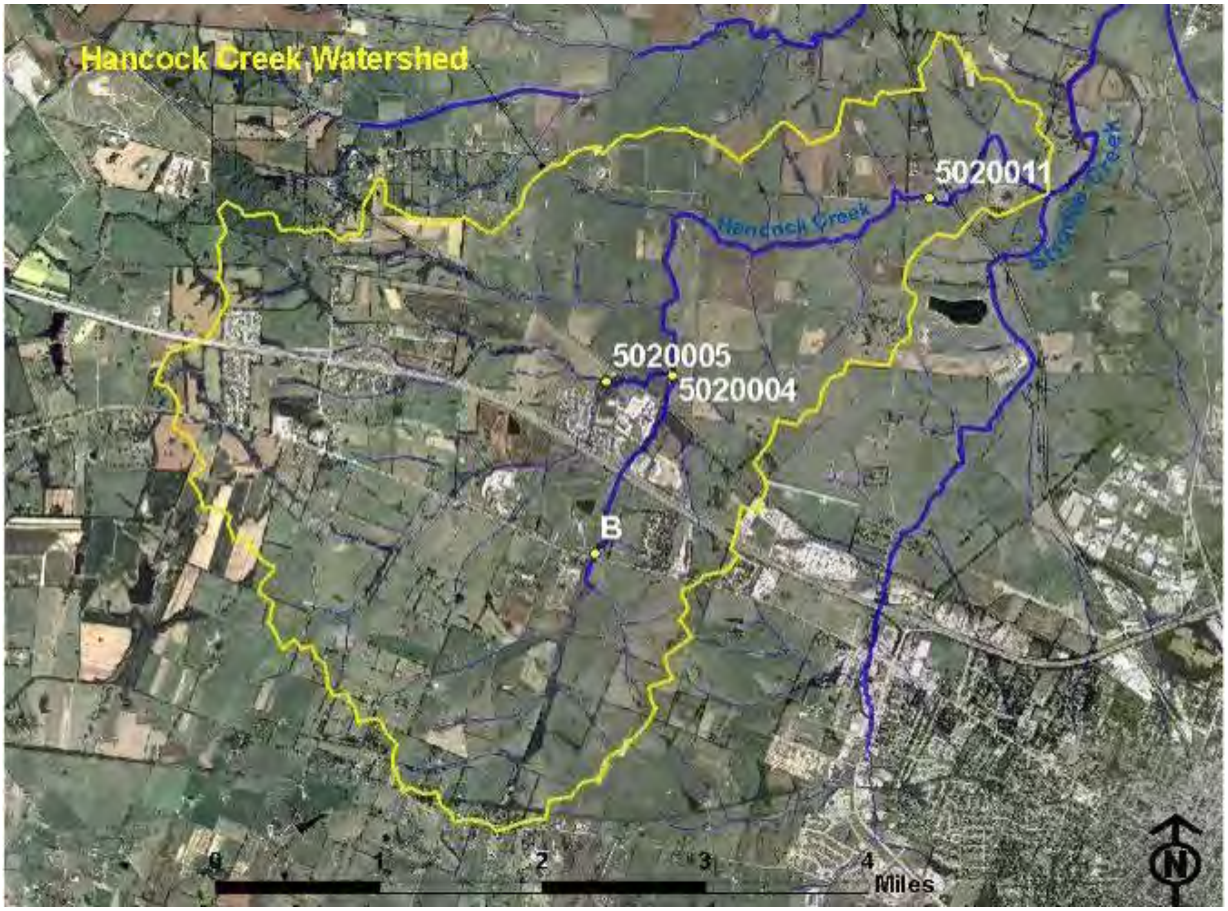


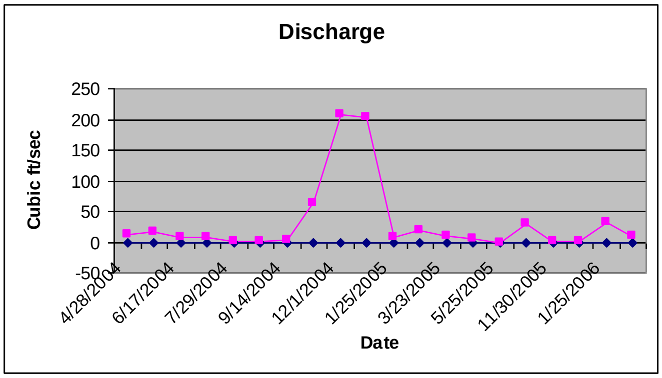
Figure 3.1: Location of Hancock Creek Monitoring Sites. Source: Tetra Tech, 2008.

Sampling Site 5020011

This is the farthest downstream sampling site, located between Van Meter Road and the confluence of Hancock Creek into Strodes Creek. In general most parameters are within water quality criteria limits during all sampling events, with the exception of ammonia. Ammonia concentrations exceeded the 0.05 mg/l criteria limit in August 2005 and were at the limit in December of 2005 and again in February 2006. Elevated ammonia readings could be linked to livestock waste in the Hancock Creek, which is accessible to livestock along most reaches; poor wastewater treatment at one of the three larger wastewater treatment plants which discharge to the creek; or to stormwater runoff from one of the industrial facilities just upstream from the sampling site. It is interesting to note that specific conductance was also elevated during the December 2005 sampling event – readings exceeded 700 mS, which is generally an indicator of human, animal, or other high-conductivity wastes. Sulfates and chlorides were also recorded at higher concentrations in December 2005, but nitrogen and phosphorus concentrations were lower. The high ammonia readings in February 2006 were not accompanied by high sulfate and chloride numbers.

Dissolved oxygen levels were recorded near 5 mg/l on August 31, 2005, which is at the criteria limit for daily averages. Other DO readings were well above the minimum. Temperature levels are elevated during the summer months and approach criteria levels, but have not exceeded them.

Hancock Creek Monitoring Site: DOW05020011



Figures 3.2 Discharge at Site DOW05020011

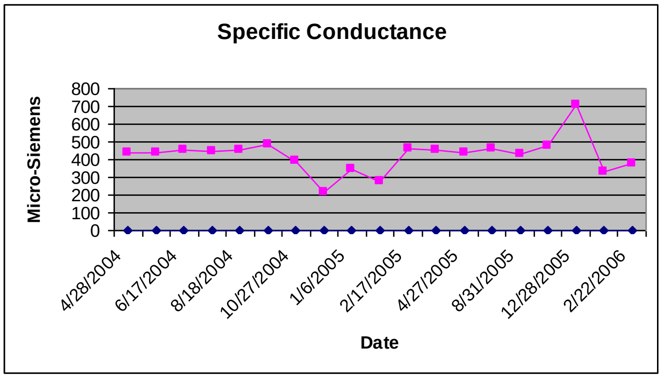


Figure 3.3 Specific Conductance at Site DOW05020011

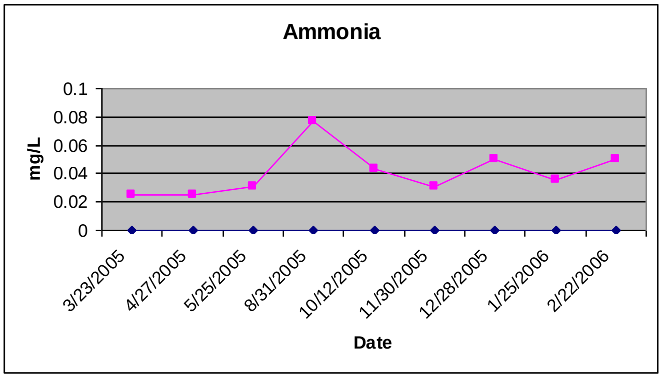


Figure 3.4 Ammonia at Site DOW05020011

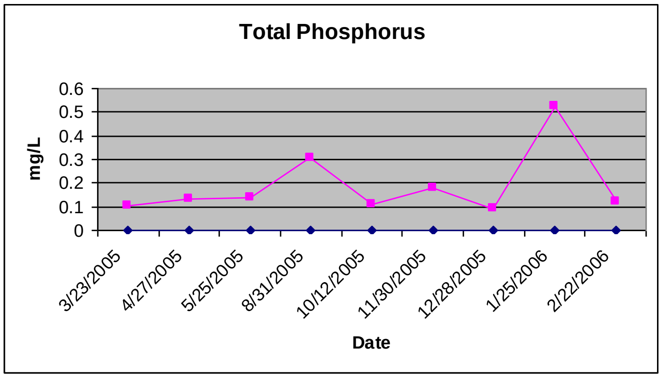


Figure 3.5 Total Phosphorus at Site DOW05020011

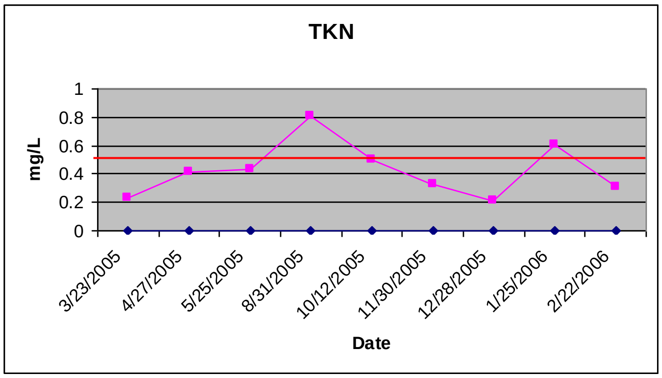


Figure 3.6 TKN at Site DOW05020011

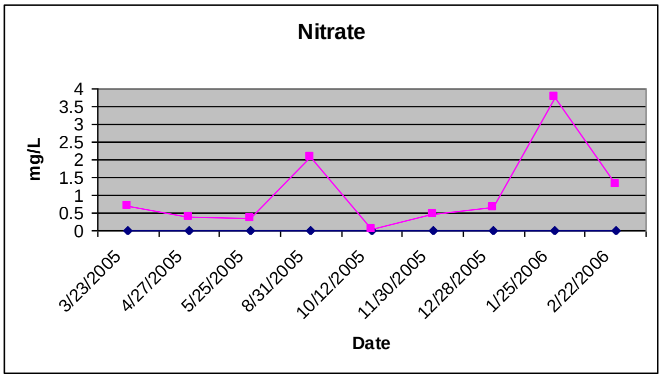


Figure 3.7 Nitrate at Site DOW05020011

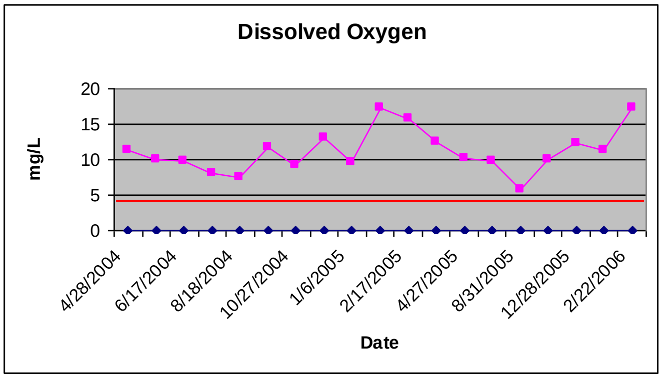


Figure 3.8 Dissolved Oxygen at Site DOW05020011

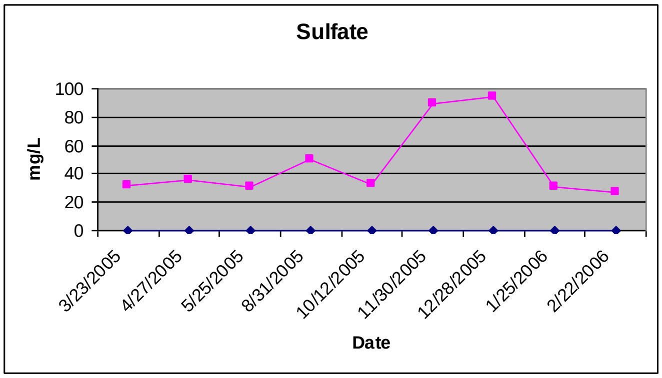


Figure 3.9 Sulfate at Site DOW05020011

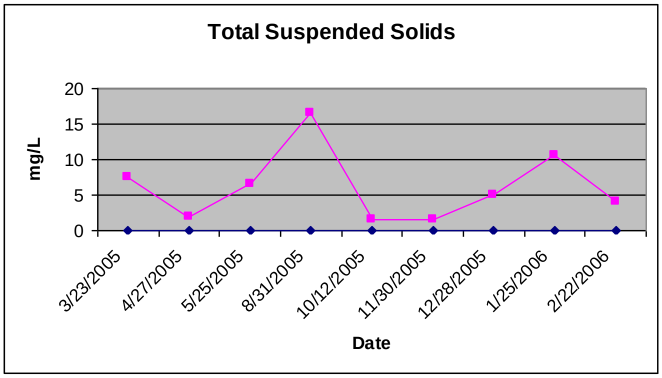


Figure 3.10 TSS at Site DOW05020011

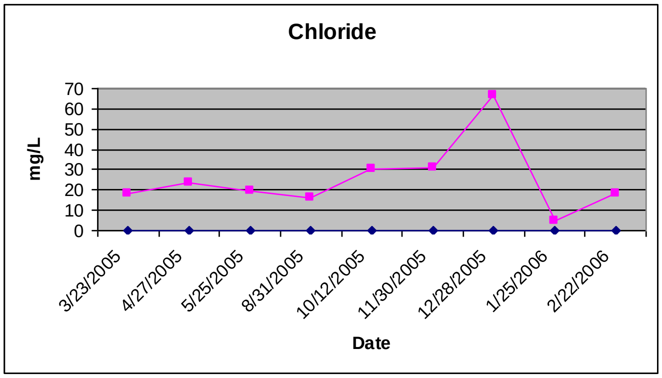


Figure 3.11 Chloride at Site DOW05020011

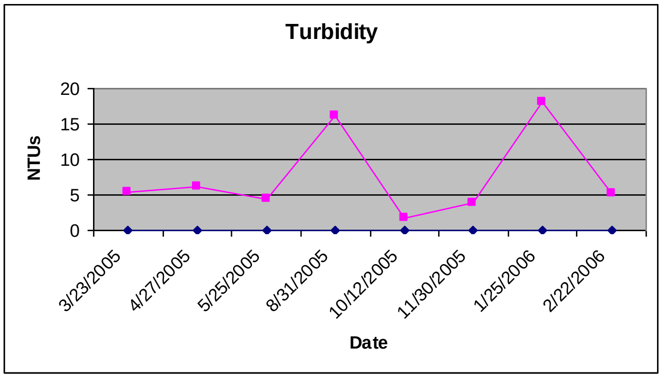


Figure 3.12 Turbidity at Site DOW05020011

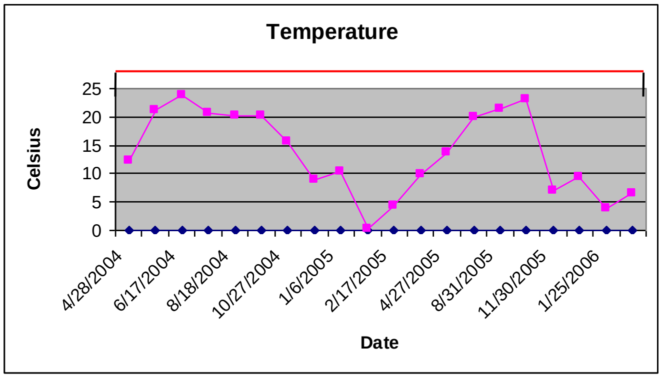


Figure 3.13 Temperature at Site DOW05020011

Sampling Site 5020005

This site captures impacts from the fork of Hancock Creek that receives wastewater effluent from the Yorktowne Mobile Home Park and Rockwell Village wastewater treatment plants, as well as other scattered residential and agricultural (mostly pasture) land. It should be noted that the Rockwell WWTP receives untreated wastewater from several industrial facilities in the area.

Dissolved oxygen levels for this site generally reflect seasonal variations, but were near criteria limits throughout the summer 2005 sampling season, and dipped to 4 mg/l in late November. Ammonia levels spiked to more than three times the criteria limits during the summer of 2005 as well, and are likely linked to the lower DO readings during the same period, and appear to hover near criteria limits at other times. Conductivity, phosphorus, nitrogen, chlorides, sulfate, and total suspended solids all show elevated concentrations during this period, indicating the type of continuous impacts often linked to poorly performing wastewater treatment plants. Total phosphorus concentrations for this site was logged consistently at near 0.2 mg/l during the spring of 2005 and the fall/winter of 2005/2006, but ranged upward between 1.0 and 1.5 mg/l during the summer of 2005.

This was a low-flow period as indicated by stream discharge data (i.e., approximately 6.5 cfs, a slight bump up from the less than 1 cfs flows earlier), further suggesting a wastewater treatment plant source for much of the higher pollutant concentrations. Of interest regarding this tributary of Hancock Creek is data collected by a volunteer from the Strodes Creek Conservancy and Licking River Watershed Watch during 2003. These data, which are graphed below, plot fecal coliform concentrations against 24-hour rainfall. In general, it shows that elevated bacteria counts are somewhat related to precipitation, which may indicate that bacteria is being washed off the surrounding pasture land by rainfall. However, there are some bacteria spikes that are clearly not linked to precipitation, which may indicate some discharge of bacteria-laden effluent from the Yorktowne treatment plant.

Hancock Creek Monitoring Site: Hancock Valley Drive at Bridge

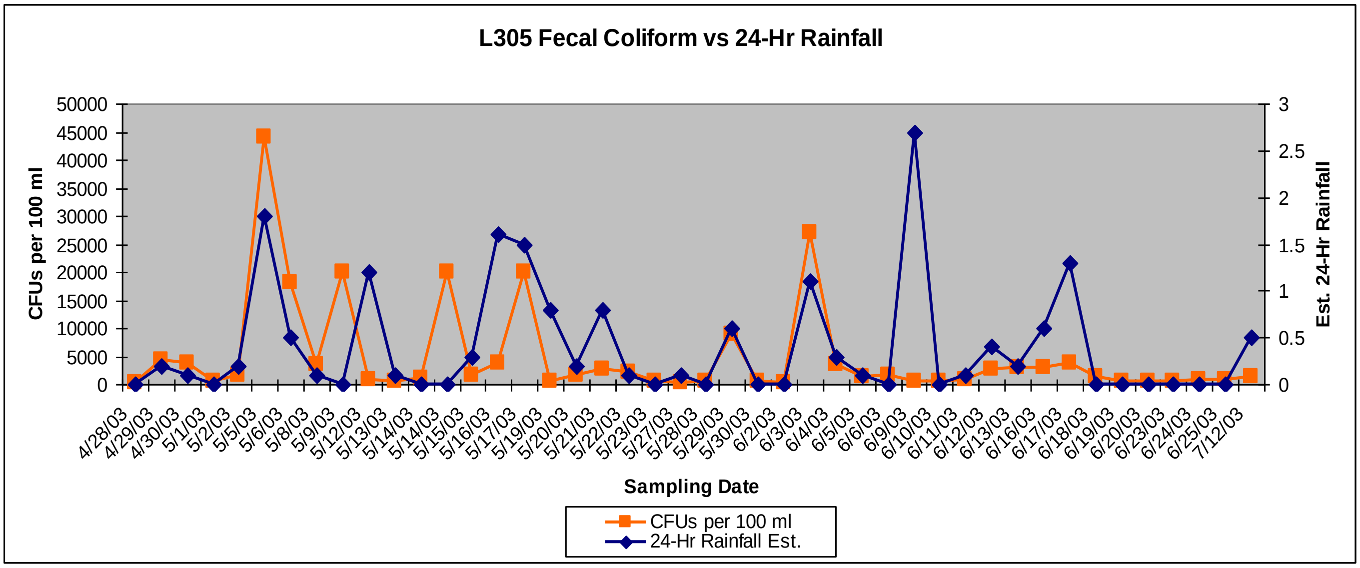


Figure 3.14: Fecal coliform data over time. Source: Tetra Tech, 2009.

CFUs = Colony Forming Unites

Hancock Creek Monitoring Site: DOW05020005

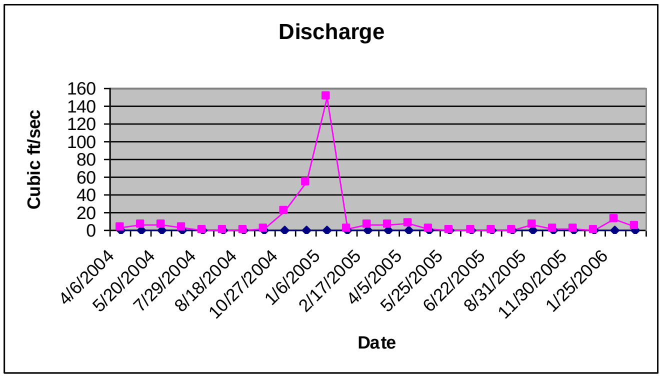


Figure 3.15 Discharge at Site DOW05020005

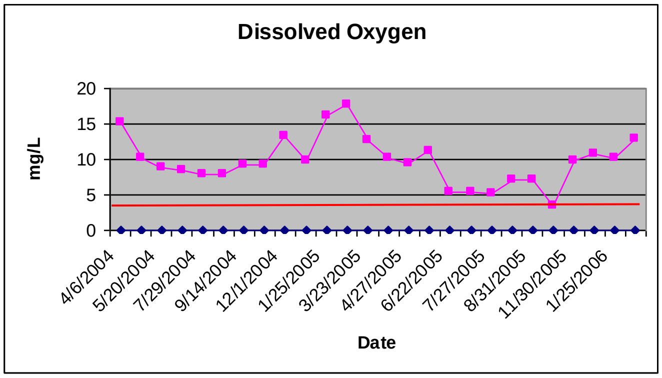


Figure 3.16 Dissolved Oxygen at Site DOW05020005

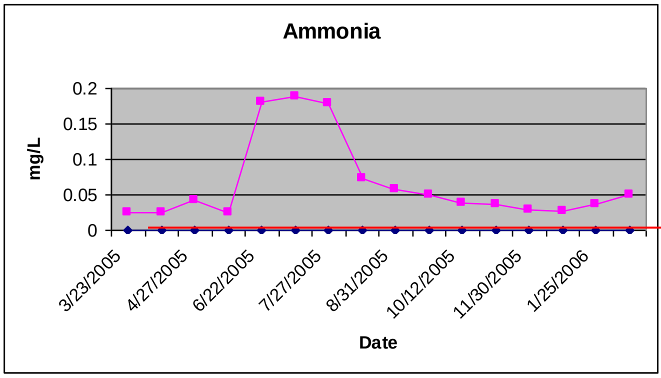


Figure 3.17 Ammonia at Site DOW05020005

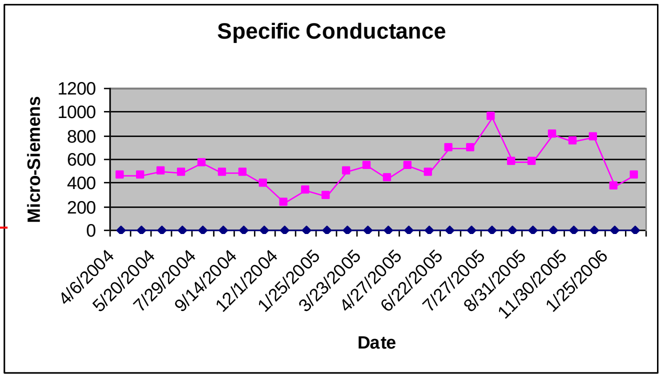


Figure 3.18 Specific Conductance at Site DOW05020005

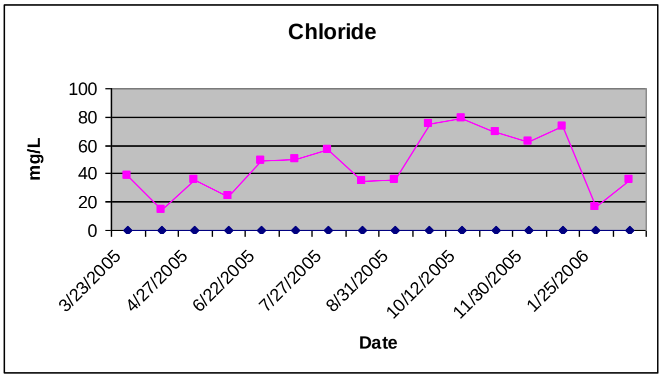


Figure 3.19 Chloride at Site DOW05020005

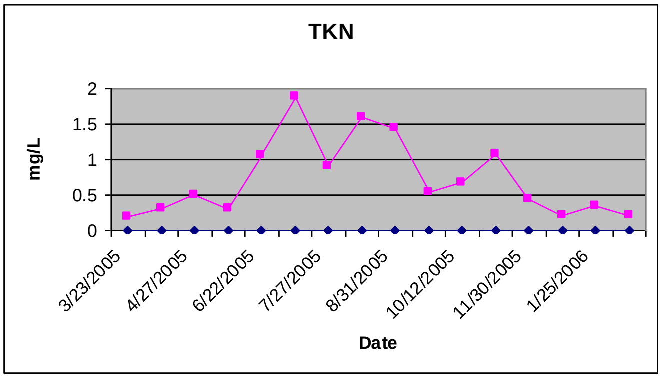


Figure 3.20 TKN at Site DOW05020005

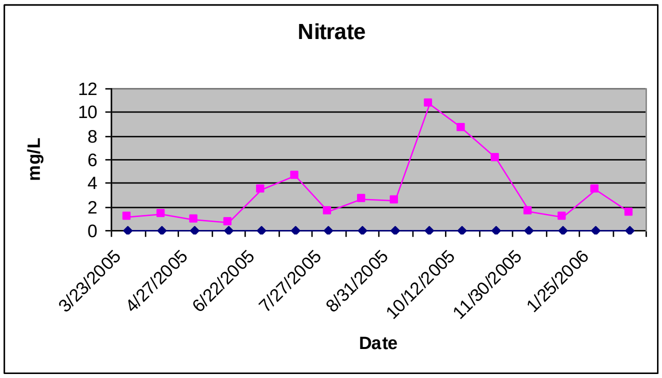


Figure 3.21 Nitrate at Site DOW05020005

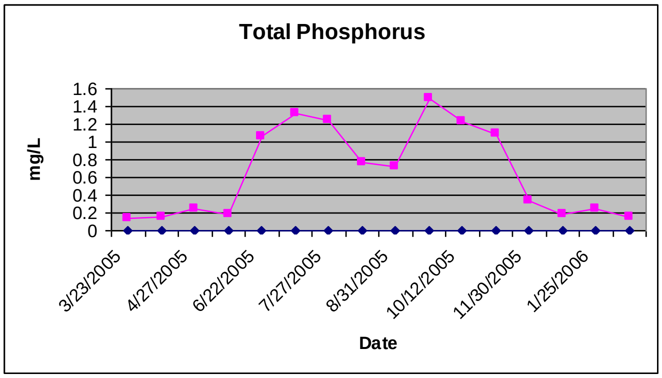


Figure 3.22 Total Phosphorus at Site DOW05020005

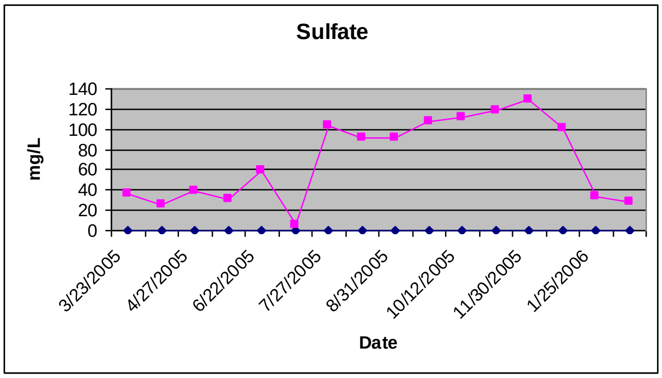


Figure 3.23 Sulfate at Site DOW05020005

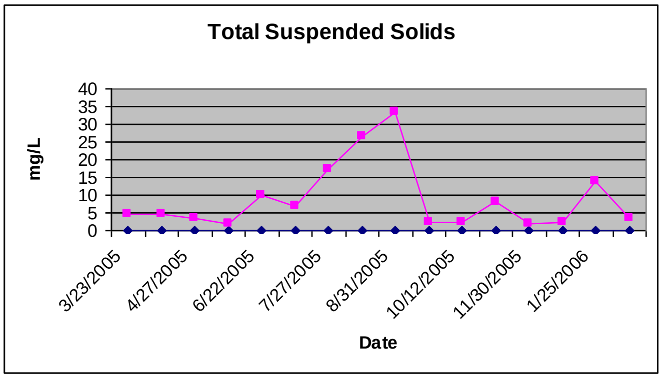


Figure 3.24 TSS at Site DOW05020005

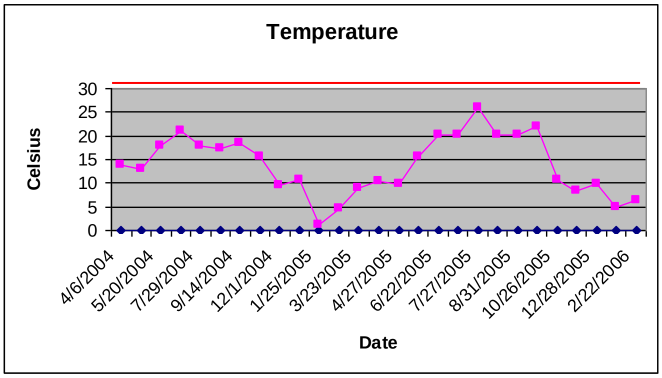


Figure 3.25 Temperature at Site DOW05020005

Sampling Site 5020004

This site captures a large portion of the upper watershed, including scattered residential development, a golf course, and extensive cattle pasture lands south of I-64. Dissolved oxygen levels reflect seasonal trends – lower in the warmer months (but not testing the criteria limits), and higher during the winter.

Results from the August 2005 sampling event show elevated concentrations for a number of parameter of concern, including ammonia (0.14 mg/l, or nearly three times the criteria limit), turbidity (70 NTUs), total suspended solids (80 mg/l), and phosphorus (0.6 mg/l). The August 2005 results correspond with higher stream discharge levels, which rose from less than one cubic ft per second to nearly 20 CFS recorded on August 31, 2005. It is likely that the higher readings for the parameters listed above were linked to polluted runoff caused by the summer rains that increased channel flow during late August. There is a small wastewater treatment plant upstream from this sampling location – Verna Hills – but it is approximately 4.5 miles away and averages only about 30,000 gallons per day (less than 0.05 cfs), making any pollutant contributions during storm event high stream flows highly diluted.

Hancock Creek Monitoring Site: DOW05020004

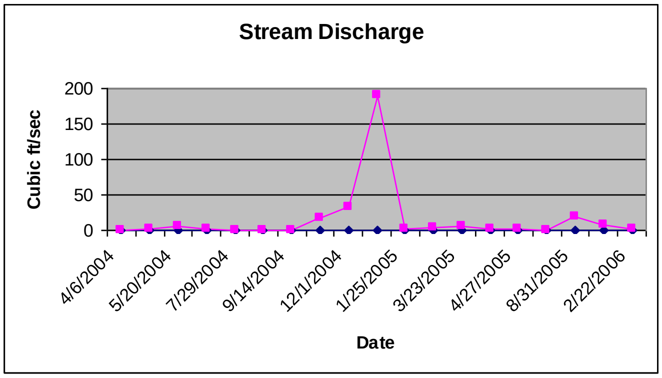


Figure 3.26 Stream Discharge at Site DOW05020004

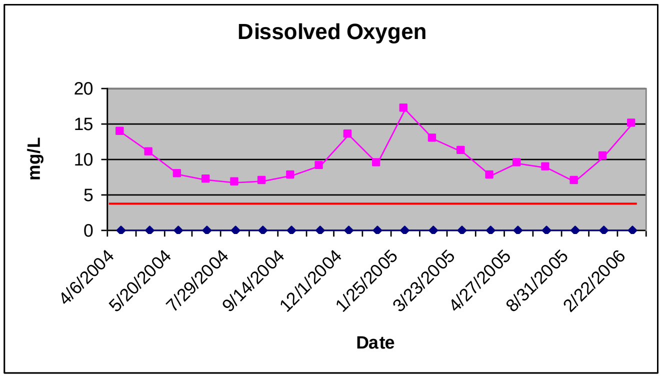


Figure 3.27 Dissolved Oxygen at Site DOW05020004

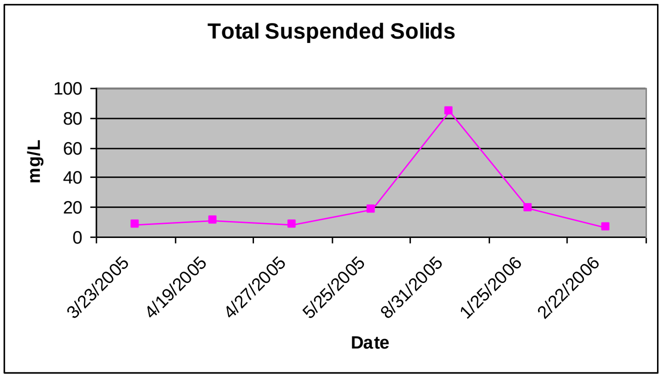


Figure 3.28 TSS at Site DOW05020004

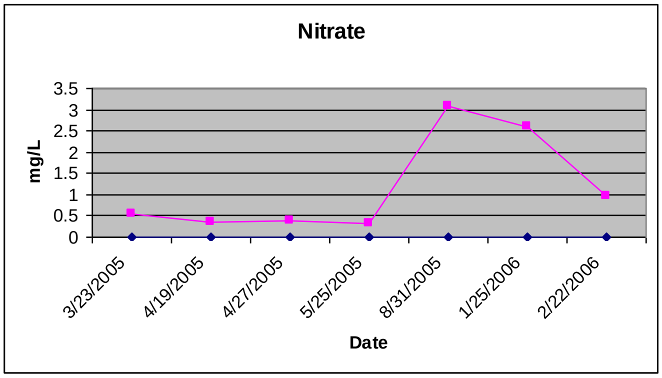


Figure 3.29 Nitrate at Site DOW05020004

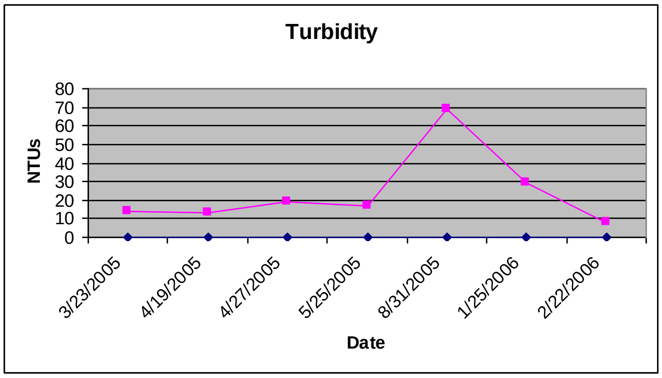


Figure 3.30 Turbidity at Site DOW05020004

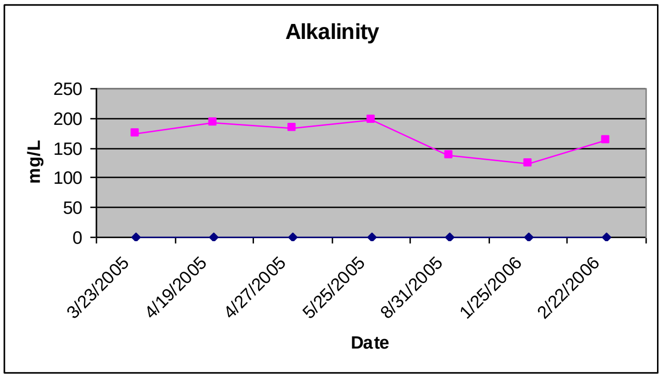


Figure 3.31 Alkalinity at Site DOW05020004

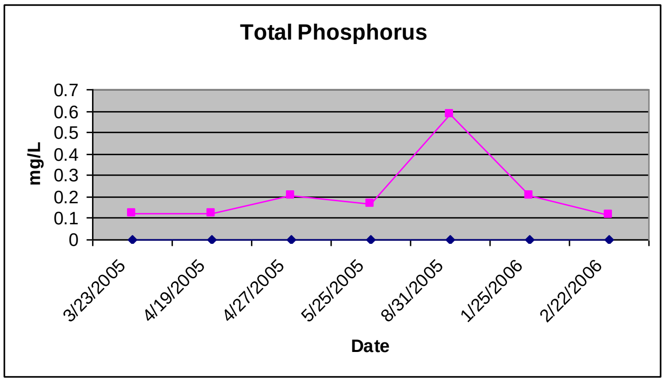


Figure 3.32 Total Phosphorus at Site DOW05020004

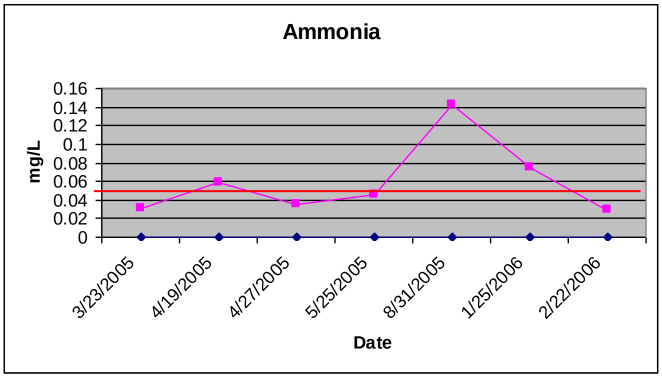


Figure 3.33 Ammonia at Site DOW05020004

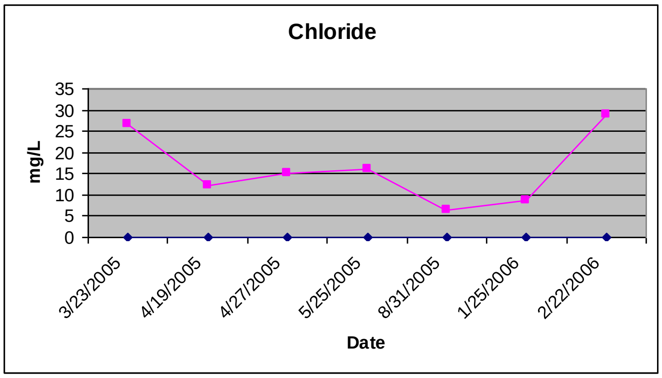


Figure 3.34 Chloride at Site DOW05020004

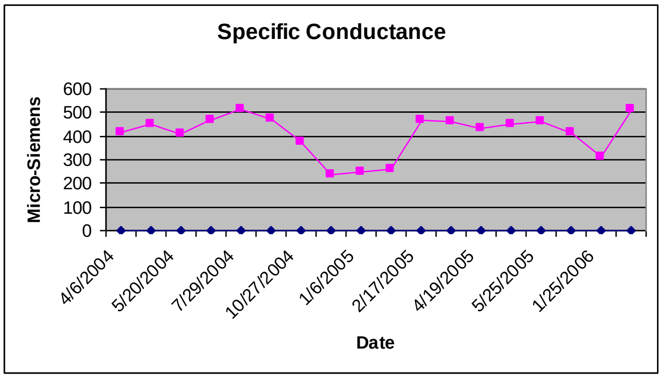


Figure 3.35 Specific Conductance at Site DOW05020004

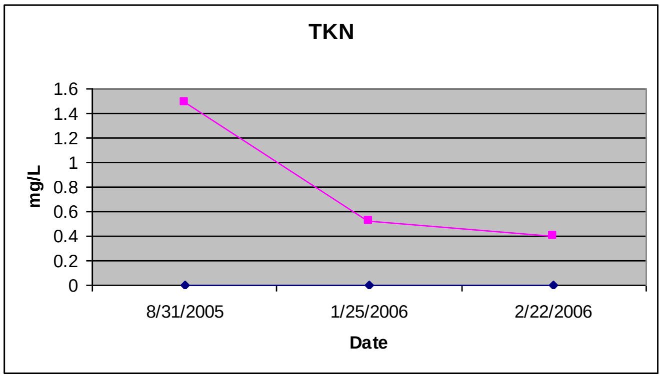


Figure 3.36 TKN at Site DOW05020004

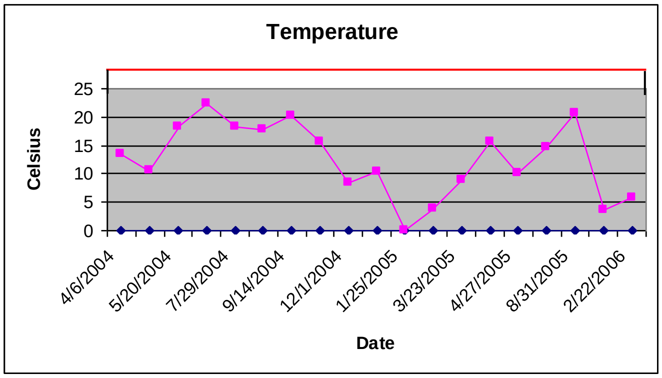


Figure 3.37 Temperature at Site DOW05020004

Other organizations have collected bacteria samples at stations in the Hancock Creek watershed, as noted in the previous section. Bacteria samples have been analyzed in the Hancock Creek watershed since at least 1999. The Licking River Watershed Watch group, which samples four sites in the Hancock Creek drainage area three times annually (near Memorial Day, July 4th, and Labor Day), reports bacteria counts ranging from 300 to more than 14,000 colony-forming units (cfus) per 100 milliliters of stream water sampled during 2001 to 2004. A review of these data indicate that the highest bacteria concentrations appear to be occurring during wet weather (i.e., the May sampling period), but elevated numbers during the drier sampling periods (July and September) might indicate bacteria loadings from either upstream wastewater treatment plants, livestock in the stream channels, or both. Warm weather steam sampling in the watershed has also found low dissolved oxygen (DO) concentrations – for example, during July of 2002 samplers logged a DO reading of 3.4 mg/l, which is below the WAH criterion of 4.0 mg/l. Low DO concentrations are likely caused by slow summertime flows and warm temperatures unmitigated by streamside tree canopy cover.

2. Stream Assessment

KDOW has assessed biota and supporting habitat parameters at the three monitoring stations identified in the previous section during 2004 and 2005. Aggregate scores for biota collected by the Division of Water during 2004 and 2005 were in the poor ranges, with Macroinvertebrate Biological Index (MBI) scores between 26 and 36 (note: scores below 38 are generally considered to be poor). The overall lack of instream habitat and stream bank vegetation probably contributes to the low MBI scores by 1) increasing exposure to sunlight during warm weather, causing higher stream temperatures, 2) limiting the amount and extent of instream habitat structure and refugia, and 3) increasing runoff and stream velocities during heavy storm "flushing" events. The presence of high percentages of fines (i.e., 35 to 50 percent of substrate) indicate upland and/or stream bank erosion and poor habitat conditions for macroinvertebrates. Also scoring in the poor range was bank stability and riparian vegetation.

Figure 3.38: Lower reach of Hancock Creek, showing revegetated section with livestock exclusion fencing (center) and denuded banks with livestock access (right). Note variations in pasture grass density, a factor in sediment loading from sloped grazing areas. Source: Tetra Tech, 2008.

Besides the KDOW data on habitat and riparian conditions, no data on stream geomorphology were found, but a visual assessment of several reaches conducted by Tetra Tech during 2008 found bedrock controlled stream segments with deposits of fine material of variable depths, and moderate-to-heavy bank erosion on Hancock Creek tributaries in pastures where livestock have unrestricted access to the stream. Erosion was also observed in areas with residential and/or commercial development. Channel widening is obvious in many of these areas, as higher flows resulting from greater runoff from compacted soils and/or impervious surfaces erode stream banks to increase channel cross-sectional area.

In general, banks along the mainstem of Hancock Creek appear to be better vegetated and more stable than the tributaries, with some exceptions (e.g., between Van Meter Road and the confluence with Strodes Creek). Fine sediment is also moving from heavily grazed pastures to the stream network – the following section indicates that pasture land is probably the largest contributor of sediment in the Hancock Creek drainage area.

As noted in the preceding section, two reaches of the Hancock Creek system are being proposed for listing as impaired due to nonsupport of biological, habitat, and physicochemical parameters. The MBI (Macroinvertebrate Biotic Index) ratings were reported as poor, while the habitat scores reflected nonsupport. In addition, the reported dissolved oxygen values were greater than 9 mg/L for more than 25% of the data, which KDOW uses as a surrogate measure indicating impairment due to nutrient enrichment (i.e., higher nutrients support more algae, which produce higher DO readings).

KDOW staff also noted that some of the specific conductivity values appeared to be high at all sites monitored (i.e., 300 to 600 microSiemens; certain insect orders begin to disappear above 300 to 400 mS). However, higher values are not unusual in the interior Bluegrass plateau (see preceding section) due to natural geologic conditions and heavy agricultural land uses.

3. Pollutant Load Prediction

An estimate of pollutant loads for the Hancock Creek watershed was produced through use of the *US EPA Spreadsheet Tool for Estimating Pollutant Loads* (STEPL), which was developed to provide general estimates of nutrients and sediments in watersheds without overly complex issues (e.g., contaminated sediments, large and numerous wastewater dischargers, legacy hotspots, etc.). The information used in the STEPL analysis was derived from the US Census of Agriculture, published by the US Department of Agriculture; the STEPL online data server; and mapping data provided by the Kentucky Division of Water. Additional information was provided by members of the Hancock Creek Watershed Planning Team.

STEPL input parameters and pollutant load estimates for Hancock Creek based on the STEPL model appear in the tables below. Some analysis of aerial photography to determine relative channel widening or data collected via walking surveys along some stream reaches would aid in more accurately reflecting the contributions from streambank erosion. For the purpose of the analysis below, streambank instability was estimated at a total of 4 miles throughout the watershed, which is a very conservative estimate. The total length of the main stem and larger tributary drainages exceeds 16 miles.

Table 3.4 Input parameters for the STEPL pollutant load estimate spreadsheet.

STEPL Input Parameter	Input Value	Notes
Number of Watersheds	1	Entire Hancock Creek watershed is treated as one drainage area
Urban Land (acres)	774	Includes all developed land – residential, commercial, industrial
Crop Land (acres)	509	Row crop land only
Pasture Land (acres)	6575	Pasture land only
Forest Land (acres)	355	Forest land only
Beef Cattle (# animals)	1500	Original estimate of 1725 lowered to 1500 based on local input
Chickens, Ducks, Turkeys, Hogs, Sheep (# animals)	0	Based on local input
Horses (# animals)	7	Based on local input
Annual Rainfall (inches)	45	Lexington airport – STEPL data server
Septic Systems (total #)	125	Estimated from aerial photos
Septic System Failure Rate (percent)	5	Estimated from local input
Streambank Erosion (total ft)	21120	Estimated from aerial photographs and visual windshield survey
Streambank Erosion (lateral recession ft/yr)	0.03	Used "slight" default setting, based on personal observation and clayey soil type
Streambank Erosion (height of eroded area, ft)	1.5	Based on personal observation – average throughout watershed; most occurring along tributaries to Hancock Creek
USLE Parameters	Default Values	From STEPL data server info for Clark County KY

Sources: Clark County GIS, Hancock Creek Watershed Team, Tetra Tech, 2009.

Table 3.5 STEPL model pollutant load estimates for Hancock Creek.

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	5994.25	922.70	23122.58	137.56
Cropland	10211.38	2532.38	20891.44	1579.98
Pastureland	55451.82	8335.71	163376.37	4210.51
Forest	135.59	61.52	311.69	17.05
Feedlots	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	194.30	76.10	793.40	0.00
Gully	0.00	0.00	0.00	0.00
Streambank	122.41	47.13	244.82	66.53
Groundwater	0.00	0.00	0.00	0.00
Total	72109.74	11975.54	208740.29	6011.63

Nitrogen, phosphorus, and sediment loads by land use. Source: Tetra Tech, 2009.

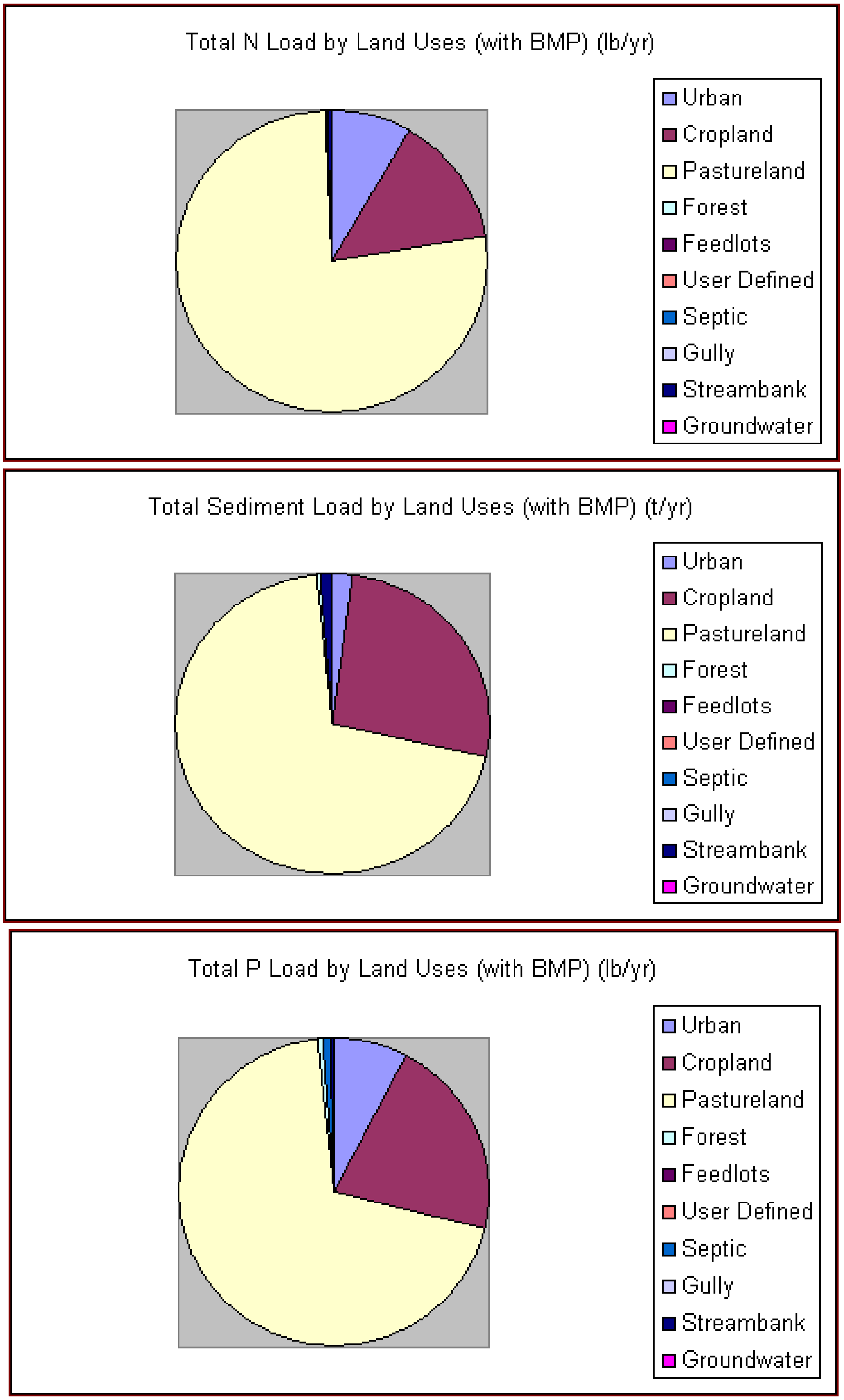


Figure 3.39 Pollutant Loads by Land use for Hancock Creek. Source: Tetra Tech, 2009.

Agricultural Sources

The STEPL analysis indicates that pasture land is the predominant source of nitrogen, phosphorus, and sediment in the Hancock Creek watershed, with row crop land representing a distant second place for all three parameters. This result is not surprising, since pasture represents approximately 80 percent of the land use in the watershed. In addition, aerial photographs of pasture land in the area shows a wide range of relative vegetation densities, due to variable cattle stocking rates (i.e., animals grazing per acre) and pasture management practices. The photograph below shows the Hancock Creek watershed, the main stem of the creek, and the major tributaries during the summer season. Heavy cattle use areas, plowed fields near drainageways, unvegetated riparian areas, and related conditions are evident.

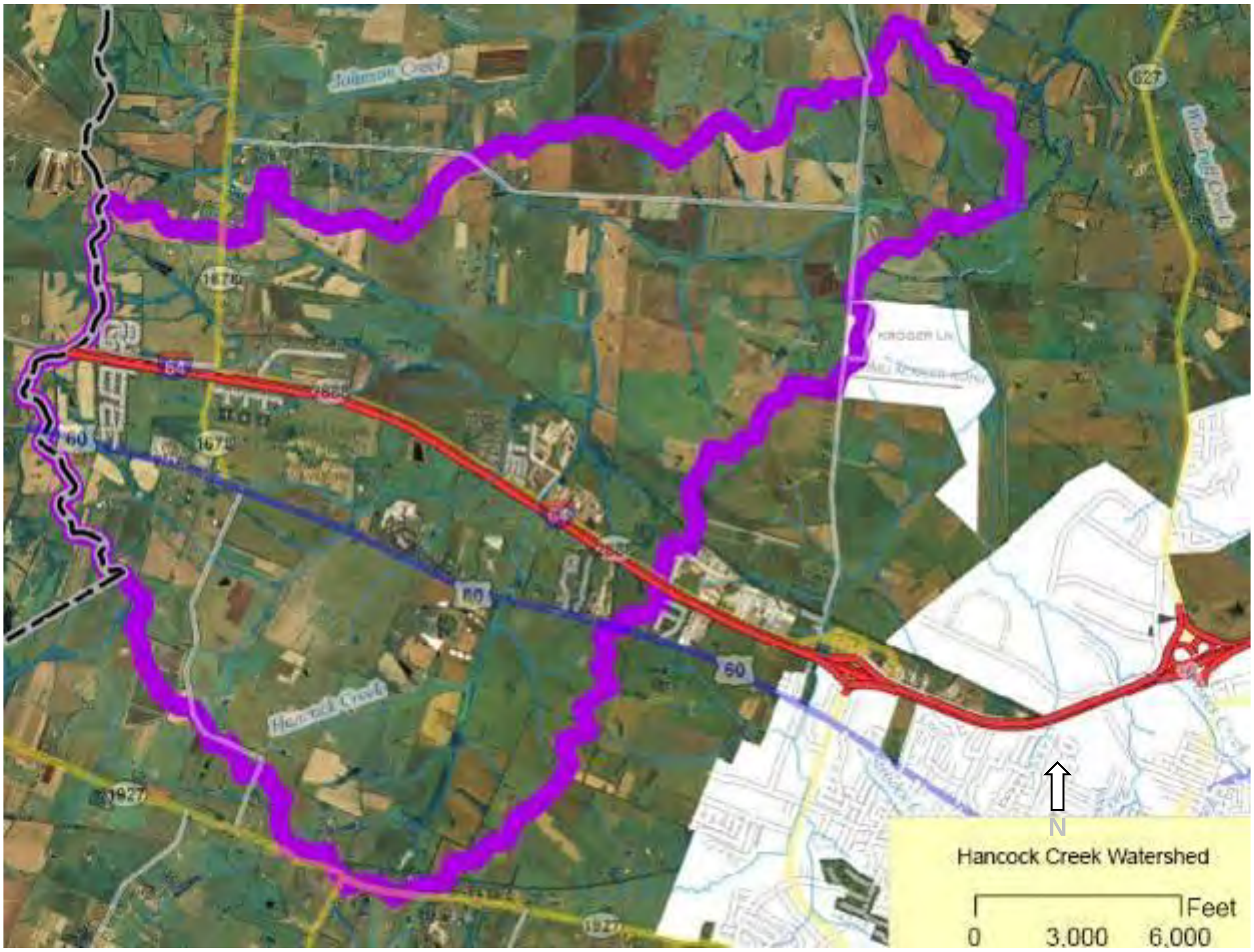


Figure 3.40: Hancock Creek watershed and land cover conditions. Source: Tetra Tech, 2009.

Sources from Wastewater Treatment Plants

The four small wastewater treatment plants that discharge into Hancock Creek and its tributaries might be significant sources of nitrogen, phosphorus, and bacteria during certain periods. However, the total average daily discharge for all four treatment plants is about 90,000 gallons per day, or far less than one cubic foot per second. Based on discharge monitoring reports reviewed for the 2006 – 2007 period (see Table 3.6), these treatment plants do not appear to be significant sources of low dissolved oxygen, bacteria, or total suspended solids. The three larger plants – Yorktowne, Verna Hills, and Rockwell – do appear to be moderate to significant sources of ammonia, especially during low-flow periods.

For example, all three plants regularly report effluent ammonia concentrations that far exceed the numeric water quality criteria of 0.05 mg/l (Yorktowne ammonia concentrations range from 1 to 2 mg/l, Verna Hills ranges from 1 to 3 mg/l and higher, and Rockwell ranges from 0.2 to 0.4 mg/l). With summer stream flows regularly approaching zero cfs during the dry season, and only averaging 16 cfs at the confluence with Strodes Creek, it appears that high ammonia concentrations in summer effluent discharges may not be adequately diluted by the lower stream flows. In fact, all three sampling sites show high ammonia spikes during the summer sampling period (KY Division of Water Discharge Monitoring Reports, January 2006 to December 2007).

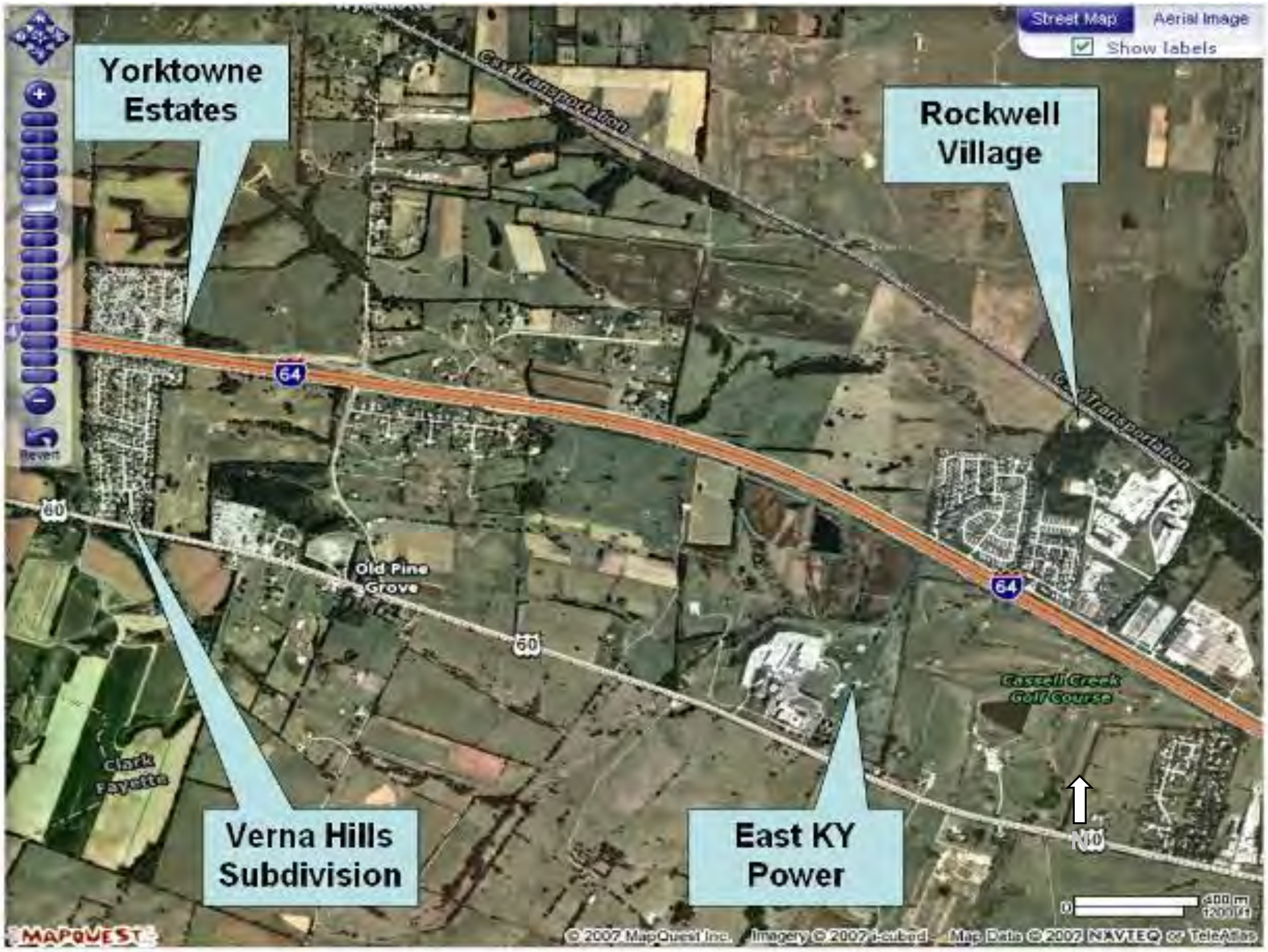


Figure 3.41: Locations of the wastewater treatment plants that discharge into Hancock Creek. Source: Tetra Tech, 2009.

Table 3.6: Wastewater Treatment Plant Data for 2006 – 2007: Hancock Creek KPDES Dischargers

EAST KY POWER 0036625 001 1

Parameter	Permit Limits	Jan-Mar 06	Apr-Jun 06	Jul-Sep 06	Oct-Dec 06	Jan-Mar 07	Apr-Jun 07	Jul-Sep 07	Oct-Dec 07
DO	7 MIN	9.4	7.9	7.3	8.4	7.1		9	7.6
PH	6-9 SU	7.45	7.5	5	7.67	8.35	7.03	7.85	8.76
TSS	30AV 45MX	5	4.2	22	8	6	3	18	13
AM-N	4-6	9.4	0.1	0.1	0.25	0.14	0.1	0.1	0.48
FLOW	REP G/D	0.002	0.003	0.003	0.002	0.003	0.028	0.001	0.003
FC	200AV 400MX	<1	<10	<10	20	<10	<10	<10	80
BOD	30AV 45MX	9	6	7	2	2	1	2	2

ROCKWELL VILLAGE 0076597 001 2

		1/06	2/06	3/06	4/06	5/06	6/06	7/06	8/06	9/06	10/06	11/06	12/06
DO	7 MIN	10.3	11.4	11.5	9	9	9	8.1	7.7	8.8	9	10.4	10.2
PH	6-9 SU	7.5	7.2	7.5	6.7	6.9	7.2	7.4	7.2	7.4	7.4	7.5	7.2
TSS	30AV 60MX	17	16	17	3	3	2	7	10	13	9	2	7
AM-N	9AV 18MX	0.2	0.2	0.84	0.2	0.2	0.2	0.44	0.32	0.42	0.22	0.22	< 0.10
FLOW	REP 30 DY AV	0.02	0.017	0.019	0.21	0.02	0.018	0.017	0.019	0.023	0.024	0.02	0.023
FC	200AV 400MX	< 10	< 10	10	<10	<10	< 10	< 10	<10	< 10	< 10	<10	< 10
BOD	10AV 20MX	5	9	7	2	2	6	8	1	< 1	3	< 1	1

Parameter	Permit Limits	1/07	2/07	3/07	4/07	5/07	6/07	7/07	8/07	9/07	10/07	11/07	12/07
DO	7 MIN	10.3	10.2	9.4	8.80	8.1	8	7.8	7.4	8	8.3	8.8	11
PH	6-9 SU	7.4	7.3	7.1	7.2	7	7.1	7.2	7	7.2	7.6	7.1	7.2
TSS	30AV 60MX	16	9	25	24	6	6	< 1	8	6	5	14	3
AM-N	9AV 18MX	< 0.1	0.4	0.22	0.28	0.47	0.45	0.33	0.1	0.34	0.2	<0.10	0.2
FLOW	REP 30 DY AV	0.027	0.027	0.025	0.026	0.022	0.023	0.027	0.024	0.024	0.024	0.0254	0.031
FC	200AV 400MX	10	< 10	< 10	10	20	< 10	< 10	< 10	<10	20	40	<10
BOD	10AV 20MX	2	6	2	< 1	3	2	3	2	2	<1	<1	4

VERNA HILLS 0042757 001 1

Parameter	**Permit Limits**												
		1/06	**2/06**	**3/06**	**4/06**	**5/06**	**6/06**	**7/06**	**8/06**	**9/06**	**10/06**	**11/06**	**12/06**
DO	7 MIN	7.8	7.9	7.9	7.8	7.7	7.8	7.2	7.1	7.5	7.6	7.8	7.8
PH	6-9 SU	6.391	6.87	7.08	7.11	7.6	7.3	7.3	7.3	7.3	7	7	6.9
TSS	30AV 60MX	6.5	4.7	10.8	2.63	12.2	6	5	6.2	7.3	8	8	7
AM-N	10AV 20MX	1	1	1	1.25	2.28	1.5	2.7	1.9	1.9	5.6	1.5	5
FLOW	REP 30 DY AV	0.03	0.025	0.02	0.025	No Rep	0.022	0.025	0.03	0.035	0.03	0.03	0.025
FC	200AV 400MX	1	1	1	1	1	1	1	1	2	14.9	1	1
BOD	15AV 30MX	3.3	2.67	2.5	3.25	2.6	6.3	2.8	3.2	4.5	6.75	2	3.5

Parameter	**Permit Limits**	**1/07**	**2/07**	**3/07**	**4/07**	**5/07**	**6/07**	**7/07**	**8/07**	**9/07**	**10/07**	**11/07**	**12/07**
DO	7 MIN	7.9	7.9	8	7.8	7.9	7.7	7.6	7.3	7.4	7.3	7.6	7.7
PH	6-9 SU	6.9	6.8	6.8	6.8	6.8	6.4	7.3	7.2	6.7	7.1	6.7	6.9
TSS	30AV 60MX	3	4.5	9.3	38.8	4.6	0.24	4	4.4	3.3	3	3	4.75
AM-N	9AV 18MX	2.8	1.1	1	1.1	3.5	4	3.6	3.82	3.2	1.5	1.13	1.23
FLOW	REP 30 DY AV	0.034	0.038	0.036	0.028	0.026	0.024	0.2	0.015	0.015	0.02	0.02	0.035
FC	200AV 400MX	1	1	1	1	1	1	1.3	1	1	1	1	14.4
BOD	10AV 20MX	4.2	2	2.3	4	2.2	5.5	3.75	5	2	2.6	5.5	4.25

YORKTOWNE 0023400 001 1

Parameter	**Permit Limits**												
		1/06	2/06	3/06	4/06	5/06	6/06	7/06	8/06	9/06	10/06	11/06	12/06
DO	7 MIN	7.8	7.8	7.9	7.87	7.7	7.8	7.4	7.7	7.9	7.8	7.9	8
PH	6-9 SU	7.02	6.88	7.05	7.18	7.1	7.2	7.1	7.1	7.1	7.2	7	7
TSS	30AV 60MX	11.8	4	9.5	10.5	12	4.3	7.8	8	5	8.5	8.2	3
AM-N	10AV 20MX	1	1	1	1	1.2	1	1.1	1	1	1.7	2	1.9
FLOW	REP 30 DY AV	0.04	0.04	0.03	0.039	0.038	0.034	0.035	0.033	0.034	0.034	0.039	0.039
FC	200AV 400MX	< 1	1	1	1	1	1	1	< 1	2.3	1.3	1	1
BOD	20AV 40MX	3.25	2	2.5	5	4.6	3.8	6.5	3.6	2	8.3	8.8	6

Parameter	**Permit Limits**	1/07	2/07	3/07	4/07	5/07	6/07	7/07	8/07	9/07	10/07	11/07	12/07
DO	7 MIN	8	8.1	7.9	8	7.8	7.8	7.9	7.6	7.7	7.7	7.6	7.8
PH	6-9 SU	6.9	6.8	6.8	6.8	6.7	6.5	7.6	7.6	6.7	6.6	6.9	6.5
TSS	30AV 60MX	5.5	3.3	9	9.5	24	9.8	9.8	4.4	3.5	7.6	11.5	5.3
AM-N	9AV 18MX	1.2	1.1	1.1	1.5	2.2	3.1	1	1.2	1	1	1.1	1.93
FLOW	REP 30 DY AV	0.045	0.04	0.039	0.038	0.039	0.039	0.039	0.038	0.033	0.033	0.035	0.04
FC	200AV 400MX	1	1	5.08	1	1	1	1	1	1	1	1	1
BOD	10AV 20MX	3	3	3.5	6.3	6	6.8	4.8	2.2	2.3	3.2	2.5	3

Source: Tetra Tech, 2009.

Notes: DO = dissolved oxygen; pH = power of hydrogen ion strength; TSS = total suspended solids; AM-N = ammonia nitrogen; FLOW = daily flow in millions of gallons per day; FC = fecal coliform colony forming units per 100 milliliters; BOD = carbonaceous oxygen demand over a 5-day period.

Bacteria Load Analysis

Bacteria is a pollutant parameter of concern due to potential human health impacts resulting from contact with – or ingestion of – bacteria laden surface waters. Kentucky water quality standards for bacteria have been based on concentrations of bacteria, analyzed as colony-forming-units (CFUs) of fecal coliform bacteria. The criterion limit for bacteria has been 200 CFU / 100 ml of raw stream water, calculated as a geometric mean for 5 samples over 30 days during the contact recreation period – May 1st through October 31st, with 20% of samples not exceeding 400 CFUs. However, Kentucky adopted an *Escherichia coliform* (*E. coli*) water quality criterion two years ago. The currently applicable criterion is 130 CFU / 100 ml, calculated as a geometric mean for 5 samples over 30 days, during the May 1st – October 31st period, with 20% of samples not exceeding 240 CFUs.

Bacteria data for the Hancock Creek load estimate were supplied by the Strodes Creek Conservancy, which collected fecal coliform samples from 2005 – early 2008 and *E. coli* samples from late 2008 through the end of 2009. No stream flow data were collected concurrent with bacteria sample collection (Strodes Creek Conservancy Sampling Data, 2005 to 2009). Data collected by the Licking River Watershed Watch (LRWW) organization were also reviewed, because it contained at least some indication of stream flow conditions at the time of sample collection; i.e., samplers noted the total amount of rainfall which had occurred during the 24 hour period prior to sample collection. The LRWW data were not used to determine bacteria loads, but were useful in confirming that a significant portion of the bacteria in Hancock Creek and its tributaries is linked to precipitation-induced runoff, such as manure from pastured cattle, rather than inputs from wastewater treatment plants or other direct sources (Licking River Watershed Watch Sampling Data, 2001 to 2004).

Bacteria loads were calculated using mean annual flow data from the Kentucky Geonet web site, expressed in cubic feet per second (cfs), and data collected from each of five sampling sites in the watershed (see Figure 3.42). *E. coli* data were used for the load analysis because:

- The data were collected during the most recent sampling period – late 2008 through 2009
- Kentucky water quality criteria for bacteria are now expressed as *E. coli*, rather than fecal coliform bacteria, making *E. coli* results essential for future analyses
- The 2009 sampling period represents a moderately wet year, with moderate rates of runoff, mitigated by the presence of high pasture vegetation growth, which intercepts and meditates runoff impacts, reflecting conditions common to central Kentucky

Sampling results for fecal coliform concentrations during 2005 – early 2008 are also presented below in tables and graphs for comparison purposes. Stream flow graphs derived from data collected by the Kentucky Division of Water TMDL section are included to provide some sense of stream flow variability. The data appear to indicate that instream bacteria concentrations are highest in the upper watershed, where large numbers of livestock are pastured, and decline farther downstream due to high volumes of stormwater runoff relatively devoid of obvious bacteria sources (e.g., parking lots, roads, golf course, industrial facilities, etc.).

Bacteria load information appears in Figures 3.43 to 3.53 and in Tables 3.7 and 3.8 on the following pages. Figures 3.43 to 3.45 address flow while Figures 3.46 to 3.49 address bacteria concentrations and rainfall specifically. Tables 3.7 illustrates flow, bacteria concentration, and load data. Also Table 3.8 compares the geometric means (and averages) of the fecal coliform vs. *E. coli* data for the various sampling sites.

The load information summarized below represents at best an estimate of actual daily and annual bacteria loads. Collection of stream flow data along with bacteria concentrations provides the best means of calculating loads, because flows and loads can be modeled to more accurately characterize the effects of storm events and pollutant runoff.

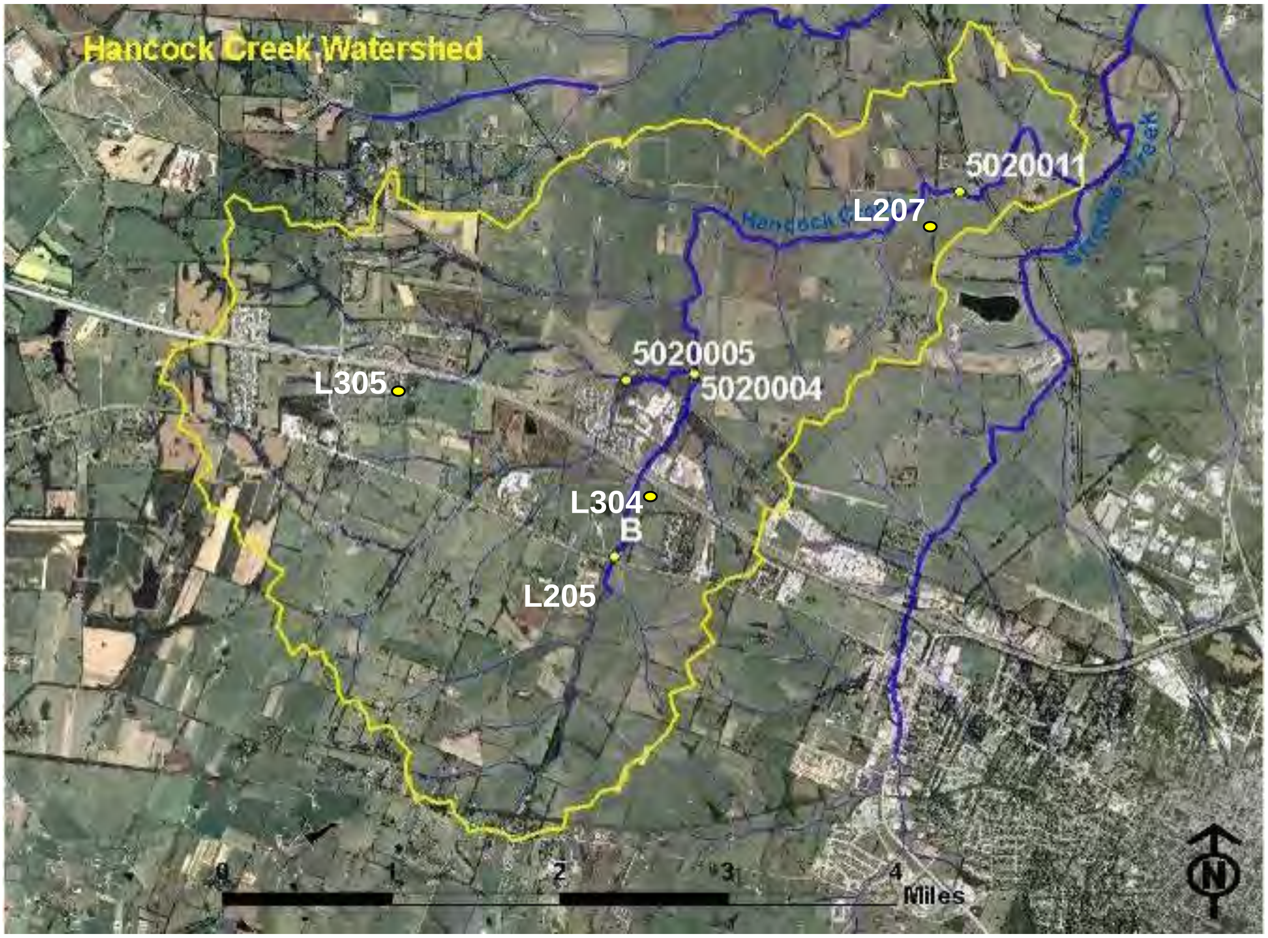


Figure 3.42: Location of Hancock Creek water quality monitoring sites. Source: Tetra Tech, 2008.

Finally, it should be noted that nearly all of the fecal coliform bacteria samples collected exceeded the previous state water quality criterion. In addition, all but three *E. coli* samples exceed the new Kentucky limit for *E. coli*. Although stream flow information was not collected with these samples, based on overall analyses conducted for the Hancock Creek Watershed Plan it appears that elevated concentrations of *E. coli* are linked to nonpoint source runoff from livestock operations and pasture areas, particularly those south of U.S. 60. Elevated bacteria results from sampling site 5020005 may also be linked to livestock: self-reported fecal coliform monitoring information derived from the Rockwell Village wastewater plant's discharge monitoring reports do not indicate problems with disinfection, though some periodic inconsistencies in plant operation might occur.

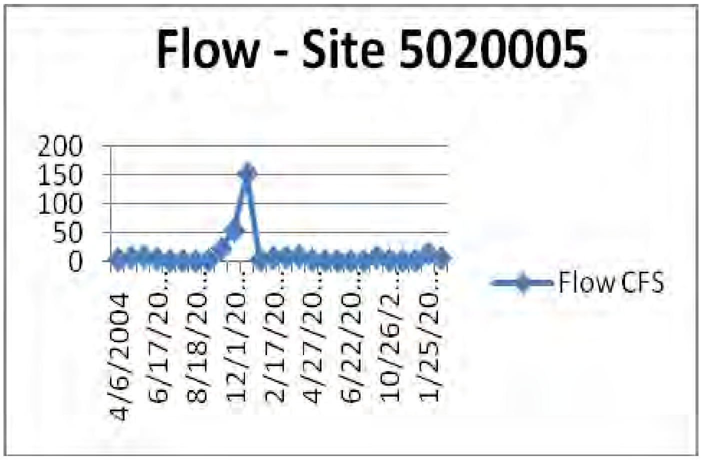


Figure 3.43 Stream flow (only) for primary Hancock Creek monitoring site 5020005. Source: Tetra Tech, 2009.

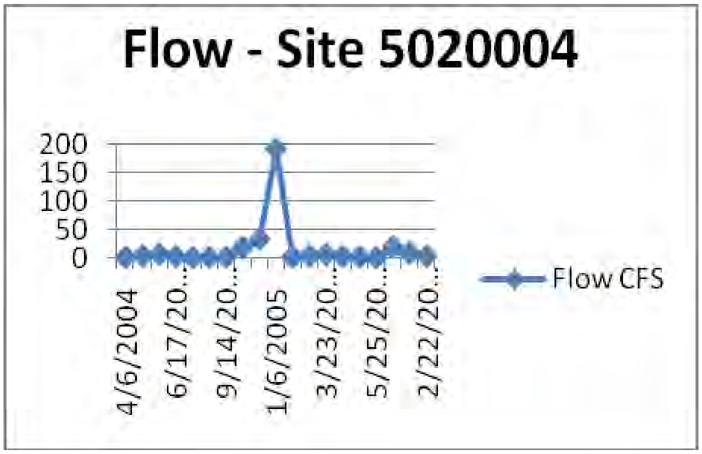


Figure 3.44 Stream flow (only) for primary Hancock Creek monitoring site 5020004. Source: Tetra Tech, 2009.

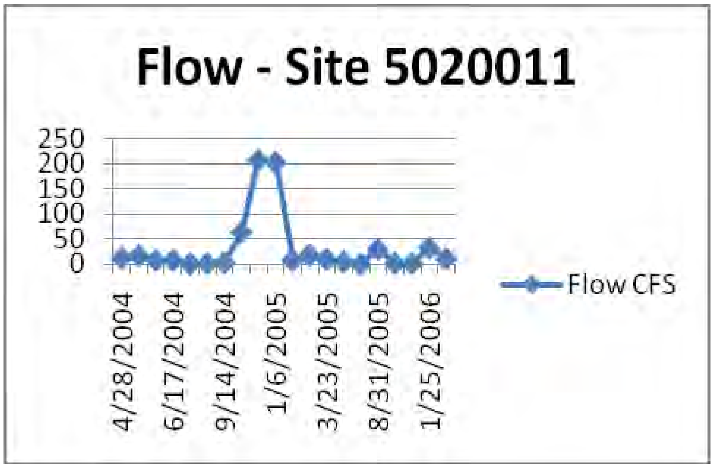


Figure 3.45 Stream flow (only) for primary Hancock Creek monitoring site 5020011. Source: Tetra Tech, 2009.

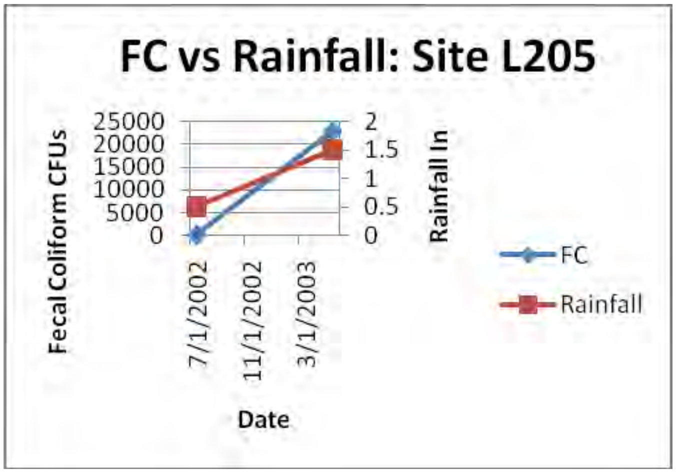


Figure 3.46 Fecal coliform vs 24-hour rainfall, Hancock Creek LRWW site L205.
Source: Tetra Tech, 2009.

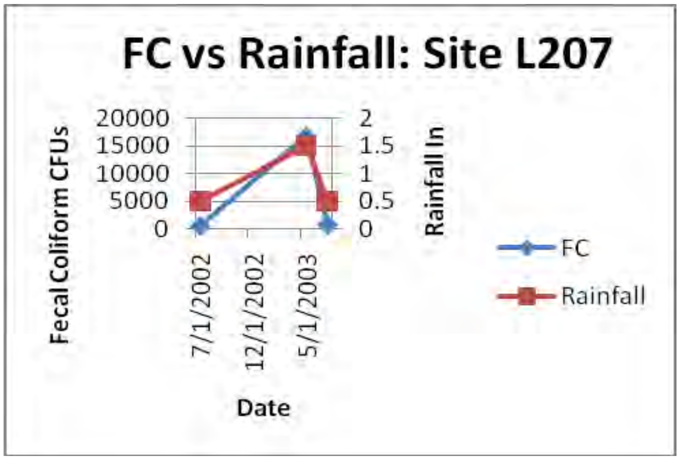


Figure 3.47 Fecal coliform vs 24-hour rainfall, Hancock Creek LRWW site L207.
Source: Tetra Tech, 2009.

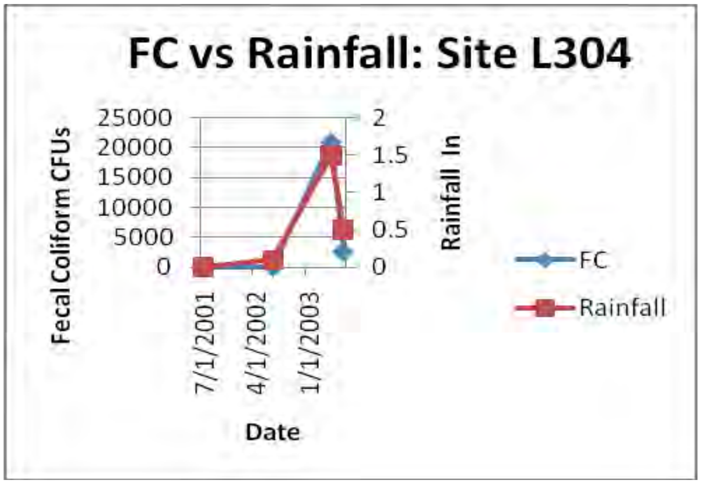


Figure 3.48 Fecal coliform vs 24-hour rainfall, Hancock Creek LRWW site L304.
Source: Tetra Tech, 2009.

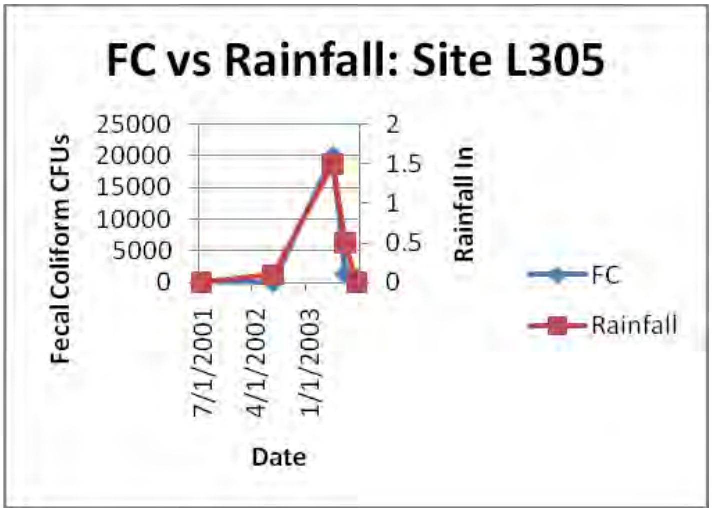


Figure 3.49 Fecal coliform vs 24-hour rainfall, Hancock Creek LRWW site L305. Source: Tetra Tech, 2009.

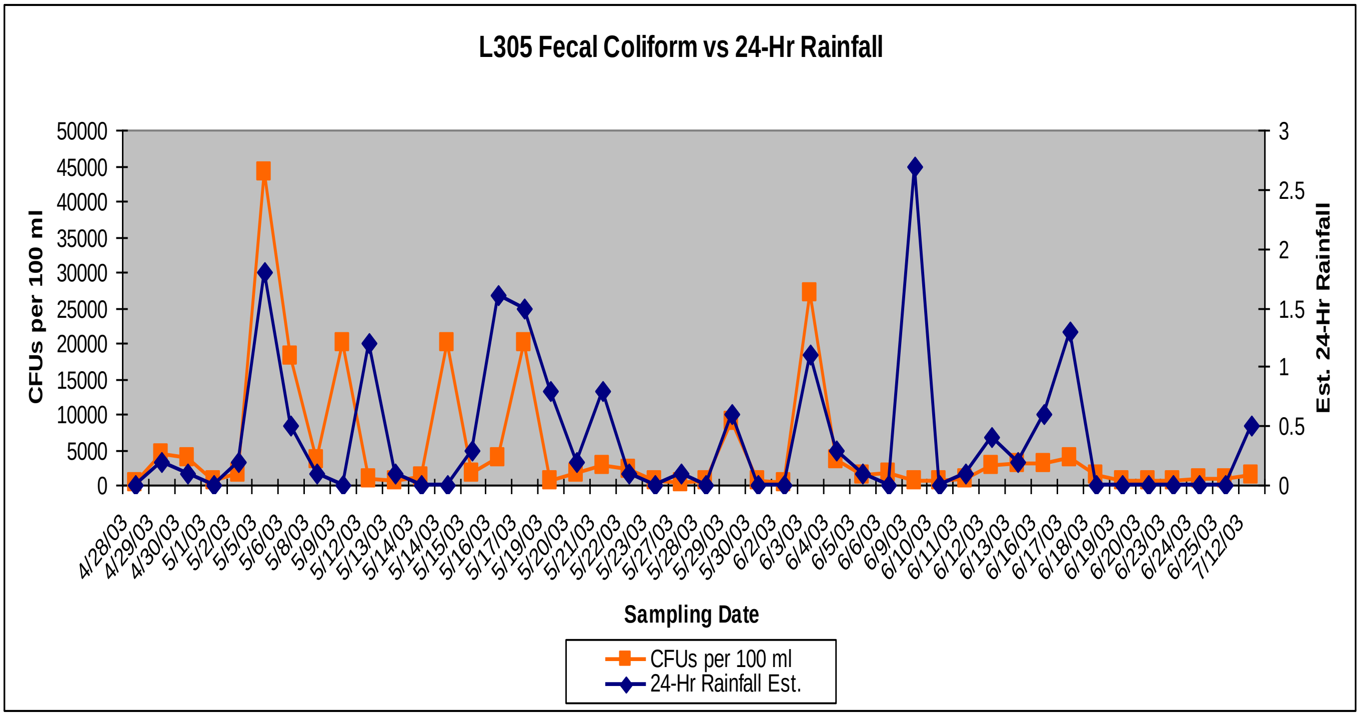


Figure 3.49. Fecal coliform vs rainfall at the Hancock Valley Drive at Bridge monitoring site. Source: Tetra Tech, 2009.
CFUs = Colony Forming Units

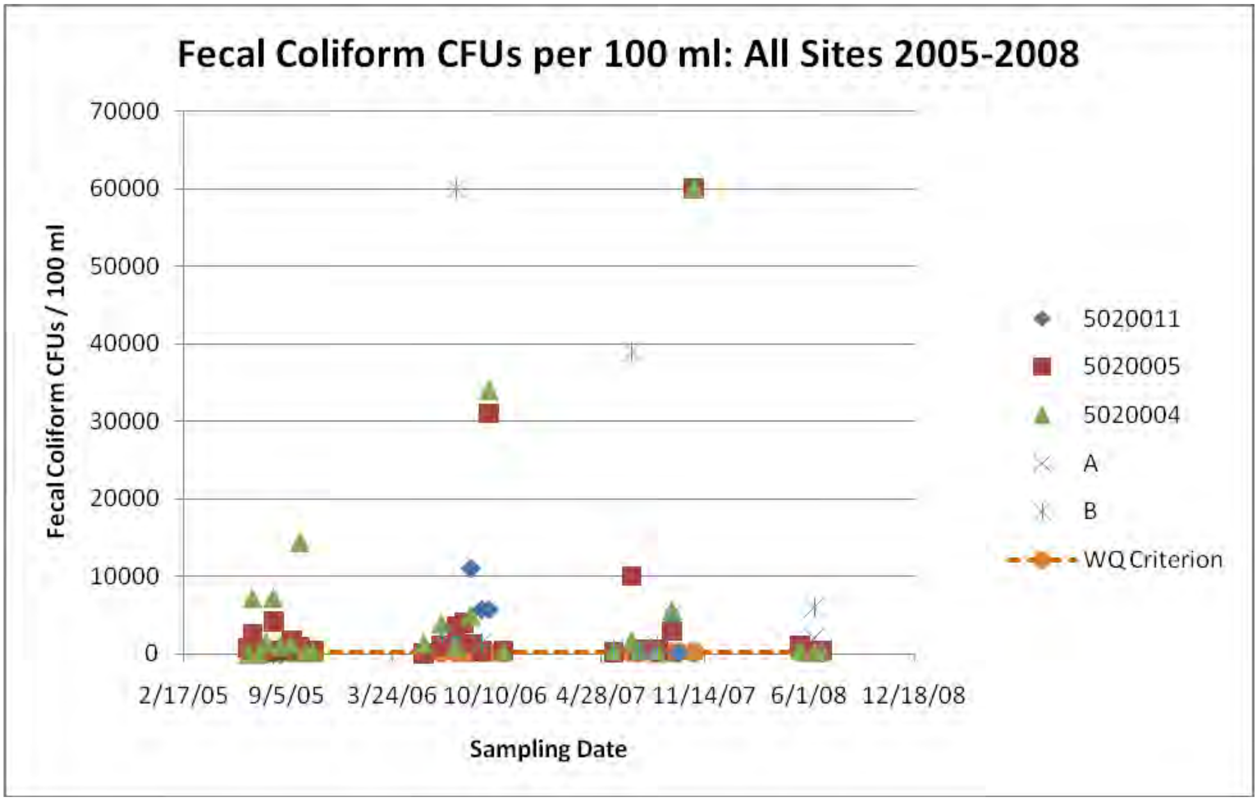


Figure 3.50: Fecal coliform data for Hancock Creek sites during 2005 – early 2008. Source: Tetra Tech, 2009.

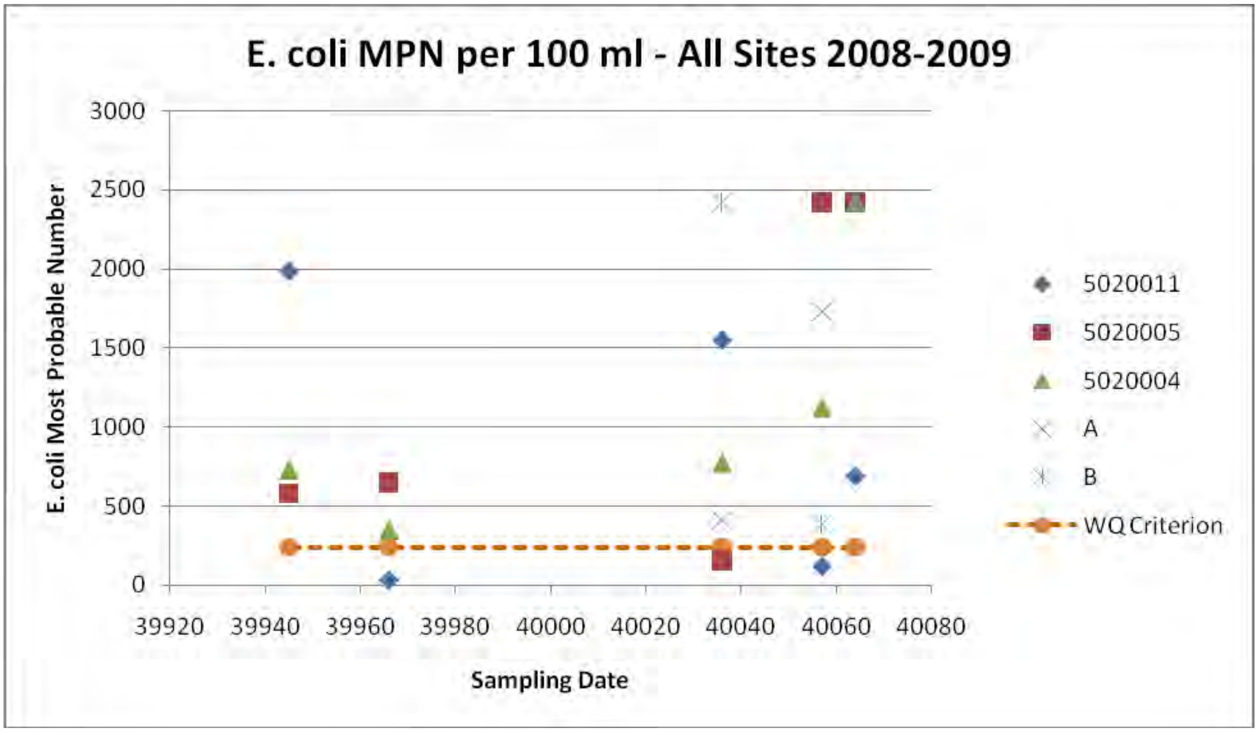


Figure 3.51: *E. coli* data for Hancock Creek sampling sites during late 2008 – 2009. Source: Tetra Tech, 2009.

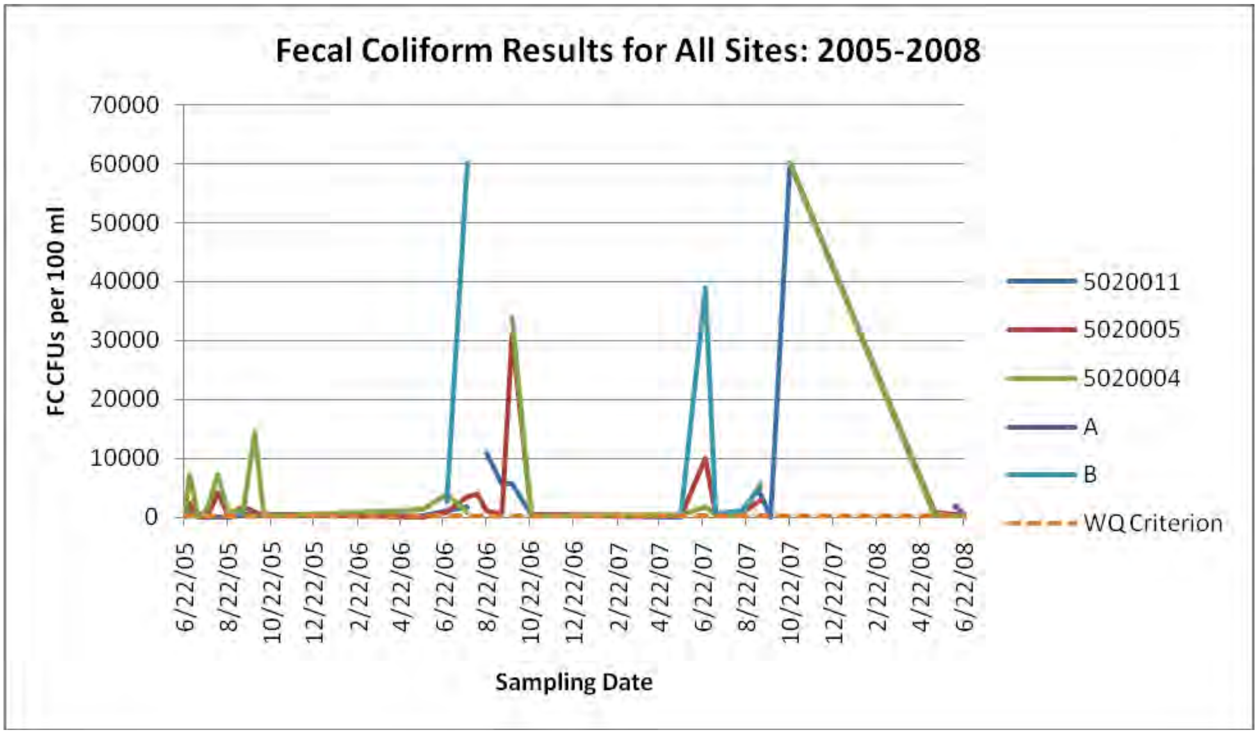


Figure 3.52: Time-series fecal coliform results for Hancock Creek sites during 2005 – 2008. Source: Tetra Tech, 2009. *Note: Data are incomplete for sites A and B.*

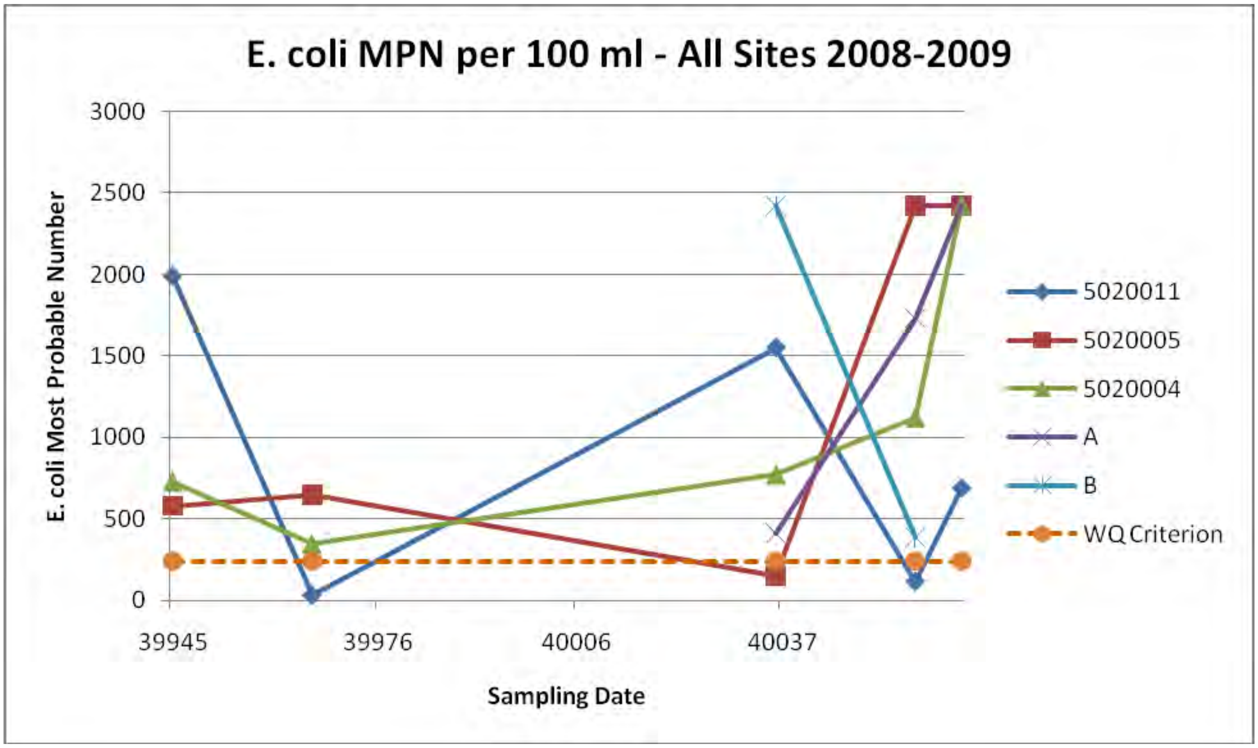


Figure 3.53: Time-series *E. coli* results for Hancock Creek sites during 2008 – 2009. Source: Tetra Tech, 2009.

Table 3.7: Current bacteria loads, load targets, and required reductions in the Hancock Creek Watershed. Source: Tetra Tech, 2009.

Mean Annual Flow (CFS)	Pollutant Parameter	Current Concentration (Geometric mean; CFUs/100 ml)	Current Average Daily Load (Billions)	Current Annual Load (Billions)	Target Concentration (Geometric mean; CFUs/100 ml)	Target Average Daily Load (Billions)	Target Annual Load (Billions)	Annual Load Reduction Required (Billions)	Load Reduction % Over Current
Behind Rockwell Village 05020005									
6.1	Fecal Coliform	804	119.990	43826.179	240.000	35.818	13082.442	30743.738	70.15%
Off Gawthorpe Drive 05020004									
3.4	Fecal Coliform	879	73.118	26706.410	240.000	19.964	7291.853	19414.558	72.70%
Off Van Meter Road 05020011									
15	Fecal Coliform	371	136.152	49729.363	240.000	88.076	32169.938	17559.425	35.31%
Mainstem on US 60 Site B									
2		968	47.366	17300.278	240.000	11.744	4289.325	13010.953	75.21%

Table 3.8: Comparison of fecal coliform and *E. coli* data for the Hancock Creek Watershed. Source: Tetra Tech, 2009.

Fecal coliform				***E. coli***	
Site	*Geomean*	*Average*		*Geomean*	*Average*
B	3582	12919		968	1404
A	1047	1274		1139	1488
5020011	215	3768		371	873
5020005	817	4780		804	1244
5020004	843	5920		879	1076

B. Sources and Locations of Waterway Impairments

1. Impairments to Water Quality

As noted above, two reaches of Hancock Creek are listed as impaired due to nonsupport of biological, habitat, and physicochemical parameters. This determination was made based on data collected by the KDOW Nonpoint Source Pollution and Total Maximum Daily Load programs in 2004, 2005, and 2006. In addition, conditions in Hancock Creek may be contributing to the impairment of Strodes Creek due to elevated levels of sediment, bacteria, and ammonia. This watershed plan presents a hybridized approach – it seeks to generally reduce pollutant inputs to Hancock Creek and ultimately to Strodes Creek, while protecting the segments of Hancock Creek and its tributaries from further degradation.

The strategy outlined in subsequent sections of this plan encompasses both objectives, restoration and protection. Below is a summary of the pollutants to be controlled, their sources, and their general locations throughout the watershed.

Table 3.9 Pollutants to be controlled with suspected sources and locations. Source: Tetra Tech, 2009.

Pollutants	**Source(s) of Pollutant**	**General Locations (see maps)**
Ammonia	Wastewater treatment plant discharges	Rockwell Village, Yorktowne, and Verna Hills WWTPs
Sediment	Overgrazed pasture land	Areas with pasture stocking rates that exceed capacity, based on vegetation, slopes, soils.
Sediment	Stream and tributary bank areas	Extreme lower portion of Hancock Creek, some mainstem segments, and tributaries
Sediment	New construction and development sites	Along US 60 and other scattered locations
Bacteria	Pastured livestock	Pasture areas near Hancock mainstem and tributaries
Phosphorus	Overgrazed pasture land and stream/tributary bank erosion; wastewater treatment plant discharges	Rockwell Village, Yorktowne, and Verna Hills WWTPs; pasture and drainageway areas shown on map

The map below shows the locations of these pollutant sources throughout the Hancock Creek watershed. Control strategies will be designed to restore and protect the creek.

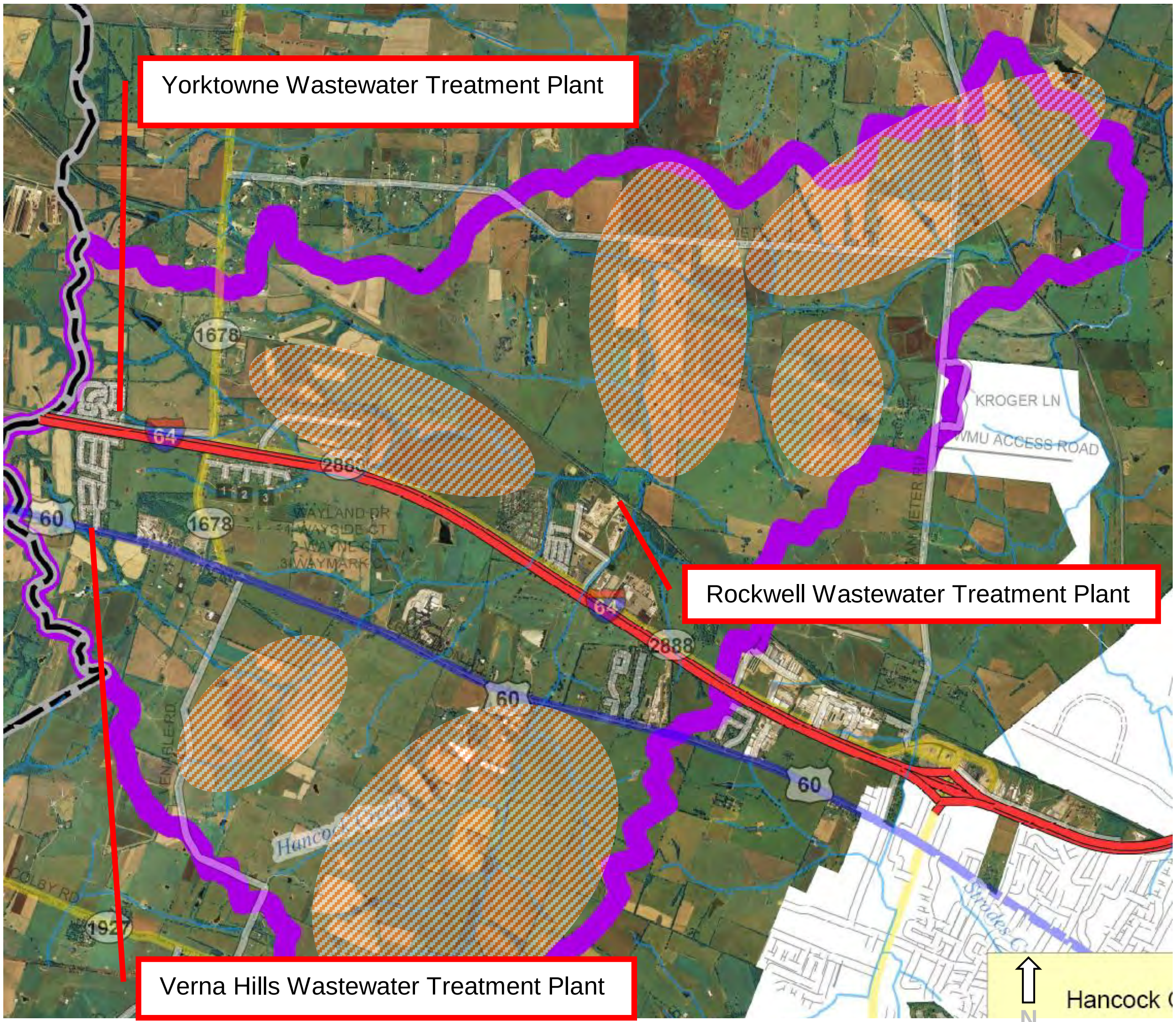


Figure 3.54: Hancock Creek watershed, showing locations of pollutant sources – wastewater treatment plants and pasture/riparian areas (shaded in red). Source: Tetra Tech, 2009.

2. Causes and Sources of Water Quality Impairment

As noted above, segments of Hancock Creek are listed as impaired for nonsupport for Warm Water Aquatic Habitat (WAH) due to pH, nutrients, biological indicators, and specific conductance) and nonsupport for Primary and Secondary Contact Recreation PCR SCR due to pH and bacteria. The preceding section and the map above provide specific information on the causes, sources, and locations of the conditions linked to lowered water quality.

The most significant cause of water quality degradation in the northwestern quadrant of the watershed is believed to be poor effluent quality discharged by the Yorktowne and Rockwell Village wastewater treatment plants. WMU has plans to extend a collection line to the Rockwell Village WWTP, which will transport all of the wastewater handled by Rockwell to the Winchester plant for treatment.

The other three sources of water quality degradation are all linked to sediment inputs to Hancock Creek and its tributaries: pasture land erosion, stream and tributary bank erosion, and new construction sites. Pasture land erosion and bank erosion have been documented to varying degrees and described in detail in this watershed plan. Sediment loss from new construction sites is not as extensive as pasture and bank erosion. It is highly localized, but is expected to become a more significant source of sediment in Hancock Creek as the pace of construction resumes in 2010 and 2011. Pasture land erosion is also somewhat localized, and is linked to stocking rates that exceed the capacity of the pasture vegetation to keep the soil in place. While no farm-by-farm analysis of pasture erosion has yet been conducted in the Hancock Creek watershed, aerial imagery provides some indication of the possible locations of overgrazed land. In the photograph below of a portion of the upper watershed, the variability of pasture vegetation is evident, and areas of possible overgrazing can be noted. In addition, stream and tributary segments lacking riparian vegetation can also be identified. These are the areas that are prioritized on the map above for implementation of the management practices described in subsequent chapters of this watershed plan.

Figure 3.55: Upper Hancock Creek watershed aerial photo, showing variable pasture quality. Source: Tetra Tech, 2009.

3. Present and Future Stressors in the Watershed

Present and future stressors in the Hancock Creek watershed are expected to be the same – wastewater treatment plant discharges, soil erosion from pasture land, erosion of creek and tributary banks, and some localized sediment runoff from new development. Wastewater treatment plant discharges are expected to continue at Verna Hills, Yorktowne, and the small facility at the East Kentucky Power office. The plant at Rockwell Village is expected to be eliminated due to extension of a sewage collection pipe from the recently upgraded Winchester treatment plant. This watershed plan identifies treatment upgrades at Yorktowne and Verna Hills as priorities for reducing ammonia concentrations in Hancock Creek and its tributaries.

One factor that has probably reduced sediment inputs into the Hancock Creek drainage system over the past five years has been the marked decrease in row crop tobacco production, due to the tobacco buyout in 2004. Former tobacco fields have been converted to pasture, for the most part. The conversion of heavily cultivated tobacco row crop land to pasture land has likely decreased sediment loading to Hancock Creek and its tributaries, because row crop land cultivation practices result in greater exposure of disturbed soil to precipitation during the growing season, greater runoff (see table), and greater likelihood of field soil loss.

Table 3.10 Land Use Descriptions. Source: Purdue University, USDA NRCS, 2009.

Land Use Description	**Description and Curve Numbers from TR-55**					
	Cover Description		**Curve Number for Soil Group**			
	Cover Type and Hydrologic Condition	% Impervious Areas	A	B	C	D
Agricultural	**Row Crops - Straight Rows + Crop Residue Cover- Good Condition**		**64**	**75**	**82**	**85**
Commercial	Urban Districts: Commercial and Business	85	89	92	94	95
Forest	Woods - Good Condition		30	55	70	77
Grass/Pasture	**Pasture, Grassland, or Range - Good Condition**		**39**	**61**	**74**	**80**
High Density Resiid.	Residential districts by average lot size: 1/8 acre or less	65	77	85	90	92
Industrial	Urban district: Industrial	72	81	88	91	93
Low Density Resid.	Residential districts by average lot size: 1/2 acre lot	25	54	70	80	85
Open Spaces	Open Space (lawns, parks, golf courses, cemeteries, etc.) Fair Condition (grass cover 50% to 70%)		49	69	79	84
Parking and Paved Spaces	Impervious areas: Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	100	98	98	98	98
Residential 1/2 acre	Residential districts by average lot size: 1/2 acre	25	54	70	80	85
Residential 1 acre	Residential districts by average lot size: 1 acre	20	51	68	79	84
Residential 2 acres	Residential districts by average lot size: 2 acre	12	46	65	77	82

Land cover (i.e., “C,” the “cropping / cover” parameter value in the Universal Soil Loss Equation) provides an even greater indication that more soil loss is associated with row crop land vs. pasture land. The C factor in the USLE estimates the reduction of soil loss from land cropped under specified vegetative, residue, and management conditions as compared to clean-tilled, continuous fallow conditions. C values used in the USLE for pasture land can range from 0.003 to 0.013; however, values for row crop land can be 0.16 – 0.53, which translates into a 40 to 50 times difference in this parameter value.

However, there has been a very gradual trend toward increasing tobacco production in Kentucky over the past two years. If this trend continues, there might be some increase in heavily cultivated row crop production land in the watershed in coming years. Currently, only six percent of the watershed land use is categorized as row crop.

Another factor that might affect water quality is developmental patterns. If the trend toward conversion of pasture land to subdivisions and commercial areas accelerates after the current recession ends, management of new construction areas through the statewide KPDES Construction Site Stormwater Permit Program could become a priority.

During the period 2009 – 2014, new construction erosion and sediment control and post-construction stormwater management, wastewater treatment plant upgrades, improved pasture management, and restoration of stream and tributary bank areas will be the focus of watershed plan implementation efforts.

Hancock Creek Watershed Plan
Chapter 4: Get Your Act Together!

The BMPs recommended in Chapter 4 are designed to address the specific issues affecting Hancock Creek. They have been prioritized based on feasibility and cost (or what BMP will give you the most bang for your buck) for reducing pollutant loads and improving water quality. The BMP recommendations and their associated action items include the local information gathered in chapter 2 and what we have learned about the watershed. The following is a list of the BMPs that are prescribed in chapter 4 for various watershed problems. The explanations below are intended to connect the watershed problems to their BMPs and explain how they will improve water quality. More information about specific issues and their locations in the watershed can be found in chapters two and three.

Beginning on page 69, each of the major water quality issues in Hancock Creek is discussed in detail from its sources in the watershed to the available BMPs to ameliorate its affects. Corresponding to these narratives is a set of BMP tables, organized by water quality issue. These *Best Management Practices and Action Item Tables* can be found in Appendix C. Each table lists the water quality issue it addresses, action items, responsible party, cost/funding mechanism, location, and milestones in achieving the action items.

Rain barrels and rain gardens: These are designed to capture stormwater (runoff). Reducing the amount of stormwater directly impacts water quality, water quantity, and habitat in Hancock Creek in that stormwater finding its way to the creek will increase the instream flow of the creek, increase the possibility of bank scouring, increase erosion, carry pollutants to the stream as the water flows over land, and possibly increase the temperature of the stream water.

Regulation Compliance: This refers to a variety of regulations impacting water quality including construction site silt fencing, obtaining proper permits such as groundwater protection plans, and meeting state requirements at the waste water treatment plants.

Stormwater education/low impact development: Educating the public is crucial to watershed improvement success and should take place in a variety of venues such as schools, churches, garden clubs, the chamber of commerce, utility boards, other conservation groups, city offices, Winchester/Clark County planning commission, the homebuilders association, and others.

Ordinance assessment: Winchester/Clark County will have the opportunity to assess many of its ordinances dealing with stormwater issues such as curb and gutter restrictions, street and/or sidewalk width, and impervious surface cover. In some cases, removing restrictions can create options for the city/county, developers, businesses, and homeowners to become better stewards of our watershed.

Water quality education and demonstration: As with stormwater education, public understanding and support of watershed initiatives are crucial to success. To facilitate public understanding, demonstration sites are recommended for rain gardens and barrels, natural channel design, agricultural BMPs, stream bank restoration, low impact development practices and technologies, and riparian plantings. A demonstration site could be as simple as a rain garden on a city site with a sign or brochure explaining how rain gardens help reduce stormwater runoff and thereby contribute to overall watershed health.

Water quality modeling: A planning BMP, water quality modeling will help determine the impacts of structural BMPs on water quality. It will also have the potential to help city officials select action items.

Fencing/Alternative Watering Systems: Agricultural BMPs like these help to keep cattle out of Hancock Creek, thereby reducing erosion and pathogen issues and damage to stream bank vegetation. There are several existing programs helping farmers with these issues.

Constructed Wetlands/Riparian Plantings: Constructed wetlands are built to help capture and filter stormwater runoff and septic or sewer discharge to reduce pollutant loads in streams. Riparian plantings improve the health of the riparian zones and, thus, water quality. Both of these BMPs can serve as teaching and demonstration sites for the community.

Natural Channel Design: Restoring the natural channel design to Hancock Creek will improve the creek’s habitat, help reduce erosion, and improve water quality. It will also serve as an educational demonstration.

Cost/Benefit Analysis

Cost/Benefit Analysis is a powerful, widely used tool for deciding whether to make a change or follow through with a project. It allows you to work out how much the change will cost to make and then calculate the benefit from it. The final decision is informed (though not necessarily determined) by a comparison of the total costs and benefits. Conducting a cost/ benefit analysis on practices that will improve environmental conditions is a little less cut and dry than analyzing the cost/benefit of a new computer system, for example, because the benefits are less tangible. Determining the cost/benefit analysis of a stormwater workshop is difficult to gauge since one does not know in advance the number of participants that will attend the workshop and to what degree the lessons learned at the workshop will be used in the field.

The Hancock Creek Watershed Team sought to prioritize the implementation of BMPs in the watershed based on their effectiveness, feasibility, and affordability. A BMP received points for effectiveness if it has been proven to reduce pollutant loads and if the item could reduce the load by itself or if it would be done in conjunction with other action items. A BMP also received points for feasibility if sufficient leadership, authority, partners, technology, and landowner willingness was available to implement the best management practice. Lastly, a BMP received points for its affordability if resources were available to implement it.

The results of the BMP ranking are as follows:

1. Ordinance Assessment (including water quality modeling)
2. Pasture Renovation and Management
3. Fencing and Alternative Watering Systems (includes both streambank and inner fencing)
4. Low Impact Development and Stormwater Education (includes rain gardens and barrels)

These were the BMPs that were determined to be the most effective in improving water quality and the most feasible when considering cost, land owner willingness, and organizational responsibility. In the tables and narratives that follow, these and other BMPs will be listed as measures to address water quality issues. The BMPs that are not on the above priority list are still considered viable options. Figure 4.1 details the BMPs and their associated costs.

BMP	Estimated Cost/Unit
Fencing	$2.08/foot
Alternative Watering Systems	
Watering Facility - Concrete Pad & Trough/Tank	$1823.71/each
Watering Facility - Rock/Geotextile & Trough/Tank	$1460.93/each
Stream Crossing	$1731.65/each
Pipeline - Typical Installation	$2.36/foot
Septic Tank Cleanouts & Inspections	$175/each
Constructed Wetlands	$200/square foot
Riparian Plantings	
Trees only	$.10/square foot
Trees with Seedling Protector Tubes	$.70/square foot
Rain Garden Installation	
Residential	$4/square foot
Institutional	$20/square foot
Rain Barrel Installation	$25/each

Stormwater Education/ Low Impact Development	$3,000 per workshop
Water Quality Education	$16.00/hour
Regulation Compliance	$20/hour
Ordinance Assessment	$20/hour
Water Quality Modeling	varies
Natural Channel Design	$200/square foot

Figure 4.1: BMP cost estimate per unit
Source: Strodes Creek Conservancy, 2009.

Problem: Bacteria

E. coli are bacteria that live in the gut of all warm blooded animals. If their fecal matter enters our waterways, *E. coli* can be detected in the water. Some types of *E. coli* that can cause serious illness, but most are not harmful. *E. coli* represents the potential for other harmful disease-causing organisms; it serves as an indicator of the amount of fecal matter getting into the water. The most common sources are from homes (failing septic systems or straight pipes), livestock, or poorly maintained wastewater treatment plants.

Causes/Sources/Pollutants

Septic and sewer discharge
Effluent from wastewater treatment plants
Runoff from pastureland
Livestock in stream

Desired Conditions

Lower levels of fecal coliform colonies in Hancock Creek
Primary and Secondary Recreation Contact designations restored

Best Management Practices (BMPs)

1. Install rain gardens and rain barrels to reduce stormwater runoff
2. Install constructed wetlands downstream of wastewater treatment plants
3. Education and outreach on maintaining septic systems
4. Protect existing intact riparian areas
5. Vegetate degraded riparian areas with native trees, shrubs, and grasses
6. Fence off cattle from Hancock Creek and encourage rotational grazing/inner fencing

Measurable Criterion: Fecal coliform colonies, unvegetated portions of streambank

	Target Value	**Analysis /Model Method**	**Interim Targets Short-term**	**Interim Target Mid-term**	**Interim Target Long-term**
Fecal Coliform (PCR)	200 CFU/100 ml geometric mean for 5 samples over 30 days, 5/1-10/31. 20% of samples must not exceed 400 CFUs	Grab sample/ Colilert	All samples </= 1,000 CFUs	All samples </= 800 CFUs	All samples </= 200 CFUs
***E. coli* (PCR)**	130 CFU/100 ml geometric mean for 5 samples over 30 days, 5/1-10/31. 20% of samples must not exceed 240 CFUs	Grab sample/ Colilert	All samples </= 800 CFU/ml	All samples </= 600 CFUs	All samples </= 130 CFUs
Fecal Coliform	1000 CFU/100 ml geometric mean for 5 samples over 30 days, year round. 20% of samples must not exceed 2000 CFUs	Grab sample/ Colilert	All samples </= 1,000 CFU/ml	All samples </= 1,000 CFU/ml	All samples </= 1,000 CFUs

Figure 4.2 Bacteria Reduction Objective. Source: Strodes Creek Conservancy, 2009.

Problem: Nutrients

Runoff from agricultural, residential, and stormwater sources and industrial effluent often contain nutrients that can have an adverse affect on water quality. Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen and ammonia in a water body. High TKN can result from sewage and manure discharges to water. Phosphorus comes mainly from septic systems, industrial discharges, agricultural fields, urban runoff, construction sites, and feedlots.

Causes/Sources/Pollutants

Stormwater runoff, Septic and sewer discharge, Effluent from wastewater treatment plants
Runoff from pastureland

Desired Conditions

Reduce nutrient loading in Hancock Creek to be in compliance with Kentucky's water quality standards for warm water aquatic habitat, or in absence of state standards, Mean Parameter Concentrations from Reference Reaches in the Bluegrass Bioregion (see chapter 3).

Best Management Practices

1. Education on stormwater and water quality issues
2. Construct rain garden demonstration sites
3. Encourage rain barrel usage with homeowners and businesses
4. Locate and address leaking and failing septic systems and educate homeowners on septic maintenance.
5. Protect existing riparian areas and help restore degraded areas with native plants
6. Promote rotational grazing and other pasture restoration measures

Measurable Criterion: Ammonia, TKN, Total Phosphorus (TP), Total Nitrogen, Sulfate, *E. coli*

	Target Value	Analysis/Model Method	Interim Targets Short-term	Interim Target Mid-term	Interim Target Long-term
Ammonia*	< 0.05 mg/L after mixing	Standard Method 4500-NG3G	Meet target value in low flow	Meet target value in low and moderate flow	Meet target value in all flows
TKN*	0.320 mg/L	SM4500	Meet target value in low flow	Meet target value in low and moderate flow	Meet target value in all flows
Total Phosphorus*	0.132 mg/L	EPA 365-1	Meet target value in low flow	Meet target value in low and moderate flow	Meet target value in all flows
Total Nitrogen*	0.656 mg/L	EPA Method 300	Meet target value in low flow	Meet target value in low and moderate flow	Meet target value in all flows
Sulfate*	47.3 mg/L	EPA Method 300	Meet target value in low flow	Meet target value in low and moderate flow	Meet target value in all flows

Figure 4.3 Nutrient Reduction Objective. Source: Strodes Creek Conservancy, 2009.
*Mean Parameter Concentrations from Reference Reaches in the Bluegrass Bioregion

Problem: Siltation

When particles of soil, silt, and earth enter a stream, they eventually settle to the stream bottom. Siltation can cause a variety of problems in streams from aquatic habitat loss to loss of productivity. Soil particles often carry along other pollutants into the water. Total Suspended Solids (TSS) is one way to measure how much siltation is happening. TSS contain a wide variety of materials such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

Causes/Sources/Pollutants

Erosion from construction sites, agricultural fields, and roads
Increased stream flows from stormwater runoff and impervious surfaces

Desired Conditions

No adverse effects on indigenous aquatic communities from TSS. Stream bottom (substrate) should be suitable for native fish and macroinvertebrate populations. The substrate is 25 percent or less embedded by fine sediment.

Measurable Criterion: Total Suspended Solids; Substrate condition

Best Management Practices (BMPs)

1. Education and outreach on erosion prevention
2. City and County ordinances to reduce erosion and runoff during construction and maintenance projects
3. Reduce stormwater runoff through the installation of rain gardens and barrels
4. Protect and restore existing riparian areas and revegetate degraded areas
5. Promote pasture restoration, rotational grazing, and inner fencing

	Target Value	Analysis/Model Method	Interim Targets Short-term	Interim Target Mid-term	Interim Target Long-term
Total Suspended Solids	No adverse effects on indigenous aquatic community	Turbidity and TSS analyzer	No adverse effects on indigenous aquatic community	No adverse effects on indigenous aquatic community	No adverse effects on indigenous aquatic community
Substrate Condition	Substrate 25% or less embedded by fine sediment	Visual Assessment	50% embedded by fine sediment	40% embedded by fine sediment	25% embedded by fine sediment

Figure 4.4 Siltation Reduction Objective. Source: Strodes Creek Conservancy, 2009.

Problem: Habitat Modification

Stream habitat is very important to the health of aquatic organisms and water quality. Physical, man-made alterations to the channel, floodplain, or riparian zone of a stream (channelization, culverting headwater streams, destruction of riparian cover, levee construction) can alter and degrade stream habitat. The EPA's Rapid Biological Protocol assigns a numeric score to a stream reach based on a variety of factors.

Causes/Sources/Pollutants

Construction, impervious surfaces, agriculture, stream channelization, loss of riparian areas, cattle in stream or on the banks

Desired Conditions

- A well-developed riparian area providing some canopy over the stream
- Presence of adequate aquatic habitats in the form of root mats and coarse woody debris
- Greater than (>) 70 percent (or >50 percent for low gradient) mix of rubble, gravel, boulders, submerged logs, root mats, aquatic vegetation or other stable habitats for aquatic organisms
- Rapid Biological Protocol score of 135, fully supporting habitat
- Score of 11 or better for Bank Stability, Vegetative Protection, and Riparian Vegetation Zone Width (combined score for both banks)

Best Management Practices

1. City and County ordinances and zoning that prevents or limits direct stream rerouting or modification, erosion during construction projects, and stormwater runoff
2. Education and outreach concerning stormwater runoff issues
3. Constructed wetlands and protection and expansion of riparian areas
4. Fence cattle out of stream

Measurable Criterion: Improved fish and macroinvertebrate habitat; Visual Assessments (Qualitative)

	Target Value	**Analysis/Model Method**	**Interim Targets Short-term**	**Interim Target Mid-term**	**Interim Target Long-term**
Visual Assessment	Score of 11 or better for Bank Stability, Vegetative Protection, and Riparian Vegetation Zone Width (combined score for both banks)	Bank Stability score sheet	Improving bank stability score	Fair	Good
Visual Assessment	RBP score of 135 or higher, a fully supporting habitat	RBP score sheet	Improving RBP score	Fair	Good

Figure 4.5 Better Habitat Objective. Source: Strodes Creek Conservancy, 2009.

Problem: Dissolved Oxygen

Dissolved Oxygen is found in microscopic bubbles of oxygen that are mixed in water and occur between water molecules. It is a very important indicator of a waterway's ability to support aquatic life. Fish breathe by absorbing dissolved oxygen through their gills. Oxygen enters the water by absorption directly from the atmosphere or by aquatic plant photosynthesis. Oxygen is removed from water by respiration and decomposition of organic matter.

Causes/Sources/Pollutants

Absent or degraded riparian area
Polluted WWTP discharge
Stormwater runoff

Desired Conditions

A healthy riparian area will provide the shade needed to keep creek temperatures within optimal ranges to keep algae growth at a minimum (excessive algae in the creek results in reduced dissolved oxygen). Reduce nutrient loading in order to increase levels of dissolved oxygen.

Best Management Practices

1. Education and outreach about riparian area role in clean water
2. Protect existing riparian areas and help restore degraded areas with native plants
3. Require sewage treatment plants that discharge wastewater to creek to limit pollutants that require oxygen consumption as they break down in the stream.
4. Reducing organic matter getting into the river with stormwater runoff.

Measurable Criterion

Dissolved oxygen

	Target Value	Analysis/Model Method	Interim Targets Short-term	Interim Target Mid-term	Interim Target Long-term
Dissolved Oxygen	>5.0 mg/L	Water chemistry testing dissolved oxygen probe	>5.0 mg/L	>5.0 mg/L	>5.0 mg/L

Figure 4.6 Increased Dissolved Oxygen Objective. Source: Strodes Creek Conservancy, 2009.

Problem: Specific Conductance

Specific Conductance is a measure of how well water can conduct an electrical current. Conductivity increases with increasing amount and mobility of ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Specific conductance is, thus, an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, and phosphate. It can be used as an indicator of human or animal waste.

Causes/Sources/Pollutants

Septic and sewer discharge
Effluent from wastewater treatment plants
Runoff from pastureland

Desired Conditions

Reduce nutrient loading in Hancock Creek to be in compliance with Kentucky state water quality standards for warm water aquatic habitat in order to achieve healthy levels of specific conductance.

Best Management Practices

1. Locate and address leaking and failing septic systems and educate homeowners on septic maintenance.
2. Education on stormwater and water quality issues
3. Construct rain garden demonstration sites
4. Encourage rain barrel usage with homeowners and businesses
5. Protect existing riparian areas and help restore degraded areas with native plants
6. Promote rotational grazing and other pasture restoration measures

Measurable Criterion

Specific Conductance

	Target Value	Analysis/Model Method	Interim Targets Short-term	Interim Target Mid-term	Interim Target Long-term
Specific Conductance*	457.6 µmhos	Water chemistry testing probe	Meet target value in low flows	Meet target value in moderate flows	Meet the target value during all flows

Figure 4.7 Specific Conductance Objective. Source: Strodes Creek Conservancy, 2009.
*Mean Parameter Concentrations from Reference Reaches in the Bluegrass Bioregion.

Hancock Creek Watershed Plan
Chapter 5: Implementation organization, monitoring, and evaluation

Organization

The Strodes Creek Conservancy will oversee all aspects of the watershed plan. The SCC will give the watershed coordinator leadership and direction on implementation of the plan, will keep projects moving according to schedule, analyze monitoring data, seek new funding and resource opportunities, and share results with the community. Strodes Creek Conservancy currently operates under a 319(h) grant held by the City of Winchester and has been awarded a subsequent 319(h) grant for the implementation of this watershed plan. The organization has 501(c) 3 status. The Strodes Creek Conservancy through the City of Winchester currently has a watershed coordinator and will retain that position for the next several years for the implementation of this watershed plan. Funding for a watershed coordinator position will continue to be sought after the most recent grant award has ended. The Strodes Creek Conservancy board of directors is a talented group of individuals with expertise in such areas as hydrology, natural channel design, forestry, planning, local government, landscape architecture, agriculture, and land management.

While the Strodes Creek Conservancy has a lot of technical expertise on hand, some projects will need more focused technical expertise. For example, the SCC will call on consultants for low impact development workshops, agricultural best management practice design and installation, stream restoration, and all other practices recommended in chapter 4.

Monitoring Plan

Continued monitoring will be conducted as part of the Reobligated 319(h) project. All sites will be in the Hancock Creek watershed. After all monitoring has been completed for the calendar year, the Strodes Creek Conservancy will compile all monitoring data and evaluate the progress being made toward pollutant load reductions for bacteria, dissolved oxygen, turbidity, pH, temperature, and conductivity. After data evaluations have been made, the watershed coordinator will present to the Winchester City Commission and Clark County Fiscal Court the results and the progress that has been made on the watershed plan.

The watershed coordinator will conduct the monitoring. The current watershed coordinator has sampled in the watershed for several years, has been trained for the task and will continue to receive training as necessary. Because the Strodes Creek Conservancy is funded through a 319(h) grant, a Quality Assurance Project Plan (QAPP) will be submitted.

Plan for evaluation of progress

The Hancock Creek Watershed team identified four BMPs as priorities for their community.

These are:

1. Ordinance Assessment
2. Pasture Renovation and Management
3. Fencing and Alternative Watering Systems
4. Low Impact Development and Stormwater Education

The evaluation plan will be based on the implementation of these items. The watershed coordinator (Shanda Cecil of the Strodes Creek Conservancy) will be in charge of organizing the implementation of the BMPs.

Every six months the watershed coordinator will present a progress report to the SCC Board of Directors. It will be up to the board to evaluate progress made and/or alterations to plan that need to be made. Below is an example of the type of evaluation form or report card they may use. The goal is to be adaptive in the management of the BMPs to meet watershed goals.

Activity	Status	Obstacles to Completion	Is this activity still necessary?
Rain Garden Installation			
1. Conduct workshop on benefits, design, and site location of rain gardens 2. Establish rain garden demonstration sites throughout the watershed			

Figure 5.1: Sample report card. Source: Strodes Creek Conservancy, 2009.

Ordinance Assessment

The first priority BMP, ordinance assessment, will take place with the cooperation of local Winchester/Clark County Planning Commission officials and technical advisors (local expert volunteers and contractors when necessary). The action items for this BMP are as follows:

1. The SCC will ask the Winchester-Clark County Planning Commission Director to complete the Center for Watershed Protection's Codes & Ordinances Worksheet.
2. Based on worksheet findings, the SCC will work to create more flexible ordinances that allow for low impact development, green infrastructure, and stormwater friendly growth.

The evaluation of this BMP will be conducted by the Strodes Creek Conservancy (SCC) Board of Directors upon completion of the ordinance review by the watershed coordinator. The board will issue a decision ("report card," see Figure 5.1) on the ordinance review and recommend the ordinance changes to Winchester-Clark County Planning Commission. The next step of evaluation will be conducted by the watershed coordinator when feedback from Winchester-Clark County Planning Commission is completed. She will report to the SCC board of directors about adopted ordinance changes and any pertinent discussion therein. Ultimately, this BMP will be considered successful if ordinance changes are adopted and the public is educated about them.

Pasture Renovation and Management

Action Items for the second priority BMP, pasture renovation and management, are as follows:

1. Offer financial and technical assistance to install pasture improvement BMPs
2. Promote agricultural fencing project
3. Showcase benefits of agricultural benefits to farm and environment

The evaluation of this BMP will be conducted by the SCC Board of Directors with consultation by the Clark County Conservation District. The Board will comment on and approve the proposed plan ("report card," see Figure 5.1) for a first phase of evaluation. The second phase of evaluation will entail reporting on the number of participants in the renovation program, the number of feet of inner fencing installed, and feedback from program participants.
The long-term goals of this BMP include improving water quality by reducing in *E. coli* and fecal coliform and increasing the dissolved oxygen levels in stream. This facet of the BMP will be evaluated through the regular water quality monitoring that is conducted in Hancock Creek by the watershed coordinator. The specifics of these water quality improvements can be found in chapter 4.

Fencing and Alternative Watering Systems
Action Items for the third priority BMP, Fencing and Alternative Watering Systems, are as follows:

1. Offer financial and technical assistance to install BMPs
2. Promote agricultural fencing project
3. Showcase benefits of agricultural benefits to farm and environment

The evaluation of this BMP will be conducted by the SCC Board of Directors with consultation by the Clark County Conservation District. The Board will comment on and approve the proposed plan ("report card") for a first phase of evaluation. The second phase of evaluation will entail reporting on the number of participants in the renovation program, the number of feet of inner fencing installed and alternative watering systems installed, and feedback from program participants.

The long-term goals of this BMP include improving water quality by reducing in *E. coli* and fecal coliform and increasing the dissolved oxygen levels in stream. This facet of the BMP will be evaluated through the regular water quality monitoring that is conducted in Hancock Creek by the watershed coordinator. The specifics of these water quality improvements can be found in chapter 4.

Low Impact Development and Stormwater Education

Action Items for the fourth priority BMP, Low Impact Development and Stormwater Education, are as follows:

1. Conduct stormwater management workshop for businesses in the watershed to equip them with the knowledge necessary to comply with their stormwater permits.
2. Work with facilities to encourage the implementation of green infrastructure.
3. Conduct workshop on benefits, design, and site location of rain gardens
4. Establish rain garden demonstration sites throughout the watershed.

The long-term goals of this BMP include improving water quality by reducing in *E. coli* and fecal coliform and increasing the dissolved oxygen levels in stream. This facet of the BMP will be evaluated through the regular water quality monitoring that is conducted in Hancock Creek by the watershed coordinator. The specifics of these water quality improvements can be found in chapter 4.

Presentation

The watershed plan and its progress will be presented to the public in a variety of ways. Once a year, representatives from the SCC will meet with both the Winchester City Commission and Clark County Fiscal Court to present monitoring data and plan implementation progress. In addition, the watershed coordinator will be available to speak upon request to various civic groups about the plan. A brochure will be published to educate all of the citizenry of the community as to the plan’s goals, opportunities, and accomplishments. Also, the board report card will be made available on the SCC website.

This project is funded in part by a grant from the U.S. Environmental Protection Agency under 319(h) of the Clean Water Act through the Kentucky Division of Water to the Kentucky Waterways Alliance (Grant # C9994861-04).

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Appendix A
Roundtable Report

Outline for Hancock Creek Roundtable Report

I. Executive Summary

II. Introduction
  - A. Background Information
  - B. Roundtable Agenda
  - C. How Roundtable Information Will be Utilized

III. Responses from Roundtable

IV. Conclusion
  - A. Impacts of the Roundtable on the Planning Process and the Community
  - B. Roundtable Participant Evaluation Results

V. Appendices
  - A. Map of Watershed
  - B. Roundtable Attendance List
  - C. Roundtable Agenda

I. Executive Summary

The Hancock Creek Watershed Roundtable was held on March 18, 2008 at the Clark County Cooperative Extension Office in Winchester. The event attracted ten participants, three previously not involved with the Hancock Creek Watershed Planning Project.

A tributary of Strodes Creek, the Hancock Creek watershed is an 8295 acre area located in Clark County, Kentucky. To address point and nonpoint source pollution in Hancock Creek, the Strodes Creek Conservancy and the Kentucky Waterways Alliance are working together, with community input, to create a watershed plan.

The roundtable was held to draw more stakeholders into the watershed planning process, increase the public visibility, educate the public on issues facing the Hancock Creek watershed, and to gain stakeholders' input for the planning process.

Of the three participants who were not already involved in the project, one expressed interest in serving on the Watershed Planning Team. Furthermore, according to the roundtable evaluations, participants learned about issues facing the watershed. Finally, the publicity received and the attendance indicate that public visibility was enhanced by the event.

The overall project to develop a watershed plan is funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act through the Kentucky Division of Water to the Kentucky Waterways Alliance *(Grant # C9994861-04).* The Hancock Creek Watershed Planning Team will continue to work to develop the plan through early 2010. A second Watershed Roundtable will be held in 2009, once a draft watershed plan has been completed, to present the plan to the public.

II. Introduction

A. Background Information

A tributary of Strodes Creek, the Hancock Creek watershed is an 8295 acre area located in Clark County, Kentucky. Most of the watershed is used to graze livestock or grow hay (79%), with approximately nine percent developed, and around six percent used to grow row crops. The rest of the area is made up of forest, grasslands, and wetlands. The developed portions of the watershed are mainly located along US-60 and Interstate 64.

Water samples from Hancock Creek show a few areas of concern. Fecal coliform levels are often more than three times the state limits. Conductivity ranges up to 500 microSiemens/cm, and though the area is naturally high in conductivity, this could indicate mild sewage impacts. Dissolved oxygen levels are also low during summer low flows. Finally, phosphorus ranges up to 1 milligram per liter in some locations, yet the area is high in limestone, which can contribute to phosphorus levels.

To address point and nonpoint source pollution in Hancock Creek, the Strodes Creek Conservancy and the Kentucky Waterways Alliance are working together, with community input, to create a watershed plan.

The roundtable was held to draw more stakeholders into the watershed planning process, increase the public visibility, educate the public on issues facing the Hancock Creek watershed, and to gain stakeholders' input for the planning process.

B. Roundtable Agenda

The Hancock Creek Watershed Roundtable was held on the evening of Tuesday, March 18, 2008. The event had been previously scheduled for February 21, but had to be cancelled due to inclement weather.

After registration, there were three presentations on various aspects of the Watershed Planning Project. Katie Holmes from the Kentucky Waterways Alliance presented background on watersheds, the watershed planning process, and ways to protect the watershed. Shanda Cecil, Director of the Strodes Creek Conservancy and Watershed Plan Facilitator, gave some background on the Hancock Creek watershed and projects of the Strodes Creek Conservancy. Finally, Barry Tonning of Tetra Tech, Incorporated and Technical Assistant for the Watershed Plan, presented on Hancock Creek's water quality.

Following the presentations, participants had a lively facilitated discussion about the following questions:

- How do you use the creek?
- How would you like to use it?
- How do you use the watershed?
- Why is the Hancock Creek watershed important to you?
- What are the problems in the watershed?
- What are your goals for the watershed?

Following the discussion, participants were urged to turn in their evaluations of the roundtable, which were designed to measure their knowledge of watershed issues before and after the roundtable, as well as their opinions related to the watershed plan. (See Section IV B. for the results of the evaluations.) Participants were also urged to turn in a form if they were interested in any of the following:

- ☐ I am interested in receiving updates on the Hancock Creek Watershed Plan Project (2008-2010)
- ☐ I am interested in joining the Hancock Creek Watershed Planning Team
- ☐ I am interested in participating in a Hancock Creek Clean Up

C. How Roundtable Information Will be Utilized

The Hancock Creek Watershed Planning Team is in the beginning stages of working on a watershed plan for the Hancock Creek watershed. At its next meeting, the team will consider the input from roundtable participants, and will decide which problems and goals should be incorporated into the scope of the plan.

All comments from participants in the roundtable have been included in this report to provide an accurate representation of the discussion that occurred. Some comments may not be appropriate to incorporate into the plan at this time, but all feedback will be reviewed by the team.

III. Responses from Roundtable

Participants at the roundtable were asked the following questions:

- How do you use the creek?
- How would you like to use it?
- How do you use the watershed?
- Why is the Hancock Creek watershed important to you?
- What are the problems in the watershed?
- What are your goals for the watershed?

The following were the participants' responses:

How do you use the creek?

1. Bird habitat – enjoy bird watching
2. View of stream
3. Irrigation
4. Beaver habitat
5. Duck hunting
6. Food plots to attract beavers and ducks
7. Quail habitat

8. Fenced Cattle Crossing
9. Water for livestock
10. Fishing – huge carp
11. Natural tree growth (after stream straightening)

How would you like to use the creek?

1. Plant trees (possibly quick growing for timber)
2. Children could play in the creek – if it was clean enough and there was public access
3. Stabilize soil on banks

How do you use the watershed?

1. Crop production
2. Resident
3. Vegetable garden
4. Golf course- no fertilizer

Why is the Hancock Creek watershed important to you?

1. Element that we cannot live without
2. If the creek doesn't affect me, it affects my neighbor. It will also eventually drain into my stream.
3. Don't want water to get any worse
4. It is important to make good planning and zoning decisions

What are the problems in the watershed?

1. Bank erosion
2. Decisions made without proper input and advocates present
3. We fear change
4. Flooding used to occur once every 10 years. After commercial developments went in it floods 3 times a year.
5. Excessive runoff
6. Bad permitting decisions – like construction in wetland
7. Not sure of who to contact on issues
8. Planning needs changing to help with flooding, etc.
9. Newly approved developments – how can we help to make those better – Phase II may cover this.
10. Ordinances need changing

What are your goals for the watershed?

1. Have an advocate for water quality for planning decisions
2. Enforce Phase II rules
3. Include Low Impact Development options in ordinances
4. Have a committee and public hearings about runoff, ordinances, and related issues
5. More public attention and education about issues
6. Involvement in Growth Readiness Program
7. Inclusive approach – not "us versus them"

8. Create filtering systems – wetlands or rain gardens
9. Start simple – riparian buffers, etc.
10. Focus on assets as well/use rewards
11. Use water quality modeling in planning
12. Have a stormwater managers training
13. Education on channel modification and floodplains
14. Stream bank stabilization project – possibly on the golf course
15. Investigate dump sites and solvents and partner with the Superfund Inventory

IV. Conclusion

A. Impacts of the Roundtable on the Community and the Planning Process

Publicity for the roundtable reached many watershed residents. Flyers advertising the event's original date were mailed to all residents in the watershed. The *Winchester Sun* ran an article on the front page of the paper about the roundtable on February 13th, advertising the original date for the event. Once the roundtable had to be rescheduled due to an ice storm, posters advertising the new date were posted around town, and the newspaper ran an update on the event.

The roundtable drew additional residents from the Hancock Creek watershed and the surrounding area to be part of the planning process. The Watershed Planning Team will benefit from the added knowledge of the watershed that these residents bring to the table.

Through discussions held at the roundtable, the Watershed Planning Team learned about additional issues to add to the plan, and has attracted interested citizens to call upon when it is time to implement Best Management Practices in the watershed.

B. Roundtable Participant Evaluation Results

At the conclusion of the event, participants were urged to turn in their evaluations of the roundtable, which were designed to measure their knowledge of watershed issues before and after the roundtable, as well as their opinions related to the watershed plan.

The majority of participants who were already involved in the project did not fill out surveys, but the three new participants filled in surveys. The results from these surveys show that the roundtable participants learned a great deal about watersheds and watershed planning and pollution in Hancock Creek. Furthermore, the results show that the roundtable participants have a moderate-to-high expectation that the Hancock Creek Watershed Plan will succeed, and they feel confident that their concerns and goals for the watershed had been heard and considered for the watershed plan. Results from the roundtable evaluations are below:

SCALE	**1 Low**	**2 Low-to-Moderate**	**3 Moderate**	**4 Moderate -to-High**	**5 High**	**Total # of responses**	**Average Weight**
Your understanding of activities that cause water pollution							
Before the Roundtable		1		2		**3**	**3.3**
After the Roundtable				2	1	**3**	**4.3**
Your understanding of the definition and processes of watershed planning							
Before the Roundtable		1	1	1		**3**	**3**
After the Roundtable				2	1	**3**	**4.3**
Your understanding of the activities that cause water pollution in Hancock Creek watershed							
Before Roundtable	1			2		**3**	**3**
After Roundtable				1	2	**3**	**4.7**
Your understanding of the project to develop a watershed plan for Hancock Creek watershed							
Before the Roundtable		3				**3**	**2**
After the Roundtable				1	2	**3**	**4.7**
Please rate your expectation for success for the watershed plan			1	2		**3**	**3.7**
Please rate confidence that your concerns about the watershed were heard at the Roundtable				**2**	**1**	**3**	**4.3**
Please rate your confidence that your contributions to the watershed plan project were heard				**2**	**1**	**3**	**4.3**

Appendix B
Watershed Information

Climate and precipitation information

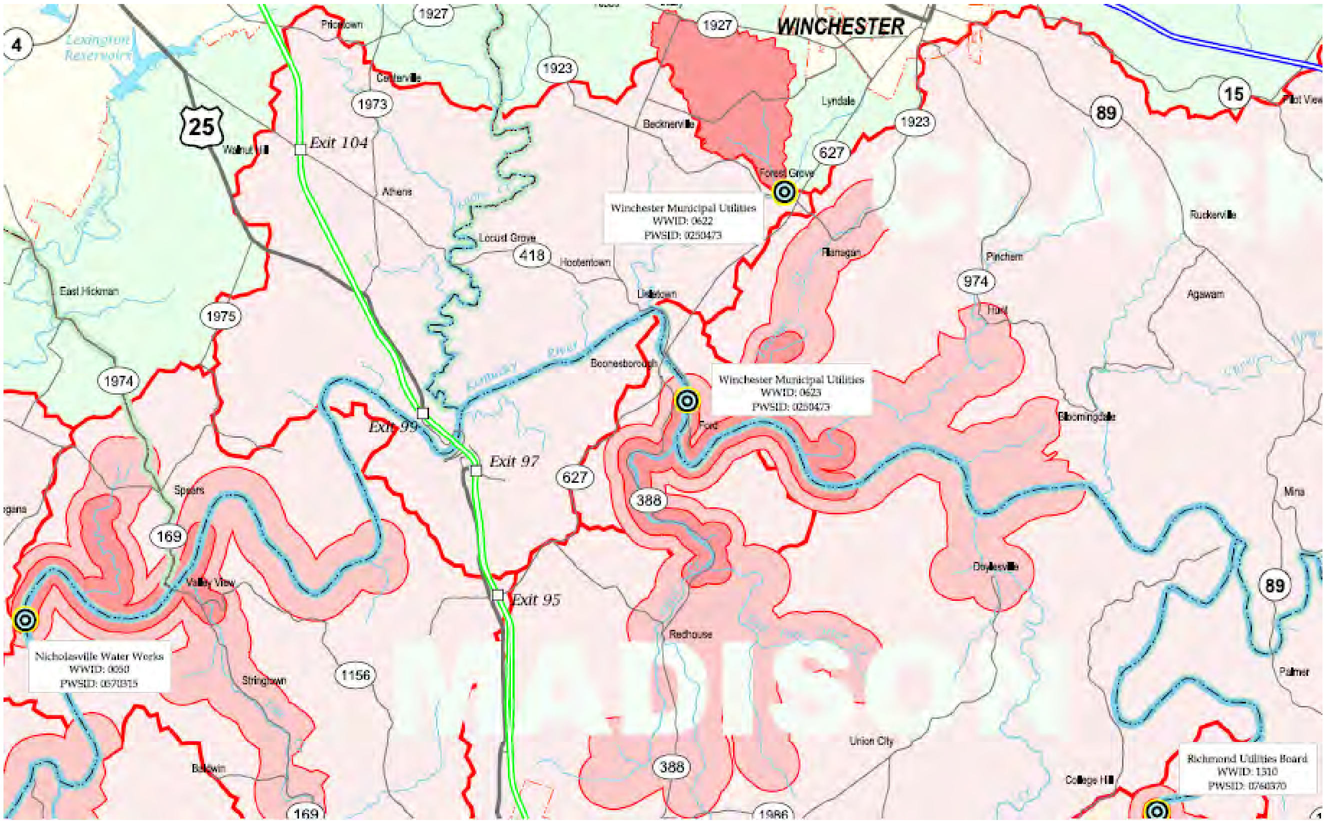
Period of Record Monthly Climate Summary

Period of Record : 6/ 1/1948 to 6/30/2007

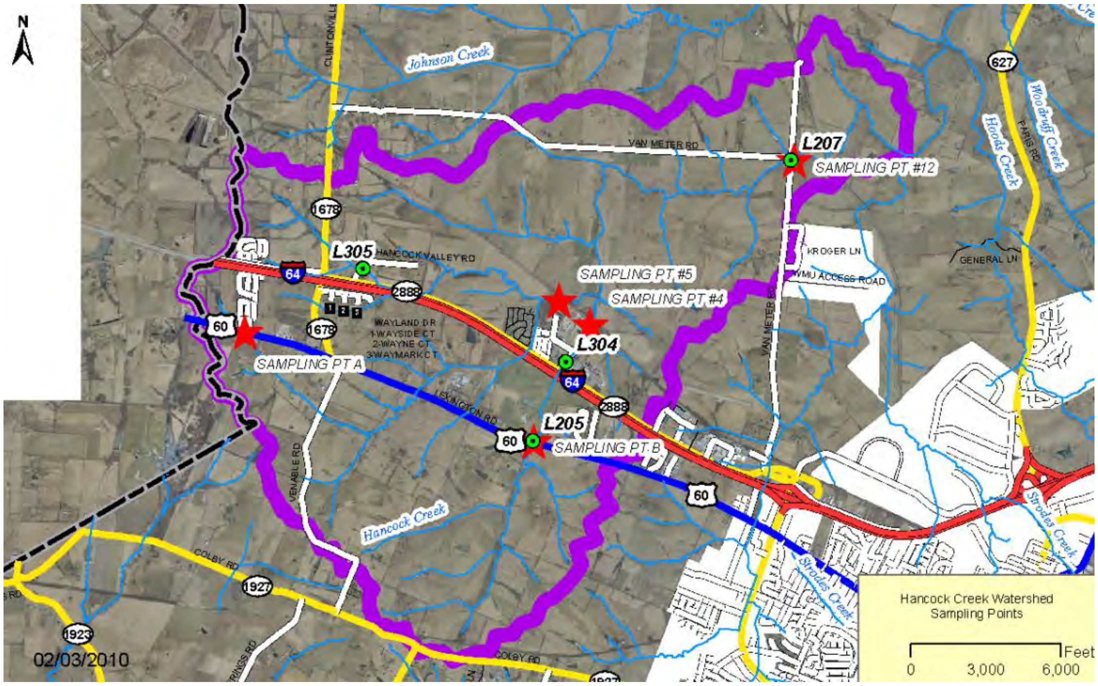
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.8	44.8	54.4	65.5	74.7	82.7	86.1	85.1	78.7	67.6	54.6	44.3	64.9
Average Min. Temperature (F)	24.4	26.8	34.6	44.3	53.8	62.1	66.3	64.8	57.7	46.3	36.4	27.9	45.4
Average Total Precipitation (in.)	3.62	3.27	4.51	3.76	4.60	4.31	4.74	3.64	3.13	2.60	3.52	3.83	45.51
Average Total SnowFall (in.)	5.7	4.6	2.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.4	16.5
Average Snow Depth (in.)	1	1	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.

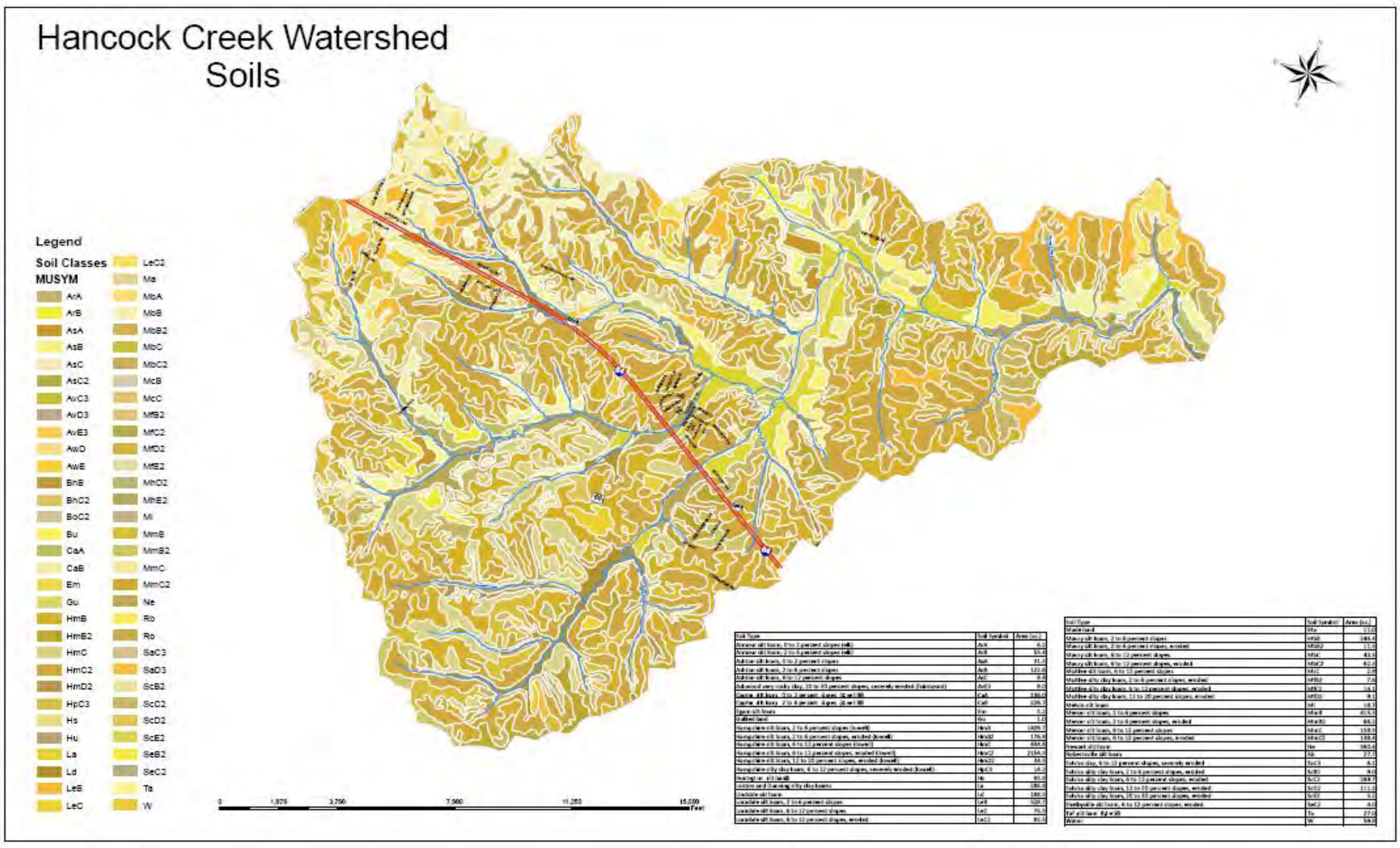
Source Water Protection Plans



Licking River Watershed Watch Hancock Creek Sampling Sites



Soils of Hancock Creek Watershed



Source: Clark County Geographic Information Systems, 2008.

Appendix C
Best Management Practices and Action Item Tables

Please see the attached tables.

Appendix D
Hancock Creek Watershed Plan Comments from the Kentucky Division of Water

These comments were made by Kentucky Division of Water staff during the review of the Hancock Creek Watershed Plan. These comments will be addressed as part of the 2007 Reobligated 319(h) Hancock project.

Overall:

1. All maps should have a north arrow, scale bar, and date when the map was generated.

Chapter 1

2. Figure 2.1 – Suggest displaying area where the 9361 housing units have been approved for development.

Chapter 2

3. Page 13, Designated Uses – The impairment status information for Hancock Creek varies throughout the chapter and the plan. Segments of Hancock Creek will be listed as impaired for nonsupport for Warm Water Aquatic Habitat WAH (due to pH, nutrient/eutrophication biological indicators & sp. conductance) and nonsupport for Primary and Secondary Contact Recreation PCR SCR (due to pH and bacteria). The 305(b) Data Assessment Sheets were provided to the Hancock Creek planning group by KDOW, so this reference can be included. This impairment status should be updated throughout the document for consistency. It is very confusing that certain sections refer to the overall water quality as moderate to good while others refer to it as moderately to severely degraded.
4. Page 16, Chemical Parameters – The TMDL data shows high nitrates at site 05020005 from 6/22/05 to 1/25/06. This corresponded to episodes of higher levels of TKN, sulfate, chloride, hardness, TOC, TP, specific conductance and alkaline pH. Some of the same trend was observed at site 0502011, but sample collection was less frequent so it's difficult to tell for sure at this site. This portion of the data set was what resulted in the pH and specific conductance listings for Hancock so looking at it in depth and determining the root cause may be critical in addressing these impairments.
5. Be consistent with the use of terms for the wastewater facilities in the watershed. The four plants identified on page 16 are package sewage treatment plants. These should be referred to as package sewage treatment plants or package treatment plants throughout the document.

Chapter 3

6. Overall there are many inconsistencies when discussing the impairment status of Hancock Creek. Refer to comment # 20 above. This needs to be revised throughout this chapter and the plan.
7. The organization of the chapter makes it difficult to follow in areas, especially in the Pollutant Load Prediction section. It appears that some information has been added through past revisions but the overall chapter hasn't been revised to incorporate this new information. For example the bacteria data are added in a separate section but not incorporated into the rest of the overall load analysis. Also target loads and needed load reductions were calculated for bacteria data but not for the N, P or Sediment data. Refer back to the second comment for this section that was provided during the first review of this chapter.
8. Page 33, Numeric Criteria Table - The units should be included in the Numeric Criteria Table.
9. Graphs for monitoring sites - Suggest having the same x scale on all graphs from the same site. Initially for site DOW5020005, it looked like the ammonia spike happened at the same time as the large flow event (not four months later). It might also more clearly demonstrate the summer-fall 05 issue (can see all the peaks and low DO lining up). Also suggest having graphs of pH, one of the impairments on Hancock (2010 303(d) listing).
10. Page 49-51 - Suggest summarizing DMR data from 2004/2005 to indicate what these facilities were reporting when the in-stream data was collected, particularly for the "episode" at site 5020005.
11. Page 54, Figures 3.43, 3.44 – Dates are cutoff on figures. Please reformat.
12. Page 56, Figure 3.49 - Because most of the data is below 10000, this graph may display the data better if it was on a log scale for the y axis.
13. Page 57-58, Figures 3.51 and 3.53 - MPN should be changed to CFU.
14. Page 59, Table 3.7 –Should the parameter be *E.coli* not Fecal Coliform?

Chapter 4

15. This mentions reducing nutrients to achieve the goal for specific conductance, but there may be something else going on to cause high conductivity. This may need to be investigated further. Possible data gap?
16. Suggest adding pH to "Problems" and to develop a list of BMPs to address this pollutant.

BMP Tables

17. The Load Reductions expected for the BMPs should be included.