

Public Outreach Summary Document Woolper Creek Watershed Plan



Prepared for Woolper Creek Watershed Initiative September 2016

1.0 Introduction

The Woolper Creek Watershed drains 33 square miles of Boone County, Kentucky into the Ohio River. This community asset includes over 140 miles of streams, some of which are classified as Outstanding State Resource Waters. However, the rapidly growing population in Boone County continues to convert forests and pastures to urbanized landscapes including commercial, residential, and industrial developments. Although large forested landscapes remain in the lower portion of the watershed, the headwaters have been stressed by substantial amounts of urbanization. Several sections of Woolper Creek and its tributaries are listed on the Kentucky Division of Water's (KDOW) 303(d) List for Impaired Waters, a report that summarizes stream impairments across the Commonwealth. The impairments in the Woolper Creek network include high levels of sediment, bacteria, and nutrients.

One of the goals of this watershed planning effort was to better understand the extent, severity, and causes of the impairments in order to identify the most sensible ways to restore the health of our community's streams. Along the way we learned that one of the biggest contributors to the impairments was excess stormwater runoff generated from impervious areas, such as rooftops and roadways. As documented by the watershed plan, inadequate control of excess stormwater runoff can amplify flooding, cause water quality concerns, increase streambank erosion, and degrade biological communities that depend on the resource (Figure 1).



Wood Duck



Double-Breasted Cormorant

White-tailed Deer



Damselfly





North American Beaver

Cravfish

Figure 1: Examples of wildlife found in and around Woolper Creek Photos courtesy of Mark Jacobs at Boone County Conservation District

A federal grant was received to help the Boone County Conservation District (BCCD) form the Woolper Creek Watershed Initiative (WCWI) to focus on improving and protecting the Woolper Creek Watershed. The funding has allowed the WCWI to better understand the watershed and its impairments while determining various methods and technologies that will help to reverse the degradation as well as protect the stream reaches exhibiting high water quality and biological integrity. There are many stakeholders involved in the WCWI and this watershed plan's development, including:

- Kentucky Division of Water
- Sanitation District No. 1 of Northern Kentucky
- Boone County Planning Commission
- NKU Center for Environmental Restoration
- Boone County Fiscal Court
- Kentucky Transportation Cabinet
- Northern Kentucky Area Development District
- Northern Kentucky Health Department

2.0 Exploring the Woolper Creek Watershed

The Woolper Creek Watershed has six subwatersheds (Figure 2). Upper Woolper Creek and Allen Fork are the most upstream subwatersheds and also have the largest proportions of impervious land cover including the roads, parking lots, and rooftops associated with numerous industrial, commercial, and residential developments concentrated around Burlington and Hebron. By contrast, the Double Lick Creek, Ashby's Fork, and Lower Woolper Creek subwatersheds have the least amount of developed lands, with surrounding land cover that is dominated by forests and open pastures. Approximate bounds of the watershed include Interstate 275 to the north and North Bend Road (KY-237) to the east. No one road serves as the southern boundary, but Burlington Pike (KY-18), East Bend Road (KY-338), Rogers Lane, and Botts Lane approximate the bounds. The outlet to the Ohio River, on the western side of the watershed, is just downstream of where Woolper Creek crosses Belleview Rd (KY-20).



Figure 2: Woolper Creek Subwatersheds

Over the last 65 years the population of Boone County has increased tremendously. Boone County's population growth ranks the second highest in all of Kentucky (US Census, 2009), with a 2010 population of nearly 120,000 (Figure 3). The growth rate over the last 10 years was 38.2% (BCPC, 2010) and continued growth is expected. In Woolper Creek, this growth is expected to be heaviest in the central and eastern portions of the watershed.

Evaluation of the land use throughout the Woolper Creek Watershed indicates 20% of the land is classified as residential, 43% of the watershed is open space/forested, 32% is agricultural area, and the remaining 5% is classified as commercial, industrial, public, and transportation. The Allen Fork and Upper





With Woolper Creek still in the earlier stages of development, large portions of forested, healthy streams can still be protected.

Woolper Creek Subwatersheds are the most developed, with the remaining subwatersheds being a mill of mostly agricultural and undeveloped land.



Figure 4: Double Lick Creek, an Outstanding State Resource Water, to be protected

The unique characteristics found in the Woolper Creek Watershed are the precise reasons why the watershed should and can be protected from degradation. The Double Lick Subwatershed (Figure 4) is a high quality reference stream classified as one of the Commonwealth's Outstanding State Resource Waters. Split Rock and other picturesque areas can also be preserved, which would protect some of Boone County's most scenic resources as well as help to protect the high-quality waterways.

By contrast, the most upstream reaches within the developed headwaters of Allen Fork and Upper Woolper have begun to experience the

initial stages of degradation. This includes several locations with recurring flooding problems, which can reduce the quality of life for private property owners and make portions of public roadways unsafe during heavy rains. Implementing commonsense, cost-effective stormwater control measures in these areas will help to mitigate these localized impacts as well as transfer those benefits to the downstream waterways.

3.0 Learning More and Monitoring

Several years of stream monitoring has been conducted to better understand the conditions and rates of degradation in Woolper Creek. The monitoring was completed in two phases. Phase 1 data was collected between 2006 and 2011 by SD1. Phase 2 monitoring was completed from 2012 to 2013 by the Woolper Creek Watershed Initiative. Monitoring was conducted at a total of 19 sites throughout the Woolper Creek Watershed (Figure 5).



Figure 5: Woolper Creek monitoring locations

The monitoring components included

- <u>Stream flow monitoring</u>: Velocity and depth measurements as well as flow data from the USGS gauge at Woolper Road within Middle Woolper Creek.
- <u>Geomorphic surveys</u>: Surveys of the distribution of the rocks in the streambeds and measurements of stream geometry designed to measure the rates of erosion (Figure 6).
- <u>Habitat assessments</u>: Evaluations of stre_am habitat elements such as the frequency of fast-flowing riffle habitats, amount of sediment, and the quality of riparian vegetation adjacent to the streambank.
- <u>Water quality samples</u>: Field and laboratory measurements for parameters such as bacteria, nutrients, pH, temperature, and sediment.
- <u>Biological assessments</u>: Sampling of fish and aquatic insects (i.e., macroinvertebrates) to quantify the diversity of the biologic community (Figure 7).

September 2016



Figure 6: Geomorphic surveying on the main stem of Woolper Creek

4.0 Analyzing Results

Stream function depends on many components (Figure 8). For example, the land use and land management in the watershed influences the amount of water that drains to a stream as well as its quality. Inadequately managed stormwater runoff from roads and homes can be routed too quickly to streams causing increased flood depths and faster currents in and along waterways. This can increase the erosive power of the stream current, sweeping many of the rocks and pebbles on the streambed downstream toward the Ohio River. The amplified current can also



Figure 7: Conducting biological sampling in Woolper Creek



Figure 8: Stream Function Pyramid adapted from Harmon *et al.* (2012)

erode streambanks and make the stream wider, which can destroy property and pose a threat to adjacent roads and buildings. Such sudden increases in the rates of erosion also impacts the physical habitat and can change the type of aquatic species that can inhabit the stream. As the habitat and physical characteristics change, the water quality and biological integrity of the stream can also be impacted. Excess bank erosion can cause high sediment loads, which cloud the water and can smother important streambed habitat. If not properly treated, stormwater can also carry pollutants such as nutrients from lawn fertilizer and/or bacteria from pet waste. The water quality of the runoff and the changes in habitat can ultimately reduce the amount of animals that can live in and around the stream. This is why biological stream function is placed at the top of the pyramid in Figure 8, as aquatic animals depend on all components of a healthy stream and watershed network, including good water quality, stable habitat, and natural streamflows, in order to fully function.

Several years of monitoring and analysis were conducted to pinpoint the primary impacts in the Woolper Creek Watershed as well as the priority areas for targeted management efforts to mitigate such impacts. As described below, the key driver of the poor habitat and fair biological conditions documented in the developed headwater streams was inadequately managed stormwater runoff generated from urban land uses. Water quality impacts tended to be less prevalent; however, bacteria, as measured by *E.coli*, and nutrients (phosphorus and nitrogen) were found to be pollutants of concern in a few targeted areas of the watershed. These results are discussed in greater detail in the following sections.

Stream Flow Monitoring Results

Flow monitoring was conducted to understand the intensity of streamflow and how conventional development has influenced flows. By comparing monitoring results between the developed site in Allen Fork and the undeveloped site in Double Lick Creek, results showed that the water in the stream was about twice the depth during rainfall events at the developed site. Additionally, the flows were quicker to change, or more "flashy", at the developed site. The rapid changes in depth and flow can cause erosion, degrade water quality, and increase flooding risks.

The developed site had deeper flows that changed more quickly when compared to the undeveloped site. The deeper, faster flows cause erosion,

Physical/Geomorphic Monitoring Results

The stream reaches in the urbanized regions of the watershed, which are experiencing high flows and increased flooding potential, exhibited substantially greater streambed erosion than what was measured in undeveloped watersheds. For example, the streambed composition at the developed sites showed increases in the average pebble size of up to ~100 to 200% during the 2012-2013 monitoring period. This implies that the

Unnaturally high rates of streambed instability were measured at the developed sites in the watershed, meaning the high flows are transporting pebbles downstream –disturbing habitat and aquatic organisms.

high flows are literally picking up the rocks and pebbles on the streambed of the suburban headwater streams and moving them downstream toward the Ohio River, leaving only the largest and heaviest rocks in place. A summary of the rates of streambed instability as compared to the benchmark conditions measured in Double Lick Creek is provided in Figure 9. Notice that the major/moderate rates of streambed instability were predominantly in the developed portions of the watershed.



Figure 9: Stream stability in the Woolper Creek Watershed

Habitat Results

Stream habitat assessments in the Woolper Creek Watershed documented a similar trend in that the sites with the most stable geomorphic conditions tended to have the best habitat. For example,

Stable stream geometry leads to higher quality habitat.

monitoring site WPC 12.3, located in the Upper Woolper Creek Subwatershed and having a watershed that contains 27.3% impervious surfaces (roads, rooftops, etc.), was one of the most unstable sites and had a habitat score of 103 (poor). In comparison, the Double Lick Subwatershed, which was the most stable reference site used in the analysis and has one of the least developed watersheds (3.1% impervious) had a habitat score of 156 (good). Stable streambanks and streambeds tend to provide more desirable aquatic habitat for the macroinvertebrates that live on the rocks and pebbles in the streambed and serve as an important component of the aquatic food chain for insect-eating fish.

Water Quality Results

Several water quality parameters were analyzed to understand which stream reaches could be experiencing high levels of pollutants, such as bacteria, sediment, and nutrients. The analysis included a detailed evaluation of wet and dry weather monitoring events to determine if the pollutants are being carried to the stream through stormwater runoff during rain events (i.e., wet weather) or if pollutants are present during dry conditions.

A total of ten sites were evaluated, but only two sites showed potential water quality concerns. This includes site UT ALF 0.2, located on an unnamed tributary in the Allen Fork Subwatershed, and site WPC 12.3, which again is located in the Upper Woolper Creek Subwatershed (Figure 10). Monitoring results indicate unusually high levels of nutrients at the site on the unnamed tributary in Allen Fork and high levels of *E.coli* in the headwaters of Upper Woolper Creek. Analysis of the upstream land use at these sites suggests potential sources of pollution. For example, agriculture could be a source for the high nutrients along the unnamed tributary in Allen Fork, because a considerable amount of land draining to this monitoring location is used for crop cultivation. If, for example, fertilizer is a primary source of these elevated nutrient loads, it would be beneficial for both Boone County's wate r resources and our crop production to implement management strategies that limit the amount of fertilizer runoff such that the nutrients remain available for crop nurishment in the fields.



Figure 10: Water quality impairments in the Woolper Creek Watershed

The good news about the Woolper Creek Watershed is that the pollutant loads measured are generally much lower than those measured in the neighboring Gunpowder Creek Watershed. This suggests that Woolper Creek is still in the earlier stages of degradation. Targeted implementation efforts in key focus areas should improve the water quality in the upstream reaches and transfer these benefits to the middle and lower reaches of the watershed as well.

With the exception of two sites, water quality monitoring indicates relatively good conditions, as pollutant loads are near benchmark levels for healthy streams.

Biological Results

Lastly, the streams of the Woolper Creek Watershed were rated using a biologic index, and generally, all sites were rated as fair or good. Therefore, the biological integrity of the streams throughout the watershed is pretty good and not nearly as degraded as the neighboring watershed of Gunpowder Creek, which exhibits mostly poor biologic conditions. Looking closer at the results throughout the Woolper Biological results closely aligned with streambed instability: the sites with developed land use and unstable geomorphic conditions ranked "fair" during

Creek Watershed, the sites that ranked fair during the biological assessments typically corresponded to the streams with the most unstable streambeds (Figures 9 & 11). They also tended to be at sites draining the most developed portions of the watershed. This implies that the high stream flows caused by inadequate stormwater management in the developed headwaters is disrupting the aquatic habitat by moving the rocks and pebbles downstream. It also suggests that by investing in cost-effective stormwater management strategies to throttle back the erosive nature of urban stormwater runoff, we could restore more natural rates of streambed erosion and address one of the primary causes of biological degradation in the watershed.



Figure 11: Biology scores in the Woolper Creek Watershed

Prioritized Subwatersheds

While all of the Woolper Creek Watershed will be considered for implementation efforts, the subwatersheds of Double Lick Creek, Allen Fork, and Upper Woolper Creek have been prioritized for more focused implementation efforts. Both Allen Fork and Upper Woolper Creek have flashy, erosive flows, unstable habitat, flooding concerns, mostly good water quality, but only fair biology (Figure 12). Implementation efforts in these subwatersheds will focus on reducing the erosive power of urban stormwater runoff to restore more natural rates of streambed erosion throughout the receiving stream network. Double Lick Creek was selected as the priority rural subwatershed because of its Outstanding State Resource Water status, which has been further supported by the ongoing monitoring efforts. Multiple years of monitoring in Double Lick Creek document a stable streambed with high quality habitat, benchmark water quality, and consistently one of the best biological communities in all of Northern Kentucky. All of these factors support its prioritization for watershed conservation efforts to preserve this community resource for generations to come.



Figure 12: Developed sites in Woolper Creek have worse stream health than undeveloped streams

5.0 Finding Solutions

After understanding the existing conditions of the streams throughout the Woolper Creek Watershed as well as the leading causes of degradation, WCWI determined a wide range of Best Management Practices (BMPs) appropriate for the community and well-suited for the watershed. The data

Best management practices reduce pollution and protect streams.

analysis portion of the planning effort informed the development of these implementation strategies to improve stream impairments and protect the areas in good condition. As previously discussed, stormwater runoff from developed regions of the watershed is causing unnaturally high rates of streambed erosion and degraded habitat/biological conditions; and therefore, stormwater BMPs are a primary focus of the watershed plan.

From retrofitting existing detention basins to release stormwater at a more natural rate (Figure 13) to installing new storage practices such as bankfull wetlands, bioretention, or additional detention basins (Figure 14), WCWI is considering many different types of stormwater BMPs, all of which can provide water quality treatment, channel protection, and flood control. Initially, WCWI will evaluate the opportunity to retrofit existing stormwater detention basins to reduce peak flows and remove

pollutants from the runoff, as this is one of the most costeffective stormwater BMPs because it does not involve extensive earth moving activities. Conventional detention basin designs only provide flood control, but simple retrofits can enhance the basin to throttle back the flows, providing a more natural flow regime to the downstream channel and reducing erosion in receiving streams. The WCWI, along with

EPA, SD1, and Toyota, was an active partner on the pilot installation of the DetainH2O detention retrofit device in the Upper Woolper Subwatershed to document prolonged baseflows in receiving streams, which would also be a benefit to aquatic communities. Over 200 basins have been identified throughout the developed portions of the watershed and the WCWI has completed more detailed studies of the detention basins throughout Allen Fork and the headwaters of the Upper Woolper Subwatershed.

Stormwater BMPs are a primary focus of the Watershed Plan, with an emphasis on detention basin retrofits.



Figure 13: DetainH2O detention retrofit device installed at a site in Upper Woolper Subwatershed



Figure 14: Stormwater BMPs: bioretention (left), detention basin (middle), and bioswale (right)

Although stormwater-volume based BMPs are a major focus of WCWI's planned implementation efforts, the watershed plan also includes many other types of BMPs including agricultural BMPs such as incentive programs for manure management or riparian buffer strips and livestock exclusion fencing to keep livestock out of the streams, construction BMPs that detain sediment on active construction sites, BMPs for forestry practices, onsite wastewater treatment BMPs, and programming such as a pet waste program (Figure 15).

September 2016



Figure 15: Other BMPs included in the Watershed Plan: livestock exclusion fencing agricultural BMP (left), silt fence construction BMP (middle), and onsite wastewater maintenance (right)

In addition, public outreach and education are central to the success of the watershed plan. WCWI plans to continue to engage the community in finding BMP opportunities, assisting with installation efforts, and participating in watershed stewardship programs. The WCWI will continue to publish articles about the watershed plan and its implementation efforts in media outlets such as the

Continuing educational efforts using signage, training, and media will increase the impact of the BMPs with the public.

Landscapes newsletter. Furthermore, the WCWI plans to include educational signage for various BMPs installed throughout the watershed to engage stakeholders about the purpose of the BMPs as well as their progress for implementation and maintenance plans.

While the developed headwaters of Allen Fork and Upper Woolper were prioritized for implementation of stormwater BMPs, WCWI recognizes the importance of conservation and has also prioritized the Double Lick Subwatershed as an undeveloped watershed and an Outstanding State Resource Water. The Center for Watershed Protection (2013) considers preservation of large, undeveloped land to be one of the most cost-effective strategies to protect water quality.

Conservation of undeveloped, forested land throughout the western portions of the watershed can protect healthy streams in this region.

As such, the WCWI understands that 43% of the land throughout Woolper Creek is considered open space/forest, and protecting this land is an important component of the watershed plan. The WCWI will work closely with conservation agencies such as the Boone Conservancy to protect undeveloped land, and it will also work closely with SD1's Stormwater Program to promote sustainable development practices and responsible stormwater controls that are calibrated to the region and protect all components of stream health.

6.0 Strategy for Success

While Chapter 5 of the watershed plan includes an in-depth discussion of the types of BMPs that the WCWI has identified to be implemented, Chapter 6 presents a more detailed plan of action for improvements to the watershed. This includes the most optimal BMPs to be implemented with consideration for pollutants of concern, most probable sources, cost effectiveness, and feasibility. As a

reminder, the monitoring and data analysis portions of the watershed plan build the case for implementing stormwater volume-based BMPs to restore a more natural flow regime to the watershed; and therefore, stormwater BMPs are a primary focus for improving conditions in the developed regions of the watershed.

Restoring a natural flow regime to the watershed through optimizing and implementing stormwater volume BMPs is an important focus of the watershed plan.

Numerous stakeholders have been involved with the

creation of the detailed plan of action presented in Chapter 6. The planning efforts were also discussed at two public roundtable meetings to gain additional input from the community. **Table 1** presents a summary of some of the questions and responses discussed at these meetings. Development and stormwater runoff were leading concerns and priority issues documented by the roundtable groups, and consequently, the most highly recommended BMPs were detention and retention basins to better control stormwater runoff. Education and more responsible development practices and/or revised ordinances were also recommended along with conservation of undeveloped subwatersheds such as Double Lick.

Table 1. Questions and responses from participants		
Question		Responses
1.	Why is a clean healthy stream important to you?	Recreation, Safety, Quality of Life, Aquatic Habitat/Wildlife, Drinking Water Resource
2.	What land uses in the watershed are you most concerned about?	Development, Impervious Surfaces
3.	What do you think are the most common	Erosion and Runoff, Flooding, Development,
	problems?	Pesticide Use
4.	What BPMs do you consider feasible in	Detention/Retention, Education, Responsible
	Woolper Creek?	Development/Ordinances/Planning
5.	What issues in Woolper Creek do you	Stormwater Runoff, Flooding, Conservation of
	consider a priority?	Undeveloped Regions (i.e., Double Lick)

Table 1: Questions and responses from participants

Additionally, the conversations covered the damaging impacts from flooding within the watershed (Figure 16). The following quotes from residents indicate the severity of their experiences and are consistent with the results of the monitoring and data analysis phases of the watershed plan.

"The number one issue we need to correct is flooding concerns and the increased amount of impervious surfaces in the headwaters is the reason we are having these flooding issues."



Figure 16: Flooding in Upper Woolper Creek

"Water quantity seems to be a bigger issue than water quality."

"The stream in my backyard has dramatically changed since I was a child. It used to be a small creek with riffles where we would play, and now the banks have widened and the rocks have been flushed downstream, leaving long deep pools that frequently flood my yard after small rain events."

"The amount the creek has changed in the last 2 years is mind blowing – especially in the springtime. A few years ago we had an 8-foot deep pool in the stream on our property and the next year it filled and it is now only 4-feet deep."

"The creek has changed dramatically – it used to be deep, but now it is shallow and filled in. My fields are frequently flooded and trees washed up onto my land."

Subwatershed Prioritization

Subwatersheds were prioritized for implementation, according to the list below, based on the extent of the impairment and number, cost, and feasibility of identified opportunities within each subwatershed. However, the primary goal of the WCWI is to make the biggest impact possible on the Woolper Creek Watershed. To achieve this goal, it is important to look at beneficial projects as they arise, regardless of the specific location. While the Double Lick Creek, Allen Fork, and Upper Woolper Creek Subwatersheds are currently the three priority subwatersheds, the WCWI may choose to implement projects in other subwatersheds, if it will have a greater impact on overall watershed health. Some examples of items that will be considered include additional funding, location, project partners, willing property owners, project size, and visibility. While project ranking criteria has not been specifically developed, the Steering Committee will discuss and evaluate projects as necessary during implementation.

The action items have been selected based on their applicability and the current needs of the priority subwatersheds. These priority subwatersheds and specific action items have been chosen with the current data available; and as such, the action items were developed for specific land uses (overall watershed BMPs, developed headwaters BMPs, undeveloped BMPs,

WCWI proposes for their subwatershed prioritization to be responsive to the opportunities that arise in the watershed by stakeholders.

and agricultural BMPs) in order to apply these BMPs to anywhere in Woolper Creek that the land uses are found.

- 1. Allen Fork (developed headwaters, with some agricultural land use)
- 2. Upper Woolper Creek (developed headwaters)
- 3. Double Lick Creek (undeveloped)
- 4. Ashby's Fork (mixed rural/agricultural & developed)
- 5. Middle Woolper Creek (mixed rural/agricultural & developed)
- 6. Lower Woolper Creek (undeveloped bottomlands)

Overall Watershed BMPs

The following BMPs are considered appropriate measures to implement throughout the watershed.

- Stewardship programs
- Education and Outreach
- Training and/or Technical Support Programs
- Coordination with Northern Kentucky University's (NKU) Stream and Wetland Restoration Program
- Revision of Rules and Regulations
- On-site Wastewater Treatment
- Riparian Plantings
- Structural and Non-structural BMPs
- Success monitoring and analysis
- Watershed Coordinator

From stewardship programs and education/outreach in the community to training and technical support for local designers/contractors and coordination with other partners such as NKU's Stream and Wetland Restoration Program, the WCWI understands the importance of community engagement and project stakeholders; and therefore, these elements are important BMPs to implement throughout the entire watershed. Engaging the public as well as educating local designers and contractors on the most appropriate stormwater management strategies for the watershed is critical to the success of the watershed plan. With that, the WCWI will support efforts to revise stormwater rules and regulations to include requirements related to protecting streams from excess erosion in addition to the water quality requirements that already exist. Furthermore, the Fee-In-Lieu-Of (FILO) funds are collected as part of the NKU Stream and Wetland Restoration Program when developments or other land disturbance projects physically alter streams. The FILO program has already funded stream and wetland restoration projects in the watershed (e.g., Boone Woods Park) and the WCWI plans to continue to coordinate with the NKU program to find other beneficial projects in the watershed.

In addition to these outreach activities, the WCWI has included onsite wastewater treatment BMPs such as maintenance of septic systems, riparian plantings that provide a buffer to help cleanse overland stormwater runoff entering the stream, and other structural and non-structural BMPs to be implemented as appropriate throughout the watershed. BMPs will be constructed as cost-effective opportunities arise. Once BMPs are constructed, success monitoring and analysis will be conducted to provide information on the benefits of the BMPs and allow the WCWI to assess the effectiveness of its implementation strategies.

Perhaps one of the most important elements included under this section of the Watershed Action Plan is the Watershed Coordinator, who will be devoted to implementing the watershed plan through installation, maintenance, and monitoring of BMPs as well as outreach activities. The Watershed Coordinator for the WCWI is Mark Jacobs (Figure 17) at the Boone County Conservation District.



Figure 17: Mark Jacobs of BCCD receiving an award at the KY-TN Water Professionals Conference for the success of the Gunpowder and Woolper Creek Watershed Plans.

Developed Headwaters BMPs

Recall that monitoring and data analysis indicated that the developed headwaters of Allen Fork and Upper Woolper Creek present the most degraded stream reaches, suffering from fair biological conditions caused by erosive urban stream flows and unnatural rates of streambed erosion. These developed areas were also the biggest areas of concern for the public, with known stormwater, flooding, and erosion issues, and are the highest priority for focused efforts to mitigate erosive flows that have altered the habitat and lowered the biologic integrity. The following BMPs are considered appropriate measures to implement in the developed headwater subwatersheds.

- Detention basin retrofits
- New detention and bioretention basins
- Enhanced swale pilot study

- Pet waste program
- Wetland creation/restoration

Most of the BMPs identified for the developed regions of the subwatershed include stormwater controls designed to mitigate erosive flows by throttling back the release of stormwater below the level that causes streambed erosion. As previously mentioned, detention basin retrofits are one of the most cost-effective stormwater volume-based BMPs, as these retrofits are estimated to be 10 to 100 times more cost-effective than creating new detention basins because they do not require extensive earthwork. Some retrofit projects have already been installed within the Woolper Creek Watershed, and the WCWI has completed detailed studies of the basins in the Allen Fork Subwatershed (Figure 18) and a portion of the Upper Woolper Subwatershed, identifying 11 basins as initial opportunities for basin retrofits in the Allen Fork Subwatershed and 17 for further consideration in the Upper Woolper Subwatershed. Depending on the willingness of property owners and potential partnerships, these will be prime candidates to target for implementation. However, not every basin is conducive to retrofitting; and therefore, new storage (e.g., detention basins, bioretention basins, enhanced swales, and wetlands) may be necessary in the developed regions of the watershed.



Figure 18: Allen Fork Prioritized Detention Basin Retrofit Locations

Another innovative strategy in our developed watersheds targets improved management of highway runoff. Coordination between the WCWI, SD1, and the Kentucky Transportation Cabinet could provide a viable opportunity to design, install, and monitor an innovative BMP, the enhanced swale pilot study, which incorporates flood control, water quality, and channel protection to roadway projects. This linear BMP would provide control to roads and interstates, which are commonly discharged directly to the streams without any treatment. If the pilot project proves to be as successful as preliminary



Figure 19: Boone Woods Wetland and Stream Restoration Project

estimates suggest, the WCWI may pursue this opportunity throughout several regions of the watershed. Wetland creation/restoration has already occurred in the Allen Fork Subwatershed in Boone Woods (Figure 19). Additional efforts to construct or restore wetlands can provide storage to mitigate erosive flows as well as enhance water quality and restore wetland habitat.

Lastly, a pet waste program is targeted for areas popular to dog walkers, such as parks and residential neighborhoods with walking trails. As simple as it sounds, encouraging responsible pet ownership to keep dog waste out of stormwater runoff and away from our waterways is one of the most cost-effective management strategies available. Pet waste stations and educational signage (Figure 20) depicting the importance of cleaning up and keeping bacteria out of the streams will be installed in these areas. Other benefits of such simple programs include protecting public health (especially keeping it away from children) as well as helping everyone in the community by avoiding stepping in it.

Agricultural BMPs

The primary agricultural BMP to be implemented initially includes livestock exclusion fencing that will help to remove farm animals from the stream and protect them from potential injury and drinking polluted water. Livestock can



Figure 20: Example sign for pet waste program

easily degrade the stream by trampling bank vegetation and depositing waste directly into the stream. This fencing prohibits livestock from entering the stream; and therefore, in many cases an alternate water source must also be provided. The WCWI will work with cattle and horse farms to implement this BMP in the agricultural regions of the watershed. Additionally, the WCWI anticipates the potential for implementing other structural agricultural BMPs such as filter strips and cover crops or non-structural BMPs such as nutrient management plans.

Undeveloped Areas

Conservation of open space/forested land is an important aspect of the watershed plan, particularly in the undeveloped subwatershed of Double Lick. With the high rate of development throughout Boone County, identification of conservation areas and sustainable development practices is critical. The WCWI may be able to find opportunities to purchase land or obtain conservation easements within the subwatershed.

Maps of preliminary opportunities for the priority subwatersheds of Allen Fork and Upper Woolper have been included in the stand alone figures located at the end of this document. Stormwater-volume based controls are not anticipated within the Double Lick Creek Subwatershed at the time this document was written, so no map has been included.

7.0 Making It Happen

Restoring the degraded portions of the watershed and conserving the beautiful resources throughout Woolper Creek requires good leadership, teamwork, and dedication. This section of the *Woolper Creek Watershed Plan* highlights the plan's biggest advocates, various roles for implementation, financial details, and the approach for measuring progress and success.

Mark Jacobs from BCCD has been the plan's number one advocate, serving as the Watershed Coordinator and project manager. His leadership and knowledge of the watershed has provided a great framework for the plan's development and will be beneficial as the WCWI moves into the implementation phases of the watershed plan. Throughout the development of the plan, the WCWI Steering Committee and Technical Subcommittee have met on a regular basis, and these stakeholders will continue to meet in order to identify opportunities and ensure proper implementation of the plan. The WCWI will also continue to reach out to the community, as public engagement is integral to the success of the plan. Through media outlets such as BCCD's quarterly newsletter (*Landscapes*), Boone County's publication of *What's Happening in Boone County, The Boone County Recorder* newspaper, BCCD's website, and BCCD's Facebook page, the WCWI will engage the local community and provide updates regarding implementation projects.

Funding to date has been primarily through a Kentucky Nonpoint Source Pollution Control Program, or 319(h) grant, supported by matching funds from a variety of sources. The WCWI anticipates additional funding from the grant program to support BMP implementation and continue to make this watershed plan a successful endeavor. Additionally, the WCWI understands the importance of partnerships with other entities, such as private organizations, public institutions, volunteer agencies and utilities like SD1. Through these partnerships the WCWI can generate match opportunities and work in collaboration to implement the plan.



Figure 21: WCWI Implementation

The WCWI's approach of implementation, monitoring, and reassessing strategies for future projects is an important aspect of the implementation efforts (Figure 21). Stream monitoring will continue to occur at the locations highlighted in Figure 7. Additionally, the success of various implementation projects will be measured differently. Some will involve detailed monitoring while others will be measured by the number of BMPs installed or participation rate in a particular program.

The WCWI would like to express its gratitude to everyone involved with the development and ongoing implementation of the *Woolper Creek Watershed Plan*. From the participants at the community round tables to vested stakeholders on the Steering Committee and Technical Subcommittee, involvement and interest to date has been greatly appreciated. May we all continue to be stewards of the watershed, working together to improve the degraded reaches and to conserve the pristine reaches of the Woolper Creek!

Glossary of Terms

Dry weather: Event that experienced less than or equal to 0.7 inches of rainfall within 48 hours prior to of the sample date (for purposes of this document).

Geomorphology: The study of landforms and topography, with an emphasis on geologic/topographic formation and movement.

Headwaters: Upstream, or higher, portions of a creek or stream that feed the main channel.

Nutrients: Nitrogen and phosphorus (for purposes of this document). High levels of nutrients in the stream can lead to excess growth of algae and other aquatic plants, altered stream habitat, and degraded biological conditions.

Onsite wastewater treatment: Decentralized wastewater treatment at the house or business level. Also known as a septic system.

Riparian: of or relating to the banks of a stream or river.

Wet weather event: Event that experienced over 0.7 inches of rainfall within 48 hours prior to of the sample date (for purposes of this document).

References

- Boone County Planning Commission (BCPC), 2010. <u>2010 Boone County Comprehensive Plan: Planning</u> <u>for the year 2035</u>. Adopted June 6, 2012. Boone County Planning Commission, Burlington, KY.
- Center for Watershed Protection (CWP), 2013. Cost-Effectiveness Study of Urban Stormwater BMPs in the James River Basin. Center for Watershed Protection, Eliot City, MD. June.
- Harmon, W., Starr, R., Carter, M., Tweedy, K., Clemmons, M., Suggs, K., Miller, C., 2012. A Function-Based Framework for Stream Assessment and Restoration Projects. US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006.
- US Census, 2009. Annual Estimates of the Resident Population for Counties of Kentucky: April 1, 2000 to July 1, 2009. U.S. Census Bureau, Population Division. http://ksdc.louisville.edu/kpr/popest/coest2009.xls