319 WATERSHED IMPLEMENTATION PLAN:

BUFFALO CREEK WATERSHED
UNION COUNTY, PA

NOVEMBER 2008

PREPARED BY THE UNION COUNTY CONSERVATION DISTRICT
WITH ASSISTANCE FROM THE BUFFALO CREEK WATERSHED ALLIANCE

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CHAPTER 1

WATERSHED OVERVIEW

OVERVIEW

The Buffalo Creek Watershed is located in central Pennsylvania and covers a land area of 134 square miles or 85,760 acres[1]. The watershed is in the heart of Buffalo Valley and is one of the most important watersheds and the largest in land area within Union County (See Figure 1.1). Buffalo Creek and its headwater tributaries originate in the western forested mountains of Union County and eastern Centre County. The main stem flows 28 miles from its origin to the mouth at Lewisburg where it empties into the West Branch of the Susquehanna River. The watershed has a regular dendritic drainage pattern. The meander ratio of Buffalo Creek is 1.18 with a relief ratio of 63.8 and a channel slope of 46.8 feet per mile.[2] Average annual precipitation is 42 inches with an average daily temperature of 51 degrees.[3]

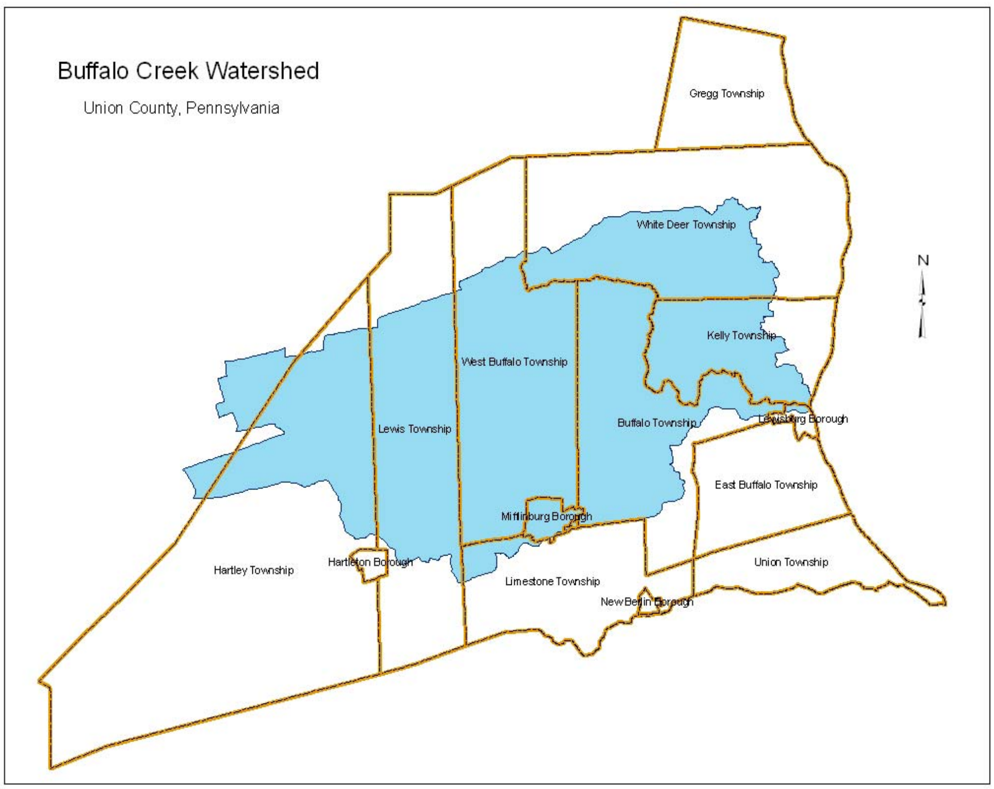


Figure 1.1 Map of the Buffalo Creek watershed located in Union County, Pennsylvania.

The Buffalo Creek watershed covers portions of 9 townships and two boroughs in parts of two counties. In addition to the two larger boroughs of Lewisburg and Mifflinburg, the watershed includes villages and locales such as Pleasant Grove, Forest Hill, Vicksburg, Cowan, Mazeppa, Buffalo Crossroads, Kelly Crossroads and Kelly Point. In total, the watershed is home to nearly 15,000 people.[4]

LAND RESOURCES

As stated above the Buffalo Creek watershed is 134 square miles in area. Topography throughout the watershed is varied. The headwater areas in the western and northern regions of the watershed are more rugged and mountainous with steeper ridges while the central and eastern portion is a more level to small-scale rolling hill topography.

GEOLOGY

Geology in the Buffalo Creek Watershed and all of Union County is within the Ridge and Valley Physiographic Province and is characterized by folded, faulted and fractured sedimentary rocks. The Buffalo Valley lies between topographic highs to the northwest and southeast. Over time less resistant, younger bedrock has weathered away exposing more resistant older bedrock. These older rocks are typically sandstones and conglomerates of the Tuscarora, Juniata, and Bald Eagle Formations. The valley floor occurs in younger carbonate rocks of the undifferentiated Keyser and Tonoloway Formations. The Keyser and Tonoloway Formations include nodular limestone, and, argillaceous (shaley) limestone and dolomite. In addition the undifferentiated Onondaga and Old Port Formations consist of cherty limestone, calcareous shale and calcareous sandstone. The Union County Water Supply and Wellhead Protection Plans identify these limestone formations as having a greater capacity to yield groundwater. Buffalo Creek flows mostly on weaker, easily-eroded rocks in the major valley or in the synclines between anticlinal ridges while some of the headwaters show evidence of being superimposed on resistant rock. To this day Buffalo Creek and its tributaries are responding to a geologic framework imposed millions of years ago by deposition of sediments, deformation of rocks, and subsequent differential erosion of weak and strong rocks to form valleys and uplands.[5]

Often people overlook the importance or influence geology has on a stream network. In the Buffalo Creek watershed the underlying geology has been found to have a dramatic impact on water quality. For example in the headwaters of Buffalo Creek the stream is chronically acidified in the upper five to seven miles due to acid deposition (acid precipitation) while just over the mountains to the north the North Branch of Buffalo Creek and Spruce Run are not. The reason the other two are not similarly affected is believed to be a result of the geology. The North Branch and Spruce Run originate in rock that contains carbonate minerals (i.e. limestone and dolomite) which provide natural buffering capacity, while the main stem headwaters are in a Tuscarora sandstone formation which cannot neutralize the acid precipitation. Refer to Figure 1.2 for map of the watershed surface geology and Appendix A for geologic descriptions.[6]

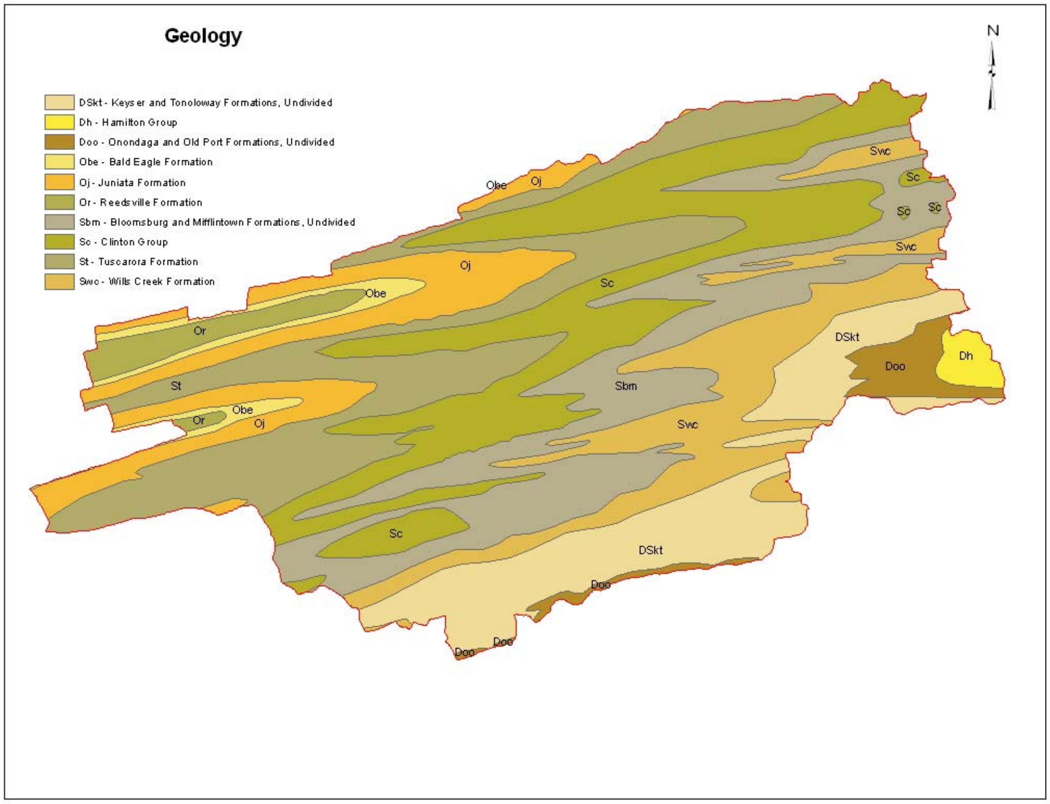


Figure 2.1 Surface geology of the Buffalo Creek watershed.

SOILS

Soils throughout the watershed are varied and can be classified into specific soil associations or generalized categories such as hydrologic soil groups which provide a basic description of how certain soil associations will affect water runoff. Individual soil associations that are commonly found in the watershed and make up a significant portion of the overall soil cover include the following: LaidigBuchanan-Meckesville, Dekalb-Ungers-Hazelton, Weikert-Berks-Hartleton, Edom, Hagerstown-Elliber-Washington, Holly-Basher-Monongahela, Allenwood-Alvira-Shelmadine, and Klinesville-CalvinMeckesville.[7]

The hydrologic soil groups are in four main sub-groups lettered "A" through "D" based on infiltration rate and depth. Refer to Figure 1.3 for the watershed hydrologic soil grouping map. Hydrologic Soil Group (HSG) "A" soils are the most permeable and have the lowest runoff potential while HSG "D" soils have low permeability and have a high runoff potential. Often these are floodplain and wetland soils. The majority of the soils in the watershed fall into the HSG "B" and "C" categories with HSG "B" soils found mainly in the western upper portion of the watershed and "C" soils in the eastern reaches.[8]

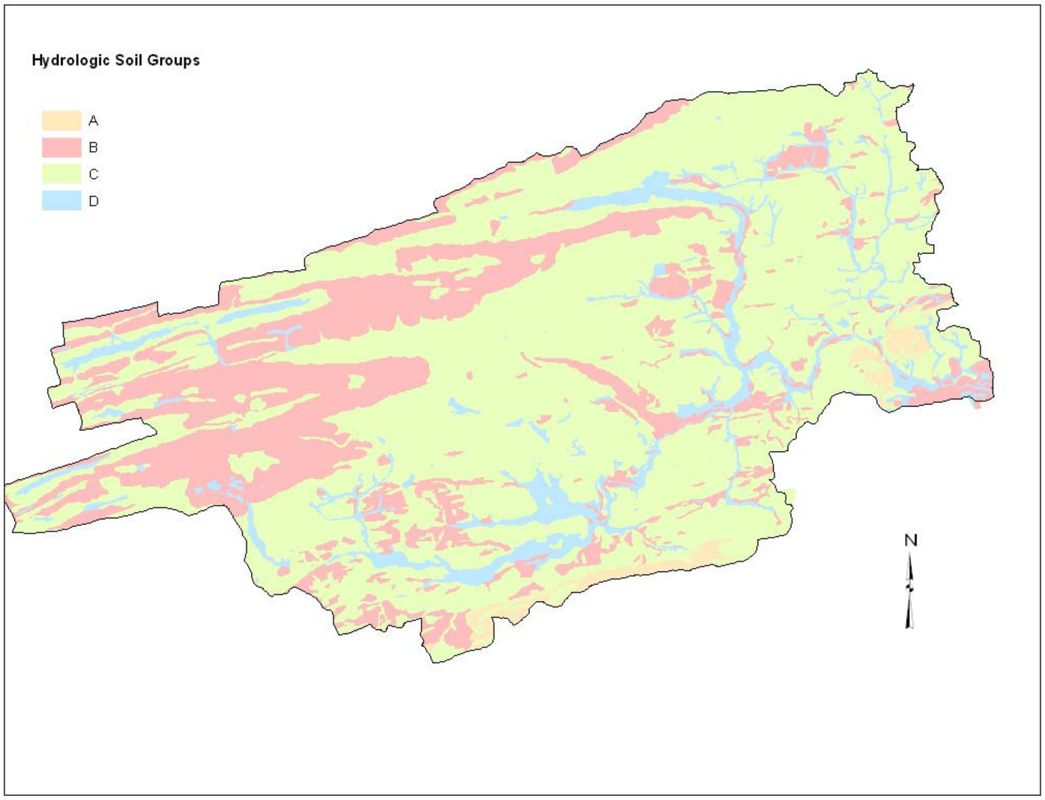


Figure 1.3 Hydrologic soil groups in the Buffalo Creek watershed.

FLOODPLAINS & WETLANDS

Floodplains are low-lying areas adjacent to watercourses that are either inundated or likely to be inundated by flood waters and serve to store excess water during high flow events. Typically the floodplain is expressed in terms of the 100-year floodplain, which is the area of land adjacent to a stream that would be flooded by a storm on the magnitude of having a statistical probability of occurring once every 100 years or a one percent chance in any year. In many cases floodplains are delineated on maps and in Flood Insurance Studies prepared by the United States Department of Housing and Urban Development or the Federal Emergency Management Agency. For those streams that do not have floodplains identified by such sources the regulatory floodway and floodplain in Pennsylvania is 50 feet landward from the top of the stream bank as per the regulations contained in Title 25, Chapter 105 of the Pennsylvania Code. Within the Buffalo Creek Watershed there are 3,945 acres of floodplains that are mapped by the Federal government. In addition there are 1,672 acres of additional floodplains in the watershed based on the 50 foot rule. Refer to Figure 1.4 for a map of floodplains in the watershed.

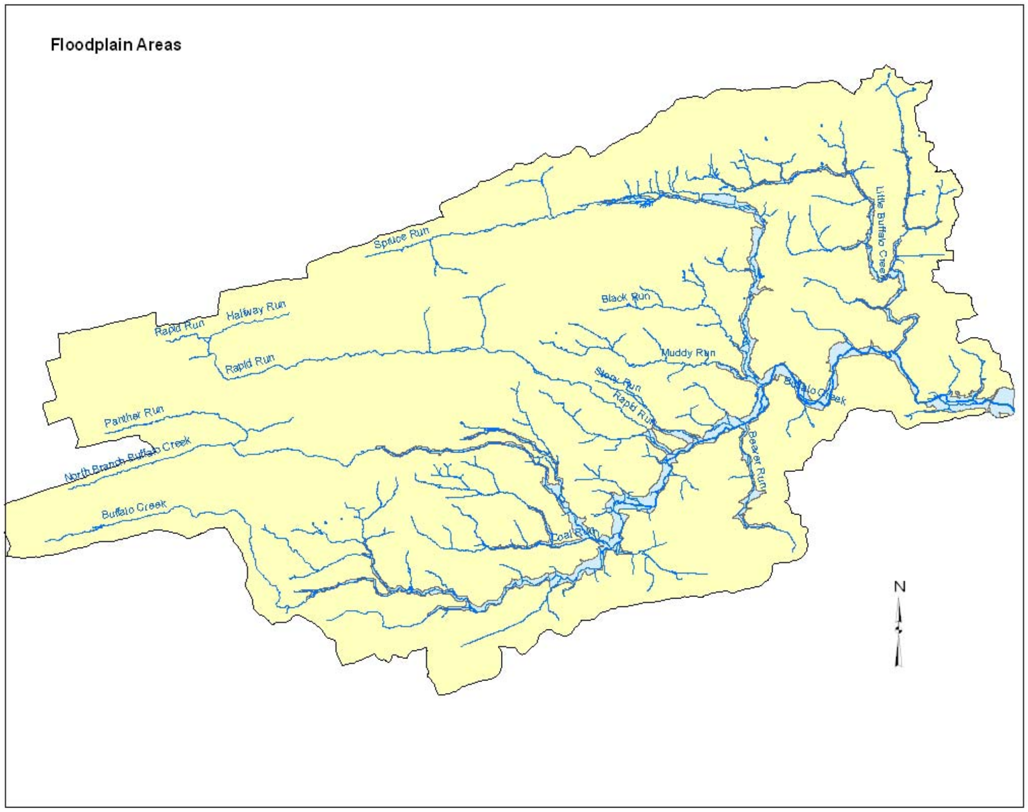


Figure 1.4 Floodplain areas throughout the Buffalo Creek watershed.

Wetlands are defined as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation adapted for life in saturated soil conditions and includes terms such as swamps, marshes, bogs, fens, and similar areas. Wetlands perform many important functions within watershed ecosystems such as filtering sediments and pollutants, groundwater recharge, floodwater storage and wildlife habitat. In the Buffalo Creek Watershed there are 800 acres of wetlands mapped on the National Wetland Inventory (NWI) which was prepared and is maintained by the United States Department of Interior, Fish and Wildlife Service. However these maps are very general in nature and should be used with extreme caution. They cannot be relied upon to determine if a site does or does not contain wetlands. Professionals experienced in wetland regulation and permitting believe the NWI maps miss 50% or more of all actual wetlands.[9] If this is the case there would actually be at least

1,600 acres of wetlands in the Buffalo Creek Watershed. Due to the unreliability and frequent misuse of the NWI data a wetlands map was not included in this watershed plan.

WATER RESOURCES

The watershed has over 268 stream surface miles that range in quality from pristine reaches to those with lesser attributes. Major tributaries to Buffalo Creek include: North Branch of Buffalo Creek, Rapid Run, Spruce Run, Beaver Run, and Little Buffalo Creek. Waters in the Commonwealth of Pennsylvania have been assigned water quality designations which are contained in Title 25, Chapter 93- Water Quality Standards of the Pennsylvania Code. Buffalo Creek and its tributaries are listed in Table 1.1 along with the applicable use classification assigned by the PA DEP. Water quality standards can be found in Tables 1.2 and 1.3.

Table 1.1 Buffalo Creek watershed tributaries and their designated uses.

Name	Segment	Designated Use[1]
Buffalo Creek	Source to SR 3005 bridge	HQ-CWF
Buffalo Creek	SR 3005 bridge to Rapid Run	CWF
Buffalo Creek	Rapid Run to mouth	TSF
Unnamed tributaries to Buffalo Creek	Basins, SR 3005 bridge to Rapid Run	CWF
North Branch Buffalo Creek	Source to Mifflinburg Reservoir	EV
North Branch Buffalo Creek	Mifflinburg Reservoir to mouth	HQ-CWF
Rapid Run	Basin	HQ-CWF
Unnamed tributaries to Buffalo Creek	Basins, Rapid Run to mouth	CWF
Stony Run	Basin	HQ-CWF
Beaver Run	Basin	CWF
Spruce Run*	Basin	HQ-CWF[11]
Little Buffalo Creek	Basin	CWF

[1]HQ-CWF = High Quality Cold Water Fishery, * Headwaters to Bald Eagle State Forest Boundary is in CWF – Cold Watery Fishery and is in the process of being upgraded to EV. TSF – Trout Stocking EV- Exceptional Value

High Quality-Cold Water Fisheries are streams or watersheds that have excellent water quality and environmental or other features that require special water quality protection. They also maintain and/or propagate fish species, including the Salmonidae family, and additional flora and fauna which are indigenous to a cold water habitat. A Cold Water Fishery is similar except it lacks the higher-level water quality protection provisions under state law. An Exceptional Value stream or watershed constitutes an outstanding national, state, regional or local resource such as waters of national, state, or county parks, forests, or waters which are a source of unfiltered potable water supply…or of substantial recreational or ecological significance. Only one area of the watershed has attained this designation, North Branch of Buffalo Creek, although a case could perhaps be made for the upper reaches of Spruce Run from its source to the Spruce Run Reservoir. Both the North Branch of Buffalo Creek and Spruce Run are public drinking water supplies. Trout Stocked Fisheries are waters that maintain stocked trout from February 15th to July 31st and also support the maintenance and propagation of fish species and other flora and fauna that are indigenous to a warm water habitat.

Table 1.2 Water quality standards and their critical use.

Parameter	**Criteria**	**Critical Use***
Alkalinity	Minimum 20 mg/L as $CaCO_3$ (except where natural conditions are less)	CWF, WWF, TSF, MF
DO_1	Minimum daily average 6.0 mg/L	CWF
DO_3	Minimum daily average 6.0 mg/L (Feb 15 - July 13), 5.0 mg/L (rest of year)	TSF
DO_4	Minimum daily average 7.0 mg/L	HQ-CWF
Iron	30-day average 1.5 mg/L as total recoverable	CWF, WWF, TSF, MF
Osmotic Pressure	Maximum 50 milliosmoles/kg	CWF, WWF, TSF, MF
pH	From 6.0 to 9.0 inclusive	CWF, WWF, TSF, MF
Chlorine	Four-day average 0.011 mg/L as total residual	CWF, WWF, TSF, MF

*EV streams based on existing quality

Table 1.3 Temperature standards by critical use.

	Temperature (F)		
Critical Use Period	**CWF**	**WWF**	**TSF**
January 1-31	38	40	40
February 1-29	38	40	40
March 1-31	42	46	46
April 1-15	48	52	52
April 16-30	52	58	58
May 1-15	54	64	64
May 16-31	58	72	68
June 1-15	60	80	70
June 16-30	64	84	72
July 1-31	66	87	74
August 1-15	66	87	80
August 16-30	66	87	87
September 1-15	64	84	84
September 16-30	60	78	78
October 1-15	54	72	72
October 16-31	50	66	66
November 1-15	46	58	58
November 16-31	42	50	50
December 1-31	40	42	42

Besides Chapter 93 the PA DEP maintains a statewide list of impaired waters as is required by the Federal Clean Water Act. This list was previously referred to as the 303.d list but is now commonly called the Integrated Streams list. There are a number of stream reaches in the Buffalo Creek Watershed that are on this list. The location of these and their sources of stream impairment will be identified later in this report and on the map in Appendix A.

Often overlooked but equally important to surface water is the groundwater in the watershed. The watershed is underlain by a complex underground flow regime that provides well owners with potable water and serves as the main source of water for stream base flow during the dryer months of the year. In the Buffalo Creek Watershed groundwater quality and quantity is linked to the underlying geology. Limestone aquifers typically produce larger yields of water but can be susceptible to pollution due to the fractured nature of the formations. Sinkholes and other cracks and voids can develop over and within limestone that can eventually become direct conduits for pollutants to enter the groundwater supply. Once it is contaminated groundwater is extremely difficult to clean, and treatment measures are often cost prohibitive. Even small amounts of substances around the home like motor oil, gasoline, and pesticides can ruin millions of gallons of water.

Biological resources of the watershed include all the plant and animal species that dwell in the woods, waters, and open areas of the drainage basin including but not limited to aquatic and terrestrial insects, fish, vegetation, mammals, reptiles, trees, shrubs, grasses, and other vegetation. The watershed forests are primarily deciduous hardwoods of oak, cherry, maple, hickory and beech with coniferous stands of hemlock and pine interspersed.

Common fish in the colder flowing stream segments are brook and brown trout while the warmer water reaches hold suckers, smallmouth bass and those species tolerant of warmer conditions. Half of all Pennsylvania Fish and Boat Commission approved trout waters in Union County are in the Buffalo Creek Watershed and include: Buffalo Creek from the T-366 Bridge on Aikey Road in Hartley Township downstream to the confluence with Rapid Run at Cowan, Halfway Lake at Raymond B. Winter State Park, North Branch of Buffalo Creek, Rapid Run and Spruce Run. In addition two of the four Class A Wild Trout Waters in Union County are in the watershed and include the North Branch of Buffalo Creek (brook trout) above the Mifflinburg Reservoir intake and Rapid Run (brown trout) from the Walbash Road Bridge on T-383 upstream to Buffalo Path.

A summary and description of available in-stream biological data will be presented in the next chapter of this plan. The watershed is also home to a variety of wildlife such as whitetail deer, black bear, wild turkey, songbirds, raptors, waterfowl, rodents such as mice, squirrel, muskrat and chipmunk, red and gray fox, raccoon, opossum, skunk, reptiles and amphibians too numerous to mention. Probably unbeknownst to the average homeowner is the fact the watershed also contains a number of species of special concern, such as rare, threatened, or endangered plants and animals, that were identified in the Union County Natural Areas Inventory of 1993 and the 2000 update.

LAND USE

Land use can significantly influence water quality. Generally areas undeveloped with little human presence have better water quality while streams in and around agricultural and developed areas generally show some signs of degradation. Erosion from cultivated fields and streambanks where livestock is not excluded, manure runoff, and over-application of fertilizer and pesticides can be problems associated with land that is farmed. Land that is used for residential and commercial purposes often contribute excessive amounts of stormwater runoff, pollutants that wash off parking lots, thermal inputs, and increased nutrient loads associated with over application of lawn and garden chemicals, malfunctioning on-lot septic systems and effluent from sewage treatment plants.

The predominant land uses in the watershed are forest at approximately 60 percent, a significant portion of which is within the Bald Eagle State Forest District, and agriculture at 34 percent. The remaining six percent is developed in the form of residential, commercial, industrial and institutional uses. The majority of the forested area lies in the western and northern extremities of the watershed while the central and eastern portion is largely farmland with development mainly concentrated in the Lewisburg and Mifflinburg regions. Figure 1.5 shows the distribution of land uses throughout the watershed.

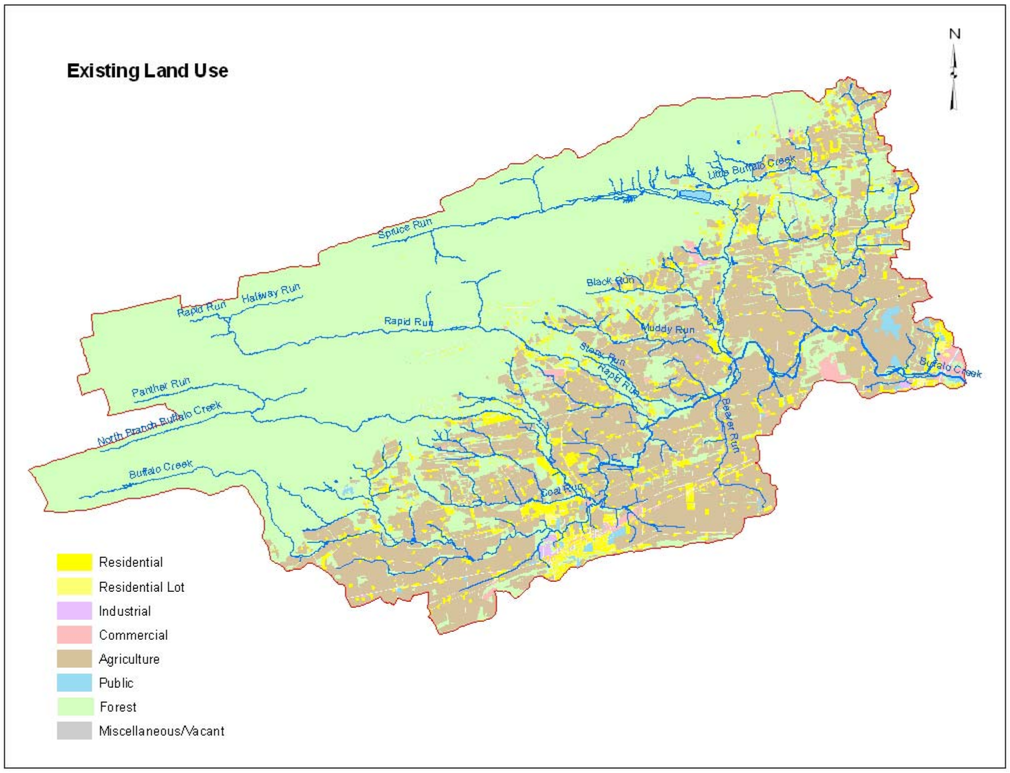


Figure 1.5 Existing land use in the Buffalo Creek watershed.

Expected future development will primarily occur where it is most easily attained under existing land use regulations, such as zoning ordinances, and where it will be readily served by necessary infrastructure like roads, water, and sewer. By examining the municipal zoning districts and associated infrastructure service areas, it appears the majority of future development will occur in and around Mifflinburg and Lewisburg Boroughs, particularly the PA Route 45 corridor. However, growth is also expected in and around the villages of Vicksburg and Pleasant Grove and northwest of Mazeppa in the Black Run area.

Currently about 38% of the watershed is zoned Agricultural Preservation and 36% Woodland/Public Land. Agricultural and Woodland zoning, although intended to be conservation type zoning districts, do not preclude development of those areas. Generally non-agricultural development is permitted to a limited scale. Today's changing nature of agricultural production can bring significant development to the watershed even in the agricultural areas. Newly constructed barns intended to house large animal production operations are often 20,000 to 40,000 square feet per structure. One of these facilities can contribute as much impervious surface as a small residential development of five to seven homes, and nearly 8% is zoned low density residential, while approximately 4% is zoned medium to high density residential, typical of suburban and urban development patterns. If one were to guide growth within a watershed with the goal of maintaining a healthy ecosystem the best approach might be to locate the most intense growth near the mouth or stream outlet thereby confining the negative impacts of human impact to a smaller area. However in this watershed much of the rural residential zoned land is in the middle of the watershed. In much of these areas zoning promotes what is typically referred to as suburban sprawl where there are homes on larger lots of at least one-acre in size with wider than necessary streets. Commercial zoned areas barely account for 1% of the entire watershed land area. It should be noted that there are two areas in the watershed that are not zoned that equal about 5% of the watershed in Haines, Miles and Limestone Townships. The land in Haines and Miles Townships are in the Bald Eagle State Forest but the 1,108 acres in Limestone Township is in private ownership. Refer to Figure 1.6 for watershed zoning districts. Figure 1.7 shows the protected lands in the watershed in the form of state forest, state parks, state gamelands, preserved farms, conservation easements and federal reservation which accounts for 33,000 acres or 33% of the land area.

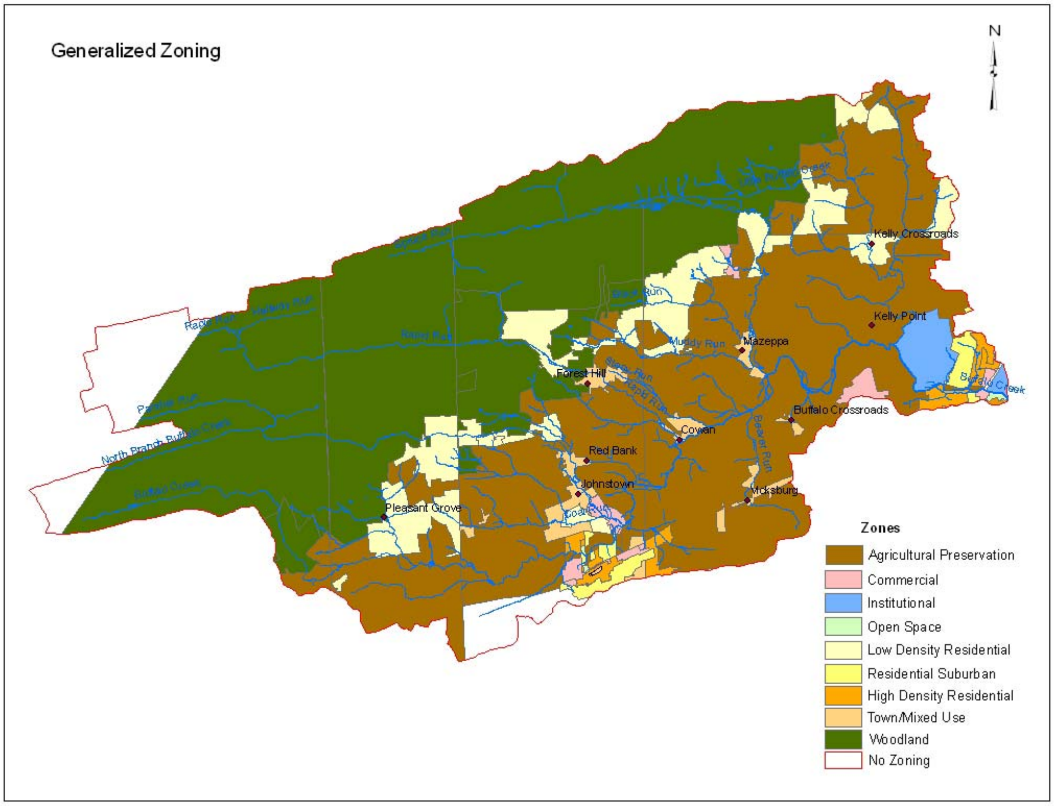


Figure 1.6 Zoning districts within the Buffalo Creek watershed.

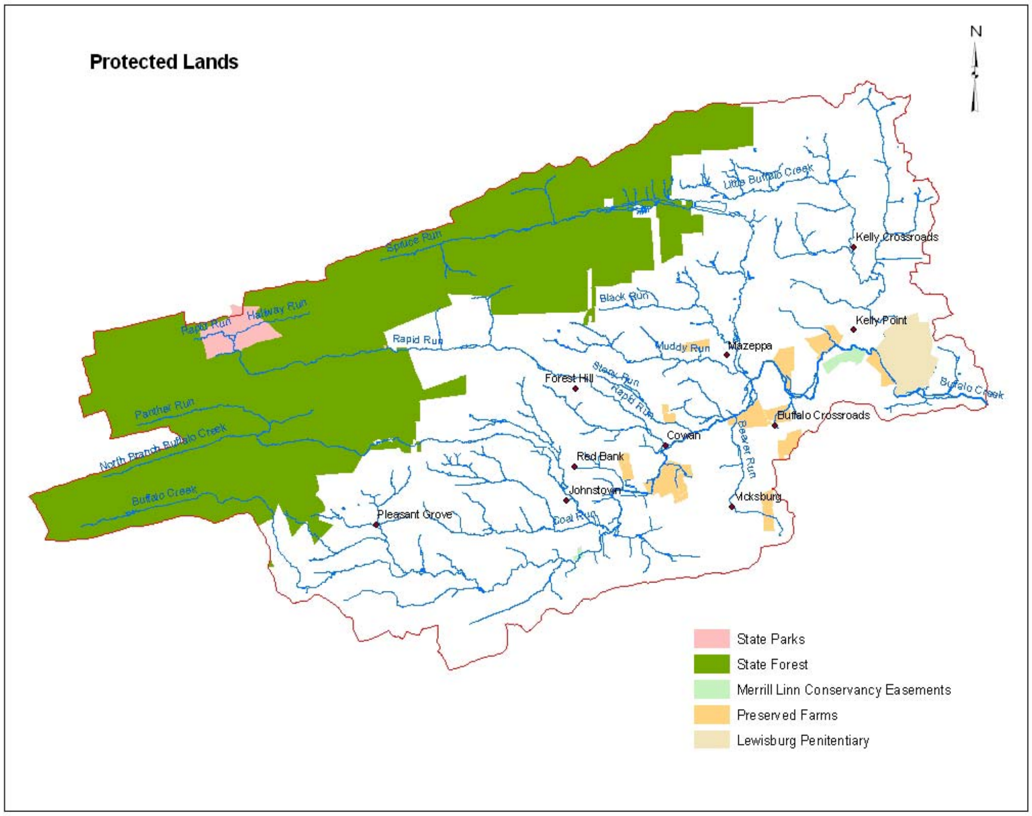


Figure 1.7 Protected lands within the Buffalo Creek watershed.

Within the watershed there are two water supply reservoirs, one operated by Mifflinburg Borough on the North Branch of Buffalo Creek and the other is operated by the Pennsylvania American Water Company on Spruce Run. At one time Pennsylvania American had land holdings along Rapid Run as a potential future water supply; however, the company recently sold a number of these holdings. The Borough of Mifflinburg provides a public water system to its residents and to a limited number of homes in the surrounding townships of Buffalo, Limestone and West Buffalo. Pennsylvania American supplies water to the eastern fringe of the watershed in Lewisburg Borough and portions of Kelly Township. There are two sewage treatment plants with effluent discharges into Buffalo Creek; these are the Mifflinburg Borough and the Buffalo Township Sewage Treatment Plants. The Mifflinburg plant had a 10-year Average Monthly Daily Flow of 0.74 million gallons per day (MGD) from 1995 to 2004 and is currently rated for an Average Daily Flow of 1.40 MGD.[12] The plant uses gaseous chlorine for primary disinfection. Presently Mifflinburg is looking to invest several million dollars to bring the plant into compliance with the latest Chesapeake Bay nutrient removal requirements. The Buffalo Township operation is permitted for 0.05 MGD and is operating at approximately 50% capacity.[13]

Transportation infrastructure in the watershed is limited to roadways as the area is too rural to support public transit. The major roadways are PA Routes 45 and 192 that bisect the middle of the watershed and provide an east-west connection from Lewisburg to the greater State College region. US Route 15 passes through a small portion of the watershed near the mouth of Buffalo Creek.

The Mifflinburg Area School District has several schools in the watershed including the elementary, intermediate, middle, and high schools in the Borough of Mifflinburg and the Buffalo Crossroads Elementary School in Buffalo Township. The BCWA has utilized a number of these facilities for public meetings in the past. In addition Buffalo Township, Mifflinburg Borough, and West Buffalo Township have their buildings and maintenance operations in the watershed. Union County Government also owns a building adjacent to the Mifflinburg Borough office which BCWA has frequently used.

ENDNOTES

[1] Union County Geographic Information System. Lewisburg, PA, 2005.

[2] Commonwealth of Pennsylvania, Department of Environmental Resources, Gazetteer of Streams. 1978.

[3] DeBarry, Paul. Buffalo Creek Act 167 Stormwater Management Plan. Stroudsburg, PA. 1998.

[4] Union County Planning Department estimates based on United States Census Bureau, 2000 Decennial Census. 2005, Lewisburg, PA.

[5] Nickelsen, Richard. Unpublished *Geology of the Buffalo Creek Watershed.* Lewisburg, PA, 2002.

[6] Wardrop, Richard and Ewart, Dr. James. Union County Wellhead and Aquifer Protection Plan. State College, PA.

[7] United States Department of Agriculture. Soil Survey of Union County, PA. March 1985.

[8] DeBarry, Paul. Buffalo Creek Act 167 Stormwater Management Plan. Stroudsburg, PA. 1998.

[9] Personal communiqué with staff of Union County Conservation District and Mid-Penn Engineering, Corp. Lewisburg, PA. 2005.

[10] Commonwealth of Pennsylvania, Title 25, Chapter 93: Water Quality.

[11] Exceptional Value designation proposed and pending for headwaters to the eastern boundary of Bald Eagle State Forest as per Commonwealth of Pennsylvania, Department of Environmental Protection, July 19, 2006. Available online at http://www.depweb.state.pa.us/watersupply/lib/watersupply/Co60.pdf.

[12] Herbert, Rowland, & Grubic. Borough of Mifflinburg Act 537 Plan Update. State College, PA. 2005.

[13] Personal communiqué with Larry Berger of Buffalo Township Sewer Authority.

CHAPTER 2

WATERSHED CONDITION

As the title would suggest this chapter presents a summary of existing watershed conditions based on relevant and available data and reports. This information has been synthesized to identify critical issues within the watershed that are presently causing, or could in the future result in stream impairment or degradation of the ecosystem.

EXISTING REPORTS AND STUDIES

There are a number of existing reports and studies that provide data and information about the Buffalo Creek Watershed. Some of these are published, while others are simply raw data sheets that have not been compiled, analyzed, and thoroughly reported. The following is a list of documents known to be available entirely about, or having a heavy concentration on, conditions in the Buffalo Creek Watershed.

1985 *Buffalo Creek Watershed, Union County Pennsylvania Watershed Plan* – prepared by the Union County Conservation District and the USDA Soil Conservation Service

1998 *Buffalo Creek Act 167 Stormwater Management Plan* – prepared by RKR Hess Associates for Union County

1998 *Union County Water Supply and Wellhead and Aquifer Protection Plan* – prepared by Gannet Fleming, Inc. and Nittany GeoScience, Inc. for Union County.

1998 *Biological and Hydraulic & Hydrological Investigations of Buffalo Creek Watershed, PA* – prepared by Versar, Inc. for the United States Army Corps of Engineers and Union County

2004 *A Physical, Chemical, and Biological Assessment of Buffalo Creek* – prepared by the Lycoming College Clean Water Institute on behalf of BCWA.

2005 *Technical Report Summary: Hydrogeomorphic Studies of Buffalo Creek (2003-2005)* – prepared by Dr. Craig Kochel, Bucknell University on behalf of BCWA.

2005 *A Physical, Chemical, and Biological Assessment on Buffalo Creek Tributaries* – prepared by the Lycoming College Clean Water Institute on behalf of BCWA.

2007 *Buffalo Creek Watershed Alliance Watershed Management Plan* – prepared by BCWA with assistance for the Union County Conservation District, Union County Planning Commission, and PA Department of Environmental Protection. *(This plan serves as the primary source for Chapters 1, 2, and 3 of this WIP.)*

SUBWATERSHEDS

The Buffalo Creek Watershed is made of smaller subwatershed areas. The watershed has eleven main subwatersheds, including the main stem of Buffalo Creek, that range in size from one to 40 square miles in land area. Figure 2.1 shows and Table 2.1 lists each subwatershed and the contributing drainage acreage to the total watershed. As can be seen from Table 2.1 the main stem of Buffalo Creek is the largest contributor to the entire system with Little Buffalo, Rapid Run and Spruce Run all nearly equal in size. Figure 2.1 shows the subwatershed boundaries, land use, and impaired waters.

Table 2.1 Subwatersheds of the Buffalo Creek watershed

Subwatershed	Square Miles	Acreage	% Contribution	Forested	Agriculture	Existing Imperv.	Future Imperv.
North Branch	14	8,720	10%	87%	9%	2%	10%
Spruce Run	18	11,434	13%	88%	9%	2%	7%
Black Run	5	3,009	3%	71%	22%	3%	31%
Muddy Run	5	2,928	3%	57%	35%	3%	26%
Stony Run	1	925	1%	61%	32%	3%	30%
Little Buffalo	19	12,147	14%	54%	37%	3%	26%
Panther Run	3	2,024	2%	100%	0%	0%	0%
Beaver Run	5	3,051	3%	6%	83%	7%	41%
Coal Run	5	3,405	3%	40%	50%	3%	24%
Rapid Run	19	11,926	14%	88%	7%	2%	7%
Buffalo (Main)	40	25,517	30%	38%	51%	8%	28%

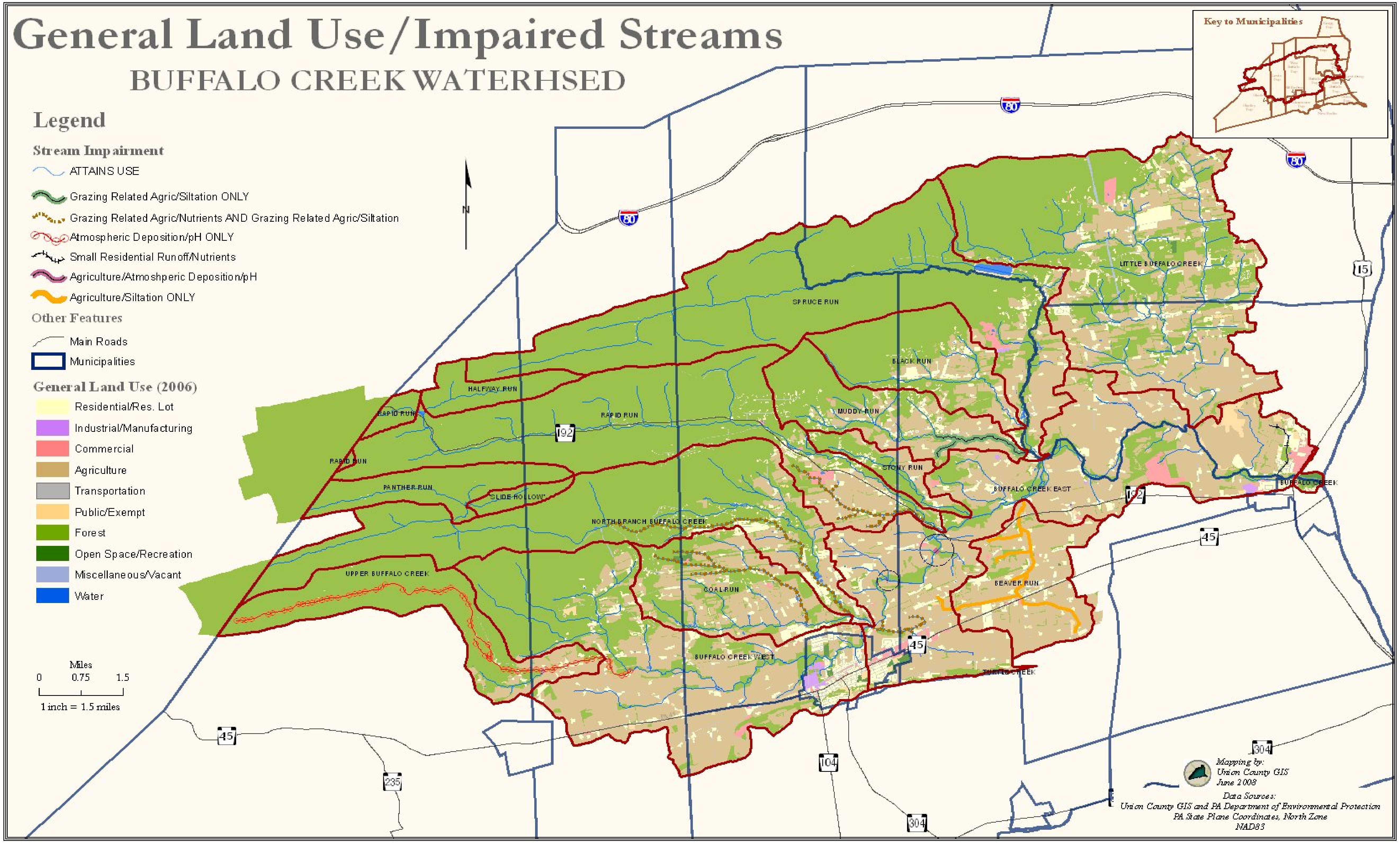


Figure 2.1 Land use, subwatersheds, and impaired streams of the Buffalo Creek Watershed.

From Table 2.1 it is easy to see the distribution of forested and agricultural land in the sub-watersheds, which should correlate to expected levels of impairment from sources such as nutrients, livestock access, etc. But the profound effects of urbanization and suburbanization on the hydrology, morphology, and water quality are also important. Research has quantified the relationship between development and the health of watersheds; the Center for Watershed Protection has suggested that once impervious coverage in a watershed reaches 25% or greater the stream will be impaired to a point it can no longer attain its original water quality designation.[4] Table 2.2 also shows the existing and future impervious coverage under existing zoning requirements. Seven of the eleven subwatersheds will be near or above that 25% threshold in the future.

BIOLOGICAL CONDITIONS

Benthic macroinvertebrates are extremely useful indicators of water quality conditions and respond to a variety of physical and chemical changes in streams. As a result, they have been used to determine the health of streams throughout Pennsylvania, including Buffalo Creek. BCWA reviewed benthic macroinvertebrate data from surveys conducted in 1993, 1995, 1998, and 2000 by PA DEP and 2004 (main stem) and 2005 (tributaries) by Lycoming College Clean Water Institute (CWI) to describe the biological condition of sites throughout the Buffalo Creek watershed. Based on our evaluation of data from these six surveys, several observations can be made related to reach-specific conditions along the main stem and tributaries along with patterns over time. In general, the main stem and many tributaries (e.g., North Branch, Rapid Run, Stony Run, and unnamed tributary in Pleasant Grove) support healthy benthic macroinvertebrate populations. Benthic macroinvertebrate assemblages in much of the main stem and healthy tributaries contain greater than 15 families, many of which are pollution-sensitive Ephemeroptera, Plecoptera, and Trichoptera (EPT) families. However, invertebrate assemblages from several sites indicate impairment from acid deposition in the headwater sites, agriculture and development along the main stem in the valley and on tributaries, and inadequate or improper sewage treatment in the Mifflinburg area.

The more pervasive factors causing biological impairment of streams in Buffalo Creek are agriculture and development. In the main stem, sites surrounded by and downstream of agriculture were characterized by lower abundance of pollution-sensitive invertebrates (lower EPT) and higher abundance of tolerant Hilsenhoff Biotic Index (HBI) invertebrates than less impaired tributaries of similar size (e.g., Rapid Run, Little Buffalo Creek, Spruce Run). As you move down the main stem, diversity and abundance of pollution-sensitive taxa decreases (lower EPT, higher HBI), which indicates the cumulative effects of agriculture and development in the watershed. Although not "technically" impaired, these observations suggest that Buffalo Creek is not achieving its biological potential and could be particularly vulnerable to further degradation from agriculture and development. Agriculture and development appear to affect Buffalo Creek primarily through high sediment loading (as evidenced by several tributaries with impaired habitat), but the stream also shows moderate eutrophication from nutrient loading.

DEP has identified and listed many impaired tributaries in Buffalo Creek as a result of agricultural activity in the sub-watersheds and riparian zones. However, some tributaries like Beaver Run, which is equally degraded but did not receive an impaired designation, should be reconsidered by DEP. In Beaver Run chemical and biological indicators point toward a more pronounced problem than was recognized by the PA DEP during its assessment. Beaver Run registers high nitrogen levels and lacks macroinvertabrate diversity as pollution tolerant species are most prevalent. In September of 2006 BCWA petitioned the PA DEP Northcentral Regional Office to reconsider data for Beaver Run that was summarized by Bucknell University professor Matthew McTammany, Ph.D. in hopes the tributary would be reclassified as an impaired stream to accurately reflect the observed state of the drainage basin[6]. This would make work to correct agricultural impacts along Beaver Run eligible for Section 319 funding. Beaver Run was reevaluated by DEP, and was officially listed as impaired in the 2008 Integrated Streams List (see Table 2.2).

Biological data also indicate some positive patterns related to riparian management and wetland restoration efforts in two major tributaries. Little Buffalo Creek is less impaired biologically than was expected given the amount of agriculture and the local fervor about livestock activities in the watershed. Several forested riparian zones have been established on previously agricultural land as part of USDA's Conservation Reserve Enhancement Program (CREP). In addition, some landowners have re-created wetlands along Little Buffalo Creek to improve habitat for waterfowl. The cumulative effect of these activities enables the Little Buffalo Creek watershed to support agriculture while maintaining healthy biological communities in streams.

The effects of the Mifflinburg Sewage Treatment Plant (STP) on water quality and benthic macroinvertebrates in Buffalo Creek were assessed in some detail by the PA DEP in 1993 and 1995. During these surveys, macroinvertebrates immediately at and downstream of the Mifflinburg STP were less diverse and were comprised of fewer pollution-sensitive and more pollution-tolerant groups than at sites upstream of the plant. These negative effects appeared to remain highly localized and did not affect benthic macroinvertebrates for more than a mile downstream. According to DEP, the Mifflinburg STP has fixed the problems in its treatment system that caused these impairments in the mid-1990s. As a result, surveys in 1998, 2000, and 2004 do not indicate any effect of the STP effluent on Buffalo Creek at sites near the STP or further downstream. This finding enables us to have cautious optimism that Mifflinburg STP effluent effects have been improved and no longer have a major influence on macroinvertebrates in Buffalo Creek.

SUBWATERSHED IMPAIRMENT

The various reports and data point to several impairment problems, such as widespread erosion and sedimentation (silt loading), elevated nutrients, and atmospheric deposition. There is a total of 37.5 miles in the watershed included on the state and federal impaired waters list that require the development and implementation of Total Maximum Daily Loads (TMDL's). A TMDL is the total allowable pollutant load a water body can receive while still maintaining water quality standards for its designated use. This allowable load includes all contributing point and non-point sources. A TMDL report includes these allowable loads as well as sections on pollutant source analyses, margins of safety, seasonal variations, critical conditions, public participation, implementation, and monitoring. Table 2.2 lists the stream segments, miles of impairment, cause of impairment, and date by which a TMDL will be developed by the Pennsylvania Department of Environmental Protection. These impaired waters are also shown on Figure 2.1 and on the watershed map found in Appendix A. Thus far the only TMDL that has been developed by the PA DEP is for the headwaters area that is impacted by atmospheric deposition.

Table 2.2 Impaired streams in the Buffalo Creek watershed.

Map No.	Stream	NHD Code	Assess. ID	Miles Impacted	Cause	TMDL Date
1	Buffalo Creek	02050206000290	981	9.3	Atmospheric deposition/pH	2005
2	Tributaries to Coal Run	02050206000650	1025	5.1	Grazing related agric/nutrients and siltation	2015
3	North Branch of Buffalo Creek	02050206000410	1286	5.9	Grazing related agric/nutrients and siltation	2015
4	Tributaries to Rapid Run	02050206000638	1286	4.1	Grazing related agric/nutrients and siltation	2015
5A	Buffalo Creek	02050206000281	8141	0.02	Agric/unknown, Atmospheric deposition/pH	2008
5B	Buffalo Creek	02050206000281	8141	0.09	Agric/unknown, Atmospheric depositions/pH	2008
6	Tributaries to Buffalo Creek	02050206000668	1159	1.3	Grazing related agric/nutrients and siltation	2015
7	Beaver Run and tributaries *(2008 list)*	02050206000670	14157	7.8	Agriculture/siltation	2021
8	Muddy Run and tributary	02050206000623	932	2.6	Grazing related agric siltation	2015
9	Tributary to Buffalo Creek	02050206000610	1179	1.3	Small residential runoff/nutrients	2015

*Map number corresponds to the map in Figure 3.1

The list in Table 2.2 represents the primary impairments in the Buffalo Creek watershed. Visual assessments and other reports suggest other issues associated with agriculture may exist in the watershed, however not to the degree of those streams listed in Table 2.2. Currently listed impaired streams are our highest priority for remediation. In the event new streams become listed in the future, these too would then become priorities.

Table 2.3 lists pollutant types found in the Buffalo Creek watershed, sources of those pollutants, their causes, and the sub-watersheds that have potential to be impacted by the particular pollutant. These are based on the irregularly collected and non-systematic data available and are somewhat general for that reason. However a sustained monitoring program should improve the BCWA's ability to identify trends in water quality and put the group in a position where, with continued and ongoing research by partners such as Bucknell University, it will be able to make more informed decisions and will be able to identify pollutants and their sources with more accuracy.

Table 2.3 Common pollutants in the Buffalo Creek watershed.

Pollutant	Source	Cause	Subwatersheds Impacted*
Nutrients	Livestock in streams, failing on-lot septic systems, agricultural and residential fertilizer, manure runoff, community sewage treatment plants.	Unrestricted livestock access, improper installation and maintenance of on-lost sewage systems, improper application of fertilizer and manure, lack of barnyard runoff controls.	NB, SpR, BlR, BvR, CR, MR, StR, LB, RR, MB
Sediment	Livestock in streams, crop fields, stream banks/legacy sediment, dirt and gravel roads, construction sites, and developed areas.	Lack of crop field and pasture BMPs, excessive storm flows, inadequate stormwater controls, and elimination of riparian buffers.	NB, SpR, BlR, BvR, CR, MR, StR, LB, RR, MB
E. Coli	Livestock, failing septic, manure runoff, community sewage treatment plants.	Unrestricted livestock access, improper installation and maintenance of on-lot sewage systems, over application of manure.	MR, StR, LB, BvR, CR, RR, MB
Oil, grease, & metals	Parking lots, roads, stormwater conveyances, sewage treatment plants, homeowners.	Improper disposal of materials, lack of BMPs for stormwater control, lack of buffers to filter out materials.	MB
Thermal/Heat	Natural radiant heat from sun.	Removal of buffers and streamside canopy trees that shade the water, impervious surfaces.	BvR, CR, MR, StR, LB, RR, MB

*North Branch (NB), Spruce Run (SpR), Black Run (BlR), Coal Run (CR), Muddy Run (MR), Stony Run (StR), Little Buffalo (LB), Rapid Run (RR), and Mainstem Buffalo Creek (MB).

ENDNOTES

[1] McDiffett, Wayne, Ph.D. personal communiqué at BCWA March 26, 2006 planning retreat.

[2] Buffalo Township has not adopted the minimum ordinance standards of the Buffalo Creek Stormwater Management Plan as required by Act 167 of 1978.

[3] Hartley, Lewis, Limestone, and West Buffalo Townships are under the county Subdivision and Land Development Ordinance and the stormwater provisions contained therein.

[4] Caraco, Claytor, et al. Rapid Watershed Planning Handbook – A Comprehensinve Guide for Managing Urbanizing Watersheds. Center for Watershed Protection, Endicott, MD. 1999.

[5] Kochel, Craig, Ph.D. Technical Report Summary: Hydrogeomorphic Studies of Buffalo Creek (2003-2005). Lewisburg, PA.

[6] McTammany, Matthew, Ph.D. personal communiqué, unpublished reports and data summary provided to the Buffalo Creek Watershed Alliance. Lewisburg, PA. October 2006.

CHAPTER 3

WATERSHED RESTORATION

AGRICULTURAL STREAM ASSESSMENTS

Due to the prevalence of farming and agriculturally impaired streams in the Buffalo Creek watershed a series of farm visits were conducted along many of the impaired streams in order to better understand the BMP needs along those reaches. An Agricultural/Environmental Specialist was hired by the Union County Conservation District in June of 2007 as part of a 319 grant cosponsored by the Conservation District and BCWA. This position was specifically created to assess streams impaired by agriculture, conduct windshield surveys, utilize GIS resources, make preliminary BMP recommendations, conduct watershed modeling with DEP, and write this implementation plan. Being in the field helps to better determine the status of agricultural BMP use. Simply reviewing conservation plans would show the watershed to be worse than it actually is. We recognize that not having a conservation plan does not necessarily mean a total lack of BMPs. By having someone in the field to see firsthand some of the issues facing our impaired streams we feel we will be a step ahead when the time comes for working with landowners to identify and implement needed BMPs.

RECOMMENDED BMPS

One of the primary reasons for conducting farm visits, windshield surveys, GIS research, etc. was to generate a list of recommended BMPs for farms located along agriculturally impaired stream sections. Table 3.1 (pages 34-47) shows past (before 2000), present (2000 – 2008), and future BMP recommendations for individual farms. Also included are the BMP units (Acres, Feet, or Number) and their NRCS practice codes. This table is not for every farm in each subwatershed, but rather those having potential to directly impact an agriculturally impaired stream section; as these subsheds are our higher priorities. Figure 3.1 shows the location of these farms in reference to the impaired streams. Each numbered dot represents one tax parcel. Note many tax parcels fall under the same farm number. We recognize that, although not eligible for 319 funding at this time, all subwatersheds could benefit from an increase in agricultural BMPs.

Table 3.1 Individual farm BMPs

Farm #	Water-shed	Past BMPs before July, 2000	Unit Ac, Ft, No	Present BMPs July, 2000 to present	Unit Ac, Ft, No	Future BMPs	Unit Ac, Ft, No
1	Buffalo Trib	Conservation Crop Rotation (Ac.) (328)	84	Stripcropping, Field (Ac.) (586)	20	Barnyard Runoff Control (No.) (357)	1
		Conservation Plan (Ac.) (003)	69	Cover Crop (Ac.) (340)	30	Waste Management System (No.) (312)	1
		Residue Mgmt, Mulch Till (Ac.) (329B)	84			Residue Mgmt, No-Till (Ac.) (329A)	84
		Roof Runoff Structure (No.) (558)	2			Fence (Ft.) (382)	1800
		Grassed Waterway (Ac.) (412)	0.3			Stream Crossing (No.) (578)	2
		Grassed Waterway (Ac.) (412)	0.55			Animal Trails and Walkways (Ft.) (575)	350
		Fence (Ft.) (382) (*streambank one side)*	730			Riparian Forest Buffer (Ac.) (391) in Ft. length	1800
2	Buffalo Trib	Conservation Plan (Ac.) (003)	190	Use Exclusion (Ac.) (472)	0.3	Fence (Ft.) (382)	3060
		Roof Runoff Structure (No.) (558)	3	Riparian Forest Buffer (Ac.) (391) in Ft. length	600	Streambank & Shoreline Protection (Ft.) (580)	245
		Pond (No.) (378)	2	Riparian Forest Buffer (Ac.) (391) in Ft. length	800	Stream Crossing (No.) (578)	2
		Waste Storage Facility (No.) (313)	2	Riparian Forest Buffer (Ac.) (391) in Ft. length	2600	Riparian Forest Buffer (Ac.) (391) in Ft. length	3060
		Grassed Waterway (Ac.) (412)	1.5	Riparian Forest Buffer (Ac.) (391) in Ft. length	880	Stream (equipment) Crossing (No.) (578)	1
		Conservation Crop Rotation (Ac.) (328)	55	Residue Mgmt, No-Till (Ac.) (329A)	7.2	Cover Crop (Ac.) (340)	88
		Contour Farming (Ac.) (330)	78			Barnyard Runoff Control (No.) (357)	1
		Cover Crop (Ac.) (340)	31			Waste Management System (No.) (312)	1
		Residue Mgmt, No-Till (Ac.) (329A)	130			Cover Crop (Ac.) (340)	7.2
		Roof Runoff Structure (No.) (558)	2				

2		Fence (Ft.) (382) (*streambank one side*)	420				
3	Buffalo Trib	Prescribed Grazing (Ac.) (528A)	6			Roof Runoff Structure (No.) (558)	1
		Trough or Tank (No.) (614)	3			Riparian Forest Buffer (Ac.) (391) in Ft. length	835
		Channel Bank Vegetation (Ac.) (322)	0.3				
		Riparian Herbaceous Cover (Ac.) (390) in Ft. length (*one side)*	340				
		Fence (Ft.) (382) *(streambank one side)*	540				
4	Buffalo Trib			Channel Bank Vegetation (Ac.) (322)	0.2	Residue Mgmt, No-Till (Ac.) (329A)	6.3
				Conservation Cover (Ac.) (327)	1.6	Riparian Forest Buffer (Ac.) (391) in Ft. length	590
5	Buffalo Trib	Conservation Plan (Ac.) (003)	12			Residue Mgmt, No-Till (Ac.) (329A)	8
		Roof Runoff Structure (No.) (558)	2				
		Grassed Waterway (Ac.) (412)	0.2				
6	Buffalo Trib	Conservation Plan (Ac.) (003)	136.5			Waste Management System (No.) (312)	1
		Roof Runoff Structure (No.) (558)	3			Barnyard Runoff Control (No.) (357)	1
		Residue Mgmt, No-Till (Ac.) (329A)	123.6			Fence (Ft.) (382)	1520
		Grassed Waterway (Ac.) (412)	1.3			Stream Crossing (No.) (578)	3

6		Pond (No.) (378)	1			Riparian Forest Buffer (Ac.) (391) in Ft. length	1520
		Cover Crop (Ac.) (340)	16			Cover Crop (Ac.) (340)	54.75
		Conservation Crop Rotation (Ac.) (328)	123.6				
		Barnyard Runoff Control (No.) (357)	1				
		Heavy Use Protection (Ac.) (561)	1.5				
		Riparian Herbaceous Cover (Ac.) (390) in Ft. length	2000				
7	Buffalo Trib	Conservation Crop Rotation (Ac.) (328)	45			Prescribed Grazing (Ac.) (528A)	7.7
		Conservation Plan (Ac.) (003)	80			Fence (Ft.) (382)	3400
		Residue Mgmt, Mulch Till (Ac.) (329B)	45			Cover Crop (Ac.) (340)	11.25
8	Buffalo Trib	Conservation Plan (Ac.) (003)	125	Prescribed Grazing (Ac.) (528A)	10	Fence (Ft.) (382)	1380
		Conservation Crop Rotation (Ac.) (328)	79	Roof Runoff Structure (No.) (558)	2	Stream Crossing (No.) (578)	2
		Stripcropping, Contour (Ac.) (585)	50	Conservation Cover (Ac.) (327)	2.5	Riparian Forest Buffer (Ac.) (391) in Ft. length	690
		Contour Farming (Ac.) (330)	37.5	Residue Mgmt, No-Till (Ac.) (329A)	79	Cover Crop (Ac.) (340)	50
		Channel Bank Vegetation (Ac.) (322)	0.4	Cover Crop (Ac.) (340)	15.5		
		Pond (No.) (378)	2				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	1500				
9	Buffalo Trib			Riparian Herbaceous Cover (Ac.) (390) in Ft. length	2000	Riparian Forest Buffer (Ac.) (391) in Ft. length	2000

10	Buffalo Trib						
11	Buffalo Trib						
12	Rapid	Conservation Plan (Ac.) (003)	42	Residue Mgmt, No-Till (Ac.) (329A)	16.8	Stream Crossing (No.) (578)	2
		Roof Runoff Structure (No.) (558)	2				
		Pond (No.) (378)	1				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	1426				
13	Rapid	Conservation Plan (Ac.) (003)	102	Conservation Cover (Ac.) (327)	7		
		Conservation Cover (Ac.) (327)	17.1				
		Pond (No.) (378)	3				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	3000				
14	Rapid			Conservation Plan (Ac.) (003)	82.5	Stream (equipment) Crossing (No.) (578)	1
				Nutrient Mangement (Ac.) (590)	73.8	Waste Storage (stacking) Facility (No.) (313)	1
				Cover Crop (Ac.) (340)	11.85		
				Residue Mgmt, No-Till (Ac.) (329A)	65		
				Diversion (Ft.) (362)	600		
				Contour Farming (Ac.) (330)	6		
				Contour Buffer Strips (Ac.) (332)	1.8		
				Stripcropping, Contour (Ac.) (585)	25		

14				Waste Storage Facility (No.) (313)	1		
				Heavy Use Protection (Ac.) (561)	0.1		
				Barnyard Runoff Control (No.) (357)	1		
				Waste Management System (No.) (312)	1		
				Roof Runoff Structure (No.) (558)	2		
				Conservation Crop Rotation (Ac.) (328)	65		
				Riparian Herbaceous Cover (Ac.) (390) in Ft. length	3000		
				Riparian Herbaceous Cover (Ac.) (390) in Ft. length	1860		
				Fence (Ft.) (382) (*streambank)*	1455		
15	Rapid	Conservation Plan (Ac.) (003)	63	Residue Mgmt, No-Till (Ac.) (329A)	40	Fence (Ft.) (382)	2200
				Cover Crop (Ac.) (340)	6	Stream Crossing (No.) (578)	1
						Riparian Forest Buffer (Ac.) (391) in Ft. length	2200
16	Rapid	Conservation Plan (Ac.) (003)	56			Fence (Ft.) (382)	2600
		Prescribed Grazing (Ac.) (528A)	64			Stream Crossing (No.) (578)	1
		Roof Runoff Structure (No.) (558)	3			Riparian Forest Buffer (Ac.) (391) in Ft. length	1600
		Pasture and Hayland Planting (Ac.) (512)	54.7			Pasture and Hayland Planting (Ac.) (512)	0.25
17	Rapid	Riparian Forest Buffer (Ac.) (391) in Ft. length	4620	Residue Mgmt, No-Till (Ac.) (329A)		Fence (Ft.) (382)	1200

17				Roof Runoff Structure (No.) (558)		Riparian Forest Buffer (Ac.) (391) in Ft. length	1200
				Cover Crop (Ac.) (340)		Stream Crossing (No.) (578)	1
						Conservation Plan (Ac.) (003)	105
18	Rapid	Baryard Runoff Control (No.) (357) (*ROOF*)	1	Residue Mgmt, No-Till (Ac.) (329A)	35	Conservation Plan (Ac.) (003)	95
				Contour Farming (Ac.) (330)	8	Fence (Ft.) (382)	2300
				Pasture and Hayland Planting (Ac.) (512)	29	Riparian Forest Buffer (Ac.) (391) in Ft. length	2300
				Prescribed Grazing (Ac.) (528A)	43	Riparian Forest Buffer (Ac.) (391) in Ft. length	2500
						Stream Crossing (No.) (578)	1
						Cover Crop (Ac.) (340)	7.8
						Heavy Use Area Protection (Ac.) (561)	0.1
						Waste Storage (stacking) Facility (No.) (313)	1
						Stream Crossing (No.) (578) (equipment)	1
						Access Road (Field Lane fix) (Ft.) (561)	390
19	Rapid					Conservation Plan (Ac.) (003)	51
20	Rapid	Conservation Plan (Ac.) (003)	33	Nutrient Management (Ac.) (590)	9.2	Riparian Forest Buffer (Ac.) (391) in Ft. length	1400
21	Rapid					Conservation Plan (Ac.) (003)	64
22	Rapid			Conservation Plan (Ac.) (003)	36		
23	Rapid	Conservation Plan (Ac.) (003)	64				

24	Coal	Conservation Plan (Ac.) (003)	250				
		Riparian Forest Buffer (Ac.) (391) in Ft. length					
24	Coal	Conservation Plan (Ac.) (003)	11			Channel Stabilization (Ft.) (584)	100
		Pond (No.) (378)	5				
		Conservation Cover (Ac.) (327)	11				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	3300				
25	Coal	Conservation Plan (Ac.) (003)	100	Residue Mgmt, No-Till (Ac.) (329A)	13.6	Cover Crop (Ac.) (340)	13.6
		Pond (No.) (378)	1	Contour Farming (Ac.) (330)	9.6		
		Riparian Forest Buffer (Ac.) (391) in Ft. length	3700				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	4550				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	4400				
26	Coal	Conservation Plan (Ac.) (003)	60			Riparian Forest Buffer (Ac.) (391) in Ft. length	4000
		Pasture and Hayland Planting (Ac.) (512)	35				
27	Coal	Conservation Plan (Ac.) (003)	60				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	5200				
		Riparian Forest Buffer (Ac.) (391) in Ft. length	1400				
		Residue Mgmt, No-Till (Ac.) (329A)	32				
28	Coal	Residue Mgmt, No-Till (Ac.) (329A)	16	Fence (Ft.) (382)	1700	Conservation Plan (Ac.) (003)	

28		Stripcropping, Field (Ac.) (586)	16	Riparian Herbaceous Cover (Ac.) (390) in Ft. length	1700	Fence (Ft.) (382)	600
						Riparian Herbaceous Cover (Ac.) (390) in Ft. length	600
29	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length				Conservation Plan (Ac.) (003)	
30	Coal	Stripcropping, Field (Ac.) (586)	60			Conservation Plan (Ac.) (003)	77
		Waste Storage Facility (No.) (313)	1			Residue Mgmt, No-Till (Ac.) (329A)	60
						Prescribed Grazing (Ac.) (528A)	5.25
						Fence (Ft.) (382)	2000
						Riparian Forest Buffer (Ac.) (391) in Ft. length	2000
						Stream Crossing (No.) (578)	1
						Barnyard Runoff Control (No.) (357)	1
31	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length	400			Conservation Plan (Ac.) (003)	24
						Stream Crossing (No.) (578)	1
						Barnyard Runoff Control (No.) (357)	1
						Fence (Ft.) (382)	200
						Riparian Herbaceous Cover (Ac.) (390) in Ft. length	200
32	Coal	Conservation Plan (Ac.) (003)	105			Residue Mgmt, No-Till (Ac.) (329A)	62
		Stripcropping, Field (Ac.) (586)	62			Prescribed Grazing (Ac.) (528A)	27
		Riparian Forest Buffer (Ac.) (391) in Ft. length	4120			Stream Crossing (No.) (578)	1

32		Waste Storage Facility (No.) (313)	1			Access Road (Field Lane fix) (Ft.) (561)	2100
33	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length Residue Mgmt, No-Till (Ac.) (329A)	2800 35			Grassed Waterway (Ac.) (412)	1.5
34	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length	1860				
35	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length	1900				
36	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length	1000				
37	Coal	Riparian Forest Buffer (Ac.) (391) in Ft. length	1000				
38	Muddy	Conservation Plan (Ac.) (003) Conservation Plan (Ac.) (003) CREP (Ac.) (grasses) Riparian Herb. Buffer	84 35 120 7000			Riparian Forest Buffer (Ac.) (391) in Ft. length	2100
39	Muddy	Conservation Plan (Ac.) (003) Stripcropping, Contour (Ac.) (585)	64 48	Riparian Forest Buffer (Ac.) (391) in Ft. length	400	Fence (Ft.) (382) Stream Crossing (No.) (578) Riparian Forest Buffer (Ac.) (391) in Ft. length Prescribed Grazing (Ac.) (528A)	1800 1 1800 6
40	Muddy			Conservation Plan (Ac.) (003) Stripcropping, Contour (Ac.) (585)	75 64	Fence (Ft.) (382) Riparian Forest Buffer (Ac.) (391) in Ft. length	3000 3000

40				Residue Mgmt, No-Till (Ac.) (329A)	64	Stream Crossing (No.) (578) Prescribed Grazing (Ac.) (528A)	1 6
41	Muddy	Conservation Plan (Ac.) (003) Nutrient Management (Ac.) (590) Riparian Forest Buffer (Ac.) (391) in Ft. length	75 18 3000			Riparian Forest Buffer (Ac.) (391) in Ft. length	800
42	Muddy	Conservation Plan (Ac.) (003) Stripcropping, Contour (Ac.) (585) Prescribed Grazing (Ac.) (528A)	122.8 60 9			Riparian Forest Buffer(Ac.) (391) in Ft. length Residue Mgmt, No-Till (Ac.) (329A)	3000 60
43	Muddy	Riparian Forest Buffer (Ac.) (391) in Ft. length	1100				
44	Muddy	Riparian Forest Buffer (Ac.) (391) in Ft. length	1500				
46	Beaver	Riparian Herbaceous Cover (Ac.) (390) in Ft. length Residue Mgmt, No-Till (Ac.) (329A)	2100 87				
47	Beaver	Stripcropping, Contour (Ac.) (585) Residue Mgmt, No-Till (Ac.) (329A)	78 78	Cover Crop (Ac.) (340)	24	Riparian Herbaceous Cover (Ac.) (390) in Ft. length	5900
48	Beaver	Stripcropping, Contour (Ac.) (585)	42			Riparian Forest Buffer (Ac.) (391) in Ft. length Residue Mgmt, No-Till (Ac.) (329A) Fence (Ft.) (382) Stream Crossing (No.) (578)	3700 42 3700 2

49	Beaver	Contour Farming (Ac.) (330)	41			Riparian Forest Buffer (Ac.) (391) in Ft. length	2600
						Residue Mgmt, No-Till (Ac.) (329A)	41
50	Beaver						
51	Beaver	Stripcropping, Field (Ac.) (586)				Riparian Forest Buffer (Ac.) (391) in Ft. length	4200
		Waste Storage Facility (No.) (313)	2			Residue Mgmt, No-Till (Ac.) (329A)	
52	Beaver					Residue Mgmt, No-Till (Ac.) (329A)	4
						Riparian Forest Buffer (Ac.) (391) in Ft. length	730
53	Beaver	Stripcropping, Contour (Ac.) (585)	37				
54	Beaver	Residue Mgmt, No-Till (Ac.) (329A)	60				
55	Beaver	Riparian Forest Buffer (Ac.) (329A)	3500				
56	Beaver	Stripcropping, Contour (Ac.) (585)	7				
57	Beaver						
58	Beaver	Stripcropping, Contour (Ac.) (585)	51				
59	Beaver	Stripcropping, Contour (Ac.) (585)	20	Cover Crop (Ac.) (340)	3	Riparian Forest Buffer (Ac.) (391) in Ft. length	1000
				Fence (Ft.) (382)	1000	Residue Mgmt, No-Till (Ac.) (329A)	20
				Riparian Herbaceous Cover (Ac.) (390) in Ft. length	1000	Barnyard Runoff Control (No.) (357)	1
						Stream Crossing (No.) (578)	1
60	Beaver	Stripcropping, Contour (Ac.) (585)	68	Cover Crop (Ac.) (340)	2	Riparian Forest Buffer (Ac.) (391) in Ft. length	3400

60						Residue Mgmt, No-Till (Ac.) (329A)	68
61	Beaver	Stripcropping, Contour (Ac.) (585)	68			Riparian Forest Buffer (Ac.) (391) in Ft. length Residue Mgmt, No-Till (Ac.) (329A)	2100 68
62	Beaver	Stripcropping, Contour (Ac.) (585)	100	Fence (Ft.) (382) Riparian Herbaceous Cover (Ac.) (390) in Ft. length	2600 2600	Riparian Forest Buffer (Ac.) (391) in Ft. length Residue Mgmt, No-Till (Ac.) (329A)	2600 100
63	Beaver			Fence (Ft.) (382) Riparian Herbaceous Cover (Ac.) (390) in Ft. length	2100 2100	Residue Mgmt, No-Till (Ac.) (329A) Riparian Forest Buffer (Ac.) (391) in Ft. length	100 2100
64	Beaver	Residue Mgmt, No-Till (Ac.) (329A)	53			Riparian Forest Buffer (Ac.) (391) in Ft. length	2500
65	Beaver	Stripcropping, Contour (Ac.) (585)	25			Riparian Forest Buffer (Ac.) (391) in Ft. length	700
66	Beaver	Riparian Forest Buffer (Ac.) (391) in Ft. length	3900			Residue Mgmt, No-Till (Ac.) (329A)	15
67	Beaver				`	Residue Mgmt, No-Till (Ac.) (329A)	4
68	Beaver					Residue Mgmt, No-Till (Ac.) (329A) Riparian Forest Buffer (Ac.) (391) in Ft. length	7 530
69	Beaver	Stripcropping, Contour (Ac.) (585)	51	Cover Crop (Ac.) (340) Fence (Ft.) (382) Riparian Herbaceous Cover (Ac.) (390) in Ft. length	5 3500 3500	Riparian Forest Buffer (Ac.) (391) in Ft. length	3500
70	Beaver	Stripcropping, Field (Ac.) (586)	73				
71	Beaver	Stripcropping, Field (Ac.) (586)	24			Grassed Waterway (Ac.) (412)	2

72	Buffalo Main	Farms along the two impaired sections of the main stem of Buffalo Creek (Agriculture/Atmospheric Deposition/pH ONLY) have not yet been assessed					
73	Buffalo Main						
74	Buffalo Main						
75	Buffalo Main						
76	Buffalo Main						
77	Buffalo Main						
78	Buffalo Main						
79	Buffalo Main						
80	Buffalo Main						
81	Buffalo Main						
82	Buffalo Main						
83	North Branch	Stripcropping, Contour (Ac.) (585) Residue Mgmt, No-Till (Ac.) (329A)	24 25.5	Waste Storage (stacking) Facility (No.) (313)	1		
84	North Branch	Riparian Forest Buffer (Ac.) (391) in Ft. length	1500				
85	North Branch					Barnyard Runoff Control (No.) (357)	1
86	North Branch						
87	North Branch	Stripcropping, Contour (Ac.) (585) Residue Mgmt, No-Till (Ac.) (329A)	52 28			Riparian Forest Buffer (Ac.) (391) in Ft. length Residue Mgmt, No-Till (Ac.) (329A)	1500 32

88	North Branch	Stripcropping, Field (Ac.) (586)	9		Residue Mgmt, No-Till (Ac.) (329A)	71
					Riparian Forest Buffer (Ac.) (391) in Ft. length	4200
89	North Branch	Stripcropping, Field (Ac.) (586)	28		Heavy Use Protection (Ac.) (561)	1
		Residue Mgmt, No-Till (Ac.) (329A)	46		Riparian Forest Buffer (Ac.) (391) in Ft. length	950
					Fence (Ft.) (382)	950
90	North Branch	Riparian Forest Buffer (Ac.) (391) in Ft. length	1900			

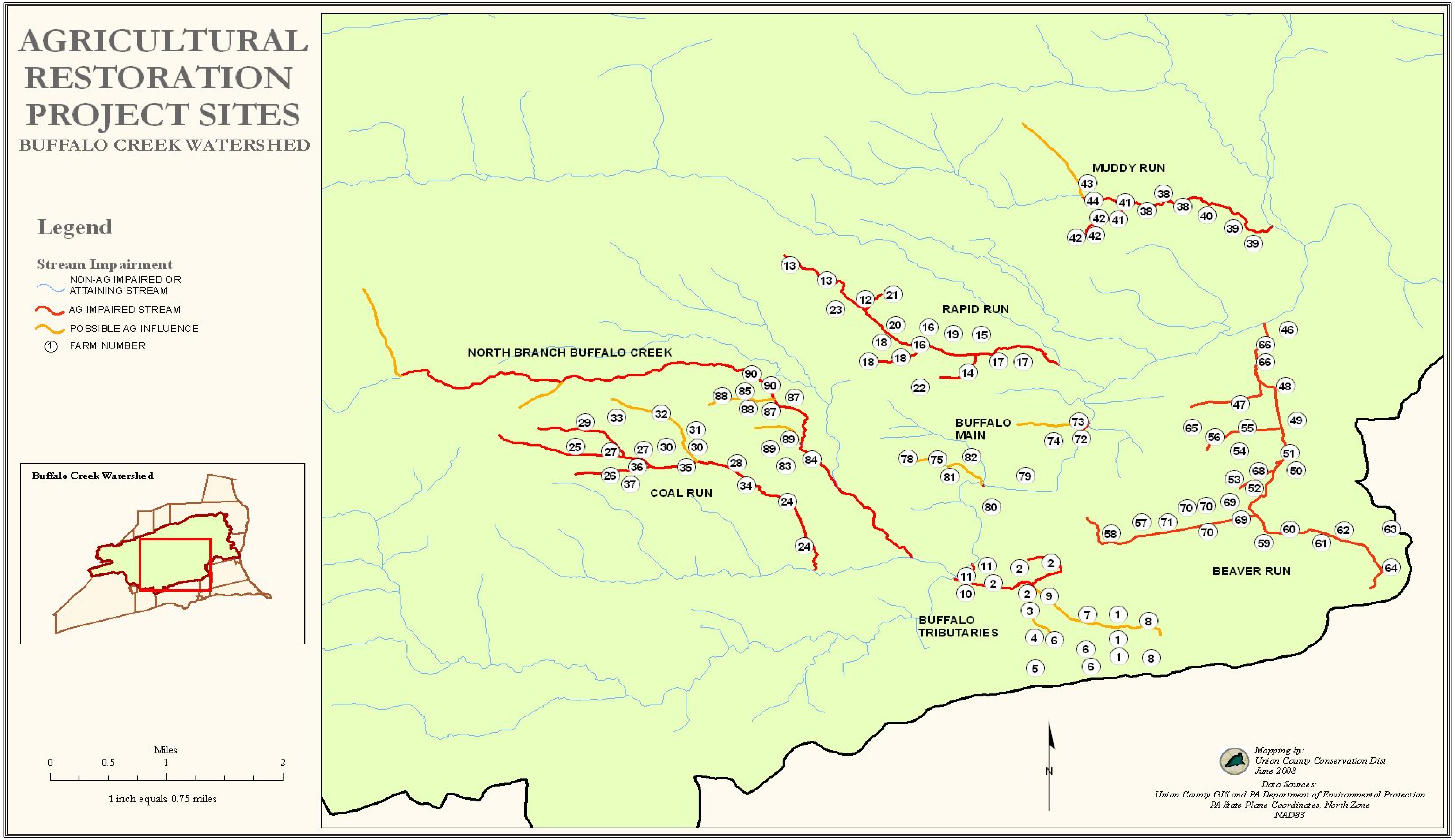


Figure 3.1 Possible farm restoration sites along agriculturally impaired streams.

CURRENT BMPS

Currently (June, 2008), there are a few new BMP projects in various stages of completion throughout the Buffalo Creek watershed. These projects include:

Conservation Plan Development in East Buffalo Creek subwatershed

- 1 acre Conservation Cover
- 80 acres Crop Rotation
- 77 acres Contour Farming
- 30 acres Cover Crop
- 300 ft Diversion
- 2 acres of Filter Strips
- 0.5 acre Grassed Waterway
- 80 acres Nutrient Management
- 80 acres Pest Management
- 32 acres No-till

Barnyard Improvement Project in East Buffalo Creek subwatershed

- 400 ft Access Road
- 2030 ft Animal Trails and Walkways
- 0.5 acre Grassed Waterway
- 1 acre Heavy Use Area Protection
- 1 Manure Transfer
- 4 acres Nutrient Management
- 4 acres Pest Management
- 1 Roof Runoff Structure
- 85 ft Underground Outlet
- 1 Waste Storage Facility

Pasture Management Project in East Buffalo Creek subwatershed

- 100 ft Fence
- 1.5 acres Nutrient Management

Field Lane Improvement Projects

- 7816 ft in West Buffalo Creek subwatershed (3 farms)
- 1625 ft in Muddy Run subwatershed
- 1009 ft in Rapid Run subwatershed

No-till Conversions

- 21 acres in Coal Run subwatershed
- 28 acres in Rapid Run subwatershed

Headwaters to Buffalo Creek Acid Remediation Project

- Passive treatment wetland system (2 basins) in the Upper Buffalo Creek subwatershed

Certainly, most subwatersheds could benefit from an increase in agricultural BMPs. However, there may be other avenues for reducing pollutant loads, especially in streams impaired by other impacts. Of the impaired streams in the Buffalo Creek watershed, only two are listed due to non-agricultural impacts. The upper reach of Buffalo Creek, listed for atmospheric deposition/pH is one. As mentioned earlier, efforts to remediate this stream section are already underway. A combined system consisting of an aerobic limestone basin (AeLB) and an anaerobic vertical flow wetland (AVFW) are currently under construction on the headwaters of Buffalo Creek. The treatment of acidification impacts associated with acidic deposition will require design approaches that will provide adequate alkalinities to treat acid loads at both baseflow and storm flow event acid loads in Buffalo Creek. To accomplish this, the passive treatment design will include an AeLB in combination with an AVFW. The AeLB generates a lower alkalinity (~ 35 mg/L), but at short detention times (~8 hours), and the AVFW generates high alkalinity (~ 150 mg/L) at long detention times (>50 hours). The combination system will use the fast alkalinity of the AeLB to treat high storm flows and high alkalinity of the AVFW to treat low flows. During high flows, stream flow up to 2 cfs (900 gpm) will be diverted into the first unit (AeLB) where alkalinity of approximately 20 mg/L will be generated. Most of the flow will be directed back to the stream with treatment only from the AeLB; a small amount of treated AeLB water (35 gpm) will be directed through the AVFW. At low flow only 0.07 to 0.09 cfs (20 to 40 gpm) of stream flow will be directed into the AeLB, which will then flow into the AVFW. Here the water will be treated to high alkalinity concentrations that will be needed to maintain downstream alkalinity at baseflow. At high stream flow the combined system effluent will contain 25 mg/L of alkalinity at a maximum treated flow of 900 gpm. At low stream flow the combined system effluent will contain up to 150 mg/L for a treated flow of 35 gpm.

The location is to the north of Buffalo Creek at a location approximately 1,000 feet upstream of Buffalo Flat Road. The approach requires installation of an intake structure upstream of the combination treatment to collect and direct low pH stream water to the combination system; this collection location will be 100 feet upstream depending on stream gradient. The diverted flow, 0.07 to 0.09 cfs (30 to 40 gpm) at low flow and 1 to 2 cfs (450 to 900 gpm) at high flow, will be directed into the AeLB. The acidic water will be neutralized and between 15 and 30 mg/L of alkalinity will be added. Water from the AeLB underdrain will enter the AVFW. Up to 0.09 cfs (40 gpm) will pass through the underdrain of the AVFW with the remainder of the flow overflowing the AVFW by the spillway. The combination of treated flows from the AeLB and AVFW will produce adequate alkalinity to remediate Buffalo Creek for baseflows as well as high flows; flow ranging from 0.1 to 35 cfs (45 to 15,500 gpm). Remediation of Buffalo Creek using this combination passive treatment approach will result in:

1) Anticipated baseflow alkalinity and pH will be > 5 mg/L and 6.5, respectively; and
2) Anticipated high flow (up to 95^{th} percentile) alkalinity and pH will be > 0.5 mg/L and 5.8, respectively.

This water quality is likely similar to conditions found in Buffalo Creek prior to alkalinity depletion from soils and shallow groundwater in the upper Buffalo Creek watershed. The water quality is also adequate to provide suitable conditions for return of a wild brook trout fishery in the areas downstream of the treatment system.

Construction costs for the proposed combined passive treatment system approach have been estimated for the engineering designs developed for the Buffalo Creek remediation. The estimated total construction costs for the AeLB/AVFW combination system are approximately $259,000. The total construction cost equates to approximately $34,000 per chronic stream mile restored, which would be lower if episodically acidified stream miles are included. Based on the longevity of the combined system (25 to 50 years) the cost of the restoration will be less than $650 per mile per year.

The other non-agricultural impaired stream section is an unnamed tributary to Buffalo Creek near Lewisburg, listed for small residential runoff/nutrients. Although the source of impairment is listed as urban runoff it is likely the stream suffers from a combination of factors including agriculture, urban runoff, and waterfowl. Solutions to this problem could entail agricultural BMPs, reduction in lawn fertilizer and chemical applications by homeowners, removal of nuisance waterfowl, and stormwater retrofits that would address water quality treatment of runoff from residential developments and local streets.

Another possibility when considering sediment loads is dealing with legacy sediments. Throughout the 17th through 19th centuries European settlers built tens of thousands of milldams for water-powered mills. According to the 1840 U.S. Manufacturing Census Union County had 139 mills[1], making legacy sediments a possibility in the Buffalo Creek watershed. Research suggests the resulting millponds (slack water upstream of the dam) trapped vast amounts of sediment that eroded from deforestation and agricultural practices, covering the original floodplain and wetlands[2]. Over time dams were abandoned and eventually failed. Millponds drained, and the resulting faster moving water began cutting through the elevated, more erodible floodplain we know today, creating incised channels and considerable streambank erosion.

WATERSHED MODELING

Watershed modeling was conducted for the entire Buffalo Creek watershed in order to estimate the effect implementing agricultural BMPs will have on water quality. These BMPs include those in Table 3.1 as well as any other BMP that could potentially be implemented to improve water quality. Modeling also aids in subwatershed prioritization by indicating which subwatersheds have the highest potential to improve as a result of implementing BMPs. In order to simplify the modeling process, certain subwatersheds were combined. Panther Run and Slide Hollow were included in the North Branch Buffalo Creek subshed, Halfway Run was included in the Rapid Run subshed, and Black Run was included in the Spruce Run subshed. Also, due to its large size, the main branch of Buffalo Creek was split into the Upper Buffalo, West Buffalo and East Buffalo subsheds. In all, the Buffalo Creek watershed was divided into 11 subwatersheds, each modeled individually.

Software created by Penn State University and PA DEP to run with ArcView GIS was used to produce a model of the Buffalo Creek watershed. First, a model of the watershed was generated using the ArcView Generalized Watershed Loading Function (AVGWLF). The AVGWLF program takes various data (e.g. land use, soils, weather, etc.) including animal data to create a scenario file of baseline conditions for each subwatershed. These scenario files were then used as the primary input for the Pollution Reduction Impact Comparison Tool (PRedICT). The PRedICT program allows users to input various BMPs in various categories, such as agricultural, animal-related, stream-related, and urban. Due to the prevalence of agriculturally impaired streams, modeling was focused on agricultural, animal-related, unpaved roads, and stream-related BMPs. The BMP options in PRedICT are relatively general, and may encompass many specific practices. Tables 3.2, 3.3, and 3.4 show some possible NRCS practices that correlate to the general BMP options in PRedICT. These tables serve as suggestions only; as recommended BMPs are site specific, as seen in Table 3.1.

Table 3.2 Agricultural BMP options in PRedICT, and corresponding NRCS practices.

PRedICT Option	Agricultural BMP Type	Possible Components	NRCS Codes
BMP 1	Cropland Protection	Cover Crop	340
		Conservation Crop Rotation	328
BMP 2	Conservation Tillage	Residue and Tillage Management	329, 344-346
BMP 3	Stripcropping/Contour Farming	Stripcropping	585
		Contour Farming	330
BMP 4	Ag to Forest Land Conversion	Conservation Cover	327
		Forest Site Preparation	490
		Tree/Shrub Establishment	612
BMP 5	Ag to Wetland Conversion	Constructed Wetland	656
		Wetland Restoration	657
		Wetland Creation	658
		Wetland Enhancement	659
		Wetland Habitat Management	644
BMP 6	Nutrient Management	Nutrient Management	590
BMP 7	Grazing Land Management	Fence	382
		Heavy Use Area Protection	561
		Pasture and Hayland Planting	512

		Prescribed Grazing	528
		Pipeline	516
		Pond	378
		Pond Sealing or Lining	521
		Spring Development	574
		Watering Facility	614
		Water Well	642
BMP 8	Terraces and Diversions	Terrace	600
		Diversion	362

Table 3.3 Animal-related BMP options in PRedICT, and corresponding NRCS practices.

Animal-related BMP Type	Possible Components	NRCS Codes
AWMS/Livestock	Critical Area Planting	342
	Diversion	362
	Fence	382
	Filter Strip	393
	Heavy Use Area Protection	561
	Nutrient Management	590
	Pond Sealing or Lining	521
	Roof Runoff Structure	558
	Structure for Water Control	587
	Subsurface Drain	606
	Underground Outlet	620
	Waste Storage Facility	313
	Manure Transfer	634
	Waste Treatment Lagoon	359
	Waste Utilization	633
AWMS/Poultry	Nutrient Management	590
	Waste Storage Facility	313
	Waste Facility Cover	367
	Waste Utilization	633
Runoff Control	Access Road	560
	Critical Area Planting	342
	Dike	356
	Diversion	362
	Fence	382
	Filter Strip	393
	Grassed Waterway	412
	Heavy Use Area Protection	561
	Roof Runoff Structure	558
Phytase Feed	Feed Management	592

AWMS – Animal Waste Management System

Table 3.4 Stream-related BMP options in PRedICT, and corresponding NRCS practices.

Stream-related BMP Type	Possible Components	NRCS Codes
Vegetative Buffers	Riparian Forest Buffer	391
	Riparian Herbaceous Cover	390
Streambank Fencing	Fence	382
Streambank Stabilization	Streambank and Shoreline Protection	580

The program then computes estimates of nutrient (phosphorus and nitrogen) and sediment loads that can be expected from changes in the amount of BMPs implemented. The amount of BMPs is represented by percentages. For example, agricultural BMPs are entered based on the percentage of applicable agricultural acres (crop fields and/or pastures) they are utilized on, whereas stream-related BMPs are entered based on the percentage of stream miles they affect.

Most agriculturally impaired streams in the watershed were assessed by DEP in July of 2000. This serves as the reference date for modeling. Any BMPs implemented before July 2000 are considered "Past" BMPs, those implemented between July 2000 and the present are considered "Present" BMPs, and those we wish to see implemented are considered "Future" BMPs. In addition to nutrient and sediment load reductions, PRedICT also provides cost estimates for installing "Future" BMPs. The PRedICT program allows users to edit unit cost estimates, which we did to match more current prices.

Without completed TMDLs it is difficult to determine the amount of load reductions needed for each impaired tributary to be restored. This difficulty was compounded by the inability of the watershed modeling software to accurately model the small areas around the impaired streams only. In order to show some differences across the watershed, modeling was done on each of the previously mentioned 11 subwatersheds. A "best-case scenario" approach was taken when modeling. The primary BMPs (agricultural, stream, roads, and animal) were set to their highest installation potential (100%) to model the "best-case" in order to see the potential each subwatershed has for improvement. This “best-case” scenario of 100% installation potential represents not only the listed BMPs in Table 3.1 (highest priority BMPs), but also includes 100% installation of BMPs in the rest of the watershed. Default settings for BMP efficiencies (developed by NRCS) were used in this scenario. It would be a waste of time, resources, and effort working in the agricultural community if implementing agricultural BMPs had no potential to improve subwatersheds. This scenario basically includes:

- All crop fields with no-till, residue, and cover crops
- All pastures managed properly/rotationally grazed
- All barnyards equipped with Runoff Controls & Waste Management Systems
- All farms practicing Nutrient Management
- Streams fully buffered and fenced
- All unstable stream banks stabilized
- All dirt and gravel roads improved

Once TMDLs are created, and load requirements are available, modeling will be run again to determine a more “realistic” scenario of exactly what percentage of each BMP will be needed. This plan can then be amended accordingly.

Results can be seen in Table 3.5 and Figures 3.2, 3.3, and 3.4. PRedICT scenario reports for the 2008 to “future” run can be found in Appendix B. Results of this “best-case scenario” indicate that certain subwatersheds do have the potential to significantly reduce loads through agricultural, stream, roads, and animal-related BMPs. These subwatersheds include Beaver Run, Coal Run, East Buffalo, Muddy Run, and West Buffalo. Notice, all these subwatersheds, with the exception of West Buffalo, contain a currently listed impaired stream section, leaving only the Rapid Run subwatershed. Looking at land use, it is not hard to see why the Rapid Run subwatershed is not included in this group. Only a small area (around the impaired tributary) in the Rapid Run subwatershed is dominated by agricultural land use. The main branch of Rapid Run, along with all other tributaries, run through forested land. This majority of forested land most likely overshadows the negative impacts of agriculture when modeling the entire subwatershed.

Modeling results are reported in total loads (pounds) and in load based on subwatershed area (pounds per acre) in order to more easily compare from one subwatershed to the next. These results (Figures 3.2, 3.3, and 3.4) suggest that when looking at loads relative to the size of the watershed, considerable reductions in sediment, nitrogen, and phosphorus can be made through the implementation of agricultural, stream, road, and animal-related BMPs.

Table 3.5.a Pollutant loads for each subwatershed in 2000, 2008, and in a future "best-case scenario."

Subshed	Sediment (pounds)			Nitrogen (pounds)			Phosphorus (pounds)		
	2000	2008	Future	2000	2008	Future	2000	2008	Future
Beaver Run	1,360,397	1,349,807	441,599	98,545	97,345	58,951	4,651	4,537	2,121
Coal Run	608,838	571,464	218,504	58,691	58,248	46,264	2,033	1,999	1,123
East Buffalo	4,715,391	4,405,312	1,219,654	254,362	250,455	165,299	11,606	11,254	5,375
Little Buffalo	2,565,051	2,430,940	803,723	121,901	120,819	99,766	4,377	4,265	2,597
Muddy Run	526,669	494,901	245,956	37,176	36,879	29,406	1,372	1,343	839
North Branch	1,173,659	1,147,538	443,963	42,881	42,554	30,377	2,107	2,079	1,414
Rapid Run	1,475,373	1,426,011	643,635	45,102	44,593	35,482	2,054	2,010	1,449
Spruce/Black	2,065,843	2,021,053	1,166,137	79,278	78,608	68,105	2,998	2,939	2,223
Stony Run	89,897	83,827	26,467	8,325	8,231	5,254	378	370	199
Upper Buffalo	383,477	353,817	143,096	17,670	17,498	12,133	826	811	489
West Buffalo	3,225,028	3,003,644	1,150,073	169,516	167,945	132,742	5,730	5,599	3,361
Total	**18,189,623**	**17,288,314**	**6,502,807**	**933,447**	**923,175**	**683,779**	**38,132**	**37,206**	**21,190**

Table 3.5.b Pollutant load reductions by percentage for each subwatershed from 2008 to a future "best-case scenario."

Subshed	Sediment Reduction (%)	Nitrogen Reduction (%)	Phosphorus Reduction (%)
Beaver Run	67.28	39.44	53.25
Coal Run	61.76	20.57	43.82
East Buffalo	72.31	34.00	52.24
Little Buffalo	66.94	17.43	39.11
Muddy Run	50.30	20.26	37.53
North Branch	61.31	28.62	31.99
Rapid Run	54.86	20.43	27.91
Spruce/Black	42.30	13.36	24.36
Stony Run	68.43	36.17	46.22
Upper Buffalo	59.56	30.66	39.70
West Buffalo	61.71	20.96	39.97
Total	62.39	25.93	43.05

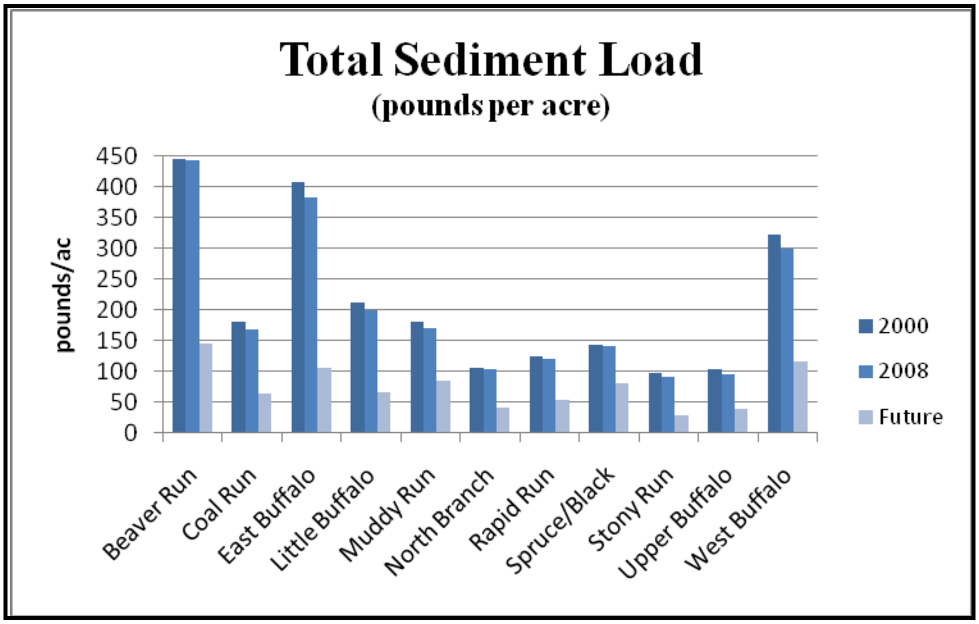


Figure 3.2 Total sediment load (pounds/ac) reductions from 2000 to 2008 and for a future "best-case"

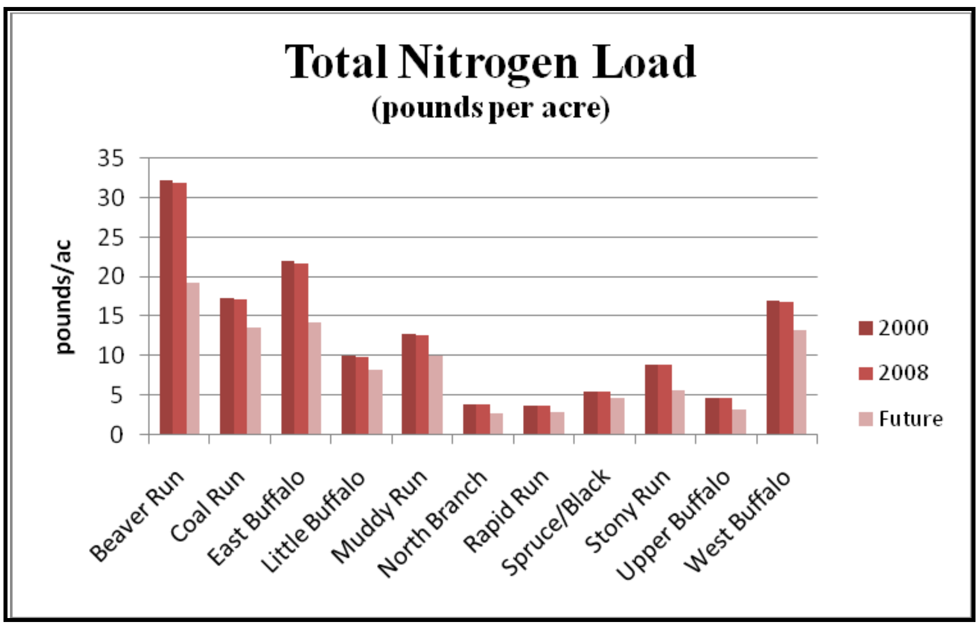


Figure 3.3 Total nitrogen load (pounds/ac) reductions from 2000 to 2008 and for a future "best-case."

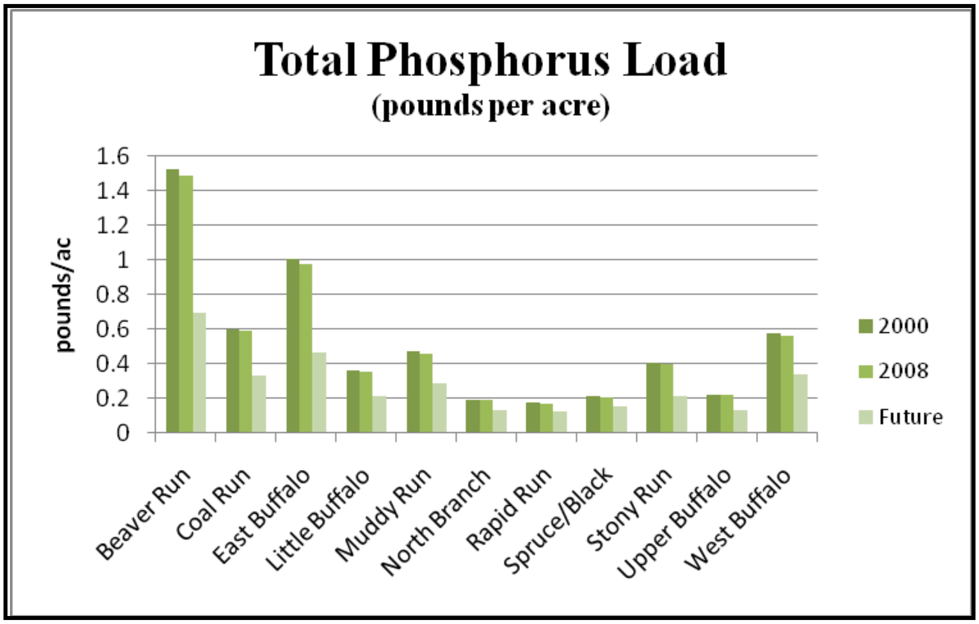


Figure 3.4 Total phosphorus load (pounds/ac) reductions from 2000 to 2008 and for a future "best-case."

However, such profound reductions require 1) landowner cooperation watershed-wide, and 2) funding. PRedICT estimates the following installation costs for a "best-case scenario."

Agricultural BMPs……………...$5,434,559
Animal/Barnyard BMPs………...$7,144,586
Unpaved Road Improvements…..$1,569,841
Streambank Stabilization…….$185,147,517
Total………………………….$199,296,503

Streambank stabilization, by far is the most expensive of the BMP categories. However, this cost was estimated based on the stabilization of *all* stream miles. Although an important and needed BMP, many miles, especially those in forested landscapes, are not in need of stabilization. Also, it is important to note that some streambank erosion can be addressed through other practices such as streambank fencing and riparian buffers. As mentioned, these figures represent the best possible implementation percentages from these four BMP categories.

SUBWATERSHED PRIORITIZATION

The data and information that were reviewed for the previous two chapters serve as the basis for evaluating problems, solutions, and benefits within the Buffalo Creek watershed on a subwatershed basis. Subwatersheds were prioritized for future action taking into account the size of drainage area, land use, levels of impairment, number of potential project areas, ecological benefit of restoration, and a number of other factors that are shown in the subwatershed prioritization matrix in Table 3.6. The matrix found in Table 3.6 was originally published in BCWA's watershed plan. The current version is essentially the same matrix; however a twelfth column was added to factor in the results of the aforementioned watershed modeling (see "Modeling Results – Potential for Improvement"). The potential for a subwatershed to be restored via BMP implementation should be considered when choosing priorities. In other words, higher priority was placed on subwatersheds where the most difference can be made.

Each factor, appearing in bold in the Table 3.6 columns, was assigned a value based on how important each element is in terms of the BCWA's restoration goals. The most important was assigned a value of "12", in this case Level of Tributary Impairment, with the least important receiving a "1" (% Public Access). This rank of importance was then multiplied by a score of 1, 2 or 3 (with 1 being low, 2 medium and 3 high) that was derived from answering a series of worksheet questions provided in the workbook titled Developing A Watershed Management Plan provided by the PA DEP as a guidance document for plan development. For example with Beaver Run, when answering the question in the PA DEP workbook about the Impact of Impairment on Main Stem a value of "11" (taken from the column heading) was multiplied by a factor of "1" to generate the score of 11 that is shown in the table. Essentially this indicates that, although Beaver Run experiences impairment, it is not a major source of impairment to the Buffalo Creek main stem by volume when compared to other tributaries. The final result is a subwatershed score and ranking.

According to this exercise the subwatersheds are prioritized as follows:

1. Buffalo Creek main stem
2. Beaver Run
3. Muddy Run/Coal Run (tied)
4. Little Buffalo
5. Rapid Run
6. North Branch Buffalo Creek
7. Spruce Run
8. Panther Run
9. Black Run
10. Stony Run

There are two factors to note regarding the prioritization of subwatersheds for restoration. One, the BMPs outlined earlier in this plan are only recommendations. Landowner cooperation and consent will dictate the type and amount of BMPs installed and in which subsheds they are implemented. Two, a current grant through Section 319 is the Union County Conservation District's largest source of funding for BMP implementation. To be eligible for this funding, BMP projects must be located to directly benefit impaired stream segments listed on EPA's Integrated Streams List. This, however, does not necessarily conflict with our prioritization as 6 of the top 7 subwatersheds contain currently listed impaired stream sections (refer to Table 2.2).

Table 3.6 Subwatershed prioritization matrix.

Restoration Impact				Restoration Potential									
Rank each column in order of importance with 12 being the most and 1 being the least	12	11	8	10	3	5	1	4	9	7	6	2	Multiply ranking by score
Tributary Name	**Level of Tributary Impairment**	**Impact of Impairment on Main Stem**	**# of Sites for Potential Recovery**	**Modeling Results - Potential for Improvement**	**Stakeholder Involvement**	**Site Access**	**% Public Access**	**Suitability for Restoration Goal**	**Ecological Benefit of Restoration**	**Financial Feasibility**	**Technical Feasibility**	**Socio-economic Benefit of Restoration**	**TOTAL**
Beaver Run	36	11	24	30	3	10	1	8	18	14	12	4	171
Black Run	12	11	8	10	3	5	1	4	9	7	12	2	84
Buffalo Main	36	33	24	30	9	10	2	12	27	7	18	6	214
Buffalo N. Branch	12	11	8	10	9	10	2	8	18	14	12	4	118
Coal Run	36	11	24	20	6	10	1	12	18	14	12	4	168
Little Buffalo	12	22	16	20	6	10	1	8	9	14	12	4	134
Muddy Run	36	11	24	20	6	10	1	12	18	14	12	4	168
Panther Run	12	11	8	10	3	15	3	4	9	7	6	2	90
Rapid Run	12	11	16	10	6	10	2	8	18	21	12	4	130
Spruce Run	12	11	8	10	6	10	3	4	9	14	12	4	103
Stony Run	12	11	8	10	3	5	1	4	9	7	6	2	78

ENDNOTES

[1] Merritts, D.J. and R.C. Walter. Disconnected Streams and the Legacy of Sediment Storage – Presentation slides/unpublished data.

[2] Walter, R.C. and D.J. Merritts. Natural Streams and the Legacy of Water-Powered Mills. Science. Volume 319. 2008.

CHAPTER 4

RESTORATION STRATEGIES

IMPLEMENTATION SCHEDULE & MILESTONES

There are many factors to consider when setting a schedule for BMP implementation. The Union County Conservation District and BCWA strive to set a schedule that will make significant progress, yet at the same time, will be realistic and feasible. The Conservation District will take the lead on soliciting landowner cooperation and administering implementation grants. Until TMDLs are completed, our approach will be to implement as many BMPs as possible along impaired stream sections with a focus on one impaired tributary at a time. The success of this approach depends on 1) funding, and 2) landowner cooperation. The primary funding source for proposed BMPs will fall under Section 319, however it should be noted a variety of other County, State, and Federal programs are available (see Additional Funding on page 65) to supplement work on priority streams and increase progress. The following are the milestones by which progress will be measured:

2008-2011

1) Continue generalized and one-on-one marketing to eligible landowners
2) Solicit sign-ups and implement as many BMPs as financially possible (target 3 farms per year)
3) Seek additional funding (to be used 2012-2015) for additional cooperating landowners.

2012-2015

1) Continue generalized and one-on-one marketing to eligible landowners
2) Continue to implement as many BMPs as financially possible (target 3 farms per year)
3) Seek additional funding (to be used 2016-2019) for additional cooperating landowners.

2016-?

1) Market program to landowners on original impaired and any newly impaired stream sections
2) Continue to implement as many BMPs as financially possible at a targeted rate of 3 farms per year until completed or TMDLS are met
3) Seek additional funding for additional cooperating landowners.

These dates will provide milestones against which progress in implementing this plan may be evaluated.

ADDITIONAL FUNDING

In addition to Section 319 implementation grants, there are other funding sources available to address impairments throughout the Buffalo Creek watershed. Because Section 319 applies only to EPA listed impaired streams, other funding sources allow for remediation work to take place watershed, or even county-wide. These funding sources include NRCS programs such as EQIP and CREP, Chesapeake Bay special projects such as no-till conversion incentives, cover crop incentives, and barnyard improvements, and the DEP Streambank Fencing Program. The Conservation District also offers a no-till grain drill and low rate manure spreader for rent to county farmers. While not additional funding sources, these programs do help promote no-till farming and better nutrient management, both of which can be help alleviate some impact farming may have on water quality.

WATER QUALITY MONITORING & MILESTONES

Currently, only one stream listed on the Integrated Streams List has a completed TMDL. Completed TMDLs would make planning future BMPs easier. However, work to implement BMPs must begin, and the progress made as a result must be monitored. Evaluating reductions in nutrient and sediment loads can be difficult, especially considering no State Water Quality Standards currently exist for nutrient and sediment in Pennsylvania, and improvements may not be immediately evident. Nevertheless, we feel by utilizing an existing monitoring plan and revising where needed we can capture indications of change.

Monitoring will be carried out by the BCWA. The BCWA has a monitoring committee that will continue the measurement of water quality at eight sites currently being monitored and add representative subsets of the stream sections selected for remediation if they do not already fall within one of the eight historical sites. The purpose of monitoring will be to assess benefits gained from BMP installations and provide continuous data for future restoration projects.

The BCWA will conduct at least one pre-construction sampling and annual post-construction sampling to show probable gains in water quality. Volunteer monitoring teams will measure temperature, alkalinity, pH, and dissolved oxygen in the field using LaMotte kits or field probes when available. Each team will also collect a 1-liter grab sample using standard protocol. This sample will be stored on ice until it can be delivered to Bucknell University for processing.

At Bucknell, the following analyses will be performed on the water from the sample using standard protocols and quality control procedures:

1. total suspended solids (TSS)
2. ion chromatography for concentrations of major anions (chloride, nitrate, phosphate, sulfate) and cations (sodium, potassium, calcium, magnesium, ammonium)
3. spectrophotometric determination of soluble reactive phosphorus (SRP)

In order to mark physical progress, additional monitoring will consist of annual visual habitat assessment and photographs. All data will be analyzed by Bucknell annually. A summary of the results and recommendations will be reported to the BCWA board and published on the BCWA web site. BCWA will meet annually to review both progress in water quality improvement and BMP implementation.

An additional way to mark progress is to update the watershed modeling periodically. Recurring modeling, combined with completed TMDLs, should give us up to date information regarding the current state of the watershed and what further work needs done. Without TMDLs it is difficult to determine the exact load reductions needed on each impaired tributary. We are estimating approximately 60% reductions in nitrogen, phosphorus, and sediment loads will be needed (subject to change when TMDLs are completed). We would like to see a 10% reduction in each pollutant load every 5 years for 30 years to reach 60%.

The official determination of water quality improvement will be through DEP water quality assessments. Every five years PA DEP will conduct In-stream Comprehensive Evaluations (ICEs) using an Index of Biotic Integrity (IBI) as the measure of stream health. An IBI is actually an integration of six different indices used to measure biological integrity. Once standardized and combined, the resulting IBI score can range from 0 to 100. Table 4.1 shows the IBI scores for supporting use by stream designation.

Table 4.1 Index of Biotic Integrity scoring benchmarks for each designated stream use.

Designated Use	**IBI scoring benchmark**
EV, HQ	$\geq$ 80.0
CWF	$\geq$ 63.0
TSF	
WWF	

Monitoring and analyses by BCWA will serve as interim measures of progress between scheduled DEP assessments. The assessments will serve as the primary measure of progress on streams selected for remediation. Our goal is to reach the milestone that 90% of each of the agriculturally impaired streams will reach their IBI scoring benchmark by 2038. We would like to see this accomplished by setting a target of 15% of stream miles meeting their IBI benchmark every 5 years.

In the future, as more specific detail regarding the type and location of newly implemented agricultural BMPs becomes available, this monitoring plan may be reviewed and revised to include other monitoring techniques to better track changes in water quality and stream condition. Once TMDLs are completed, and modeling is rerun on a more realistic scenario we will have a much better understanding of where water quality needs to be. This will also help in the reevaluation of the monitoring plan, and the development and evaluation of more precise monitoring milestones.

REMEDIAL ACTIONS

At some point TMDLs will be completed for each impaired stream in the watershed. These TMDLs can be used as tools for evaluating remediation strategies laid out in this plan. When completed, each TMDL can be compared with modeling results. By comparing the two, we will be better equipped to determine how effective BMPs in this plan will be in remediating impaired streams, as the primary goal for remediation is meeting the TMDLs. In the event modeling results show an inadequacy in planned BMPs to meet the TMDLs, this plan and modeling inputs will have to be reviewed and revised. However, until TMDLs are completed, we feel the projected load reductions discussed earlier will make substantial progress towards meeting the TMDLs. This plan may also need to be revised if monitoring trends show we are making less progress in improving water quality than expected from installed BMPs. It is important to note, however, that it may take several BMPs installed along the same reach to show appreciable gains in water quality, and these BMPs may need to be in place for several years before these gains can be seen.

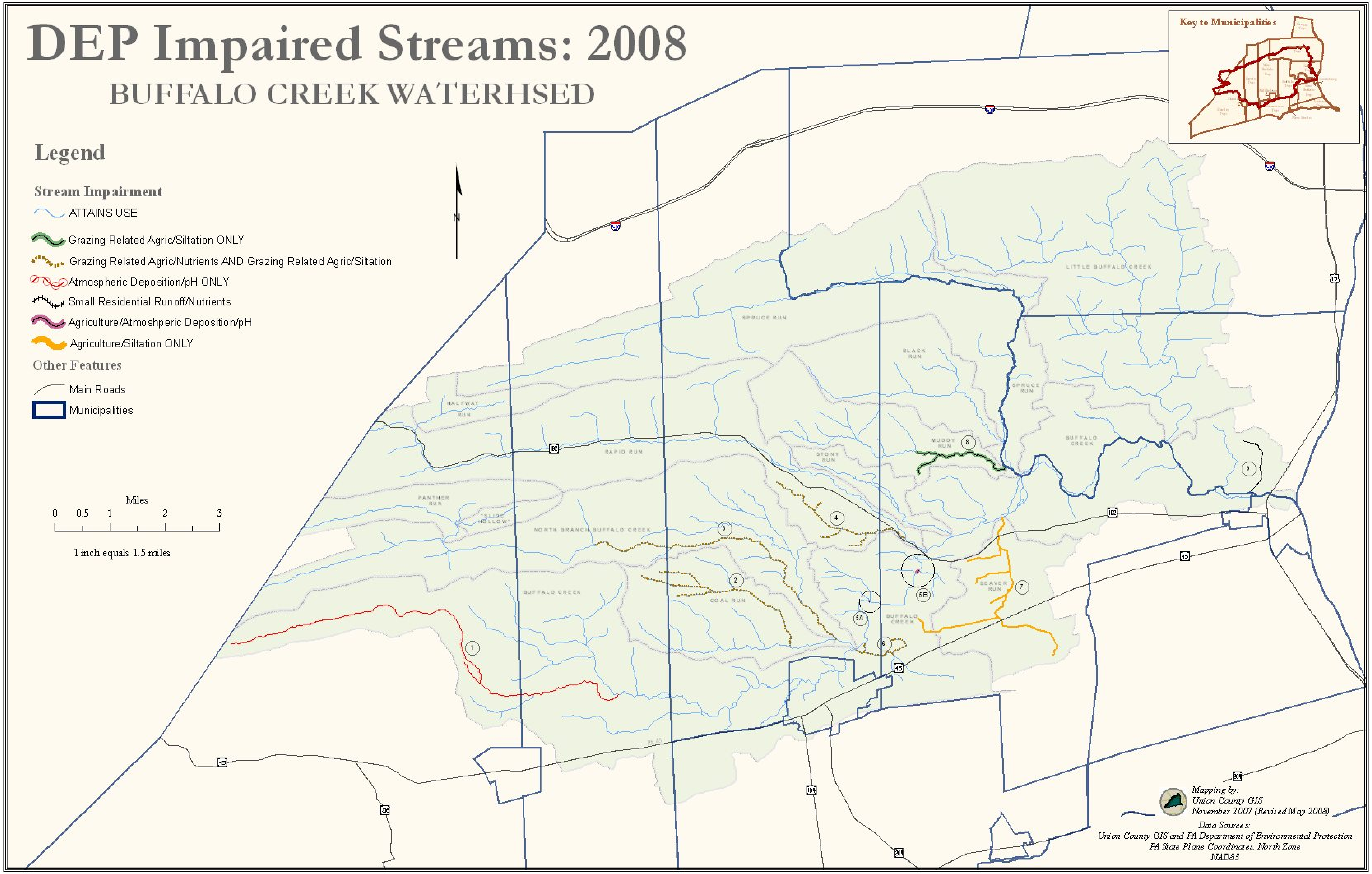
PUBLIC INFORMATION AND PARTICIPATION

There are many stakeholders within the Buffalo Creek watershed that could benefit from improved water quality. These stakeholders include farmers (both English and Mennonite) as well as residents in the watershed who utilize our water resources in a variety of ways. Drinking water is one important use. The North Branch of Buffalo Creek and Spruce Creek are public drinking water supplies, and many streams in agricultural areas serve as a supply for livestock. Also, the watershed offers many recreational opportunities. Buffalo Creek and its tributaries are popular among anglers, hunters, those who enjoy scenic drives, hiking, horseback riding, mountain biking, cross-country skiing, camping, canoeing, and swimming. Bald Eagle State Forest and Raymond B. Winter State Park provide the public with access to thousands of acres of land for these activities within the watershed. Stakeholders of influence throughout the watershed include Township Supervisors, DCNR, wastewater treatment plant operators, Mennonite bishops, borough councils, County Commissioners, and local academia.

There are a variety of ways to keep the public informed of remediation efforts. The Conservation District and BCWA frequently attend local events, fairs, field days, and outdoor shows, which provide an opportunity for the public to learn about current projects, sign up to volunteer, and pick up informational literature. Both organizations also often post current news and information on their websites or in local newspapers. Probably, one of the harder communities to reach will be farmers, especially Old Order Mennonite farmers. Additional effort can be made to contact these farmers, particularly those eligible for 319 funding, through mailings, visits, and agricultural field days. Some steps have already been taken as part of the work done by the Agricultural/Environmental Specialist hired last year. Progress may be slow, but over time we hope to build trust and a working relationship with the community. This work and all other responsibilities such as planning, prioritization, and securing of funding will primarily be carried out by the Conservation District, with additional assistance from BCWA, NRCS, Bucknell University, and the Union County Planning Commission.

APPENDIX A

MAP OF IMPAIRED STREAMS


DEP Impaired Streams: 2008
BUFFALO CREEK WATERHSED
Legend
Stream Impairment
ATTAINS USE
Grazing Related Agric/Siltation ONLY
Grazing Related Agric/Nutrients AND Grazing Related Agric/Siltation
Atmospheric Deposition/pH ONLY
Small Residential Runoff/Nutrients
Agriculture/Atmoshperic Deposition/pH
Agriculture/Siltation ONLY
Other Features
Main Roads
Municipalities
Miles
0 0.5 1 2 3
1 inch equals 1.5 miles
Key to Municipalities
LITTLE BUFFALO CREEK
SPRUCE RUN
BLACK RUN
SPRUCE RUN
BUFFALO CREEK
HALFWAY RUN
RAPID RUN
MUDDY RUN
STONY RUN
PANTHER RUN
NORTH BRANCH BUFFALO CREEK
BUFFALO CREEK
COAL RUN
BEAVER RUN
BUFFALO CREEK
Mapping by:
Union County GIS
November 2007 (Revised May 2008)
Data Sources:
Union County GIS and PA Department of Environmental Protection
PA State Plane Coordinates, North Zone
NAD83

APPENDIX B

PRedICT REPORTS

BEAVER RUN

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	1066189	6931	1150
Hay/Pasture	46374	1006	112
High Density Urban	0	0	0
Low Density Urban	23408	121	20
Unpaved Road	3192	22	3
Other	23580	148	19
STREAMBANK EROSION	197654	10	4
GROUNDWATER/SUBSURFACE		24427	276
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		52	6
TOTAL	1360397	98545	4651
BASIN AREA	3052	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	2019	% Existing	0	50	0	0	0	10		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	630	% Existing				0	0	10	25	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	325	Acres
Streams in Agricultural Areas	6.1	Miles
Total Stream Length	7.3	Miles
Unpaved Road Length	0.9	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	0.7	6.1
Stream Miles with Fencing	0.0	6.1
Stream Miles with Stabilization	0.1	7.3
Unpaved Road Miles w/E & S Controls	0.0	0.9

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	2019	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	247	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	.4	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	134		
	Future	134		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	**Secondary**	**Tertiary**
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	**Primary to Tertiary**	**Secondary to Tertiary**
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		
Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	1066189	6931	1150
Hay/Pasture	46374	1006	112
High Density Urban	0	0	0
Low Density Urban	23408	121	20
Unpaved Roads	3192	22	3
Other	23580	148	19
STREAMBANK EROSION	197654	10	4
GROUNDWATER/SUBSURFACE		24427	276
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		52	6
FARM ANIMALS		65828	3061
TOTALS	**1360397**	**98545**	**4651**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	352758	834	376
Hay/Pasture	41853	252	62
High Density Urban	0	0	0
Low Density Urban	23408	121	20
Unpaved Roads	0	22	3
Other	23580	148	19
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		24279	216
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		52	6
FARM ANIMALS		33244	1419
TOTALS	**441599**	**58951**	**2121**
PERCENT REDUCTIONS	67.5	73.9	84.9
TOTAL SCENARIO COST	$7,171,736.55		
Ag BMP Cost (%)	4.7		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	80.3		
Unpaved Road Protection Cost (%)	1.4		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	1.389e+15	2.933e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	1.224e+12	1.224e+12
Urban Areas	6.497e+15	6.497e+15
Wildlife	4.672e+10	4.672e+10
Totals	7.887e+15	6.791e+15
PERCENT REDUCTIONS		13.89
TOTAL SCENARIO COST	$7,171,736.55	

COAL RUN

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	289101	2190	260
Hay/Pasture	56742	1588	150
High Density Urban	0	0	0
Low Density Urban	5639	84	14
Unpaved Road	9808	71	7
Other	17404	234	14
STREAMBANK EROSION	230144	12	5
GROUNDWATER/SUBSURFACE		24034	304
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		41	6
TOTAL	608838	58691	2033
BASIN AREA	3395	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	974	% Existing	0	50	0	0	0	3		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	969	% Existing				0	0	3	25	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	346	Acres
Streams in Agricultural Areas	6.1	Miles
Total Stream Length	13.4	Miles
Unpaved Road Length	3.2	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	3.3	6.1
Stream Miles with Fencing	0.0	6.1
Stream Miles with Stabilization	0.0	13.4
Unpaved Road Miles w/E & S Controls	0.1	3.2

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban					
		Acres	974	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban					
		Acres	171	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers				
			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	.2	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	74		
	Future	74		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	**Secondary**	**Tertiary**
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	**Primary to Tertiary**	**Secondary to Tertiary**
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	289101	2190	260
Hay/Pasture	56742	1588	150
High Density Urban	0	0	0
Low Density Urban	5639	84	14
Unpaved Roads	9808	71	7
Other	17404	234	14
STREAMBANK EROSION	230144	12	5
GROUNDWATER/SUBSURFACE		24034	304
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		41	6
FARM ANIMALS		30437	1273
TOTALS	**608838**	**58691**	**2033**
	Future (lbs)		
LAND EROSION/RUNOFF	**Total Sed (lbs)**	**Total N (lbs)**	**Total P (lbs)**
Row Crops	144251	372	117
Hay/Pasture	51210	345	81
High Density Urban	0	0	0
Low Density Urban	5639	84	14
Unpaved Roads	0	70	7
Other	17404	234	14
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		23969	257
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		41	6
FARM ANIMALS		21149	628
TOTALS	**218504**	**46264**	**1123**
PERCENT REDUCTIONS	64.1	57.2	75.6
TOTAL SCENARIO COST	$11,789,563.48		
Ag BMP Cost (%)	4.0		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	89.3		
Unpaved Road Protection Cost (%)	2.9		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	5.303e+14	1.580e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	1.054e+12	1.054e+12
Urban Areas	6.526e+15	6.526e+15
Wildlife	4.451e+11	4.451e+11
Totals	7.058e+15	6.686e+15
PERCENT REDUCTIONS		5.28
TOTAL SCENARIO COST	$11,789,563.48	

EAST BUFFALO CREEK

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	2395721	18356	2773
Hay/Pasture	120821	4520	456
High Density Urban	617	184	20
Low Density Urban	75157	662	110
Unpaved Road	7768	67	9
Other	219389	1164	161
STREAMBANK EROSION	1895918	95	42
GROUNDWATER/SUBSURFACE		89918	1014
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		197	23
TOTAL	4715391	254362	11606
BASIN AREA	11550	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	5520	% Existing	0	50	0	0	0	0		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	2768	% Existing				0	0	0	25	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	1,029	Acres
Streams in Agricultural Areas	18.0	Miles
Total Stream Length	32.0	Miles
Unpaved Road Length	3.0	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	2.5	18.0
Stream Miles with Fencing	0.6	18.0
Stream Miles with Stabilization	0.1	32.0
Unpaved Road Miles w/E & S Controls	0.2	3.0

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	5520	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	1349	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	2.1	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	472		
	Future	472		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	2395721	18356	2773
Hay/Pasture	120821	4520	456
High Density Urban	617	184	20
Low Density Urban	75157	662	110
Unpaved Roads	7768	67	9
Other	219389	1164	161
STREAMBANK EROSION	1895918	95	42
GROUNDWATER/SUBSURFACE		89918	1014
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		197	23
FARM ANIMALS		139199	6998
TOTALS	**4715391**	**254362**	**11606**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	815450	1854	893
Hay/Pasture	109041	919	245
High Density Urban	617	184	20
Low Density Urban	75157	662	110
Unpaved Roads	0	66	9
Other	219389	1164	161
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		89521	810
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		197	23
FARM ANIMALS		70733	3104
TOTALS	**1219654**	**165299**	**5375**
PERCENT REDUCTIONS	74.1	62.8	80.4
TOTAL SCENARIO COST	$29,064,634.94		
Ag BMP Cost (%)	4.9		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	86.6		
Unpaved Road Protection Cost (%)	1.1		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	2.939e+15	6.685e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	4.310e+12	4.310e+12
Urban Areas	2.274e+16	2.274e+16
Wildlife	5.438e+11	5.438e+11
Totals	2.568e+16	2.341e+16
PERCENT REDUCTIONS		8.84
TOTAL SCENARIO COST	$29,064,634.94	

LITTLE BUFFALO CREEK

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	962287	5938	1017
Hay/Pasture	127748	3481	395
High Density Urban	0	0	0
Low Density Urban	36520	341	57
Unpaved Road	0	0	0
Other	178689	1283	132
STREAMBANK EROSION	1259807	63	28
GROUNDWATER/SUBSURFACE		64752	886
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		165	17
TOTAL	2565051	121901	4377
BASIN AREA	12145	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	2632	% Existing	0	50	0	0	0	8		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	2572	% Existing				0	0	8	30	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	1,049	Acres
Streams in Agricultural Areas	14.6	Miles
Total Stream Length	38.7	Miles
Unpaved Road Length	0.0	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	7.6	14.6
Stream Miles with Fencing	0.6	14.6
Stream Miles with Stabilization	0.0	38.7
Unpaved Road Miles w/E & S Controls	0.0	0.0

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	2632	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	771	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	2.7	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	440		
	Future	440		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	962287	5938	1017
Hay/Pasture	127748	3481	395
High Density Urban	0	0	0
Low Density Urban	36520	341	57
Unpaved Roads	0	0	0
Other	178689	1283	132
STREAMBANK EROSION	1259807	63	28
GROUNDWATER/SUBSURFACE		64752	886
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		165	17
FARM ANIMALS		45878	1845
TOTALS	**2565051**	**121901**	**4377**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	472391	1099	459
Hay/Pasture	116123	866	223
High Density Urban	0	0	0
Low Density Urban	36520	341	57
Unpaved Roads	0	0	0
Other	178689	1283	132
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		64630	788
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		165	17
FARM ANIMALS		31382	921
TOTALS	**803723**	**99766**	**2597**
PERCENT REDUCTIONS	68.7	43.9	61.7
TOTAL SCENARIO COST	$32,222,747.43		
Ag BMP Cost (%)	3.6		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	94.0		
Unpaved Road Protection Cost (%)	0		

Pathogen Loads		
Source	Existing (orgs/month)	Future (orgs/month)
Farm Animals	9.564e+14	2.940e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	3.214e+12	3.214e+12
Urban Areas	5.684e+15	5.684e+15
Wildlife	2.182e+12	2.182e+12
Totals	6.646e+15	5.984e+15
PERCENT REDUCTIONS		9.97
TOTAL SCENARIO COST	$32,222,747.43	

MUDDY RUN

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	247195	1588	250
Hay/Pasture	32677	983	99
High Density Urban	0	0	0
Low Density Urban	8838	84	14
Unpaved Road	11133	45	7
Other	82528	431	51
STREAMBANK EROSION	144298	7	3
GROUNDWATER/SUBSURFACE		14221	229
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		44	6
TOTAL	526669	37176	1372
BASIN AREA	2926	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	608	% Existing	0	50	0	0	0	2		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	605	% Existing				0	0	2	27	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	227	Acres
Streams in Agricultural Areas	4.3	Miles
Total Stream Length	9.7	Miles
Unpaved Road Length	1.2	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	2.4	4.3
Stream Miles with Fencing	0.2	4.3
Stream Miles with Stabilization	0.1	9.7
Unpaved Road Miles w/E & S Controls	0.0	1.2

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	608	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	171	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	.9	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	90		
	Future	90		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	**Secondary**	**Tertiary**
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	**Primary to Tertiary**	**Secondary to Tertiary**
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	247195	1588	250
Hay/Pasture	32677	983	99
High Density Urban	0	0	0
Low Density Urban	8838	84	14
Unpaved Roads	11133	45	7
Other	82528	431	51
STREAMBANK EROSION	144298	7	3
GROUNDWATER/SUBSURFACE		14221	229
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		44	6
FARM ANIMALS		19773	713
TOTALS	**526669**	**37176**	**1372**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	125014	268	113
Hay/Pasture	29576	212	54
High Density Urban	0	0	0
Low Density Urban	8838	84	14
Unpaved Roads	0	44	7
Other	82528	431	51
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		14193	203
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		44	6
FARM ANIMALS		14130	391
TOTALS	**245956**	**29406**	**839**
PERCENT REDUCTIONS	53.3	58.9	67.3
TOTAL SCENARIO COST	$8,225,387.54		
Ag BMP Cost (%)	3.5		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	91.6		
Unpaved Road Protection Cost (%)	1.6		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	3.120e+14	1.010e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	1.019e+12	1.019e+12
Urban Areas	6.526e+15	6.526e+15
Wildlife	5.447e+11	5.447e+11
Totals	6.840e+15	6.629e+15
PERCENT REDUCTIONS		3.09
TOTAL SCENARIO COST	$8,225,387.54	

NORTH BRANCH OF BUFFALO CREEK

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	188406	1557	178
Hay/Pasture	20202	767	74
High Density Urban	47	33	4
Low Density Urban	6835	147	24
Unpaved Road	4546	49	6
Other	364909	2181	181
STREAMBANK EROSION	588714	29	13
GROUNDWATER/SUBSURFACE		18501	673
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		126	17
TOTAL	1173659	42881	2107
BASIN AREA	11147	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	477	% Existing	0	50	0	0	0	5		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	502	% Existing				0	0	5	30	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	129	Acres
Streams in Agricultural Areas	3.2	Miles
Total Stream Length	32.1	Miles
Unpaved Road Length	1.1	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	0.0	3.2
Stream Miles with Fencing	0.1	3.2
Stream Miles with Stabilization	0.2	32.1
Unpaved Road Miles w/E & S Controls	0.2	1.1

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

	Acres	477	% Impervious Surface	50

Constructed Wetlands		Bioretention Areas		Detention Basins	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

	Acres	299	% Impervious Surface	25

Constructed Wetlands		Bioretention Areas		Detention Basins	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	1.3	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	240		
	Future	240		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	**Secondary**	**Tertiary**
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	**Primary to Tertiary**	**Secondary to Tertiary**
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	188406	1557	178
Hay/Pasture	20202	767	74
High Density Urban	47	33	4
Low Density Urban	6835	147	24
Unpaved Roads	4546	49	6
Other	364909	2181	181
STREAMBANK EROSION	588714	29	13
GROUNDWATER/SUBSURFACE		18501	673
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		126	17
FARM ANIMALS		19491	937
TOTALS	**1173659**	**42881**	**2107**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	53809	141	51
Hay/Pasture	18364	180	41
High Density Urban	47	33	4
Low Density Urban	6835	147	24
Unpaved Roads	0	48	6
Other	364909	2181	181
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		18494	657
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		126	17
FARM ANIMALS		9027	432
TOTALS	**443963**	**30377**	**1414**
PERCENT REDUCTIONS	62.2	50.2	53.4
TOTAL SCENARIO COST	$25,277,902.09		
Ag BMP Cost (%)	0.9		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	97.7		
Unpaved Road Protection Cost (%)	.4		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	3.085e+14	5.746e+13
WWTP	0.000e+00	0.000e+00
Septic Systems	3.419e+12	3.419e+12
Urban Areas	2.289e+16	2.289e+16
Wildlife	3.493e+12	3.493e+12
Totals	2.320e+16	2.295e+16
PERCENT REDUCTIONS		1.08
TOTAL SCENARIO COST	$25,277,902.09	

RAPID RUN

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	327197	1975	248
Hay/Pasture	20857	647	63
High Density Urban	0	0	0
Low Density Urban	24774	186	31
Unpaved Road	7024	56	7
Other	485082	2364	231
STREAMBANK EROSION	610439	31	13
GROUNDWATER/SUBSURFACE		24302	732
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		139	19
TOTAL	1475373	45102	2054
BASIN AREA	11920	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	544	% Existing	0	50	0	0	0	0		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	482	% Existing				0	0	0	25	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	242	Acres
Streams in Agricultural Areas	3.0	Miles
Total Stream Length	30.0	Miles
Unpaved Road Length	1.0	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	0.5	3.0
Stream Miles with Fencing	0.0	3.0
Stream Miles with Stabilization	0.1	30.0
Unpaved Road Miles w/E & S Controls	0.2	1.0

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	544	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	395	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	2.3	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	260		
	Future	260		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	327197	1975	248
Hay/Pasture	20857	647	63
High Density Urban	0	0	0
Low Density Urban	24774	186	31
Unpaved Roads	7024	56	7
Other	485082	2364	231
STREAMBANK EROSION	610439	31	13
GROUNDWATER/SUBSURFACE		24302	732
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		139	19
FARM ANIMALS		15402	710
TOTALS	**1475373**	**45102**	**2054**
	Future (lbs)		
LAND EROSION/RUNOFF	**Total Sed (lbs)**	**Total N (lbs)**	**Total P (lbs)**
Row Crops	114955	207	82
Hay/Pasture	18823	132	34
High Density Urban	0	0	0
Low Density Urban	24774	186	31
Unpaved Roads	0	55	7
Other	485082	2364	231
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		24293	714
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		139	19
FARM ANIMALS		8106	331
TOTALS	**643635**	**35482**	**1449**
PERCENT REDUCTIONS	56.4	39.3	45.6
TOTAL SCENARIO COST	$23,707,425.11		
Ag BMP Cost (%)	1.0		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	97.6		
Unpaved Road Protection Cost (%)	.4		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	3.210e+14	7.228e+13
WWTP	0.000e+00	0.000e+00
Septic Systems	3.704e+12	3.704e+12
Urban Areas	5.579e+15	5.579e+15
Wildlife	3.713e+12	3.713e+12
Totals	5.907e+15	5.659e+15
PERCENT REDUCTIONS		4.21
TOTAL SCENARIO COST	$23,707,425.11	

SPRUCE/BLACK RUN

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	313184	1800	280
Hay/Pasture	52886	1398	147
High Density Urban	332	40	4
Low Density Urban	22385	162	27
Unpaved Road	0	0	0
Other	916349	3952	441
STREAMBANK EROSION	760707	38	17
GROUNDWATER/SUBSURFACE		28239	828
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		203	24
TOTAL	2065843	79278	2998
BASIN AREA	14374	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	974	% Existing	0	50	0	0	0	0		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	966	% Existing				0	0	0	30	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	434	Acres
Streams in Agricultural Areas	4.0	Miles
Total Stream Length	36.0	Miles
Unpaved Road Length	0.0	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	2.9	4.0
Stream Miles with Fencing	0.0	4.0
Stream Miles with Stabilization	0.1	36.0
Unpaved Road Miles w/E & S Controls	0.0	0.0

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	974	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	366	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	1.1	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	454		
	Future	454		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	**Secondary**	**Tertiary**
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	**Primary to Tertiary**	**Secondary to Tertiary**
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	313184	1800	280
Hay/Pasture	52886	1398	147
High Density Urban	332	40	4
Low Density Urban	22385	162	27
Unpaved Roads	0	0	0
Other	916349	3952	441
STREAMBANK EROSION	760707	38	17
GROUNDWATER/SUBSURFACE		28239	828
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		203	24
FARM ANIMALS		43446	1230
TOTALS	**2065843**	**79278**	**2998**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	178997	334	140
Hay/Pasture	48073	293	81
High Density Urban	332	40	4
Low Density Urban	22385	162	27
Unpaved Roads	0	0	0
Other	916349	3952	441
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		28224	797
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		203	24
FARM ANIMALS		34897	710
TOTALS	**1166137**	**68105**	**2223**
PERCENT REDUCTIONS	43.6	58.1	49.5
TOTAL SCENARIO COST	$28,735,683.39		
Ag BMP Cost (%)	1.5		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	96.7		
Unpaved Road Protection Cost (%)	0		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	4.514e+14	1.290e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	4.643e+12	4.643e+12
Urban Areas	1.636e+16	1.636e+16
Wildlife	4.242e+12	4.242e+12
Totals	1.682e+16	1.650e+16
PERCENT REDUCTIONS		1.92
TOTAL SCENARIO COST	$28,735,683.39	

STONY RUN

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	46974	483	64
Hay/Pasture	4438	224	22
High Density Urban	0	0	0
Low Density Urban	2710	27	4
Unpaved Road	0	0	0
Other	2602	79	4
STREAMBANK EROSION	33173	2	1
GROUNDWATER/SUBSURFACE		2131	53
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		15	2
TOTAL	89897	8325	378
BASIN AREA	924	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	195	% Existing	0	50	0	0	0	0		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	143	% Existing				0	0	0	30	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	0	Acres
Streams in Agricultural Areas	1.0	Miles
Total Stream Length	4.0	Miles
Unpaved Road Length	0.0	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	0.2	1.0
Stream Miles with Fencing	0.0	1.0
Stream Miles with Stabilization	0.0	4.0
Unpaved Road Miles w/E & S Controls	0.0	0.0

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

	Acres		195	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

	Acres		54	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	.4	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	30		
	Future	30		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		
Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	46974	483	64
Hay/Pasture	4438	224	22
High Density Urban	0	0	0
Low Density Urban	2710	27	4
Unpaved Roads	0	0	0
Other	2602	79	4
STREAMBANK EROSION	33173	2	1
GROUNDWATER/SUBSURFACE		2131	53
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		15	2
FARM ANIMALS		5364	228
TOTALS	**89897**	**8325**	**378**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	17121	53	22
Hay/Pasture	4034	47	12
High Density Urban	0	0	0
Low Density Urban	2710	27	4
Unpaved Roads	0	0	0
Other	2602	79	4
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		2127	48
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		15	2
FARM ANIMALS		2906	107
TOTALS	**26467**	**5254**	**199**
PERCENT REDUCTIONS	70.6	71.8	75.8
TOTAL SCENARIO COST	$3,260,741.42		
Ag BMP Cost (%)	2.0		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	95.6		
Unpaved Road Protection Cost (%)	0		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	1.034e+14	2.366e+13
WWTP	0.000e+00	0.000e+00
Septic Systems	3.287e+11	3.287e+11
Urban Areas	6.738e+15	6.738e+15
Wildlife	1.745e+11	1.745e+11
Totals	6.842e+15	6.762e+15
PERCENT REDUCTIONS		1.16
TOTAL SCENARIO COST	$3,260,741.42	

UPPER BUFFALO CREEK

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	230489	1121	144
Hay/Pasture	12071	115	12
High Density Urban	0	0	0
Low Density Urban	977	19	3
Unpaved Road	1261	31	3
Other	65319	463	35
STREAMBANK EROSION	73360	4	2
GROUNDWATER/SUBSURFACE		7801	229
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		42	6
TOTAL	383477	17670	826
BASIN AREA	3704	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	336	% Existing	0	50	0	0	0	0		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	205	% Existing				0	0	0	30	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	77	Acres
Streams in Agricultural Areas	1.0	Miles
Total Stream Length	10.0	Miles
Unpaved Road Length	1.0	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	0.0	1.0
Stream Miles with Fencing	0.1	1.0
Stream Miles with Stabilization	0.0	10.0
Unpaved Road Miles w/E & S Controls	0.2	1.0

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban

		Acres	336	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban

		Acres	47	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	.4	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	80		
	Future	80		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	230489	1121	144
Hay/Pasture	12071	115	12
High Density Urban	0	0	0
Low Density Urban	977	19	3
Unpaved Roads	1261	31	3
Other	65319	463	35
STREAMBANK EROSION	73360	4	2
GROUNDWATER/SUBSURFACE		7801	229
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		42	6
FARM ANIMALS		8074	392
TOTALS	**383477**	**17670**	**826**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	65828	91	40
Hay/Pasture	10973	24	7
High Density Urban	0	0	0
Low Density Urban	977	19	3
Unpaved Roads	0	31	3
Other	65319	463	35
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		7796	220
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		42	6
FARM ANIMALS		3667	175
TOTALS	**143096**	**12133**	**489**
PERCENT REDUCTIONS	62.7	52.1	62.0
TOTAL SCENARIO COST	$8,050,830.29		
Ag BMP Cost (%)	1.2		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	96.1		
Unpaved Road Protection Cost (%)	1.1		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	1.760e+14	3.746e+13
WWTP	0.000e+00	0.000e+00
Septic Systems	1.140e+12	1.140e+12
Urban Areas	4.504e+15	4.504e+15
Wildlife	1.101e+12	1.101e+12
Totals	4.682e+15	4.544e+15
PERCENT REDUCTIONS		2.96
TOTAL SCENARIO COST	$8,050,830.29	

WEST BUFFALO CREEK

2008 – FUTURE

Mean Annual Load Data Editor

Load Data Type	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
UPLAND EROSION/RUNOFF			
Row Crops	1638332	8200	1016
Hay/Pasture	83711	2283	217
High Density Urban	2201	33	4
Low Density Urban	65599	549	92
Unpaved Road	21079	109	11
Other	204052	1139	94
STREAMBANK EROSION	1210054	61	27
GROUNDWATER/SUBSURFACE		65583	876
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		118	15
TOTAL	3225028	169516	5730
BASIN AREA	10023	Acres	

Agricultural Land BMP Scenario Editor

Land Use	Acres		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	3734	% Existing	0	50	0	0	0	3		0
		% Future	0	100	0	0	0	100		0
Hay/Pasture	1426	% Existing				0	0	3	30	0
		% Future				0	0	100	100	0

Agricultural Land on Slope > 3%	895	Acres
Streams in Agricultural Areas	8.7	Miles
Total Stream Length	24.9	Miles
Unpaved Road Length	3.6	Miles

	Existing	Future
Stream Miles with Vegetated Buffer Strips	4.5	8.7
Stream Miles with Fencing	0.3	8.7
Stream Miles with Stabilization	0.1	24.9
Unpaved Road Miles w/E & S Controls	0.1	3.6

	% Existing	% Future
AWMS (Livestock)	70.0	100.0
AWMS (Poultry)	50.0	100.0
Runoff Control	50.0	100.0
Phytase in Feed	85.0	100.0

Urban Land BMP Scenario Editor

High Density Urban					
		Acres	3734	% Impervious Surface	50
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	5	% Drainage Area Used	6	% Drainage Area Used	3
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Low Density Urban					
		Acres	1119	% Impervious Surface	25
Constructed Wetlands		**Bioretention Areas**		**Detention Basins**	
% Existing	0	% Existing	0	% Existing	0
% Future	0	% Future	0	% Future	0
% Drainage Area Used	3	% Drainage Area Used	6	% Drainage Area Used	2
Impervious Acres Drained	0.0	Impervious Acres Drained	0.0	Impervious Acres Drained	0.0
CW Acres Required	0.0	BA Acres Required	0.0	DB Acres Required	0.0

Vegetated Stream Buffers				
			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		High Density Urban Streambank Stabilization	0	0
Stream miles in low density urban areas	2.3	Stream miles in low density urban areas w/buffers	0	0
		Low Density Urban Streambank Stabilization	0	0

Septic Systems and Point Source Discharge Scenario Editor

Number of persons on septic systems	Existing	244		
	Future	244		
Spetic systrems converted by treatment type %	Secondary	0	Tertiary	0
	Existing Point Source Load		No	
		Primary	**Secondary**	**Tertiary**
Distribution of pollutant discharge by treatment type %	Existing	0	0	0
	Future	0	0	0
		Primary to Secondary	**Primary to Tertiary**	**Secondary to Tertiary**
Distribution of treatment upgrades %		0	0	0

Rural and Urban BMP Load Reduction Efficiency Editor

BMP Type	Nitrogen	Phosphorus	Sediment	Pathogens
BMP 1	0.25	0.36	0.35	
BMP 2	0.50	0.38	0.64	
BMP 3	0.23	0.40	0.41	
BMP 4	0.95	0.94	0.92	
BMP 5	0.96	0.98	0.92	
BMP 6	0.70	0.28		
BMP 7	0.43	0.34	0.13	
BMP 8	0.44	0.42	0.71	
Vegetated Buffer Strips	0.64	0.52	0.58	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilizatio	0.95	0.95	0.95	
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55	
AWMS (Livestock)	0.75	0.75		0.75
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Urban BMP Load Reduction Efficiency Editor				
BMP Type	**Nitrogen**	**Phosphorus**	**Sediment**	**Pathogens**
Constructed Wetlands	0.53	0.51	0.88	0.71
Bioretention Areas	0.46	0.61	0.10	0.82
Detention Basins	0.40	0.51	0.93	0.71

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of Septic Systems to Secondary Treatment Plant	0.14	0.10
Conversion of Septic Systems to Tertiary Treatment Plant	0.56	0.60
Conversion of Primary Treatment to Secondary Treatment	0.14	0.10
Conversion of Primary Treatment to Tertiary Treatment	0.56	0.60
Conversion of Secondary Treatment to Tertiary Treatment	0.42	0.50

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	1638332	8200	1016
Hay/Pasture	83711	2283	217
High Density Urban	2201	33	4
Low Density Urban	65599	549	92
Unpaved Roads	21079	109	11
Other	204052	1139	94
STREAMBANK EROSION	1210054	61	27
GROUNDWATER/SUBSURFACE		65583	876
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		118	15
FARM ANIMALS		91441	3378
TOTALS	**3225028**	**169516**	**5730**
	Future (lbs)		
LAND EROSION/RUNOFF	**Total Sed (lbs)**	**Total N (lbs)**	**Total P (lbs)**
Row Crops	802127	1364	449
Hay/Pasture	76093	512	120
High Density Urban	2201	33	4
Low Density Urban	65599	549	92
Unpaved Roads	0	107	11
Other	204052	1139	94
STREAMBANK EROSION	0	0	0
GROUNDWATER/SUBSURFACE		65433	754
POINT SOURCE DISCHARGE		0	0
SEPTIC SYSTEMS		118	15
FARM ANIMALS		63486	1822
TOTALS	**1150073**	**132742**	**3361**
PERCENT REDUCTIONS	64.3	59.2	73.1
TOTAL SCENARIO COST	$21,762,335.17		
Ag BMP Cost (%)	3.2		
WW Upgrade Cost (%)	0.0		
Urban BMP Cost (%)	0.0		
Stream Protection Cost (%)	89.1		
Unpaved Road Protection Cost (%)	1.8		

Pathogen Loads		
Source	**Existing (orgs/month)**	**Future (orgs/month)**
Farm Animals	1.483e+15	4.641e+14
WWTP	0.000e+00	0.000e+00
Septic Systems	2.941e+12	2.941e+12
Urban Areas	2.275e+16	2.275e+16
Wildlife	1.239e+12	1.239e+12
Totals	2.424e+16	2.322e+16
PERCENT REDUCTIONS		4.20
TOTAL SCENARIO COST	$21,762,335.17	

BMP COST EDITOR

(USED FOR ALL SUBWATERSHEDS)

BMP Cost Editor

Agricultural Cost Editor	
Conservation Tillage (per acre)	$20.00
Cropland Protection (per acre)	$20.00
Grazing Land Management (per acre)	$590.24
Streambank Fencing (per acre)	$10.00
Streambank Fencing (per mile)	$15,000.00
Streambank Stabilization (per foot)	$73.00
Vegetated Buffer Strip (per mile)	$2,100.00
Terraces and Diversions (per acre)	$500.00
AWMS Livestock (per AEU)	$1,675.00
AWMS Poultry (per AEU)	$685.00
Runoff Control (per AEU)	$400.00
Phytase in Feed (per AEU)	$17.00
Nutrient Management (per acre)	$16.00
Ag to Wetland Conversion (per acre)	$2,300.00
Unpaved Roads (per foot)	$10.40
Ag to Forest Conversion (per acre)	$1,600.00
Urban Cost Editor	
Constructed Wetlands (per acre)	$13,400.00
Bioretention Areas (per acre)	$8,000.00
Detention Basins (per acre)	$10,700.00
Septic System and Point Source Upgrades	
Conversion of Septic Systems to Centralized Sewage Treatment (per home)	$15,000.00
Conversion From Primary to Secondary Sewage Treatment (per capita)	$250.00
Conversion From Primary to Tertiary Sewage Treatment (per capita)	$300.00
Conversion From Secondary to Tertiary Sewage Treatment (per capita)	$150.00