WATERSHED-BASED PLAN FOR THE WOLF CREEK WATERSHED OF THE NEW RIVER

From the headwaters to the mouth, Fayette County, West Virginia

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

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ABBREVIATIONS

Alum.	aluminum
AMD	acid mine drainage
AML	abandoned mine land
BMP	best management practice
cfs	cubic feet per second
CNA	condition not allowable
CSO	combined sewer overflow
LAI	Lombardo Associates, Inc.
mg/L	milligram per liter
MPPRP	Maryland Power Plant Research Project
NA	not applicable
ND	no data
NPS	National Park Service
OAMLR	Office of Abandoned Mine Lands and Reclamation
OLC	oxic (or open) limestone channel
OSM	Office of Surface Mining, Reclamation, and Enforcement
PAD	problem area description
PAN	Plateau Action Network
POTW	publicly owned treatment works
RM	river mile
SRG	Stream Restoration Group
STED	septic tank effluent discharge (or drain)
STEP	septic tank effluent pump
SWS	subwatershed in the TMDL
TMDL	total maximum daily load
µg/L	microgram per liter
UIC	underground injection control
UIUC	University of Illinois Urbana-Champaign
UNT	unnamed tributary
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
VISTA	Volunteers In Service To America
WCAP	Watershed Cooperative Agreement Program
WCET	Wolf Creek Environmental Trust
WVDEP	West Virginia Department of Environmental Protection
WVDHHR	West Virginia Department of Health and Human Resources
WVDNR	West Virginia Department of Natural Resources
WVSAMB	West Virginia Statewide Addressing and Mapping Board
WOPEC	Working on People's Environmental Concerns
WTCMC	Wastewater Treatment Coalition of McDowell County

1 INTRODUCTION

This watershed-based plan covers the entire Wolf Creek watershed in Fayette County, West Virginia from the headwaters near Oak Hill to its confluence with the New River near the Fayette Station Bridge (Figure 1). Streams within the Wolf Creek watershed are impaired by high levels of iron, aluminum, and fecal coliform bacteria, as well as low pH. In addition, biological impairments are caused by organic enrichment and sedimentation. Total maximum daily loads (TMDLs) have been calculated for the Wolf Creek watershed as part of a broader TMDL report for the New River (Tetra Tech, 2008).[1]

To correct these impairments so all streams in the watershed once again meet water quality standards, load reductions are required for a variety of pollutants and sources. As shown in Table 1, the iron, aluminum, and fecal coliform impairments will be solved by addressing four types of nonpoint sources: abandoned mine lands (AMLs), streambank erosion, pasture/cropland, and onsite sewer systems. The pH impairment will be solved if the iron and aluminum problems are addressed. Likewise, the biological impairment—determined by the TMDL to be caused by organic enrichment and sedimentation—will be solved if the iron and fecal coliform problems are addressed. Therefore, this watershed-based plan focuses on AMLs, streambank erosion, pasture/cropland, and onsite sewer systems. As detailed in Section 5, this watershed-based plan estimates the total cost of meeting the goals of the TMDL in the Wolf Creek watershed to be $18.24 million.

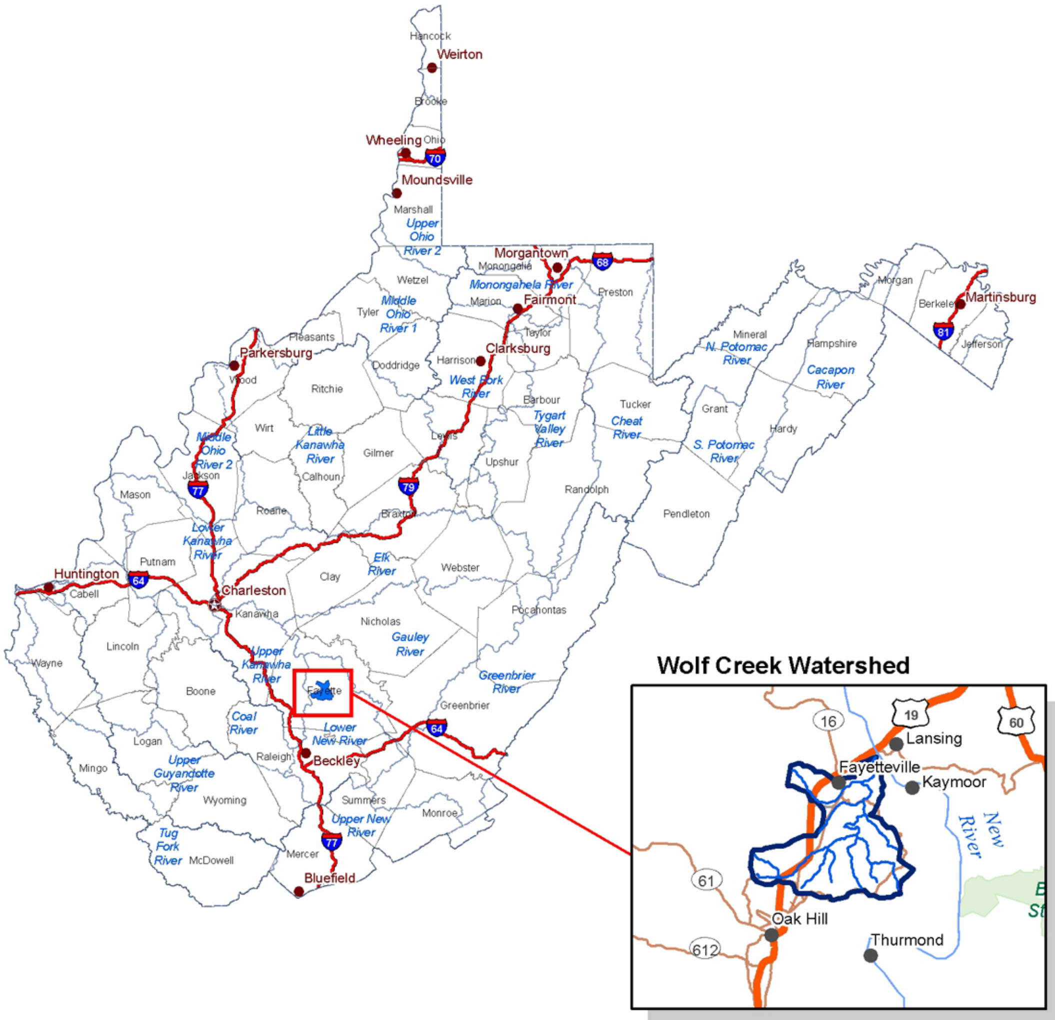
Table 1: Impairments, pollutants, and nonpoint sources targeted for allocations

Impairment	Pollutant	Nonpoint sources targeted for allocations
Iron	Iron	AMLs, streambank erosion
Aluminum (dissolved)	Aluminum (dissolved)	AMLs
Fecal coliform	Fecal coliform	Pasture/cropland, onsite sewer systems
pH	Iron, Aluminum (dissolved)	Same as above
CNA-Biological (organic enrichment and sedimentation)	Iron, Fecal coliform	Same as above

Source: Tetra Tech (2008). CNA=condition not allowable. AML=abandoned mine land

[1] In 2006, Downstream Strategies released a watershed assessment and draft plan (Pavlick et al., 2006), but this plan was not approved as a watershed-based plan because the TMDL with its load allocations was pending.

Figure 1: The Wolf Creek watershed in West Virginia



The following background information on the Wolf Creek watershed is quoted from a 2004 stormwater management and flood hazard mitigation plan for the Wolf Creek watershed (Parsons Brinckerhoff, 2004).

1.1 General information

"The Wolf Creek watershed is located in the center of Fayette County, West Virginia. Parts of Fayetteville and Oak Hill are located within the watershed. The northern boundary of the watershed runs through the northern section [of] Fayetteville, following High Street southeast to East Maple Street, turning northeast at East Maple Street and following it to Huse Street. At Huse Street, the boundary turns southeast, bisecting Park Drive before turning northward again and exiting the city limits. The southern boundary of the watershed runs through the northern section of Oak Hill, following Summerlee Road eastward to Highway 16, turning south at Highway 16 and following west of the highway to Dickenson Street. At Dickenson Street, the boundary turns east, crossing Highway 16 and Adkins Avenue and exiting the city limits at Gatewood Road. The Fayetteville Reservoir, which provides emergency drinking water to the residents of Fayetteville, is also located within the Wolf Creek watershed. The reservoir, formed by the damming of Wolf Creek, is located approximately ½ mile north [of] the confluence of Wolf Creek and Short Creek.

"The Wolf Creek watershed, which encompasses approximately 10,947 acres, lies within the Allegheny Plateau. Valleys in the watershed tend to be narrow with very steep sides (20-30 percent slopes). The plateau areas between the stream valleys tend to be more gently rolling. Slopes of less than 10 percent are common in these areas. The headwaters of Wolf Creek are located in the southwestern part of the watershed above Lochgelly. Wolf Creek flows in a northeasterly direction for approximately 10.5 miles before emptying in the New River. Wolf Creek originates at an elevation of approximately 2,000 feet. The stream gradient in the upper reaches is fairly gentle, averaging less than 5 percent until just below its confluence with House Branch. At this point, the stream channel steepens dramatically, dropping from an elevation of 1760 feet to 880 feet in a distance of just over one mile as it flows into the New River.

"The headwaters of Wolf Creek flow through areas that were surface mined for coal at one time and have since been reclaimed or capped. The Wolf Creek tributary originating on the Summerlee mine site [referred to as the unnamed tributary at river mile 8.7 in this watershed-based plan] flows through a wooded wetland between the culvert at Summerlee Road and the residential development approximately 1,000 feet to the east. The wetland is bounded on the north by Summerlee Road and the south by the abandoned railroad bed. Another wetland [that] begins at the confluence of the Summerlee tributary and Wolf Creek on the south side of Summerlee Road continues to US 19, stopping as the stream passes under the road and continuing again until the stream reaches US 19 again. A small wetland, a consequence of road construction and commercial development, is located along Wolf Creek as it flows along US 19 adjacent to the Fayette Plaza/Fayette Landing shopping center. The majority of the remainder of the wetlands in the watershed is associated with ponds and impoundments.

"Wolf Creek flows through or adjacent to developed or agricultural land a majority of its length between its headwaters and the Fayetteville Reservoir. Tree cover, where it exists is generally a mix of oak, poplar, and maple, with few evergreens. An exception to this is the area of Wolf Creek between Adkins Branch and Levisee Branch, where the stream flows through an area with a dense canopy of hemlock, rhododendron, and pine. North of the reservoir, Wolf Creek flows through the National Park Service's New River Gorge National River. The character of Wolf Creek changes dramatically along this section. The channel is rocklined and strewn with boulders, the gradient steepens, and the flow rate increases.

"Five named tributaries flow into Wolf Creek: Adkins Branch, Levisee Branch, Short Creek, Crooked Run, and House Branch. Several unnamed tributaries also flow into Wolf Creek, the most notable of which is the one flowing from the Summerlee mine site. The headwaters of Adkins Branch, Levisee Branch, and Short Creek flow through areas that are predominantly agricultural, often flowing into ponds near their sources before continuing downstream. The downstream sections of Adkins Branch and Levisee Branch flow through areas that are predominantly forested and relatively undisturbed by development. The upper reach of Short Creek flows through an area that is predominantly agricultural with little or no tree cover or buffering. The lower reach flows through a narrow evergreen forest. Crooked Run originates in an area dominated by agriculture and residential development. Below the agricultural and residential areas, Crooked Run flows through a woodland dominated by oak, poplar, and maple, with few evergreens, unlike Adkins and Levisee Branches. House Branch flows through an evergreen forest for most of its length, except for an area dominated by oak, poplar, and maple on either side of Highway 16. A tributary to House Branch originates west of Fayetteville and flows through town adjacent to Lively [S]treet and under West Maple Street before joining House Branch." (Parsons Brinckerhoff, 2004, pp. 6-8)

1.2 Land use/Land cover

Land use in the Wolf Creek watershed has been divided into 12 categories, as shown in Table 2.

Table 2: Land use in the Wolf Creek watershed

Land use	Acres	Percent of total land use
Forest	6,903	63%
Agriculture	2,059	19%
Residential	1,230	11%
Mining	190	2%
Commercial and services	142	1%
Mixed urban	134	1%
Industrial	101	1%
Transportation	101	1%
Water (ponds and reservoirs)	35	<1%
Mixed industrial and commercial	28	<1%
Barren land - transitional	22	<1%
Water treatment facility	2	<1%
Total	**10,947**	**100%**

Source: Parsons Brinckerhoff (2004).

1.2.1 Forest

"Currently, 6,903 acres, or over half of the watershed (63 percent), are covered by forest. The majority of the forest is comprised of deciduous trees. Narrow bands of evergreen forest occur along Adkins Branch and its tributaries, Levisee Branch and its tributaries, House Branch, and the lower reaches of Wolf Creek." (Parsons Brinckerhoff, 2004, p. 12)

1.2.2 Agriculture

"Approximately 2,059 acres (19 percent) of land within the watershed is currently used for agricultural purposes. The majority of the farmland is located in two sections of the watershed: (the area between the east side of Highway 16, the north side of Wolf Creek, the south side of Crooked Run, and the west side of Gatewood Road) and the southern and eastern (along or adjacent to Gatewood Road). Much of the farmland in the upper reaches of the watershed is used for grazing dairy cows and beef cattle." (Parsons Brinckerhoff, 2004, p. 12)

In addition to the approximately 230 head of cattle, there are approximately 60 horses and 100 sheep in the Wolf Creek watershed (Gasper, 2007).

1.2.3 Residential

"Approximately 1,230 acres (11 percent) of land within the watershed are currently being used for residential purposes. The majority of the residential development within the watershed occurs along the Highway 16 corridor from Oak Hill in the upper reach of the watershed to Fayetteville in the lower reach of the watershed. The other area of residential development follows the eastern and southern perimeter of the watershed along the Gatewood Road corridor. Residential development in the interior of the watershed is sparse. Most of the residential development within the watershed consists of single-family housing on small lots." (Parsons Brinckerhoff, 2004, p. 12)

1.2.4 Commercial and services

"Commercial and service-related uses currently occupy 142 acres of land ([about] one percent) in the watershed. These uses are concentrated along the US 19 and Highway 16 corridors, mainly in and near Oak Hill and Fayetteville. The largest commercial development occurs along US 19 at its intersection with Highway 16 and Lochgelly Road. A large shopping center (Fayette Plaza and Fayette Landing) is located on the west side of US 19. Banks, gas stations and fast food restaurants are also located at or adjacent to this intersection." (Parsons Brinckerhoff, 2004, p. 12)

1.2.5 Water (Ponds and reservoirs)

"Ponds and reservoirs account for less than one percent of the total land area within the watershed. The majority of the ponds are associated with agricultural uses and are located in the southern and eastern portions of the watershed. The Fayetteville Reservoir is the largest waterbody (excluding streams) in the watershed." (Parsons Brinckerhoff, 2004, p. 12)

1.3 Changes since 2004

Since 2004, when the Parsons Brinckerhoff report was released, certain conditions have changed in the watershed. In 2008, the City of Fayetteville transferred its water and wastewater systems to West Virginia American Water (Gray, 2008). In January 2008, several months before the transfer to West Virginia American, Fayetteville took its water treatment plant offline and began purchasing water from the company's New River facility in Beckwith (Gray, 2009). This remains the drinking water source for Fayetteville.

Also, a major interchange was constructed in 2007 on Route 19 in the Wolf Creek watershed. A 2005 United States Army Corps of Engineers (USACE) public notice document documented the planned construction. This initial plan included the filling of approximately 2,500 linear feet of stream and 4.3 acres of wetlands, the relocation of 430 linear feet of Wolf Creek, and the installation of several temporary dams (USACE, 2005, p 2). Sediment control practices at this site were the subject of litigation, as the City of Fayetteville contended that sediment was washing off the site and impacting the reservoir downstream. The county circuit court case resulted in the construction company being ordered to repair a dam that was allowing excess sediment to fill Wolf Creek and to monitor all of their erosion-control fixtures on a daily basis (Hill, 2007).

Wolf Creek Park, a new 1,000-acre residential, industrial, retail, and educational community, is being developed east of Route 16 around the mouth of the Adkins Branch subwatershed. Initial construction of the primary roadways and water system for the community is complete. The development is currently seeking businesses interested in relocating their operations to the park.

2 MEASURABLE WATER QUALITY GOALS AND IMPAIRMENTS

The goal of this watershed-based plan is to provide a road map toward meeting West Virginia's numeric and narrative water quality criteria. Streams not meeting water quality standards are placed on a statewide list of impaired streams called the 303(d) list. Improving water quality so these streams are once again clean and can be removed from this list is the primary goal of this plan.

The numeric and narrative water quality standards shown in Table 3 are relevant for the nonpoint source pollution problems addressed by this watershed-based plan. Wolf Creek itself is a trout stream; therefore, its iron goal is more stringent than all other streams in the watershed (Tetra Tech, 2008). However, according to the TMDL:

> "…the iron TMDLs presented for troutwaters do not assure complete attainment of the chronic aquatic life protection iron criterion. Criterion attainment would require pollutant reductions from existing sources that are well beyond practical levels, coupled with significant reductions of undisturbed upland and streambank background loadings, and no provisions for future growth. The relatively high iron content of the soils in the New River watershed is the primary influencing factor. An adaptive implementation approach is proposed…under which source allocations necessary to universally achieve the iron criterion for warmwater fisheries (1.5 mg/L, 4-day average, once per three years average exceedance frequency) are implemented concurrently with additional study of the situation." (Tetra Tech, 2008, p. x)

Table 3: Selected West Virginia water quality standards

		Aquatic life		Human health	
Parameter	**Section**	**Category B1 (warm water fishery streams)**	**Category B2 (trout waters)**	**Category A (public water supply)**	**Category C (water contact recreation)**
Aluminum (dissolved)	8.1	Not to exceed 750 µg/L (chronic and acute)	Not to exceed 750 µg/L (acute) or 87 µg/L (chronic)	None	None
Biological impairment	3.2.i	[N]o significant adverse impact to the…biological [component] of aquatic ecosystems shall be allowed.			
Fecal Coliform	8.13	None	None	Maximum allowable level of fecal coliform content for Primary Contact Recreation…shall not exceed 200/100 ml as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 ml in more than ten percent of all samples taken during the month.	
Iron (total)	8.15	Not to exceed 1.5 mg/L (chronic)	Not to exceed 0.5 mg/L (chronic)	Not to exceed 1.5 mg/L	None
pH	8.24	No values below 6.0 nor above 9.0. Higher values due to photosynthetic activity may be tolerated.			

Source: 47 Code of State Rules Series 2. Sections refer to this rule.

As shown in Table 4 and Figure 2, one or more streams in the Wolf Creek watershed are impaired for each parameter listed in Table 3. To quantify the narrative water quality standard for biological impairments in Table 3, the West Virginia Department of Environmental Protection (WVDEP) uses surveys of benthic macroinvertebrate communities. A West Virginia Stream Condition Index score is generated from this survey. Streams with a score of 60.6 or less are considered biologically impaired and placed on the list. The entire length of Wolf Creek has been listed for biological impairment (Table 4).

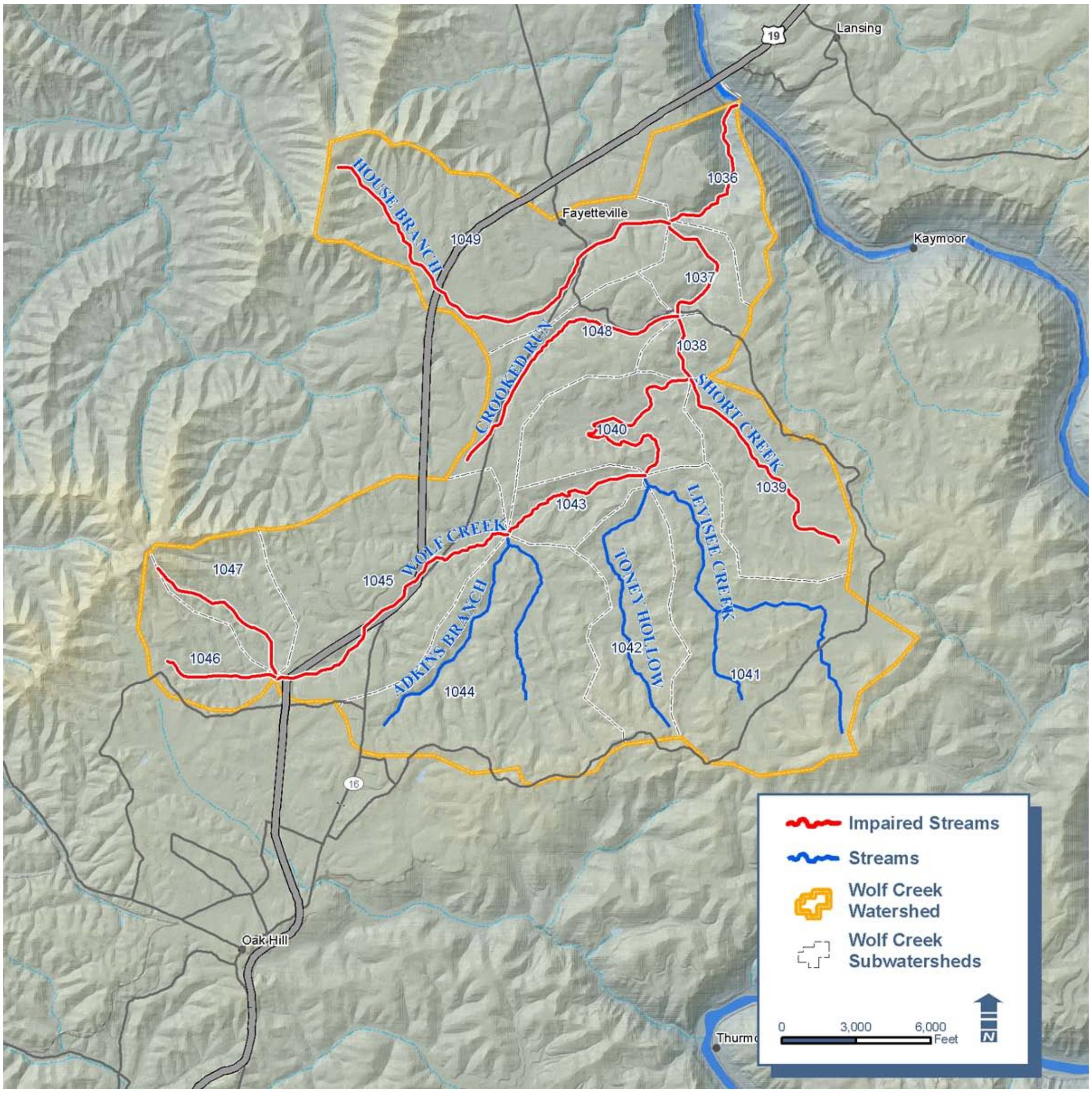
Table 4: Impaired streams and other streams requiring pollutant reductions

Stream	Stream code	Subwatershed codes	Impairments
Impaired streams			
Wolf Creek	WVKN-10	1036, 1037, 1038, 1040, 1043, 1045, 1047	CNA-Biological Fecal coliform Iron
House Branch	WVKN-10-A	1049	Fecal coliform
Crooked Run	WVKN-10-B	1048	Fecal coliform
Short Creek	WVKN-10-C	1039	Fecal coliform
UNT/Wolf Creek RM 8.7	WVKN-10-M	1046	Aluminum (dissolved) Iron pH
Other streams requiring reductions			
Levisee Creek	WVKN-10-D	1041	NA
Toney Hollow	WVKN-10-D-1	1042	NA
Adkins Branch	WVKN-10-E	1044	NA

Source: WVDEP (2008) and Tetra Tech (2008). In previous 303(d) lists and in the TMDL, the stream draining the Summerlee site was called UNT/Wolf Creek RM 8.7. In the new 2008 303(d) list, this stream has been renamed UNT/Wolf Creek RM 9.08. The original name, which was used in the TMDL, is used in this watershed-based plan. CNA=condition not allowable. UNT=unnamed tributary. RM=river mile. NA=not applicable

While the TMDL report provides a recent summary of water quality data, acid mine drainage (AMD) pollution has been documented in the past by the Plateau Action Network (PAN), WVDEP, and others. These data are summarized in the previous draft plan for the Wolf Creek watershed (Pavlick et al., 2006).

Figure 2: Impaired streams in the Wolf Creek watershed



Source: WVDEP (2008) and Tetra Tech (2008).

3 POLLUTANT REDUCTIONS FROM THE TMDL

The New River TMDL—which includes Wolf Creek as one of many subwatersheds—calculates specific pollutant reductions required for nonpoint and point sources of pollution for each impaired stream. These load allocations and wasteload allocations are used as the basis for this watershed-based plan.

Three categories of impairments are found in the Wolf Creek watershed:

1. iron, aluminum, and pH;
2. fecal coliform; and
3. biological impairments.

The TMDL report presents an analysis that simplifies the allocations in the Wolf Creek watershed. First, pH impairments, such as the one on the unnamed tributary at river mile 8.7, will be abated if the load and wasteload allocations for iron and aluminum are met. Therefore, pH-specific allocations are not provided by the TMDL (Tetra Tech, 2008).

Also, the TMDL analysis concludes that the biological impairment on Wolf Creek is caused by organic enrichment and sedimentation, and that these two stressors will be solved with the same load and wasteload allocations already required for fecal coliform and iron. No separate allocations are provided to specifically meet the biological impairment (Tetra Tech, 2008).

Therefore, the TMDL report calculates load and wasteload allocations for three pollutants of interest in the Wolf Creek watershed: iron, aluminum, and fecal coliform.

3.1 Iron and aluminum

The TMDL report contains detailed information regarding the load allocations, wasteload allocations, margins of safety, and percent reductions for iron and aluminum (Table 5 and Table 6). On the unnamed tributary at river mile 8.7, 98% reductions for nonpoint source aluminum and iron loads are required. On Wolf Creek itself, nonpoint source iron reductions of 87% are required. No point source iron or aluminum reductions are required anywhere across the Wolf Creek watershed.

Table 5: Metals total maximum daily loads and major components (pounds/day)

Stream	Metal	Load allocation	Wasteload allocation	Margin of safety	TMDL
Wolf Creek	Iron	141	15	8	165
UNT/Wolf Creek RM 8.7	Aluminum	3	0	0.2	3
	Iron	17	1	1	19

Source: Tetra Tech (2008) Tables A-1-4 and A-1-5. TMDL=total maximum daily load. UNT=unnamed tributary. RM=river mile. TMDL may not sum to total of other columns due to rounding.

Table 6: Metals baseline loads, allocations, and percent reductions (pounds/day)

		Nonpoint source			Point source		
Stream	Metal	Baseline	Allocation	% reduction	Baseline	Allocation	% reduction
Wolf Creek	Iron	1,064	141	87	15	15	0
UNT/Wolf Creek RM 8.7	Alum.	122	3	98	0	0	0
	Iron	916	17	98	1	1	0

Source: Tetra Tech (2008) allocation spreadsheets. UNT=unnamed tributary. RM=river mile.

Further details about these required load allocations are provided in the TMDL on an average annual basis. The TMDL targets two nonpoint source categories for all nonpoint source reductions of metals: AMLs and streambank erosion (Table 7). No other nonpoint source categories—and no point sources whatsoever— require reductions of iron or aluminum in the Wolf Creek watershed.[2]

Table 7: Specific nonpoint source reductions required for iron and aluminum (pounds/year)

			Abandoned mine lands			Streambank erosion		
Stream	Metal	SWS	Base-line	Allo-cation	% reduction	Base-line	Allo-cation	% reduction
Wolf Creek	Iron	1036	347	111	68	608	554	9
		1037	0	0	0	682	621	9
		1038	0	0	0	1,470	774	47
		1040	0	0	0	6,424	512	92
		1043	0	0	0	644	323	50
		1045	0	0	0	386	194	50
		1047	0	0	0	49	18	63
House Branch	Iron	1049	0	0	0	115	70	39
Crooked Run	Iron	1048	0	0	0	49	32	34
Short Creek	Iron	1039	0	0	0	269	40	85
Levisee Creek	Iron	1041	0	0	0	663	72	89
Toney Hollow	Iron	1042	0	0	0	48	24	50
Adkins Branch	Iron	1044	0	0	0	155	78	50
UNT/Wolf Ck. RM 8.7	Alum.	1046	44,527	1,030	98	NA	NA	NA
	Iron	1046	331,358	3,305	99	346	167	52

Source: Tetra Tech (2008) allocation spreadsheet. SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile. NA=not applicable.

As shown in Table 7, the unnamed tributary at river mile 8.7 requires very significant metals reductions from the Summerlee AML site: 99% for iron and 98% for aluminum. At the far other end of the watershed, where Wolf Creek flows into the New River, a second AML site—the Fayette Station (NPS) Slide—is targeted with a 68% iron reduction.

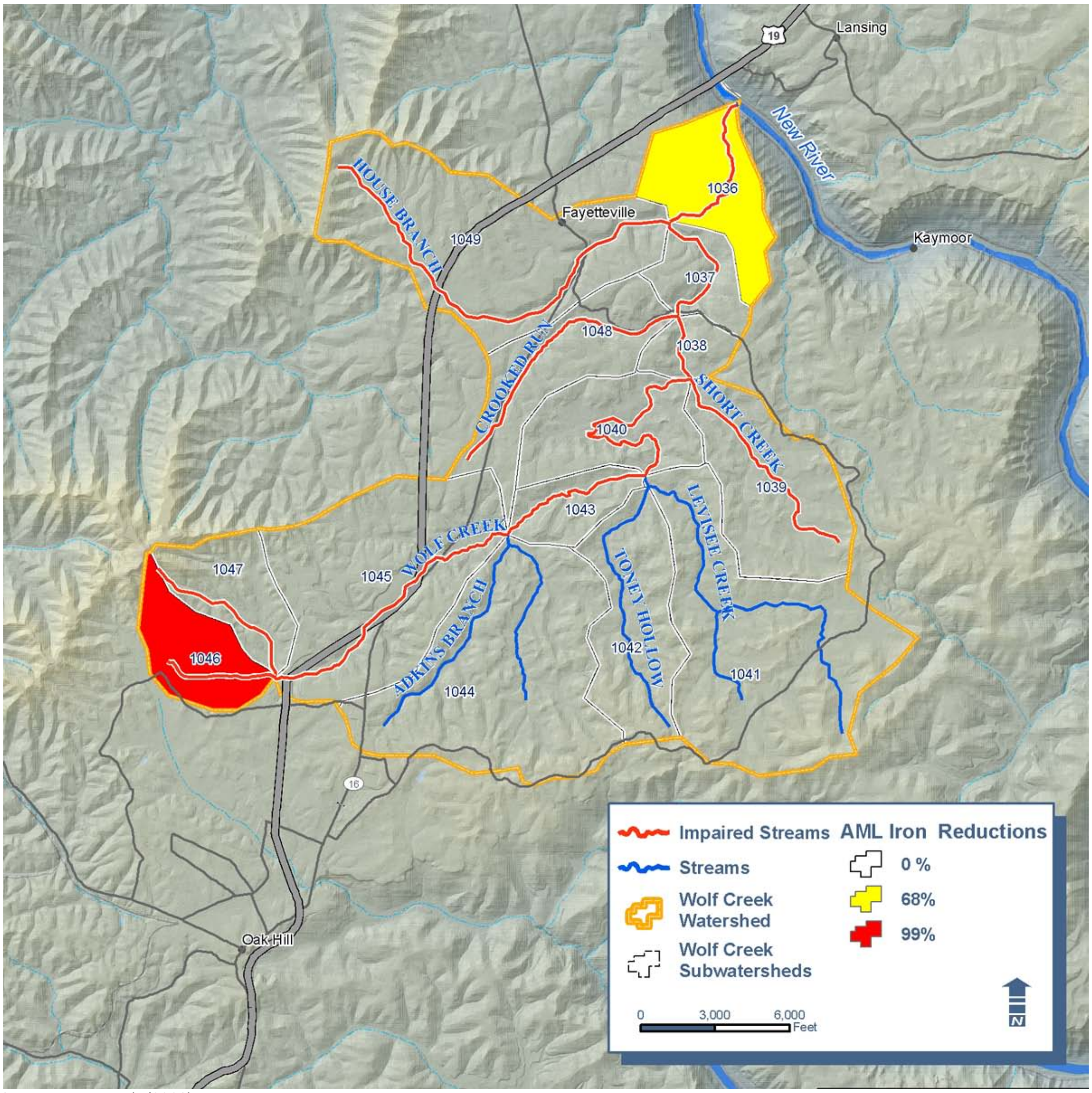
In addition to these two AMLs, iron reductions from streambank erosion are required from every subwatershed across the Wolf Creek watershed. Solving the metals and pH impairments, and the associated biological impairment, will require two types of efforts: AMD remediation and the prevention of streambank erosion.

3.1.1 Abandoned mine lands

The TMDL targets two AMLs for iron and aluminum reductions: the Summerlee Refuse Pile, which discharges to the unnamed tributary at river mile 8.7, and the Fayette Station (NPS) Slide, which discharges to Wolf Creek near its confluence with the New River. Figure 3 and Figure 4 show the locations of these two AMLs and their associated reductions for iron and aluminum.

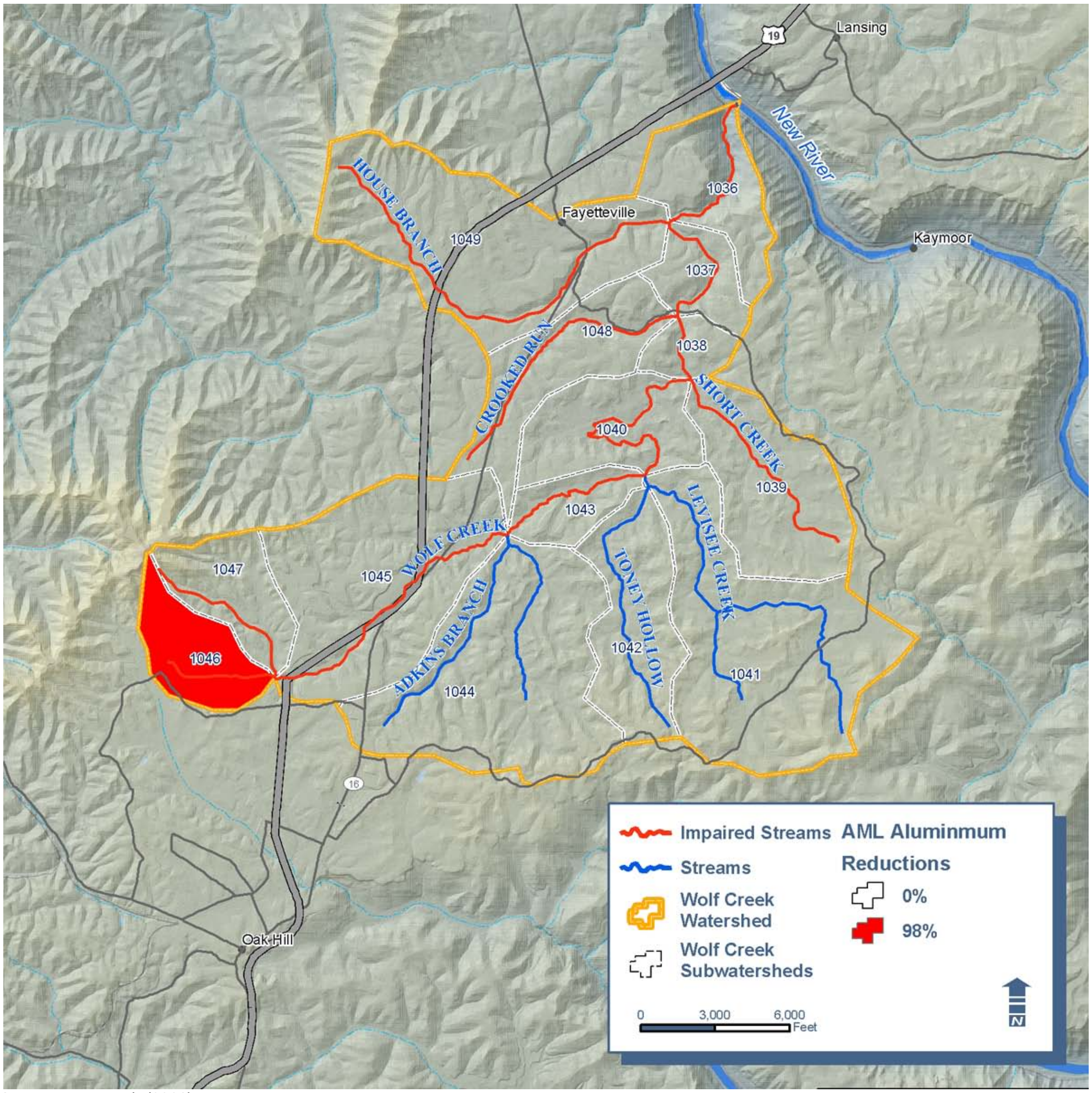
[2] The nonpoint source categories that are modeled but that do not require reductions include bond forfeiture sites, forest harvest, oil and gas, barren land, urban/res/road, and other nonpoint sources.

Figure 3: Abandoned mine lands in the Wolf Creek watershed: iron reductions



Source: Tetra Tech (2008).

Figure 4: Abandoned mine lands in the Wolf Creek watershed: aluminum reductions



Source: Tetra Tech (2008).

The Summerlee Refuse Pile, located at the headwaters of the watershed and discharging into the unnamed tributary at river mile 8.7, is the most significant AMD source in the watershed. PAN and partner agencies are already taking action to start remediating this site, but more remains to be done. Details on this AML are provided in Section 5.1.1.1.

The second AML targeted by the TMDL, the Fayette Station (NPS) Slide, is located at the mouth of the New River, and therefore does not affect water quality throughout most of the watershed.

Two other AMLs with distinct problem area descriptions (PADs) are known to exist in the watershed (OSM, 2006a and WVDEP, Various dates); however, these AMLs are not assigned allocations in the TMDL. The first of these sites, the Lochgelly (Fredericks) Impoundment, is comprised of a pond constructed from mine refuse that is beginning to overflow. No water quality data are available. The water may have ceased seeping through the spoil due to concrete waste that has been added to the pond.

The second AML not considered in the TMDL is the Summerlee (Willis) Impoundment. Because allocations are not provided in the TMDL, these sites are not considered further in this plan.

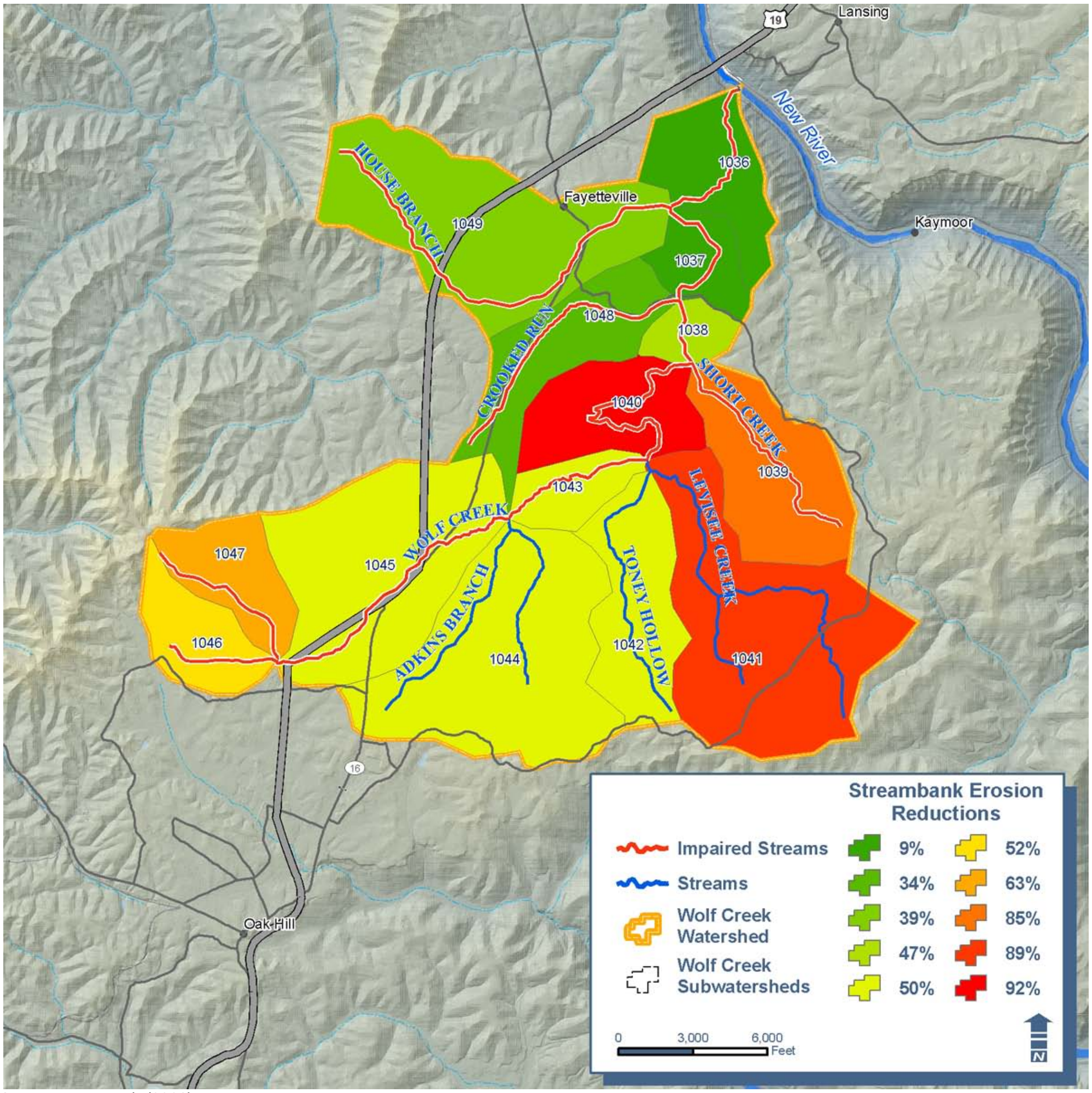
3.1.2 Streambank erosion

As shown in Table 7 and Figure 5, the TMDL requires reductions in iron loads from streambank erosion across the entire Wolf Creek watershed. The required percent reductions vary considerably from subwatershed to subwatershed.

The most significant reductions are required in the Levisee Creek and Short Creek subwatersheds, along with the segment of Wolf Creek between these two tributaries. Iron reductions of 85% to 92% are required in these subwatersheds. Upstream from this area, reductions of 50% to 63% are required, while downstream, reductions of 9% to 47% are required.

Heightened runoff in impervious areas and compromised streambank stability are major contributors to excessive sedimentation. The TMDL recommends bank stabilization projects as a means of complimenting and accelerating the watershed's natural recovery. More specific suggestions regarding streambank erosion are provided in Section 4.1.2.

Figure 5: Streambank erosion reductions from the TMDL: iron reductions



Source: Tetra Tech (2008).

3.1.3 Other potential sources

While the TMDL only provides allocations for AMLs and streambank erosion to address the metals and pH impairments, other point and nonpoint sources may affect iron and aluminum levels. These other sources are briefly discussed to provide greater context.

The TMDL report identifies eight industrial stormwater permits that discharge iron to the Wolf Creek watershed; however, none of these facilities are targeted for reductions.[3] The TMDL report does not

[3] In particular, the following permits discharge iron but are not assigned reductions: WVG610074, WVG610605, WVG610739, WVG610761, WVG611125, WVG611287, WVG611031, and WVG611121.

identify any mining National Pollutant Discharge Elimination System permits or municipal separate storm sewer systems in the watershed that might discharge iron or aluminum.

According to WVDEP (2006a), the bond forfeiture sites in the Wolf Creek watershed shown in Table 8 do not contribute AMD to Wolf Creek. The TMDL report does not include any allocations for these sites. Should it be needed, reclamation at bond forfeiture sites is addressed by the WVDEP Division of Land Restoration through the Special Reclamation Fund.

Table 8: Bond forfeiture sites in the Wolf Creek watershed

Company	Permit	Receiving stream	Date revoked	Date reclaimed
Harvey Energy Corp.	S-3070-86	House Branch	9/16/92	11/6/04
Tri-County Mining, Inc.	P-3038-86	Wolf Creek headwaters	11/1/87	6/9/89

Source: WVDEP (2006a).

A series of wetlands are thought to help treat AMD pollution in the Wolf Creek watershed. One wetland is located on the unnamed tributary at river mile 8.7, while the rest are located along Wolf Creek.

An important wetland is located along Wolf Creek between river miles 8.5 and 8.7, and may be responsible for metals reductions that have been documented between river mile 8.6-8.7 and river mile 8.1 (West Virginia Water Research Institute, 2005 and Scott and Eades, 1999). The wetland may fail to retain all the metals under certain flow regimes.

Some wetlands were removed during construction of the new Lochgelly Road interchange, near river mile 7.6. Removal of these wetlands could impact downstream water quality in two ways. First, loss of the wetlands' biogeochemical processes such as sulfate reduction will slow the continued recovery of water quality in Wolf Creek. In addition, if the material from the wetlands was removed from an anaerobic environment, metals that accumulated over decades may have become soluble and entered the stream. These potential impacts cannot be quantified with current data.

In addition, as the watershed continues to develop, wetland removal may take place in other areas, further reducing natural AMD treatment in Wolf Creek.

3.2 Fecal coliform

TMDLs are calculated for each of the fecal coliform–impaired streams in the watershed: Wolf Creek, House Branch, Crooked Run, and Short Creek. As shown in Table 9, load allocations for nonpoint wastewater sources are provided for all four of these subwatersheds, while wasteload allocations for point sources are only provided for House Branch and Wolf Creek. While the nonpoint source load reductions vary from 2% to 76% by subwatershed, the point source wasteload reductions are virtually 100% (Table 10).

Table 9: Fecal coliform total maximum daily loads and major components (counts/day)

Stream	Pollutant	Load allocation	Wasteload allocation	Margin of safety	TMDL
Wolf Creek	Fecal coliform	1.49E+11	3.88E+08	7.88E+09	1.58E+11
House Branch	Fecal coliform	2.16E+10	1.87E+08	1.15E+09	2.29E+10
Crooked Run	Fecal coliform	8.95E+09	NA	4.71E+08	9.42E+09
Short Creek	Fecal coliform	1.30E+10	NA	6.82E+08	1.36E+10

Source: Tetra Tech (2008) Table A-1-7. TMDL may not sum to total of other columns due to rounding. NA=not applicable.

Table 10: Fecal coliform baseline daily loads, allocations, and percent reductions (counts/day)

	Nonpoint source			Point source		
Stream	Baseline	Allocation	% reduction	Baseline	Allocation	% reduction
Wolf Creek	2.65E+11	1.49E+11	44	9.36E+10	3.88E+08	99.6
House Branch	2.21E+10	2.16E+10	2	9.34E+10	1.87E+08	99.8
Crooked Run	3.08E+10	8.95E+09	71	NA	NA	NA
Short Creek	5.31E+10	1.30E+10	76	NA	NA	NA

Source: Tetra Tech (2008) allocation spreadsheet. NA=not applicable.

As shown in Table 11, two categories of nonpoint sources are targeted: pasture/cropland and onsite sewer systems.[4] Pasture/cropland is targeted selectively in four subwatersheds, including one subwatershed on Wolf Creek itself and the subwatersheds for Crooked Run, Short Creek, and Levisee Creek (Table 11 and Figure 6).

In contrast, onsite sewer systems are targeted with 100% reductions across the entire watershed. These reductions are not mapped because they are the same across the entire Wolf Creek watershed. The TMDL presents a model of failing septic systems, which shows a "medium" septic failure rate across the entire Wolf Creek watershed. The TMDL also analyzes agricultural intensity, as shown in Figure 7.

While the contribution of fecal coliform by onsite systems is ubiquitous, the amount of fecal coliform coming from agriculture is an order of magnitude greater than that from onsite systems. This is an important consideration in prioritizing projects to clean up the watershed.

[4] Other categories of nonpoint sources considered in the TMDL but not assigned allocations include (1) residential, and (2) background and other nonpoint sources.

Table 11: Specific nonpoint source reductions required for fecal coliform (counts/year)

		Pasture/Cropland			Onsite sewer systems		
Stream	SWS	Baseline	Allocation	% reduction	Baseline	Allocation	% reduction
Wolf Creek	1036	0	0	0	3.53E+10	0	100
	1037	0	0	0	1.02E+10	0	100
	1038	1.03E+12	1.03E+12	0	7.63E+10	0	100
	1040	1.11E+13	6.66E+12	40	1.83E+11	0	100
	1043	3.01E+11	3.01E+11	0	2.05E+10	0	100
	1045	7.53E+11	7.53E+11	0	3.96E+11	0	100
	1047	5.22E+10	5.22E+10	0	1.73E+11	0	100
House Branch	1049	6.79E+11	6.79E+11	0	1.94E+11	0	100
Crooked Run	1048	9.57E+12	1.91E+12	80	3.29E+11	0	100
Short Creek	1039	1.81E+13	3.61E+12	80	1.48E+11	0	100
Levisee Creek	1041	1.62E+13	3.24E+12	80	4.93E+11	0	100
Toney Hollow	1042	9.38E+11	9.38E+11	0	9.91E+10	0	100
Adkins Branch	1044	8.54E+11	8.54E+11	0	3.78E+11	0	100
UNT/Wolf Creek RM 8.7	1046	0	0	0	1.98E+11	0	100

Source: Tetra Tech (2008) allocation spreadsheet. SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile.

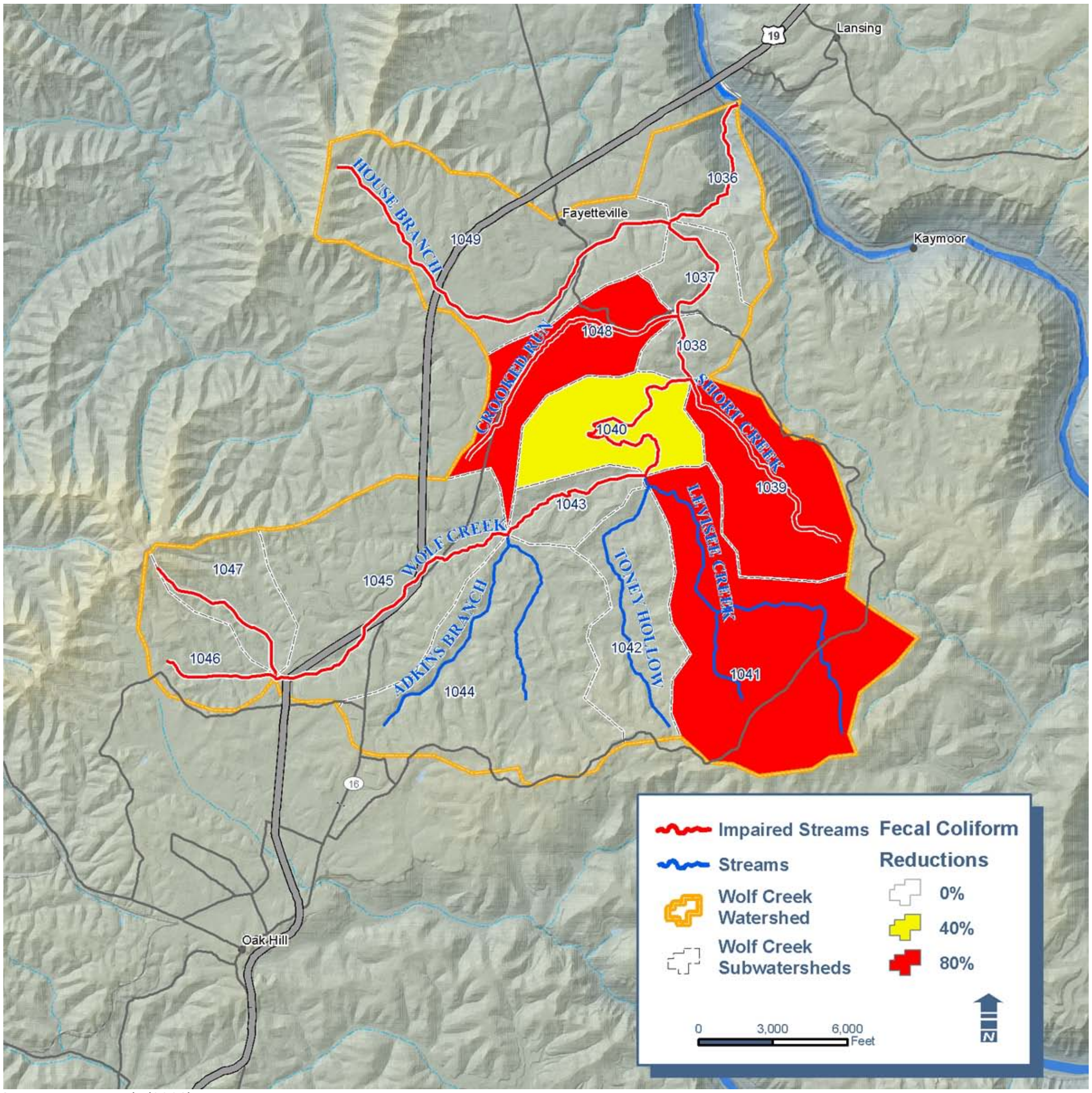
Regarding point sources, three permits are assigned wasteload allocations based on allocated concentrations of 200 counts/100 mL (Table 12). For the Whitewater Inn and Oak Hill publicly owned treatment works (POTWs), these allocations do not require any reductions. However, for the combined sewer overflow (CSO) from the City of Fayetteville's wastewater collection system, which discharges to House Branch, this allocation requires a 99.8% reduction. Since the preparation of the TMDL, West Virginia American Water has taken over Fayetteville's wastewater treatment facility. West Virginia American Water is developing a Long Term Control Plan for this CSO that will be submitted to WVDEP by September 2009. They are also mapping the collection system and will install flow meters to find areas where stormwater is entering the system. This information will be used to set priorities for repair (Riggleman and Suder, 2009). While it will be important to meet the wasteload allocations in order to fully implement the TMDL, this watershed-based plan focuses on nonpoint sources only.

Table 12: Specific point source reductions required for fecal coliform (counts/year)

Stream	SWS	Permit	Facility	Outlet	Baseline	Allocation	% reduction
Wolf Creek	1045	WVG550626	Whitewater Inn	001	2.93E+10	2.93E+10	0
UNT/Wolf Creek RM 8.7	1046	WV0020281	Oak Hill POTW	003	4.42E+10	4.42E+10	0
House Branch	1049	WV0022314	Fayetteville CSO	C003	3.41E+13	6.82E+10	99.8

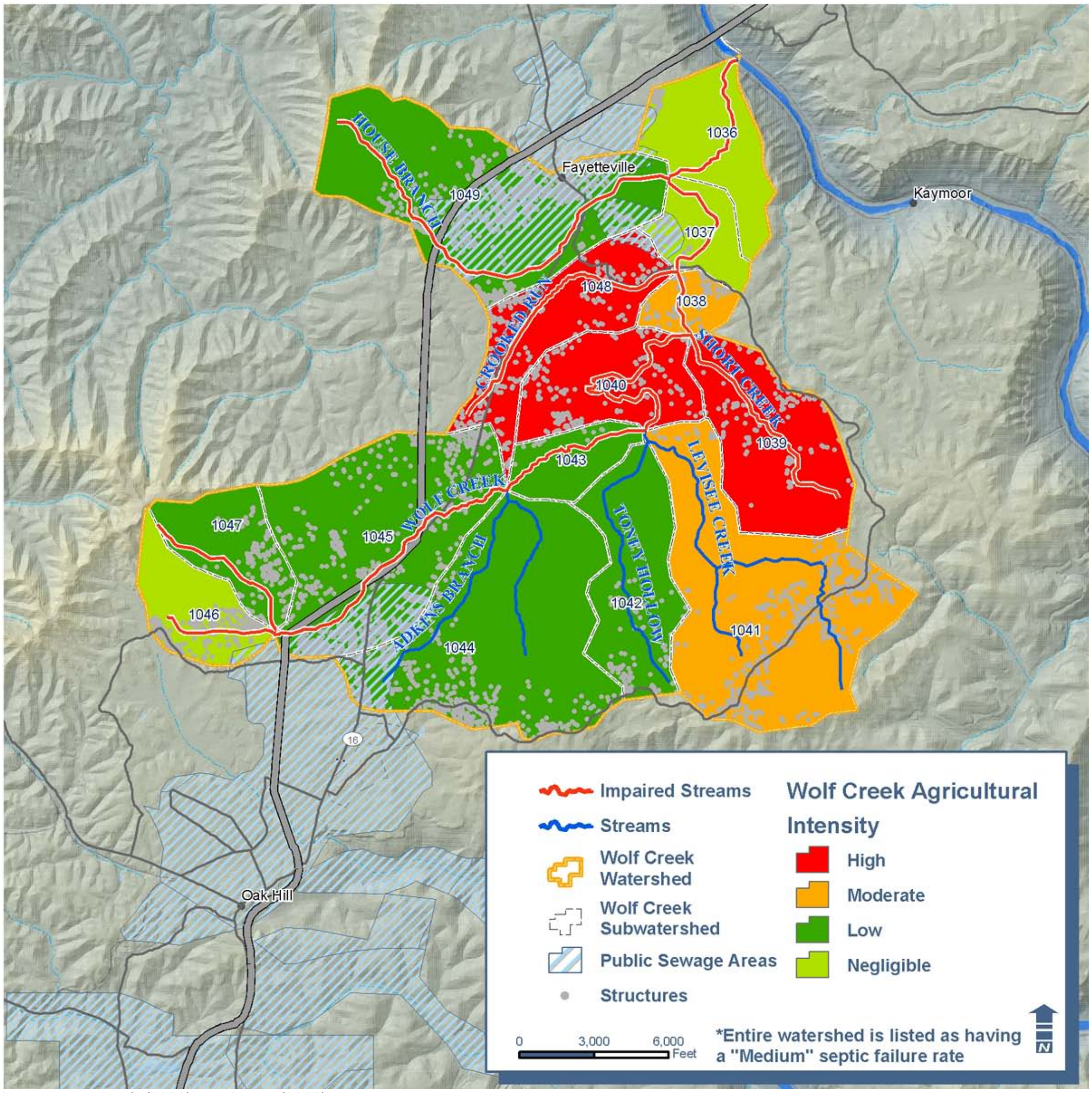
Source: Tetra Tech (2008) allocation spreadsheet. SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile. POTW=publicly owned treatment works. CSO=combined sewer overflow.

Figure 6: Pasture and cropland reductions from the TMDL: fecal coliform



Source: Tetra Tech (2008).

Figure 7: Agricultural intensity, predicted septic failure rates, public sewage areas, and structures



Source: Tetra Tech (2008), WVSAMB (2003).

4 NONPOINT SOURCE MANAGEMENT MEASURES

4.1 Iron and aluminum

4.1.1 Abandoned mine lands

This section describes the various measures that may be used to control AMD from AMLs, which are targeted for reductions to meet iron, aluminum, and biological water quality standards. Numbers in parentheses following the name of the method indicate the potential load reductions when the method is used correctly and in the proper situation.

4.1.1.1 Land reclamation

- **Removing acid-forming material.** This method has the potential to eliminate the acid load completely if all of the acid-forming material can be removed.
- **Isolating acid-forming material from flowpaths.** See the next two items. It is difficult to estimate the efficacy of these measures exactly. On the one hand, some AMD is often visible seeping from the edges of reclaimed areas. On the other hand, a measurement of AMD loads frequently shows such seeps are small compared to loads from nearby mine openings.
- **Sealing from above.** Infiltration of water into acid-forming material can be slowed by covering the material with low-permeability material, such as clay, and covering that layer with a vegetated layer to stabilize it. Effective reclamation and revegetation can eliminate a large proportion of the AMD from a given site.
- **Isolating from below.** Interactions between water and acid-forming materials can be further minimized by separating the waste material from impermeable bedrock below with conductive materials. Water may then flow beneath the spoil and be conducted away from it rapidly, so the water table does not rise into the spoil.
- **Surface water management.** Rock-lined ditches or grouted channels can be used to convey surface water off site before it can percolate into acid-forming material. Limestone is often used in such channels to neutralize acidity, as with oxic limestone channels (OLCs), discussed below.

4.1.1.2 Passive acid mine drainage treatment

- **Reducing and Alkalinity Producing Systems.** In these systems, also known as “successive alkalinity producing systems” and “vertical flow ponds,” water encounters two or more treatment cells in series. First, water passes through organic material to deplete dissolved oxygen. Several helpful reactions take place in the anoxic environment. Bacteria reduce sulfate in an alkalinity-producing reaction. Also, ferric iron, which comes into contact with pyrite, should reoxidize the sulfur and turn to ferrous iron. In a second cell, the anoxic solution comes into contact with limestone. H^+ acidity is neutralized through contact with the limestone. Additional alkalinity dissolves into the water as well. Iron does not armor the limestone because it is in the ferrous form. Water then runs through an aeration and settling pond, in which ferrous iron oxidizes and then precipitates out of solution as ferric hydroxide. The acidity released in this process is neutralized by the alkalinity that has accumulated in the solution.
- **Sulfate-reducing bioreactors.** These systems also consist of organic matter and limestone, but in sulfate-reducing bioreactors, the materials are all mixed in a single cell. Some of the organic material included is of a coarser nature, such as sawdust or woodchips. Reactions in these systems are similar to those in Reducing and Alkalinity Producing Systems: compost eliminates oxygen and drives the iron and sulfur to reduced forms. The coarser organic matter may serve to protect hydraulic conductivity and may retain metals as various organic complexes.

- **Manganese removal beds.** Manganese may be removed from AMD either by active treatment (Section 4.1.1.3) or by manganese removal beds. In manganese removal beds, water is passed over a wide limestone bed, and dissolved manganese oxidizes and precipitates from solution.
- **Oxic (or Open) limestone channels.** Research to estimate the efficacy of OLCs is active. Continually moving water may erode any armoring from limestone, and that water flow should remove precipitates from OLCs so that they do not interfere with acid neutralization. In practice, the efficacy of OLCs may suffer because they are too short, most limestone may be placed so as to react with water only at high flows, and fluctuating water levels enhance armoring. Recent research suggests that the acid neutralization that takes place in OLCs is actually greater than can be accounted for by limestone dissolution.
- **Limestone leachbeds.** Limestone leachbeds are most effective when water has a pH of 3 or less, and when water retention times are short (about 90 minutes). The low pH promotes rapid limestone dissolution, but the short retention time prevents armoring.
- **Steel slag leachbeds (addition of alkalinity).** Steel slag leachbeds are not exposed to AMD. Rather, circumneutral feed water passes through these leachbeds, and that water is then mixed with AMD to reduce its acidity drastically.
- **Compost wetlands.** Constructed wetlands can serve multiple functions in AMD treatment. Wide areas of exposure to the atmosphere allow metals in solution to oxidize. Slower waters allow precipitates to fall out of suspension. Anaerobic zones in sediments allow for sulfate reduction, which consumes acidity. Inclusion of limestone in the substrate provides an additional alkalinity source and helps maintain conditions that support sulfate reduction.
- **Grouting.** Setting up grout walls or curtains in deep mines has great potential to solve AMD problems. Ideally, such barriers may serve to keep water from entering mines and interacting with acid-forming materials. They must be constructed carefully so as not to build water pressures near a weak point and to avoid blowouts. Also, fractures in bedrock always allow some water into mines, even if flows are eliminated. A grouting project at Winding Ridge, near Friendsville, MD, decreased acidity by 50% (MPPRP, 2000).

4.1.1.3 Active acid mine drainage treatment

- **Treating.** A variety of active treatment methods exist for AMD. One of a number of alkaline chemicals can be mixed with the polluted water. The mixture may then be aerated and passed through ponds, allowing metal hydroxides to settle out as sludge.

4.1.2 Streambank erosion

According to the TMDL report that includes the Wolf Creek watershed, heightened runoff in impervious areas and compromised streambank stability are major contributors to excessive sedimentation (Tetra Tech, 2008). Several specific measures can help minimize streambank erosion.

4.1.2.1 General measures

- **Stabilizing streambanks using natural stream channel design.** Streambank stabilization projects can promote appropriate riparian vegetation that prevents the banks from eroding during high flows. Principles of natural stream channel design can ensure that stream channels are of the appropriate size and dimensions to handle the flows that are generated by a watershed, and that inevitable high flows are handled appropriately.

4.1.2.2 Developed areas

Stormwater runs off from land more quickly when forests and fields are developed into impervious surfaces. Measures can be taken during the development or redevelopment process to promote infiltration of rainwater.

- **Pervious pavement.** Pervious pavement allows rainwater to infiltrate directly into the land, rather than washing into storm drains before discharging directly to streams.
- **Detention and retention ponds.** Ponds can hold back the initial runoff from a rainstorm so that runoff patterns mimic those during pre-construction periods.
- **Underground storage tanks.** In locations without enough surface area for ponds, storage tanks can be buried to hold back rain water. This approach is often used under parking lots in cities and towns.
- **Rain gardens.** Rain gardens are planted areas designed to absorb storm runoff from impervious areas such as roofs and pavement. They tend to absorb about 30% more than typical lawns. Several factors should be considered when creating a rain garden, including proximity to septic systems, soil permeability, plant selection, and runoff volume (Kassulke, 2003).
- **Rain barrels.** Rain barrels collect runoff from downspouts and hold it for later use watering lawns, washing cars and clothes, and other purposes not requiring potable water.
- **Wetland protection.** Wetlands are a naturally existing way to reduce runoff and flooding. Preserving wetland areas in the vicinity of urban and residential development will buffer the effects of increased runoff from impervious surfaces.

4.1.2.3 Agricultural areas

In agricultural areas, several best management practices (BMPs) can be used to prevent direct livestock access to streams, thereby protecting streambanks from disturbance. These agricultural BMPs not only reduce streambank erosion, but can also reduce fecal coliform pollution.

- **Livestock fencing.** If livestock are kept away from the streams, they cannot trample the streambanks and disturb the riparian vegetation.
- **Armored stream crossings.** Sometimes, it is necessary to preserve stream crossings so that livestock can be moved to other locations. Armored stream crossings can be built to prevent livestock from disturbing riparian areas.
- **Alternative watering sources.** If livestock are fenced away from streams that had been used for watering, alternative watering sources such as springs may need to be developed.
- **Riparian buffers.** Protected stream buffers allow natural riparian vegetation to grow and stabilize streambanks.

4.2 Fecal coliform

4.2.1 Pasture/Cropland

According to the TMDL report, agricultural runoff must be reduced to meet the pasture/cropland load allocations (Tetra Tech, 2008). Many specific measures can be taken to reduce fecal coliform discharges from pastures and cropland. Several of these measures are the same as those discussed above to prevent streambank erosion in agricultural areas.

- **Livestock fencing (70-90%).**[5] Livestock fencing ensures that manure is not deposited directly into streams.

[5] Efficiencies taken from a watershed-based plan for Mill Creek of the South Branch of the Potomac by Hardy et al. (2007).

- **Armored stream crossings.** As discussed above, armored stream crossings may be required if livestock are fenced from streams.
- **Alternative watering sources.** As discussed above, alternative water sources may be required if livestock are fenced from streams.
- **Riparian buffers (70%).**[5] In addition to stabilizing streambanks, protected stream buffers help filter runoff before it reaches streams, and can therefore reduce fecal coliform concentrations in runoff from pasture and cropland.

4.2.2 Onsite sewer systems

According to the TMDL report, untreated sewage must be removed from streams to meet the onsite sewer system load allocations (Tetra Tech, 2008). Many specific measures can be taken to meet this broad goal. The Fayette County Commission's *Comprehensive Wastewater Management Plan for Fayette County* (LAI, 2005a) was developed to address wastewater management issues and improve overall water quality, and includes several control measures that can help solve fecal coliform discharges from onsite sewer systems, as listed below (LAI, 2005b).

- **Replacing and repairing onsite systems and leach fields.** In some cases, onsite systems are the most appropriate solution but are in need of replacement or repair. Traditional septic systems and drain fields can work well if properly installed and maintained. In addition, the West Virginia Department of Health and Human Resources (WVDHHR) will consider "alternative and experimental sewer systems" on sites of at least two acres (WVDHHR, 2003). These systems, commonly referred to as "class II" may include "shallow fields, soil absorption mounds, shallow beds, low pressure pipe systems, elevated fields, evapotranspiration systems and unique systems designed for specific situations" (WVDHHR, 2003).
- **Upgrading underground injection control (UIC) permitted systems.** Some onsite wastewater systems are permitted with UIC permits. These systems may be upgraded to better control fecal coliform discharges.
- **Installing community cluster systems.** In some cases, cluster systems are a more practical or economical alternative. Cluster systems can serve up to hundreds of homes. These systems incorporate options that bridge the extremes between individual onsite systems and centralized systems. Septic tanks are installed at each house, and the septic tank effluent is then piped to a central location for treatment and dispersal.
- **Extending lines for municipal and public service district systems.** Collection systems for large, centralized systems can be extended in some locations to take on new customers that are now discharging wastewater through failing or nonexistent onsite systems.

When lots are near wetlands or floodplains, when there is shallow depth to bedrock or water table, or when soil percolation rates are slower than 1 hour/inch, the addition or modification of onsite systems is not feasible and an offsite solution must be found (LAI, 2005c).

For an extensive review of available wastewater treatment technologies, onsite and cluster systems, CSO control, and wastewater management options, see Task 6 of the *Comprehensive Wastewater Management Plan for Fayette County* (LAI, 2005d).

5 LOAD REDUCTIONS AND COSTS

5.1 Iron and aluminum

5.1.1 Abandoned mine lands

As discussed above in Section 3.1, significant iron and aluminum reductions are required from two AMLs: the Summerlee Refuse Pile and the Fayette Station (NPS) Slide. These two sites are considered in more detail below.

5.1.1.1 Summerlee Refuse Pile

The key to eliminating most of the AMD from Wolf Creek watershed is to eliminate the polluted drainage from the Summerlee site. The extent of the problem is explained in a recent report:

> "A mine and coal processing facility was operated at the head of Wolf Creek by Mountain Laurel Resources known as the Summerlee Site. In the early 1980's, Mountain Laurel Resources filed bankruptcy and the land was reclaimed by the [O]ffice of Abandoned Mine Lands in the mid 1990's. … [T]he primary concern of the site is the water drainage…. [It] is classic acid mine drainage that is very acidic and loaded with iron, aluminum and manganese. The water that drains from this site forms a tributary which flows into Wolf Creek and consequently impairs Wolf Creek. The impairment resulted in the West Virginia Department of Natural Resources (WVDNR) to remove Wolf Creek from its trout stocking list and required the town of Fayetteville further downstream to drill wells to supplement the town's drinking water." (Kimley-Horn, 2005a, Attachment A)

A $375,000 settlement was obtained regarding the discharge of pollutants from this site. In 2001, PAN; fourteen local, state, and federal agencies; and United States Congressman Rahall signed a memorandum of understanding with the goal of abating the AMD discharges from the Summerlee site (PAN et al., 2001).

At the Summerlee site, WVDEP reclaimed 63 acres, extinguished surface burning, removed waste, and eliminated dangerous impoundments. The site still discharges significant loads of AMD, as shown by recently collected water quality data (Table 13). The AMD treatment consultant Working on People's Environmental Concerns (WOPEC) proposed a five-phase plan for addressing these loads (Hilton, 2005). Building treatment in phases allows the performance of earlier phases to be evaluated before later phases are finalized. The plan includes the following steps:

1. Modification of channels through which AMD in the site drains to promote oxygenation of the water and oxidation of dissolved iron, mostly in the ferrous form;
2. Construction of a leachbed or sulfate reducing bioreactor to neutralize particular AMD seeps on the site;
3. Modification of an existing wetland to increase its ability to retain metals and add alkalinity;
4. Development of a source of unacidified water to dilute the AMD and promote the generation of additional alkalinity in wetlands and in a bioreactor; and
5. Implementation of additional plans based on observations of the performance of earlier phases. (Hilton, 2005)

Table 13: Recent water quality data from the Summerlee site

Date	Aluminum (dissolved) (mg/L)	Total Iron (mg/L)	Manganese (dissolved) (mg/L)	Conductivity (µmhos/cm)	Total acidity (mg/L)	pH	Temp (°C)	Flow (cfs)
5/5/2007	56.9	137	12.8	3,610	1,200	2.70	16.6	0.34
10/29/2007	20.0	133	24.5	ND	637	2.20	14	ND
1/10/2008	19.3	341	11.2	1,550	ND	2.50	7.1	0.09
2/26/2008	17.6	94.0	15.9	2,220	ND	2.80	8.33	ND
4/17/2008	41.8	202	16.9	3,180	ND	2.70	13.32	0
6/26/2008	31.5	182	13.9	3,340	688	2.78	ND	ND
8/8/2008	20.2	108	15.9	2,750	450	2.90	21.64	0.11
9/11/2008	27.4	146	4.83	>1,990	<4.97	2.80	20.5	0.05
12/15/2008	5.44	46.1	13.9	1,470	206	2.89	12.7	0.08

Source: PAN (2009). ND=no data.

In 2007, PAN submitted an application for an Office of Surface Mining Watershed Cooperative Agreement Program (WCAP) grant to help fund Phase 1. According to this grant application, Phase 1 would cost a total of $290,000, and would be funded by the WCAP grant ($100,000), WVDEP AML Office ($147,059), the Wolf Creek Trust ($25,000), and administrative in-kind support from PAN ($18,241) (PAN, 2007). This grant was awarded, and Phase 1 construction took place in 2007. Phase 1 is described in detail by this application:

> "Due to the large size of the site, the variety and fluctuation in the flows, and the poor water quality from many of the seeps at the site, it is not practical to utilize existing passive treatment technology to treat the entire site at this time. Instead, we plan to address the site in phases, utilizing Phase I to 'pre-treat' the water containing very high metals and high acidity. By utilizing the low pH-iron oxidation process, water with a low pH and high in ferrous iron (indicative of the water at the site) reacts to the sudden association with atmospheric oxygen to change the ferrous iron to ferric iron. During this ferrous to ferric conversion, iron and acidity are removed from the water, resulting in reductions as high as 60% of the iron and 40% of the acid. The intent of this phase of the project is to optimize this oxidation process by redistributing the existing flows and exposing the drainage to as much oxygen as possible. This will be achieved by altering the existing drainage patterns, including reconstructing the existing surface channels and retention ponds, and establishing new flow configurations to provide consistent flows.
>
> "Phase I will reduce the acidity and metal loads, but will not eliminate them. Current acidity levels from the largest seeps are in the range of 900 to over 1,000 mg/l, and iron over 300 mg/l. High levels of manganese and aluminum are also present. After Phase I, acidity levels discharging from the site are estimated to be approximately 700 mg/l, with iron estimated at 150 mg/l, aluminum at 30 mg/l and manganese at 15 mg/l. The pH of the water discharging from the site is estimated to remain very low (2.7).
>
> "There is no significant alkalinity proposed under the initial phase. The system does not depend on the addition of alkalinity to cause the reduction in iron, thus there is little concern with the clogging of the system. There is a long-term life expectancy of the system." (PAN, 2007)

PAN and partner agencies held a Summerlee Phase 1 Review meeting in June 2008. At this meeting, vandalism was identified as a major issue. Guardrails were removed to allow access onto the site for all-terrain vehicle trespassing, and the cap on the gob pile is eroding and exposing the coal refuse, due to this trespassing. At this review meeting, it was agreed that partners would not move forward with subsequent phases until the trespassing issue is resolved (PAN, 2008).

Regarding the efficacy of Phase 1, discussion centered on how it will take time for Phase 1 to "settle in" and it might take one or two years of monitoring to determine its effectiveness. PAN and the AML Office will continue monitoring the site in preparation for future phases (PAN, 2008).

With the completion and evaluation of Phase 1 and subsequent phases, it will be possible to refine estimates of load reductions and costs for the remaining phases. An initial indication of the scale of the problem is provided by the TMDL and by onsite water monitoring. OSM's AMDTreat software was used to calculate estimated costs for Phases 2 and 3, based on the available water quality data. These cost estimates are provided in Table 14. Phase 1 is complete, and the cost for Phases 4 and 5 cannot be estimated until future phases are complete.

According to the TMDL report, iron loads from the Summerlee site must be reduced from 331,358 to 3,305 pounds per year, a 99% reduction. A 98% reduction is required for aluminum loads, which must be reduced from 44,527 to 1,030 pounds per year. While theoretical reductions of metals and acidity approach 100%, practical evaluations of the systems have shown variable results as low as 14% and as high as 99% for iron and aluminum (McCauley, 2009; Neculita et al., 2008). Actual efficiencies depend on pH, metal concentrations, ambient temperature, hydraulic retention times, and characteristics of the biomass (Neculita et al., 2008). Efficiency values of 87% for iron and 85% for aluminum, averages from several studies cited in a 2009 report (McCauley, 2009), are used in Table 14 to estimate metals reductions from a bioreactor.

Wetlands have the potential to be highly effective at removing metals from AMD—96% to 99% for iron (Smith et al., 2003). However, if the influent is too acidic or metal-laden, it will harm wetland plants, reducing the wetland's efficacy. For this reason, the reduction resulting from passive treatment in wetlands is linked to the acid-neutralizing efficiency of the bioreactor and other upstream treatment. To be conservative, an efficiency of 50% is assumed for the Summerlee wetland because the chemistry of the wetland inflow will not be known until Phase 2 is completed.

In total, the bioreactor and wetland would achieve an estimated iron reduction of 94% and aluminum reduction of 93%. Additional treatment contemplated in Phases 4 and 5 would help achieve the 99% and 98% reductions required by the TMDL, but these phases cannot be modeled until earlier phases are completed.

Table 14: Estimated future costs and metals reductions of Summerlee remediation, Phases 2 and 3

Phase	Action	Cost	Metal	Metals reduction (%)	Reduction (pounds/ year)
2	Construction of a bioreactor or similar treatment	$1,300,000	Iron Aluminum	87 85	288,000 38,000
3	Wetland modification	$50,000	Iron Aluminum	50 50	22,000 3,000
Total		**$1,350,000**	Iron Aluminum	**94** **93**	**310,000** **41,000**

Cost estimates were made using AMDTreat. Metal reduction percentages in bioreactors are an average of values presented in McCauley et al. (2009).

5.1.1.2 Fayette Station (NPS) Slide

This site is associated with the extremely large Kaymoor mine, which has a portal near the mouth of Wolf Creek. In 1992, a PAD was submitted for the Fayette Station Slide (OSM, 1992). The PAD describes two high priority problems at the site: a dangerous slide and a dangerous impoundment, both caused by mine drainage from the mine portal. The mine drainage saturated and lubricated the soil, causing the slope to fail, resulting in a slide that blocked a popular access road to the New River. Similarly, the drainage destabilized the impoundment, resulting in its classification as a "Priority 1 (Extreme Danger)" problem, with approximately 2,300 cubic yards of material in jeopardy of being released down the slope (OSM, 1992). This problem area was abated by the West Virginia AML Reclamation Emergency Program circa 1993 (Ramsey, 2009).

The TMDL targets the Fayette Station (NPS) Slide AML site for a 68% iron reduction, from 347 to 111 pounds per year. Because the site is near the mouth of Wolf Creek, it only has the potential to pollute a very small portion of the watershed. However, the short band of polluted water may form a barrier for fish migrating to and from the New River. The annual load of iron from this site is considerably smaller than the load from the Summerlee site.

The National Park Service (NPS) monitors water quality in the New River and some tributaries. In contrast to the assessment in the TMDL, the NPS ceased metals monitoring in the area several years ago because metals are a relatively minor problem at this location (Purvis, 2009). Similarly, data collected by PAN near the mouth of Wolf Creek throughout 2008 do not show iron exceedances; total iron at this site ranged from 0.0564 mg/L to 0.268 mg/L (PAN, 2009). The apparent discrepancy between the TMDL and the PAN water quality data may be explained by a combination of factors. The TMDL baseline load figure of 347 pounds is not based on water quality data collected from the site, but rather on a model that uses the area of the AML to derive an estimate of pollutant loads discharging from the site (Montali, 2009). While it is possible that storm event data would show disproportionately high pollutant discharges, justifying the TMDL baseline load estimate, it is clear that the Fayette Station site (with a prescribed annual iron reduction of 236 pounds) is a much lower priority than the Summerlee site (for which the TMDL requires an annual iron reduction of more than 300,000 pounds, as noted in Section 5.1.1.1).

Given the lack of specific water chemistry and flow data from the Fayette Station (NPS) Slide site, it is not possible at this time to calculate the cost of reclamation. Furthermore, it is not clear that reclamation would improve water quality (Purvis, 2009; PAN, 2009). Given the location and scale of the Fayette Station (NPS) Slide site, it is a much lower priority than the Summerlee AML site. For this reason, it is recommended that remediation efforts focus on Summerlee, and revisit Fayette Station once the other sources of pollution in the watershed have been ameliorated.

5.1.2 Streambank erosion

While the TMDL report assigns percent reductions for each subwatershed, it only offers the most general suggestion for addressing streambank erosion: bank stabilization projects to compliment and accelerate the watershed's natural recovery. In Section 4.1.2, several types of management measures are introduced that can address streambank erosion in developed areas and agricultural areas.

The TMDL presents load reductions, but as detailed above in Table 7, streambank erosion load reductions are provided in pounds of iron, as opposed to pounds of soil. Also, the TMDL does not specify whether to target developed areas, agricultural areas, or both. In Section 4.1.2, various measures are listed for both of these land use areas.

5.1.2.1 Pasture/Cropland

The most significant pollutant reductions related to streambank erosion are in subwatersheds with the highest level of agricultural intensity. When agricultural areas are targeted, consideration should be given to identifying measures that will reduce both the iron loads from streambank erosion as well as the fecal coliform loads from pasture and cropland. In this way, efficiencies are created because single projects can fix both types of impairments.

In order to most effectively reduce streambank erosion in agricultural areas, it is necessary to keep livestock away from the streams. Riparian buffers may accelerate and protect streambank stabilization efforts. Additional measures are often necessary when livestock are fenced away from streams. These include armored stream crossings and alternative watering sources. Table 15 presents unit cost estimates for fencing, riparian buffer establishment, stream crossings, and alternative watering sources.

Table 15: Estimated costs of best management practices associated with streambank erosion

Best management practice	Unit cost	Unit
Livestock fencing	$2	1 linear foot
Riparian buffer establishment	$1,000	1 acre
Armored stream crossing	$1,200	18" culvert, 20' length
	$2,800	30" culvert, 30' length
	$5,900	48" culvert, 40' length
Alternative watering source	$3,000	Per watering best management practice

Source: Hardy et al. (2007), Meyer and Olsen (2005), USDA (2008).

In order to estimate the total potential cost of agricultural BMPs, a GIS analysis was conducted to determine the acreage of agricultural land in the Wolf Creek watershed, as well as the linear feet of stream passing through agricultural land. According to the West Virginia Gap Analysis Land Cover Project, there is no land classified as "Row Crop Agriculture" in the Wolf Creek watershed (Tetra Tech, 2008). Pasture/grassland in the Wolf Creek watershed is concentrated in a few subwatersheds, but is present in most subwatersheds.

Table 16 shows the length of stream that flows through pasture/grassland; the length of fencing required, assuming both sides of the stream would be fenced; the acres of riparian buffer to be constructed, assuming a 35-foot buffer on each side of the stream; the number of stream crossings, assuming one per 1,000 feet of stream; and the number of necessary alternative watering sources, assuming one per 1,000 feet of stream.

Table 16: Measures required by subwatershed and relevant subwatershed characteristics

Agricultural intensity	Stream	SWS	Stream feet through pasture	Maximum feet of fencing required	Acres of riparian buffer	Stream crossings	Alternative watering sources
High	**Crooked Run**	1048	2,313	4,626	3.7	3	3
	Wolf Creek	1040	3,126	6,252	5.0	4	4
	Short Creek	1039	3,179	6,358	5.1	4	4
Moderate	**Wolf Creek**	1038	385	770	0.6	1	1
	Levisee Creek	1041	3,710	7,420	6.0	4	4
Low	**Wolf Creek**	1045	1,020	2,040	1.6	2	2
	Wolf Creek	1043	595	1190	1.0	1	1
	House Branch	1049	1,558	3,116	2.5	2	2
	Adkins Branch	1044	588	1176	0.9	1	1
	Toney Hollow	1042	2,180	4,360	3.5	3	3
	Wolf Creek	1047	0	---	---	---	---
Negligible	**UNT Wolf Creek RM 8.7**	1046	383	766	0.6	1	1
	Wolf Creek	1036	0	---	---	---	---
	Wolf Creek	1037	0	---	---	---	---
Total			19,037	38,074	30.5	26	26

Source: Carr (2009), Tetra Tech (2008). Impaired streams appear in bold. SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile.

Table 17 shows the estimated costs of fencing, riparian buffer, stream crossings, and alternative watering sources. Because some parcels may already be fenced and other parcels may not be active pastureland, the cost estimates should be considered an upper bound. Wolf Creek subwatersheds 1036, 1037, and 1047 are not included in Table 18 and Table 19, as they have no stream feet through pasture. Similarly, the unnamed tributary of Wolf Creek is not included. Since there is no fecal coliform baseline load in subwatershed 1046 from pasture/cropland, it is assumed that streambank erosion in this subwatershed is not associated with agriculture.

Table 17: Estimated costs of best management practices by subwatershed

Agricultural intensity	Stream	SWS	Fencing	Riparian buffer	Stream crossings	Alternative watering sources	Total
High	**Crooked Run**	1048	$9,252	$3,700	$17,700	$9,000	$39,652
	Wolf Creek	1040	$12,504	$5,000	$23,600	$12,000	$53,104
	Short Creek	1039	$12,716	$5,100	$23,600	$12,000	$53,416
Moderate	**Wolf Creek**	1038	$1,540	$600	$5,900	$3,000	$11,040
	Levisee Creek	1041	$14,840	$6,000	$23,600	$12,000	$56,440
Low	**Wolf Creek**	1045	$4,080	$1,600	$11,800	$6,000	$23,480
	Wolf Creek	1043	$2,380	$1,000	$5,900	$3,000	$12,280
	House Branch	1049	$6,232	$2,500	$11,800	$6,000	$26,532
	Adkins Branch	1044	$2,352	$900	$5,900	$3,000	$12,152
	Toney Hollow	1042	$8,720	$3,500	$17,700	$9,000	$38,920
Total	Total		$74,616	$29,900	$147,500	$75,000	$327,016

Source: Hardy et al. (2007), Meyer and Olsen (2005). Impaired streams appear in bold. SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile.

Sediment load reduction efficiencies of 75% and 56% are assumed for fencing and riparian buffer best management practices respectively (Chesapeake Bay Program, 2007). The riparian buffer and total reductions were calculated by assuming that of the 25% of sediment still reaching the stream after fencing is in place, 56% will be trapped by the addition of a riparian buffer, for a total reduction of 89%.

Table 18: Iron reductions by subwatershed and agricultural best management practice (pounds/year)

Agricultural intensity	Stream	SWS	Fencing	Riparian buffer	Total
High	**Crooked Run**	1048	37	7	43
	Wolf Creek	1040	4,818	899	5,717
	Short Creek	1039	202	38	239
Moderate	**Wolf Creek**	1038	1,103	206	1,309
	Levisee Creek	1041	497	93	590
Low	**Wolf Creek**	1045	289	54	343
	Wolf Creek	1043	483	90	573
	House Branch	1049	86	16	102
	Adkins Branch	1044	116	22	138
	Toney Hollow	1042	36	7	43
Total	Total		7,666	1,431	9,098

Source: Impaired streams appear in bold. SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile. Reduction efficiencies from Chesapeake Bay Program (2007).

To develop more precise cost estimates for agricultural areas, it will be necessary to initiate a process with agencies and local organizations that interface with the agricultural community. Ultimately, the projects implemented will depend upon the size, function, and layout of the individual farms.

5.1.2.2 General streambank stabilization

While the highest prescribed reductions in streambank erosion are in highly agricultural subwatersheds, reductions are called for in all subwatersheds of Wolf Creek. Three of these subwatersheds (Wolf Creek's 1036, 1037, and 1047) have zero stream feet through pasture/cropland and two of them (1036 and 1037) are in heavily forested areas. As explained in section 5.1.2.1, the unnamed tributary of Wolf Creek (subwatershed 1046) is not recommended for agricultural BMPs related to streambank erosion. However, streambank erosion must be addressed in this subwatershed as a source of iron.

Engineered streambank stabilization is recommended for subwatersheds 1036, 1037, 1046, and 1047, but these projects will be a lower priority, as their prescribed reductions (in terms of pounds of iron per year), are much lower than those in agriculture-intensive watersheds, as shown in Table 7. It is probable that short stretches of streambank are responsible for most of the erosion. For this reason, the figures in Table 19 should be viewed as maximum estimates.

“Unimpacted, stable channels tend to have negligible rates of streambank erosion, so an eroding channel that is stabilized can be assumed to have a negligible rate of erosion as well” (USEPA 2008, p. 273). Following this logic, a sediment load reduction efficiency of 100% is used in Table 19.

Streambank stabilization projects vary in cost based on the characteristics of the failing banks. Costs range from $15/foot to over $300/foot (UIUC, undated; USEPA, 1993). An intermediate value of $150/foot is used in Table 19.

Table 19: Streambank stabilization project estimated costs and iron load reductions

Stream	SWS	Stream feet	Cost	Reduction (pounds/ year)
Wolf Creek	1036	6,970	$1,045,500	608
	1037	5,790	$868,500	682
	1047	7,200	$1,080,000	49
UNT Wolf Creek RM 8.7	1046	4,690	$703,500	346
Total		24,650	$3,697,500	1,685

Source: Tetra Tech (2008), UIUC (undated), USEPA (1993). Impaired streams appear in bold. SWS=subwatershed in the TMDL. Reduction efficiency from USEPA (2008).

5.2 Fecal coliform

5.2.1 Pasture/Cropland

The TMDL targets four subwatersheds for fecal coliform reductions from pasture and cropland (Table 11). Reductions of 80% are required in the Crooked Run, Short Creek, and Levisee Creek subwatersheds, and a reduction of 40% is required in the Wolf Creek subwatershed 1040, which is located between the mouths of Levisee Creek and Short Creek.

The BMPs discussed above in Section 5.1.2 to address streambank erosion will contribute to the reduction of fecal coliform in agricultural areas. Since reductions from streambank erosion are called for in all subwatersheds, the associated reductions in fecal coliform are calculated in Table 20, even for subwatersheds not requiring fecal coliform reductions from pasture/cropland. Subwatersheds 1036, 1037, 1046, and 1047 are not considered here as they either have no streamside pastureland or no baseline pasture/cropland load in the TMDL.

Fecal coliform reduction efficiencies of 70% are assumed for fencing pasture away from streams and for planting riparian buffers (Hardy et al., 2007). The riparian buffer and total reductions were calculated by assuming that of the 30% of bacteria still reaching the stream after fencing is in place, 70% will be trapped by the addition of a riparian buffer, for a total reduction of 91%. The load reductions were calculated by multiplying the efficiencies by the baseline loads presented in the TMDL (Table 11).

Table 20: Fecal coliform reductions by subwatershed and agricultural best management practice (counts/year)

Agricultural intensity	Stream	SWS	Fencing	Riparian buffer	Total
High	**Crooked Run**	1048	6.7E+12	2.01E+12	8.71E+12
	Wolf Creek	1040	7.77E+12	2.33E+12	1.01E+13
	Short Creek	1039	1.27E+13	3.8E+12	1.65E+13
Moderate	**Wolf Creek**	1038	7.21E+11	2.16E+11	9.37E+11
	Levisee Creek	1041	1.13E+13	3.4E+12	1.47E+13
Low	**Wolf Creek**	1045	5.27E+11	1.58E+11	6.85E+11
	Wolf Creek	1043	2.11E+11	6.32E+10	2.74E+11
	House Branch	1049	4.75E+11	1.43E+11	6.18E+11
	Adkins Branch	1044	5.98E+11	1.79E+11	7.77E+11
	Toney Hollow	1042	6.57E+11	1.97E+11	8.54E+11
Total			4.17E+13	1.25E+13	5.42E+13

Impaired streams appear in bold. SWS=subwatershed in the TMDL. UNT=unnamed tributary. Reduction efficiencies from Hardy et al. (2007).

5.2.2 Onsite sewer systems

The TMDL targets every subwatershed within the Wolf Creek watershed for 100% reductions of fecal coliform loads from onsite sewer systems (Table 11). In describing the Wolf Creek/Salem-Gatewood community, the *Wastewater Management Plan* notes the presence of failing septic systems, cases of direct discharge of sewage into the stream, and a “high potential for economic and residential development” (LAI, 2005e, p. 48).

As discussed in Section 4.2.2, possible solutions include replacing or repairing onsite systems, upgrading UIC permitted systems, installing cluster systems, and extending lines for municipal and public service district systems. Table 21 presents initial installation and annual maintenance costs for various components of these wastewater treatment options. Individual site conditions (soil type, depth to bedrock or water table) and location (proximity to other homes and to municipal systems) will determine the most appropriate solution for each site.

Table 21: Estimated costs of specific treatment system options

Technology	Includes installation and:	Initial cost per house	Annual cost per house
Individual onsite systems			
New individual onsite septic system, traditional drain field	New tank and drain field	$5,000	$50
Septic tank		$1,000	
Alternative systems			
Textile filter		$11,000	$240
Peat filter		$8,500	$240
Recirculating sand filter		$7,000	$240
Sand filter-single pass		$2,500	$240
UV treatment	Home-sized unit	$800	$150
Drain field	Area 0.2 gallons/ft^2 for individual home	$2,500	
Drip field	For individual home	$8,000	
Low pressure pipe	For individual home	$5,000	
Recirculating sand filter with direct discharge	For individual home	$5,040	$200
Cluster systems			
Package plant with direct discharge	Treatment plant only	$2,800	$425
Septic tank effluent pump (STEP) system	New septic tank with street-side hookup	$9,000	$180
Septic tank effluent discharge (or drain) (STED) system	New septic tank with street-side hookup	$6,000	$50
Vacuum valve pit	Valve pit can handle 2-4 homes	$2,000	$50
Vacuum collection station		$325,000	
Centralized system hook-ups			
Connection tap fee		$300	
8" Line installed per foot	Manholes, no lift station	$100	
4" Line installed per foot		$50	

Source: WTCMC et al. (Undated).

While the *Comprehensive Wastewater Management Plan for Fayette County* outlines general goals and estimated costs for wastewater management improvement for Fayette County (LAI, 2005b), limited information regarding the exact number of homes hooked up to inadequate wastewater treatment systems makes predicting loads and associated remediation costs for individual sources difficult. However, the *Wastewater Management Plan* does provide a per-system cost estimate of $8,000-$12,000 (LAI, 2005a, p 6).

According to a GIS analysis performed for this watershed-based plan, there are 3,680 structures in the Wolf Creek watershed (WVSAMB, 2003). Many of these structures may be barns or sheds and thus not require treatment systems; the type of structure is not specified in the dataset. However, these numbers can be used to arrive at rough estimates of the cost to implement a comprehensive treatment system update. For example, assuming 35% of the structures require installation or repair of a treatment system, and assuming a per-system estimate of $10,000, the entire Wolf Creek watershed could be upgraded at a total cost of $12.9 million.

Using these assumptions, Table 22 presents estimates of system upgrade costs by subwatershed. Due to inflation and to the continued deterioration of the wastewater treatment equipment, the cost of repairs is likely to increase each year the work is delayed. Repair or replacement of septic systems is expected to be accompanied by a 100% reduction in fecal coliform loads (USEPA, 2002).

Table 22: Structures, septic upgrades, cost estimates, and load reductions by subwatershed

Subwatershed	SWS	Number of structures	Units requiring replacement or repair	Cost	Reduction (counts/year)
Wolf Creek	1036	47	16	$160,000	3.53E+10
	1037	50	18	$180,000	1.02E+10
	1038	67	23	$230,000	7.63E+10
	1040	161	56	$560,000	1.83E+11
	1043	18	6	$60,000	2.05E+10
	1045	711	249	$2,490,000	3.96E+11
	1047	152	53	$530,000	1.73E+11
House Branch	1049	818	286	$2,860,000	1.94E+11
Crooked Run	1048	316	111	$1,110,000	3.29E+11
Short Creek	1039	130	46	$460,000	1.48E+11
Levisee Creek	1041	433	152	$1,520,000	4.93E+11
Toney Hollow	1042	87	30	$300,000	9.91E+10
Adkins Branch	1044	501	175	$1,750,000	3.78E+11
UNT/Wolf Creek MR 8.7	1046	189	66	$660,000	1.98E+11
Total		**3,680**	**1,287**	**$12,870,000**	**2.74E+12**

Source: LAI (2005a), WVSAMB (2003). SWS=subwatershed in the TMDL. UNT=unnamed tributary. RM=river mile. Reduction efficiency based on efficiency of properly maintained systems as presented in USEPA (2002).

As part of the *Comprehensive Wastewater Management Plan*, several communities were evaluated for the suitability of cluster systems (LAI, 2005c). The communities were assessed based on the following criteria:

- population density,
- human health threat posed by existing systems and/or direct discharges,
- water quality problems associated with existing systems and/or direct discharges,
- soil characteristics, and
- lot size.

One of the communities recommended for a cluster system was Summerlee. According to the *Comprehensive Wastewater Management Plan*, a cluster system here would treat approximately 137 homes. Another alternative for the Summerlee community would be to extend the services of the Oak Hill sewage system.

5.3 Total cost for remediation of all impairments

Based on the calculations presented in Sections 5.1 and 5.2, the total estimated cost to restore the entire Wolf Creek watershed is $18.24 million, as shown in Table 23.

Table 23: Summary of estimated costs for Wolf Creek watershed restoration

Remediation effort	Impairments addressed	Estimated cost (million $)
Summerlee AML remediation	Aluminum, iron	1.35
Agricultural best management practices	Iron, fecal coliform	0.33
Streambank stabilization	Iron	3.70
Septic systems upgrade	Fecal coliform	12.87
Total		**18.24**

6 TECHNICAL AND FINANCIAL ASSISTANCE

A combination of federal and state agencies, academic institutions, watershed organizations, consultants, and citizens will be involved in providing technical and financial assistance for Wolf Creek watershed projects. Specific technical and financial resources are provided for AMLs, streambank erosion, pasture/cropland, and onsite sewer systems.

6.1 <u>Iron and aluminum</u>

6.1.1 Abandoned mine lands

Technical assistance is needed for the following tasks related to AMD:

- collecting data at AMD sources in preparation for the design of remediation projects;
- creating conceptual designs of remediation projects;
- creating detailed engineering designs of remediation projects;
- performing project management, including putting projects out for bid, managing projects, tracking their progress, and providing ongoing project operation and maintenance; and
- monitoring instream and source water quality following the installation of remediation projects to document their effectiveness.

Financial assistance is needed to design and build the selected remediation projects. Many funding sources are available for nonpoint source AMD remediation on AMLs and for water quality monitoring, including:

- Section 319 funds,
- the AML Trust Fund, including money in the AMD Set-Aside Fund,
- Watershed Cooperative Agreement Program grants,
- Wolf Creek Environmental Trust (WCET),
- mitigation fees,
- USACE Section 206 funds,
- NRCS Public Law 566 funds,
- Stream Partners Program grants, and
- local government contributions.

6.1.1.1 Plateau Action Network

While many organizations and agencies will play a role in implementing this watershed-based plan, PAN will take a leading role. PAN's mission is to work within the community to promote responsible economic development and sustainable environmental management. PAN will locate and apply for funding, partner with agencies to implement AMD reclamation projects, collect data to determine the effectiveness of reclamation projects, monitor impaired streams, assist with ongoing project operation and maintenance plans, and inform the local community and watershed stakeholders about reclamation efforts and water quality achievements.

One financial resource at the disposal of PAN and WVDEP is WCET, which was generated when PAN intervened in an ongoing AMD environmental suit, resulting in a $375 thousand settlement. PAN and WVDEP then established a public/private environmental trust fund—only the second in state history. Since then, PAN has worked with the Office of Surface Mining, Reclamation, and Enforcement (OSM), Office of Abandoned Mine Lands and Reclamation (OAMLR), and others to design and implement an AMD treatment system at the Summerlee site. The fund principle as of February 2009 is $402 thousand (Kistler, 2009). While the primary purpose of the trust is to address the ongoing costs associated with reclaiming the Summerlee site, the money may also be used to address additional water quality, educational, and/or recreational projects at or near Wolf Creek, even if outside the watershed boundary (WCET, 2002).

6.1.1.2 West Virginia Department of Environmental Protection

Two WVDEP divisions will provide technical assistance. The Division of Water and Waste Management provides technical assistance for the use of BMPs, educates the public and land users on nonpoint source issues, enforces water quality laws that affect nonpoint sources, and restores impaired watersheds through its Nonpoint Source Program (WVDEP, 2006b).

Clean Water Act Section 319 funds are provided by USEPA to WVDEP, and can be used for reclamation of nonpoint source AMD sources. This watershed-based plan is being developed so that these funds can be allocated to the Wolf Creek watershed. WVDEP's Nonpoint Source Program sets priorities and administers the state Section 319 program (WVDEP, 2006b). It is the intention of PAN to prepare a Section 319 proposal focused on the Summerlee site for WVDEP to include in its 2009 submittal to USEPA.

A second division within WVDEP, the OAMLR, directs technical resources to watersheds to address AMLs. Within OAMLR, the Stream Restoration Group (SRG) conducts extensive source monitoring of AMLs—as well as instream monitoring—before remediation systems are designed.

OAMLR also funds AML remediation projects via the Abandoned Mine Land Trust Fund. Before 1977, when the Surface Mining Control and Reclamation Act was enacted, coal mines generally did not manage acid-producing material to prevent AMD or treat the AMD that was produced. These "pre-law" mines continue to be significant AMD sources and are treated as nonpoint sources under the Clean Water Act. Both AMLs targeted for reductions in the TMDL are "pre-law" mines.

To reclaim these AMLs, the Act established the AML Trust Fund. This fund, supported by a per-ton tax on mined coal, is allocated to coal mining states for remediation projects. WVDEP has funded many AMD remediation projects on AMLs, but these projects are typically not designed to meet stringent water quality goals. The agency typically uses a small number of cost-effective techniques, such as OLCs, and chooses the layout for these measures based on how much land is available (for example, the distance between a mine portal and the boundary of properties for which the agency has right-of-entry agreements).

While the AML Trust Fund is an important funding source, it is not likely to be adequate to solve the AMD problems at the Summerlee site on its own.

OAMLR also administers a closely linked source of funding: the AMD Set-Aside Fund. In the past, up to 10% of states' annual AML Trust Fund allocations could be reserved as an endowment for use on water quality projects. With recent changes in the law, states can reserve up to 30%. These funds are critically important, because while regular AML Trust Fund allocations can only be spent on capital costs, AMD Set-Aside Fund allocations can be spent on operations and maintenance.

6.1.1.3 Mitigation fees

The West Virginia Division of Highways recently installed an interchange in Oak Hill to separate US 19 and Lochgelly Road and WV 16 (Kimley-Horn, 2005b). Construction resulted in the removal of wetlands and impacted perennial and intermittent stream channels in the Wolf Creek watershed. In order to receive its Section 404 permit, the agency was required to pay mitigation fees to compensate for impacts on waters of the state. The total fees generated by this project amount to $456,400 (Bennett, 2006). Final decisions on how and where the money will be spent will be determined by the project Mitigation Review Team, consisting of USACE, WVDEP, WVDNR, USEPA, and the United States Fish and Wildlife Service (Bennett, 2006). Meetings of Mitigation Review Team members are scheduled for March 2009 to discuss the next steps in the process toward distributing the collected funds to proposed projects (Bennett, 2009). These funds might be available to help implement nonpoint source measures identified in this plan.

6.1.1.4 Stream Partners Program

The Stream Partners Program offers grants of up to $5,000 to watershed organizations in West Virginia. Grants can be used for range of projects including small watershed assessments and water quality monitoring, public education, stream restoration, and organizational development. This grant has regularly provided funding for PAN projects in the past. Stream Partners grants will be pursued in the future to compliment nonpoint source research, education, and reclamation projects in the watershed.

6.1.1.5 Office of Surface Mining, Reclamation and Enforcement

In the past, OSM has helped place summer interns and AmeriCorps*Volunteers In Service To America (OSM/VISTA) volunteers with PAN to assist with AMD-related projects. It is expected that OSM will play a similar role in the future in the Wolf Creek watershed.

OSM also provides grants specifically for AMD remediation projects on AMLs are available through the WCAP. This program is part of the Appalachian Clean Streams Initiative. Grants of up to $100 thousand are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (OSM, 2006b). A match is required to receive these grants and is typically met with money from the AML Trust Fund. In 2007, PAN received a WCAP grant for Phase 1 of the Summerlee site (See Section 5.1.1.1). PAN plans to apply for additional WCAP grants in the future.

6.1.1.6 Working on People's Environmental Concerns

WOPEC, a consulting company based in Lewisburg, West Virginia, is respected for its expertise in AMD treatment. Under contract with WVDEP, WOPEC has developed the conceptual designs for the Summerlee reclamation project. WOPEC may continue to provide assistance as the reclamation project proceeds.

6.1.1.7 Environmental testing laboratories

Research Environmental & Industrial Consultants, Inc. (REIC Labs)—an environmental consulting, monitoring and testing company from Beaver, West Virginia—has assisted with preconstruction sampling and water quality testing for the Summerlee AML project. This monitoring was funded by WCET. PAN is now sending all water samples collected at the Summerlee site to Analabs in Beckley, West Virginia.

6.1.1.8 United States Army Corps of Engineers

Using Section 206 funds, USACE has funded an AMD ecosystem restoration study in the lower Cheat River watershed in northern West Virginia (USACE, 1997) and is planning to fund remediation work in one of the tributaries. The success of this project will help determine whether or not similar funds could be pursued for future AML reclamation projects in the Wolf Creek watershed.

6.1.1.9 Natural Resources Conservation Service

Although it has not been active in AMD remediation in the Wolf Creek, NRCS is funding AMD remediation in the Deckers Creek watershed in West Virginia though a Public Law-566 watershed restoration project. NRCS engineers have experience developing conceptual designs and detailed engineering designs for AMD remediation projects.

6.1.1.10 Local governments
Fayette County will be approached to provide in-kind support for Wolf Creek projects and to take ownership of any property in the watershed that may be acquired by PAN in the future.

6.1.2 Streambank erosion

6.1.2.1 West Virginia Department of Environmental Protection
Once a watershed-based plan is approved for Wolf Creek, the watershed will be eligible for funds from the 319 program through the USEPA. In addition to AMD remediation mentioned above, 319 grants can be used to help implement other nonpoint source pollution control projects such as those that address streambank erosion. A 40% match is required.

6.1.2.2 West Virginia Conservation Agency
The West Virginia Conservation Agency (WVCA) provides support to local watershed organizations. WVCA helps coordinate and implement 319 projects, especially those related to agriculture and streambank stabilization.

6.1.2.3 Natural Resources Conservation Service
The voluntary Wildlife Habitat Incentives Program (WHIP) program provides funds to private landholders who wish to devote some of their land to the development of habitat areas. Wildlife habitat may include upland, wetland, riparian, and aquatic habitat. The projects must target a specific species for habitat improvement, generally require an agreement of 5-10 years, and offer up to 75% cost-share assistance. WHIP projects can help address streambank erosion.

6.1.2.4 Farm Service Agency
The Conservation Reserve Enhancement Program (CREP) is a voluntary program in which landholders agree to retire some portion of their land from agricultural production for a period of 10-15 years. Eligible land includes cropland or marginal pasture land that has been owned and operated for at least a year and that demonstrates a need, such as wildlife habitat restoration or erosion control. The government pays the rental value of the retired land plus $100/acre, as well as some portion of the costs for necessary improvements. If the project includes active restoration (as opposed to natural regeneration), a cost-share incentive is offered. CREP enrollment is limited to specific geographic areas and practices; therefore, communication with the Fayette County Farm Service Agency will be required to confirm whether these funds can be used in the Wolf Creek watershed.

6.1.2.5 Partners for Fish and Wildlife
The Partners for Fish and Wildlife Program is sponsored by the United States Fish and Wildlife Service. This voluntary program primarily involves streambank fencing, tree-planting, and invasive species control. The United States Fish and Wildlife Service offers technical and financial assistance to conserve or restore native ecosystems.

6.1.2.6 Canaan Valley Institute
Canaan Valley Institute has experience with natural stream channel design. Staff can help diagnose problems and design solutions.

6.1.2.7 Parsons Brinckerhoff

Parsons Brinckerhoff has been one of the key players in developing the *Wolf Creek Watershed: Stormwater Management & Flood Hazard Mitigation Plan* (Parsons Brinckerhoff, 2004). As this plan is implemented, Parsons may be available for additional technical assistance for projects designed to improve the biological integrity of Wolf Creek. They have also been involved with the development of Wolf Creek Park, an innovative low impact residential and business development designed to reduce stormwater runoff onsite.

6.1.2.8 Private developers

As the Wolf Creek watershed develops, private developers will play a key role in determining the biological impacts that will result from their actions. Partnerships with developers will likely be important for maintaining and improving the biological health of the creek.

6.1.2.9 Local governments

Fayette County government may be approached to provide in-kind support for water improvement projects occurring in the watershed. The County may also be approached to support and enforce ordinances related to stormwater management that have the potential for reducing biological impairment in Wolf Creek.

6.2 Fecal coliform

6.2.1 Pasture/Cropland

Many of the same technical assistance providers discussed in Section 6.1.2 for streambank erosion can also be used for fecal coliform reductions from pasture/cropland. In particular, the following providers and sources should be considered:

- WVDEP,
- WVCA,
- Natural Resources Conservation Service,
- Farm Service Agency, and
- Partners for Fish and Wildlife.

6.2.2 Onsite sewer systems

Technical assistance is needed for the following tasks related to fecal coliform bacteria:

- collecting data at bacteria sources in preparation for the design and implementation of remediation projects;
- creating conceptual designs of remediation projects;
- creating detailed engineering designs of remediation projects;
- performing project management, including putting projects out for bid, managing projects, and tracking their progress,
- monitoring instream and source water quality following the installation of remediation projects to document their effectiveness, and
- managing decentralized onsite systems after installation.

6.2.2.1 Wastewater Management Plan Project Advisory Committee

As shown in Table 24, many people and organizations are represented in the Wastewater Management Plan Project Advisory Committee. This Committee developed the *Comprehensive Wastewater*

Management Plan for Fayette County. It is expected that these people and organizations will be available for technical assistance for bacteria reclamation projects in the Wolf Creek watershed, whether or not these projects are specifically outlined in the management plan.

Table 24: Wastewater Management Plan Project Advisory Committee

Member	Organization
Dave Pollard	Fayette County
Al Gannon	Public Service Districts
Elbert Morton	West Virginia Department of Environmental Protection
Ken Toney	Fayette County Transition Team
Doug Proctor	West Virginia Professional River Outfitters
Mark Ehrnschwender	Fayette County Water Quality Coalition
Randy Boyd	Plateau Action Network
Jesse Purvis	National Park Service
Pio Lombardo	Lombardo Associates
Edward Shutt	Stafford Consultants
General public members	

Source: LAI (2006).

6.2.2.2 Section 319 funds

Clean Water Act Section 319 funds may be available for reclamation of nonpoint sources of fecal coliform bacteria. This watershed-based plan is being developed so that these funds can be allocated to the Wolf Creek watershed. WVDEP's Nonpoint Source Program will determine whether or not funds will be allocated to Wolf Creek for projects addressing fecal coliform bacteria pollution (WVDEP, 2006b).

6.2.2.3 National Park Service

The National Park Service will continue to fund instream bacteria monitoring to determine water quality changes resulting from the implementation of the Wastewater Management Plan and this watershed-based plan.

6.2.2.4 Wolf Creek Environmental Trust

While WCET was implemented primarily to address the ongoing costs associated with reclaiming the Summerlee site, the money may also be used to address additional water quality and recreational projects at or near Wolf Creek (WCET, 2002). Money from the Trust may be available for projects addressing fecal coliform bacteria impairment.

6.2.2.5 Local governments

Fayette County government may be approached to provide in-kind support for water improvement projects occurring in the watershed. The County government is supportive of and has adopted the *Comprehensive Wastewater Management Plan for Fayette County* (LAI, 2005a). The County may also be approached to support and enforce ordinances related to wastewater management.

6.2.2.6 Onsite System Loan Program

The West Virginia Housing Development Fund has partnered with WVDEP to make this low-interest available to home owners and those on long-term leases. Loans of up to $10,000 are to be used to replace or repair existing septic tanks or to connect to a public water treatment system.

6.2.2.7 Section 504 very low-income housing repair program

This loan and grant program through the United States Department of Agriculture's Rural Development office is available for rural homeowner-occupants who earn less than 50% of the area median income.

The low-interest loans are to be used specifically to render the home more safe or sanitary. Homeowners over 62 years old may be eligible for grants.

6.2.2.8 Additional funding sources

As the *Comprehensive Wastewater Management Plan for Fayette County* is being implemented, a number of funding source may be pursued to install and repair onsite and centralized wastewater treatment systems including:

- Clean Water State Revolving Funds,
- Housing and Urban Development Small Cities Block Grants,
- Appalachian Regional Commission funds,
- special appropriations from the United States Congress,
- United States Department of Agriculture Rural Utility Service funds,
- funds from a private purveyor of wastewater treatment services interested in an operations and maintenance contract on the system, and
- a local bond issue using tax increment financing or industrial development bonds (LAI, 2005a).

7 IMPLEMENTATION SCHEDULE, MILESTONES AND MEASURABLE GOALS

7.1 Iron and aluminum

The measurable goals for iron and aluminum are to meet the instream water quality criteria for these pollutants. As discussed in Section 2, however, the TMDL target for iron is the warm water criterion for all waters in the Wolf Creek watershed (Tetra Tech, 2008). While Wolf Creek itself is a trout water, implementation of the load and wasteload allocations in the TMDL is not predicted to lower iron concentrations to the level that they will meet the trout water quality criterion. The TMDL goal is inconsistent with the explicit goal of the Wolf Creek memorandum of understanding, which aims to restore a trout fishery in Wolf Creek (PAN et al., 2001). These goals will be reconciled by the use of an adaptive implementation approach.

7.1.1 Abandoned mine lands

7.1.1.1 Step 1: Remediate the Summerlee site

As discussed in Section 5.1.1.1, Phase 1 construction was completed in 2007 at the Summerlee site, the watershed's most significant source of iron and aluminum. In June 2008, project partners agreed to pause for one or two years of monitoring to determine its effectiveness (PAN, 2008). Now that almost one year has passed, it is an appropriate time to start seeking funding for Phase 2. A Section 319 grant proposal will be submitted in 2009 to help fund a portion of Phase 2. PAN will also submit a WCAP grant proposal in 2009. PAN may also approach OAMLR for supplemental funding.

Remediation of the Summerlee site—using the phased approach outlined above—will proceed as fast as possible, with the recognition that it will take years to fund, build, and monitor each phase before moving on to the next phase.

7.1.1.2 Step 2: Conduct monitoring to evaluate progress

After installation, monitoring at the Summerlee site and in the receiving stream will be conducted to track improvements over time.

On the site, four monitoring points have been established by OAMLR to measure the impacts from the two cells that are in place. Monthly monitoring occurred at these points for the first several months. Since July 2008, monthly data have been collected only at the mouth of the reclamation area, because this point shows the water quality of the water running off the site into the receiving stream. In addition, quarterly sampling is done at six sites along the mainstem.

In addition to site monitoring, monthly monitoring of AMD-related parameters will be done at the immediate receiving stream (unnamed tributary at river mile 8.7) and in Wolf Creek from the headwaters to the mouth, at appropriate intervals. Monitoring will continue until monthly data for an entire year shows that water quality standards are being met for all AMD-related parameters.

7.1.1.3 Step 3: Study and, if necessary, remediate the Fayette Station (NPS) Slide

The Fayette Station (NPS) Slide site is a much lower priority than the Summerlee site. It is located at the mouth of the watershed, and water monitoring data suggests that is not a large AMD source. In fact, even the TMDL model suggests that its iron reduction needed at this site is about 1,400 times less than the reductions required at Summerlee.

The next step with this site is for PAN, WVDEP, and other partners to confirm whether it is, in fact, discharging AMD. However, a systematic monitoring program will not be instituted until remediation at the Summerlee site has started showing significant reductions in iron and aluminum.

7.1.2 Streambank erosion

While the TMDL requires streambank erosion reductions across the entire Wolf Creek watershed, the largest reductions are concentrated in the agricultural areas that also require fecal coliform reductions from pasture/cropland. Therefore, streambank erosion reductions will be concentrated first on these subwatersheds.

7.1.2.1 Step 1: Form partnerships with agriculture agencies and organizations and with farmers

The first step in addressing streambank erosion on agricultural land will be for PAN to form strong partnerships with agriculture agencies and organizations such as the Natural Resources Conservation Service, WVCA, Farm Service Agency, and Farm Bureau. These entities are already actively working with farmers on projects that often involve environmental improvements. Because PAN is focusing its initial efforts on the Summerlee site, it plans to initiate contact with these agencies and organizations in 2010.

7.1.2.2 Step 2: Develop and implement first round of projects

Based on these partnerships, specific streambank erosion projects will be developed. This process will involve communication with farmers and will also require soliciting funding. Some funding sources such as Section 319 funds may cover a range of projects, while other sources such as Farm Bill programs will be focused on specific farms. Initial project development is likely to occur starting in 2011, with the goal of implementing the first projects in 2012. The first round of projects will target subwatersheds with the highest agricultural reductions required in fecal coliform and streambank erosion. Additionally, two other potential sites have been identified: one at the intersection of Wolf Creek Road and Pleasantview Road, and one adjacent to the Wolf Creek Park subdivision (DuPree, 2009).

7.1.2.3 Step 3: Conduct monitoring to evaluate progress

Monitoring will be required to confirm baseline iron levels in receiving streams and to evaluate the effectiveness of streambank stabilization projects. As discussed above, monitoring will continue until monthly data for an entire year shows that water quality standards are being met for iron.

7.1.2.4 Step 4: Develop and implement second and third rounds of projects

Based on the success of past projects and the water monitoring results, two additional rounds of projects are anticipated. The second round may target the Wolf Creek subwatershed 1040 and nearby subwatersheds. The third round may target subwatersheds of low and negligible agricultural intensity. Implementation is expected in 2015 and 2018, allowing three years between each round of projects.

7.2 Fecal coliform

The measurable goal for fecal coliform is to meet the instream water quality criterion.

7.2.1 Pasture/Cropland

For fecal coliform pollution from pasture/cropland, the same schedule and milestones discussed directly above for streambank erosion will be used. Partnerships will be formed, projects implemented, and receiving streams monitored. As often as possible, projects will address both streambank erosion and fecal coliform so that both iron and fecal coliform impairments can be efficiently addressed.

7.2.2 Onsite sewer systems

7.2.2.1 Step 1: Create an inventory of onsite systems

The *Comprehensive Wastewater Management Plan for Fayette County* recommends developing a detailed inventory and database of onsite septic systems. The database should include location and ownership information, system specifications, and site conditions (LAI, 2005a). In combination with water quality monitoring, this will allow for the prioritization of communities targeted for upgrades. This inventory will require funding and interfacing with the Wastewater Management Plan Project Advisory Committee. PAN will take initial steps to start developing this inventory in 2010.

7.2.2.2 Step 2a: Repair or replace existing onsite systems

The onsite inventory will help to identify systems in need of repair and replacement. Some of these systems will likely be candidates for alternative individual systems or cluster systems. PAN is specifically focusing on the Lochgelly community to determine the efficacy and expected life of existing systems, and to determine whether a cluster system would be a more practical solution there (Ehrnschwender, 2009). It is expected that these efforts will begin in 2012, after the onsite inventory is completed.

7.2.2.3 Step 2b: Extend municipal sewer system

PAN has begun working with the county commission to promote the possibility of extending the Oak Hill sewer system to serve the community of Summerlee (Ehrnschwender, 2009). This extension would provide service to roughly 100 additional residences; funding possibilities include a Housing and Urban Development Small Cities Block Grant. PAN will continue these discussions through 2009 and beyond; therefore, the soonest possible construction start date would be 2011.

7.3 Summary

Table 25and Table 26 consolidate the milestones and goals set forth in Sections 7.1 and 7.2. Water quality monitoring as specified in Section 8 will continue through this time period. Community outreach will also be an ongoing effort.

Subwatersheds were prioritized for projects based on their potential contribution to the necessary reductions in iron, aluminum, and fecal coliform.

Reductions presented in Table 14, Table 18, and Table 20 were used to calculate the cumulative percent attainment of iron, aluminum, and fecal coliform load reductions required by the TMDL as shown in Table 25 and Table 26.

The following assessment of projects does not show 100% attainment of required reductions for iron and aluminum. Reductions resulting from Summerlee remediation Phases 4 and 5 would help achieve the reductions required by the TMDL, but cannot be modeled until earlier phases are completed.

Table 25: Implementation schedule and reductions for iron and aluminum

Year	Abandoned mine lands	Streambank erosion	Cumulative percent attainment of iron and aluminum reductions required by the TMDL
2009	Submit funding proposals for Summerlee Phase 2		
2010	Install Summerlee Phase 2	Form partnerships	86% (Iron) 87% (Aluminum)
2011		Develop plans and funding for first round of fencing and riparian buffer projects— Short Creek (SWS 1039) and Levisee Creek (SWS 1041)	
2012	Submit funding proposals for Summerlee Phase 3	Implement first round of projects	
2013	Install Summerlee Phase 3		92% (Iron) 93% (Aluminum)
2014	Reassess Fayette Station (NPS) AML	Develop plans and funding for second round of fencing and riparian buffer projects — Wolf Creek SWS 1038 and 1040, and Crooked Run (1048)	
2015	Submit funding proposals for Summerlee Phase 4	Implement second round of projects	94% (Iron)
2016	Install Summerlee Phase 4		
2017		Develop plans and funding for third round of fencing and riparian buffer projects — Wolf Creek SWS 1045, Toney Hollow (SWS 1042), and Adkins Branch (SWS 1044)	
2018	Submit funding proposals for Summerlee Phase 5	Implement third round of projects	
2019	Install Summerlee Phase 5	Re-evaluate sediment load and sources	
2020		Develop plans and funding for fourth round of fencing and riparian buffer projects — Wolf Creek SWS 1043 and House Branch (SWS 1049); and for streambank stabilization projects—Wolf Creek (SWS 1037, 1036, and 1047), and UNT/RM 8.7 (SWS 1046)	
2021		Implement fourth round of projects	95% (Iron)

Table 26: Implementation schedule and reductions for fecal coliform

Year	Pasture/ cropland action*	Wastewater treatment action	Cumulative percent attainment of fecal coliform reductions required by the TMDL
2009			
2010	Form partnerships	Create an inventory of onsite systems	
2011	Develop plans and funding for first round of projects—Short Creek (SWS 1039) and Levisee Creek (SWS 1041)	Repair Fayetteville combined sewer overflow	45%
2012	Implement first round of projects		85%
2013		Extension of Oak Hill sewer system	
2014	Develop plans and funding for second round of projects—Wolf Creek SWS 1038 and 1040, and Crooked Run (1048)	Repair/replace onsite systems in SWS 1041, 1045, 1047	87%
2015	Implement second round of projects		113%
2016		Repair/replace onsite systems in SWS 1044, 1046, 1048, 1049	114%
2017	Develop plans and funding for third round of projects— Wolf Creek SWS 1045, Toney Hollow (SWS 1042), and Adkins Branch (SWS 1044)		
2018	Implement third round of projects	Repair/replace onsite systems in SWS 1040, 1039, 1042, 1038	118%
2019			
2020	Develop plans and funding for fourth round of projects— Wolf Creek SWS 1043 and House Branch (SWS 1049)		
2021	Implement fourth round of projects		119%

* Fecal coliform projects are to be installed in combination with streambank erosion projects on agricultural land, so the schedules for the two are identical, except for watersheds without any streamlength through pasture.

8 MONITORING

Instream monitoring is important to gage the recovery of streams after remediation projects are installed, and is also crucial to support partners as they engage in periodic strategic planning of reclamation priorities.

8.1 Quality Assurance Project Plans

Quality Assurance Project Plans name objectives for sampling and outline procedures for documenting that the quality of the observations are sufficient to answer the appropriate questions. Monitoring associated with this watershed-based plan will have the following objectives:

- To determine pollutant loads to design remediation projects at AMLs,
- To verify that loads of nonpoint source pollutants have been reduced following implementation of the measures outlined in this plan, and
- To verify that streams are no longer impaired by nonpoint source pollutants.

The most intractable sources of variation are likely to be changes over time. The most important quality assurance measure will be to sample many times throughout a range of hydrologic conditions. Additional standard quality assurance methods such as analysis of duplicates, field blanks, and samples with known concentrations will be included in Quality Assurance Project Plans as well.

8.2 Instream monitoring

Several agencies and organizations are now monitoring the Wolf Creek watershed, and will continue to do so in the future.

8.2.1 Watershed Assessment Program

According to WVDEP's five-year watershed management framework cycle, the agency performs in-depth monitoring of the state's watersheds every five years. When the next round of monitoring takes place in Wolf Creek in summer 2009, these data will be helpful to show whether streams are improving or declining in quality. In addition to water chemistry, technicians collect benthic macroinvertebrates to determine biological impairments and fecal coliform data to determine bacteria impairments. Technicians also perform sediment-related assessments. WVDEP will then use these data, plus data collected by other agencies and organizations, to make impairment decisions for the next 303(d) list.

8.2.2 Plateau Action Network

PAN board members, interns, and volunteers have conducted a variety of instream monitoring for many years, and will continue to do so in the future. In the near future, PAN will continue its quarterly instream chemical monitoring and flow measurements at six sites to document water quality changes in the mainstem of Wolf Creek. This monitoring is funded by WCET. Sites might change. PAN data are compiled into a GIS-based database so that it can be used by partners for planning purposes.

8.2.3 National Park Service

The NPS has conducted metals and bacteria monitoring in the New River and in many tributaries. In Wolf Creek, the NPS monitored baseline bacteria levels prior to the implementation of the *Comprehensive Wastewater Management Plan for Fayette County*. NPS monitoring continues.

8.2.4 Local schools

Should PAN receive a Stream Partners grant for this purpose, PAN will fund The Mountain Institute's Stream Samplers Program, a year-long teacher training program. Teachers will receive training at The Mountain Institute's Spruce Knob facility, and then take students with them for student training. This will be followed by local monitoring in the Wolf Creek watershed. Oak Hill High School and St. Peter and Paul Elementary are slated to participate.

8.3 Source monitoring

8.3.1 Office of Abandoned Mine Lands and Reclamation

OAMLR is conducting quarterly monitoring at the Summerlee site to determine the effectiveness of Phase 1. This monitoring will continue. Within OAMLR, SRG collects source data when WVDEP is designing a remediation project. It is anticipated that SRG will continue to play this valuable role in the future for future phases on the Summerlee site, and for the Fayette Station (NPS) Slide site.

8.3.2 Working on People's Environmental Concerns

WOPEC has conducted source monitoring for the Summerlee site in the past, and if appropriate may perform additional monitoring in the future.

8.3.3 Plateau Action Network

PAN will assist with source monitoring related to the Summerlee site and will support internships and other water quality improvement projects for the pollution sources outlined in this plan. Funding for this monitoring is typically provided by WCET.

8.3.4 West Virginia Division of Highways

If mitigation fees from the Lochgelly Interchange project are spent in the Wolf Creek watershed, the Division of Highways will conduct post-construction instream monitoring to determine the impact of their water quality improvement projects.

9 OUTREACH AND EDUCATION

9.1 Plateau Action Network

9.1.1 Organization

PAN has been performing outreach and education on water quality issues since its founding in 1997. PAN will continue with their outreach and education initiatives and will integrate information about nonpoint source remediation projects into these efforts.

9.1.2 Newsletters

PAN newsletters are distributed to about 300 members every quarter. Newsletters will continue to update readers about planned nonpoint source remediation projects and about remediation priorities.

9.1.3 Public education

PAN uses a number of efforts to provide public education and is actively involved in educating local students about the Wolf Creek watershed. Through The Mountain Institute's West Virginia Stream Samplers Program, PAN works with local teachers and students. In the course of learning how to make observations, collect samples, analyze results, and help with restoration projects, participants in the Stream Samplers Program develop an understanding of the interconnectedness of activities and impacts in the watershed while helping to monitor the streams. PAN also partners with the NPS to bring the Water is Life program to eighth graders. By bringing the Patagonia Wild and Scenic Film Festival to Fayetteville, PAN helps raise awareness of environmental issues such as nonpoint source pollution.

9.1.4 Web site

PAN maintains a Web site, www.plateauactionnetwork.org, with information about projects and priorities.

9.1.5 Wolf Creek Park

PAN has supported the development of the New River Birding and Nature Center in Wolf Creek Park with steering committee participation and grant funding to the Fayette County Urban Renewal Authority. Part of the plan for this center is to develop a nature trail boardwalk in the wetlands near the entrance to the development.

9.2 West Virginia Department of Environmental Protection

Prior to initiating its regular five-year monitoring effort in summer 2009, WVDEP will hold a public meeting in the watershed to gather suggestions for monitoring locations. WVDEP will include information at this meeting on the status of plans for remediating nonpoint source pollution in the watershed.

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APPENDIX A: INSTREAM WATER QUALITY DATA

The 2006 watershed assessment and draft plan for the Wolf Creek watershed presented data from a variety of sources (Pavlick et al., 2006). According to these data, reproduced here, the Summerlee site discharges strong AMD to the unnamed tributary at river mile 8.7. The acidity from this tributary is gradually neutralized and metals are removed and diluted as Wolf Creek flows to the New River.

The steepest declines in metals concentrations occur in this unnamed tributary. Iron and manganese concentrations decline by about 75%, and dissolved aluminum concentrations decline by about 25% from river mile 0.8 to the mouth of this tributary.

In Wolf Creek itself, violations of AMD-related water quality criteria are common down to at least river mile 6.9. Data from river mile 5.1 show no pH violations, but do not include any metals data. Even at river mile 3.3, AMD-related violations occur, but average pH and metals values meet standards. Some violations of the iron and dissolved aluminum criteria have been documented within one-half mile of the mouth of Wolf Creek. Unknown sources other than the Summerlee site may account for some of the metals loads encountered near the mouth of Wolf Creek.

Wetlands may be responsible for some of these improvements in Wolf Creek and in the unnamed tributary that drains the Summerlee site.

Fecal coliform data are also summarized in these tables. Wolf Creek above the tributary that drains the Summerlee site shows the highest average concentrations of fecal coliform. Other monitoring sites along Wolf Creek also show high average values and high percentages of violation.

Based on tributary data, House Branch, Crooked Run, and Short Creek, show the highest average fecal coliform levels and the highest percent exceedances.

Table 27: Instream data for pH, metals, and fecal coliform in Wolf Creek

River mile	Description	Statistic	pH (SU)	Alum. (dis) (mg/L)	Iron (mg/L)	Manga-nese (mg/L)	Fecal coliform (cfu/ 100 mL)	Sources (No. samples)
0.1 - 0.2	Near mouth	N	194	13	16	16	189	NPS (174), PAN (4),
		Avg.	8.06	0.08	0.27	0.09	86	WVDEP (16)
		% viol.	0	25	13	0	19	
0.5	Near crossing of	N	4		4	4	4	PAN (4)
	WV Route 82	Avg.	8.3		0.21	0.5	219	
		% viol.	0		25	0	25	
2.6	Near hairpin turn	N	11				11	WVDEP (11)
	in WV Route 82	Avg.	6.72				65	
		% viol.	0				0	
3.1 - 3.3	Near crossing of	N	6	2	6	6	6	PAN (4), WVDEP (2)
	Wolf Creek Road	Avg.	6.83	0.02	0.4	0.5	200	
		% viol.	33	0	33	17	50	
5.1	Near Wolf Creek	N	9				10	WVDEP (10)
	and Jeffries Roads	Avg.	6.7				64	
		% viol.	0				20	
6.9	Below Route 16	N	12	7	11	11	5	KH (7), PAN (4),
	Overpass	Avg.	6.1	0.86	1.27	1.68	940	WVDEP (1)
		% viol.	50	71	73	64	80	
7.3	Upstr. from US 19	N	7	7	7	7		KH (7)
	(lowest crossing)	Avg.	3.84 - 5.85	1.6	0.3	1.7		
		% viol.	100	NA	NA	NA		
7.6	Below UNT at	N	11	7	11	11	4	KH (7), PAN (4)
	Lochgelly interchange	Avg.	3.2 - 7.4	3.8	1.1	1.9	686	
		% viol.	64	NA	NA	NA	75	
7.8	Below middle US 19	N	4		4	4	4	PAN (4)
	Overpass	Avg.	7.07		0.9	1.6	147	
		% viol.	0		75	75	25	
8.1	Below most upstream	N	7		7	7	7	KH (7)
	Wetland	Avg.	2.54 - 4.24		2.5	3	3.5	
		% viol.	100		NA	NA		
8.6 - 8.7	Below UNT KN-10-M	N	11	1	11	11	4	KH (7), PAN (4)
		Avg.	2.13 - 5.51	9.1	92	4.5	10	
		% viol.	100	100	NA	NA	0	
8.8 - 9.1	Above KN-10-M	N	12	1	1	1	11	KH (1), WVDEP (11)
		Avg.	6.77	0.01	0.7	0.1	2220	
		% viol.	0	0	100	0	91	

Note: Data sources: WVDEP=WVDEP (2006c), Hilton=Hilton (2005), KH= Kimley-Horn (2005a), NPS=NPS (2006), PAN=Scott and Eades (1999). Percent of measurements violating standards is not available for sites including data from Kimley-Horn, because the report contained averages, rather than individual data. NA is used for these sites.

Table 28: Instream data for pH, metals, and fecal coliform in tributaries to Wolf Creek

Stream code	River mile	Description	Statistic	pH (SU)	Alum. (dis) (mg/L)	Iron (mg/L)	Manga-nese (mg/L)	Fecal coliform (cfu/ 100 mL)	Sources (No. samples)
KN-10-A	0.7	House Branch	N	12				11	WVDEP (12)
			Avg.	7.17				359	
			% viol.	0				45	
KN-10-B	0.1	Crooked Run	N	11				11	WVDEP (11)
			Avg.	6.88				243	
			% viol.	0				36	
KN-10-C	0	Short Creek	N	9				9	WVDEP (9)
			Avg.	6.69				109	
			% viol.	0				22	
KN-10-D	0.1	Levisee Creek	N	11				11	WVDEP (9)
			Avg.	6.6				54	
			% viol.	9				9	
KN-10-M	0.05	KN-10-M near mouth	N	3	1	3	3		KH (3)
			Avg.	3.03 - 3.59	29.6	40.9	5.2		
			% viol.	100	100	NA	NA		
KN-10-M	0.2 - 0.25	KN-10-M near Bethel Baptist Church	N	13	12	13	13	11	KH (2), WVDEP (11)
			Avg.	3.2	16.9	45	6.3	3	
			% viol.	100	100	100	100	0	
KN-10-M	0.59	KN-10-M after first wetland	N	2		2	2		KH (2)
			Avg.	2.91 - 2.99		97.6	11.8		
			% viol.	100		NA	NA		
KN-10-M	0.8	KN-10-M Below Summerlee site	N	16	1	15	15	4	Hilton (1),
			Avg.	2.91	38.2	173	19	9	PAN (4),
			% viol.	100	100	100	100	0	SRG (11)

Note: Data sources: WVDEP=WVDEP (2006b), Hilton=Hilton (2005), KH= Kimley-Horn (2005a), NPS=NPS (2006), PAN=Scott and Eades (1999). Percent of measurements violating standards is not available for sites including data from Kimley-Horn, because the report contained averages, rather than individual data. NA is used for these sites.