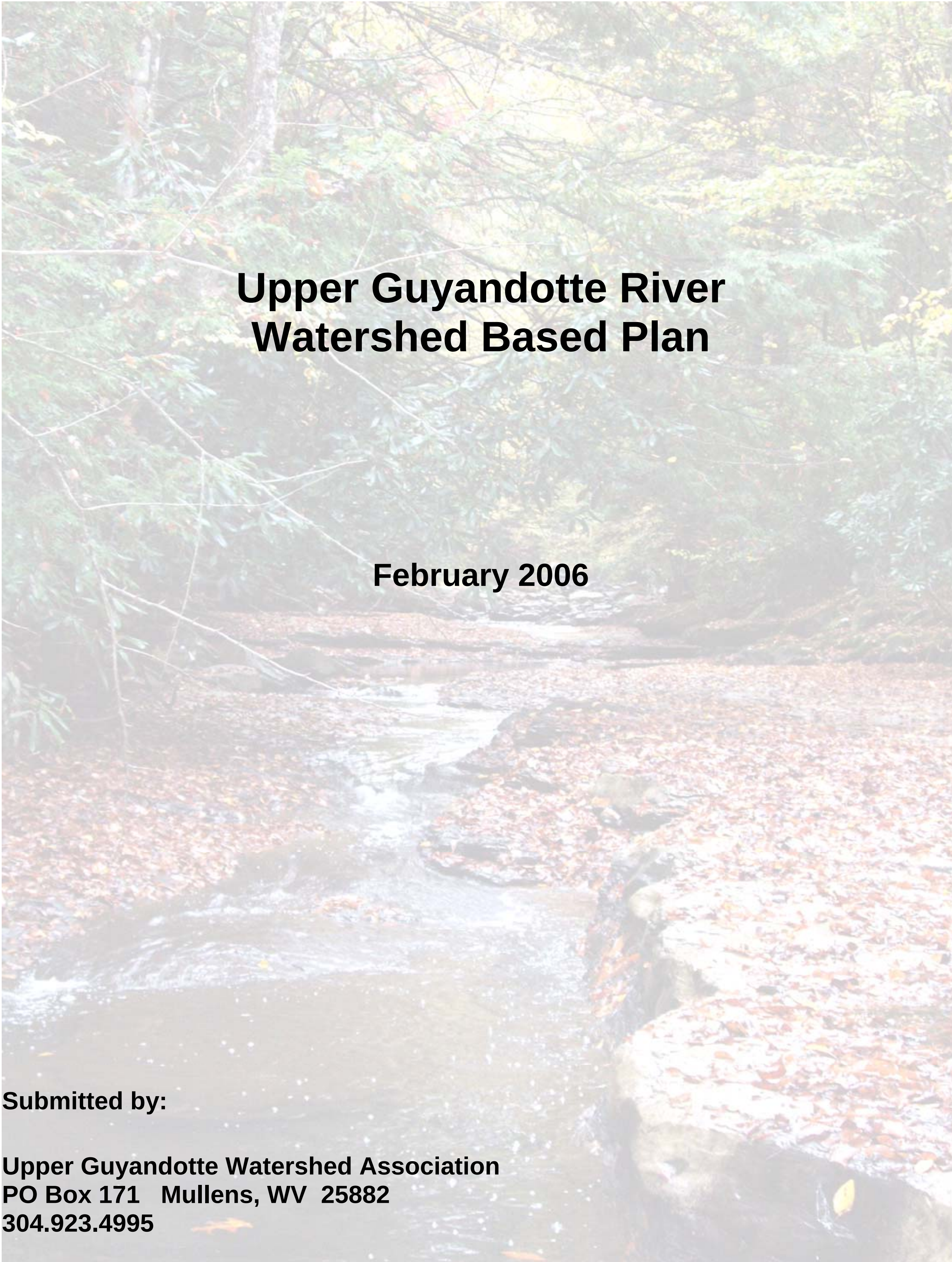

Upper Guyandotte River
Watershed Based Plan

February 2006

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Upper Guyandotte Watershed Association

Canaan Valley Institute

WV Department of Environmental Protection

Mountain Resource Conservation and Development Council

West Virginia Conservation Agency

Crab Orchard MacArthur Public Service District

Wyoming County Commission

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West Virginia Bureau for Public Health

Wyoming County Health Department

WV Division of Natural Resources

Virginia Department of Health

Southern Conservation District

Beckley-Raleigh County Health Department

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Downstream Strategies

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1 Introduction

The Upper Guyandotte watershed is 260 square miles in size and is heavily forested. The watershed includes portions of both eastern Wyoming and southern Raleigh Counties, West Virginia and has a population of approximately 7,700. The landscape is rugged topography with steep hillsides and narrow valley floodplains. Many watershed communities are located in these valleys which are prone to flooding (Figure 1). Coal mining and logging are the major industries in the watershed.

Table 1 shows land area and percent land cover in the Upper Guyandotte watershed listed according to use and by major subwatershed.

Table 1: Percent land cover according to use[1]

Subwatershed	Commercial, Mining, etc.	Forest	Agriculture	Other	Area (sq. mi.)
Slab Fork	1.06	94.91	2.01	2.01	35.36
Winding Gulf	1.67	92.54	3.99	1.82	21.63
Stonecoal Creek	1.48	92.29	4.58	1.64	33.01
Guyandotte River 2	1.30	93.93	0.85	3.90	20.69
Guyandotte River 1	1.08	93.13	3.20	2.58	32.42
Devil's Fork	1.03	94.94	2.88	1.17	23.21
Pinnacle Creek	1.90	95.89	1.28	0.93	57.23
Barker's Creek	2.07	94.09	1.61	2.24	36.85
Upper Guyandotte	**1.51**	**94.18**	**2.42**	**1.89**	**260.40**

Source: USGS, 1992.

Figure 1: Downtown Mullens as seen from above

[1] Other includes wetlands, water, residential, and transitional. Forest includes deciduous forest, evergreen forest, and mixed forest. Commercial includes commercial, industrial, transportation, quarries, strip mines, and gravel pits. Agriculture includes pasture, hay, and row crops.

The service area of the Upper Guyandotte Watershed Association (UGWA) defines the geographical area covered by this plan. This watershed area is situated in the Allegheny Plateau and encompasses the headwaters of the Guyandotte River downstream to the mouth of Pinnacle Creek, only a portion of the entire Upper Guyandotte basin (Hydrologic Unit Code 05070101) (Figure 2). Stonecoal Creek and Winding Gulf rise in Raleigh County and join to form the Guyandotte River just above the Raleigh-Wyoming county line, near Amigo. The Guyandotte River flows westerly through Wyoming County then flows northwesterly, eventually draining into the Ohio River at Huntington, West Virginia.

Figure 2: Extent of Upper Guyandotte watershed within the Guyandotte River basin

Major subwatersheds, as referred to throughout this Watershed Based Plan (WBP), have been defined by the Upper Guyandotte Watershed Association and include the watersheds of the major tributaries: Winding Gulf, Stonecoal Creek, Slab Fork, Devil's Fork, Barker's Creek, and Pinnacle Creek. Guyandotte River 1 includes the drainages of Still Run and Cabin Creek as well as the direct drains between Barker's Creek and Pinnacle Creek. Guyandotte River 2 includes the drainages of Allen Creek and Big Branch as well as the direct drains between the start of the Guyandotte River and Barker's Creek. The Upper Guyandotte watershed encompasses TMDL regions 13 and 14 as well as a portion of region 7 (USEPA, 2004, Figure 1-3). Figure 3 displays the major subwatersheds of the Upper Guyandotte in relation to the smaller 4-digit TMDL subwatersheds (SWS), as defined by the US Environmental Protection Agency (2004).

Figure 3: TMDL SWS and major subwatersheds of the Upper Guyandotte

Local sportsmen's groups and the WV Division of Natural Resources have stocked area streams with trout fingerlings since the mid-1990's and many Upper Guyandotte streams now support viable populations of cold-water game fish including rainbow and brown trout (WVDNR, Various dates). Healthy populations of several other game species including squirrel, grouse, mink, and wild turkey are also present in the watershed (Reed, Various dates). No sightings of any federally listed endangered or threatened species have been recorded. Most records of rare species date back to the 1970's or earlier (Sargent, 2005).

Berks-Pineville and Gilpin-Lily are the dominate soil types in the watershed and are located on the uplands, foot slopes, and in mountain coves. Berks and Gilpin soils are moderately deep are found on ridge tops and side slopes. They formed in material weathered from interbedded siltstone, shale and fine-grained sandstone. Pineville soils are deep and are found on foot slopes, on side slopes, and in coves. They formed in mixed colluvial material from sandstone, siltstone, and shale. Lily soils are moderately deep and are found on the broad and narrow ridge tops and the upper side slopes. They formed in material weathered from shale, siltstone, and sandstone.

Each soil association has a distinctive pattern of soils, relief, and drainage. Typically, these soil associations consist of one or more major soils and some minor soils inclusions.[2]

Communities in the watershed are small and rural; many originally existed as coal camps and were built in the early 1900's. Development has occurred in a linear fashion along streams where enough flat land is available for building. There are only two incorporated towns in the watershed: Mullens (Wyoming County, pop. 1,760) and Rhodell (Raleigh County, pop. 435). In general, there has been a downward trend in population in towns in the watershed since the 1970's. There are no four lane roads, interstates, airports, or navigable waterways in the watershed.

Raleigh County (pop. 79,220, 607 sq. mi.), as a whole, is more densely populated, with the city of Beckley located in the county and a population density of 130.5 persons per square mile. In contrast, Wyoming County (pop. 25,708, 501 sq. mi.) is sparsely populated with no large population centers and a population density of 49.3 persons per square mile. However, the economic and demographic characteristics of the portion of Raleigh County that is located within the Upper Guyandotte watershed more closely resemble that of Wyoming County. Wyoming County has been designated a "distressed county" by the Appalachian Regional Commission (ARC).

[2] Soil data is from the USDA Natural Resources Conservation Service (NRCS) Soils Survey for Wyoming County (1988). Agriculture land use data was provided by Farm Service Agency (1996 aerial photographs), NRCS, and WV University Extension Service Raleigh County field offices.

Income, home values, and educational attainment in the watershed are below the state and national median. The following table provides a comparison.

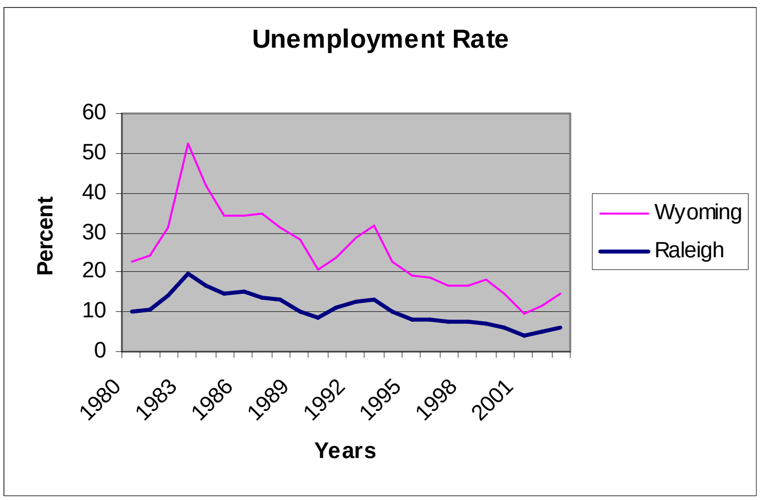
Table 2: Demographics of the Upper Guyandotte watershed

Demographic	United States	West Virginia	Upper Guyandotte
Percent of population that is white	75%	95%	97%
Median household income	$41,994	$29,696	$24,767
Percent of residents living below poverty level	12.05%	17.46%	23.18%
Percent of homes that are owner-occupied	66.19%	75.18%	79.97%
Median value of owner-occupied homes	$119,600	$72,800	$40,800
Percent of residents age 25 or older with educational attainment of high school diploma/equivalency or beyond	80.40%	75.21%	67.23%
Percent of residents age 25 or older with educational attainment of bachelor's degree or beyond	24.40%	14.83%	7.35%

Source: US Census Bureau (2000).

Extensive deposits of low-sulfur coal, of the Pocahontas formation, are found throughout the watershed. Both Wyoming and Raleigh County are among the top 10 coal producing counties in West Virginia.[3] However, current unemployment rates in both counties are relatively high and reflect weak economies. Employment trends in the area also reflect the heavy dependence on mining in the 1980's and 1990's (Figure 4).

Figure 4: Unemployment rates



Raleigh County's largest private employers are in the fields of health care and social assistance with an average annual wage per job of $32,125. Wyoming County's major job sector is in the field of mining, accounting for an average annual wage per job of $52,988. However, per capita personal income for all job sectors in Raleigh County and Wyoming County is $24,050 and $19,110 respectively. In addition, Raleigh County has an unemployment rate of 5.7%, while Wyoming County has an unemployment rate of 6.4%.[4]

[3] Source: WV Office of Miner's Health Safety and Training. 2005 Coal Production by County. http://www.wvminesafety.org/cnty2005.htm
[4] Source: WORKFORCE West Virginia, http://www.wvbep.org/bep/LMI

2 Nonpoint source pollution in the Upper Guyandotte (a)

Rivers and streams that do not meet West Virginia state water quality standards (Table 4, pg. 9) are identified as impaired and placed on the statewide 303(d) list. Upper Guyandotte streams covered by this plan were listed as impaired in 1998 and 2002 for fecal coliform bacteria, pH, iron, aluminum, manganese, and/or biological impairments (WVDEP 1998 and 2003). Impaired streams are shown as thick grey lines in Figure 5.

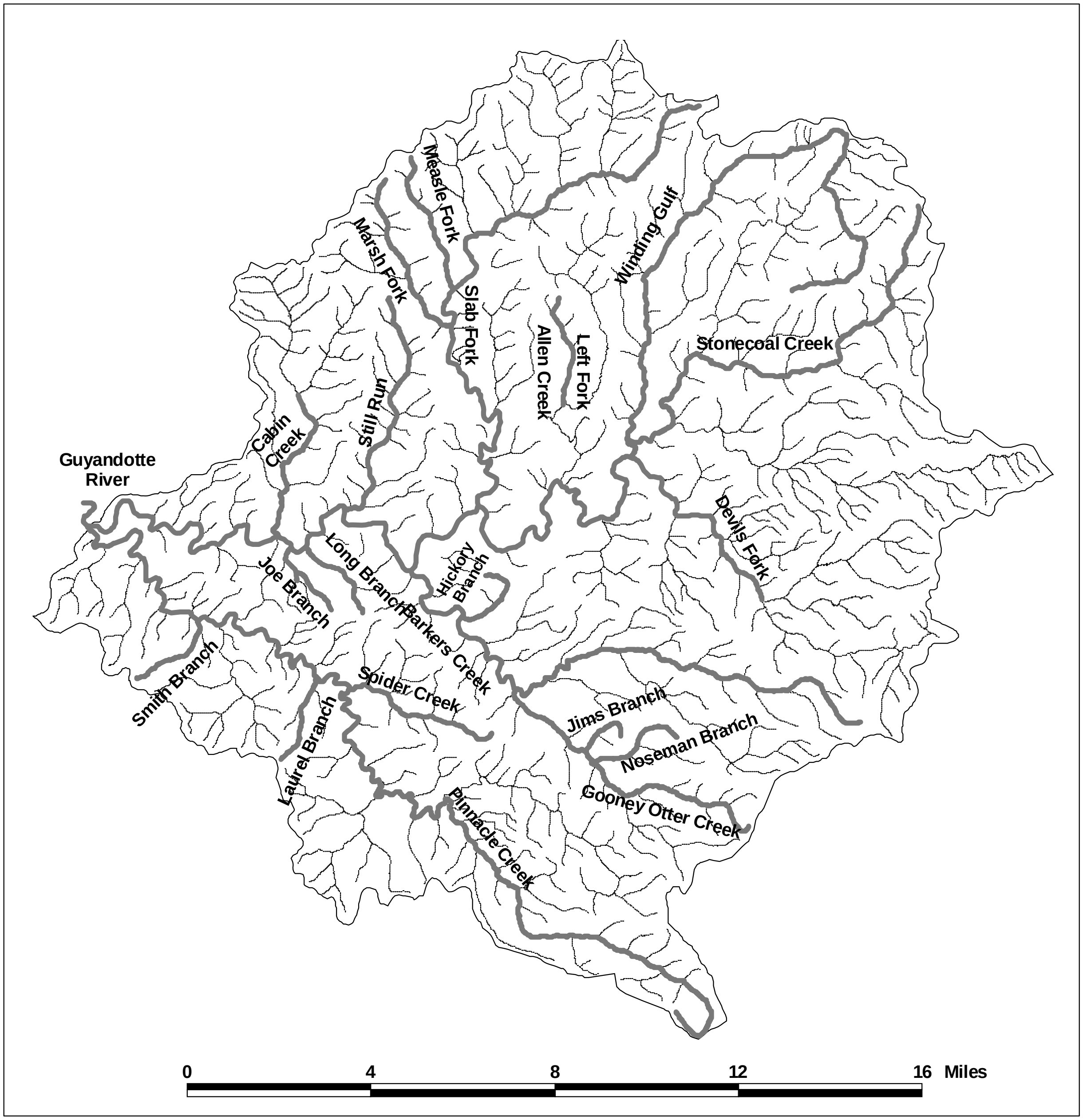
The US Environmental Protection Agency (USEPA) prepared a Total Maximum Daily Load report (TMDL) for the entire Guyandotte River basin in March 2004. The TMDL identifies pollution load reductions required in order for impaired streams to attain water quality standards.

The mainstem of the Guyandotte River is the only stream listed as being impaired for fecal coliform bacteria. However, the TMDL does require load reductions in major tributaries (Table 13, pg. 40) in order to achieve the overall fecal coliform load reduction required for the Guyandotte River. In addition, it is likely that future monitoring will document impairment in these tributaries (see Chapter 6.5 for further explanation).

Table 3 lists stream segments impaired by metals; Table 15 (pg. 43) lists TMDL target loads for metals.

The goal of this Watershed Based Plan is to provide a framework for reducing nonpoint sources of metals and fecal coliform bacteria in order to achieve required load reductions and attain water quality standards in all Upper Guyandotte streams affected by these pollutants.

Figure 5: Impaired streams in the Upper Guyandotte watershed



Source: WVDEP (2004).

Table 3: Stream segments impaired by metals

Stream code	Stream name	Subwatershed	Miles impaired	Al (dis)	Fe	Mn	pH
Guyandotte River 1							
OG-up	Upper Guyandotte River	1117-1121	11.8	x			
OG-127	Cabin Creek	2900-2911	3.6		x	x	
OG-128	Joe Branch	3000	1.6		x	x	
OG-129	Long Branch	3100	2.1		x	x	
OG-130	Still Run	3200	5.3		x	x	
Guyandotte River 2							
OG-up	Upper Guyandotte River	1122-1124, 1126	11.2	x			
OG-135-A	Left Fork/Allen Creek	3501	2.6		x	x	
Pinnacle Creek							
OG-124	Pinnacle Creek	2800-2813	26.6		x	x	
OG-124-D	Smith Branch	2801	2.1		x	x	
OG-124-H	Laurel Branch	2805	2.1		x	x	
OG-124-I	Spider Creek	2807	3.5		x	x	
Barker's Creek							
OG-131	Barker's Creek	3300-3310	8		x	x	
OG-131-B	Hickory Branch	3301	2.1		x	x	
OG-131-F	Gooney Otter Creek	3304-3310	6.8		x	x	
OG-131-F-1	Jims Branch	3305	1.4		x	x	
OG-131-F-2	Noseman Branch	3307	2.3		x	x	
Slab Fork							
OG-134	Slab Fork	3400-3406	15.1	x	x	x	
OG-134-C	Marsh Fork	3403	3.9				
OG-134-D	Measle Fork	3405	3.3		x	x	x
Devil's Fork							
OG-137	Devil's Fork	3600-3604	4.9		x	x	
Winding Gulf							
OG-138	Winding Gulf	3701	15.5	x	x	x	
Stonecoal Creek							
OG-139	Stonecoal Creek	3700-3707	10.2		x	x	

Source: All impairments except dissolved aluminum are from the 2004 303(d) list Supplemental Table B (WVDEP, 2004). Dissolved aluminum impairments are from USEPA (2004). Impaired mileages for all streams are from the 1998 303(d) list (WVDEP, 1998), which lists all streams as impaired by metals from mine drainage, and Measle Fork as impaired by pH.

2.1 Measurable Water Quality Goals

All stream segments in the Upper Guyandotte watershed should, at a minimum, be fishable and swimmable, and should be clean enough to contain healthy communities of indigenous aquatic species. The federal Clean Water Act, state Water Pollution Control Act, and federal and state regulations have determined a set of interlinked water quality goals. Designated uses for the streams in the Upper Guyandotte watershed include public water supply (Category A), maintenance and propagation of aquatic life (warm water fishery streams) (Category B1), maintenance and propagation of aquatic life (trout waters) (Category B2), and water contact recreation (Category C). The numeric and narrative water quality standards shown in Table 4 are relevant for the nonpoint source pollution problems addressed by this Watershed Based Plan.

Table 4: Selected West Virginia water quality standards[5]

		Aquatic life		Human health	
Parameter	**46 CSR 1 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 87 µg/L (chronic) or 750 µg/L (acute)		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 (either MPN or MF) 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
Manganese (total)	8.17	None	None	Not to exceed 1.0 mg/L	None
pH	8.23	No values below 6.0 nor above 9.0. Higher values due to photosynthetic activity may be tolerated.			

2.1.1 Recent manganese criteria changes

When the TMDL was written, the manganese criterion applied to all waters. Since then, the criterion was modified so that it only applies within the five-mile zone immediately upstream above a known public or private water supply used for human consumption (46 CSR 1 6.2.d).

Manganese load reductions in the Upper Guyandotte TMDL will still be required in watersheds with a public or private water supply intake, but WVDEP has not yet finalized its list of intakes in the Upper Guyandotte watershed (Montali, 2005). For segments where the manganese criterion may no longer apply, the costs of manganese removal may be entirely avoided. Because the TMDL has not been updated to account for this water quality standard change, this

[5] Source: 46 Code of State Rules Series 1. When the TMDL was approved, the manganese criterion applied to all waters. USEPA has recently approved a modification to this criterion: "The manganese human health criterion shall only apply within the five-mile zone immediately upstream above a known public or private water supply used for human consumption." After the TMDL was written, the aluminum criterion was changed from a total aluminum criterion of 750 µg/L to dissolved aluminum, and a chronic criterion was added. Also, the chronic dissolved aluminum criterion of 87 µg/L has been suspended in all but trout waters until July 2007. On January 9, 2006 USEPA approved this suspension.

Watershed Based Plan calculates load reductions and costs based on the standard in place when the TMDL was approved.

2.1.2 Recent aluminum criteria changes

While the TMDL was being written, the aluminum criterion was changed from total to dissolved aluminum, and then the more stringent chronic dissolved aluminum criterion was suspended in all but trout waters until July 2007. On January 9, 2006 USEPA approved this suspension.

The TMDL addresses the first aluminum criteria issue, and when possible sets TMDLs based on the dissolved aluminum criteria. Because the total aluminum standard no longer applies, streams previously listed for total aluminum—and that do not have adequate dissolved aluminum data—are not addressed by this plan. Streams previously listed for total aluminum impairment are highlighted in Appendix G (pg. 98).

When the TMDL was being written, adequate dissolved aluminum data only existed for the Upper Guyandotte mainstem and two of the subwatersheds; therefore, dissolved aluminum TMDLs were developed for these subwatersheds. WVDEP considered developing dissolved aluminum TMDLs for other tributaries based on total aluminum data, but as explained in the TMDL:

> "[a]vailable monitoring data shows widely variable ratios between dissolved and total aluminum depending upon sites, soil types and flow conditions. [It was] determined that the best and most scientifically supported way to evaluate waters under the new aluminum criteria is to obtain additional monitoring data for both total and dissolved aluminum where adequate dissolved aluminum data does not exist." (USEPA, 2004, p. 1-12)

Whether or not dissolved aluminum TMDLs will be developed for other tributaries in the Upper Guyandotte watershed will be determined after WVDEP collects additional data following the normal Watershed Management Framework monitoring schedule, and after WVDEP assesses data collected by permittees over the next three years (USEPA, 2004).

The TMDL asserts that the "Guyandotte River watershed TMDL allocations and permit limits set to reduce iron and manganese loads are likely to reduce most, if not all, of the aluminum load occurring on these streams. Any necessary dissolved aluminum TMDLs will be developed by West Virginia within 8-13 years of the original listing." (USEPA, 2004, p. 1-13) Winding Gulf and Slab Fork are the only subwatersheds in the Upper Guyandotte for which dissolved aluminum TMDLs have been calculated. It was determined during the development of the TMDL that if the iron and manganese load reductions were met in these subwatersheds, then the dissolved aluminum load reduction would also be met. Therefore, the TMDL does not provide a specific value for dissolved aluminum load reductions for these subwatersheds.

2.2 Fecal coliform bacteria

2.2.1 Failing septic systems

Failing septic systems and illicit discharges of untreated household wastewater pollute streams through both surface and subsurface means and are the primary nonpoint sources of fecal coliform bacteria in the Upper Guyandotte (USEPA, 2004, pg 3-21). In order to determine locations of fecal sources and relative pollution loads, several datasets were collected, collated and mapped, including:

- the geographic extent of each community in the watershed (Figure 7),
- the number of occupied homes in each community, and
- the current status of wastewater treatment for each community in the watershed.

The number of occupied homes and an average household size of 2.4 persons (US Census Bureau, 2000) were used to calculate the approximate population of the watershed. Figure 6 shows the population distribution by major subwatershed.

In some instances, for the purposes of plan development and implementation, communities were also subdivided into project areas. Project area boundaries were based on the physical characteristics of the community including density of groups of home, lot size, terrain, and other factors that influenced the choice of treatment technology. For example, two discrete project areas are identified within the community of Alpoca. 94 homes are densely grouped along the river bottom and will be best served by a traditional gravity collection system with a package plant. An additional 8 homes are scattered up Mill Branch hollow; this area will be better served by individual onsite septic systems (Table 11, pg. 25).

Figure 6: Total watershed population distribution by subwatershed

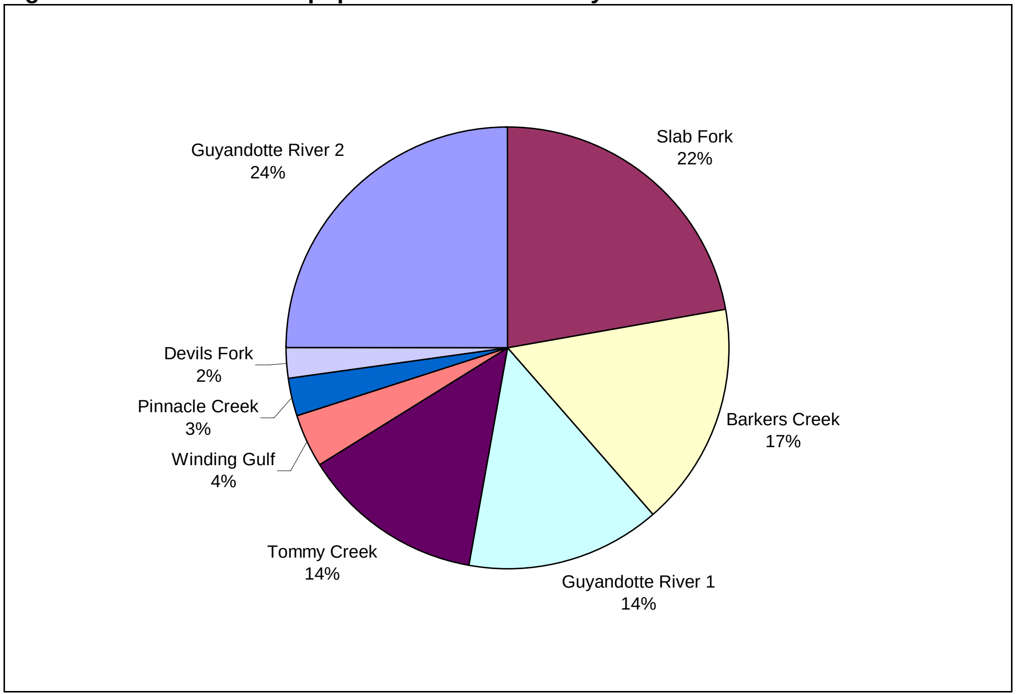


Figure 7: Community boundaries in the Upper Guyandotte

The current status of wastewater treatment was compiled using several sources of data, including community surveys, septic permits, individual plant operators, and NPDES permits. Individual onsite septic systems, municipal sewer service, and package plants are the methods of wastewater treatment currently being utilized by homeowners in the Upper Guyandotte. A review of septic system permit applications on file with the Wyoming County Health Department and the Beckley-Raleigh County Health Department was conducted. Permitted septic systems were assumed to be functioning properly. Unpermitted septic systems were assumed to be failing. The survey results show that 9% of the homes in the watershed have a permitted septic system.

The only municipal wastewater treatment facility in the watershed serves approximately 735 homes (and approximately 65 businesses) and is located in Mullens. This activated sludge plant was designed to handle an average daily flow of 330,000 gallons per day (gpd). Designers anticipated adding additional customers in the future and constructed stub walls to allow the addition of a third Sequencing Batch Reactor tank. Currently, the plant treats 150,000-180,000 gpd in dry weather. However, the system has significant inflow and infiltration problems and the flow can reach or exceed 800,000 gpd during wet weather. Wet weather flows which exceed the 800,000 gpd capacity of the plant are discharged out of permitted combined sewer overflow points and are a likely source of fecal coliform pollution. However, because the Mullens plant has an NPDES permit, this potential source of pollution is not discussed in this plan. Additionally, the TMDL assumes the plant is meeting discharge limits defined in its permit and does not assign a waste load allocation. This I&I problem would need to be addressed, or the plant would need to be expanded, prior to the construction of any line extensions (Coontz, 2006). The Mullens plant currently provides service to 23% of the homes in the watershed.

Two package plants service residential areas in the watershed. They are located in Hotchkiss (permit number WVG550687) and Slab Fork (permit number WVG550077). The Slab Fork plant serves the entire community (51 homes) while the Hotchkiss plant serves a 20-unit trailer park located within the community. Eight other package plants exist in the watershed and service public and/or commercial facilities.

The Mullens municipal plant and any existing package plants require NPDES discharge permits and, therefore, are not discussed in detail in this plan. When operating within their permit limits, these plants should not be a significant source of fecal coliform pollution. Additionally, because all homes in Mullens and Slab Fork currently receive wastewater treatment, treatment technologies were not proposed in this plan for those two communities. Treatment technologies were proposed for the 36 homes in Hotchkiss that do not receive treatment from the package plant (Table 11, pg. 25).

The remaining 66% of watershed households have an inadequate or an unidentified method of wastewater treatment (

Table 5).

Table 5: Wastewater treatment methods currently being utilized

	Permitted septic	Municipal sewer	Package Plant	None/ Unknown	Total No. of Households	Approximate Population
Raleigh County	108	0	71	586	765	1,836
Wyoming County	184	735	0	1,519	2,438	5,851
Upper Guyandotte	292	735	71	2,105	3,203	7,687
% of Total Households	**9.1**	**22.9**	**2.2**	**65.7**		

2.2.2 Agriculture

Agriculture land uses are, in some instances, a source of fecal coliform bacteria, especially through stormwater runoff. However, it is unlikely that this is a significant source in the Upper Guyandotte.

The primary agriculture activity in the watershed is animal husbandry. Most of the grazing animals are cattle, but sheep and horses are also present. The majority of the grassland is located on the ridge tops where geologic topography allows normal farming and best management practices to be pursued. Some small valley areas are pastured but are prime locations for garden/truck crop locations.

NRCS and WVU Extension have estimated livestock numbers to be in the neighborhood of 225 head of cattle and 42 head of sheep. Of concern is the common practice by livestock producers to feed and/or confine cattle in late winter, often due to calving requirements. Most of the farming operation usually exists at or adjacent to the farmstead. Most animal waste from barns or confined areas is stacked nearby or is spread on fields throughout the year. The waste in general is not tested for nutrient value and usually not considered when applications of commercial fertilizer are made. This is due to the generally low volume of waste produced. Approximately 95 % of the operators are part-time farmers with small beef cattle operations. Nearly 100 % of the farmers in the area are Limited Resource Farmers.

NRCS has 600 acres (of the approximately 2,800 acres of agricultural land) under conservation program contracts within the watershed. These conservation contracts are designed to address environmental concerns that were created by the farming operations. Under the current 2002 Farm Bill the NRCS has several farm related cost share programs available: Environmental Quality Incentive Program (EQIP), Agricultural Management Assistance (AMA), Conservation Reserve Program (CRP), Wetland Reserve Program (WRP), and the Wildlife Habitat Incentive Program (WHIP). Conservation planning and technical assistance is also available upon request.

Due to the low concentration of agricultural enterprises, the majority of which are located on the ridge tops, no significant stream degradation is being seen as it relates to overall stream quality as a result of agricultural land uses in the watershed. If problem areas are located, they will be addressed by working with the producers and NRCS to facilitate change while utilizing the Farm Bill resources.

2.2.3 Wildlife

In 2004, Wyoming County had a deer harvest of only 1.0 animals/sq. mi. while the statewide total was 7.82 animals/sq. mi.[6] Due to the low deer population density and the diffuse nature of the contribution, wildlife is also assumed to be a negligible source of fecal coliform pollution (Reed, Various dates).

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[6] Source: WV Division of Natural Resources deer harvest summary, http://www.wvdnr.gov/Hunting/PDFFiles/BGB2004deer9.PDF

2.3 Metals

Various metals enter streams in the Upper Guyandotte watershed from nonpoint sources, particularly abandoned mine lands (AMLs), and cause the waters to violate standards. WVDEP's most recent 303(d) list (WVDEP, 2004) lists specific segments of the watershed as impaired by high concentrations of iron, aluminum, and manganese from polluted mine drainage. These mine drainage-impaired streams, which are listed in Table 3 (pg. 8), are drawn as thick, grey lines in Figure 5 (pg. 7).

Table 6 summarizes whether AMLs, bond forfeiture sites (BFSs), or other sources (Chapter 2.3.2) contribute metals to each impaired stream segment. Of the 26 TMDL subwatersheds for which iron or manganese load reductions are required, 16 receive polluted mine drainage from nonpoint source AMLs. These watersheds are highlighted in Table 6 and are drawn in Figure 8 with a red background.

Nine additional TMDL subwatersheds have AML sources of polluted mine drainage but do not have iron or manganese load reductions. These watersheds are drawn in Figure 8 with a pink background.

Because the data resolving pollutant loads to subwatersheds are sparse, costs of eliminating metal pollution from AMLs in all subwatersheds are tabulated, even where reductions are not required by the TMDL.

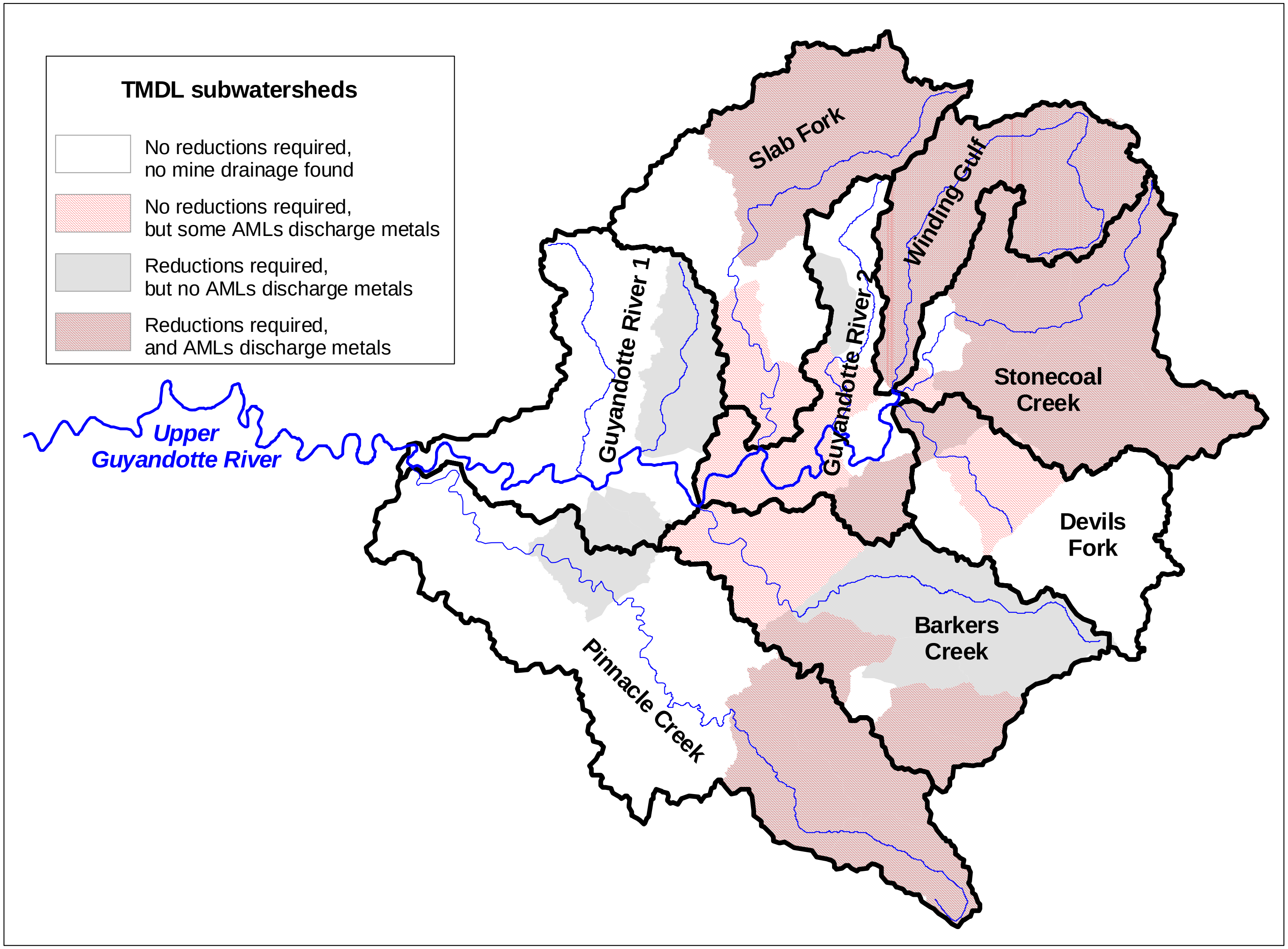
Reductions are required in 10 TMDL subwatersheds that contain no AMLs with water quality problems listed in the PADs. These watersheds are drawn in Figure 8 with a gray background. Additional fieldwork is needed to identify the sources polluting streams in these subwatersheds.

Table 6: Known and likely sources of metals pollution by subwatershed[7]

Region name/ Stream name	Stream code	TMDL sub-watershed	TMDL requires reductions: Fe	TMDL requires reductions: Mn	Metals sources: BFS	Metals sources: AML	Metals sources: Other
Guyandotte River 1							
Joe Branch	OG-128	3000	Y	Y			
Long Branch	OG-129	3100	Y	Y			
Still Run	OG-130	3200	Y	Y			
Guyandotte River 2							
Main stem	OG-up	1122	N	N		X	
Main stem	OG-up	1123	N	N		X	
Allen Creek	OG-135	3500	N	N	X	X	
Allen Creek	OG-135	3502	N	N	X		
Left Fork Allen Creek	OG-135-A	3501	Y	Y			
Big Branch	OG-136	1125	Y	N		X	
Pinnacle Creek							
Main stem	OG-124	2804	Y	N			
Main stem	OG-124	2812	Y	Y		X	
Main stem	OG-124	2813	Y	Y	X	X	
Smith Branch	OG-124-D	2801	N	Y			
Spider Creek	OG-124-I	2807	N	Y			
Beartown Fork	OG-124-N	2811	Y	N		X	
Barker's Creek							
Main stem	OG-131	3300	N	N	X	X	
Main stem	OG-131	3302	N	N		X	
Main stem	OG-131	3303	Y	N			
Hickory Branch	OG-131-B	3301	N	Y		X	
Gooney Otter Creek	OG-131-F	3304	Y	Y		X	
Gooney Otter Creek	OG-131-F	3309	Y	Y		X	
Gooney Otter Creek	OG-131-F	3310	Y	Y	X	X	
Jims Branch	OG-131-F-1	3305	Y	Y		X	
Noseman Branch	OG-131-F-2	3307	Y	Y			
Slab Fork							
Main stem	OG-134	3400	N	N	X	X	
Main stem	OG-134	3402	N	N	X	X	
Main stem	OG-134	3406	Y	Y	X	X	X
Cedar Creek	OG-134-B	3401	N	N	X		
Measle Fork	OG-124-D	3405	N	Y			X
Devil's Fork							
Main stem	OG-137	3600	N	Y		X	
Main stem	OG-137	3602	N	N	X	X	
Bluff Fork	OG-137-B	3603	N	N	X		
Winding Gulf							
Main stem	OG-138	3701	Y	Y	X	X	
Stonecoal Creek							
Main stem	OG-139	3702	N	N		X	
Main stem	OG-139	3703	N	N	X		
Main stem	OG-139	3705	Y	Y	X	X	
Main stem	OG-139	3706	Y	Y	X	X	
Tommy Creek	OG-139-A	3707	Y	N	X	X	
Riffe Branch	OG-139-B	3704	Y	Y		X	

[7] Source: TMDL subwatersheds and reductions are enumerated in USEPA (2004). BFS information from Table 8. AML information from Table 7. "Other" column refers to metals from barren lands, roads, harvested forest, oil and gas wells. Dissolved aluminum reductions not noted here; see Chapter 2.1.2 for further explanation. Manganese reductions from non-AML sources for subwatersheds 3301 and 3600 not included here; see Chapter 2.1.1 for further explanation. Rows are highlighted if the TMDL requires reductions for Fe or Mn, and if AMLs were found that likely discharge these metals.

Figure 8: Status of TMDL subwatersheds regarding load reductions and AMLs with metal loads



Source: Subwatersheds with load reductions from WVDEP (2004). Locations of AMLs discharging metals from WVDEP (Various dates).

2.3.1 Abandoned Mine Lands

Abandoned mine lands add to metal loads because metal-bearing minerals in the coal, particularly pyrite, decompose when they are exposed to water and air. This decomposition usually produces acid and dissolved iron and manganese, and may produce dissolved aluminum once those chemicals have reacted with other rocks and soil material. These reactions take place inside deep mines or in piles of refuse coal on the surface of the ground. Therefore, the abandoned mine features most likely to add metals to streams are portals discharging mine water from underground or large piles of refuse coal exposed to the elements on the surface.

From the list of all 129 AMLs in the watershed (Appendix A, pg. 82), this report identifies 54 with discharges of water from mine portals and unreclaimed piles of refuse coal (Table 7). The criteria for identifying AMLs with metal loads are not foolproof. Some portal discharges may contain such low concentrations of metals that they do not contribute much to impairment of the streams. In fact, water from the mines is sometimes used for household water supply, although this use does not necessarily ensure that the water meets water quality standards. Some old refuse piles may also have already released the majority of their metals.

Table 7: Abandoned mine lands known to discharge polluted mine drainage

Problem area name (Problem area number)	Stream code	TMDL subwatershed	Stream name
Guyandotte River 1			
None			
Guyandotte River 2			
Allen Creek Complex (1898)	OG-135	3500	Allen Creek
Blackeagle #2 Refuse (1901)	OG	1123	Guyandotte River
Wyco (Pugh) Refuse Pond (4662)	OG-135	3500	Allen Creek
Blackeagle Refuse Pile (4811)	OG	1123	Guyandotte River
Mullins (Lester) Landslide (5097)	OG	1122	Guyandotte River
Stephenson (Bowling) Drainage (5594)	OG-136	1125	Big Branch
Mullens (Grogg) Refuse (5687)	OG	1122	Guyandotte River
Mullens (Musser) Landslide (5689)	OG	1122	Guyandotte River
Mullen (Dixon) Landslide (5690)	OG	1122	Guyandotte River
Mullens Portals (5696)	OG	1122	Guyandotte River
Mullens Portals & Refuse (5823)	OG	1122	Guyandotte River
Pinnacle Creek			
Beartown Church Refuse Pile (630)	OG-124	2812	Pinnacle Creek
Beartown Fork Refuse Pile (631)	OG-124-N	2811	Beartown Fork
Pinnacle Creek #2 Refuse Pile (651)	OG-124	2813	Pinnacle Creek
Pinnacle Mining Corp. (4968)	OG-124	2813	Pinnacle Creek
Road Branch (Marshall) Portals (5537)	OG-124	2812	Pinnacle Creek
Barker's Creek			
Clark Gap Refuse Pile (633)	OG-131-F	3310	Gooney Otter Creek
Covel Refuse Pile (634)	OG-131-F	3309	Gooney Otter Creek
Gooney Otter Creek Refuse (637)	OG-131-F	3309	Gooney Otter Creek
Milam Ridge Refuse Pile (647)	OG-131-F	3309	Gooney Otter Creek
Pilot Knob Refuse Pile (650)	OG-131-F	3309	Gooney Otter Creek
Hickory Branch Mine Dump (924)	OG-131-B	3301	Hickory Branch

Problem area name (Problem area number)	Stream code	TMDL subwatershed	Stream name
Alpoca Mine Dump (926)	OG-131	3302	Barker's Creek
Tralee Mine Dump (930)	OG-131	3300	Barker's Creek
Montecarlo Complex (1903)	OG-131-F	3304	Gooney Otter Creek
Jim's Branch Refuse Piles (1905)	OG-131-F-1	3305	Jims Branch
Bud Portal (5031)	OG-131	3302	Barker's Creek
Slab Fork			
Pierpont Refuse Pile (932)	OG-134	3402	Slab Fork
Richardson Branch Complex (2304)	OG-134	3406	Slab Fork
Slab Fork Impoundments (2580)	OG-134	3406	Slab Fork
Terry Branch Portals and Refuse (5695)	OG-134	3400	Slab Fork
Devil's Fork			
Amigo Abandoned Structures (93)	OG-137	3600	Devil's Fork
Madeline Refuse Pile (1908)	OG-137	3602	Devil's Fork
Winding Gulf			
Helen "B" Refuse Pile (1727)	OG-138	3701	Winding Gulf
Horsepen Ridge Refuse Pile (2297)	OG-138	3701	Winding Gulf
Berry Branch Refuse Pile (2301)	OG-138	3701	Winding Gulf
Bailey Branch Complex (2305)	OG-138-C	3701	Bailey Branch
Alderson Branch Refuse Pile (2307)	OG-138	3701	Winding Gulf
Ury Structures (2308)	OG-139	3701	Winding Gulf
Big Stick Mine Dump (2309)	OG-138	3701	Winding Gulf
Winding Gulf Deep Mine (2749)	OG-138	3701	Winding Gulf
Berry Branch Drainage (5654)	OG-138	3701	Winding Gulf
Helen Portals (5655)	OG-138	3701	Winding Gulf
Helen Landslide (5688)	OG-138	3701	Winding Gulf
Stonecoal Creek			
Paul Kizer Site 31 Pineyland Co. (999)	OG-139	3706	Stonecoal Creek
Rhodell Refuse Piles & Portal (1907)	OG-139	3707	Stonecoal Creek
Killarney Mine Dump (2298)	OG-139	3705	Stonecoal Creek
Riffe Branch Impoundments (2312)	OG-139-B	3704	Riffe Branch
Rhodell Portals (2504)	OG-139	3702	Stonecoal Creek
Site #16 Adventure Resources, Inc. (4163)	OG-139	3705	Stonecoal Creek
Odd (Airy) Refuse (4695)	OG-139-A	3707	Tommy Creek
Stonecoal Creek Complex (4809)	OG-139	3706	Stonecoal Creek
Stonecoal Junction Refuse (5640)	OG-139	3702	Stonecoal Creek
Josephine (Doss) Portals (5884)	OG-139	3706	Stonecoal Creek

Source: WVDEP (Various dates). Subwatersheds are enumerated in USEPA (2004).

2.3.2 Other sources of metals

The Upper Guyandotte contains a number of active mining operations, coal preparation plants, and mine refuse disposal sites. By law, mining operations are required to obtain mining permits and NPDES permits in order to operate and discharge into the Upper Guyandotte (and are therefore not discussed in detail in this plan). The active mining permits in the Upper Guyandotte watershed are listed in

B (pg. 85). When operating within their permit limits, active mines are a source of metals although their contribution should not be significant enough to cause impairment.

The Upper Guyandotte River is also impacted by four bond forfeiture sites (BFSs) that discharge polluted mine drainage, as shown in Table 8. These sites may contribute a significant amount of metals and in some cases may account for most or all of the pollution in a subwatershed. However, BFSs are considered to be point sources and are not eligible for Section 319 funding. These sites are therefore not covered in detail in this plan.

Table 8: Bond forfeiture sites that discharge polluted mine drainage[8]

Stream code (TMDL subwatershed)	Stream name	Company	Mining permit	Planned Const.
OG-137-B-1 (3603)	Lefthand Fork/Bluff Fork	Lillybrook Coal Co.	S-86-85	
OG-134 (3402)	Slab Fork	Lodestar Energy, Inc.	R-5-84	9/08
OG-124 (2813)	Pinnacle Creek	Pinnacle Creek Mining Corp.	R-721	6/07
OG-139 (3706)	Stonecoal Creek	Plum Tree Minerals LLC.	S-3010-98	

The TMDL also indicates that some nonpoint sources other than AMLs contribute metals, via sediment, to the watershed. These sources include roads, barren land, harvested forest, and oil and gas wells. The TMDL requires load reductions for manganese from these sources in four subwatersheds covered by this plan, as outlined in
Table 9.

Table 9: Subwatersheds requiring manganese reductions from non-AML sources

Subwatershed	Sources requiring reductions
3301	Barren land, roads
3405	Roads, harvested forest, oil and gas wells
3406	Barren land, roads, harvested forest, oil and gas wells
3600	Barren land, roads, harvested forest

Source: USEPA (2004).

As described in Chapter 2.1.1, manganese standards will only apply in waters five miles upstream of any public or private drinking water intake. According to WVDEP, TMDLs will remain in effect if a public or private drinking water intake occurs anywhere within a subwatershed that currently requires manganese load reductions (Montali, 2005). According to current WVDEP records, subwatersheds 3301 and 3600 do not fall into this category and more than likely their manganese TMDLs will be eliminated (Montali, 2005). Subwatersheds 3406 and 3405 do fall into this category due to a drinking water intake located in the Slab Fork watershed.

In subwatershed 3406, the need to address non-AML nonpoint sources can be eliminated because the overall manganese load reductions required for this watershed can be met by addressing just the AMLs.

In subwatershed 3405, however, the TMDL does not list AMLs as a source of manganese. According to WVDEP (Various dates), no problem areas have been documented in this subwatershed. However, an undocumented refuse pile is located at the mouth (Snyder, 2005). It

[8] Source: McCarthy (2005). If construction dates are not shown, than the project has been contracted or completed. Stream codes are for the smallest tributary that the site is known to discharge to, and for which a stream code is known. Subwatersheds are enumerated in USEPA (2004).

is suggested that the further data be collected in subwatershed 3405 to determine if the manganese load reductions can be met by addressing AMLs only.

3 Nonpoint source management measures (c)

3.1 Wastewater Treatment Systems

Several physical, social, and economic constraints have prevented most communities in the Upper Guyandotte from being served by traditional wastewater treatment systems, either centralized wastewater treatment facilities or individual onsite systems. Steepness of terrain, depth to bedrock, low population density, and the relative isolation of individual communities have made the construction of centralized systems cost prohibitive. This problem is compounded by lower than average household income levels that make it difficult for local residents to advocate for the additional monthly expense associated with wastewater treatment. Dense clusters of homes located in flood prone valleys, a common sight in the Upper Guyandotte, do not have the space or soil characteristics needed to support individual onsite systems.

Decentralized and alternative wastewater treatment technologies are available, however, and, in many cases, offer viable, affordable solutions for these constrained communities. In preparing this WBP, traditional/centralized, alternative/decentralized, and individual onsite treatment options were all considered. All treatment options considered have been permitted for use in West Virginia or other states. The Upper Guyandotte Wastewater Project committee (Chapter 5.1.1) has strived to find innovative solutions that will allow *all* communities in the Upper Guyandotte watershed to receive adequate wastewater treatment.

In order to learn about wastewater treatment technologies that are currently available, representatives from several Upper Guyandotte Wastewater Project partner organizations traveled to southwest Virginia on June 23, 2005 for a one-day tour of operating decentralized treatment systems.

During the tour, which was hosted by the Virginia Department of Health, attendees were instructed on the capacity, operation, and maintenance requirements of several types of decentralized wastewater treatment systems, including a cluster system with drip irrigation and a package plant with spray irrigation. These technologies had been employed in situations where traditional forms of wastewater treatment were not feasible due to cost, terrain, impact on water quality, and other constraints. During the tour, the efficacy of the treatment technologies visited and their applicability for Upper Guyandotte communities was clearly demonstrated.

On August 24 and 25, 2005 representatives from several Upper Guyandotte Wastewater Project partner organizations gathered to discuss appropriate treatment technologies for Upper Guyandotte communities. The two-day workshop brought together a diverse group of experienced professionals from both the private sector and state agencies--experts in decentralized treatment technologies, regulators and permit writers, enforcement officers, as well as local installers, residents, health department officials, and other practitioners who have an understanding of the local communities, terrain, and soils.

Using an agreed upon list of cost assumptions (

Table 10), digital aerial photographs, the results of the wastewater needs assessment (Chapter 2.2), and local expertise and anecdotal information, workshop participants preliminarily identified the most feasible and cost-effective wastewater treatment system for each project area in the watershed (Table 11). Future engineering studies will provide more detail and further refine both the specifications of the system proposed as well as its cost.

Table 10: Wastewater treatment technology cost assumptions

Item	Cost	Included in cost (all include installation)	Annual O/M cost per home
Individual on-site system w/ traditional drainfield	$5,000 per home	New tank & drainfield	$50
Individual on-site system w/ drip dispersal drainfield	$9,000 per home	New tank & drainfield	$180
Individual on-site system w/ low pressure pipe drainfield	$6,500 per home	New tank & drainfield	$180
Cluster system w/ traditional drainfield	$2,870 per home	New tanks, 4 in. line, and treatment field for 2-15 homes	$50
Cluster system w/ drip dispersal	$4,600 per home	New tanks, 4 in. line, and treatment field for 2-15 homes	$180
Cluster system w/ low pressure pipe	$2,850 per home	New tanks, 4 in. line, and treatment field for 2-15 homes	$180
STEP	$6,000 per home	New septic tank w/ streetside hook-up	$180
STEG	$4,000 per home	New septic tank w/ streetside hook-up	$50
4 in. diameter line	$35 per foot		
Vacuum Valve Pit	$2000 per home	Valve pit serving 2-4 homes	$50
Vacuum Collection Station	$325,000		
Textile filter	$11,000		$240
Peat filter	$8,500		$240
Sand filter - recirculating	$7,000		$240
Sand filter - single pass	$2,500		$240
Package plant w/ direct discharge	$2,800		$150
8 in. diameter line	$100 per foot	Manholes but no lift stations	$120
Connection "tap fee"	$500 per home		

Cost assumptions were verified by a technical advisory committee and Dr. Edward Winant, P.E. (2005). See Chapter 3.1 for further explanation. All installation costs were based on prevailing wage rates, whenever applicable.

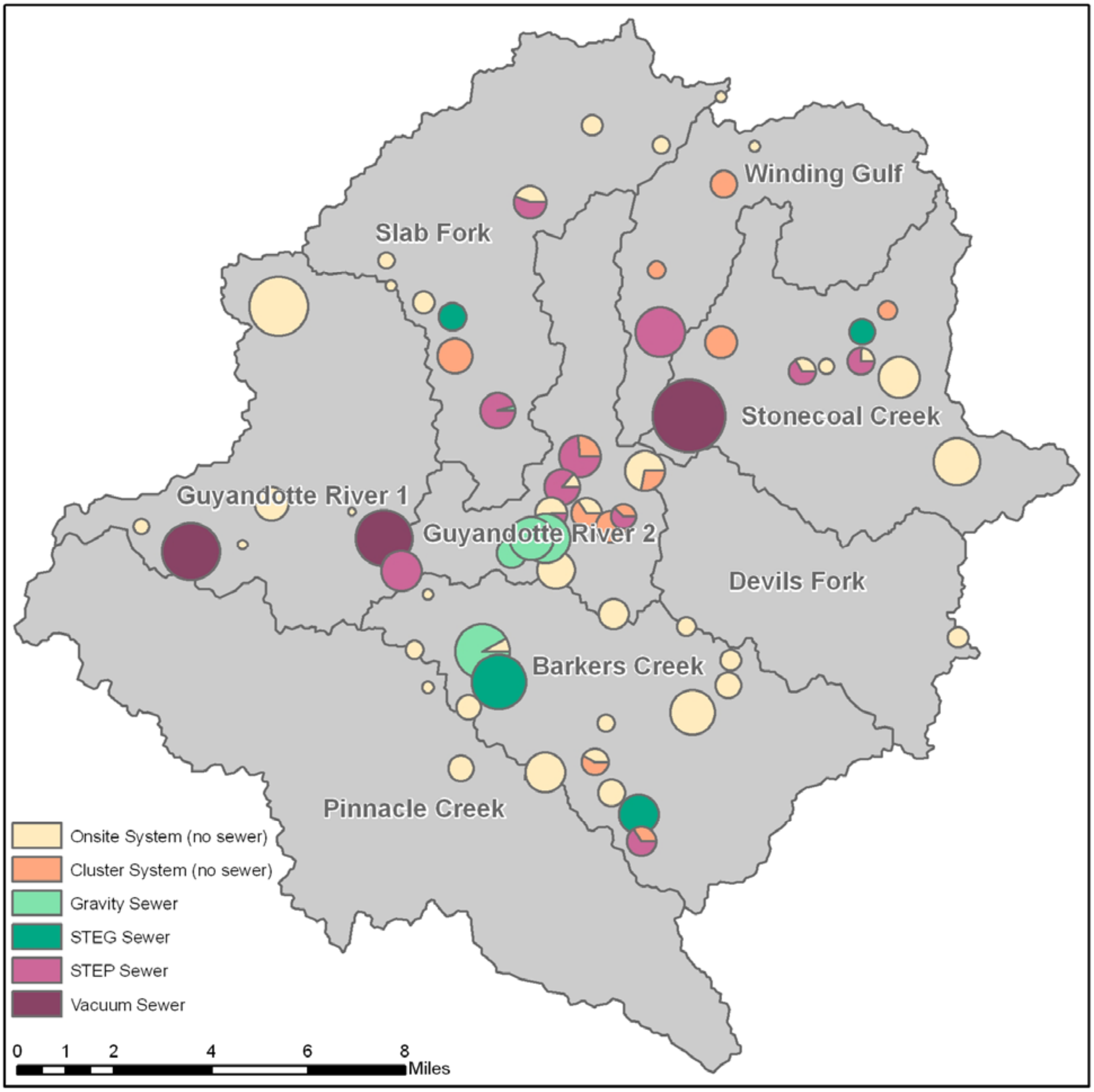
Table 11: Proposed collection system and treatment type by project area

Community/ Project Area	**TMDL SWS**	**No. of Homes**	**Collection System Type**	**Treatment Type**	**Flow (gallon/day)**	**Construction Cost**
Pinnacle Creek (OG-124)		**105**			**29,400**	**$525,000**
Bob's Branch	2807	11	Onsite	Onsite	3,080	$55,000
Bud Lite	2807	5	Onsite	Onsite	1,400	$25,000
Herndon Heights	2811	54	Onsite	Onsite	15,120	$270,000
Micajah	2811	13	Onsite	Onsite	3,640	$65,000
Spider Ridge	2810	22	Onsite	Onsite	6,160	$110,000
Guyandotte River 1 (OG -up, OG-125 through OG-130)		**453**			**109,940**	**$3,472,500**
Lower Itmann	1121	110	Vacuum	Package Plant	22,000	$1,027,500
Upper Itmann	1121	56	Gravity	Package Plant	13,200	$560,000
New Richmond	1117	114	Gravity	Package Plant	26,300	$1,020,000
Cabin Creek	2900	38	Onsite	Onsite	10,640	$190,000
Rt. 16 pg 1	1117	8	Onsite	Onsite	2,240	$40,000
Rt. 16 pg 6	1120	2	Onsite	Onsite	560	$10,000
Saulsville	2909	119	Onsite	Onsite	33,320	$595,000
Still Run	3200	2	Onsite	Onsite	560	$10,000
Upper Polk Gap	3200	4	Onsite	Onsite	1,120	$20,000
Barker's Creek (OG-131)		**575**			**141,310**	**$3,568,400**
Alpoca						**$642,500**
Alpoca Mill Branch	3302	8	Onsite	Onsite	2,240	$40,000
Alpoca Bottom	3302	94	Gravity	Package Plant	20,550	$602,500
Garwood						**$250,500**
Garwood West	3310	10	Cluster	Cluster LPP	2,800	$28,500
Garwood East	3310	19	STEP	Package Plant	3,800	$222,000
Herndon						**$114,400**
Herndon	3305	14	Cluster	Cluster Drip	3,920	$64,400
Herndon Gooney Otter	3305	10	Onsite	Onsite	2,800	$50,000
Bud	3302	101	Vacuum	Extension	20,200	$754,500
Covel	3309	54	STEG	Package Plant	10,800	$481,500
Basin	3303	15	Onsite	Onsite	4,200	$75,000
Basin Ridge 1	3303	25	Onsite	Onsite	7,000	$125,000
Basin Ridge 2	3303	67	Onsite	Onsite	18,760	$335,000
Basin Road	3303	11	Onsite	Onsite	3,080	$55,000
Bud Mountain	3302	21	Onsite	Onsite	5,880	$105,000
Herndon II	3308	24	Onsite	Onsite	6,720	$120,000
Lusk Community	3303	12	Onsite	Onsite	3,360	$60,000
Lusk Settlement	3303	10	Onsite	Onsite	2,800	$50,000
Montecarlo	3304	4	Onsite	Onsite	1,120	$20,000
Peak Creek	3303	23	Onsite	Onsite	6,440	$115,000
Tracy's Mountain	3302	49	Onsite	Onsite	13,720	$245,000
Tralee	3300	4	Onsite	Onsite	1,120	$20,000
Slab Fork (OG-134)		**198**			**48,480**	**$1,344,700**
Hotchkiss						**$310,000**
Hotchkiss North	3406	16	Onsite	Onsite	4,480	$80,000
Hotchkiss South	3406	20	STEP	Package Plant	4,000	$230,000

Community/ Project Area	TMDL SWS	No. of Homes	Collection System Type	Treatment Type	Flow (gallon/day)	Construction Cost
Otsego						**$430,000**
Otsego South	3401	2	Gravity	Package Plant	400	$5,000
Otsego East	3401	10	STEP	Package Plant	2,000	$115,000
Otesgo West	3401	30	STEP	Package Plant	6,000	$310,000
Maben	3404	25	STEG	Package Plant	5,000	$220,000
Pierpoint	3402	42	Cluster	Cluster LPP	11,760	$119,700
Acord Mt.	3406	14	Onsite	Onsite	3,920	$70,000
Lower Polk Gap	3403	16	Onsite	Onsite	4,480	$80,000
McKinney Ridge	3406	10	Onsite	Onsite	2,800	$50,000
Polk Gap	3403	9	Onsite	Onsite	2,520	$45,000
Tams Mt.	3406	4	Onsite	Onsite	1,120	$20,000
Guyandotte River 2 (OG-up, OG-132, OG-133, OG-135,OG-136)		**436**			**104,200**	**$3,054,030**
Allen Junction						**$479,800**
Allen Junction Lower	1123	13	STEP	Cluster Drip	2,600	$186,800
Allen Junction Upper	1123	25	STEP	Package Plant	5,000	$263,000
Allen Junction S.S.	1123	6	Onsite	Onsite	1,680	$30,000
Beechwood						**$253,680**
Beechwood Center	1123	14	STEP	Cluster Drainfield	2,800	$148,680
Beechwood S.S.	1123	21	Onsite	Onsite	5,880	$105,000
Iroquois						**$114,850**
Iroquois S.S.	1124	11	Onsite	Onsite	3,080	$55,000
Iroquois Clusters	1124	21	Cluster	Cluster LPP	5,880	$59,850
Stephenson Hill						**$161,800**
Stephenson Hill High	1126	8	Cluster	Cluster LPP	2,240	$22,800
Stephenson Hill Low	1126	13	STEP	Package Plant	2,600	$139,000
Wyco						**$659,000**
Wyco Lower	3500	16	Cluster	Cluster LPP	4,480	$45,600
Wyco Middle	3500	20	STEP	Cluster Drip	4,000	$282,000
Wyco Upper	3500	24	STEP	Cluster Drip	4,800	$331,400
Blackeagle	1123	31	Gravity	Extension	8,460	$467,500
Corrine	1123	66	Gravity	Extension	14,480	$289,000
Corrine Bottom	1123	83	Gravity	Extension	18,300	$381,500
Sand Gap	1125	30	Onsite	Onsite	8,400	$150,000
Stephenson Bottom	1125	34	Cluster	Cluster LPP	9,520	$96,900
Devil's Fork (OG-137)		**68**			**19,040**	**$307,750**
Amigo						**$237,750**
Amigo Lower	3600	15	Cluster	Cluster LPP	4,200	$42,750
Amigo Middle	3600	6	Onsite	Onsite	1,680	$30,000
Amigo Devils Fork	3600	24	Onsite	Onsite	6,720	$120,000
Amigo Upper Devils Fork	3600	9	Onsite	Onsite	2,520	$45,000
Egeria	3603	14	Onsite	Onsite	3,920	$70,000

Community/ Project Area	**TMDL SWS**	**No. of Homes**	**Collection System Type**	**Treatment Type**	**Flow (gallon/day)**	**Construction Cost**
Winding Gulf (OG-138)		**123**			**27,720**	**$1,032,750**
Helen	3701	84	Vacuum	Package Plant	16,800	$913,000
McAlpin	3701	4	Onsite	Onsite	1,120	$20,000
Stotesbury	3701	24	Cluster	Cluster LPP	6,720	$68,400
Ury	3701	11	Cluster	Cluster LPP	3,080	$31,350
Stonecoal Creek (OG-139)		**439**			**103,960**	**$2,971,320**
Besoco						**$364,000**
Besoco Middle	3706	9	STEP	Package Plant	1,800	$177,000
Besoco North	3706	10	STEP	Package Plant	2,000	$157,000
Besoco West	3706	6	Onsite	Onsite	1,680	$30,000
Eastgulf						**$118,120**
Eastgulf Upper Riffe	3704	11	Cluster	Cluster Drainfield	3,080	$31,570
Eastgulf Lower Riffe	3704	11	Cluster	Cluster LPP	3,080	$31,350
Eastgulf Stonecoal	3704	12	Cluster	Cluster Drip	3,360	$55,200
Mead						**$188,500**
Mead S.S.	3705	8	Onsite	Onsite	2,240	$40,000
Mead North	3705	16	STEP	R.S.F.	3,200	$148,500
Lego	3706	22	STEG	Extension	4,400	$161,500
Rhodell	3703	180	Vacuum	Package Plant	36,000	$1,395,000
Pickshin	3706	12	Cluster	Cluster LPP	3,360	$34,200
Josephine	3706	57	Onsite	Onsite	15,960	$285,000
Kilarney	3705	2	Onsite	Onsite	560	$10,000
Mead II	3705	8	Onsite	Onsite	2,240	$40,000
Odd	3707	75	Onsite	Onsite	21,000	$375,000

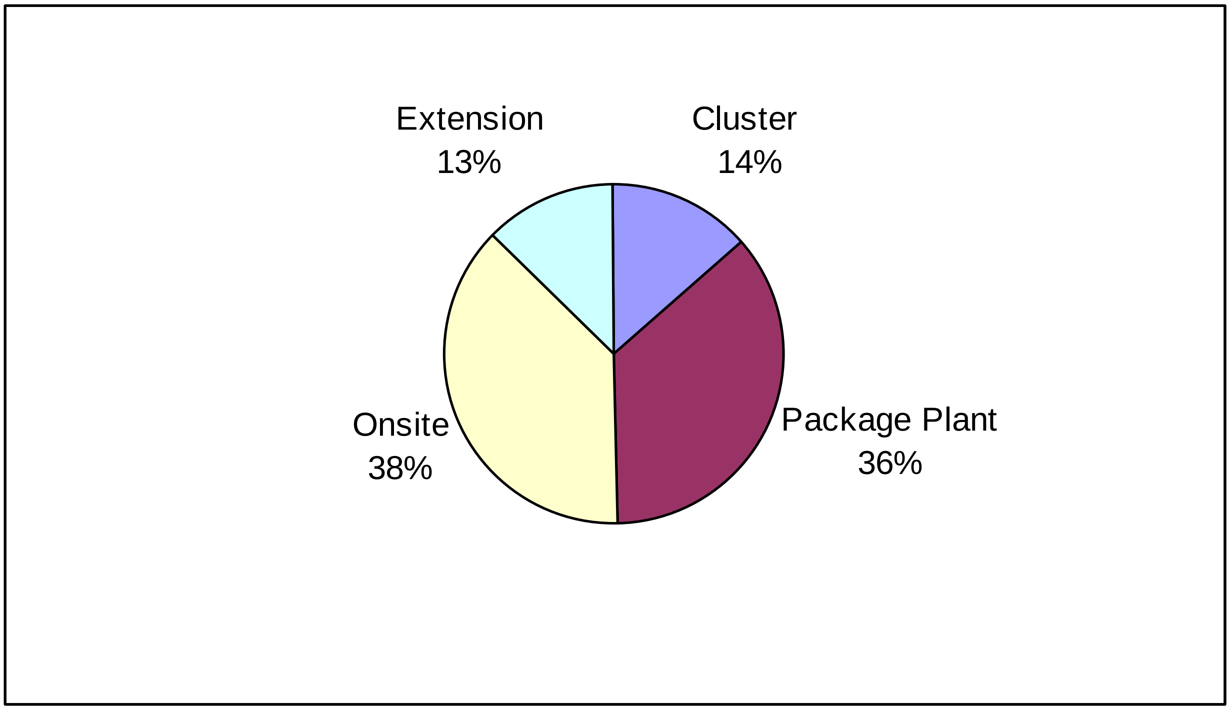
Figure 9: Proposed wastewater collection systems in the Upper Guyandotte watershed



Circles drawn on Figure 9 are color-coded to represent the type of collection system proposed for each community (as noted in the legend). The circles are also relatively sized in order to indicate the number of homes in each community. When more than one type of collection system is proposed within a community, a pie chart is shown. The pieces of the pie are also relatively sized in order to indicate the proportion of the total number of homes within that community which will utilize that particular collection system (as indicated by the color of the pie slice). For further information on proposed collection systems, see also Table 11.

Table 11 lists the wastewater treatment type proposed for each community in the column labeled "Treatment Type". Figure 10 summarizes that data and displays the percentage of the total number of homes in the watershed expected to receive each treatment type.

Figure 10: Wastewater treatment types and the percent of total homes for which each is proposed



Note: Chapters 3.1.1, 3.1.2, and 3.1.3 draw heavily from *Helping Solve Local Wastewater Problems: A Guide for WV Watershed Organizations,* pg 16-32. WV Rivers Coalition 2005.

3.1.1 Onsite

Individual

Where space and soil conditions allow, traditional onsite treatment systems serving a single home or business are the simplest and most cost-effective option. Space constraints often preclude the use of individual onsite systems in communities located in narrow valleys. Nevertheless, onsite systems are the preferred wastewater treatment method for many communities, particularly those in more isolated areas and those located along ridge tops.

Onsite systems commonly consist of a septic tank and a subsurface wastewater infiltration system (or treatment field). The septic tank allows solids to settle out and grease and “scum” to float to the top. The effluent from the tank is then transported, typically by gravity, to the treatment field. The treatment field disperses the effluent and allows it to be absorbed and purified by the soil. Conventional treatment fields consist of perforated pipes lain in gravel-filled trenches. Additional treatment technologies (as detailed below) may be necessary on some lots in order to ensure effective treatment.

Cluster

Cluster systems utilize the same treatment technologies as do individual onsite systems and are the most cost-effective wastewater treatment solution for several Upper Guyandotte communities. Unlike individual onsite, cluster systems are shared by two or more homes and may use small (4 inch) diameter pipes to transport, typically by gravity, septic tank effluent to a common treatment field. (Shallow-burial collection systems may use even smaller-diameter, light-weight pipe in longer lengths in order to minimize joints.) Additional treatment technologies (as detailed below) are necessary in some communities in order to ensure effective treatment. When space and soil conditions allow, multiple cluster systems can be installed in order to serve as many homes as possible in the community.

<u>Low Pressure Pipe (LPP)</u>
Low pressure pipe systems use a pump or siphon to pressure dose effluent to a treatment field. Pressure dosing forces the effluent completely through the pipe system and creates a more equal distribution of effluent through the field. (A pump typically achieves a more uniform distribution than does a siphon). Also, dosing the field a few times a day allows for resting, more time for the effluent to percolate through the soil, and more chance for oxygen in the soil to rejuvenate the treatment field.

LPP systems are typically slightly more expensive than conventional fields because of the pump or siphon and the extra tank each device uses. However, these systems have many advantages. They can be installed on upslope sites, on sites with high groundwater tables or bedrock, and in soils with slow percolation rates. When used on sites with high groundwater, some additional treatment of the effluent may be required.

Drip Dispersal
Drip dispersal systems, or drip irrigation, also use pumps to pressure dose effluent to a subsurface absorption field. However, in this case, small flexible tubes with emitters are used to force the effluent into the soil. Because the tubes and emitters are so small, a filter is typically installed after the pump to remove most of the solids.

Installing drip tubes is relatively easy; they can be placed at a depth of 12-18 inches below the soil using a small plow. This ease of installation allows for the utilization of unconventional treatment fields such as forested or rocky sites, sites with high bedrock or groundwater tables, or sloping sites. They do require a sophisticated pumping and control system, which adds to the cost. Most designers also recommend additional treatment beyond a septic tank before using drip dispersal. However, for cluster systems, the cost per house drops rapidly because of the low cost of installation.

Pretreatment
At some sites, septic tank effluent requires additional treatment before entering the treatment field. One of the most reliable and effective pretreatment systems is the recirculating media filter. In a recirculating media filter, microorganisms are attached to a fixed media and the effluent passes over the media. A variety of materials can be utilized for the media including sand, peat, or textiles. Effluent percolates through the media, is collected by an underdrain, and recirculates for additional treatment. A once-through variation of this approach is the intermittent sand filter. In an intermittent sand filter, the septic tank effluent is similarly spread evenly over the surface of the sand, ground glass, or peat at a lower loading rate, is collected by an underdrain and discharged to the treatment field.

3.1.2 Decentralized

Collection Systems

Septic Tank Effluent
When decentralized community systems are employed, a septic tank effluent system is the preferred collection system for many communities. These systems are economical solutions for small, dense communities, where lot size, soil conditions, depth to bedrock, groundwater, or other constraints prevent a straightforward onsite approach.

In this type of collection system, properly sized septic tanks are installed at each home and/or business. The septic tank collects the solids and the effluent from the tank then enters the collection system. The collection system consists of shallowly buried, small diameter pipe. The effluent is transported through the system by gravity or, when necessary, small pumps. When gravity flow and 4-inch pipes are utilized the system is referred to as Septic Tank Effluent Gravity or STEG; when pumps and 2- or 3-inch pipes are used the system is called Septic Tank Effluent Pumped or STEP.

These small diameter sewers are advantageous and cost-effective because the need for constant slope, manholes, lift stations and their inherent capital and operation and maintenance costs are minimized. In addition, because the collection and on-lot piping system is sealed, inflow and infiltration is rare. Drawbacks include a more expensive on-lot component and the periodic need to access private property in order to pump and haul solids from the tank.

Vacuum

Vacuum sewers also use small diameter pipes (typically 4-inch), but, unlike STEP or STEG, they use centrally-located pumps to generate a vacuum to pull sewage along rather than using pressure to force it through the mains. The onsite component for the system is a vacuum valve pit, which can serve 1 to 4 homes. The valve is actuated when enough sewage collects in the pit to allow the vacuum in the line to "suck" the collected sewage to the vacuum collection station. The collection station houses the vacuum pumps and storage tanks and pumps the sewage to the treatment plant.

Vacuum sewers are capable of lifting sewage over high points and are advantageous for densely populated areas of 75 or more homes, in rolling terrain, and for areas with high bedrock or water tables. They are also capable of transporting solids, so there are no residuals left on site for periodic pump and haul operations. The valve pit is cheaper than a STEP connection, especially where multiple houses share a pit, but the vacuum collection station can be quite expensive.

Gravity

Traditional gravity collection systems transport all the wastewater from a home or business to a treatment plant using a large diameter (8 inch and greater) pipe. In order for these systems to transport solids in addition to fluids, pipes must be installed at a certain slope to ensure scouring and movement of solids. Maintaining this slope moves the pipe deeper, which requires either deep excavations or lift stations to pump the waste back up toward the ground surface. Manholes are also required at set intervals and pipe junctions for maintenance purposes.

Gravity collection systems are well understood, reliable and frequently chosen because engineers and designers have little experience with alternative sewers. However, a high capital cost often makes them cost prohibitive in rural areas of low population density and they have been selected as the preferred treatment type in only a limited number of communities. Because of their depth, high number of pipe joints, leaking manholes, poor on-lot lateral construction and insufficient inspection (which often results in illegal "clear water" entry), they are also subject to extensive infiltration and inflow, as witnessed at the Mullens facility (Chapter 2.2.1).

Treatment Systems

Community Treatment Field

When space and soil conditions allow, a single treatment field can be used to serve an entire community. If state codified site criteria can be met, treatment fields offer very high treatment efficiency in removing total suspended solids (TSS), biological oxygen demand (BOD), phosphorus, and microbiological contaminants. These subsurface wastewater infiltration systems typically demonstrate 99% efficiency in removing pollutants from wastewater (USEPA, 2002) and the design is based on the same principles as in onsite systems (Chapter 3.1.1).

Additional treatment technologies (Chapter 3.1.1) may be necessary in some communities in order to meet code requirements and ensure effective treatment. In order to protect water quality, treatment technologies utilizing subsurface dispersal are preferred.

Package Plant

Package plants utilize the same treatment technology as do large, centralized wastewater treatment facilities (Chapter 3.1.3), but on a smaller scale. Unfortunately, the same level of skilled operation is required for both.

Package plants can treat wastewater to secondary levels (30 mg/L of BOD and TSS) and typically demonstrate 90% efficiency in removing pollutants from wastewater. They must be followed by disinfection to meet surface discharge requirements for pathogens, and must be augmented in order to perform significant nutrient (nitrogen and phosphorus) removal.

They are the preferred treatment system only for communities where a subsurface discharge is not feasible. Because package plants result in a surface discharge which requires a NPDES permit, Section 319 funding will not be sought to implement these projects.

3.1.3 Centralized

Collection and Treatment Systems

Traditional, centralized wastewater collection and treatment systems pipe wastewater from a large number of homes and businesses to a central place for treatment. Gravity collection systems are used as described in Chapter 3.1.2. Treatment plants are sized according to the volume of wastewater they handle. During primary treatment, solids and fluids are separated and aerobic bacteria treat the waste. Most facilities also use chlorine, UV light, or ozone to further disinfect treated effluent. Disinfected effluent is then discharged to a surface water body. Ultimately, the solids generated by the treatment facility must be removed from the system, treated if necessary, and disposed of by hauling to a sewage treatment facility or landfill or, more typically, via land application.

Within the Upper Guyandotte watershed, the City of Mullens operates the only centralized wastewater treatment facility. A conventional sewer line extension from the Mullens plant was identified as the preferred option for three communities. However, the significant I&I problem at the Mullens plant would need to be addressed prior to the construction of any line extensions (see Chapter 2.2.1 for further explanation).

3.1.4 Operation and Maintenance

Adequate and capable management of wastewater treatment systems is critical to ensuring system performance and the protection of water quality and public health. If the options presented in this WBP are to be long-term, sustainable solutions, then proper maintenance of treatment systems is essential.

The health department is typically the entity responsible for permitting and inspecting single-family onsite wastewater treatment systems.

A responsible management entity (RME) must be in place for any community system to be permitted or constructed. Local public service districts (PSDs) or municipalities usually serve as RMEs for larger, community systems.

Primary roles and responsibilities of an RME include:

- Inspection and maintenance of all their systems
- Water quality monitoring (to fulfill permit requirements)
- Billing and other administrative functions
- Authority to set rates, collect fees, levy taxes, acquire debt, and issue bonds
- Authority to obtain easements for access to property
- Training, certification, and licensing for staff and contractors
- Public education

A wide variety of models and areas of expertise will be drawn upon to develop long-term management agreements for wastewater treatment in the Upper Guyandotte. Potential RMEs include: Crab Orchard MacArthur PSD, Eastern Wyoming PSD, and the City of Mullens. These entities have been involved, in varying degrees, throughout the planning process. Meetings have been conducted to discuss the capabilities of the potential RMEs and responsibilities they may be able or willing to take on. Progress is being made toward establishing a formal agreement.

A training program for wastewater treatment system installers and operators is also being planned and will be implemented as funding permits. This training program will focus on alternative or innovative technologies that technicians may not be currently familiar with. Training may need to include training on maintenance of collection systems (i.e. vacuum technologies), filtration mediums (i.e. textile filters, sand filters), and dispersal mechanisms (i.e. drip irrigation, spray irrigation). Training providers will need to include state agency personnel, service providers, and system manufacturers.

Obstacles to effective management in the Upper Guyandotte

Several potential barriers exist to proper management of wastewater treatment systems in the watershed, particularly with regard to decentralized, clustered approaches. These possible obstacles include:

- Eastern Wyoming Public Service District is the PSD in the Wyoming County region of the watershed, and was established only recently to manage public drinking water systems. While Eastern Wyoming PSD is willing to take on wastewater management, its primary objective remains public water access. They currently do not have the experience or staff needed to manage wastewater. Assistance from UGWA and others will be needed to increase the capacity of the PSD, and to provide ongoing support for initial phases of implementation.

- Land ownership patterns in the region suggest that 75-85% of the land in the watershed is owned by out-of-state interests. Acquiring the necessary easements to install systems may require extensive, long-distance negotiation. And in some cases, it may not be in the landowner's interest to invest in infrastructure on leased lands. Project partners at the state and local level will need to foster dialogue and leverage participation from all relevant stakeholders.

- As in most states, delinquent payment of wastewater bills is traditionally addressed by shutting off public water to an individual house. In many communities in the Wyoming County portion of the Upper Guyandotte watershed, however, public water is not available, and therefore no enforcement mechanism exists. PSDs and funding entities are reluctant to support a system where enforcement is difficult if not impossible. Legislative and/or rule changes may need to be made providing for additional enforcement tools, such as placing liens that are added to tax bills.

- Substandard plumbing and electrical services in individual homes can provide impediments to proper operation of decentralized wastewater systems. System designers will need to address these potential problems on a case-by-case basis, and be fluent in system requirements.

- In general, the application of alternative wastewater treatment technologies in the state has not always been successful, typically due to inadequate maintenance and care. Because of the reputation such systems have acquired, some potential managers, permit providers, and enforcement officers are reluctant to assist with the installation of decentralized and onsite solutions. UGWA and its project partners must work to both educate all stakeholders in current technologies and best practices, and insure that adequate maintenance measures are concurrently put in place with treatment systems.

Many of these have been long-standing obstacles to the provision of wastewater treatment in West Virginia's Southern Coalfields. Recognition of these problems is increasing, however, and UGWA and its project partners are well situated to address these concerns through local, hands-on project implementation, through cooperative capacity building, and through the initiation of local and state policy reform as needed.

3.2 Abandoned Mine Land Reclamation

This chapter describes the various measures that may be used to control polluted mine drainage. 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.

3.2.1 Land reclamation

- **Removing refuse coal (95%).** This method has the potential to eliminate the metal loads completely if all of the refuse material can be removed. However, the cost of removing the materials is often much greater than the cost of covering them with an impervious layer and revegetating the cap.
- **Isolating refuse coal from flowpaths (50%).** See the next two items. It is difficult to estimate the efficacy of these measures exactly.

- **Sealing from above.** Infiltration of water into refuse coal 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.
- **Isolating from below.** Interactions between water and refuse coal can be further minimized by separating the waste material from impermeable bedrock below with conductive materials. Water may then flow beneath the refuse and be conducted away without reacting with it.
- **Surface water management.** Rock-lined ditches or grouted channels can be used to convey surface water off site before it can percolate into refuse coal. Limestone is often used in such channels to neutralize acidity, as with oxic limestone channels (OLCs), discussed below.

3.2.2 Passive treatment

- **Acidity reducing techniques.** Where mine drainage is strongly acidic, which is more typically seen in northern West Virginia, a number of measures have been developed that neutralize acid, including limestone leachbeds, sulfate-reducing bioreactors, and reducing and alkalinity producing systems. Water quality data from the Upper Guyandotte region, though sparse, do not indicate strongly acidic water, so other water treatment methods will be more important.
- **Manganese removal beds (MRBs) (to 2 mg/L).** Manganese may be removed from polluted mine drainage either by active treatment (Chapter 3.2.3) or by MRBs. In MRBs, water is passed over a wide limestone bed, and dissolved manganese oxidizes and precipitates from solution.
- **Oxic (or Open) limestone channels (30%).** Research to estimate the efficacy of OLCs is active. OLCs have the advantage that 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
- **Aerobic wetlands (wide range).** Wide areas of exposure to the atmosphere in constructed wetlands can allow metals in solution to oxidize. Slower waters allow precipitates to fall out of suspension.
- **Grouting (50%).** Setting up grout walls or curtains in deep mines has great potential to solve polluted mine drainage 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).

3.2.3 Active treatment

- **Treating (100+ %).** A variety of active treatment methods exist for mine drainage. One of a number of alkaline chemicals can be mixed with the polluted water if alkalinity is required. The mixture may then be aerated or treated with an oxidant, such as hydrogen peroxide, and is finally passed through ponds allowing metal hydroxides to settle out as sludge.

4 Estimated load reductions and costs (b)

The TMDL sets goals for pollutant reductions from nonpoint and point source activities that, if enacted, should improve water quality so that the stream segments are removed from the 303(d) list and meet standards (USEPA, 2004).

4.1 Fecal coliform bacteria

In the Upper Guyandotte watershed, the mainstem of the Guyandotte River is listed for fecal coliform impairments. The TMDL for the Guyandotte Basin therefore identifies load reductions for fecal coliform bacteria that are required in the major tributaries of the Upper Guyandotte watershed in order to delist the mainstem of the Guyandotte River.

Load reductions anticipated upon implementation of this WBP (Table 12) meet or exceed target load reductions required by the TMDL for the major tributaries only (Table 13). It is not expected that implementation of this WBP will achieve the entire required load reduction for the mainstem of the Guyandotte River.

Even though TMDL load reductions for the tributaries were not calculated specifically to attain water quality standards in those tributaries, the total anticipated load reduction represents a 95% reduction in the overall current annual load across the Upper Guyandotte watershed, and attainment of water quality standards in the tributaries is a likely outcome.

In addition, in assigning load reductions, the authors of the TMDL state that, "Headwaters tributaries were reduced first because their impact frequently had a profound effect on downstream water quality in the Guyandotte mainstem" (USEPA, 2004, pg 5-12). Therefore, load reductions achieved in the Upper Guyandotte watershed will likely have a significant impact on the success of future efforts to attain standards in the mainstem of the Guyandotte River.

Current load[9] and load reduction estimates were based on the number of homes in each community, the efficiency of the treatment system proposed, and the number of fecal coliform bacteria counts present annually in untreated waste discharged from one household (a constant). A detailed description of these calculations is given in Appendix C (pg. 87).

[9] Current baseline loads as given in the TMDL document are not listed in Table 12 because the calculations used in generating those numbers were based on an assumption that over estimated the number of homes in the watershed currently being served by onsite septic systems. See Chapter 6.5 for further explanation.

Table 12: Anticipated fecal coliform load reductions

Community	TMDL SWS	Current Load (cfu/year)	Anticipated Load Reduction (cfu/year)
Pinnacle Creek (OG- 124)		**2.149E+14**	**2.128E+14**
Bob's Branch	2807	2.233E+13	2.211E+13
Bud Lite	2807	1.015E+13	1.005E+13
Herndon Heights	2811	1.109E+14	1.098E+14
Micajah	2811	2.639E+13	2.613E+13
Spider Ridge	2810	4.517E+13	4.472E+13
Guyandotte River 1 (OG -up, OG-125 through OG-130)		**9.006E+14**	**8.370E+14**
Cabin Creek	2900	6.312E+13	6.249E+13
Lower Itmann	1121	2.385E+14	2.147E+14
New Richmond	1117	2.472E+14	2.225E+14
Rt. 16 pg 1	1117	1.735E+13	1.717E+13
Rt. 16 pg 6	1120	4.337E+12	4.294E+12
Saulsville	2909	1.977E+14	1.957E+14
Still Run	3200	4.337E+12	4.294E+12
Upper Itmann	1121	1.214E+14	1.093E+14
Upper Polk Gap	3200	6.644E+12	6.578E+12
Barkers Creek (OG-131)		**1.236E+15**	**1.172E+15**
Alpoca	3302	2.188E+14	1.985E+14
Basin	3303	3.391E+13	3.357E+13
Basin Ridge 1	3303	5.652E+13	5.595E+13
Basin Ridge 2	3303	1.515E+14	1.500E+14
Basin Road	3303	2.487E+13	2.462E+13
Bud	3302	2.050E+14	1.845E+14
Bud Mountain	3302	4.263E+13	4.221E+13
Covel	3309	1.208E+14	1.088E+14
Garwood	3310	6.489E+13	6.042E+13
Herndon	3305	4.928E+13	4.878E+13
Herndon II	3308	4.928E+13	4.878E+13
Lusk Community	3303	2.713E+13	2.686E+13
Lusk Settlement	3303	2.053E+13	2.033E+13
Montecarlo	3304	8.213E+12	8.131E+12
Peak Creek	3303	5.200E+13	5.148E+13
Tracy's Mountain	3302	1.017E+14	1.007E+14
Tralee	3300	8.582E+12	8.496E+12
Slab Fork (OG-134)		**3.867E+14**	**3.676E+14**
Acord Mt.	3406	3.036E+13	3.006E+13
Hotchkiss	3406	6.893E+13	6.480E+13
Lower Polk Gap	3403	2.473E+13	2.448E+13
Maben	3404	3.864E+13	3.478E+13
McKinney Ridge	3406	2.030E+13	2.010E+13
Otsego	3401	9.302E+13	8.371E+13
Pierpoint	3402	9.108E+13	9.017E+13
Polk Gap	3403	1.495E+13	1.480E+13
Tams Mt.	3406	4.707E+12	4.660E+12

Community	TMDL SWS	Current Load (cfu/year)	Anticipated Load Reduction (cfu/year)
Guyandotte River 2 (OG-up, OG-132, OG-133, OG-135, OG-136)		**9.402E+14**	**8.900E+14**
Allen Junction	1123	9.846E+13	9.244E+13
Beechwood	1123	7.832E+13	7.754E+13
Blackeagle	1123	5.864E+13	5.278E+13
Corinne	1123	1.370E+14	1.233E+14
Corinne Bottom	1123	1.723E+14	1.551E+14
Iroquois	1124	7.235E+13	7.162E+13
Sand Gap	1125	6.713E+13	6.646E+13
Stephenson Bottom	1125	7.608E+13	7.532E+13
Stephenson Hill	1126	4.699E+13	4.390E+13
Wyco	3500	1.329E+14	1.316E+14
Devils Fork (OG-137)		**1.404E+14**	**1.390E+14**
Amigo	3600	1.171E+14	1.159E+14
Egeria	3603	2.325E+13	2.302E+13
Winding Gulf (OG-138)		**2.652E+14**	**2.458E+14**
Helen	3701	1.860E+14	1.674E+14
McAlpin	3701	7.013E+12	6.943E+12
Stotesbury	3701	4.651E+13	4.604E+13
Ury	3701	2.563E+13	2.537E+13
Stonecoal Creek (OG-139)		**8.653E+14**	**8.112E+14**
Besoco	3706	5.594E+13	5.156E+13
Eastgulf	3704	7.687E+13	7.610E+13
Josephine	3706	1.236E+14	1.224E+14
Kilarney	3705	4.660E+12	4.613E+12
Lego	3706	5.126E+13	4.613E+13
Mead	3705	5.592E+13	5.536E+13
Mead II	3705	1.864E+13	1.845E+13
Odd	3707	4.154E+13	4.112E+13
Pickshin	3706	2.575E+13	2.549E+13
Rhodell	3703	4.111E+14	3.700E+14
Total		**4.949E+15**	**4.675E+15**
% Reduction			**94.47**

Load reduction calculations are described in detail in Appendix C (pg. 87).

Table 13: Anticipated fecal coliform load reductions and TMDL required reductions

Subwatershed (Stream Code)	SWS with a treatment system proposed	SWS with a reduction required by TMDL	Anticipated Load Reduction (cfu/yr)	Required Reduction (cfu/yr)
Barker's Creek (OG-131)	3300, 3302, 3303, 3304, 3305, 3308, 3309, 3310	3300, mouth of Barker's Creek	1.172E+15	1.364E+14
Devil's Fork (OG-137)	3600, 3603	3600, mouth of Devil's Fork	1.390E+14	1.247E+14
Pinnacle Creek (OG-124)	2807, 2810, 2811	2800, mouth of Pinnacle Creek	2.128E+14	2.059E+14
Slab Fork (OG-134)	3401, 3402, 3403, 3404, 3406	3400, mouth of Slab Fork	3.676E+14	1.738E+14
Stonecoal Creek (OG-139)	3703, 3704, 3705, 3706, 3707	3700, start of Guyandotte River	8.112E+14	
Winding Gulf (OG-138)	3701	3700, start of Guyandotte River	2.458E+14	
			1.057E+15	5.616E+14
Guyandotte River 1 (OG-127)	2900	2900, mouth of Cabin Creek	2.582E+14	4.21E+13
Guyandotte River 1 (OG-125, OG-126, OG-128, OG- 129)	1117, 1120, 1121	none given	5.679E+14	0
Guyandotte River 1 (OG-130)	3200	3200, Still Run	1.087E+13	2.611E+13
			8.370E+14	6.821E+13
Guyandotte River 2 (OG-132, OG-133)	1123, 1124, 1126	none given	6.167E+14	0
Guyandotte River 2 (OG-136)	1125	1125, Big Branch	1.418E+14	1.123E+13
Guyandotte River 2 (OG-135)	3500	3500, mouth of Allen Creek	1.316E+14	4E+13
			8.900E+14	5.123E+13

Source: Table 11 (pg. 25), Table 12 (pg. 38), and USEPA (2004).

The total cost of providing adequate wastewater treatment to all homes in the Upper Guyandotte watershed will be over $16.28 million; a summary of construction cost estimates by subwatershed is given in Table 14. The estimated construction cost for each project area is given in Table 11 (pg. 25).

Table 14: Wastewater treatment costs by subwatershed

Subwatershed	Stream Code(s)	Estimated Construction Cost
Devil's Fork	OG-137	$307,750
Pinnacle Creek	OG-124	$525,000
Winding Gulf	OG-138	$1,032,750
Slab Fork	OG-134	$1,344,700
Stonecoal Creek	OG-139	$2,971,320
Guyandotte River 2	OG-up, OG-132, OG-133, OG-135, OG-136	$3,054,030
Guyandotte River 1	OG -up, OG-125 through OG-130	$3,472,500
Barker's Creek	OG-131	$3,568,400
	Total	**$16,276,450**

Construction costs for each project area were determined using the cost assumptions in

Table 10 (pg. 24) and the length (in feet) of sewer line needed. The length of sewer line needed was estimated using GIS software and digital aerial photographs. Cost estimates were calculated for several different wastewater treatment technologies in order to determine the most cost effective option. Construction costs for project areas were summed, when necessary, to give total costs for each community. A detailed description of these calculations is given in Appendix E (pg. 92).

In developing this WBP, the construction cost estimates were used primarily to compare individual projects to one another in order to generate a relative priority ranking. It is not assumed that the cost estimates definitively represent the entire cost of project implementation.

For example, construction cost estimates do not include stream, railroad or highway crossings. The need and cost estimates for such crossings will be determined during development of preliminary engineering reports. Crossings can be quite costly and could greatly increase the total construction cost for any project where they are necessary. However, one of the advantages of clusters systems in the minimization of the need for such crossings.

Other costs that may be incurred during project implementation which are not included in all[10] construction cost estimates include: project management, water quality monitoring, training and operator certification, engineering and design work, contingencies, soft costs (Public Service Commission fees, attorney fees, etc.), and/or other costs associated with addressing the obstacles listed in Chapter 3.1.4. The amount of these costs will be estimated on a project by project basis and will be included in the budget of any project proposal submitted for implementation funding.

[10] Construction cost estimates for onsite and cluster systems include both engineering/design and contingency cost estimates.

4.2 Metals

While the TMDL calls for metals wasteload allocations for specific point sources, load allocations for nonpoint sources are not tied to specific AMLs. Instead, the load allocations are provided catchment-by-catchment. If all wasteload and load allocations for dissolved aluminum, iron, and manganese are met, the TMDL assumes that the water quality criteria for pH will also be met (USEPA, 2004).

As noted in Chapter 2.1, the aluminum and manganese criteria have become more lenient since the TMDL was approved. The aluminum and manganese TMDL targets therefore may be more stringent than required to meet current water quality standards, and the costs calculated in this chapter may be overestimates.

Table 15 lists the load allocations from the TMDL in the “TMDL target” column. Implementation of this Watershed Based Plan should reduce loads to those goals. The treatment measures proposed for each site are sized with the goal of reducing the loads to meet the TMDL targets. If measures are implemented and targets are still not met, it may be necessary to collect more data and to design additional treatment measures.

Treatment systems for each site are chosen based on the assumption that Section 319 funds will continue to be limited to funding capital costs. Treatment options are therefore limited to land reclamation and passive systems that do not require ongoing operations and maintenance. Load reductions and costs are based on what can reasonably be achieved by land reclamation or installing appropriate passive treatment systems.

Polluted mine drainage may be generated within accumulations of mine spoil or refuse on the surface, or in similar acid forming materials located in underground mines. If site descriptions suggest that materials on the surface are responsible for the polluted mine drainage, then the remediation cost is determined according to the acres of land requiring reclamation. In some cases, spoil piles may be large and adequately vegetated, and passive water treatment may be more cost effective. Virtually all of the treatment proposed in this Watershed Based Plan is for reclamation of spoil or refuse piles.

When polluted mine drainage flows out of underground mines, a passive treatment system can be chosen and sized based on water chemistry and flow data. If the discharge is net alkaline, treatment requires aeration and settling. A correctly designed aerobic wetland could provide this treatment. In net acidic water, with low concentrations of aluminum, ferric iron or dissolved oxygen, an anoxic limestone drain can neutralized the acidity. If aluminum, ferric iron or dissolved oxygen is too concentrated, a RAPS would be advised (Watzlaf et al., 2004). If manganese remains in solution despite these measures, MRBs would be required. Only one AML has sufficient water quality and quantity data to allow the costing of a passive treatment system: Stonecoal Creek Complex (4809). On this site, an aerobic wetland was chosen as the appropriate system. No MRBs are recommended in this Watershed Based Plan.

The Office of Surface Mining, Reclamation and Enforcement's (OSM's) AMDTreat computer program is used to calculate costs for various treatment measures. Table 16 summarizes the cost calculations performed in this Watershed Based Plan: To meet TMDL targets for 146 miles of impaired streams, it will cost more than $7 million.

Table 15: Reductions required to meet TMDL targets for abandoned mine lands[11]

			Pounds/year		
Stream name	**Stream code**	**Pollutant**	**TMDL baseline**	**TMDL target**	**Required reduction**
Guyandotte River 1					
Upper Guyandotte River	OG-up	Fe	2,523	2,523	0%
		Mn	4,349	4,349	0%
Cabin Creek	OG-127	Fe	0	0	0%
		Mn	0	0	0%
Joe Branch	OG-128	Fe	2,451	147	94%
		Mn	15,589	1,559	90%
Long Branch	OG-129	Fe	1,300	78	94%
		Mn	8,268	661	92%
Still Run	OG-130	Fe	3,076	185	94%
		Mn	27,790	11,116	60%
Guyandotte River 2					
Upper Guyandotte River	OG-up	Fe	3,262	3,262	0%
		Mn	5,435	5,435	0%
Allen Creek	OG-135	Fe	4,769	2,681	44%
		Mn	16,285	8,072	50%
Pinnacle Creek	OG-124	Fe	17,998	1,079	94%
		Mn	79,702	22,900	71%
Barker's Creek	OG-131	Fe	8,110	2,198	73%
		Mn	52,671	36,088	31%
Slab Fork	OG-134	Fe	4,236	1,923	55%
		Mn	27,556	11,218	59%
Devil's Fork	OG-137	Fe	1,038	1,038	0%
		Mn	17,745	2,243	87%
Winding Gulf	OG-138	Fe	20,339	1,220	94%
		Mn	39,825	35,842	10%
Stonecoal Creek	OG-139	Fe	31,296	2,390	92%
		Mn	107,994	64,158	41%

[11] TMDL targets are load allocations for each pollutant in each subwatershed from USEPA (2004). Required reduction calculations assume the TMDL baseline values are accurate. Total aluminum loads and required reduction not included in table; see Chapter 2.1.2 for further explanation.

Table 16: Summary of AML remediation costs and stream miles improved

Stream code	Stream name	Impaired miles			Estimated future cost for water remediation
		Mainstem	Tributaries	Total	
OG-up	Upper Guyandotte River 1and 2	23	15.2	38.2	>$420,000
OG-124	Pinnacle Creek	26.6	7.7	34.3	>$450,000
OG-131	Barker's Creek	8	12.6	20.6	>$3,350,000
OG-134	Slab Fork	15.1	7.2	22.3	>$280,000
OG-137	Devil's Fork	4.9	0	4.9	$150,000
OG-138	Winding Gulf	15.5	0	15.5	>$450,000
OG-139	Stonecoal Creek	10.2	0	10.2	>$1,940,000
	Total			146.0	**>$7,040,000**

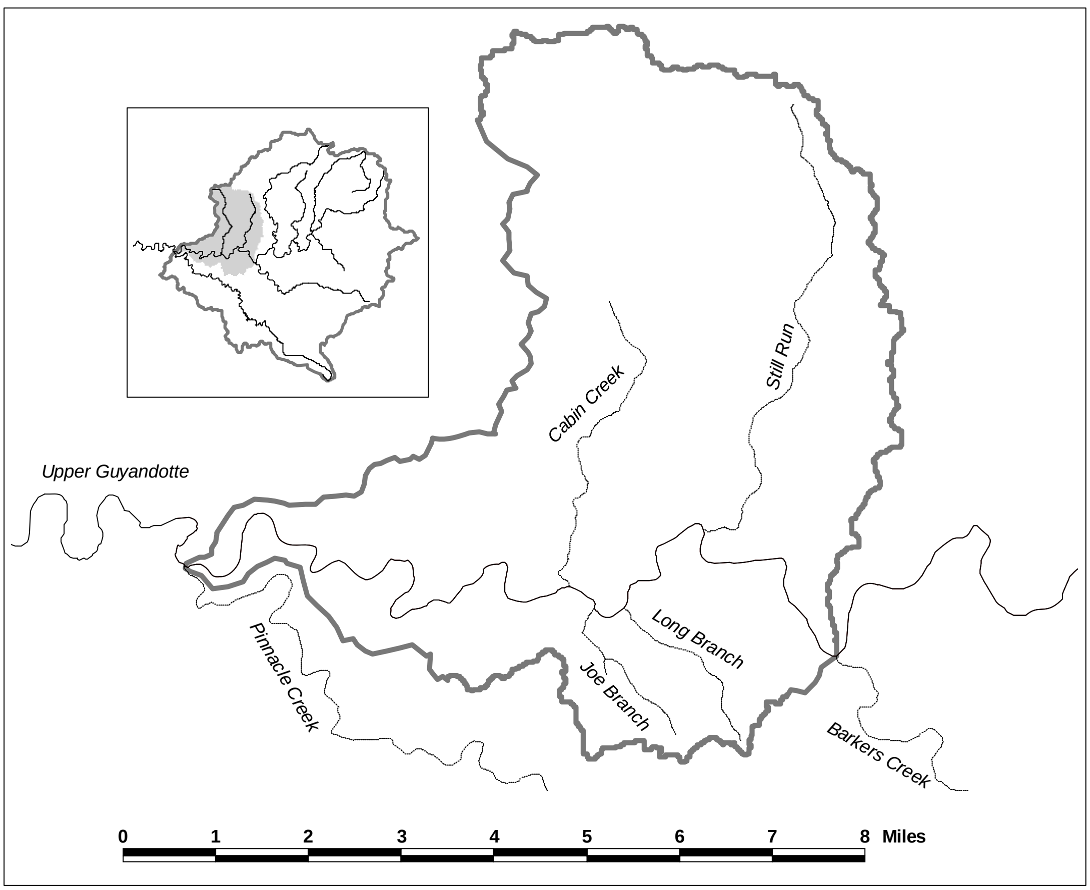
As shown in Table 6, AMLs were not found in every impaired stream.

4.2.1 Guyandotte River 1

This region is the lower (more downstream) of two regions with direct drains. It comprises subwatersheds of all the streams entering the Guyandotte River between Barker's Creek and Pinnacle Creek, including Cabin Creek (OG-127), Still Run (OG-130), Joe Branch (OG-128) and Long Branch (OG-129). The region contains TMDL subwatersheds 1117-1121, 2900-2911, 3000, 3100, and 3200. Agency data sources identified twelve AMLs in this region, but none are likely to contribute polluted mine drainage (WVDEP, Various dates). One PAD describes a large refuse area, (Itmann Refuse Pile, PAD number 529) that has been reclaimed at a cost of more than $5 million.

Cabin Creek, Still Run, Joe Branch and Long Branch are all impaired by high concentrations of iron and manganese. The TMDL calls for reductions in metal loads from AMLs for Still Run, Joe Branch, and Long Branch. Additional reconnaissance must take place in this area before specific sites can be targeted for clean-ups.

Figure 11: Guyandotte River 1

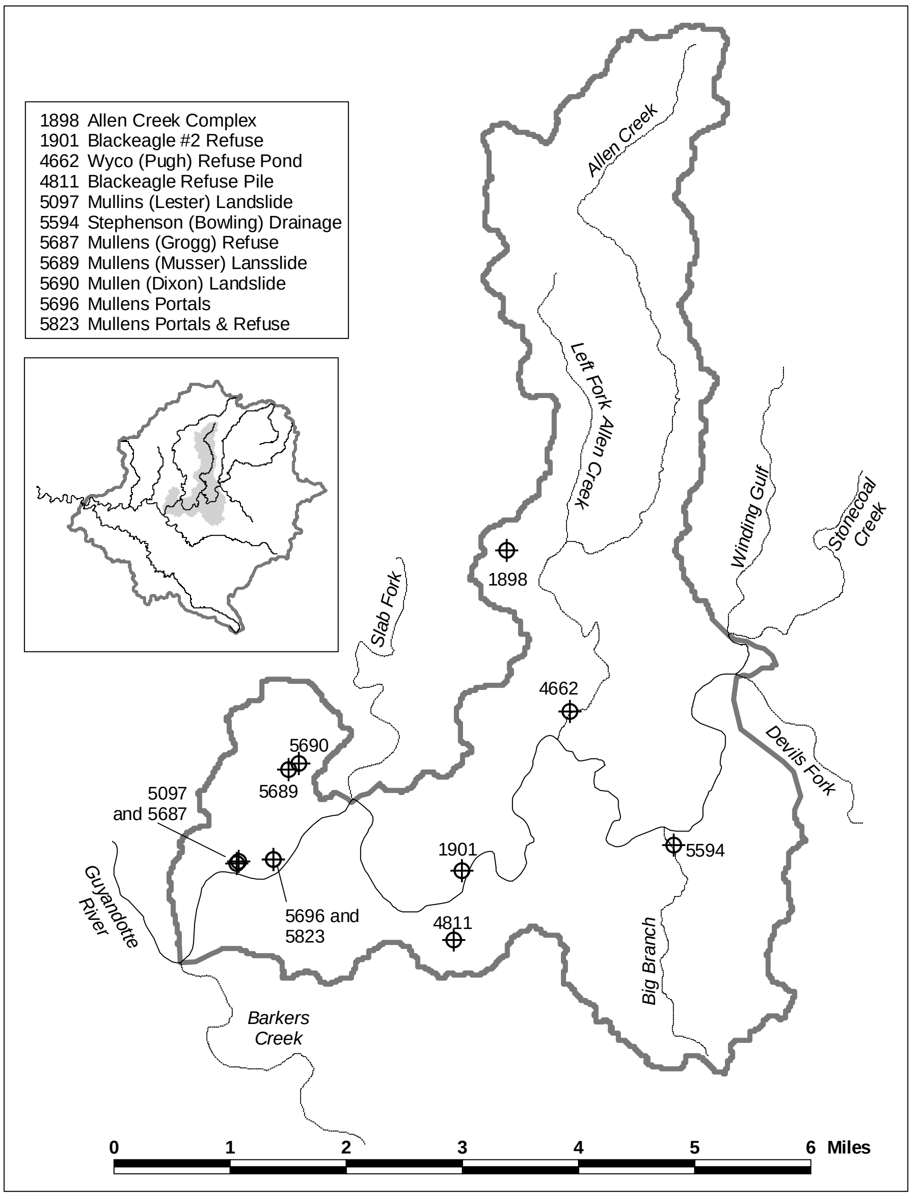


4.2.2 Guyandotte River 2

This region consists of all the drainages entering the Guyandotte River between its beginning at the confluence of Winding Gulf and Stonecoal Creek and the mouth of Barker's Creek, with the exception of the Devil's Fork and Slab Fork watersheds, which are treated separately. Important tributaries contained within this region are Allen Creek (OG-135) and Big Branch (OG-136). The region includes TMDL subwatersheds 1122-1126, 3500-3502, and 3700.

In this region, only the Guyandotte River and Left Fork Allen Creek (OG-135-A) are listed as impaired. The TMDL calls for metals reductions from AMLs that drain to Allen Creek and Big Branch.

Figure 12: Location of AMLs contributing metals to Guyandotte River 2.



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 17: AMLs adding metals to the Guyandotte River 2 watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Allen Creek Complex (1898)	$0	Fifteen acres of refuse coal must be reclaimed. The PAD mentions portals, but no discharges.	$240,000
Blackeagle #2 Refuse (1901)	$0	No PAD is available. AMLIS indicates that the site includes dangerous piles and embankments, a complaint that usually indicates refuse coal that must be reclaimed.	No estimate possible
Wyco (Pugh) Refuse Pond (4662)	$0	One acre of refuse coal must be reclaimed.	$20,000
Blackeagle Refuse Pile (4811)	$0	Ten acres of refuse coal must be reclaimed.	$160,000
Mullins (Lester) Landslide (5097)	$34,400	This landslide was started by a flow of mine drainage, but no water quality or quantity data are available.	No estimate possible
Stephenson (Bowling) Drainage (5594)	$0	Water discharges from mine spoil carrying 672 mg/L sulfate, but no water quantity data is available.	No estimate possible
Mullens (Grogg) Refuse (5687)	$0	No PAD is available. AMLIS indicates that the site includes dangerous piles and embankments, a complaint that usually indicates refuse coal that must be reclaimed.	No estimate possible
Mullens (Musser) Landslide (5689)	$97,310	This landslide was started by a flow of mine drainage, but no water quality or quantity data are available.	No estimate possible
Mullen (Dixon) Landslide (5690)	$33,999	A blowout of mine water initiated this landslide. The PAD does not indicate whether any drainage continues.	No estimate possible
Mullens Portals (5696)	$0	The PAD enumerates draining portals in the Mullens area, but has no water quality or quantity data.	No estimate possible
Mullens Portals & Refuse (5823)	$0	This is a new PAD for the complaints listed in 5687 and 5696. An additional 10 gpm drainage source is also mentioned.	No estimate possible
		Total, Upper Guyandotte Direct Drains 2 watershed	**>$420,000**

Source: Past reclamation costs from OSM (2005). Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

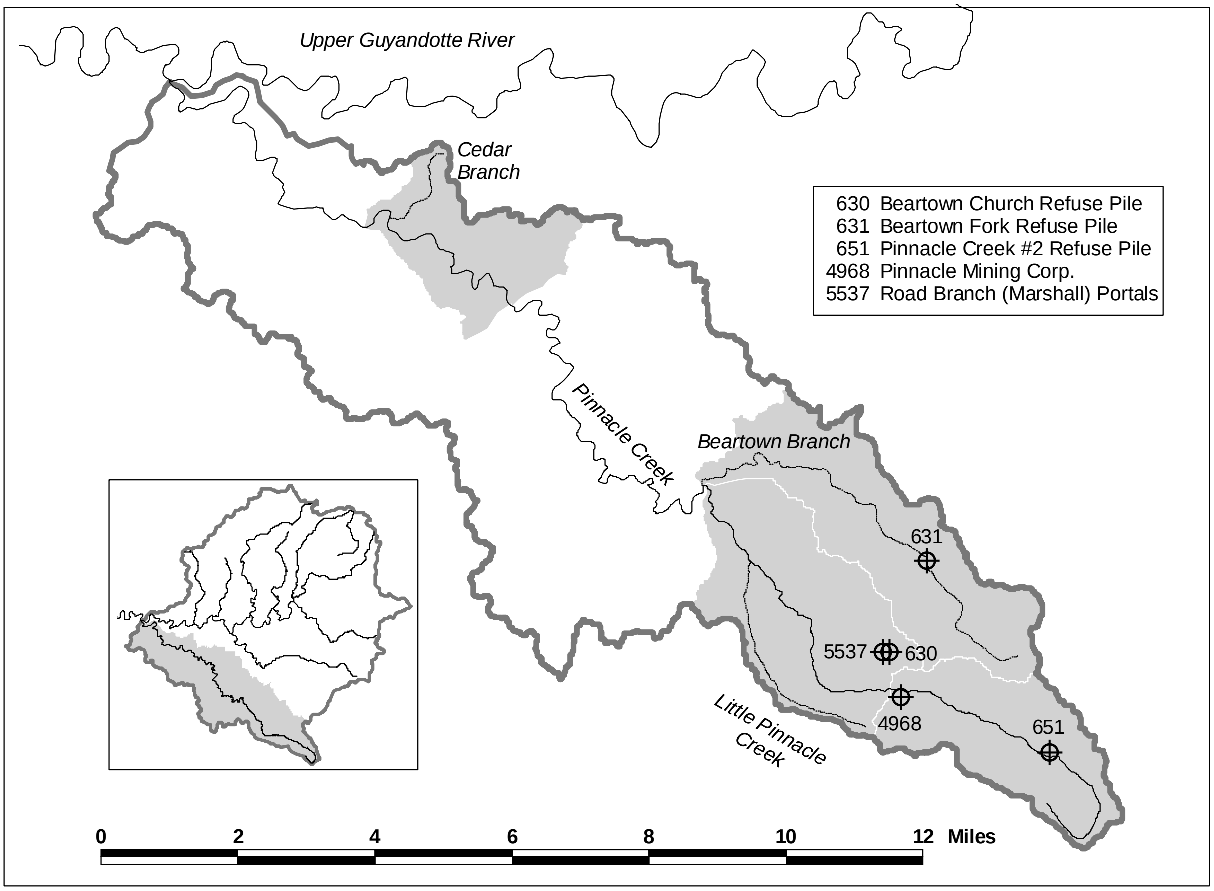
4.2.3 Pinnacle Creek

The watershed of Pinnacle Creek (OG-124) includes TMDL subwatersheds 2800-2813.

Pinnacle Creek is impaired by iron and manganese pollution. Some of its tributaries—Smith Branch, Laurel Branch, and Spider Creek—are also listed for iron and manganese impairment.

The TMDL calls for reductions in metal loads from three subwatersheds in the upper reaches of the Pinnacle Creek watershed, and also from an area containing several smaller tributaries, including Cedar Branch. PADs described nine AMLs in the upper subwatersheds, but none were found for the subwatershed containing Cedar Branch. According to the PADs, clean-ups at five of the AMLs could reduce pollutant loads.

Figure 13: Location of AMLs contributing metals to the Pinnacle Creek watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas. TMDL subwatersheds requiring reductions in metal loads from AMLs are shaded.

Table 18: AMLs adding metals to the Pinnacle Creek watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Beartown Church Refuse Pile (630)	$0	One acre of refuse must be reclaimed.	$20,000
Beartown Fork Refuse Pile (631)	$0	Two acres of refuse must be reclaimed.	$30,000
Pinnacle Creek #2 Refuse Pile (651)	$0	Twenty acres of refuse must be reclaimed.	$320,000
Pinnacle Mining Corp. (4968)	$0	Four acres of refuse must be reclaimed. A portal discharges water used for public water supply. No data are available to evaluate its pollution load or clean-up cost.	$80,000 + Portal water
Road Branch (Marshall) Portals (5537)	$0	Two portals discharge 350 gpm. No water analyses available.	No estimate possible
		Total, Pinnacle Creek watershed	**>$450,000**

Source: Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan. “+ Portal water” indicates that additional costs may be incurred to treat water discharging from portal.

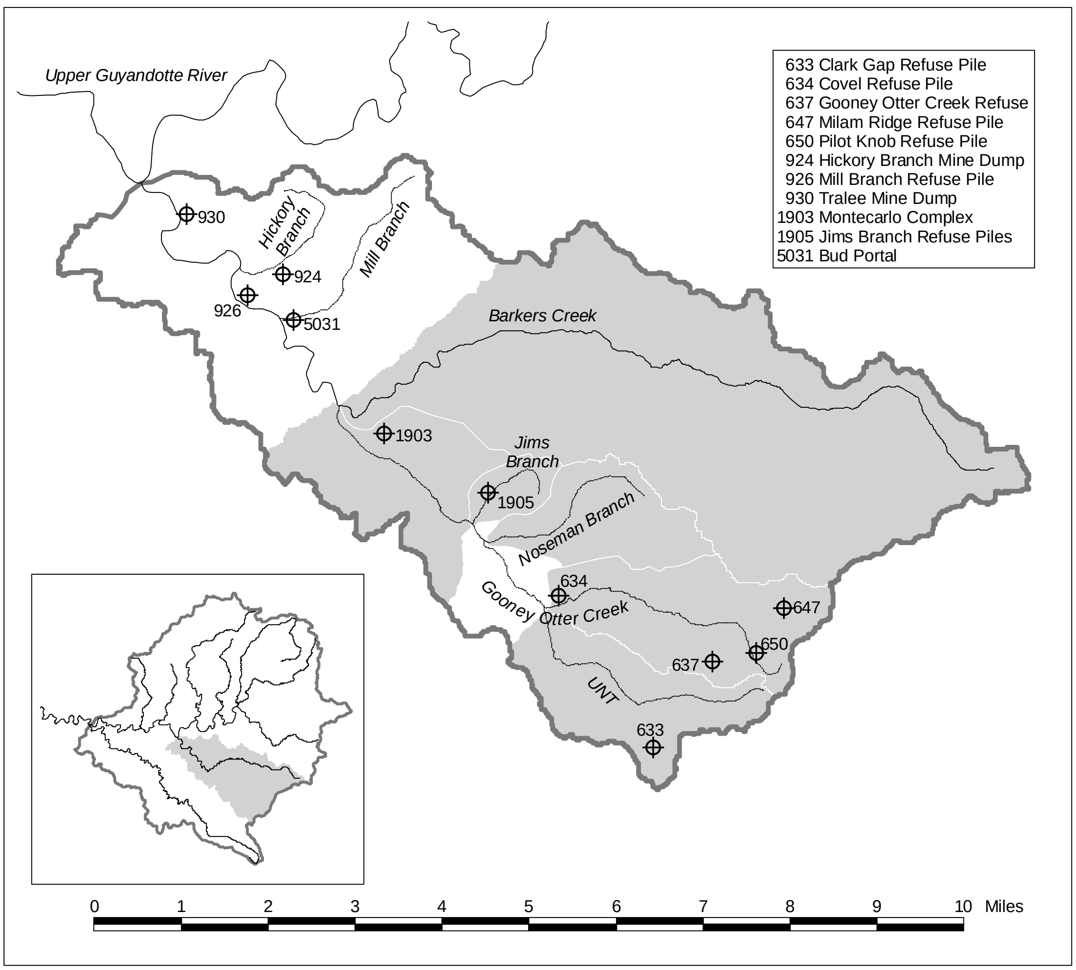
4.2.4 Barker's Creek

The watershed of Barker's Creek (OG-131) contains TMDL subwatersheds 3300-3310.

Barker's Creek and many of its tributaries, including Hickory Branch, Gooney Otter Creek, Jims Branch, and Noseman Branch, are impaired by iron and manganese.

The list of impaired streams in this watershed matches poorly with the subwatersheds in which the TMDL calls for metal reductions, and with the AMLs that generate AMD. The subwatersheds containing Hickory Branch and Mill Branch each contain AMLs that generate metals pollution, and although both streams show impairment, the TMDL does not call for reductions from AMLs there. On the other hand, reductions in metal loads are required in the subwatershed containing Noseman Branch, but no AMLs there are documented as discharging metals pollution. The TMDL does call for reductions in subwatershed containing Gooney Otter Creek and Jims Branch, and AMLs in those subwatersheds do discharge metals.

Figure 14: Location of AMLs contributing metals to the Barker's Creek



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas. TMDL subwatersheds requiring reductions in metal loads from AMLs are shaded.

Table 19: AMLs adding metals to the Barker's Creek watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Clark Gap Refuse Pile (633)	$0	Fifteen acres of refuse must be reclaimed.	$240,000
Covel Refuse Pile (634)	$475,191	Land reclamation is complete, but use of a wet seal suggests water discharge that is not treated.	No estimate possible
Gooney Otter Creek Refuse (637)	$0	30 acres of refuse must be reclaimed.	$490,000
Milam Ridge Refuse Pile (647)	$0	Ten acres of refuse must be reclaimed. Three portals will require wet seals and therefore discharge potentially polluting water. No water quality or quantity data available.	$190,000 + Portal water
Pilot Knob Refuse Pile (650)	$0	Ten acres of refuse must be reclaimed.	$160,000
Hickory Branch Mine Dump (924)	$0	75 acres of refuse must be reclaimed.	>$1,000,000
Alpoca Mine Dump (926)	$0	Ten acres of refuse must be reclaimed.	$160,000
Tralee Mine Dump (930)	$0	100 acres of refuse must be reclaimed.	>$1,000,000
Montecarlo Complex (1903)	$0	Three acres of refuse must be reclaimed, and approximately 80 gpm of drainage at pH 4.5 must be treated. No measurement of the acidity of the drainage is available for a water-treatment cost.	$110,000 + Portal water
Jim's Branch Refuse Piles (1905)	$225,232	Land reclamation is complete, but there has been no treatment of mine drainage. No data are available for water-treatment costs.	No estimate possible
Bud Portal (5031)	$0	A wet seal is required, indicating mine drainage. No data are available for water-treatment costs.	No estimate possible
		Total, Barkers Creek watershed	**>$3,350,000**

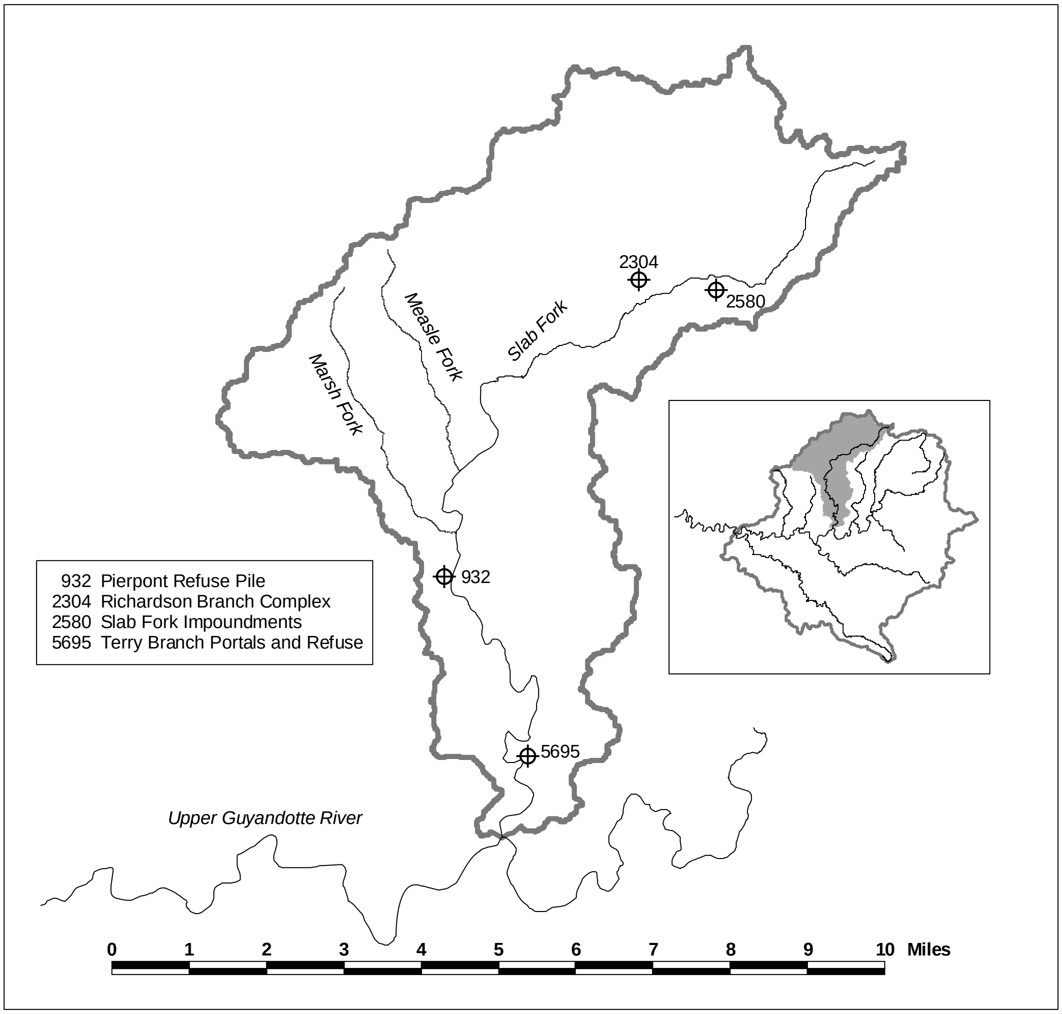
Source: Past reclamation costs from OSM (2005). Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan. "+ Portal water" indicates that additional costs may be incurred to treat water discharging from portal.

4.2.5 Slab Fork

The watershed of Slab Fork (OG-134) contains TMDL subwatersheds 3400-3406.

The Slab Fork watershed also contains Marsh Fork and Measle Fork, both of which are impaired. The TMDL, however, calls for load reductions from AMLs only in the uppermost subwatershed of the Slab Fork watershed.

Figure 15: Location of AMLs contributing metals to the Slab Fork watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 20: AMLs adding metals to the Slab Fork watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Pierpont Refuse Pile (932)	$0	Site includes 6.9 acres of refuse and two portals, one of which discharges 50 gpm, and one of which has a slow discharge. The cost provided is an estimate for land reclamation only. No chemical data are available to estimate the cost of water treatment.	$130,000 + Portal water
Richardson Branch Complex (2304)	$0	Seven acres of refuse coal must be reclaimed.	$110,000
Slab Fork Impoundments (2580)	$0	Approximately two acres must be reclaimed. The area contained slurry ponds and refuse coal.	$30,000
Terry Branch Portals and Refuse (5695)	$0	Approximately one-half acre of refuse coal must be reclaimed.	$10,000
		Total, Slab Fork watershed	**>$280,000**

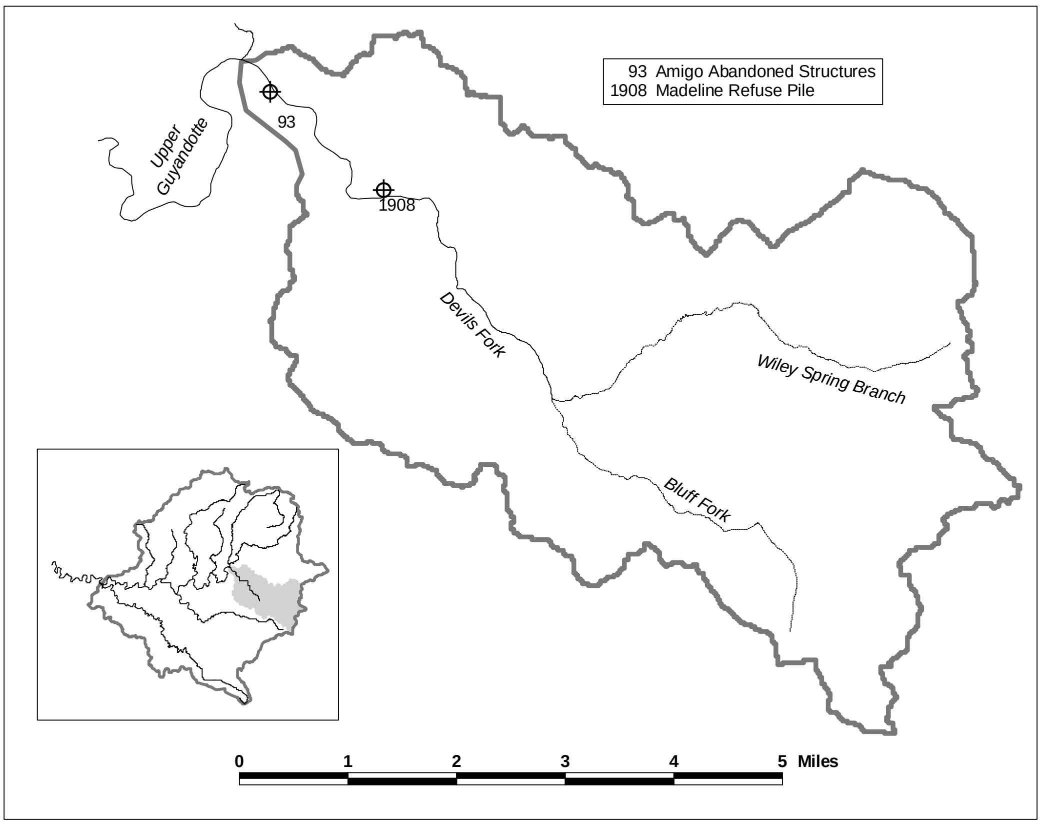
Source: Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan. "+ Portal water" indicates that additional costs may be incurred to treat water discharging from portal.

4.2.6 Devil's Fork

The watershed of Devil's Fork (OG-137) includes TMDL subwatersheds 3600-3604.

The mainstem of this watershed, Devil's Fork, is listed as impaired, and the TMDL calls for reductions only in the subwatershed nearest the confluence of Devil's Fork with the Upper Guyandotte. Seven AMLs were identified in the Devil's Fork watershed, but only two appear to have potential to discharge metals.

Figure 16: Location of AMLs contributing metals to the Devil's Fork watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 21: AMLs adding metals to the Devil's Fork watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Amigo Abandoned Mine Structures (93)	$0	Six scattered acres of refuse coal must be reclaimed.	$100,000
Madeline Refuse Pile (1908)	$0	Three acres of refuse coal must be reclaimed.	$50,000
		Total, Devils Fork watershed	**$150,000**

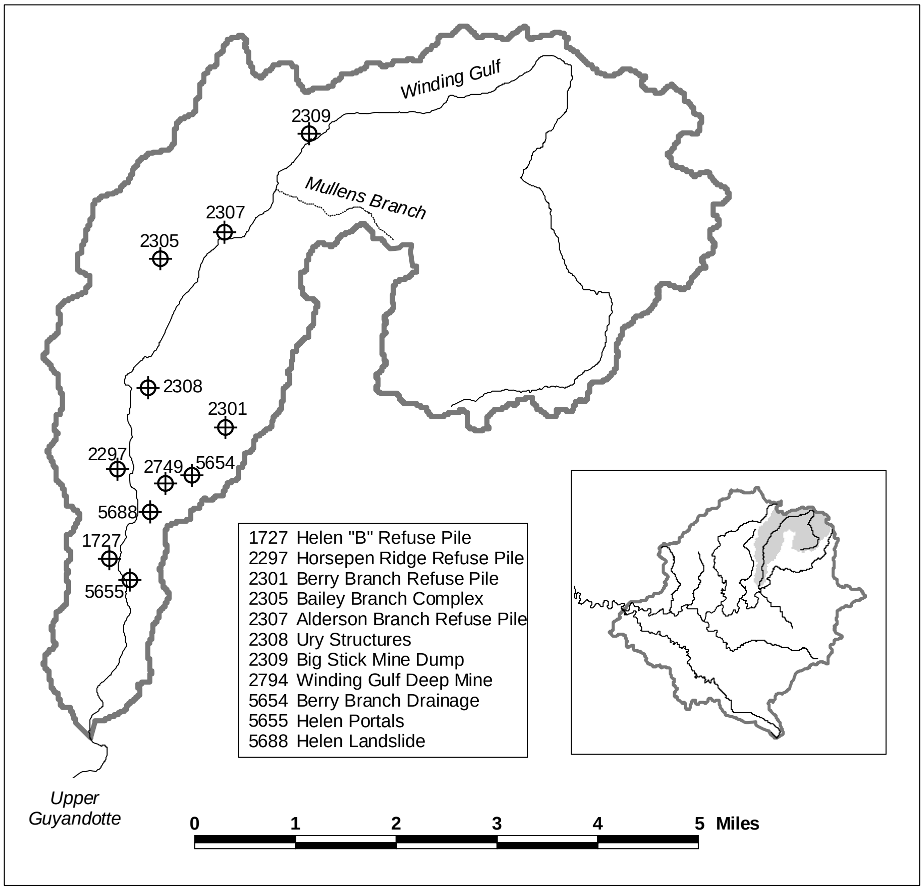
Source: Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

4.2.7 Winding Gulf

The watershed of Winding Gulf (OG-138) includes TMDL subwatershed 3701.

Winding Gulf and its tributary, Mullens Branch, are on the 303(d) list. WVDEP information identified 21 AMLs in the watershed of Winding Branch. Eleven of these are likely to contribute metals to surface water. No AMLs were identified that could contribute to Mullens Branch.

Figure 17: Location of AMLs contributing metals to the Winding Gulf watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 22: AMLs adding metals to the Winding Gulf watershed

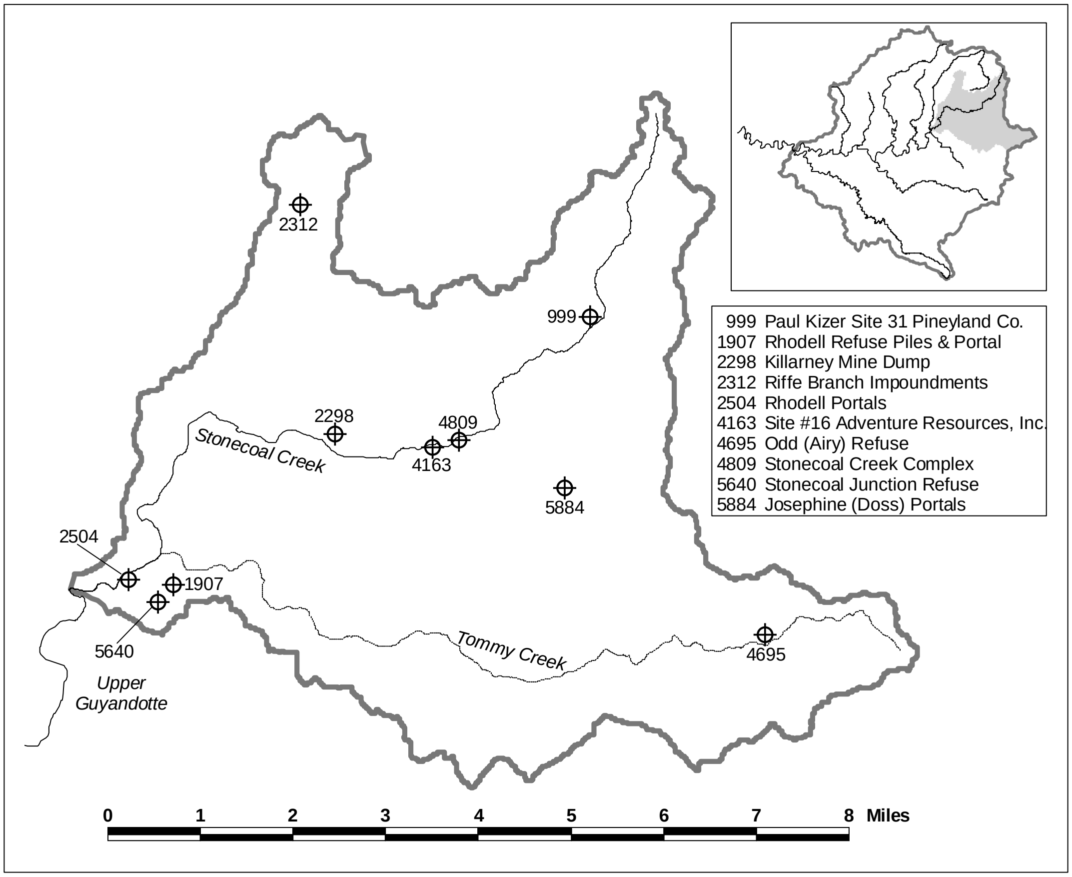
Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Helen "B" Refuse Pile (1727)	$0	Six acres of refuse coal must be reclaimed.	$100,000
Horsepen Ridge Refuse Pile (2297)	$663,296	Land reclamation is complete. Mine drainage is indicated by the use of wet seals, but there is no indication water treatment was constructed, and no water quality or quantity data.	No estimate possible
Berry Branch Refuse Pile (2301)	$0	Four acres of refuse coal must be reclaimed.	$60,000
Bailey Branch Complex (2305)	$0	Fifteen acres of refuse coal must be reclaimed.	$240,000
Alderson Branch Refuse Pile (2307)	$940,724	Land reclamation is complete. One portal is discharging mine drainage. There is no water quality or quantity data.	No estimate possible
Ury Structures (2308)	$0	Three acres of refuse coal must be reclaimed.	$50,000
Big Stick Mine Dump (2309)	$1,157,166	Land reclamation is complete. There is one 40 gpm discharge, but no water quality data.	No estimate possible
Winding Gulf Deep Mine (2749)	$0	A portal discharges 50 gpm, but there are no water quality data.	No estimate possible
Berry Branch Drainage (5654)	$72,600	PAD mentions a mine drainage problem, but provides no water quality or quantity data.	No estimate possible
Helen Portals (5655)	$0	Site includes two portals with a combined discharge >500 gpm. PAD includes no water quality data.	No estimate possible
Helen Landslide (5688)	$102,520	PAD mentions mine water that must be routed to stream, but provides no water quality or quantity data.	No estimate possible
		Total, Winding Gulf watershed	**>$450,000**

Source: Past reclamation costs from OSM (2005). Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

4.2.8 Stonecoal Creek

The watershed of Stonecoal Creek (OG-139) includes TMDL subwatersheds 3702-3707.

Figure 18: Location of AMLs contributing metals to the Stonecoal Creek watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 23: AMLs adding metals to the Stonecoal Creek watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Paul Kizer Site 31 Pineyland Co. (999)	$731,849	No PAD was found for this site. According to AMLIS, work was completed on a dangerous pile or embankment and a portal on this site. Completed work on portals usually consists of a seal, and no water treatment. This portal may be discharging mine drainage.	No estimate possible
Rhodell Refuse Piles & Portal (1907)	$0	10.6 acres of refuse coal must be reclaimed. In addition, the site contains mine drainage that is continuous with impounded surface water. Local residents supply their houses with this water, but no chemical data are available.	$170,000 + Portal water
Killarney Mine Dump (2298)	$0	40 acres of refuse coal must be reclaimed, and there is a 4 gpm discharge. Estimated cost includes reclamation only.	$660,000 + Portal water
Riffe Branch Impoundments (2312)	$0	Impoundments on a former mine site may or may not contain polluted water. Site could be remediated by filling impoundments and reclaiming the area, or by treating the water.	No estimate possible
Rhodell Portals (2504)	$10,450	Two portals are discharging mine water. Past reclamation costs suggest the portals have been sealed, but not treated. No water quality or quantity data are available.	No estimate possible
Site #16 Adventure Resources, Inc. (4163)	$0	One acre of refuse coal must be reclaimed.	$20,000
Odd (Airy) Refuse (4695)	$0	Four acres of refuse coal must be reclaimed.	$60,000
Stonecoal Creek Complex (4809)	$869,300	WVDEP has reclaimed land at this site. In addition, portals have been sealed. The amount spent on portals, however, is consistent with portal seals, and not with water treatment. Together, the portals discharge 1,700 gpm with a pH of 7.5 and an iron concentration of 4 mg/L. Additional treatment cost is for an aerobic wetland expected to sequester 5 grams per square meter per day.	>$1,000,000
Stonecoal Junction Refuse (5640)	$0	Two acres of refuse coal must be reclaimed.	$30,000
Josephine (Doss) Portals (5884)	$0	Site includes three portals discharging mine water. No water quality or quantity data are available.	No estimate possible
		Total, Stonecoal Creek watershed	**>$1,940,000**

Source: Past reclamation costs from OSM (2005). Site and cost descriptions from OSM (2005) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan. "+ Portal water" indicates that additional costs may be incurred to treat water discharging from portal.

5 Technical and financial assistance (d)

Many partners including federal and state agencies, the watershed association, consultants, non-profit assistance providers, academic institutions, and citizens will collaborate in order to provide the technical and financial resources needed to implement this Watershed Based Plan.

All or relevant parts of this WBP will be published and distributed to potential technical and/or financial assistance providers in order to provide background information, demonstrate the need for the projects being proposed, and leverage the resources needed to implement this plan.

5.1 Wastewater Treatment Projects

5.1.1 Technical assistance

Tasks required for project implementation and the partner agency or organization responsible for each task is outlined in Table 24.

Table 24: Tasks required for implementation of wastewater treatment projects

Task	**Lead Agency**/ Partners
Coordinate and apply for various funding sources	**UGWA**, CVI, Region 1 PDC, COMA PSD, WV Water Research Inst.
Collect water quality data at sources of untreated wastewater	WVDEP, UGWA, WV Water Research Inst.
Create preliminary engineering reports	Consultants, CVI
Create detailed engineering designs of wastewater treatment projects	**Engineering firm**
Coordinate training opportunities to increase the capacity of local installers and system designers	**CVI**, UGWA, COMA PSD, East. Wyo. PSD
Perform project management, including putting projects out for bid, managing projects, and tracking their progress	**UGWA, grant administrator, COMA PSD, East Wyo. PSD,** and all project partners
Coordinate program to install individual onsite systems and provide homeowners instruction on proper septic maintenance	**UGWA**
Coordinate education and outreach efforts to raise public awareness of nonpoint source wastewater pollution	**UGWA**
Monitor instream and source water quality following the installation of wastewater treatment projects in order to document their effectiveness	UGWA, WVDEP, WV Water Research Inst.

Upper Guyandotte Wastewater Project Committee

Upper Guyandotte Wastewater Project committee member agencies and organizations participate in monthly meetings which are organized and chaired by the Upper Guyandotte Watershed Association. The committee has served as a steering committee throughout the development of this plan and will continue to fulfill that function during project implementation. Committee members will share information, target priority projects for implementation, set project goals, analyze technical information and data, develop funding packages, select engineering firms and consultants, evaluate progress, and assist with other implementation tasks.

As other areas of expertise are needed, additional partners will be engaged to participate in the Upper Guyandotte Wastewater Project committee. Both *potential* and current participants are listed below.

- Upper Guyandotte Watershed Association
- Canaan Valley Institute
- WV Department of Environmental Protection
    - Non-Point Source Program and Watershed Assessment Program
- Mountain Resource Conservation and Development Council
- West Virginia Conservation Agency
- Crab Orchard MacArthur PSD
- Rural Appalachian Improvement League
- West Virginia Bureau for Public Health
- Wyoming County Health Department
- Southern Conservation District
- Beckley-Raleigh County Health Department
- Eastern Wyoming PSD
- WV Water Research Institute
- System manufacturers
- Region 1 Planning and Development Council
- USDA, Natural Resources Conservation Service
- *Rural Community Assistance Program*
- *US Army Corps of Engineers, Huntington office*
- *WV Development Office*
- *WV Sewage Advisory Board*
- *WV Public Service Commission*

5.1.2 Funding sources

Multiple funding sources have been explored for implementation of this Watershed Based Plan. Potential sources include state and federal agencies, as well as private and foundation funding, and are listed below.

- WV Infrastructure and Jobs Development Council (IJDC). Most sources of public funding for wastewater infrastructure are administered by the IJDC.
- WV Department of Environmental Protection, 319 Program & State Revolving Fund
- USDA Rural Utility Services
- Small Cities Block Grants
- Appalachian Regional Commission
- US Army Corps of Engineers
- US Environmental Protection Agency (i.e. State/Tribal Assistance Grants)
- Canaan Valley Institute (design funding)
- USDA 504(b) program (on-site septic systems)

- US Department of Housing and Urban Development (203(k) program for on-site septic systems)
- Private Foundations
- Local government
- Local land-owners, industry and other private investments

5.2 AML Reclamation Projects

5.2.1 Technical Assistance

Tasks required for project implementation and the partner agency or organization responsible for each task is outlined in Table 25.

Table 25: Tasks required for implementation of AML remediation projects

Task	**Lead Agency**/ Partners
Coordinate and apply for various funding sources	**UGWA,** RAIL
Collect data at sources of metals in preparation for the design of remediation projects	WVDEP, WVU, UGWA
Create conceptual designs of remediation projects	OSM, WVU
Create detailed engineering designs of remediation projects	**Consultants,** NRCS
Perform project management, including putting projects out for bid, managing projects, and tracking their progress	**UGWA, grant administrator,** and all project partners
Monitor instream and source water quality following the installation of remediation projects in order to document their effectiveness	WVDEP, UGWA

Both potential and current partners in project implementation, as identified in Table 25, are listed below.

- Upper Guyandotte Watershed Association
- Rural Appalachian Improvement League
- WV Department of Environmental Protection,
    - Non-Point Source Program, Watershed Assessment Program, and Office of Abandoned Mine Lands and Reclamation
- US Office of Surface Mining, Reclamation and Enforcement
- West Virginia University, National Mine Land Reclamation Center
- USDA Natural Resource Conservation Service
- Southern Conservation District
- US Environmental Protection Agency

5.2.2 Funding Sources

Several funding sources are available for nonpoint source remediation of AMLs and for water quality monitoring, including:

- WV DEP Section 319 funds
- Abandoned Mine Land Trust Fund[12]
- 10% AMD Set-Aside Fund[13]
- Watershed Cooperative Agreement Program
- US Army Corps of Engineers
- Stream Partners Program
- USEPA Brownfields Program (Chapter 6.1)
- Private Foundations
- Local government
- Local land-owners, industry and other private investments

[12] Reauthorization of the AML Trust Fund, which expired on September 30, 2004, is still not settled. At the time that this document is being written, the fund has been temporarily reauthorized through June 2006. A new OSM rule published in September 2004 also reauthorizes a much smaller per-ton tax. It is still not clear what shape a final reauthorization might take.

[13] These funds cannot be allocated to a watershed until after a Hydrologic Unit Plan is developed and approved by OSM. A new Hydrologic Unit Plan will be needed for the Upper Guyandotte watershed.

6 Implementation Schedule, Milestones, and Measurable Goals for Wastewater Treatment Projects (f, g, h)

This chapter describes in detail the implementation plan for wastewater treatment projects. Implementation of metals remediation projects is described in Chapter 7.

6.1 Prioritization Schema

The following prioritization schema was developed in order to provide an objective method for comparing individual projects to one another, a consistent tool for ranking projects, and a guideline for developing the implementation schedule. While attaining water quality standards in impaired streams is the overarching goal of this WBP, the incorporation of local needs and priorities is vital to ensuring the long-term success of implementation efforts.

It is also important to note that the prioritization schema is intended to be flexible, incorporating new data as it becomes available, and allowing implementation of projects to occur in an opportunistic fashion.

Input from the citizens of the Upper Guyandotte watershed was therefore a key factor in prioritizing wastewater treatment projects. Input was gathered from River Survey respondents, at Upper Guyandotte Wastewater Project committee meetings, at regular UGWA meetings, and through other UGWA outreach efforts (Chapter 9).

The Upper Guyandotte Watershed Association and Canaan Valley Institute also hosted a public meeting in Mullens on October 10, 2005. Attendees listed factors important to them and their communities when weighing proposed projects against each other. Many potential prioritization criteria were presented and, from among those, six were chosen as the most important. They include:

- Impact on water quality
- Construction cost
- Long-term operation and maintenance costs
- Community support
- Impact on public health
- Available funding

All 6 criteria used in project prioritization are measurable. Each project was given a numerical score for the water quality improvement, construction cost, and O/M cost criteria.

Scores for water quality improvement were based on the following ratio:

$$\frac{\textit{Load reduction expected upon project implementation}}{\textit{Current annual load across the subwatershed}}$$

This ratio describes the impact the removal of one community or source of pollution has on the total pollution load that subwatershed is contributing to the Guyandotte River. Communities located in subwatersheds with fewer communities overall scored highest in this category. Communities located in subwatersheds with several, large sources of pollution scored lowest.

Scores for construction cost were based on the following ratio:

$$\frac{\textit{Treatment system construction cost per household}}{\textit{Annual median household income}}$$

Scores for O/M cost were based on the following ratio:

$$\frac{\textit{Annual operation and maintenance cost}}{\textit{Annual median household income}}$$

The construction cost and O/M cost ratios describe the cost effectiveness of the project and the ability of the community to support either the initial construction cost or the long-term maintenance costs of the treatment system, respectively. These ratios can be critical in determining the likelihood that the project will be funded, especially by the IJDC and other traditional sources of infrastructure funding (Chapter 5.1.2). Communities for which onsite treatment systems were the preferred system scored highest for both of these criteria.

At the time this plan was developed, it was not possible to assign numerical scores for the remaining criteria: community support, impact on public health, and available funding. Rather, these criteria were considered threshold criteria. If a project meets the threshold for one of these three criteria, it will be given special consideration above all other projects, including those whose community score gave them a higher priority ranking. If sufficient data becomes available with which all projects can be compared against each other for any one of these three criteria, relative scores will be assigned using the same method described above.

The thresholds are defined as follows:

- Community support-- 50% or more of the community members have expressed support and/or demonstrated a willingness to pay a monthly fee for wastewater treatment
- Impact on public health-- Credible data documents an imminent or existing threat to public health (e.g. incidence of disease linked to exposure to untreated wastewater is present in the community, incidence of fecal coliform contamination of drinking water wells is present in the community)
- Available funding-- Project has a significant competitive advantage and is likely to receive funding

The raw data was normalized in order to allow a unit-less comparison of the water quality, construction cost, and O/M cost ratios.[14] Adding the three scores gives the total numerical score

[14] For a more detailed description of the ranking score calculations, see Appendix H, pg. 99.

for each community. Community scores were then averaged across the subwatershed to give a numerical score for each subwatershed. These subwatershed scores were then used to rank the major subwatersheds in priority order (Table 26). Individual project implementation will occur first in top priority subwatersheds. Coordinating project implementation on a subwatershed scale will allow for the achievement of significant, measurable improvements in water quality in the major tributaries of the Guyandotte River.

Table 26: Subwatersheds and communities in ranked priority order for implementation

Subwatershed and Average Score	Community	Water Quality Improvement	Construction Cost	OM Cost	Community Score
Devil's Fork	Amigo	1.000	0.737	0.614	2.351
2.001	Egeria	0.199	0.693	0.760	1.652
Pinnacle Creek	Bob's Branch	0.125	0.804	0.847	1.775
1.893	Bud Lite	0.057	0.804	0.847	1.707
	Herndon Heights	0.618	0.774	0.824	2.216
	Micajah	0.147	0.804	0.847	1.798
	Spider Ridge	0.252	0.774	0.824	1.850
Slab Fork	Acord Mt.	0.094	0.827	0.865	1.786
1.547	Hotchkiss	0.203	0.702	0.730	1.635
	Lower Polk Gap	0.077	0.771	0.821	1.668
	Maben	0.109	0.572	0.430	1.111
	McKinney Ridge	0.063	0.827	0.865	1.755
	Otsego	0.262	0.528	0.459	1.250
	Pierpoint	0.282	0.868	0.347	1.497
	Polk Gap	0.046	0.737	0.795	1.579
	Tams Mt.	0.015	0.793	0.838	1.645
Guyandotte River 1	Cabin Creek	0.084	0.719	0.781	1.584
1.533	Lower Itmann	0.289	0.608	0.508	1.404
	New Richmond	0.299	0.577	0.446	1.323
	Rt. 16 pg 1	0.023	0.768	0.819	1.610
	Rt. 16 pg 6	0.006	0.783	0.831	1.619
	Saulsville	0.263	0.733	0.791	1.788
	Still Run	0.006	0.783	0.831	1.619
	Upper Itmann	0.147	0.579	0.506	1.232
	Upper Polk Gap	0.009	0.783	0.831	1.623
Barker's Creek	Alpoca	0.194	0.735	0.671	1.601
1.491	Basin	0.033	0.736	0.793	1.562
	Basin Ridge 2	0.055	0.725	0.785	1.566
	Basin Ridge 1	0.147	0.743	0.799	1.690
	Basin Road	0.024	0.697	0.763	1.484
	Bud	0.181	0.664	0.578	1.423
	Bud Mountain	0.041	0.804	0.847	1.692
	Covel	0.107	0.542	0.398	1.047
	Garwood	0.059	0.557	0.338	0.953
	Herndon	0.048	0.726	0.482	1.256
	Herndon II	0.048	0.742	0.799	1.589
	Lusk Community	0.026	0.697	0.763	1.486
	Lusk Settlement	0.020	0.702	0.767	1.490
	Montecarlo	0.008	0.783	0.830	1.621
	Peak Creek	0.050	0.739	0.796	1.585
	Tracy's Mountain	0.099	0.749	0.804	1.651
	Tralee	0.008	0.804	0.847	1.659

Subwatershed and Average Score	Community	Water Quality Improvement	Construction Cost	OM Cost	Community Score
Guyandotte River 2	Allen Junction	0.119	0.454	0.504	1.077
1.269	Beechwood	0.100	0.626	0.799	1.525
	Blackeagle	0.068	0.317	0.575	0.960
	Corinne	0.159	0.816	0.606	1.581
	Corinne Bottom	0.200	0.772	0.535	1.508
	Iroquois	0.092	0.794	0.484	1.371
	Sand Gap	0.086	0.702	0.767	1.555
	Stephenson Bottom	0.097	0.837	0.196	1.130
	Stephenson Hill	0.057	0.605	0.339	1.001
	Wyco	0.169	0.481	0.335	0.985
Stonecoal Creek	Besoco	0.072	0.000	0.373	0.446
1.181	Eastgulf	0.106	0.756	0.250	1.113
	Josephine	0.171	0.659	0.733	1.563
	Kilarney	0.006	0.653	0.729	1.388
	Lego	0.065	0.478	0.333	0.876
	Mead	0.077	0.484	0.872	1.433
	Mead II	0.026	0.666	0.739	1.430
	Odd	0.058	0.690	0.757	1.505
	Pickshin	0.036	0.797	0.000	0.833
	Rhodell	0.518	0.486	0.222	1.225
Winding Gulf	Helen	0.764	0.264	0.205	1.234
1.178	McAlpin	0.032	0.658	0.733	1.423
	Stotesbury	0.210	0.805	0.038	1.053
	Ury	0.116	0.812	0.073	1.001

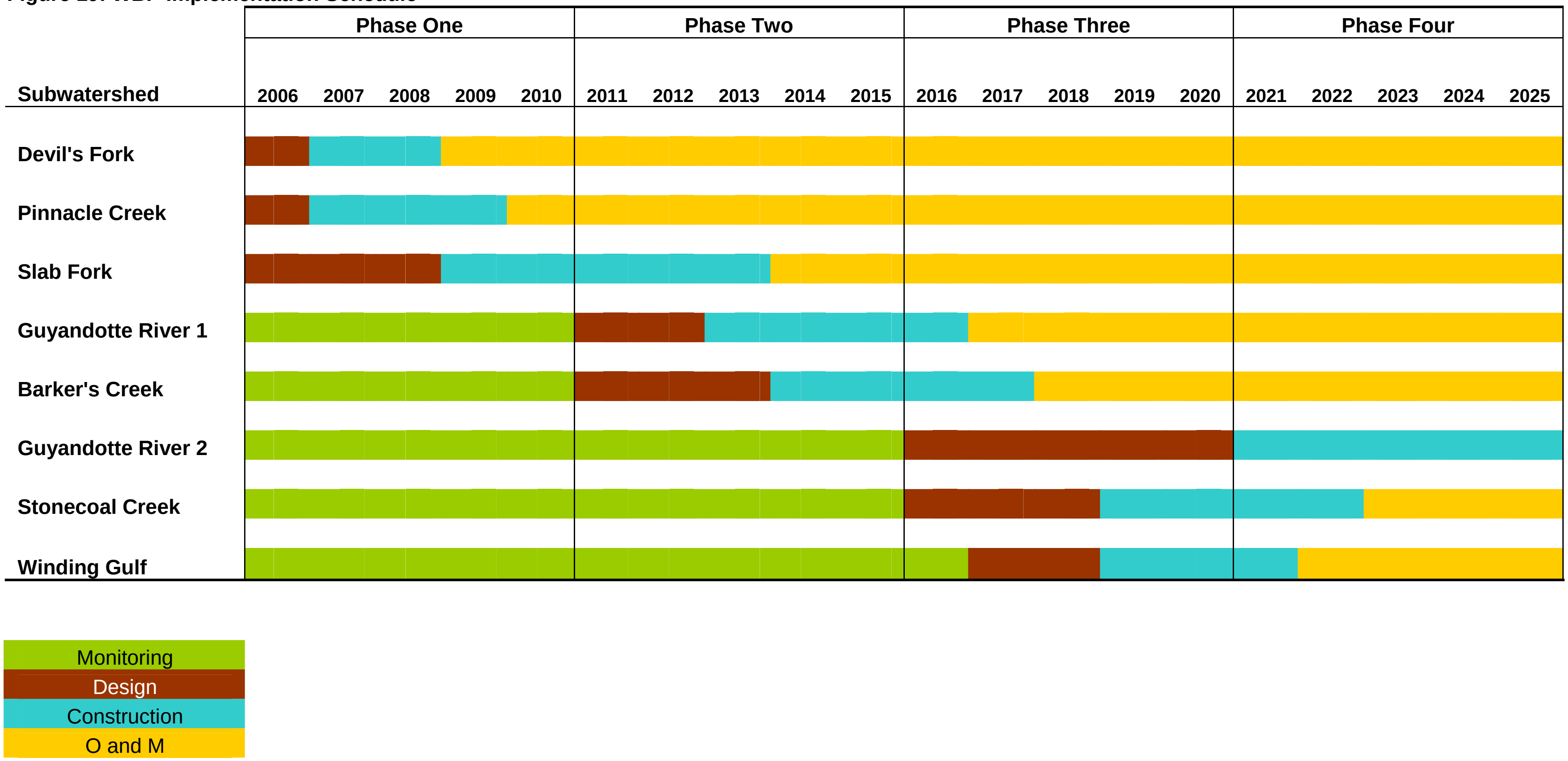
6.2 Implementation Schedule

Project implementation will occur in four phases: monitoring, design, construction, and operation and maintenance. Top priority projects will enter the design phase upon approval of this Watershed Based Plan. During the design phase a qualified engineering firm will be selected to prepare detailed engineering reports. The engineering reports will be used to solicit construction funds. When the funding package is complete, the project will enter the construction phase. Upon completion of project construction, the Responsible Management Entity will take over long-term operation and maintenance of the wastewater treatment system. Lower priority projects will remain in the monitoring phase (Chapter 8) until top priority projects have entered the construction phase and resources are available for additional projects to enter the design phase.

Whenever applicable, efforts to assist homeowners obtain individual onsite wastewater treatment systems will occur concurrently with design and construction of community wastewater treatment systems in priority subwatersheds.

Figure 19 gives an approximate implementation schedule by subwatershed. This implementation schedule represents an ideal, though realistic, scenario. All progress made towards achieving milestones is contingent on available funding.

Figure 19: WBP Implementation Schedule



6.3 Measurable Milestones

The number of: preliminary engineering reports and detailed design plans completed, projects funded for construction, wastewater treatment systems constructed, and homes being served will serve as interim milestones to measure the progress of implementation across subwatersheds.

6.3.1 Phase 1: 2006 through 2010

Devil's Fork[15]

- Create preliminary engineering report and detailed design plan for Amigo
- Formalize Memorandum of Understanding (MOU) with RME
- Complete site by site evaluation of existing septic systems in Egeria and Amigo
- Secure funding and construct wastewater treatment system for Amigo
- Install individual onsite wastewater treatment systems in Egeria and Amigo

Pinnacle Creek

- Complete site by site evaluation of existing septic systems in all 5 Pinnacle Creek communities
- Install individual onsite wastewater treatment systems in all 5 Pinnacle Creek communities

Slab Fork

- Create preliminary engineering reports and detailed design plans for Hotchkiss, Otsego, Maben, and Pierpoint
- Formalize MOU with RME
- Complete site by site evaluation of existing septic systems in 6 remaining Slab Fork communities
- Begin installation of individual onsite wastewater treatment systems in 6 remaining Slab Fork communities
- Secure funding and begin construction of community systems for Hotchkiss, Otsego, Maben, and/or Pierpoint

6.3.2 Phase 2: 2011 through 2015

Slab Fork

- Secure funding and complete construction of all remaining community systems
- Complete installation of individual onsite wastewater treatment systems

Guyandotte River 1

- Create preliminary engineering reports and detailed design plans for Upper and Lower Itmann and New Richmond
- Formalize MOU with RME

[15] Immediately prior to the submission of this WBP, a proposal for Section 319 funding to implement proposed projects in the Devil's Fork subwatershed was prepared and submitted.

- Complete site by site evaluation of existing septic systems in 6 remaining Guyandotte River 1 communities
- Install individual onsite wastewater treatment systems in 6 remaining Guyandotte River 1 communities
- Secure funding and begin construction of community systems for Upper and Lower Itmann and/or New Richmond

Barker's Creek

- Create preliminary engineering reports and detailed design plans for Alpoca, Garwood, Herndon, Bud, and Covel
- Formalize MOU with RME
- Complete site by site evaluation of existing septic systems in 12 remaining Barker's Creek communities
- Begin installation of individual onsite wastewater treatment systems in 12 remaining Barker's Creek communities
- Secure funding and begin construction of community systems for Alpoca, Garwood, Herndon, Bud, and Covel

6.3.3 Phase 3: 2016 through 2020

Guyandotte River 1

- Secure funding and complete construction of all remaining community systems

Barker's Creek

- Secure funding and complete construction of all remaining community systems
- Complete installation of individual onsite wastewater treatment systems

Guyandotte River 2

- Create preliminary engineering reports and detailed design plans for Allen Junction, Beechwood, Iroquois, Stephenson, Wyco, Blackeagle, and Corrine
- Formalize MOU with RME
- Complete site by site evaluation of existing septic systems in Sand Gap
- Install individual onsite wastewater treatment systems in Sand Gap

Stonecoal Creek

- Create preliminary engineering reports and detailed design plans for Besoco, Eastgulf, Mead, Lego, Rhodell, and Pickshin
- Formalize MOU with RME
- Complete site by site evaluation of existing septic systems in 4 remaining Stonecoal Creek communities
- Begin installation of individual onsite wastewater treatment systems in 4 remaining Stonecoal Creek communities

- Secure funding and begin construction of community systems for Besoco, Eastgulf, Mead, Lego, Rhodell, and/or Pickshin

Winding Gulf

- Create preliminary engineering reports and detailed design plans for Helen, Stotesbury, and Ury
- Formalize MOU with RME
- Complete site by site evaluation of existing septic systems in McAlpin
- Install individual onsite wastewater treatment systems in McAlpin
- Secure funding and begin construction of community systems for Helen, Stotesbury, and Ury

6.3.4 Phase 4: 2020 through 2025

Guyandotte River 2

- Secure funding and begin construction of community systems for Allen Junction, Beechwood, Iroquois, Stephenson, Wyco, Blackeagle, and Corrine

Stonecoal Creek

- Secure funding and complete construction of all remaining community systems
- Complete installation of individual onsite wastewater treatment systems

Winding Gulf

- Secure funding and complete construction of all remaining community systems

6.4 Water Quality Goals

6.4.1 Phase 1: 2006 through 2010

- At the end of Phase One, annual fecal coliform loading to the Upper Guyandotte watershed will be reduced by at least 7%.
- Instream water quality monitoring across the Devil's Fork and Pinnacle Creek watersheds will show that all streams are meeting water quality standards for fecal coliform bacteria. Macroinvertebrate monitoring will also show an improvement in habitat quality.

6.4.2 Phase 2: 2011 through 2015

- At the end of Phase Two, annual fecal coliform loading to the Upper Guyandotte watershed will have decreased by at least an additional 13%.
- Instream water quality monitoring across the Slab Fork watershed will show that all streams are meeting water quality standards for fecal coliform bacteria. Macroinvertebrate monitoring will also show an improvement in habitat quality.

6.4.3 Phase 3: 2016 through 2020

- At the end of Phase Three, annual fecal coliform loading to the Upper Guyandotte watershed will have decreased by at least an additional 36%.
- Instream water quality monitoring across the Guyandotte River 1 and Barker's Creek watersheds will show that all streams are meeting water quality standards for fecal coliform bacteria. Macroinvertebrate monitoring will also show an improvement in habitat quality.

6.4.4 Phase 4: 2021 through 2025

- At the end of Phase Four, annual fecal coliform loading to the Upper Guyandotte watershed will have decreased by at least an additional 37%.
- Instream water quality monitoring across the Stonecoal Creek, Winding Gulf, and Guyandotte River 2 watersheds will show that all streams are meeting water quality standards for fecal coliform bacteria. Macroinvertebrate monitoring will also show an improvement in habitat quality.

6.5 Progress Evaluation

The Upper Guyandotte Wastewater Project committee will annually evaluate timeliness and efficacy of implementation efforts. The committee will consider new information, wastewater treatment technologies previously unavailable or not considered, new water quality data, keys to implementation successes, reasons for short falls, and the overall applicability of implementation efforts in the local context. Based on their review, the committee will recommend amending the implementation schedule, measurable goals, and/or any other portion of this Watershed Based Plan.

Water quality monitoring data (Chapter 8) will be used to assess whether load reductions are being achieved and progress is being made towards attaining water quality standards. If the load reductions are not sufficient to achieve water quality standards as outlined in Chapter 6.4, the committee will recommend revisions of the Guyandotte River TMDL.

Water quality monitoring data will also be used to further assess the relative source contributions of fecal coliform bacteria and the accuracy of load reduction estimates presented in this WBP. If necessary, and upon collection of sufficient water quality data, more sophisticated modeling techniques will be employed in revising this plan.

The TMDL does not accurately document the endemic problems stemming from untreated wastewater in the tributaries of the Upper Guyandotte watershed. Its use of models that rely on regional-scale data and assumptions yields an assessment of impairment that is incomplete. Stream sampling by the WV DEP Watershed Assessment Program has documented violations of water quality standards in several tributaries due to the presence of fecal coliform bacteria (Table 27). However, the fecal coliform TMDL was developed to only address impairment in the

Guyandotte mainstem. The TMDL does not address fecal coliform bacteria impairment in the tributaries. In fact, "source contributions from the upstream tributaries in the Guyandotte River watershed were reduced to meet the TMDL endpoint in the Guyandotte River mainstem only." As part of its methodology the TMDL notes that "tributaries to the Guyandotte River mainstem are not known to be impaired for fecal coliform bacteria. Future monitoring in the Guyandotte River watershed may reveal fecal coliform impairments which would then be listed on the Section 303(d) list of impaired waters. Subsequent TMDL development would follow West Virginia's Watershed Management Framework process," (USEPA, 2002, pg. 5-12). It is important to understand that tributaries in the Upper Guyandotte may not be listed as "impaired" simply owing to a lack of data collection and appropriate documentation. Given the character of the stream system and the prevalence of homes without a documented means of sewage treatment it is very likely that many tributaries would qualify as "impaired" if appropriate steps were taken to document the condition.

Data collected through the watershed survey (Chapter 2.2) as well as future stream sampling will help to better characterize the prevalence of fecal coliform bacteria in both the mainstem of the Guyandotte and its tributaries. UGWA will work with WVDEP to list impaired streams on the 303(d) list whenever applicable.

Figure 4-2 in the TMDL (USEPA, 2002, pg. 4-14) illustrates an erroneous conclusion reached through the use of census tract data that is too coarse to support this level of modeling. Census tracts are the third largest unit used to report census statistics. No boundaries employed by the U.S. Census Bureau strictly conform to watershed boundaries. The figure shows the Winding Gulf Watershed as containing between 1,182 and 1,575 homes. In fact, the watershed survey recorded only 123 homes in the Winding Gulf watershed (Table 11, pg. 25). During TMDL development, the census tract population data were apportioned, by area, across several watersheds. The tract used to determine population in Winding Gulf probably includes densely populated areas in the greater Beckley, WV region, outside of the Upper Guyandotte River Watershed boundary.

This census tract data was also used to determine the number of homes with and without sewer service. Assumptions concerning the prevalence of septic systems and untreated discharges were used to account for the unsewered homes. Based on the UGWA survey of permitted septic systems, these assumptions in TMDL Chapter 4.3.4 do not accurately represent conditions and, in fact, they tend to underestimate the number of homes which lack either sewer or a permitted septic system. The TMDL assumes that 75% of the unsewered homes have septic systems while 25% discharge untreated sewage directly to a stream. According to the UGWA survey, the proportion of unsewered homes with permitted septic systems is 12%. Thus, the remaining 88% of unsewered homes either discharge untreated wastewater directly to the stream or through an unpermitted septic system.

Table 27: Water quality data showing fecal coliform levels exceeding standards

Stream Name	Stream Code	TMDL SWS	Sample Date	Mile Point	Fecal coliform cfu/100mL	Site Description
Guyandotte River	OG-up		Aug-05	155.3	1,000	
Beartown Fork	OG-124-N	2811	9/5/2000	3.7	640	Southwest of Mullens
Marsh Fork	OG-127-D		9/7/2000	2	480	Near Saulsville
Barkers Creek	OG-131	3300	9/6/2000	0.6	4,400	In Tralee
Mill Branch	OG-131-C	3302	9/6/2000	0	2,071	At Bud
Gooney Otter Creek	OG-131-F	3304	9/5/2000	0	1,589	Northwest of Herndon
Gooney Otter Creek	OG-131-F	3304	5/4/2004	0.3	530	Northwest of Herndon
Jims Branch	OG-131-F-1	3304	9/5/2000	0	1,000	In Herndon
Slab Fork	OG-134	3400	9/5/2000	0.3	1,400	In Mullens
Slab Fork	OG-134		Aug-05	9.9	7,600	
Marsh Fork	OG-134-C	3403	9/5/2000	1	480	East of Twin Falls State Park
Big Branch	OG-136		9/6/2000	0	1,060	4 mi. east of Mullens
Devils Fork	OG-137	3600	9/7/2000	0	820	In Amigo
Mullens Branch	OG-138-E	3701	9/11/2000	0	4,400	At Stotesbury
Winding Gulf	OG-138-E	3701	9/6/2000	0.7	1,060	Just north of Amigo
Winding Gulf	OG-138-E		Aug-05	2	7,200	
Stonecoal Creek	OG-139	3703	9/11/2000	3.1	91,000	West of Eastgulf and Killarney
Stonecoal Creek	OG-139	3702	9/6/2000	0	490	Just north of Amigo
Stonecoal Creek	OG-139		Aug-05	3.1	1,650	
Tommy Creek	OG-139-A	3707	9/7/2000	0	2,200	At Rhodell
Tommy Creek	OG-139-A		Aug-05	6.2	7,600	

Source: WV DEP (Various dates).

7 Implementation Schedule, Milestones, and Measurable Goals for AML Projects (f, g, h)

This chapter describes in detail the implementation plan for metals remediation projects. Implementation of wastewater treatment projects is described in Chapter 6.

7.1 Prioritization Schema

Based on input from UGWA members and River Survey respondents, it has been determined that addressing fecal coliform pollution is more important in the local context than addressing nonpoint metals pollution. In fact, 88% of survey respondents cite pollution due to "raw sewage" as a water quality issue they are concerned about; only 46% responded similarly about "old, unreclaimed mine sites". Therefore, whenever funding or personnel resources limit the number of nonpoint source management measures that can be implemented, wastewater treatment projects will be prioritized over AML remediation.

Implementation of metals remediation projects will also begin in priority subwatersheds as established by the prioritization schema described in Chapter 6.1. This coordinated approach allows streams to attain water quality standards for several nonpoint pollutants and demonstrates a more significant improvement in water quality.

Properties targeted for Brownfields cleanup and redevelopment will also be prioritized in the implementation of metals remediation projects identified in this WBP. In December 2005, the Wyoming County Economic Development Authority applied for a USEPA Brownfields Assessment Grant for mine scarred lands in the Wyoming County portion of the Upper Guyandotte watershed. The Brownfields grant program is designed to identify, assess, clean up, and reuse abandoned properties contaminated by previous industrial use. If approved, this grant will provide $200,000 to conduct assessment work on mine scarred lands. The money will fund inventory, data collection regarding land use history and screening of potential sites to target 10 sites for Phase I Environmental Site Assessments (ESAs). Phase I ESAs, including some on-site reconnaissance, will be completed for five of the targeted properties. Phase II ESAs, including extensive soil and groundwater sampling, will be completed on three properties with Recognized Environmental Conditions identified during the Phase I assessment process. Sites will be prioritized based on potential for contamination, health and environmental impacts of cleanup, redevelopment potential, and other locally identified criteria. Thus, working through the Brownfields program will address both economic and environmental revitalization of the watershed.

7.2 Implementation Schedule

Project implementation will occur in four phases: monitoring, design, construction, and post-construction, and includes tasks as outlined in Table 25.

Before specific sites can be targeted for remediation, additional water quality monitoring will need to take place. Discrepancies between known impairments and an incomplete catalogue of sources of pollution will need to be resolved. In addition, more data is needed for several known AMLs in order to estimate load reductions and costs.

When a more thorough assessment has been completed, sources of pollution will be selected for remediation. Within priority subwatersheds, implementation will occur starting at the headwaters and working downstream. During the design phase a qualified engineering firm will be selected to prepare detailed engineering reports. The engineering reports will be used to solicit construction funds. When the funding package is complete, the project will enter the construction phase.

Upon completion of project construction, AML sites will be monitored for long-term operation and maintenance needs and/or additional remediation work required.

All progress made towards achieving milestones is contingent on available funding.

7.3 Measurable Milestones

The number of: conceptual designs and detailed design plans completed, projects funded for construction, remediation projects constructed, and number of acres of AMLs remediated will serve as interim milestones to measure the progress of implementation across subwatersheds.

7.3.1 Phase 1: 2006 through 2010

Devil's Fork

- Complete assessment of nonpoint sources of metals pollution
- Complete conceptual and detailed design of sites selected for remediation
- Secure funding and begin construction of at least one remediation project

Pinnacle Creek

- Begin assessment of nonpoint sources of metals pollution

7.3.2 Phases 2 through 4

Measurable milestones for future phases of implementation will be determined at the outset of each phase and will be based on the progress made toward achieving milestones described in Chapters 6.3 and 7.3.1.

7.4 Water Quality Goals

Because the construction of no remediation projects will have been completed by the end of Phase 1, no measurable water quality goals are established for Phase 1. Measurable water quality goals for future phases of implementation will be determined at the outset of each phase and will be based on the progress made toward achieving milestones described in Chapters 6.3 and 7.3.1.

8 Monitoring (i)

UGWA will coordinate local efforts to establish the necessary monitoring regime and will work with project partners to develop a Study Design, including an approved Quality Assurance and Quality Control plan, prior to commencement of the monitoring program.

Baseline, instream monitoring will provide the data necessary to further quantify sources of pollution and to determine whether water quality is improving and streams are attaining water quality standards. Targeted monitoring of specific sources of pollution will provide the data necessary to design treatment systems, determine the efficacy of installed systems, and evaluate whether load reductions are being achieved.

Monitoring will focus first on priority subwatersheds slated for implementation and will be conducted both before and after project installation. As funding permits, the extent and frequency of monitoring efforts will increase and further baseline data may be concurrently collected in lower-priority subwatersheds.

In addition, the WVDEP WAP program will continue their regularly scheduled monitoring regime, as determined by the Watershed Management Framework. The WAP team is next scheduled to sample in the Upper Guyandotte in the summer of 2010.

The Responsible Management Entity will be responsible for ensuring that monitoring requirements, as outlined in any required permits, are being met (Chapter 3.1.4).

9 Education and Outreach (e)

Most education and outreach will be performed by the Upper Guyandotte Watershed Association. Information about nonpoint source remediation projects will be incorporated into all aspects of the outreach program. UGWA currently conducts the following outreach activities:

- The UGWA newsletter, Headwater Headlines, is distributed to members and supporters three times a year and includes information about UGWA projects and activities.

- Every spring, UGWA volunteers staff a booth at the Dogwood Festival in Mullens. This is an excellent opportunity to interact with watershed residents, solicit feedback and determine local priorities, and distribute information about both pollution problems and the cleanup efforts underway in the Upper Guyandotte.

- UGWA maintains a website, www.ugwawv.org, which also contains information about pollution problems and cleanup efforts.

- Written River Surveys are used to gauge awareness of water pollution issues, concerns of local residents related to water quality issues, and willingness to pay user-fees for wastewater treatment. Survey responses are solicited in person during public meetings, other community events, and from patrons of local businesses.

- Frequent and positive coverage is given to UGWA project and events in local newspapers including the Mullens *Advocate*, the Pineville *Independent Herald*, and the *Wyoming County Report* (of the Beckley *Register-Herald*).

- The Upper Guyandotte Wastewater Project Committee and UGWA each hold regular monthly meetings that are open to the public. Meetings dates are announced in the newsletter, on the website, and in the local paper.

UGWA will continue these activities throughout the implementation of the Watershed Based Plan. Additional education and outreach activities such as public meetings, issue-specific brochures or flyers, and youth education programs will be implemented or developed as needed. Other partner organizations may also assist UGWA with outreach efforts as needed.

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Appendix A. All Abandoned mine lands in the Upper Guyandotte watershed

Many AMLs do not discharge polluted water. Table 7 in Chapter 2.3.1 lists those AMLs known to be sources of metals. Table 28 lists the sites in Table 7 plus all other sites that have been inventoried by WVDEP. Although the PADs and other information available at OAMLR office suggest that many of these sites do not discharge metals, they are included in this plan in case new data show otherwise.

Table 28: All abandoned mine lands in the Upper Guyandotte watershed

Problem area no.	Problem area name	Stream code (TMDL subwatershed)	Stream name
93	Amigo Abandoned Structures	OG-137 (3600)	Devil's Fork
95	Herndon Burning Refuse	OG-131-F (3304)	Gooney Otter Creek
96	Helen Vertical Shaft	OG-138 (3701)	Winding Gulf
182	Glen Rogers Complex	OG-134-B (3401)	Cedar Creek
472	Bennett Open Portal	OG-138 (3701)	Winding Gulf
473	Helen Refuse Pile	OG-138 (3701)	Winding Gulf
529	Itmann Refuse Pile	OG (1120)	Guyandotte River
630	Beartown Church Refuse Pile	OG-124 (2812)	Pinnacle Creek
631	Beartown Fork Refuse Pile	OG-124-N (2811)	Beartown Fork
633	Clark Gap Refuse Pile	OG-131-F (3310)	Gooney Otter Creek
634	Covel Refuse Pile	OG-131-F (3309)	Gooney Otter Creek
637	Gooney Otter Creek Refuse	OG-131-F (3309)	Gooney Otter Creek
640	Indian Ridge Refuse	OG-124 (2813)	Pinnacle Creek
646	Micajah Refuse Pile	OG-124-N (2811)	Beartown Fork
647	Milam Ridge Refuse Pile	OG-131-F (3309)	Gooney Otter Creek
650	Pilot Knob Refuse Pile	OG-131-F (3309)	Gooney Otter Creek
651	Pinnacle Creek #2 Refuse Pile	OG-124 (2813)	Pinnacle Creek
652	Pinnacle Creek Refuse Pile	OG-124 (2812)	Pinnacle Creek
924	Hickory Branch Mine Dump	OG-131-B (3301)	Hickory Branch
925	Otsego Refuse Pile	OG-134 (3402)	Slab Fork
926	Alpoca Mine Dump	OG-131 (3302)	Barker's Creek
927	Big Hollow Mine Dump	OG-131 (3300)	Barker's Creek
929	Mill Branch Refuse Pile	OG-131 (3302)	Barker's Creek
930	Tralee Mine Dump	OG-131 (3300)	Barker's Creek
932	Pierpont Refuse Pile	OG-134 (3402)	Slab Fork
996	Hotcoal Mine Dump	OG-138 (3701)	Winding Gulf
999	Paul Kizer Site 31 Pineyland Co.	OG-139 (3706)	Stonecoal Creek
1021	McAlpin Eroding Dump	OG-138 (3701)	Winding Gulf
1727	Helen "B" Refuse Pile	OG-138 (3701)	Winding Gulf
1898	Allen Creek Complex	OG-135 (3500)	Allen Creek
1899	Allen Junction Complex	OG (1124)	Guyandotte River
1900	Pocahontas Land Co. Black Eagle	OG-139 (3706)	Stonecoal Creek
1901	Blackeagle #2 Refuse	OG (1123)	Guyandotte River
1902	Noseman Branch Refuse Piles	OG-131-F-2 (3307)	Noseman Branch
1903	Montecarlo Complex	OG-131-F (3304)	Gooney Otter Creek
1904	Iroquois Refuse Pile	OG (1124)	Guyandotte River
1905	Jim's Branch Refuse Piles	OG-131-F-1 (3305)	Jims Branch
1907	Rhodell Refuse Piles & Portal	OG-139 (3707)	Stonecoal Creek
1908	Madeline Refuse Pile	OG-137 (3602)	Devil's Fork
1909	Amigo Refuse Pile	OG-137 (3600)	Devil's Fork
1913	Odd "Moore" Refuse Pile	OG-139-A (3707)	Tommy Creek
2297	Horsepen Ridge Refuse Pile	OG-138 (3701)	Winding Gulf
2298	Killarney Mine Dump	OG-139 (3705)	Stonecoal Creek
2299	Slab Fork Mine Dump	OG-134 (3406)	Slab Fork
2301	Berry Branch Refuse Pile	OG-138 (3701)	Winding Gulf

Problem area no.	Problem area name	Stream code (TMDL subwatershed)	Stream name
2302	Berry Branch "B" Refuse Pile	OG-138 (3701)	Winding Gulf
2303	East Gulf Refuse Piles	OG-139 (3705)	Stonecoal Creek
2304	Richardson Branch Complex	OG-134 (3406)	Slab Fork
2305	Bailey Branch Complex	OG-138-C (3701)	Bailey Branch
2307	Alderson Branch Refuse Pile	OG-138 (3701)	Winding Gulf
2308	Ury Structures	OG-139 (3701)	Stonecoal Creek
2309	Big Stick Mine Dump	OG-138 (3701)	Winding Gulf
2311	Riffe Mine Dumps and Complex	OG-139-B (3704)	Riffe Branch
2312	Riffe Branch Impoundments	OG-139-B (3704)	Riffe Branch
2354	Stonecoal Junction Portals	OG-139 (3702)	Stonecoal Creek
2356	Pines Creek Portals	OG-139-D (3706)	Pines Creek
2504	Rhodell Portals	OG-139 (3702)	Stonecoal Creek
2580	Slab Fork Impoundments	OG-134 (3406)	Slab Fork
2749	Winding Gulf Deep Mine	OG-138 (3701)	Winding Gulf
2908	Allen Junction Highwall	OG-135 (3500)	Allen Creek
2909	Barkers Ridge Highwall	OG-131 (3303)	Barker's Creek
2911	Noseman Branch Tipple	OG-131-F-2 (3307)	Noseman Branch
2912	Noseman Branch Highwall	OG-131-F-2 (3307)	Noseman Branch
3214	Helen Highwall #1	OG-138 (3701)	Winding Gulf
3227	Farley Branch #1 Highwall	OG-139 (3705)	Stonecoal Creek
3230	Helen Highwall #2	OG-138 (3701)	Winding Gulf
3428	Barkers Ridge Highwall	OG-128 (3000)	Joe Branch
3429	Joe Branch Highwall	OG-128 (3000)	Joe Branch
3430	Tailing Pond Highwall	OG-128 (3000)	Joe Branch
3431	Micajah Ridge Highwall	OG-128 (3000)	Joe Branch
3432	Itmann Mine Highwall	OG-129 (3100)	Long Branch
3433	Long Branch Highwall	OG-129 (3100)	Long Branch
3434	Workman Branch Highwalls	OG-130 (3200)	Still Run
3435	Cabin Creek Ridge Highwall	OG-130 (3200)	Still Run
3436	Still Run Highwall	OG-130 (3200)	Still Run
3437	Bearwallow Ridge Highwall	OG-130 (3200)	Still Run
3438	Itmann Highwall	OG (1120)	Guyandotte River
3451	Hotchkiss "A" Highwall	OG-134 (3406)	Slab Fork
3452	Hotchkiss Highwall	OG-134 (3406)	Slab Fork
3586	Slab Fork Highwall	OG-134 (3402)	Slab Fork
3587	Otsego Highwall	OG-134 (3402)	Slab Fork
4109	Madeline (Johnson) Refuse Pile	OG-137 (3600)	Devil's Fork
4140	Wyco Hollow (Yon) Refuse Fire	OG-135 (3500)	Allen Creek
4161	Pines Creek Portals	OG-139 (3705)	Stonecoal Creek
4163	Site #16 Adventure Resources, Inc.	OG-139 (3705)	Stonecoal Creek
4165	Stephenson - Amigo Smokeless	OG-136 (1125)	Big Branch
4171	Site #22 Adventure Resources, Inc.	OG-139 (3706)	Stonecoal Creek
4173	Suite #21 Adventure Resources, Inc.	OG-139 (3706)	Stonecoal Creek
4174	Stephenson-Pocahontas Land	OG-136 (1125)	Big Branch
4296	Helen (Lewis) Refuse	OG-138 (3701)	Winding Gulf
4487	Amigo "Reed" Clogged Stream	OG-137 (3600)	Devil's Fork
4614	Iroquois "Allen" Portals	OG (1124)	Guyandotte River
4662	Wyco (Pugh) Refuse Pond	OG-135 (3500)	Allen Creek
4695	Odd (Airy) Refuse	OG-139-A (3707)	Tommy Creek
4797	Stephenson "Conley" Burning Refuse	OG (1126)	Guyandotte River
4809	Stonecoal Creek Complex	OG-139 (3706)	Stonecoal Creek
4811	Blackeagle Refuse Pile	OG (1123)	Guyandotte River
4890	Helen "Cadle" Open Portal (E)	OG-138 (3701)	Winding Gulf
4968	Pinnacle Mining Corp.	OG-124 (2813)	Pinnacle Creek
4995	Amigo (Blanchard) Burning Refuse	OG-137 (3600)	Devil's Fork
5023	Stephenson (Mills) Subsidence	OG-131 (3303)	Barker's Creek
5031	Bud Portal	OG-131 (3302)	Barker's Creek
5097	Mullins (Lester) Landslide	OG (1122)	Guyandotte River
5106	Riffe Branch (Smith) Clogged Stream	OG-139-B (3704)	Riffe Branch
5399	Barker's Creek Subsidence	OG-131 (3303)	Barker's Creek

Problem area no.	Problem area name	Stream code (TMDL subwatershed)	Stream name
5432	Herndon (Jewell) Burning Refuse	OG-131-F (3305)	Gooney Otter Creek
5438	Odd (Webb) Highwall	OG-139-D (3706)	Pines Creek
5471	Clark Gap 'A' Highwall	OG-124 (2813)	Pinnacle Creek
5537	Road Branch (Marshall) Portals	OG-124 (2812)	Pinnacle Creek
5594	Stephenson (Bowling) Drainage	OG-136 (1125)	Big Branch
5640	Stonecoal Junction Refuse	OG-139 (3702)	Stonecoal Creek
5654	Berry Branch Drainage	OG-138 (3701)	Winding Gulf
5655	Helen Portals	OG-138 (3701)	Winding Gulf
5687	Mullens (Grogg) Refuse	OG (1122)	Guyandotte River
5688	Helen Landslide	OG-138 (3701)	Winding Gulf
5689	Mullens (Musser) Landslide	OG (1122)	Guyandotte River
5690	Mullen (Dixon) Landslide	OG (1122)	Guyandotte River
5695	Terry Branch Portals and Refuse	OG-134 (3400)	Slab Fork
5696	Mullens Portals	OG (1122)	Guyandotte River
5743	Devil's Fork (Reed) Burning Refuse	OG-137 (3600)	Devil’s Fork
5751	Amigo Smokeless Impoundment	OG-131 (3300)	Barker’s Creek
5776	Wyco (Shrewsbury) Portals	OG-135 (3500)	Allen Creek
5823	Mullens Portals & Refuse	OG (1122)	Guyandotte River
5884	Josephine (Doss) Portals	OG-139 (3706)	Stonecoal Creek
5889	Farley Branch Coal Refuse Area A	OG-139 (3705)	Stonecoal Creek
5890	Farley Branch Coal Refuse Area B	OG-139 (3705)	Stonecoal Creek
5891	Farley Branch Coal Refuse Area C	OG-139 (3705)	Stonecoal Creek
5892	Stonecoal Creek Refuse Pile Area K	OG-139 (3705)	Stonecoal Creek
5893	Stonecoal Creek Refuse Pile WPP#2	OG-139-A (3707)	Tommy Creek

Source: WVDEP (Various dates).

Appendix B: Active mining operations in the Upper Guyandotte watershed

Table 29: Active mining operations in the Upper Guyandotte watershed

Mining Company	Permit	Facility Name	Stream code	Subwatershed number
NA	S008685	NA	OG-137-B-1	3603
NA	S400100	NA	OG-130	3200
NA	S400199	NA	OG-124-J, OG-124-L	2809, 2810
NA	S400999	NA	OG-124, OG-124-P	2812
NA	S402199	NA	OG-134-E, OG-134-F, OG-134-G	3406
NA	u400999	NA	OG-124, OG-124-P	2812
Bluestone Coal Corporation	h041400	NA	OG-124-J-1, OG-124-J	2809
"	o007383	NA	OG-124-J, OG-124-L, OG-124-M, OG-124-O	2809, 2810
"	s402188	NA	OG-124-O, OG-124-P	2812
"	u005284	NA	OG-124, OG-124-J, OG-124-J-1, OG-124-O	2808, 2809, 2812
"	u007183	#10 Mine	OG-124-N	2811
Brooks Run Mining Company, LLC	u400498	Still Run Mine No. 7	OG-130, OG-130-B	3200
Consolidation Coal Company	o001185	Itmann Prep Plant	OG, OG-128, OG-129	3000, 1120, 1121
"	u001184	NA	OG-131-I	3303
"	u001584	Itmann No. 1 Mine	OG, OG-129, OG-131	3300, 1121
"	u001684	NA	OG, OG-130, OG-130-A	3200
"	u001784	NA	OG, OG-125, OG-127	1119, 1117, 2906
"	u003585	NA	OG-131-I	3303
Frontier Management, LLC.	u016283	Preparation Plant/Refuse Area	OG-139, OG-139-A	3707, 3705
Glow Worm Coal Company	U401587	NA	OG-124-L	2810
Herndon Processing Company, LLC	o005983	NA	OG-131-F	3304
"	o007882	NA	OG-131-F, OG-131	3304, 3303
"	o401991	Covel No.1 Refuse Reprocessing	OG-131-F	3310
"	u002183	Mine No. 1	OG-124-I, OG-124-N, OG-131-F, OG-131-F-2, OG-131	2807, 2811, 3304, 3307, 3302
"	u040500	NA	OG-131-F-2	3307
"	u400292	Herndon No.1 Deep Mine	OG-131-F-2	3307
"	u400992	Noseman Branch No. 1 Deep Mine	OG-131-F-2	3307
"	u400995	Bennett Mine	OG-131-F-2	3307
"	u401095	Covel Mine	OG-131-F-2	3307
"	u401397	Poca 6 Mine No. 1	OG-131-F-2	3307
Honaker Leasing, Inc.	u401687	No. 31	OG-131-J, OG-131-L	2809, 2810
Justice Highwall Mining, Inc.	S400899	Pinnacle Ridge Surface Mine	OG-124, OG-124-P	2812
Lodestar Energy, Inc.	r000584	Otsego Refuse Area	OG-134	3402
Mining Technologies, Inc.	s300998	Tams No. 1 Surface Mine	OG-138-A, OG-138	3701
"	s400399	Payne Branch Surface Mine	OG-124-J-1	2809, 2808
Mountain Edge Mining Inc.	S402586	Sewell Strip No. 1	OG-124-E-1, OG-124-E, OG-124-H, OG-124-J-1	2803, 2805, 2808, 2809
Navco, INC	s304588	NA	OG-131-C	3302
New South Resources Co. DBA Black Hawk Mining	u002483	Mine No. 1	OG-134, OG-138, OG-138-F	3406, 3701
"	U303692	NA	OG-139-D	3706
Pinnacle Mining Company, LLC	e002500	NA	OG-124-A OG-124-B OG-124	2800
"	o013883	NA	OG-124-C, OG-124-D, OG-124	2800, 2802, 2801
"	o401097	8 Haulage Degas	OG-124-A	2800
"	o402292	Smith Br. Coal Refuse Disposal	OG-124-D	2801

Mining Company	Permit	Facility Name	Stream code	Subwatershed number
"	s400397	Sewell Seam Surface Mine	OG-124-C, OG-124-D, OG-124-E-0.5	2800, 2801, 2803
"	u020483	NA	OG-124, OG-124-E	2802, 2803, 2804
"	u070700	NA	OG-124	2800, 2802, 2804
Plum Tree Minerals, LLC	s301098	Lillybrook 1 Surface Mine	OG-139	3708
Riverside Energy Company, LLC	h043300	Sugar Run Haulroad	OG-130	3200
"	h044500	Sugar Run Haulroad	OG-125	1117
"	u047100	NA	OG-130	3200
"	U400196	Jims Branch Mine No. 3A	OG-126	1117
"	u400295	Still Run No. 1 Mine	OG-130, OG-130-A, OG-132, OG-133	3200, 1122
"	u400297	Joe Branch Mine No. 1	OG	1119
"	u400395	Still Run No. 2 Mine	OG-130	3200
"	u400496	Jims Branch Mine No. 3B	OG-126	1117
"	u400595	Sugar Run No. 1 MINE	OG-125	1117
"	u400695	Sugar Run No. 2 Mine	OG-125	1117
"	u400697	Still Run Mine No. 4	OG-130, OG-130-A.5	3200
"	u400996	Still Run No. 3 Mine	OG-130	3200
"	u401100	Still Run Mine No. 10	OG-130, OG-130-A	3200
"	u401300	Copperhead Mine No. 1	OG-124-G	2804
"	u401697	Still Run Mine No. 6	OG-130	3200
"	u402195	Jims Branch Mine No. 1	OG, OG-126	1117
"	u402199	Grave Fork No. 1 Mine	OG-134-E, OG-134-G	3406
"	U402595	Jims Branch Mine No. 2	OG-126	1117
Turpin Enterprises Inc.	D001182	Mine No. 26A	OG-124-J	2809
U.S. Steel Mining Company, LLC	O401692	N Main Degas Boreholes & ACCES	OG-124-B, OG-124-D, OG-124-E-0.5	2800, 2801, 2803
"	O402290	NA	OG-124-A, OG-1124-B, OG-124	2800
"	O403292	Shawnee Degas Boreholes & ACCE	OG-124-A, OG-124-B, OG-124-D	2800, 2801
White Mountain Mining Company LLC	o000183	Preparation Plant	OG-138	3701
"	o000283	Keystone No. 4 Refuse Area	OG-138-F	3701

Source: WVDEP (2005).

Appendix C. Load reduction calculations for fecal coliform bacteria

Average daily discharge of household wastewater = 70 *gallons/person/day* (Horsley and Witten, 1996)

Concentration of fecal coliform bacteria in untreated wastewater = 1.0×10^{6} *cfu/100mL* (Horsley and Witten, 1996)

Average number of persons per household in the Upper Guyandotte = 2.4 (US Census Bureau, 2000)

Typical inefficiency of a properly maintained septic system = 1% (USEPA, 2002). For efficiency ratings of other treatment systems see Chapter 3.1.

$$\left(70\, gallons\ /\ person\ /\ day\right) \times \left(\frac{1 mL}{2.64 \times 10^{-4}\ gallons}\right) \times 2.4\, persons\ /\ household = 6.37 \times 10^{5}\ mL\ /\ household\ /\ day$$

$$6.37 \times 10^{5}\ mL\ /\ household\ /\ day \times \left(\frac{1 \times 10^{6}\ \text{colony forming units}}{100\ mL}\right) \times 365\, days\ /\ year = 2.33 \times 10^{12}\ cfu\ /\ household\ /\ year$$

(2.33×10^{12} *cfu/household/year*) x (no. of homes with permitted septic) x 0.01 =Total annual contribution from permitted septic

(2.33×10^{12} *cfu/household/year*) x (no. of homes with failing septic or straight pipe) = Total annual contribution from failing septic

(contribution from permitted septic) + (contribution from failing septic) = Current annual fecal coliform loading per project area

(current annual load) x (efficiency of proposed treatment system) = Estimated load reduction per project area

The following load reduction calculation is given for Alpoca Bottom as an example.

$$(2.33x10^{12}) \text{ x } 7.52 \text{ x } 0.01 = 1.752x10^{11}$$

$$(2.33x10^{12}) \text{ x } 86.48 = 2.015x10^{14}$$

$$0.9 \text{ x } (1.752x10^{11} + 2.015x10^{14}) = 1.815x10^{14}$$

Project Area	TMDL SWS	No. of Homes	% of community with Septic	No. of Homes w/ septic	No. of Homes w/o treatment	Current Annual Contribution from septics	Current Annual contribution from homes w/o treatment	Total Current Annual load	Efficiency of treatment system	Annual Load Reduction
Alpoca Bottom	3302	94	0.08	7.52	86.48	1.752E+11	2.015E+14	2.017E+14	0.9	1.815E+14
Alpoca Mill Branch	3302	8	0.08	0.64	7.36	1.491E+10	1.715E+13	1.716E+13	0.99	1.699E+13
Basin	3303	15	0.03	0.45	14.55	1.049E+10	3.390E+13	3.391E+13	0.99	3.357E+13
Basin Ridge 1	3303	25	0.03	0.75	24.25	1.748E+10	5.650E+13	5.652E+13	0.99	5.595E+13
Basin Ridge 2	3303	67	0.03	2.01	64.99	4.683E+10	1.514E+14	1.515E+14	0.99	1.500E+14
Basin Road	3303	11	0.03	0.33	10.67	7.689E+09	2.486E+13	2.487E+13	0.99	2.462E+13
Bud	3302	101	0.13	13.13	87.87	3.059E+11	2.047E+14	2.050E+14	0.9	1.845E+14
Bud Mountain	3302	21	0.13	2.73	18.27	6.361E+10	4.257E+13	4.263E+13	0.99	4.221E+13
Covel	3309	54	0.04	2.16	51.84	5.033E+10	1.208E+14	1.208E+14	0.9	1.088E+14
Garwood East	3310	19	0.04	0.76	18.24	1.771E+10	4.250E+13	4.252E+13	0.9	3.827E+13
Garwood West	3310	10	0.04	0.4	9.6	9.320E+09	2.237E+13	2.238E+13	0.99	2.215E+13
Herndon	3305	14	0.12	1.68	12.32	3.914E+10	2.871E+13	2.874E+13	0.99	2.846E+13
Herndon Gooney Otter	3305	10	0.12	1.2	8.8	2.796E+10	2.050E+13	2.053E+13	0.99	2.033E+13
Herndon II	3308	24	0.12	2.88	21.12	6.710E+10	4.921E+13	4.928E+13	0.99	4.878E+13
Lusk Community	3303	12	0.03	0.36	11.64	8.388E+09	2.712E+13	2.713E+13	0.99	2.686E+13
Lusk Settlement	3303	10	0.12	1.2	8.8	2.796E+10	2.050E+13	2.053E+13	0.99	2.033E+13
Montecarlo	3304	4	0.12	0.48	3.52	1.118E+10	8.202E+12	8.213E+12	0.99	8.131E+12
Peak Creek	3303	23	0.03	0.69	22.31	1.608E+10	5.198E+13	5.200E+13	0.99	5.148E+13
Tracy's Mountain	3302	49	0.11	5.39	43.61	1.256E+11	1.016E+14	1.017E+14	0.99	1.007E+14
Tralee	3300	4	0.08	0.32	3.68	7.456E+09	8.574E+12	8.582E+12	0.99	8.496E+12
Amigo Devils Fork	3600	24	0.07	1.68	22.32	3.914E+10	5.201E+13	5.204E+13	0.99	5.152E+13
Amigo Lower	3600	15	0.07	1.05	13.95	2.447E+10	3.250E+13	3.253E+13	0.99	3.220E+13
Amigo Middle	3600	6	0.07	0.42	5.58	9.786E+09	1.300E+13	1.301E+13	0.99	1.288E+13
Amigo Upper Devils Fork	3600	9	0.07	0.63	8.37	1.468E+10	1.950E+13	1.952E+13	0.99	1.932E+13
Egeria	3603	14	0.29	4.06	9.94	9.460E+10	2.316E+13	2.325E+13	0.99	2.302E+13
Cabin Creek	2900	38	0.29	11.02	26.98	2.568E+11	6.286E+13	6.312E+13	0.99	6.249E+13
Lower Itmann	1121	110	0.07	7.7	102.3	1.794E+11	2.384E+14	2.385E+14	0.9	2.147E+14
New Richmond	1117	114	0.07	7.98	106.02	1.859E+11	2.470E+14	2.472E+14	0.9	2.225E+14
Rt. 16 pg 1	1117	8	0.07	0.56	7.44	1.305E+10	1.734E+13	1.735E+13	0.99	1.717E+13
Rt. 16 pg 6	1120	2	0.07	0.14	1.86	3.262E+09	4.334E+12	4.337E+12	0.99	4.294E+12
Saulsville	2909	119	0.29	34.51	84.49	8.041E+11	1.969E+14	1.977E+14	0.99	1.957E+14

Project Area	TMDL SWS	No. of Homes	% of community with Septic	No. of Homes w/ septic	No. of Homes w/o treatment	Current Annual Contribution from septics	Current Annual contribution from homes w/o treatment	Total Current Annual load	Efficiency of treatment system	Annual Load Reduction
Still Run	3200	2	0.07	0.14	1.86	3.262E+09	4.334E+12	4.337E+12	0.99	4.294E+12
Upper Itmann	1121	56	0.07	3.92	52.08	9.134E+10	1.213E+14	1.214E+14	0.9	1.093E+14
Upper Polk Gap	3200	4	0.29	1.16	2.84	2.703E+10	6.617E+12	6.644E+12	0.99	6.578E+12
Allen Junction Lower	1123	13	0.04	0.52	12.48	1.212E+10	2.908E+13	2.909E+13	0.99	2.880E+13
Allen Junction S.S.	1123	6	0.04	0.24	5.76	5.592E+09	1.342E+13	1.343E+13	0.99	1.329E+13
Allen Junction Upper	1123	25	0.04	1	24	2.330E+10	5.592E+13	5.594E+13	0.9	5.035E+13
Beechwood Center	1123	14	0.04	0.56	13.44	1.305E+10	3.132E+13	3.133E+13	0.99	3.101E+13
Beechwood S.S.	1123	21	0.04	0.84	20.16	1.957E+10	4.697E+13	4.699E+13	0.99	4.652E+13
Blackeagle	1123	31	0.19	5.89	25.11	1.372E+11	5.851E+13	5.864E+13	0.9	5.278E+13
Corrine	1123	66	0.11	7.26	58.74	1.692E+11	1.369E+14	1.370E+14	0.9	1.233E+14
Corrine Bottom	1123	83	0.11	9.13	73.87	2.127E+11	1.721E+14	1.723E+14	0.9	1.551E+14
Iroquois Clusters	1124	21	0.03	0.63	20.37	1.468E+10	4.746E+13	4.748E+13	0.99	4.700E+13
Iroquois S.S.	1124	11	0.03	0.33	10.67	7.689E+09	2.486E+13	2.487E+13	0.99	2.462E+13
Sand Gap	1125	30	0.04	1.2	28.8	2.796E+10	6.710E+13	6.713E+13	0.99	6.646E+13
Stephenson Bottom	1125	34	0.04	1.36	32.64	3.169E+10	7.605E+13	7.608E+13	0.99	7.532E+13
Stephenson Hill High	1126	8	0.04	0.32	7.68	7.456E+09	1.789E+13	1.790E+13	0.99	1.772E+13
Stephenson Hill Low	1126	13	0.04	0.52	12.48	1.212E+10	2.908E+13	2.909E+13	0.9	2.618E+13
Wyco Lower	3500	16	0.05	0.8	15.2	1.864E+10	3.542E+13	3.543E+13	0.99	3.508E+13
Wyco Middle	3500	20	0.05	1	19	2.330E+10	4.427E+13	4.429E+13	0.99	4.385E+13
Wyco Upper	3500	24	0.05	1.2	22.8	2.796E+10	5.312E+13	5.315E+13	0.99	5.262E+13
Bob's Branch	2807	11	0.13	1.43	9.57	3.332E+10	2.230E+13	2.233E+13	0.99	2.211E+13
Bud Lite	2807	5	0.13	0.65	4.35	1.515E+10	1.014E+13	1.015E+13	0.99	1.005E+13
Herndon Heights	2811	54	0.12	6.48	47.52	1.510E+11	1.107E+14	1.109E+14	0.99	1.098E+14
Micajah	2811	13	0.13	1.69	11.31	3.938E+10	2.635E+13	2.639E+13	0.99	2.613E+13
Spider Ridge	2810	22	0.12	2.64	19.36	6.151E+10	4.511E+13	4.517E+13	0.99	4.472E+13
Acord Mt.	3406	14	0.07	0.98	13.02	2.283E+10	3.034E+13	3.036E+13	0.99	3.006E+13
Hotchkiss North	3406	16	0.18	2.88	13.12	6.710E+10	3.057E+13	3.064E+13	0.99	3.033E+13
Hotchkiss South	3406	20	0.18	3.6	16.4	8.388E+10	3.821E+13	3.830E+13	0.9	3.447E+13
Lower Polk Gap	3403	16	0.34	5.44	10.56	1.268E+11	2.460E+13	2.473E+13	0.99	2.448E+13
Maben	3404	25	0.34	8.5	16.5	1.981E+11	3.845E+13	3.864E+13	0.9	3.478E+13
McKinney Ridge	3406	10	0.13	1.3	8.7	3.029E+10	2.027E+13	2.030E+13	0.99	2.010E+13
Otesgo West	3401	30	0.05	1.5	28.5	3.495E+10	6.641E+13	6.644E+13	0.9	5.980E+13
Otsego East	3401	10	0.05	0.5	9.5	1.165E+10	2.214E+13	2.215E+13	0.9	1.993E+13
Otsego South	3401	2	0.05	0.1	1.9	2.330E+09	4.427E+12	4.429E+12	0.9	3.986E+12
Pierpoint	3402	42	0.07	2.94	39.06	6.850E+10	9.101E+13	9.108E+13	0.99	9.017E+13
Polk Gap	3403	9	0.29	2.61	6.39	6.081E+10	1.489E+13	1.495E+13	0.99	1.480E+13
Tams Mt.	3406	4	0.5	2	2	4.660E+10	4.660E+12	4.707E+12	0.99	4.660E+12
Besoco Middle	3706	9	0.04	0.36	8.64	8.388E+09	2.013E+13	2.014E+13	0.9	1.813E+13
Besoco North	3706	10	0.04	0.4	9.6	9.320E+09	2.237E+13	2.238E+13	0.9	2.014E+13
Besoco West	3706	6	0.04	0.24	5.76	5.592E+09	1.342E+13	1.343E+13	0.99	1.329E+13
Eastgulf Lower Riffe	3704	11	0.03	0.33	10.67	7.689E+09	2.486E+13	2.487E+13	0.99	2.462E+13
Eastgulf Stonecoal	3704	12	0.03	0.36	11.64	8.388E+09	2.712E+13	2.713E+13	0.99	2.686E+13

Project Area	TMDL SWS	No. of Homes	% of community with Septic	No. of Homes w/ septic	No. of Homes w/o treatment	Current Annual Contribution from septics	Current Annual contribution from homes w/o treatment	Total Current Annual load	Efficiency of treatment system	Annual Load Reduction
Eastgulf Upper Riffe	3704	11	0.03	0.33	10.67	7.689E+09	2.486E+13	2.487E+13	0.99	2.462E+13
Josephine	3706	57	0.07	3.99	53.01	9.297E+10	1.235E+14	1.236E+14	0.99	1.224E+14
Kilarney	3705	2	0	0	2	0.000E+00	4.660E+12	4.660E+12	0.99	4.613E+12
Lego	3706	22	0	0	22	0.000E+00	5.126E+13	5.126E+13	0.9	4.613E+13
Mead North	3705	16	0	0	16	0.000E+00	3.728E+13	3.728E+13	0.99	3.691E+13
Mead S.S.	3705	8	0	0	8	0.000E+00	1.864E+13	1.864E+13	0.99	1.845E+13
Mead II	3705	8	0	0	8	0.000E+00	1.864E+13	1.864E+13	0.99	1.845E+13
Odd	3707	75	0.77	57.75	17.25	1.346E+12	4.019E+13	4.154E+13	0.99	4.112E+13
Pickshin	3706	12	0.08	0.96	11.04	2.237E+10	2.572E+13	2.575E+13	0.99	2.549E+13
Rhodell	3703	180	0.02	3.6	176.4	8.388E+10	4.110E+14	4.111E+14	0.9	3.700E+14
Helen	3701	84	0.05	4.2	79.8	9.786E+10	1.859E+14	1.860E+14	0.9	1.674E+14
McAlpin	3701	4	0.25	1	3	2.330E+10	6.990E+12	7.013E+12	0.99	6.943E+12
Stotesbury	3701	24	0.17	4.08	19.92	9.506E+10	4.641E+13	4.651E+13	0.99	4.604E+13
Ury	3701	11	0	0	11	0.000E+00	2.563E+13	2.563E+13	0.99	2.537E+13

Source: Watershed survey (Chapter 2.2.1).

Appendix D. Load reduction calculations for AMLs with water quality problems

Load calculations require estimates of the amount of water discharging from an AML and measurements of the pollutant concentration in the water. Both kinds of information are only available for one AML in the entire Upper Guyandotte watershed. Therefore, loads can only be calculated for this single AML.

Portals at Stonecoal Creek Complex (4809) discharge a total of 1,700 gpm with an iron concentration of 4 mg/L.

Discharge, on an annual basis, is given by:

$$\left(1{,}700\,\frac{gal}{\min}\right)\cdot\left(\frac{1{,}440\min}{day}\right)\cdot\left(\frac{365.25\,days}{year}\right)\cdot\left(\frac{3.7854\,liters}{gallon}\right)=3.385\cdot 10^{9}\,\frac{liters}{year}$$

The iron load is given by:

$$\left(3.385\cdot 10^{9}\,\frac{liters}{year}\right)\cdot\left(4\,\frac{mg}{liter}\right)\cdot\left(\frac{1\,kg}{1{,}000{,}000\,mg}\right)\cdot\left(\frac{2.205\,lbs}{kg}\right)=29{,}850\,\frac{lbs}{year}$$

On other sites, unquantified loads come both from piles of refuse coal and from portal discharges. Loads from portal discharges are relatively easy to determine after flows are estimated and metal concentrations are measured. PADs indicate that the mine water in the Upper Guyandotte watershed is frequently used for household water supply. Many of the unquantified portal discharges may add very small additional metal loads to streams.

Loads from refuse coal will be more difficult to determine because they depend on many unknown factors, including the type of coal, the mix of coal and other refuse materials, and the residence time of the water in the refuse material.

Appendix E: Cost calculations for wastewater treatment projects

The following cost calculation is given for Alpoca as an example.[16]

Alpoca Bottom (conventional gravity collection system with package plant):

(No. of homes x "tap fee" per home) + (Length sewer line x $100/ft.) = Cost of collection system

(Daily wastewater flow rate x $10) = Cost of treatment system

(94 x $500) + (3500 ft. x $100) = $397,000

(20,550 gal/day x $10) = $205,500

$397,000 + $205,500 = $602,500

Alpoca Mill Branch (individual onsite septic systems):

No. of homes x Cost per home = Total cost

8 x $5,000 = $40,000

Total cost for Alpoca = $602,500 + $40,000 = $642,500

[16] Source: Table 10 (pg. 24), Table 11 (pg. 25), and Table 30.

Table 30: Cost calculations for wastewater treatment projects[17]

Community	Project Area	SWS	No. of Homes	Type Sewer	Length Sewer (linear feet)	Sewer Cost	Type Treatment	Treatment Cost	Total Cost
Allen Junction	Allen Junction Lower	1123	13	STEP	1400	$127,000	Cluster Drip	$59,800	$186,800
Allen Junction	Allen Junction Upper	1123	25	STEP	1800	$213,000	Package Plant	$50,000	$263,000
Allen Junction	Allen Junction S.S.	1123	6	Onsite	0	$0	Onsite	$30,000	$30,000
Alpoca	Alpoca Mill Branch	3302	8	Onsite	0	$0	Onsite	$40,000	$40,000
Alpoca	**Alpoca Bottom**	**3302**	**94**	**Gravity**	**3500**	**$397,000**	**Package Plant**	**$205,500**	**$602,500**
Alpoca	Alpoca Bottom	3302	94	STEP	3500	$686,500	Package Plant	$188,000	$874,500
Alpoca	Alpoca Bottom	3302	94	Vacuum	3500	$635,500	Package Plant	$188,000	$823,500
Beechwood	Beechwood Center	1123	14	STEP	700	$108,500	Cluster Drainfield	$40,180	$148,680
Beechwood	Beechwood S.S.	1123	21	Onsite	0	$0	Onsite	$105,000	$105,000
Besoco	Besoco Middle	3706	9	STEP	3000	$159,000	Package Plant	$18,000	$177,000
Besoco	Besoco North	3706	10	STEP	2200	$137,000	Package Plant	$20,000	$157,000
Besoco	Besoco West	3706	6	Onsite	0	$0	Onsite	$30,000	$30,000
Blackeagle	Blackeagle	1123	31	Gravity	4520	$467,500	Extension	$0	$467,500
Bud	**Bud**	**3302**	**101**	**Vacuum**	**6500**	**$754,500**	**Extension**	**$0**	**$754,500**
Bud	Bud	3302	101	STEG	6500	$631,500	Package Plant	$202,000	$833,500
Bud	Bud	3302	101	Gravity	6500	$700,500	Package Plant	$234,500	$935,000
Corinne	Corrine	1123	66	Gravity	2560	$289,000	Extension	$0	$289,000
Corinne Bottom	Corrine Bottom	1123	83	Gravity	3400	$381,500	Extension	$0	$381,500
Covel	Covel	3309	54	STEG	4500	$373,500	Cluster Drainfield	$154,980	$528,480
Covel	**Covel**	**3309**	**54**	**STEG**	**4500**	**$373,500**	**Package Plant**	**$108,000**	**$481,500**
Eastgulf	Eastgulf Upper Riffe	3704	11	Cluster	0	$0	Cluster Drainfield	$31,570	$31,570
Eastgulf	Eastgulf Lower Riffe	3704	11	Cluster	0	$0	Cluster LPP	$31,350	$31,350
Eastgulf	Eastgulf Stonecoal	3704	12	Cluster	0	$0	Cluster Drip	$55,200	$55,200
Garwood	Garwood West	3310	10	Cluster	0	$0	Cluster LPP	$28,500	$28,500
Garwood	Garwood East	3310	19	STEP	2000	$184,000	Package Plant	$38,000	$222,000
Helen	Helen	3701	84	STEP	7200	$756,000	Package Plant	$168,000	$924,000
Helen	**Helen**	**3701**	**84**	**Vacuum**	**7200**	**$745,000**	**Package Plant**	**$168,000**	**$913,000**
Helen	Helen	3701	84	Gravity	7200	$762,000	Package Plant	$204,000	$966,000
Herndon	Herndon	3305	14	Cluster	0	$0	Cluster Drip	$64,400	$64,400
Herndon	Herndon Gooney Otter	3305	10	Onsite	0	$0	Onsite	$50,000	$50,000
Hotchkiss	Hotchkiss North	3406	16	Onsite	0	$0	Onsite	$80,000	$80,000
Hotchkiss	Hotchkiss South	3406	20	STEP	2000	$190,000	Package Plant	$40,000	$230,000
Iroquois	Iroquois S.S.	1124	11	Onsite	0	$0	Onsite	$55,000	$55,000
Iroquois	Iroquois Clusters	1124	21	Cluster	0	$0	Cluster LPP	$59,850	$59,850
Lego	Lego	3706	22	STEG	1500	$140,500	Cluster Drainfield	$63,140	$203,640
Lego	**Lego**	**3706**	**22**	**STEG**	**2100**	**$161,500**	**Extension**	**$0**	**$161,500**

17 Because wastewater is not transported over a significant distance in either individual onsite or cluster systems, the entire cost of these systems is given in the "treatment cost" column. This includes any small diameter line that may be needed for cluster systems. The cost given in the "sewer cost" column is therefore $0. Also, for some project areas, cost estimates were calculated for more than one treatment option. The preferred (lowest cost) option is given in **bold** type in Table 30 and is also listed in Table 11 (pg. 25).

Community	Project Area	SWS	No. of Homes	Type Sewer	Length Sewer (linear feet)	Sewer Cost	Type Treatment	Treatment Cost	Total Cost
Lower Itmann	**Lower Itmann**	**1121**	**110**	**Vacuum**	**7500**	**$807,500**	**Package Plant**	**$220,000**	**$1,027,500**
Lower Itmann	Lower Itmann	1121	110	STEP	7500	$922,500	Package Plant	$220,000	$1,142,500
Lower Itmann	Lower Itmann	1121	110	Gravity	7500	$805,000	Package Plant	$257,500	$1,062,500
Maben	Maben	3404	25	STEG	2000	$170,000	Package Plant	$50,000	$220,000
Mead	Mead S.S.	3705	8	Onsite	0	$0	Onsite	$40,000	$40,000
Mead	Mead North	3705	16	STEP	1500	$148,500	R.S.F.	$0	$148,500
New Richmond	New Richmond	1117	114	Vacuum	7000	$798,000	Package Plant	$228,000	$1,026,000
New Richmond	New Richmond	1117	114	STEP	7000	$929,000	Package Plant	$228,000	$1,157,000
New Richmond	**New Richmond**	**1117**	**114**	**Gravity**	**7000**	**$757,000**	**Package Plant**	**$263,000**	**$1,020,000**
Otsego	Otsego South	3401	2	Gravity	0	$1,000	Package Plant	$4,000	$5,000
Otsego	Otsego East	3401	10	STEP	1000	$95,000	Package Plant	$20,000	$115,000
Otsego	Otesgo West	3401	30	STEP	2000	$250,000	Package Plant	$60,000	$310,000
Stephenson Hill	Stephenson Hill High	1126	8	Cluster	0	$0	Cluster LPP	$22,800	$22,800
Stephenson Hill	Stephenson Hill Low	1126	13	STEP	1000	$113,000	Package Plant	$26,000	$139,000
Pierpoint	Pierpoint	3402	42	Cluster	0	$0	Cluster LPP	$119,700	$119,700
Upper Itmann	Upper Itmann	1121	56	STEP	4000	$476,000	Package Plant	$112,000	$588,000
Upper Itmann	**Upper Itmann**	**1121**	**56**	**Gravity**	**4000**	**$428,000**	**Package Plant**	**$132,000**	**$560,000**
Upper Itmann	Upper Itmann	1121	56	Vacuum	4000	$577,000	Package Plant	$112,000	$689,000
Rhodell	**Rhodell**	**3703**	**180**	**Vacuum**	**10000**	**$1,035,000**	**Package Plant**	**$360,000**	**$1,395,000**
Rhodell	Rhodell	3703	180	STEP	10000	$1,430,000	Package Plant	$360,000	$1,790,000
Rhodell	Rhodell	3703	180	Gravity	10000	$1,090,000	Package Plant	$410,000	$1,500,000
Wyco	Wyco Lower	3500	16	Cluster	0	$0	Cluster LPP	$45,600	$45,600
Wyco	Wyco Middle	3500	20	STEP	2000	$190,000	Cluster Drip	$92,000	$282,000
Wyco	Wyco Upper	3500	24	STEP	2200	$221,000	Cluster Drip	$110,400	$331,400
Acord Mt.	Acord Mt.	3406	14	Onsite	0	$0	Onsite	$70,000	$70,000
Amigo	Amigo Lower	3600	15	Cluster	0	$0	Cluster LPP	$42,750	$42,750
Amigo	Amigo Middle	3600	6	Onsite	0	$0	Onsite	$30,000	$30,000
Amigo	Amigo Devils Fork	3600	24	Onsite	0	$0	Onsite	$120,000	$120,000
Amigo	Amigo Upper Devils Fork	3600	9	Onsite	0	$0	Onsite	$45,000	$45,000
Basin	Basin	3303	15	Onsite	0	$0	Onsite	$75,000	$75,000
Basin Ridge 1	Basin Ridge 1	3303	25	Onsite	0	$0	Onsite	$125,000	$125,000
Basin Ridge 2	Basin Ridge 2	3303	67	Onsite	0	$0	Onsite	$335,000	$335,000
Basin Road	Basin Road	3303	11	Onsite	0	$0	Onsite	$55,000	$55,000
Bob's Branch	Bob's Branch	2807	11	Onsite	0	$0	Onsite	$55,000	$55,000
Bud Lite	Bud Lite	2807	5	Onsite	0	$0	Onsite	$25,000	$25,000
Bud Mountain	Bud Mountain	3302	21	Onsite	0	$0	Onsite	$105,000	$105,000
Cabin Creek	Cabin Creek	2900	38	Onsite	0	$0	Onsite	$190,000	$190,000
Egeria	Egeria	3603	14	Onsite	0	$0	Onsite	$70,000	$70,000
Herndon Heights	Herndon Heights	2811	54	Onsite	0	$0	Onsite	$270,000	$270,000
Herndon II	Herndon II	3308	24	Onsite	0	$0	Onsite	$120,000	$120,000
Josephine	Josephine	3706	57	Onsite	0	$0	Onsite	$285,000	$285,000
Kilarney	Kilarney	3705	2	Onsite	0	$0	Onsite	$10,000	$10,000
Lower Polk Gap	Lower Polk Gap	3403	16	Onsite	0	$0	Onsite	$80,000	$80,000
Lusk Community	Lusk Community	3303	12	Onsite	0	$0	Onsite	$60,000	$60,000

Community	Project Area	SWS	No. of Homes	Type Sewer	Length Sewer (linear feet)	Sewer Cost	Type Treatment	Treatment Cost	Total Cost
Lusk Settlement	Lusk Settlement	3303	10	Onsite	0	$0	Onsite	$50,000	$50,000
McAlpin	McAlpin	3701	4	Onsite	0	$0	Onsite	$20,000	$20,000
McKinney Ridge	McKinney Ridge	3406	10	Onsite	0	$0	Onsite	$50,000	$50,000
Mead II	Mead II	3705	8	Onsite	0	$0	Onsite	$40,000	$40,000
Micajah	Micajah	2811	13	Onsite	0	$0	Onsite	$65,000	$65,000
Montecarlo	Montecarlo	3304	4	Onsite	0	$0	Onsite	$20,000	$20,000
Odd	Odd	3707	75	Onsite	0	$0	Onsite	$375,000	$375,000
Peak Creek	Peak Creek	3303	23	Onsite	0	$0	Onsite	$115,000	$115,000
Pickshin	Pickshin	3706	12	Cluster	0	$0	Cluster LPP	$34,200	$34,200
Polk Gap	Polk Gap	3403	9	Onsite	0	$0	Onsite	$45,000	$45,000
Rt. 16 pg 1	Rt. 16 pg 1	1117	8	Onsite	0	$0	Onsite	$40,000	$40,000
Rt. 16 pg 6	Rt. 16 pg 6	1120	2	Onsite	0	$0	Onsite	$10,000	$10,000
Sand Gap	Sand Gap	1125	30	Onsite	0	$0	Onsite	$150,000	$150,000
Saulsville	Saulsville	2909	119	Onsite	0	$0	Onsite	$595,000	$595,000
Spider Ridge	Spider Ridge	2810	22	Onsite	0	$0	Onsite	$110,000	$110,000
Stephenson Bottom	Stephenson Bottom	1125	34	Cluster	0	$0	Cluster LPP	$96,900	$96,900
Still Run	Still Run	3200	2	Onsite	0	$0	Onsite	$10,000	$10,000
Stotesbury	Stotesbury	3701	24	Cluster	0	$0	Cluster LPP	$68,400	$68,400
Tams Mt.	Tams Mt.	3406	4	Onsite	0	$0	Onsite	$20,000	$20,000
Tracy's Mountain	Tracy's Mountain	3302	49	Onsite	0	$0	Onsite	$245,000	$245,000
Tralee	Tralee	3300	4	Onsite	0	$0	Onsite	$20,000	$20,000
Upper Polk Gap	Upper Polk Gap	3200	4	Onsite	0	$0	Onsite	$20,000	$20,000
Ury	Ury	3701	11	Cluster	0	$0	Cluster LPP	$31,350	$31,350

Appendix F. Cost calculations for each AML with water quality problems

Costs for eliminating AMD from each AML are usually sums of four components:

1. Reclamation of acres of refuse coal
2. Construction of mine seals,
3. Construction of OLCs, and
4. Engineering and project management costs.

In some cases, however, reclamation has taken place, and OLCs and wet seals have been installed.

Costs are rounded to nearest $10 thousand to reflect the precision of the method used to estimate costs. When the cost for a site is calculated to exceed $1 million, it is recorded as ">$1,000,000." This is done because data used for cost calculations, as already noted, are often so sparse as to make the calculations imprecise.

Decisions about the sizing of AMD treatment measures and the amounts of reclamation and of OLCs were chosen using the rules detailed below.

D.1 Land reclamation

Land reclamation costs were calculated at $10,000 per acre. The acreage chosen was that of refuse coal described in the PAD.

D.2 Mine seals

Where mine seals were not already constructed, the cost of $5,000/seal was used (Bess, 2004).

D.5 Oxic limestone channels

The price of constructing OLCs was set at $35/linear foot (Bess, 2004). The required length was estimated as 100 feet for each wet seal, and 100 feet for each acre of reclamation. OLCs are important for channeling water over reclaimed land to prevent erosion of the vegetation cover.

D.6 Engineering and project management costs

A 10% amount to be paid for the costs of developing blueprints and a 10% cost to pay for project management, including putting the project out for bid and inspecting the work as it takes place, have also been added to the costs.

Table 31: Cost calculations for each AML with water quality problems

Problem Area (Problem area number)	Amount of refuse coal (acres)	Land reclamation cost ($)	Number of wet seals	Cost of wet seals ($)	Amount of OLCs (linear feet)	OLC cost ($)	Total construction cost ($)	Engineering and project management cost ($)	Total cost, rounded ($)
Amigo Abandoned Structures (93)	6	60,000	0	0	600	21,000	81,000	16,200	100,000
Beartown Church Refuse Pile (630)	1	10,000	0	0	100	3,500	13,500	2,700	20,000
Beartown Fork Refuse Pile (631)	2	20,000	0	0	200	7,000	27,000	5,400	30,000
Clark Gap Refuse Pile (633)	15	150,000	0	0	1,500	52,500	202,500	40,500	240,000
Gooney Otter Creek Refuse (637)	30	300,000	0	0	3,000	105,000	405,000	81,000	490,000
Milam Ridge Refuse Pile (647)	10	100,000	3	15,000	1,300	45,500	160,500	32,100	190,000
Pilot Knob Refuse Pile (650)	10	100,000	0	0	1,000	35,000	135,000	27,000	160,000
Pinnacle Creek #2 Refuse Pile (651)	20	200,000	0	0	2,000	70,000	270,000	54,000	320,000
Hickory Branch Mine Dump (924)	75	750,000	0	0	7,500	262,500	1,012,500	202,500	>1,000,000
Alpoca Mine Dump (926)	10	100,000	0	0	1,000	35,000	135,000	27,000	160,000
Tralee Mine Dump (930)	100	1,000,000	0	0	10,000	350,000	1,350,000	270,000	>1,000,000
Pierpont Refuse Pile (932)	6.9	69,000	2	10,000	890	31,150	110,150	22,030	130,000
Helen "B" Refuse Pile (1727)	6	60,000	0	0	600	21,000	81,000	16,200	100,000
Allen Creek Complex (1898)	15	150,000	0	0	1,500	52,500	202,500	40,500	240,000
Montecarlo Complex (1903)	3	30,000	6	30,000	900	31,500	91,500	18,300	110,000
Rhodell Refuse Piles & Portal (1907)	10.6	106,000	0	0	1,060	37,100	143,100	28,620	170,000
Madeline Refuse Pile (1908)	3	30,000	0	0	300	10,500	40,500	8,100	50,000
Killarney Mine Dump (2298)	40	400,000	1	5,000	4,100	143,500	548,500	109,700	660,000
Berry Branch Refuse Pile (2301)	4	40,000	0	0	400	14,000	54,000	10,800	60,000
Richardson Branch Complex (2304)	7	70,000	0	0	700	24,500	94,500	18,900	110,000
Bailey Branch Complex (2305)	15	150,000	0	0	1,500	52,500	202,500	40,500	240,000
Ury Structures (2308)	3	30,000	0	0	300	10,500	40,500	8,100	50,000
Slab Fork Impoundments (2580)	2	20,000	0	0	200	7,000	27,000	5,400	30,000
Site #16 Adventure Resources, Inc. (4163)	1	10,000	0	0	100	3,500	13,500	2,700	20,000
Wyco (Pugh) Refuse Pond (4662)	1	10,000	0	0	100	3,500	13,500	2,700	20,000
Odd (Airy) Refuse (4695)	4	40,000	0	0	400	14,000	54,000	10,800	60,000
Stonecoal Creek Complex (4809)	0	0	0	0	0	0	919,603	183,921	>1,000,000
Blackeagle Refuse Pile (4811)	10	100,000	0	0	1,000	35,000	135,000	27,000	160,000
Pinnacle Mining Corp. (4968)	4	40,000	1	5,000	500	17,500	62,500	12,500	80,000
Stonecoal Junction Refuse (5640)	2	20,000	0	0	200	7,000	27,000	5,400	30,000
Terry Branch Portals and Refuse (5695)	0.5	5,000	0	0	50	1,750	6,750	1,350	10,000

Appendix G. Waters previously listed for total aluminum impairment

Table 32: Waters previously listed for total aluminum impairment

Stream code	Stream name	TMDL subwatershed	Miles impaired by Al (tot)
Guyandotte River 1			
OG-127	Cabin Creek	2900-2911	3.6
OG-127-D	Marsh Fork	2909	3.5
OG-128	Joe Branch	3000	1.6
OG-129	Long Branch	3100	2.1
OG-130	Still Run	3200	5.3
OG-125	Sugar Run	1117	2.1
Guyandotte River 2			
OG-135-A	Left Fork/Allen Creek	3501	2.6
OG-136	Big Branch	1125	2
Pinnacle Creek			
OG-124	Pinnacle Creek	2800-2813	26.6
OG-124-D	Smith Branch	2801	2.1
OG-124-H	Laurel Branch	2805	2.1
OG-124-I	Spider Creek	2807	3.5
Barker's Creek			
OG-131	Barker's Creek	3300-3310	8
OG-131-B	Hickory Branch	3301	2.1
OG-131-C	Mill Branch	3302	2.6
OG-131-F	Gooney Otter Creek	3304-3310	6.8
OG-131-F-1	Jims Branch	3305	1.4
OG-131-F-2	Noseman Branch	3307	2.3
Slab Fork			
OG-134	Slab Fork	3400-3406	15.1
OG-134-D	Measle Fork	3405	3.3
Devil's Fork			
OG-137	Devil's Fork	3600-3604	4.9
Winding Gulf			
OG-138	Winding Gulf	3701	15.5
OG-138-E	Mullens Branch	3701	1.4
Stonecoal Creek			
OG-139	Stonecoal Creek	3702-3707	10.2
OG-139-A	Tommy Creek	3707	4.8

Source: Total aluminum impairments are from the 2002 303(d) list, which does not provide any mileages (WVDEP, 2003). Impaired mileages for all streams are from the 1998 303(d) list (WVDEP, 1998), which lists all streams as impaired by pH and metals from mine drainage. See Chapter 2.1.2 for further explanation.

Appendix H: Ranking score calculations for wastewater treatment projects

Calculating the scoring ratios for water quality, construction cost, and O/M cost (as described in Chapter 6.1) results in three sets of values with different units. In order to combine those values into a community score, the data was normalized and the units removed. To do this, each value was divided by the highest value calculated within that scoring criterion. Dividing every value by the same number preserves the relationships between each value and results in a set of values between 0 and 1. For the water quality improvement criteria, a larger ratio (with 1 being the highest value) is a favorable score. However, for construction cost and annual O/M cost, a smaller ratio (with 0 being the lowest value) is a favorable score. In order to account for this difference, the normalized values for the construction cost ratio and the O/M cost ratio were also inverted (subtracted from 1).[18]

$$\left(\frac{\text{Load reduction expected upon project implementation}}{\text{Current annual load across the subwatershed}}\right) \times \text{Highest water quality improvement ratio}$$

$$+$$

$$1 - \left[\left(\frac{\text{Treatment system construction cost per household}}{\text{Annual median household income}}\right) \times \text{Highest construction cost per household ratio}\right]$$

$$+$$

$$1 - \left[\left(\frac{\text{Annual operation and maintenance cost per household}}{\text{Annual median household income}}\right) \times \text{Highest O/M per household ratio}\right]$$

$$= \text{Overall Community Score}$$

[18]This method is described in detail in Malczewski, 1999.

The following ranking score calculation is given for Alpoca as an example.

$$\left[\left(\frac{1.985\times10^{14}}{1.236\times10^{15}}\right)\times0.82597\right]+\left[1-\left(\left(\frac{6299.02}{28181.95}\right)\times0.84371186\right)\right]+\left[1-\left(\left(\frac{100}{28181.95}\right)\times0.0107907\right)\right]=1.60072049$$

$$(0.160628029\times0.82597)+[1-(0.223512544\times0.84371186)]+[1-(0.00354837\times0.0107907)]=1.60072049$$

$$0.194471556+0.735084268+0.671164666=1.60072049$$

Table 33: Ranking score calculations for wastewater treatment projects

Community	Community Annual Median Income	Water Quality Ratio	Water Quality Normalized	Construction Cost Per Home	Construction Cost Ratio	Construction Cost Normalized and Inverted	Annual OM Cost Per Home	OM Ratio	OM Ratio Normalized and Inverted	Score
Barker's Creek										
Alpoca	$28,181.95	0.160628029	0.194471556	6299.019608	0.223512544	0.735084268	100	0.003548370	0.671164666	1.60072049
Basin	$22,435.77	0.0271677	0.0328918	5000	0.222858393	0.735859593	50	0.002228584	0.793472194	1.562223588
Basin Ridge 2	$21,581.35	0.045279501	0.054819666	5000	0.231681551	0.725402044	50	0.002316816	0.785295578	1.565517289
Basin Ridge 1	$23,088.00	0.121349062	0.146916706	5000	0.216562717	0.743321473	50	0.002165627	0.799306537	1.689544716
Basin Road	$19,544.27	0.01992298	0.024120653	5000	0.255829464	0.696781002	50	0.002558295	0.762917173	1.483818829
Bud	$26,373.64	0.149331694	0.18079514	7470.29703	0.283248668	0.664282698	120	0.004549998	0.578341569	1.423419407
Bud Mountain	$30,208.00	0.034154081	0.041350176	5000	0.165519068	0.803820384	50	0.001655191	0.846609816	1.691780376
Covel	$23,088.00	0.088005297	0.106547576	8916.666667	0.386203511	0.542256627	150	0.006496881	0.397919611	1.046723814
Garwood	$23,088.00	0.048891832	0.059193098	8637.931034	0.374130762	0.556565717	165	0.007146570	0.337711572	0.953470387
Herndon	$20,583.85	0.039476743	0.047794297	4766.666667	0.231573169	0.725530503	115	0.005586905	0.482249136	1.255573937
Herndon II	$23,012.77	0.039476743	0.047794297	5000	0.217270691	0.742482354	50	0.002172707	0.798650441	1.588927092
Lusk Community	$19,544.27	0.02173416	0.02631344	5000	0.255829464	0.696781002	50	0.002558295	0.762917173	1.486011615
Lusk Settlement	$19,917.00	0.016448643	0.01991429	5000	0.251041824	0.702455499	50	0.002510418	0.767353985	1.489723775
Montecarlo	$27,277.79	0.006579457	0.007965716	5000	0.183299286	0.782746581	50	0.001832993	0.830132495	1.620844792
Peak Creek	$22,704.16	0.041657141	0.050434093	5000	0.220223966	0.738982018	50	0.002202240	0.795913576	1.585329687
Tracy's Mountain	$23,594.13	0.081503848	0.098676304	5000	0.211917073	0.74882767	50	0.002119171	0.803611758	1.651115731
Tralee	$30,208.00	0.00687513	0.008323685	5000	0.165519068	0.803820384	50	0.001655191	0.846609816	1.658753886
Devils Fork										
Amigo	$19,826.93	0.825971839	0.999999999	4402.777778	0.222060459	0.736805335	82.5	0.004161007	0.614390297	2.351195632
Egeria	$19,305.85	0.164028161	0.19858808	5000	0.258988876	0.693036344	50	0.002589889	0.759989276	1.6516137
Guyandotte River 1										
Cabin Creek	$21,126.29	0.069382749	0.084001349	5000	0.236671892	0.719487299	50	0.002366719	0.780670919	1.584159567

Community	Community Annual Median Income	Water Quality Ratio	Water Quality Normalized	Construction Cost Per Home	Construction Cost Ratio	Construction Cost Normalized and Inverted	Annual OM Cost Per Home	OM Ratio	OM Ratio Normalized and Inverted	Score
Lower Itmann	$28,235.71	0.238368578	0.288591653	9340.909091	0.330818941	0.607900567	150	0.005312421	0.507686192	1.404178412
New Richmond	$25,095.68	0.247036526	0.299085894	8947.368421	0.356530265	0.577426509	150	0.005977125	0.446086594	1.322598997
Rt. 16 pg 1	$25,546.05	0.019069486	0.023087332	5000	0.195724996	0.768019148	50	0.001957250	0.818617314	1.609723794
Rt. 16 pg 6	$27,337.00	0.004767372	0.005771833	5000	0.182902294	0.783217111	50	0.001829023	0.830500396	1.61948934
Saulsville	$22,207.74	0.217277556	0.263056857	5000	0.225146691	0.733147414	50	0.002251467	0.791351578	1.787555849
Still Run	$27,337.00	0.004767372	0.005771833	5000	0.182902294	0.783217111	50	0.001829023	0.830500396	1.61948934
Upper Itmann	$28,133.21	0.121351276	0.146919387	10000	0.355451756	0.5787048	150	0.005331776	0.505892486	1.231516672
Upper Polk Gap	$27,337.00	0.007303447	0.008842247	5000	0.182902294	0.783217111	50	0.001829023	0.830500396	1.622559755
Guyandotte River 2										
Allen Junction	$23,661.91	0.098318144	0.119033288	10904.54545	0.460848146	0.453784911	126.667	0.005353190	0.503908077	1.076726277
Beechwood	$22,997.55	0.082467289	0.099842736	7248	0.315163989	0.626455422	50	0.002174145	0.798517215	1.524815374
Blackeagle	$26,168.60	0.056134915	0.067962263	15080.64516	0.576287829	0.316961325	120	0.004585649	0.575037794	0.959961381
Corinne	$28,229.50	0.131171418	0.158808584	4378.787879	0.155113882	0.816153014	120	0.004250872	0.606062302	1.5810239
Corinne Bottom	$23,937.95	0.164957995	0.199713825	4596.385542	0.19201247	0.772419377	120	0.005012960	0.535437911	1.507571113
Iroquois	$20,666.25	0.076175889	0.09222577	3589.0625	0.173667827	0.794162159	115	0.005564629	0.484313543	1.370701472
Sand Gap	$19,917.00	0.070686247	0.085579488	5000	0.251041824	0.702455499	50	0.002510418	0.767353985	1.555388972
Stephenson Bottom	$20,752.78	0.08011108	0.096990087	2850	0.137331008	0.837229965	180	0.008673537	0.196204095	1.130424147
Stephenson Hill	$23,129.11	0.046695763	0.056534329	7704.761905	0.333119751	0.605173557	165	0.007133869	0.338888607	1.000596492
Wyco	$25,069.00	0.139915198	0.169394635	10983.33333	0.438124111	0.480718319	180	0.007180183	0.334596576	0.984709531
Pinnacle Creek										
Bob's Branch	$30,208.00	0.10286828	0.124542115	5000	0.165519068	0.803820384	50	0.001655191	0.846609816	1.774972316
Bud Lite	$30,208.00	0.046758309	0.056610052	5000	0.165519068	0.803820384	50	0.001655191	0.846609816	1.707040253
Herndon Heights	$26,261.15	0.5107276	0.618335366	5000	0.190395314	0.774336092	50	0.001903953	0.823556448	2.216227907
Micajah	$30,208.00	0.121571604	0.147186136	5000	0.165519068	0.803820384	50	0.001655191	0.846609816	1.797616337
Spider Ridge	$26,260.64	0.208074207	0.251914409	5000	0.190399021	0.774331699	50	0.001903990	0.823553013	1.849799121
Slab Fork										
Acord Mt.	$34,286.00	0.077720251	0.094095521	5000	0.145832118	0.82715412	50	0.001458321	0.864854148	1.78610379
Hotchkiss	$34,286.00	0.167555134	0.202858168	8611.111111	0.251155314	0.702320985	100	0.002916642	0.729708296	1.634887449
Lower Polk Gap	$25,825.00	0.063312854	0.076652558	5000	0.193610859	0.770524904	50	0.001936109	0.820576531	1.667753993
Maben	$24,388.22	0.089933031	0.108881474	8800	0.360829944	0.572330362	150	0.006150510	0.430018586	1.111230422
McKinney Ridge	$34,286.00	0.051971369	0.062921478	5000	0.145832103	0.827154138	50	0.001458321	0.864854162	1.754929777
Otsego	$25,713.97	0.216473714	0.26208365	10238.09524	0.398153072	0.528093544	150	0.005833405	0.459405403	1.249582597
Pierpoint	$25,554.07	0.233160752	0.282286563	2850	0.111528213	0.867812438	180	0.007043887	0.347227387	1.497326389
Polk Gap	$22,573.65	0.038270802	0.04633427	5000	0.221497141	0.737473002	50	0.002214971	0.794733697	1.57854097
Tams Mt.	$28,589.24	0.012048911	0.014587557	5000	0.174890992	0.792712416	50	0.001748910	0.837924647	1.64522462
Stonecoal Creek										
Besoco	$17,257.08	0.059584838	0.072139067	14560	0.843711857	-1.4033E-13	116.667	0.006760512	0.373488419	0.445627486
Eastgulf	$16,887.93	0.08795	0.106480628	3474.117647	0.205716039	0.756177376	136.667	0.008092566	0.250044025	1.112702029
Josephine	$17,364.21	0.141423278	0.171220459	5000	0.287948577	0.658712184	50	0.002879486	0.73315168	1.563084323
Kilarney	$17,087.06	0.005331708	0.006455072	5000	0.292619149	0.65317644	50	0.002926191	0.728823357	1.38845487
Lego	$16,681.00	0.053317076	0.064550719	7340.909091	0.44007608	0.47840477	120	0.007193813	0.333333396	0.876288885
Mead	$18,038.26	0.063980491	0.077460863	7854.166667	0.435417006	0.483926885	25	0.001385943	0.87156162	1.432949368
Mead II	$17,730.03	0.02132683	0.025820288	5000	0.282007431	0.665753861	50	0.002820074	0.738657472	1.43023162
Odd	$19,101.62	0.047525509	0.057538897	5000	0.261757914	0.689754372	50	0.002617579	0.757423147	1.504716416

Community	Community Annual Median Income	Water Quality Ratio	Water Quality Normalized	Construction Cost Per Home	Construction Cost Ratio	Construction Cost Normalized and Inverted	Annual OM Cost Per Home	OM Ratio	OM Ratio Normalized and Inverted	Score
Pickshin	$16,681.00	0.029456618	0.035662981	2850	0.170853083	0.797498302	180	0.010790721	-5.55E-09	0.833161278
Rhodell	$17,864.41	0.427593256	0.51768503	7750	0.433823529	0.485815536	150	0.008396584	0.221869935	1.225370501
Winding Gulf										
Helen	$17,496.00	0.631368352	0.764394526	10869.04762	0.621230582	0.263693431	150	0.008573390	0.205484945	1.233572902
McAlpin	$17,336.07	0.026182468	0.031698984	5000	0.288416055	0.658158111	50	0.002884161	0.732718458	1.422575552
Stotesbury	$17,331.89	0.173628906	0.210211654	2850	0.164436799	0.805103131	180	0.010385482	0.03755439	1.052869175
Ury	$17,992.68	0.095683438	0.115843463	2850	0.15839777	0.812260823	180	0.010004070	0.07290072	1.001005006

Source: US Census Bureau (2000),

Table 10 (pg. 24), Table 11 (pg. 25), Table 12 (pg. 38).