WATERSHED BASED PLAN FOR THE NORTH FORK BLACKWATER RIVER WATERSHED, WEST VIRGINIA

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

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ABBREVIATIONS

Al	aluminum
ALD	anoxic limestone drain
AMD	acid mine drainage
AML	abandoned mine land
dis.	dissolved
Fe	iron
FOBC	Friends of Blackwater Canyon
gpm	gallons per minute
L	liter
MDE	Maryland Department of the Environment
mg/L	milligrams per liter
Mn	manganese
MPPRP	Maryland Power Plant Research Project
MRB	manganese removal bed
NMLRC	National Mine Land Reclamation Center
NR	not reported
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
OAMLR	Office of Abandoned Mine Lands and Reclamation
OLC	oxic (or open) limestone channel
OSM	Office of Surface Mining, Reclamation and Enforcement
PA	problem area
PAD	problem area description
RAPS	reducing and alkalinity producing system
SRG	Stream Restoration Group
TMDL	total maximum daily load
tot.	total
ug/L	micrograms per liter
UNT	unnamed tributary
USEPA	United States Environmental Protection Agency
WCAP	Watershed Cooperative Agreement Program
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources
Zn	zinc

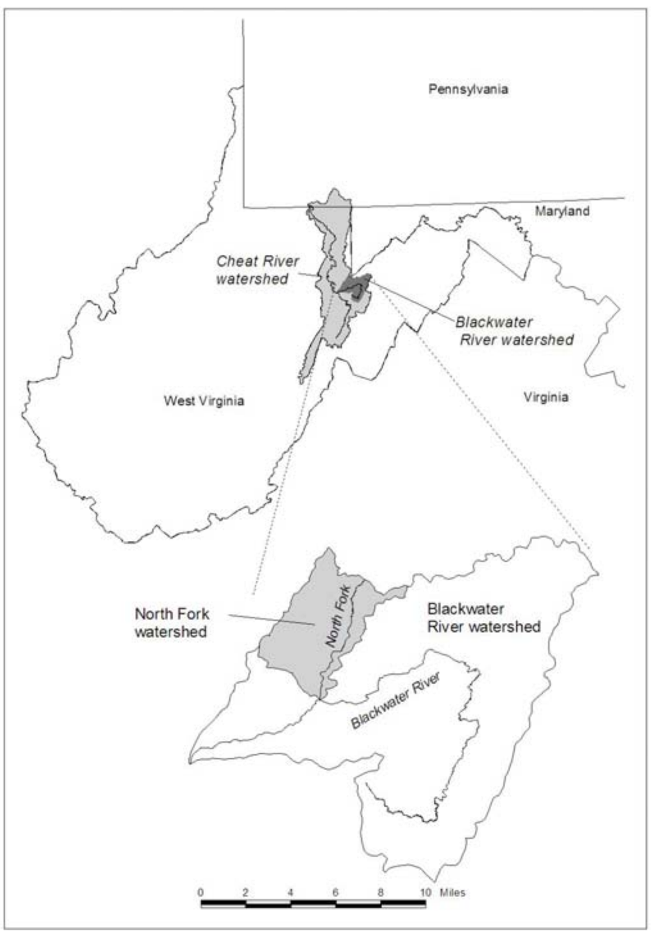
1. INTRODUCTION

This Watershed Based Plan covers the North Fork of the Blackwater River ("the North Fork") in West Virginia, from its headwaters at Fairfax Summit to the mouth, including all tributaries (Figure 1). The North Fork and three main tributaries are impaired by acid mine drainage (AMD) pollutants. Biological impairments of unknown causes and bacteria and sediment problems have also been documented.

This Watershed Based Plan has been written to allow incremental Section 319 funds to be spent in the North Fork watershed to clean up nonpoint sources that contribute to these pollution problems.

After summarizing the range of impairments documented in the watershed, this plan focuses on AMD—by far its most significant water quality problem—and documents the nonpoint sources of AMD. Where data allow, costs of remediating each site are calculated. This plan also addresses technical and financial assistance needs, proposes an implementation schedule with milestones and measurable goals, and documents an outreach and education program that will help make this plan a reality.

Figure 1: Location of the North Fork watershed



The North Fork drains into the Blackwater River, which joins with the Dry Fork to create the Black Fork. This river then joins Shavers Fork to form the Cheat River. As described by the West Virginia Division of Natural Resources (WVDNR):

> "[The] North Fork of the Blackwater begins at Fairfax Summit at an elevation of 3,050 feet and flows 7.4 miles entering the Blackwater River 1.1 miles below Douglas at an elevation of 2,400 feet. Its total fall is 650 feet or 88 feet per mile. The North Fork encompasses an area of 18.2 square miles and its principal tributaries are Long, Middle, Snyder, Sand and Glade Runs. … From Fairfax to Douglas the stream is fairly placid, but below Douglas it becomes a raging torrent with numerous low cataracts, its bed littered with huge boulders" (WVDNR, Undated, pp. 128-9).
>
> "The Blackwater River's watershed is 141.8 square miles and contained entirely within the eastern portion of Tucker County. The river originates at the southern end of Canaan Valley in Canaan Valley State Park at an elevation of 3,259 feet. It winds its way in a general northeasterly direction for 12 miles through Canaan Valley which has the largest wetland complex in West Virginia. Joining with the Little Blackwater River it turns westward, exiting the valley between Brown and Canaan mountains, and travels five miles to its juncture with Beaver Creek at the town of Davis. The river then begins a southwestward flow to its junction with the Dry Fork River at the town of Hendricks (elevation 1,705 feet). In this final 12 mile section the river goes over Blackwater Falls and down through the Blackwater Canyon which was carved over eons by its flow. In the canyon, three miles below the falls, the North Fork of the Blackwater enters from the west. (WVDNR, 1999, p. 2)

The major population center in the North Fork watershed is Thomas, population 452 (United States Census Bureau, 2005). Other towns in the North Fork watershed include Coketon, Douglas, Benbush, Pierce, and William. Most of the North Fork Blackwater watershed falls within the Monongahela National Forest.

As shown in Table 1, about 90% of the North Fork watershed is forested and 6.5% is covered with strip mines. The remaining land is split between grassland/pasture, residential, and commercial/industrial.

Table 1: Land cover summary for the North Fork watershed

Land cover	Percent of watershed
Mixed forest	57.3%
Deciduous forest	32.6%
Strip Mines	6.5%
Grassland/pasture	1.7%
Residential	1.0%
Commercial/industrial	0.6%
Coniferous forest	0.3%

Source: USEPA, 2001.

The majority of the North Fork watershed is unable to sustain a fishery due to the mining-related pollution entering the watershed. A fishery does exist in Thomas Park Lake on the mainstem of the North Fork just upstream of the first major AMD pollution source. The impoundment is stocked with trout once every month from February through May by WVDNR. The impoundment also contains largemouth bass and bullhead catfish (WVDNR, 2005).

The North Fork Watershed Project provides an overview of the watershed's history:

> "Today the North Fork of the Blackwater River flows past the quiet towns of Thomas, Coketon and Douglas in Tucker County, West Virginia. There are fewer than 700 residents in these communities, but things were not so calm a century ago.
>
> "Businessman and politician, Henry Gassaway Davis was largely responsible for the boom experienced in the area beginning in 1883. Tucker County was a vast wilderness until Davis, with help of his brothers, began pursuing the rich coal resources on the banks of the North Fork of the Blackwater River. The brothers realized that the coal and timber resources could only be developed with technology. Davis brought the railroad from Elkins through Thomas in 1884. Coal from the first deep mine was ready to be loaded by the time the track was completed. By 1892, Davis Coal and Coke Company was among the largest and best known coal companies in the world.
>
> "An experiment with two coke ovens in 1887 determined that the coal was excellent for coking … Two years following the experiment the company had constructed over 500 "beehive" coke ovens along the mile and a half rail line between Thomas and Douglas. The ovens were fed by horse-drawn cars on tracks that lead from the mine tipples. The ovens burned 250 days a year and produced 200,000 tons of coke in a single year.
>
> "Davis Coal and Coke Company, headquartered in Coketon, reached peak production in 1910. The company controlled 135,000 acres, employed 1600 men of 16 nationalities, operated two power plants, and worked over 1000 coke ovens and 9 mines within one square mile of the central office. The town of Thomas boasted the grandest railway station between Cumberland, Maryland and Elkins, West Virginia.
>
> "Coke production in beehive ovens was discontinued in 1912 due to advancements in refining techniques. Thus began the area's slow decline. Many mines remained active through World War II. But by 1950 only two mines were still working and Coketon's population remained in decline. Underground mining ceased altogether in 1956. However, the coal seams were far from exhausted, smaller surface mining operations arrived around Tucker County and some still operate today" (North Fork Watershed Project, 2005).

The 2000 census found that mining accounts for just a few jobs in the watershed's largest town, Thomas. Today, watershed residents are employed in a number of different sectors including retail, professional services, recreation, and forestry. The per capita income in 2000 was $14,918 and the median family income was $25,417 (United States Census Bureau, 2005).

Local attractions such as the Monongahela National Forest, Blackwater Falls State Park, and Canaan Valley National Wildlife Refuge draw thousands of visitors to the area every year for fishing, skiing, hunting, and other forms of outdoor recreation. Nearby Canaan Valley Resort State Park and Blackwater Falls State Park drew 560,000 and 330,000 visitors respectively in 2004 (Smith, 2005). The Tucker County Convention and Visitors Bureau estimates that at least half of the visitors to Tucker County are there to experience the outdoors and scenery (Smith, 2005).

2. MEASURABLE WATER QUALITY GOALS

All stream segments in the North Fork 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 North Fork 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 2 are relevant for the nonpoint source pollution problems addressed by this Watershed Based Plan.

Table 2: Selected West Virginia water quality standards

		Aquatic life		Human health	
Parameter	**Section**	**Category B1 (Warm water fishery streams)**	**Category B2 (Trout waters)**	**Category A (Public water supply)**	**Category C (Water contact recreation)**
Aluminum (dissolved)	8.1	Not to exceed 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.			
Turbidity	8.32	No point or non-point source to West Virginia's waters shall contribute a net load of suspended matter such that the turbidity exceeds 10 NTUs over background turbidity when the background is 50 NTU or less, or have more than a 10% increase in turbidity (plus 10 NTU minimum) when the background turbidity is more than 50 NTUs.			
Zinc (dissolved)	8.33	Not to exceed chronic and acute concentrations that vary with hardness		None	None

Source: 46 Code of State Rules Series 1. Sections refer to this rule. 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." When the TMDL was approved, an acute total aluminum criterion of 750 µg/L was in effect. Since then, the aluminum criterion was changed 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. USEPA has still not approved or disapproved this suspension. The chronic dissolved zinc equation is: $Zn = e^{(0.8473[\ln(hardness)]+0.7614)} \times 0.986$. The acute dissolved zinc equation is: $Zn = e^{(0.8473[\ln(hardness)]+0.8604)} \times 0.978$. See Sections 8.32 and 8.32.1 for special circumstances for the turbidity standard. NTU = nephelometric turbidity unit.

As explained in the notes for Table 2, the aluminum and manganese criteria have become more lenient since 2001, when the total maximum daily load (TMDL) for this watershed was approved. Therefore, the TMDL's aluminum and manganese load reduction requirements may be more stringent than required to meet current water quality standards.

3. SOURCES OF NON-POINT SOURCE POLLUTION THAT MUST BE CONTROLLED

Streams that do not meet water quality standards are placed on a statewide list of impaired streams called the 303(d) list. Improving water quality so that these streams are once again clean and can be removed from this list is the primary goal of this plan. Segments of the North Fork watershed covered by this plan are on the 2004 303(d) list for AMD-related pollutants (pH, aluminum, iron, manganese), or biological impairment (WVDEP, 2004a).

This plan also considers two other types of pollution—fecal coliform and sediment—because other data sources have identified these pollution problems in the North Fork watershed.

3.1 Acid mine drainage

The most important nonpoint source pollution in the North Fork watershed is AMD from abandoned mine lands (AMLs). The West Virginia Department of Environmental Protection's (WVDEP's) most recent 303(d) list (WVDEP, 2004a) and their earlier assessment of the North Fork watershed (WVDEP, 1999) list specific segments of the watershed as impaired by high concentrations of iron, aluminum, manganese, and by low pH from AMD.[1] Figure 2 draws these AMD-impaired streams as thick, grey lines. These impairments are further explained in Table 3.

The watershed contains no bond forfeiture sites,[2] and WVDEP's Web site shows only two permitted point sources in the North Fork watershed:

- Buffalo Coal Company, Inc., WV1013971, a surface coal mine that discharges to Snyder Run, and
- Buffalo Coal Company, Inc., WV0052973, the Kovach-Kempton and Kempton #2 jobs, which are surface coal mines that discharge to Glade Run.

Therefore, these AMD impairments are caused almost entirely by AMLs. A total of 27 AMLs are documented in the North Fork watershed and are listed in Appendix A. The problem area descriptions (PADs) and other documentation of these sites indicate that only those AMLs in Table 4 discharge AMD (WVDEP, Various dates).

Other AMLs likely do not discharge AMD; therefore, they are only listed in Appendix A. The methods used to identify sites in Table 4 and Appendix A are not foolproof. If new information indicates that an AML that was left out of Table 4 does, in fact, discharge AMD, the Watershed Based Plan will be updated as appropriate.

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[1] The Cheat River at Cheat Lake, far downstream from the North Fork Blackwater River, is also listed for zinc, and the Cheat TMDL includes a basin-wide allocation for zinc. Zinc is not included in this Watershed Based Plan.

[2] Bond forfeiture sites are distinguished from AMLs because they were abandoned after the 1977 Surface Mining Control and Reclamation Act. Bond forfeiture sites are considered to be point sources, but AMLs are considered to be nonpoint sources.

Figure 2: Impaired streams in the North Fork watershed

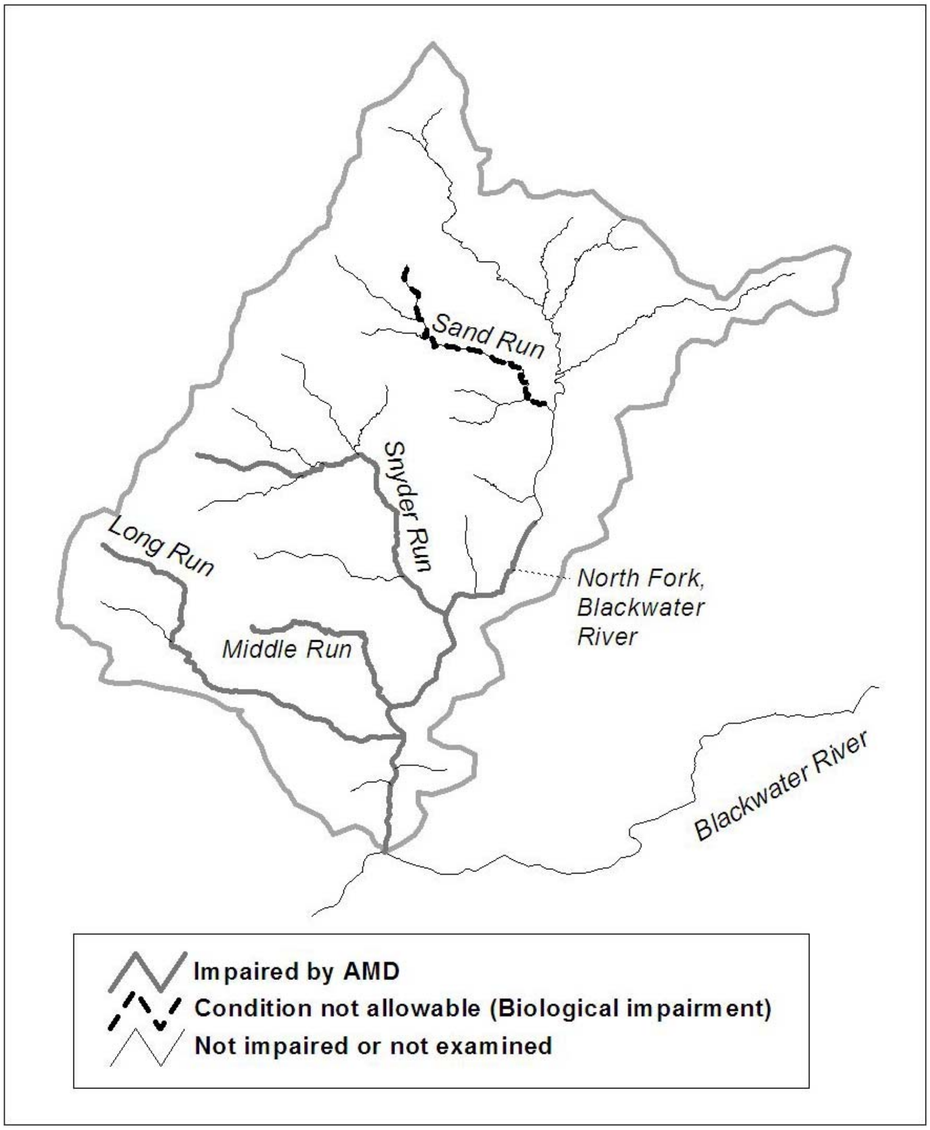


Table 3: Stream segments impaired by acid mine drainage in the North Fork watershed

Stream code	Stream name	Impaired miles	Al (dis)	Al (tot)	Fe	Mn	pH
MC-60-D-3	North Fork Blackwater	8	x	x	x	x	x
MC-60-D-3-A	Long Run	3.6		x	x	x	x
MC-60-D-3-B	Middle Run	1.8		x	x	x	x
MC-60-D-3-C	Snyder Run	2.8		x	x	x	x

Source: All impairments except total aluminum are from the 2004 303(d) list Supplemental Tables B and E (WVDEP, 2004a), which lists 8 impaired miles for dissolved aluminum for North Fork Blackwater, but no mileages for the any other AMD impairments. Total aluminum impairments are from the 2002 303(d) list, which does not provide any mileages (WVDEP, 2003). Impaired mileages for Long, Middle, and Snyder Runs are from the 1998 303(d) list (WVDEP, 1998), which lists all four streams as impaired by pH and metals from mine drainage. Although this 1998 list shows 4 impaired miles for North Fork Blackwater, the more recent figure of 8 miles from the 2004 list is used.

Table 4: Abandoned mine lands known to discharge acid mine drainage

Site name (Problem area no.)	Location	Notes
Blackwater Manor (4)	Unnamed tributary on east side of North Fork.	Completed project includes three sealed portals and water treatment measures.
Coketon Portal (275) and Douglas Highwall #2 (1623)	Large portal on west side of North Fork	This is the largest AMD flow in the watershed, and is thought to be the major discharge from the Coketon mine pool. It was addressed with a large ALD which is no longer treating the water. During the project, some of the flow changed its path, and a wet seal was placed upstream to control the flow at that point.
Albert Highwall (1622) and Long Run (3)	Portals along Long Run and Middle Run	The completed Albert Highwall project includes extensive land reclamation and several water treatment cells. This project also addressed Long Run.
Douglas Highwall #2 (1623)	Smaller portals on east side of North Fork	There are a number of portals with smaller flows across the North Fork from the Coketon Portal. There is no water treatment at this site.
Long Run Strip (1799)	Discharges to headwaters of Long Run	Large area of refuse coal probably accounts for AMD load measured in Long Run upstream from the Albert Highwall project.
Snyder Run HW No. 4 (3191)	Discharges to Middle Run	AMD was not identified at this site by OAMLR, but highwalls at this site would be updip, and probably discharge AMD that accounts for the AMD load measured in Middle Run upstream from the Albert Highwall project.
Burns Blowout (4642) and Coketon Portal (275)	Discharges to North Fork just upstream from Douglas Highwall #2	The location of this source suggests it is a discharge from the Coketon mine pool.
Thomas (Collett) AMD (5799)	Discharges to North Fork between Thomas and Douglas.	Intermittent AMD source. No flows or chemistry recorded.
Thomas (Sunrise Sanitation) Mine Drainage (5937)	Discharges to North Fork in Thomas	This AMD source discharges from the Bakerstown seam in the middle of the town of Thomas. The one SRG measurement indicates the water is not acidic. The water carries an unsightly white precipitate usually presumed to be aluminum hydroxide. The one measurement available from SRG, however, does not have high Al concentrations.

Source: WVDEP (Various dates).

3.1.1 The Coketon mine pool

The massive underground Upper Freeport Coketon mine pool underlies a large part of the North Fork watershed and discharges into the North Fork as shown in Figure 3. The mine pool is hydraulically connected with the Kempton mine pool, which discharges to the North Branch Potomac River watershed in Maryland. Because of the size and environmental impacts of these mine pools and the potential for even more water to flow from the Coketon pool to the Kempton pool and out to Maryland waters, the Maryland Department of the Environment and Frostburg State University have studied the issue, mapped the mine pools, and developed treatment plans for water flowing toward Maryland.

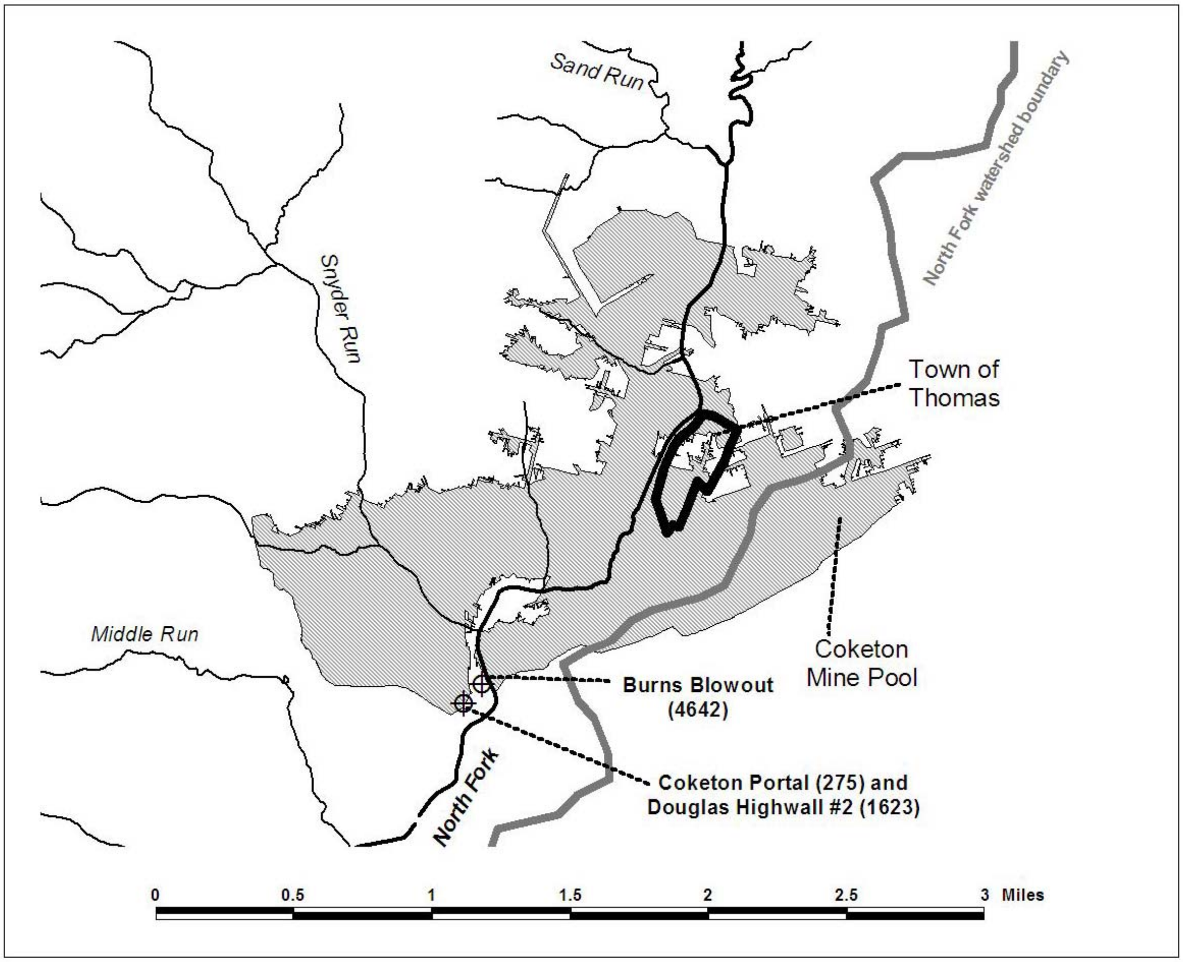
In West Virginia, the main outlets from the Coketon mine pool are the portals at the Douglas Highwall #2 and Coketon Portal sites. Flows from five outlets on the west side of the North Fork average a total of 1,350 gpm, and four flows on the east side average a total of 610 gpm (MDE, 2002b). This water is highly acidic (Leo, 2005b). An additional site, Burns Blowout, is in the same area and also likely discharges from this pool. Two other AMLs, Albert Highwall on the west side of the North Fork and Blackwater Manor on the east side, are connected to the same mine void, but lie at a higher elevation and do not discharge the same pool.

The high flows and acidities discharged from the mine pool raise the question of whether water from each AML linked to the pool should be treated separately after it is discharged, or whether the pool itself should be addressed *in situ*, so that water discharging from the AMLs would be cleaner and would require little or no treatment. Although the individual outlets discharge smaller volumes than the entire output of the pool, there may be advantages to a single project. Possible methods for *in situ* treatment include:

- Grouting the mine so that water follows a path with relatively little exposure to pyrite;
- Grouting the mine so that water comes out in one place for treatment, rather than at several places; and
- Pumping water out of the mine pool, adding alkalinity, and reinjecting it back into the mine, with the goal of turning the mine pool alkaline.

The North Fork Task Force, described in Chapter 7, is starting to consider these options. This Watershed Based Plan, however, calculates costs for treating each AML separately.

Figure 3: The Coketon mine pool and abandoned mine lands through which it discharges



Note: Map drawn by authors, with mine pool shape file provided by MDE (2002a).

3.2 Biological impairment

The 2004 303(d) list includes one stream, Sand Run, in the North Fork watershed for biological impairment, shown above in Figure 2 with a broken line. WVDEP intends to complete a TMDL for this stream in 2014 (WVDEP, 2004a). WVDEP (1999) also lists Long Run as biologically impaired, although this stream is not included on the 303(d) list.

Streams are listed for biological impairment based on a survey of their benthic macroinvertebrate communities. A West Virginia Stream Condition Index score is generated from this survey. Streams with a score of 60.6 or less are considered biologically impaired and placed on the list. Although the cause is not known at this time, AMD cannot be ruled out. Entire stream lengths are typically considered impaired, and the cause of impairment is listed as unknown until more data are collected prior to the TMDL development process (WVDEP, 2004a).

3.3 Fecal coliform

WVDEP (2004a and 1999) has found that fecal coliform bacteria impair many West Virginia waters. But currently, the 303(d) list does not contain any segments of the North Fork watershed for fecal impairment (WVDEP, 2004a). WVDEP states that:

> "[m]any West Virginia waters contain elevated levels of fecal coliform bacteria. Contributors to the problem include leaking or overflowing sewage collection systems, illegal homeowner sewage discharges by straight pipes or failing septic systems, and runoff from urban or residential areas and agricultural lands. Other West Virginia waters besides those identified on the list may be impaired for fecal coliform bacteria, but those waters are not listed because there is insufficient or no data demonstrating impairment. The WVDEP's watershed assessment and TMDL development methodologies will subject suspect streams to intensified bacteria monitoring in the future and additional listings will be forthcoming. This targeting effort has increased the number of fecal coliform listings from 29 on the 2002 Section 303(d) list to 185 on the current list. The combined length of waters identified as impaired for fecal coliform is approximately 1,490 miles." (WVDEP, 2004a, p. 27)

Currently only limited fecal coliform data exist for the North Fork watershed. As shown in Table 5, WVDEP (1999) lists several North Fork Blackwater watershed streams as violating standards based on single water samples collected in 1996. The samples were compared against the 400 units/100 mL standard because one sample is not enough to be compared with the 200 units/100 mL standard. WVDEP considers water exceeding the 400 units/100 mL standard to be potentially unsafe (WVDEP, 1999).

More recent data collected in 2001 by WVDEP provide a different picture (WVDEP, 2004b). As in 1996, only one sample was collected at each site and the data were compared to the 400 units/100 mL standard. As shown in Table 5, only one stream sampled in 2001 showed violations of the fecal coliform standard: Sand Run.

The variability in the fecal coliform levels from the two sampling periods is most likely attributed to precipitation, a common occurrence with nonpoint source pollution. A study of the watershed to locate nonpoint sources of fecal coliform bacteria is recommended.

Table 5: Stream segments with recent fecal coliform data

Stream code	Stream name	Date	Fecal coliform (units/100 mL)
MC-60-D-3-A	Long Run	6/12/2001	2
MC-60-D-3-B	Middle Run	7/16/1996	14,750
MC-60-D-3-B	Middle Run	6/6/2001	6
MC-60-D-3-C	Snyder Run	7/16/1996	5,440
MC-60-D-3-C	Snyder Run	6/6/2001	50
MC-60-D-3-C	Snyder Run	6/11/2001	4
MC-60-D-3-E	Sand Run	7/17/1996	1,470
MC-60-D-3-E	Sand Run	6/11/2001	900
MC-60-D-3-F	Glade Run	6/12/2001	15

Source: Samples collected in 1996 from WVDEP (1999) Table 19. Samples collected in 2001 from WVDEP (2004b). Stream Code listed as ANCode in WVDEP (2004b).

3.4 Sediment

Sediment sources and loads currently entering the North Fork watershed are not fully understood at this time, and the 2004 303(d) list does not list any stream segments for sediment impairment. But WVDEP has documented sediment deposition as a marginal problem in Sand Run (WVDEP, 1999).

Sources of sediment likely include, but are not limited to, logging, dirt roads, mismanaged agricultural lands, and stream bank erosion. It is suggested that a study be completed to identify sediment impairments and sources.

4. NONPOINT SOURCE MANAGEMENT MEASURES

4.1 Acid mine drainage

The following list describes in depth the various measures that may be used to control AMD. Numbers in parentheses following the name of the method indicate the potential load reductions when the method is used correctly and in the proper situation.

4.1.1 Land reclamation

- **Removing acid-forming material (95%).** This method has the potential to eliminate the acid load completely if all of the acid-forming material can be removed. In the context of the North Fork watershed, this method is unlikely to eliminate the loads to the watershed or the subwatersheds, because acid-forming materials do not seem to be gathered in small areas, and because where such materials are on the surface, there are other sources of AMD nearby. Furthermore, the cost of removing the materials is much greater than the cost of covering them with an impervious layer and revegetating the cap.
- **Isolating acid-forming material from flowpaths (50%).** See the next two items. It is difficult to estimate the efficacy of these measures exactly. On the one hand, some AMD is often visible seeping from the edges reclaimed areas. On the other hand, a measurement of AMD loads frequently shows such seeps are small compared to loads from nearby mine openings.
- **Sealing from above.** Infiltration of water into acid-forming material can be slowed by covering the material with low-permeability material, such as clay, and covering that layer with a vegetated layer to stabilize it. Effective reclamation and revegetation can eliminate a large proportion of the AMD from a given site.
- **Isolating from below.** Interactions between water and acid-forming materials can be further minimized by separating the waste material from impermeable bedrock below with conductive materials. Water may then flow beneath the spoil and be conducted away from it rapidly, so the water table does not rise into the spoil.
- **Surface water management.** Rock-lined ditches or grouted channels can be used to convey surface water off site before it can percolate into acid-forming material. Limestone is often used in such channels to neutralize acidity, as with oxic limestone channels (OLCs), discussed below.

4.1.2 Passive AMD treatment

- **Reducing and Alkalinity Producing Systems (RAPSs) (25 g acidity/m^2).** In these systems, also known as “successive alkalinity producing systems” and “vertical flow ponds,” water encounters two or more treatment cells in series. First, water passes through organic material to deplete dissolved oxygen. Several helpful reactions take place in the anoxic environment. First, bacteria reduce sulfate in an alkalinity producing reaction. Second, ferric iron, which comes into contact with pyrite, should reoxidize the sulfur and turn to ferrous iron. In a second cell, the anoxic solution comes into contact with limestone. H^+ acidity is neutralized through contact with the limestone. Additional alkalinity dissolves into the water as well. Iron does not armor the limestone because it is the ferrous form. Water then runs through an aeration and settling pond, in which ferrous iron oxidizes and then precipitates out of solution as ferric hydroxide. The acidity released in this process is neutralized by the alkalinity that has accumulated in the solution.
- **Sulfate-reducing bioreactors (40 g acidity/m^2).** These systems also consist of organic matter and limestone, but in sulfate-reducing bioreactors, the materials are all mixed in a single cell. Some of the organic material included is of a coarser nature, such as sawdust or woodchips. Reactions in these systems are similar to those in RAPSs: compost eliminates oxygen, and drives

the iron and sulfur to reduced forms. The coarser organic matter may serve to protect hydraulic conductivity and may retain metals as various organic complexes.

- **Manganese removal beds (MRBs) (to 2 mg/L).** Manganese may be removed from AMD either by active treatment (Section 4.1.3) 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
- **Limestone leachbeds (50%).** Limestone leachbeds are most effective when water has a pH of 3 or less, and when water retention times are short (~90 minutes). The low pH promotes rapid limestone dissolution, but the short retention time prevents armoring.
- **Steel slag leachbeds (addition of alkalinity).** Steel slag leachbeds are not exposed to AMD. Rather, circumneutral feed water passes through these leachbeds, and that water is then mixed with AMD to reduce its acidity drastically.
- **Compost wetlands (wide range).** Constructed wetlands can serve multiple functions in AMD treatment. Wide areas of exposure to the atmosphere allow metals in solution to oxidize. Slower waters allow precipitates to fall out of suspension. Anaerobic zones in sediments allow for sulfate reduction, which consumes acidity. Inclusion of limestone in the substrate provides an additional alkalinity source and helps maintain conditions that support sulfate reduction.
- **Grouting (50%).** Setting up grout walls or curtains in deep mines has great potential to solve AMD problems. Ideally, such barriers may serve to keep water from entering mines and interacting with acid-forming materials. They must be constructed carefully so as not to build water pressures near a weak point and to avoid blowouts. Also, fractures in bedrock always allow some water into mines, even if flows are eliminated. A grouting project at Winding Ridge, near Friendsville, MD, decreased acidity by 50% (MPPRP, 2000).

4.1.3 Active AMD treatment

- **Treating (100+%).** A variety of active treatment methods exist for AMD. One of a number of alkaline chemicals can be mixed with the polluted water. The mixture may then be aerated and is finally passed through ponds allowing metal hydroxides to settle out as sludge.

4.2 Biological impairment

Once a stream is placed on the 303(d) list for biological impairment, a stressor identification process is completed to determine the cause(s) of impairment prior to TMDL development. The WVDEP uses a modified version of the USEPA's stressor identification process (WVDEP, 2004c). Data collected prior to TMDL development is used to establish a link between the impairment and the possible source(s) of pollution. The following list of candidate causes has been developed by the WVDEP to help guide the stressor identification process:

- metal contamination (including metals contributed through soil erosion) causes toxicity;
- acidity (low pH) causes toxicity;
- high sulfates and increased ionic strength cause toxicity;
- altered hydrology, nutrient enrichment, and increased biochemical oxygen demand causes reduced dissolved oxygen;

- algal growth causes food supply shift;
- high levels of ammonia causes toxicity (including toxicity increases due to algal growth); and
- chemical spills causes toxicity (WVDEP, 2004c).

The one stream on the 303(d) list for biological impairment in the North Fork watershed, Sand Run, is scheduled to have a TMDL developed not later than 2014. Prior to TMDL development, WVDEP will most likely complete a stressor identification process similar to the one completed for the Upper Kanawha TMDL (WVDEP, 2004c). AMD is a likely cause of biological impairment for Sand Run. When the source(s) are addressed, the approaches to nonpoint source management should be consistent with this document. Source(s) not addressed in this document should be managed in such a way to ensure that water quality standards are met.

4.3 Fecal coliform

Depending on what a future investigation may find regarding possible nonpoint sources of fecal coliform bacteria in the North Fork watershed, a number of control measures may be effective. These control measures may include:

- septic system installation and maintenance,
- fencing livestock out of streams,
- hooking people up to centralized or managed decentralized wastewater treatment systems, and/or
- storm water treatment and control measures.

4.4 Sediment

Depending on what a future investigation may find regarding possible nonpoint sources of sediment in the North Fork watershed, a number of control measures may be effective. For agriculture, the following control measures may be effective in controlling nonpoint source pollution:

- planting buffer strips between streams and crop or pasture land,
- fencing off livestock from streams,
- planting cover crops, and/or
- repairing eroding stream banks using natural stream channel design.

For forestry, installing and maintaining best management practices to prevent erosion may be effective in controlling nonpoint source pollution. Besides agriculture and forestry, other sediment sources may include dirt roads, eroding stream banks, or other nonpoint sources. Control measures will be tailored to the particular sources found to be causing sedimentation.

5. LOAD REDUCTIONS AND COSTS

The TMDL for the Cheat watershed, which includes the North Fork watershed, set 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, 2001). While the TMDL calls for 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.[3] If all wasteload and load allocations for aluminum, iron, manganese, and zinc are met, the TMDL asserts that the water quality criteria for pH will also be met (USEPA, 2001).

As noted in Chapter 2, 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. In particular, for streams that no longer have a manganese criterion, the costs of MRBs may be entirely avoided. Because the TMDL has not been updated to account for these water quality standard changes, this Watershed Based Plan calculates load reductions and costs based on the standards in place when the TMDL was approved.

Table 6 lists the load allocations from the TMDL in the “TMDL target” column. Implementation of this Watershed Based Plan should reduce loads to those goals. Current loads for each site are also shown in Table 6; calculations are described in Appendix B. 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.

Table 6: Reductions required to meet TMDL targets for abandoned mine lands (lb/year)

Stream code	Subwatershed	Metal	Current load (lb/year)	TMDL target (lb/year)	Reduction required (%)
MC-60-D-3	North Fork Blackwater River	Al	183,463	4,687	97
		Fe	70,697	8,191	88
		Mn	121,453	5,227	96
MC-60-D-3-A	Long Run	Al	267,424	422	99.8
		Fe	362,835	794	99.8
		Mn	20,438	803	96
MC-60-D-3-B	Middle Run	Al	4,446	108	98
		Fe	3,636	81	98
		Mn	1,287	208	84
MC-60-D-3-C	Snyder Run	Al	Unknown	127	Unknown
		Fe	Unknown	3,091	Unknown
		Mn	Unknown	2,241	Unknown

Note: Detailed current load calculations are shown in Appendix B. TMDL targets are load allocations for each pollutant in each subwatershed from USEPA (2001), and are rounded for this plan.

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.

[3] In the TMDL, zinc is an exception. A single wasteload allocation and a single load allocation are calculated for the entire Cheat watershed.

AMD 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 AMD, 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.

When AMD flows out of underground mines, a passive treatment system can be chosen and sized based on water chemistry and flow data. The appropriate passive water treatment system for the sources that have been studied in the North Fork and nearby watersheds is a RAPS, according to Watzlaf et al. (2004). Net acidity in the water rules out treatment with only aerobic wetlands. Concentrations greater than 1 mg/L of dissolved oxygen, aluminum, or iron in the ferric state rule out use of anoxic limestone drains (ALDs). It is also assumed that deep mine AMD sources that have not been carefully examined will also produce water requiring RAPSs. RAPSs are sized according to the acidity load from the AMD source. Detailed sizing and cost assumptions are included in Appendix C.

Because RAPSs are not designed to treat manganese, MRBs are also included in the cost estimates. MRBs are sized to achieve a 24-hour retention time, which has proven effective for manganese removal. Detailed sizing and cost assumptions for MRBs are also included in Appendix C.

The Office of Surface Mining, Reclamation and Enforcement's (OSM's) AMDTreat computer program is used to calculate costs for both RAPSs and MRBs. Table 7 summarizes the cost calculations performed in this Watershed Based Plan: To meet TMDL targets for 16.2 miles of impaired streams, it will cost more than $5.52 million.

These costs are explained further in Table 8, and detailed cost calculations are shown in Appendix C. The location of each AML is shown on a map in Figure 4.

Table 7: Summary of costs and stream miles improved

Stream code	Subwatershed	Impaired miles	Estimated future cost for water remediation
MC-60-D-3	North Fork Blackwater River direct	8	>$3,390,000
MC-60-D-3-A	Long Run	3.6	>$2,130,000
MC-60-D-3-B	Middle Run	1.8	Included with Long Run
MC-60-D-3-C	Snyder Run	2.8	No estimate possible
	Total	**16.2**	>$5,520,000

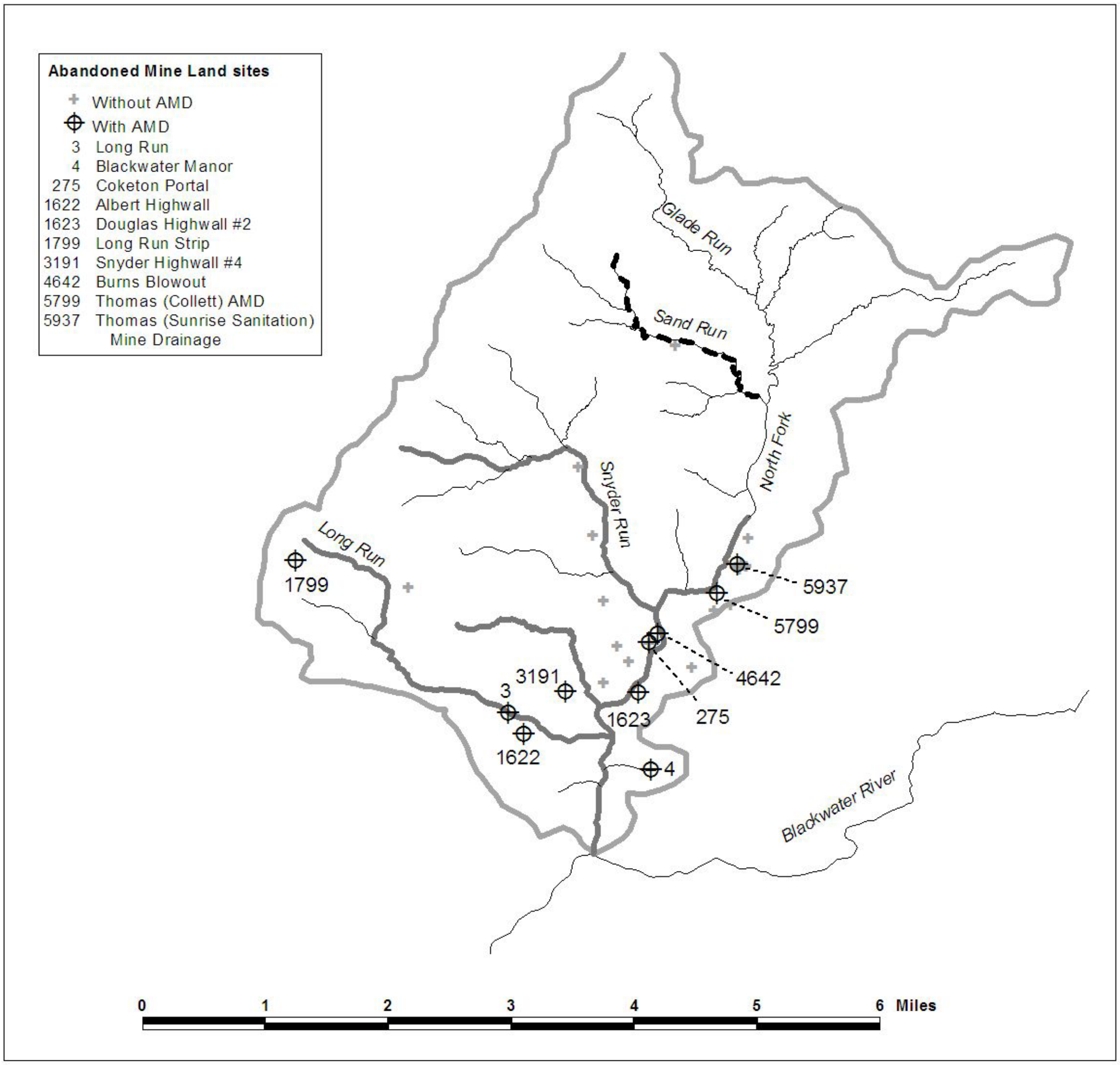
Source: Impaired miles from Table 3. Estimated future costs for water remediation are calculated in this Watershed Based Plan, as detailed below. A single source, Albert Highwall (1622), discharges to both Long and Middle Runs; therefore, separate costs estimates are not presented for these streams. No estimate is possible for Snyder Run because no AMLs discharging AMD were found.

Table 8: Costs and descriptions of abandoned mine lands in the North Fork watershed

Site name (Problem area no.)	Past recla-mation cost	Site and cost description	Estimated future cost for water remediation
North Fork Blackwater direct			
Blackwater Manor (4)	$283,929	Land reclamation work was carried out by WVDEP, but water treatment measures are failing. The old measures should be fortified, or new measures put in place.	$30,000
Coketon Portal (275)		Portal with large flow. A RAPS alone, sized for this flow, would cost millions of dollars.	>$1,000,000
Douglas Highwall #2 (1623)	$1,446,449	This site includes the Coketon Portal, but that outlet does not account for all the flow from the mine pool at the site. According to MDE (2002b), flow from the Coketon Portal account for about 50% of the flow associated with this PA. A RAPS would cost millions of dollars	>$1,000,000
Burns Blowout (4642)	$12,619	Intermittent AMD discharge with flows from 25 to 300 gpm. Located near the Douglas Highwall site and probably a discharge from the Coketon mine pool. The cost includes treating 300 gpm of water from that pool with a RAPS.	>$1,000,000
Thomas (Collett) AMD (5799)		Intermittent AMD discharge with no flows recorded. Water may be net alkaline as at PA 5937.	No estimate possible
Thomas (Sunrise Sanitation) Mine Drainage (5937)		AMD discharge in the town of Thomas. SRG data indicate net alkaline water. Metals could be removed using an aerobic wetland.	$360,000
		Total, North Fork Blackwater direct	>$3,390,000
Long and Middle Runs			
Albert Highwall (1622) and Long Run (3)	$3,650,808	Land reclamation is assumed to address AMD from spoil piles. Settling ponds and RAPSs are not successfully treating portal discharges. Remaining flows are substantial and would require a RAPS costing over $2 million.	>$1,000,000
Long Run Strip (1799)		Two sites, Long Run Strip (1799) and Long Run Highwall #1 (3187) may account for substantial loads of AMD in Long Run upstream of the Albert Highwall project. Neither PAD mentions water discharges, but the AMD loads are assigned to Long Run Strip because it reports 15 acres of gob. The cost is based on reclamation, which is assumed to address half the acidity load, and a RAPS to address the other half.	>$1,000,000
Snyder Run HW No. 4 (3191)		Although its PAD does not identify AMD, highwalls at this site would be updip, and probably discharge AMD causing Middle Run pollution upstream from Albert Highwall. Remediation includes land restoration and a RAPS.	$130,000
		Total, Long and Middle Runs	>$2,130,000
Snyder Run			
		No AMLs known to discharge AMD were found in the Snyder Run subwatershed.	No estimate possible
		Total, Snyder Run	No estimate possible

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

Figure 4: Abandoned mine lands in the North Fork watershed



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

6. TECHNICAL AND FINANCIAL ASSISTANCE

A combination of federal and state agencies, academic institutions, watershed organizations, consultants, and citizens will be involved in providing technical and financial assistance for North Fork watershed projects.

While this Watershed Based Plan considers other pollutants too, the technical and financial assistance chapter focuses on AMD only. Before technical and financial assistance can be secured for biological, bacteria, and sediment impairments, further research is needed to more accurately identify the scope of the problems and the specific nonpoint sources of pollution.

6.1 Technical Assistance Providers

Technical assistance is needed for the following tasks:

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

6.1.1 West Virginia Department of Environmental Protection

Two WVDEP divisions will provide technical assistance. The Division of Water and Waste Management monitors the water quality of the watershed through its Watershed Assessment Program and its pre-TMDL monitoring program (WVDEP, 2005b). This division also provides technical assistance for the use of best management practices, educates the public and land users on nonpoint source issues, enforces water quality laws that affect nonpoint sources, and restores impaired watersheds through its Non-Point Source Program (WVDEP, 2005c).

WVDEP's Office of Abandoned Mine Lands and Reclamation (OAMLR) directs technical resources to watersheds to address AMLs. Through their Stream Restoration Group (SRG), the office conducts extensive source monitoring of AMLs—as well as instream monitoring—before remediation systems are designed.

6.1.2 Office of Surface Mining, Reclamation and Enforcement

OSM provides technical assistance by sharing their knowledge and experience in designing and financing AML remediation projects.

6.1.3 West Virginia University

A number of the colleges and individuals at West Virginia University may provide assistance for projects in the watershed. The National Mine Land Reclamation Center (NMLRC), housed at the university, has experience providing conceptual site designs for reclamation projects and monitoring water quality produced by AMLs before and after projects are installed. NMLRC is dedicated to developing innovative AMD treatment technologies. Technical assistance may also be provided by departments within the university with expertise in fisheries and wildlife resources, mine land reclamation, and water quality improvement.

6.1.4 Other technical assistance providers

Other agencies and organizations may also provide technical assistance. Natural Resources Conservation Service (NRCS) engineers have designed AMD remediation projects in some West Virginia watersheds and may be available for assistance. Local conservation districts may also be a repository of information and assistance. In addition, USEPA staff with expertise in AMD from Region 3 and from headquarters may provide technical assistance.

6.2 Funding Sources

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

- Section 319 funds,
- the Abandoned Mine Land Trust Fund,
- the 10% AMD Set-Aside Fund,
- Watershed Cooperative Agreement Program grants,
- Stream Partners Program grants,
- Brownfields grants,
- other government funding sources, and
- private foundation grants.

These funding sources are described in turn below.

6.2.1 Section 319 funds

Clean Water Act Section 319 funds may be provided by USEPA to WVDEP to be used for reclamation of nonpoint source AMD sources. This Watershed Based Plan is being developed so that these funds can be allocated to the North Fork watershed. WVDEP's Division of Water Resources Non-Point Source Program sets priorities and administers the state Section 319 program (WVDEP, 2005c).

6.2.2 The Abandoned Mine Land Trust Fund

Before 1977, when the Surface Mining Control and Reclamation Act was enacted, coal mines generally did not manage acid-producing material to prevent AMD or treat the AMD that was produced. These "pre-law" mines continue to be significant AMD sources and are treated as nonpoint sources under the Clean Water Act.

To reclaim these AMLs, the Act established the AML Trust Fund. This fund, supported by a per-ton tax on mined coal, has been allocated to coal mining states for remediation projects, according to a formula that takes states' current coal production into account. Authorization for this tax expired and has been temporarily extended, and if a permanent reauthorization is not secured, this very important source of funding for AMD remediation may be lost.[4]

For many reasons, the AML Trust Fund has failed to address AMD at a rapid pace:

- The priorities for disbursed monies place health and safety hazards ahead of water quality issues.
- Even though OSM allows states to assign water quality problems a priority equal to that of potential health and safety problems, WVDEP has been slow to change its priorities accordingly.

[4] 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.

- Only part of the AML Trust Fund’s income is disbursed each year, so that less money is available for remediation than the legislation initially envisioned.
- Some of the money that is disbursed from interest generated by the fund pays for health benefits for former miners.
- At least half of the AML fees collected in each state are allocated back to the state of origin, and are not available for AML reclamation in other states; therefore, much of the AML monies are earmarked for states with few AML problems.
- Some of the money allocated to West Virginia from the AML Trust Fund is used for water-line extensions, because deep mines are responsible for the failure of a number of private wells.
- Funds that are sent back to West Virginia are spent on agency staff salaries in addition to on-the-ground remediation.

Still, WVDEP has funded many AMD remediation projects on AMLs. But these projects are typically not designed to meet stringent water quality goals like those set out in this Watershed Based Plan. The agency typically uses a small number of cost-effective techniques, such as open limestone channels, and chooses the layout for these measures based on how much land is available (for example, the distance between a mine portal and the boundary of properties for which the agency has right-of-entry agreements).

Unless significantly more money were allocated to West Virginia’s AML program and these augmented funds were spent on water quality problems, the AML Trust Fund will not be sufficient to implement the AMD pollutant reductions shown in Table 6 in the foreseeable future. And if the fund is not reauthorized, this important source of funding may disappear completely. OAMLR administers West Virginia’s use of AML Trust Fund grants.

6.2.3 10% AMD Set-Aside Fund

The 10% AMD Set-Aside Program allows states to reserve up to 10% of their annual AML Trust Fund allocations as an endowment for use on water quality projects. These funds are critically important, because while regular AML Trust Fund allocations can only be spent on capital costs, 10% AMD Set-Aside Fund allocations can be spent on operations and maintenance.

As of March 14, 2005, $14.7 million remains in the West Virginia Set-Aside Fund (Darnell, 2005). The agency typically only spends the interest; therefore, the amount available for AMD projects varies with interest rates. In fiscal year 2001 the fund had the highest amount of interest available: $760 thousand. As of fiscal year 2003 the interest available has fallen to $211 thousand, and in subsequent years interest has fallen even further (Darnell, 2005). Long term commitments have been made to fund operations and maintenance on many AML projects across the state. In the North Fork watershed, WVDEP is planning to spend $5,895/year on Blackwater Manor and $48,680/year on Douglass Highwall from the Set-Aside Fund (Darnell, 2005). If WVDEP continues to add money to this fund and if interest rates increase, funds may be available for even more projects in the North Fork watershed.

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 North Fork watershed.

6.2.4 Watershed Cooperative Agreement Program

Grants specifically for AMD remediation projects on AMLs are available through OSM’s Watershed Cooperative Agreement Program (WCAP). The WCAP is part of the Appalachian Clean Streams Initiative. Grants of up to $100,000 are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (OSM, 2004). A match is required to receive these grants and is typically met with Section 319 funds. Friends of Blackwater Canyon (FOBC) has initiated discussions with OSM on the potential applicability of WCAP grants for AMD remediation in the North Fork.

6.2.5 Stream Partners Program

This program offers grants of up to $5,000 to watershed organizations in West Virginia. Grants can be used for range of projects including small watershed assessments, water quality monitoring, public education, stream restoration, and organizational development. FOBC has received two Stream Partners grants to support education and outreach for their North Fork watershed project. Stream Partners grants will continue to be pursued in the future to compliment nonpoint source research, education, and reclamation projects in the watershed.

6.2.6 Brownfields grants

USEPA contractors are now starting a targeted Brownfields site assessment of the North Fork watershed. This assessment will help fill in data gaps by collecting additional water quality monitoring data. In the future, Brownfields grants of up to $200 thousand are available through a competitive process; these grants can be applied to mine scarred lands. Competitive site assessment grants can be used for inventory, planning, quantification of environmental risks, and development of risk management or remedial action plans. Competitive remediation grants can then be used to build treatment systems.

6.2.7 Other government funding sources

NRCS is funding AMD remediation in the Deckers Creek watershed in north-central West Virginia though a Public Law-566 watershed restoration project. The U.S. Army Corps of Engineers has funded an AMD study and is planning to fund AMD remediation work in the lower Cheat watershed, downstream from the Blackwater River. Pending successful outcomes of these projects, these federal agencies might be potential funders for AMD remediation in the North Fork watershed.

6.2.8 Private foundation grants

FOBC has generated funding from at least one private foundation to support a staff member responsible for interfacing with agencies and raising funds for AMD remediation. FOBC will seek additional foundation grants to continue these essential services.

7. IMPLEMENTATION SCHEDULE, MILESTONES AND MEASURABLE GOALS FOR ACID MINE DRAINAGE

Because this Watershed Based Plan focuses on AMD, a detailed schedule with milestones and measurable goals is first laid out for these pollutants. Other pollutants are addressed in the following chapter.

Significant AMD pollutant reductions are still needed in the North Fork watershed. Because of the uncertainty of securing the required funds from a variety of agencies in a short period of time, the schedule, milestones, and measurable goals are divided into five-year phases and no final end date is projected for implementing all of the reductions in this Watershed Based Plan.

Many details are provided for Phase 1, which lasts from 2005 through 2009, because cleanup efforts are ongoing. The schedule, milestones, and goals are designed to expand upon these existing efforts. Far fewer details are given for Phase 2, because of the difficulty of predicting how many remediation projects will be funded.

FOBC has initiated a North Fork Task Force, in which FOBC, WVDEP, OSM, and other partners meet periodically to share information, develop joint strategies, and avoid duplication of effort. Many of the tasks outlined below will be undertaken within the context of the North Fork Task Force.

7.1 Phase 1: 2005 through 2009

The broad goals for AMD remediation in Phase 1 are to continue collecting data, planning and coordinating activities among agencies and organizations, securing funding for remediation projects, constructing new projects, and maintaining existing projects.

7.1.1 Collect data

- **Monitor streams for AMD pollutants.** Existing monitoring data are sufficient to start the planning process at this time. New instream data will be collected over time to help guide the process in the future and to gage progress toward meeting the goals of this plan.
- **Monitor reclaimed AML sites.** Monitoring at reclaimed sites will be used to develop operations and maintenance plans and to characterize additional treatment needs at sites that were not adequately addressed during past reclamation.
- **Monitor unreclaimed AML sites.** Monitoring will also occur at sites that have not been reclaimed, as described in the following chapter. Data will be used to design appropriate treatment systems.

7.1.2 Plan and coordinate activities

- **Develop a Hydrologic Unit Plan.** A Hydrologic Unit Plan has been written for the Blackwater River, but it applies solely to the Blackwater drum station and does not include the North Fork. A new Hydrologic Unit Plan is required so that the Set-Aside Fund can be used to pay for operations and maintenance of sites in the North Fork watershed.
- **Develop plans for new and improved reclamation projects.** The North Fork Task Force will agree on plans to install new and to improve existing reclamation projects in the watershed.
- **Develop operations and maintenance plans.** Once the Hydrologic Unit Plan is completed, the North Fork Task Force will develop operations and maintenance plans for AML sites where reclamation has succeeded. These plans will be coordinated with OAMLR’s plans for using the Set-Aside Fund.

- **Agree on a solution to the Kempton-Coketon mine pool.** The North Fork Task Force will reach consensus on a solution to the Kempton-Coketon mine pool.
- **Reassess the big picture.** At the end of this five-year period, the North Fork Task Force will reassess the strategic priorities for AMD remediation in the watershed. This assessment will be used to track improvements over time and to help plan remediation and operations and maintenance priorities for the next five-year period.

7.1.3 Secure funding

- **Secure funds for reclamation projects.** Each year, appropriate partners in the North Fork Task Force will secure funds to pay capital costs from the 319 program, the AML Trust Fund, and the OSM WCAP.
- **Secure funds for operations and maintenance.** Appropriate partners in the North Fork Task Force will also ensure that sufficient operations and maintenance funds are spent from the Set-Aside Fund and other potential sources to keep all projects in the watershed functioning properly.
- **Investigate other funding sources.** NRCS Public Law 566 and USACE funds will also be investigated.

7.1.4 Install remediation projects

- **Build new projects.** As funds are secured, new projects will be built. In the short term, the North Fork Task Force is considering a limestone fines dumping project in Long Run.
- **Add water quality improvements to existing projects.** In many cases, OAMLR designs and builds remediation projects with AML Trust Fund grants that do not wholly address AMD. Wherever possible, the North Fork Task Force will add on to these remediation projects so that they directly address water quality.
- **Operate and maintain existing sites.** After Set-Aside funds are obtained, operations and maintenance will be performed on sites where necessary.

7.1.5 Measurable goals for Phase 1

By the end of Phase 1 in December 2009, the following measurable goals will be achieved:

- AMD remediation projects will have been installed on all AMLs in the North Fork watershed other than the discharges from the Coketon pool. These projects will be functioning well enough so that water discharged from these sites meet technology-based effluent limitations for pH, iron, and manganese.
- Instream water chemistry measurements will show that the North Fork is meeting water quality standards for pH, iron, manganese, and aluminum upstream from discharges from the Coketon pool. Measurements in tributaries to the North Fork will also show that they are meeting standards.

7.2 Phase 2: 2010 through 2014

Phase 2 is described in less detail than Phase 1, because of the uncertainty in what will be finished by 2009. Even though it is a measurable goal for Phase 1 to complete reclamation on all sites other than the Coketon pool discharges, new information or problems in securing funding may make it necessary to continue this process in Phase 2. The North Fork Task Force will undertake the same four categories of activities in Phase 2:

- Collect more data in receiving streams and on AML sites;
- Develop plans for new and improved reclamation projects and for operations and maintenance;

- Secure capital funds for new and improved reclamation projects, and ensure that sufficient operations and maintenance funds are available to meet the needs of the watershed;
- Build new and improved projects and operate and maintain existing sites.

In addition, the North Fork Task Force will use the information collected in Phase 1 to start implementing the consensus solution for the Coketon pool. Measurable goals will be determined at the start of Phase 2, and will be developed around the achievements of Phase 1.

8. IMPLEMENTATION SCHEDULE, MILESTONES AND MEASURABLE GOALS FOR OTHER POLLUTANTS

In addition to AMD, this plan also addresses biological impairments, fecal coliform, and sediment. Much less information is readily available on these water quality problems. For this reason, the schedule outlined below does not call for implementation of pollutant reductions until more data have been collected.

8.1 Phase 1: 2005 through 2009

8.1.1 Collect data

- **Confirm fecal coliform impairments and locate sources.** As documented in Chapter 3, data from the mid-1990s suggests that some streams may be impaired by fecal coliform. More recent data contradicts these results for all but one stream, and WVDEP does not include these streams on its 2004 303(d) list. WVDEP will collect more fecal coliform data through their regular Watershed Assessment Program data collection process in 2006.
- **Confirm sediment impairments and locate sources.** As documented in Chapter 3, data from the mid-1990s suggests that one North Fork watershed stream may be impaired by sediment. However, WVDEP does not include this stream on its 2004 303(d) list. WVDEP will collect more sediment-related data through their regular Watershed Assessment Program data collection process in 2006.
- **Locate sources of the biological impairment on Sand Run.** Sand Run is listed as biologically impaired. WVDEP will collect additional data to locate the causes of this impairment.

8.1.2 Secure funding

If impairments are confirmed and pollution sources are identified, Section 319 funding will be secured to fix the problems.

8.1.3 Install remediation projects

Funding will be used to install remediation projects, without necessarily waiting for TMDLs to be developed in 2014.

8.1.4 Measurable goals for Phase 1

No measurable water quality goals are set for Phase 1 because it will not be clear until monitoring is completed whether remediation is truly needed.

8.2 Phase 2: 2010 through 2014

8.2.1 Collect data

- **For Sand Run, listed as biologically impaired, collect data to support the TMDL development process.** WVDEP has scheduled the biological TMDL for Sand Run for 2014. If not already completed in Phase 1, WVDEP will collect data to identify the cause of this impairment and to support the TMDL development process. According to WVDEP's current schedule, data used to develop the 2014 TMDLs will be collected in 2011 and 2012.

- **If fecal coliform impairments are confirmed, locate sources.** If data collected in 2006 are sufficient to confirm fecal coliform impairments, WVDEP will include those waters on the 303(d) list and schedule TMDLs for development in 2014 so that they can be done together with the Sand Run biological TMDL. If fecal coliform TMDLs are indeed scheduled for 2014, WVDEP will collect additional data in 2011 and 2012 for use in the TMDL analysis.
- **If sediment impairments are confirmed, locate sources.** If data collected in 2006 are sufficient to confirm sediment impairments, WVDEP will include those waters on the 303(d) list and schedule TMDLs for development in 2014 so that they can be done together with the Sand Run biological TMDL. If sediment TMDLs are indeed scheduled for 2014, WVDEP will collect additional data in 2011 and 2012 for use in the TMDL analysis.

8.2.2 Plan and coordinate activities

- **For biologically impaired streams, complete TMDLs.** WVDEP already plans to develop a TMDL for Sand Run in 2014.
- **For fecal coliform-impaired streams, complete TMDLs.** If impairments are found, complete TMDLs by 2014.
- **For sediment-impaired streams, complete TMDLs.** If impairments are found, complete TMDLs by 2014.

8.2.3 Secure funding

Funding will not be needed during Phase 2 to implement loading reductions.

8.2.4 Install remediation projects

Remediation projects will not be installed during Phase 2.

8.2.5 Measurable goals for Phase 2

No measurable water quality goals are set for Phase 2 because this phase focuses only on collecting data and developing TMDLs, if required.

8.3 Phase 3: 2015 through 2019

If sources are not already addressed in previous years, Phase 3 will focus on funding and installing remediation projects.

8.3.1 Secure funding

- **For biologically impaired streams, secure 319 funds.** If nonpoint source reductions are necessary, obtain sufficient 319 funds to implement the TMDLs.
- **For fecal coliform-impaired streams, secure 319 funds.** Assuming TMDLs have been completed and nonpoint source reductions are necessary, obtain sufficient 319 funds to implement the TMDLs.
- **For sediment-impaired streams, secure 319 funds.** Assuming TMDLs have been completed and nonpoint source reductions are necessary, obtain sufficient 319 funds to implement the TMDLs.

8.3.2 Install remediation projects

- **For biologically impaired streams, implement pollutant reductions.** Implement the pollutant reductions required by the TMDLs.
- **For fecal coliform-impaired streams, implement pollutant reductions.** Implement the pollutant reductions required by the TMDLs.
- **For sediment-impaired streams, implement pollutant reductions.** Implement the pollutant reductions required by the TMDLs.

8.3.3 Measurable goals for Phase 3

Measurable water quality goals are appropriate for Phase 3 if TMDLs are actually developed in Phase 2 and if these TMDLs target nonpoint sources for pollution reductions. Because it is not known at this time which types of TMDLs might be completed, much less which sources will be targeted for reductions, measurable goals are not included at this early stage. The TMDLs, if completed, will target specific sources for reductions and this Watershed Based Plan will then be updated to include realistic goals for the implementation of the TMDL.

9. MONITORING

Instream monitoring is important to gage the recovery of streams after remediation projects are installed, and is also crucial as partners engage in periodic planning of their reclamation priorities. Monitoring of AMD sources is also necessary to understand which sources are discharging how much pollution. These data are used to help decide on priorities, and are essential for the design of realistic treatment systems.

9.1 Instream monitoring

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

9.1.1 WVDEP Watershed Assessment Program

According to WVDEP's five-year watershed management framework cycle, the agency performs in-depth monitoring of the state's watersheds every five years. The next monitoring year for the North Fork watershed is scheduled to begin in summer 2006. These monitoring data will be helpful to show whether streams are improving or declining in quality. In addition to AMD water chemistry, technicians collect benthic macroinvertebrates to determine biological impairments and fecal coliform data to determine bacteria impairments. Technicians also perform sediment-related assessments. WVDEP will then use these data, plus data collected by other agencies and organizations, to make impairment decisions for the next 303(d) list.

9.1.2 North Fork Watershed Project

The North Fork Watershed Project, a project of Friends of Blackwater Canyon, will help with instream monitoring as the need arises.

9.2 Source monitoring

9.2.1 WVDEP Stream Restoration Group

SRG, which works within OAMLR, collects source data when WVDEP is designing a remediation project. SRG has collected data in the North Fork watershed in the past (WVDEP, 2005d), but has no future plans to collect data in the watershed (Park, 2005).

9.2.2 National Mine Land Reclamation Center at West Virginia University

In some situations, NMLRC has collected source data in anticipation of creating conceptual designs for treatment systems. When appropriate, it is anticipated that NMLRC will continue to play this valuable role.

9.2.3 North Fork Watershed Project

The North Fork Watershed Project will also help with source monitoring as the need arises.

10. OUTREACH AND EDUCATION

10.1 North Fork Watershed Project

Most outreach and education for this Watershed Based Plan will be performed by the North Fork Watershed Project.

10.1.1 Newsletters

Newsletters are sent and made available twice a year to North Fork Watershed Project supporters and area residents. Newsletters will continue to update readers about planned nonpoint source remediation projects and about remediation priorities. Updates on the watershed are also included in the Friends of Blackwater Canyon newsletter, which is distributed to over 4,000 people.

10.1.2 Youth education

The North Fork Watershed Project has been educating local youth since its inception in 2002. Each spring a representative from the North Fork Project meets with high school science classes to discuss the watershed. In the future, this outreach will be expanded to include visits in the fall.

10.1.3 Web site

The North Fork Project maintains a Web site, www.northforkwatershed.org, which highlights the problems, outreach efforts, and upcoming events in the watershed.

10.1.4 Public outreach meetings

Representatives of the North Fork Watershed Project conduct an annual tour of the watershed to educate the public about the nonpoint source problems facing the watershed. Periodically public meetings are also conducted in the watershed.

10.1.5 Newspaper articles

Each summer, six articles are placed in the *Parsons Advocate*, a local newspaper, to help educate residents in nearby areas about the North Fork watershed and the work being completed to address the pollution problems.

10.2 West Virginia Department of Environmental Protection

Prior to initiating its regular five-year monitoring effort in 2006, WVDEP will hold a public meeting in the watershed to gather suggestions for monitoring locations. WVDEP will include information at this meeting on the status of plans for remediating nonpoint source pollution in the watershed.

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APPENDIX A. ALL ABANDONED MINE LANDS IN THE NORTH FORK WATERSHED

Many AMLs do not discharge polluted water. Table 4 in Chapter 3 lists those AMLs known to discharge AMD. Table 9 lists the sites in Table 4 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 AMD, they are included in this plan in case new data show otherwise. Some of these AML sites have been combined during reclamation and are described together in Table 4.

Table 9: All abandoned mine lands in the North Fork Blackwater watershed

Problem area number	Problem area name	Stream code	Tributary
1	Pierce Refuse Pile	MC-60-D-3-E	Sand Run
2	Davis Coal & Coke	MC-60-D-3	North Fork Blackwater
3	Long Run	MC-60-D-3	North Fork Blackwater
4	Blackwater Manor	MC-60-D-3	North Fork Blackwater
276	Coketon Mine Blowout	MC-60-D-3	North Fork Blackwater
277	Thomas Portals Subsidence	MC-60-D-3	North Fork Blackwater
1433	Coketon Highwall	MC-60-D-3	North Fork Blackwater
1434	Middle Run Highwall	MC-60-D-3	North Fork Blackwater
1622	Albert Highwall (formerly Douglas Highwall #1)	MC-60-D-3-A and B	Long and Middle Runs
1623	Douglas Highwall #2	MC-60-D-3	North Fork Blackwater
1798	Benbush Refuse	MC-60-D-3-C	Snyder Run
1799	Long Run Strip	MC-60-D-3-A	Long Run
1799	Long Run Highwall #1	MC-60-D-3-A	Long Run
3188	Snyder Run HW No. 1	MC-60-D-3-C	Snyder Run
3189	Snyder Run HW No. 2	MC-60-D-3-C	Snyder Run (NF Blackwater)
3190	Snyder Run HW No. 3	MC-60-D-3	North Fork Blackwater
3191	Snyder Run HW No. 4	MC-60-D-3	North Fork Blackwater
3737	Dale & Sharon Martin Subsidence	MC-60-D-3	North Fork Blackwater
4642	Burns Blowout (formerly Coketon Portal 275)	MC-60-D-3	North Fork Blackwater
4643	Thomas (Hardy) Subsidence	MC-60-D-3	North Fork Blackwater
4914	Thomas (Euclid Ave.) Subsidence	MC-60-D-3	North Fork Blackwater
5330	Thomas (Reynolds) Subsidence	MC-60-D-3	North Fork Blackwater
5512	Thomas (Northeast) Subsidence	MC-60-D-3	North Fork Blackwater
5730	Thomas (Brown Street) Subsidence	MC-60-D-3	North Fork Blackwater
5799	Thomas (Collett) AMD	MC-60-D-3	North Fork Blackwater
5872	Thomas (Douglas Road) Subsidence	MC-60-D-3	North Fork Blackwater
5937	Thomas (Sunrise Sanitation) Mine Drainage	MC-60-D-3	North Fork Blackwater

Source: OSM (2005) and WVDEP (Various dates).

APPENDIX B. LOADS FOR AMLS WITH WATER QUALITY PROBLEMS

Loads coming from the various subwatersheds of the North Fork are treated in one of three ways, as explained in Table 10.

Table 10: Load calculation methods

Load method	Applied to	Explanation
Sum of AMD sources	North Fork subwatershed, excluding watersheds of Long Run, Middle Run, Snyder Run, and Sand Run	Loads from each AML site are estimated and summed to estimate the loads from the entire subwatershed.
Instream measurements	Long Run and Middle Run	Loads are estimated using measurements of flow, acidity and/or alkalinity, and aluminum, iron and manganese measurements taken at the mouth of the watershed by SRG.
Loads not calculated	Snyder Run	Insufficient data are available to use either of the other two methods.

B.1 Sum of AMD sources

AMLs that discharge AMD directly to the North Fork are listed in Table 11, which also shows the pollutant loads calculated in this Watershed Based Plan. The methods and assumptions used to calculate these loads are explained below.

Table 11: Calculated loads based on acid mine drainage sources (lb/yr)

Site name (Problem area no.)	Al	Fe	Mn
Blackwater Manor (4)	275	286	75
Coketon Portal (275)	78,377	28,356	40,791
Douglas Highwall #2 (1623)	93,567	37,946	68,681
Burns Blowout (4642)	3,395	1,340	2,210
Thomas (Collett) AMD (5799)	N/A	N/A	N/A
Thomas (Sunrise Sanitation) Mine Drainage (5937)	7,849	2,769	9,697
Total	183,463	70,697	121,453

Blackwater Manor. OAMLR constructed a system of limestone leachbeds and a wetland to treat the AMD from this site. The discharge from the wetland is the final discharge from the entire site, and its load was calculated using SRG data (WVDEP, 2005d).

Coketon Portal. While the Douglas Highwall #2 project included some remediation of this site, its load is calculated separately in this plan. Part of the water from this discharge was diverted through an ALD for treatment. Water quality data for this site come from three sources. Data for 1994 through 1996 were mailed on a single spreadsheet printout by WVDEP (2005a), that contains measurements of flow, acidity, Al, Fe, and Mn concentrations. An additional document provided by WVDEP reports average flows for 1997 and 1998. Finally, the Maryland Department of the Environment (2002a) compiled flows and chemical measurements for all the portals draining from the Coketon mine pool. Measurements taken by WVDEP were at Site 10, which is upstream of the ALD diversion. Those taken by the Maryland DOE were at weirs 4 and 5, the discharges of the untreated and treated portions, respectively, by the Maryland

DOE. While Maryland was monitoring loads, the ALD made little if any impact on the concentration of the discharge.

The loads from the Coketon Portal are calculated as the average flow multiplied by volume-weighted concentrations for acidity, Al, Fe, and Mn. The flows used are annual averages from 1994 through 1998, and during the entire period of Maryland's monitoring (January 10, 1999 through February 28, 2000). Volume-weighted pollutant concentrations were calculated from the Maryland data.

Douglas Highwall #2. AMD enters the North Fork in this region through several portals or seeps, all but one of which are thought to drain the Coketon mine pool. Loads from these are calculated using volume-weighted concentrations and average flows calculated from the Maryland data. Maryland collected flows on more dates than it collected samples for chemical analysis, hence, multiplying the volume-weighted concentrations by the average of the larger number of flows should provide a slightly more accurate estimate. The load calculation for this site excludes the Coketon Portal, which is addressed separately.

Burns Blowout. No water quality information is available for this site. Because the site is located approximately 500 feet from the Coketon portals, its water is assumed to have the composition of Coketon mine pool water, which is estimated as the volume-weighted average of the nearby mine pool discharges.

The PAD indicates that flow from this site is intermittent, but mentions flows from 25 to 300 gpm when flow is present. The load from this site is calculated using the maximum flow of 300 gpm.

Thomas (Collett) AMD. No AMD contribution was calculated for this site because there are no data on the quantity or quality of the water coming from it. The PAD describes it as intermittent, and its load is probably negligible.

Thomas (Sunrise Sanitation) Mine Drainage. The SRG database contains only one analysis of water from this site (WVDEP, 2005d). The water is net alkaline and contains concentrations of Fe and Mn that would meet in-stream water quality standards. The Al concentration (0.68 mg/L) is less than West Virginia's former total aluminum criteria. This drainage is believed to come from workings in an abandoned mine in the Bakerstown seam. The alkaline nature of the water is consistent with that origin. Loads are calculated from that individual data point.

B.2 Instream measurements

For Long Run and Middle Run, instream measurements from SRG are used to calculate loads. SRG measured loads at the mouths of these streams four times during analysis of the Albert Highwall and Douglas Highwall #2 sites (WVDEP, 2005d). The results are compiled in Table 6.

APPENDIX C. DETAILED COST CALCULATIONS FOR AMLS WITH WATER QUALITY PROBLEMS

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

1. Construction of a RAPS,
2. Construction of an MRB,
3. Reclamation of acres of acid producing material,
4. Construction of mine seals,
5. Construction of OLCs, and
6. Engineering and project management costs.

In this case, however, many of the sites where spoil and coal refuse are sources of AMD have been addressed. Furthermore, in many of the sites, mine seals have also already been constructed. There is little cost to the sites outside of construction of a RAPS for treatment of acidity, aluminum, and iron.

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 million.” This is done because data used for cost calculations, as already noted, are often so sparse as to make the calculations imprecise. This method ensures that estimates based on questionable data do not make the results too unreliable. Furthermore, because of the large flows at these sites, particularly at the outlets from the mine pool, the costs exceed a $1,000,000 ceiling. A ceiling for passive treatment by RAPS has been set for several reasons. First, larger systems become more difficult to maintain. Poorly maintained systems are likely to experience uneven flows, and water may short circuit the system and emerge without being fully treated. In addition, the risks of failure with RAPS are not completely predictable, and the losses should an expensive RAPS fail is too great. Finally, as treatment sums start to number in the millions, it becomes possible to consider financing long-term, active treatment.

Decisions about the sizing of AMD treatment measures and the amounts of reclamation and of OLCs were chosen using the rules detailed below. Various exceptions to these rules are noted for individual sites, as described in Table 12.

C.1 Reducing and alkalinity producing systems

RAPSs were included whenever AMD flowed from deep mine portals. If site descriptions suggested that AMD came only from surface materials, the cost of a RAPS was not included. When appropriate AMD sources were present, a RAPS was sized according to two parameters: design flow and acidity, using the “Vertical Flow Pond” module in the computer program AMDTreat. This module allows a number of sizing methods. The one chosen was “Vertical Flow Pond based on Alkalinity Generation Rate.” The default alkalinity generation rate, 25 g m^{-2} day^{-1} (as $CaCO_3$) was used. Conditions for cost determination included:

- No liner for the system,
- No clearing and grubbing, and
- Standard piping costs.

In its help section, AMDTreat suggests that a RAPS should be sized according to “design flow,” or “the maximum flow that the treatment system is expected to handle.” Determination of a true design flow would require a large number of flow measurements taken under a variety of flow conditions. In most cases, the only flow measurement available was a single, visual estimate by WVDEP inspector. The design flow chosen and the reasoning behind the decisions are included in the notes.

Absence of any flow information prevented estimation of a cost for a RAPS.

C.2 Manganese removal beds

MRBs are sized using AMDTreat's default parameters for a 24 hour retention time. Cost of an MRB was calculated for only one site. Other sites had Mn levels that would not violate in-stream water quality standards

C.3 Land reclamation

Land reclamation costs were estimated at Long Run Strip and Snyder Highwall #4. In each case, the cost of $10,000 per acre was used. Acreage to be reclaimed at Long Run Strip is given in the PAD. Acreage to be reclaimed at Snyder Highwall #4 was calculated as two-thirds of the length of the highwall times twice the height of the highwall (to allow reclamation at a 2:1 slope). Approximately one third of the highwall is outside the Middle Run watershed, and its reclamation was not included in the cost.

C.4 Mine seals

In most cases, seals for mine drainage have already been constructed. Where they were not, the cost of $5,000/seal was used (Bess, 2004).

C.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.

C.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 12: Cost calculations for each abandoned mine land that discharges acid mine drainage

Site name (Problem area no.)	AMD problems	Estimated future cost for water remediation	Design flow (gpm)	Design flow rationale	Acidity (mg/L)	Cost of RAPS	Mn removal	Wet seals	OLCs	Land recla-mation	Engineering and project management
Blackwater Manor (4)	Past WVDEP project where measures are failing to treat water	$30,000	63	Maximum value	37	$28,000	Mn < 1 mg/L	In place	In place	None	$5,600
Coketon Portal (275)	Large flow from mine portal	>$1,000,000	3,300	Maximum flow, measured 5/9/1996	310	$10,373,000	$1,474,000	In place	In place	None	$2,369,000
Albert Highwall (1622) and Long Run (3)	Past WVDEP project where measures are failing to treat water	>$1,000,000	1,285	Maximum flow for all sources at site, measured 12/16/1997	152	$2,004,000	Mn < 1 mg/L	In place	In place	None	$401,000
Douglas Highwall #2 (1623)	Past WVDEP project including Coketon Portal and other sites	>$1,000,000	3603	Maximum flow measured by MDDOE, 2/21/2000	465	$16,960,000	$1,609,000	In place	In place	None	$3,714,000
Long Run Strip (1799)	Large area of gob. Site used to account for large load of AMD upstream of Albert Highwall	>$1,000,000	1,200	Half of average flow upstream of Albert site	82	$1,020,000	Mn < 1 mg/L	None	$52,500	$150,000	$244,500

Site name (Problem area no.)	AMD problems	Estimated future cost for water remediation	Design flow (gpm)	Design flow rationale	Acidity (mg/L)	Cost of RAPS	Mn removal	Wet seals	OLCs	Land recla-mation	Engineering and project management
Snyder Run Highwall #4 (3191)	Probable source of AMD upstream of measured sources on Middle Run	$130,000	500	Half of Middle Run flow	8	$46,000	Mn < 1 mg/L	$5,000	$3,500	$50,000	$21,000
Burns Blowout (4642)	Intermittent AMD discharge	>$1,000,000	300	Maximum value cited in PAD	400	$1,238,000	$134,000	$5,000	$3,500	None	$1,657,000
Thomas (Sunrise Sanitation) mine drainage (5937)	Mine drainage	$360,000	2,600	Single value from WVDEP	0	$290,000[5]	Mn < 1 mg/L	$5,000	$3,500	None	$59,700

Note: Thomas (Collett) AMD (5799)is not included in this table because a cost calculation is not possible.

[5] This estimate is for an aerobic wetland, not a RAPS, because the water discharged from this site is net alkaline.