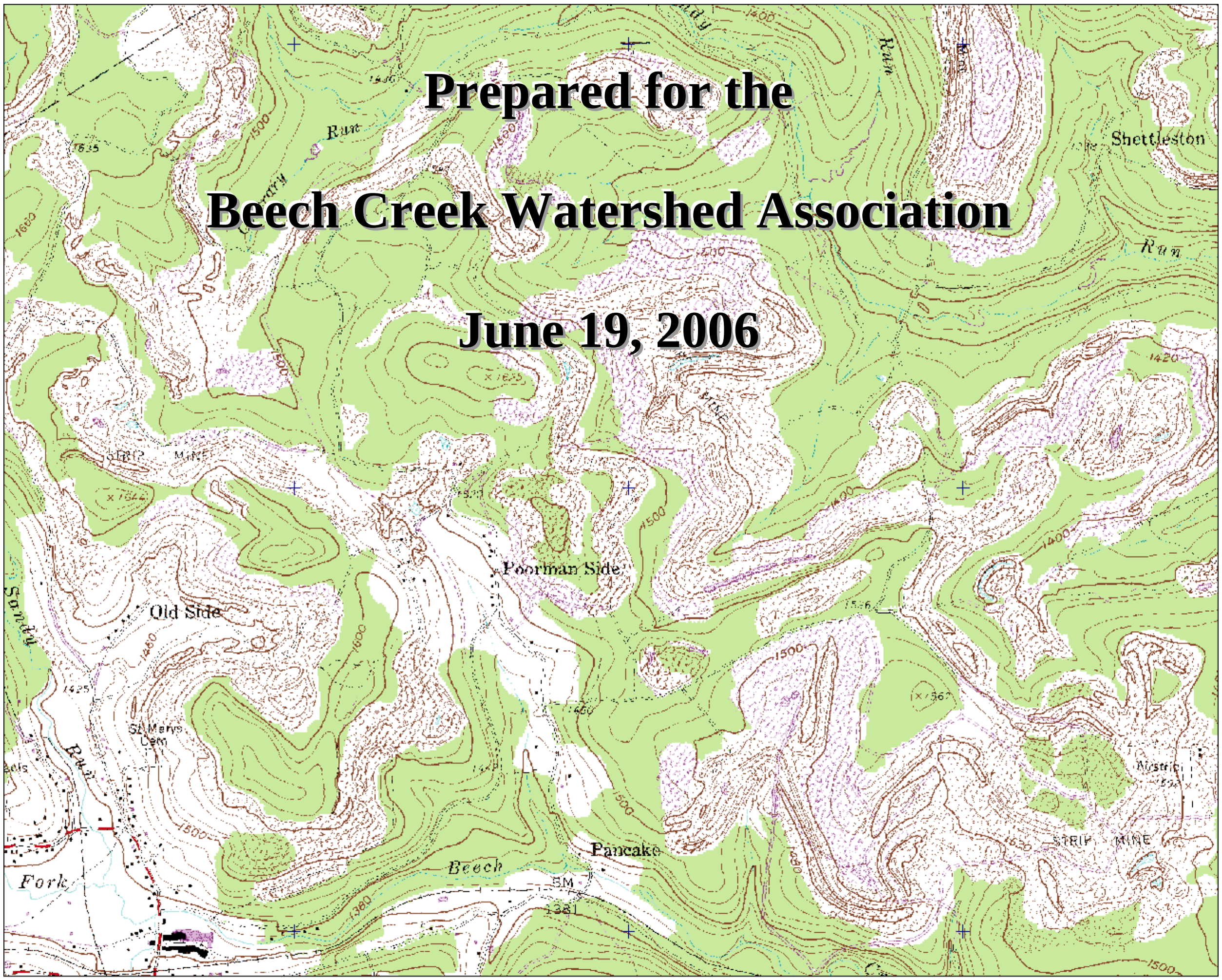
Acid Mine Drainage Restoration Plan for the Beech Creek Watershed



Prepared for the

Beech Creek Watershed Association

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Executive Summary

The Beech Creek Watershed covers approximately 171 square miles in Centre and Clinton Counties in central Pennsylvania. The watershed is part of State Water Plan Code 9C (Bald Eagle Creek). Beech Creek originates near the village of Snow Shoe and flows generally eastward to its confluence with Bald Eagle Creek near the village of Beech Creek. Snow Shoe and Beech Creek are the only heavily populated areas of the watershed. Several other small villages, such as Monument and Orviston, are present in the watershed.

Several coal seams are present in the watershed, including the Brookville, Clarion, Kittanning, Freeport and Mercer coal formations. Extensive surface mining and more limited deep mining, including some clay mining, have caused pollution throughout the watershed. To compound these problems, the geology of the watershed is devoid of alkaline strata, resulting in poorly buffered streams that are susceptible to damage by acid rain and mine drainage.

Some streams, such as Big Run, South Fork, and Wolf Run, have mild to moderate pollution, which can be remedied with one or two projects. However, North Fork and Sandy Run, major tributaries near the western portion of the watershed, are severely polluted, with many sources of mine drainage and hundreds of acres of unreclaimed spoils.

The goals of this project were to perform a mine drainage assessment of the watershed and to formulate a restoration plan. This document represents the final deliverable for the project, which was funded in late 2002 by a grant to the Beech Creek Watershed Association from the PA DEP Growing Greener program (Round 4).

Eight high-priority projects have been identified that will help BCWA to meet its watershed goals. These projects include 2 alkaline wetlands on Big Run, continued PennDOT work on Jonathan Run, self-flushing limestone beds on Tributary K (Butts Run), alkaline addition to Wolf Run, and 3 reclamation projects totaling 81 acres. The total cost estimate for these projects is approximately $1.4 million. While these 8 projects will not completely restore the entire Beech Creek watershed, they will restore over 15 miles of tributary streams and remove significant loading from the main stem of Beech Creek. Several other “medium” priority projects have also been identified.

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I. Introduction

A. Watershed Description

The Beech Creek Watershed covers approximately 171 square miles in Centre and Clinton Counties in central Pennsylvania. The watershed is part of State Water Plan Code 9C (Bald Eagle Creek). Beech Creek originates near the village of Snow Shoe and flows generally eastward to its confluence with Bald Eagle Creek near the village of Beech Creek. Snow Shoe and Beech Creek are the only heavily populated areas of the watershed. Several other small villages, such as Monument and Orviston, are present in the watershed.

Map 1 shows an overview of the watershed. This map also indicates the areas of the subsequent, more detailed maps. Although the entire watershed is not shown on Map 1, the areas contaminated by mining are covered.

The largest landowner in the watershed is the Commonwealth of Pennsylvania. Approximately 28% of the watershed (47.5 square miles) is contained within Sproul State Forest (Gannett Fleming, 2000). Pending land acquisitions, particularly in the Big Run area, will increase this percentage.

Outside of Beech Creek and Snow Shoe, the watershed is largely rural. Accessibility is poor in many areas, which are only accessible by foot during the winter months. Mining and natural gas exploration in the watershed have resulted in many undocumented roads, some with gates.

For more information on the population, demographics, and history of the watershed, see Gannett Fleming (2000).

B. Existing Sources of Information

Several reports have been prepared for the Beech Creek watershed, including an Operation Scarlift report (SL-111), several TMDL reports, and a restoration plan that was developed using existing data sources. These documents are listed in the References (Section XV).

In addition, three small tributaries of Beech Creek (Jonathan Run, Contrary Run, and Tributary K (Butts Run) have been subjected to more rigorous study. These reports are also listed in the References.

Existing data sources were reviewed as part of this project but most of the analysis done for this document used data that was collected as part of this project.

C. Project Description

This project was funded in late 2002 by a grant to the Beech Creek Watershed Association from the PA DEP Growing Greener program (Round 4). Hedin Environmental was the primary consultant on this project, with laboratory analyses by G&C Laboratories of Summerville, PA.

Work began on the project in spring 2003. The first critical steps of this project were to review existing information on the watershed and to perform reconnaissance of the watershed. Although previous studies had located many problem areas, one goal of this project was to ensure that all problem areas had been located and sampled.

The BCWA compiled a list of landowners and notified them of the project. Several landowners did not allow access to their property, particularly in the extreme headwaters of the North Branch of Bear Creek and in the central portion of the watershed between Kato and Orviston (Logway Run, for example).

After landowner notifications were completed, reconnaissance took place as allowed by weather until summer 2004. The first round of monthly samples was taken in August 2004. Monthly sampling continued until July 2005.

In addition to the regular monthly sampling, watershed “snapshots” of portions of the watershed were performed on Sandy Run, the North Fork, Wolf Run, the South Fork, and Big Run. The purpose of these snapshots was to obtain more detailed sampling results and loading capture analyses on these subwatersheds. 396 samples were analyzed as part of this project.

D. Data Collection Methods

For each sample, both field and laboratory measurements were made. In the field, samples were analyzed for, pH, alkalinity, conductivity and temperature. Flow rates were also measured where possible. Temperature, conductivity, and pH were measured using a Hanna Combo pH/EC multi-meter. Alkalinity was measured using a HACH digital titration kit. At each location, a 500-mL raw sample and a 125-mL acidified sample were collected for laboratory analyses. The acidified sample was preserved using nitric acid. Because the samples were not filtered prior to analysis, metals concentrations represent total metals. All laboratory analyses were performed by G&C Laboratories of Summerville, PA using standard and approved methods.

Flow rate was measured using a variety of methods. For small discharges (generally less than 100 gpm), pipes were installed to collect the flow. A bucket was used to collect a known amount of volume in a known time period, which was measured with a stopwatch. This is known as the “timed volume” method. For larger discharges and small streams (generally less than 900 gpm), H-flumes were temporarily installed. The depth of the water in the flume was measured and converted to a flow rate using standard flume charts. Additionally, stream flows were measured using a Swoffer Model 3000 velocity meter.

Precipitation data was obtained from the Williamsport NOAA station.

Daily flow rate data for Beech Creek was obtained from the USGS stream gage located in Monument (Gage #01547950). The USGS website (http://waterdata.usgs.gov/pa/nwis/sw) provides information on daily stream flow as well as statistical information for the period of record.

For the purposes of this report, the following units will be used unless otherwise specifically noted.

Table 1: Standard Units for Data

Parameter	**Unit**	**Abbreviation**
Flow Rate	Gallons per minute	gpm
Field and Lab pH	Standard Units	S.U.
Conductivity	microSiemens per centimeter	uS
Temperature	Degrees Celsius	C
Field and Lab Alkalinity	milligrams per liter as calcium carbonate	mg/L as $CaCO_3$
Measured and Calculated Acidity	milligrams per liter as calcium carbonate	mg/L as $CaCO_3$
Iron	milligrams per liter	mg/L Fe
Aluminum	milligrams per liter	mg/L Al
Manganese	milligrams per liter	mg/L Mn
Sulfate	milligrams per liter	mg/L SO_4
Total Suspended Solids	milligrams per liter	mg/L TSS
Net Acidity Loading	pounds per day as calcium carbonate	ppd
Iron Loading	pounds per day	ppd Fe
Aluminum Loading	pounds per day	ppd Al
Sulfate Loading	pounds per day	ppd SO_4

E. Data QA/QC and Common Calculations

Data obtained from the laboratory was subjected to QA/QC analysis by calculating the acidity based on metals concentrations and pH and comparing this value with the reported value. Results were reviewed on an on-going basis in order to flag any results that were outside the normal results for any given station.

Acidity is calculated using the following formulae:

If the pH is greater than 3.0, the acidity (in mg/L as $CaCO_3$) is calculated based on the following formula:

$$(1.79 \text{ x Fe}) + (1.82 \text{ x Mn}) + (5.56 \text{ x Al}) + 50{,}000 \text{ x } 10^{-pH}$$

If the pH is less than 3.0, the acidity is calculated based on the following formula:

$$(2.86 \text{ x Fe}) + (1.82 \text{ x Mn}) + (5.56 \text{ x Al}) + 50{,}000 \text{ x } 10^{-pH}$$

For both of these formulae, metals concentrations are in mg/L.

Another common calculation for mine drainage data is the pollution loading. Loading is generally reported in pounds per day and is calculated according to the following formula:

$$\frac{Pounds}{Day} = \frac{Gallons}{Minute} x \frac{mg}{L} x \frac{3.784 Liters}{1 Gallon} x \frac{1g}{1000mg} x \frac{1 pound}{454g} x \frac{1{,}440 \text{minutes}}{1 day}$$

This formula can be used to calculate the pounds per day of any water quality parameter that is measured in mg/L, including, acidity, alkalinity, metals, and sulfate. Sulfate loading is often the best measure to use because metals and acidity loading are not directly conservative and are affected by alkaline inputs from other areas and metal deposition on the stream bottoms.

II. Geology and Mining History

Two physiographic provinces are represented in the Beech Creek watershed. Nearly the entire watershed lies within the Appalachian Plateau Province with the exception of a small portion of the watershed near its mouth, which lies within the Ridge and Valley Province. These two provinces are divided by the Allegheny Front Escarpment. Each province is divided into sections. In the Appalachian Plateau Province, the topography of the watershed is highly variable and represents a zone of transition between three sections (Pittsburgh Low Plateau, Allegheny Front, and Deep Valleys). Near its mouth, the watershed is in the Appalachian Mountain Section of the Ridge and Valley Province, which is characterized by narrow parallel ridges separated by broad valleys. Bald Eagle Valley at the mouth of Beech Creek is the northernmost valley in the Ridge and Valley Province.

A. Structural Features

The geologic structure of an area is determined by the way the rocks folded and fractured through geologic time. The sedimentary rocks found within the Beech Creek watershed were initially formed by sediments deposited in nearly horizontal layers. Through time, these once horizontal layers of rock were folded and fractured by tectonic activity. The land surface (topography) does not necessarily coincide with the underlying geologic structure. That is, the top of a hill isn’t necessarily the top of a fold. Streams eroding downward into their channels have carved the topography out of what would be a relatively flat plateau. In the Beech Creek watershed, the structure influences the topography by controlling which bedrock units are at the surface. The harder sandstones generally form the topographic highs since they are resistant to erosion. The opposite is true of finer grained rocks that erode relatively easily and generally form topographic lows.

The geologic structure of the Beech Creek watershed is characterized by the transition from the broad folds of the Appalachian Plateau Province to the intensely deformed strata of the Ridge and Valley Province. This transition is marked by the Allegheny Front Escarpment that parallels the southeastern edge of the watershed. The Allegheny Front marks a change in how the bedrock responded to tectonic forces during continental collisions. To the south and east of the front (and closer to the point of contact between the colliding continents), the bedrock is bent into large folds and intensely fractured and faulted. To the north and west of the front, the folding, fracturing, and faulting is less intense with broad folds that diminish in size as you move away from the Allegheny Front (and away from the point of contact between the colliding continents).

Much of the watershed lies within the Snow Shoe syncline (a structural “valley” in the rock formations), which is bound by the Hyner anticline (“ridge”) to the north and west and the Allegheny Front to the south and east. This synclinal structure, fractures, joints, and faults associated with deformation play a critical role in the groundwater flow regime of the watershed.

Ground water and surface water are affected by the Hyner Anticline, which directs flow towards the main stem of Beech Creek. Most of the tributary streams to Beech Creek that flow in from the north have a ground water system flowing down dip in the same southeasterly direction as the tributary streams themselves.

The northeast trending Nittany Anticline is located southeast and adjacent to the Snow Shoe syncline and helps direct ground water and surface water towards Beech Creek from the southeast. Below the town of Monument there are no significant tributary streams entering Beech Creek.

Like the dramatic asymmetrical folds of the Ridge and Valley Province, the lower amplitude folds of the Appalachian Plateau Province found within the watershed appear to also be asymmetrical. The axis of the folds are dipping to the east southeast resulting in steeply dipping limbs on the northwest side of the fold and more gently dipping limbs on the southeast side of the folds. The result of this asymmetry is that streams flowing to Beech Creek from the north off of the longer synclinal limb of the Hyner anticline are much longer streams than those flowing from the south.

On the eastern fringes of the watershed there are two closely spaced structural features located between the Snow Shoe syncline and the Hyner anticline to the north. The Ferney anticline pinches out from the east as it terminates near Monument. Just north of this feature, the Jersey Mills syncline terminates just north of the Ferney anticline. These two features may have a small affect on the ground water system in the Big Run area by influencing fracture patterns.

B. Stratigraphy

The way that rocks are layered is referred to as the stratigraphy. Layers are divided into Ages, which are further divided into Formations, then Groups, and finally individual seams. The Beech Creek watershed is underlain by late Silurian to Pennsylvanian aged sedimentary rocks. Erosion patterns superimposed on the geologic structure have resulted in exposure of the oldest rocks near the mouth of Beech Creek and the youngest rocks in the headwaters along the Snow Shoe syncline. The erosion-resistant sandstones of the Mississippian aged Huntly Mountain formation, Burgoon sandstone and Mauch Chunk formation are present along the axis of the

Hyner anticline. The scenic SR 144 follows the ridge formed by these erosion-resistant sandstones along the watershed's northern boundary between Moshannon and Renovo.

Economically recoverable coals exist in only the youngest rocks found in the watershed. These rocks have been removed by erosion in much of the watershed but remain along the structural low of the Snow Shoe syncline. Coals and clays from the Pennsylvanian aged Pottsville formation and Allegheny group are present and have been mined extensively, resulting in degradation of water quality. In portions of the watershed where coal is not present or has not been mined, the water quality is good.

The two coal-bearing formations within the watershed are the Allegheny and Pottsville Formations. The Allegheny Formation contains the Brookville, Clarion, Lower and Upper/Middle Kittanning and the Lower Freeport coal seams. There are no carbonate rocks (for example, limestone) contained within the watershed, which results in poorly buffered streams that are unable to assimilate acid inputs. The Mercer Clay and in some instances the associated Mercer Coal of the Pottsville Formation have been extensively mined within the watershed.

The Allegheny Formation contains the bulk of the economically recoverable coals and clays and is present in the headwaters region of the watershed in and around the town of Clarence. The Kittanning and Freeport coal seams in this area are above drainage (that is, the coal is above the normal ground water elevation) and have been extensively surface mined. Coal seams of this type are often deep mined followed by surface mining with total coal removal. Clay was extensively deep mined within this formation.

The Clarion and Brookville coal seams are generally below drainage (that is, the coal is below the normal ground water elevation) in the headwater area and have been extensively deep mined. Therefore, deep mine pools may have formed. In areas where these seams have been mined (North Fork Beech Creek and Sandy Run), the seams are entirely below drainage.

From a point just north of the Kato bridge the mouth of Beech Creek, all of the coal seams within the Allegheny Formation are above drainage and could not form large mine pools. Any deep mining in these areas would produce small discharges from drift mines driven in off of the crop area. Extensive surface mining extended in from the crop towards the hill tops, creating many toe of spoil discharges.

The Pottsville Formation was mined within the watershed for the Mercer coal and, to a larger extent, for the clay that is present within this formation. The Pottsville Formation underlies almost the entire watershed excepting for where streams have eroded and removed these materials. In the western headwater region of the watershed, the formation is entirely below drainage, while the formation is often removed by erosion in stream valleys in the lower portion of the watershed. On the lower stretches of the watershed, the Pottsville is present high above the stream valleys on isolated hilltops.

III. Problem Identification

Sampling stations were established based on the results of the reconnaissance, which involved walking streams and tributaries to identify polluted inflows. Field sampling equipment was used during this process to identify the most important sources in the watershed.

A. Beech Creek at Monument

The following table shows the flow and chemistry data from Station 25 (Beech Creek at Monument, See Map 1).

Table 2: Flow and Chemistry at Station 25 (Beech Creek At Monument)

Date	Flow (gpm)	Field pH	Lab pH	Cond (uS)	Field Alk	Net Acid, Meas	Fe	Mn	Al	SO4	TSS
06-Aug-04	100,000	4.90	4.81	152	1	10	0.6	1.0	0.7	66	4
22-Sep-04	351,000	4.74	4.79	154	1	12	0.4	1.2	1.0	69	1
21-Oct-04	150,000	4.18	4.71	203	0	15	0.5	1.7	1.1	99	5
11-Feb-05	209,590	4.89	4.84	156	0	12	0.6	1.1	0.0	65	6
18-Mar-05	88,400	4.12	4.89	242	0	15	0.4	1.6	1.2	91	8
20-Apr-05	89,760	4.33	4.61	209	0	12	0.0	1.7	1.2	57	4
25-May-05	43,100	3.87	4.27	270	0	16	0.3	2.6	1.4	102	1
23-Jun-05	22,000	4.22	4.15	322	0	19	0.1	3.1	1.4	144	2
19-Jul-05	13,900	3.10	3.97	402	0	20	0.3	4.4	2.1	141	5
Average	**118,639**	**4.26**	**4.56**	**234**	**0**	**14**	**0.4**	**2.0**	**1.1**	**93**	**4**

Alkalinity and acidity are in mg/L as CaCO3; metals are in mg/L

Station 25 is below all known inflows of mine drainage to Beech Creek. At this station, the quality of Beech Creek is poor, with net acidity of 10 – 20 mg/L. These conditions do not support fish life. At high flow rates (August 2004 – February 2005), the pollution levels are lower due to dilution. At lower flow rates (May – July 2005), pollution levels are higher.

Table 3 shows the loadings that were calculated using the flow and chemistry data from Table 2. Loading values vary widely. The most useful loading values are for acidity and sulfate (SO4). Sulfate is generally conservative throughout a watershed, so it can be used to determine how much pollution is coming from one area or discharge. Acidity must be known because the stream will not be fully recovered until the net acidity loading is at or close to zero (net neutral or net alkalinity condition). Therefore, the acidity loading at Monument gives an indication of the total amount of loading that must be removed from all projects in order to restore the stream at this point.

Figure 1 shows all of the flow rate information from Station 25 (Beech Creek at Monument) throughout the sampling period, as well as the mean flow rate for each day of record. In addition, Figure 1 shows when the sampling events for this project took place. Note on Figure 1 that the actual stream flow rate (blue line) was generally above the mean from July 2004 through February 2005.

Table 3: Pollution Loading at Station 25 (Beech Creek at Monument)

Date	Flow (gpm)	Fe (ppd)	Al (ppd)	Acid (ppd)	SO4 (ppd)
06-Aug-04	100,000	696	816	12,408	79,080
22-Sep-04	351,000	1,685	4,044	50,123	291,049
21-Oct-04	150,000	954	1,944	26,334	177,660
11-Feb-05	209,590	1,484	101	30,106	162,977
18-Mar-05	88,400	424	1,241	15,477	96,745
20-Apr-05	89,760	43	1,271	12,602	61,396
25-May-05	43,100	171	709	8,084	52,599
23-Jun-05	22,000	16	372	5,037	37,963
19-Jul-05	13,900	47	349	3,353	23,586
Average	**118,639**	**613**	**1,205**	**18,169**	**109,228**

The sampling events for this project took place over a wide variety of flow conditions, allowing an assessment of the high and low flow conditions of the stream and of discharges. Two hurricanes affected the area in the fall of 2004. On September 18th, 2004, Beech Creek at Monument recorded a flow rate of 6,310 CFS (2,832,000 gpm) as a result of Hurricane Ivan. This is the third-highest flow rate recorded at this station from 1968 to the present. Note that the other two high flow rates were also influenced by hurricanes.

While historically high flow rates occurred during the fall of 2004, very low flow rates occurred from February through July 2005. Although the USGS does not report the lowest annual recorded flow rate, the median flow rate in July 2005 was 32.4 CFS (14,600 gpm). Of the 432 months where data are available (October 1968 to September 2004) and Y), only 21 months (5%) had a lower median flow rate. Most of these historic low flows occurred in August and September; only one occurred in July. Therefore, stream and discharge flow rates measured in July 2005 represent very low flow conditions.

B. *Precipitation*

Table 4 shows the total monthly precipitation and mean precipitation for the Williamsport climate station near the watershed. Blue shading indicates months when precipitation exceeded the mean; yellow shading indicates months when the precipitation was less than the mean.

The area experienced more precipitation over the sampling period than would be expected in a normal year. However, most of this excess precipitation occurred in September 2004 during hurricane season. Note the dramatic increases in the flow rate of Beech Creek that resulted from this precipitation in September 2004 (Figure 1). Likewise, discharge flow rates taken during this period likely represent very high flow conditions.

During the second half of the sampling period, several drier than normal months caused stream flow and discharge flow rates to drop dramatically.

Table 4: Total Monthly Precipitation and Normal Precipitation

Month	**Actual (in.)**	**Normal (in.)**
Aug-04	3.1	3.5
Sep-04	10.6	3.8
Oct-04	2.7	3.2
Nov-04	3.5	3.7
Dec-04	4.2	3.0
Jan-05	4.5	2.7
Feb-05	2.3	2.6
Mar-05	3.9	3.4
Apr-05	4.6	3.5
May-05	1.7	3.8
Jun-05	1.8	3.9
Jul-05	6.3	4.1
TOTAL	**49.2**	**41.1**

C. Beech Creek Main Stem

Four stations on the main stem of Beech Creek were sampled regularly. They were (starting at the mouth) Beech Creek at Monument (Station 25, See Map 1), Beech Creek at Kato Bridge (Station 90, See Map 5), North Fork at Pancake (Station 125, See Map 2), and North Fork at Cattail Road (Station 3, See Map 2). South Fork below Butts Run (Station 110, See Map 6) was sampled less often. Section III.A (above) discusses the results from Station 25 in more detail.

This main-stem sampling was performed in order to determine which areas of the watershed were producing the most pollution. Whenever possible, in-stream flow rates were measured using the velocity/area method. However, this was not always possible due to unsafe conditions at high flows.

Table 5 shows the loading data for the main stem stations on all dates where flow rate was measured at Station 3, 125, or 90. The points are grouped by sampling event and listed in order from headwaters to the mouth. The flow and loading data from Station 25 (Beech Creek at Monument) is included for comparison.

Based on two dates where flow and chemistry are available at both Stations 90 (Kato) and 25 (Monument), 70-100% of the acidity and aluminum loading present at Monument was measured at Kato. (This does infer that discharges are absent between these two stations; inflows may be offset by clean water from unpolluted tributaries).

Table 5: Main Stem Loading Data

Point	Station Description	Date	Flow (gpm)	Fe (ppd)	Al (ppd)	Acid (ppd)	SO4 (ppd)
125	Pancake	10-Aug-04	12,266	392	386	3,531	27,392
90	Kato Bridge	10-Aug-04	30,956	888	754	8,692	51,895
25	Monument	06-Aug-04	100,000	696	816	12,408	79,080
3	NF Headwaters	22-Oct-04	5,200	122	134	1,570	10,558
125	Pancake	22-Oct-04	19,443	299	387	2,093	30,354
25	Monument	21-Oct-04	150,000	954	1,944	26,334	177,660
3	NF Headwaters	18-Mar-05	1,798	72	65	800	4,410
25	Monument	18-Mar-05	88,400	424	1,241	15,477	96,745
3	NF Headwaters	21-Apr-05	2,675	67	147	1,446	11,318
125	Pancake	19-Apr-05	6,093	224	205	1,811	16,217
25	Monument	20-Apr-05	89,760	43	1,271	12,602	61,396
90	Kato Bridge	24-May-05	27,597	3,047	672	9,749	59,808
25	Monument	25-May-05	43,100	171	709	8,084	52,599

D. Halfway Coal Yard

Halfway Coal Yard is an active chemical treatment plant located on an unnamed tributary to Beech Creek just downstream of the Kato Bridge (See Map 5). This treatment plant is owned and operated by Waste Management, Inc, which inherited the liability for the site by purchasing the company that originally mined the site. The goal of this section is to evaluate the relative importance of the Halfway Treatment System in relation to the overall pollution present in the Beech Creek Watershed. The following data sources were used in this evaluation:

- Chemistry data provided by Halfway operators for three points (6” Overflow, Wheel Treater, Outlet D)
- Flow data provided by Halfway operators for the total treated flow at Halfway (112 measurements between July 2004 and July 2005)
- USGS daily average flow data of Beech Creek at Monument obtained from www.usgs.gov for station 01547950
- Chemistry results obtained as part of this project for Beech Creek at the Monument station (9 samples from August 2004 – July 2005)

Because there are multiple inflows of polluted water to the Halfway treatment system and not all of them are measured, a composite water quality cannot be calculated. However, the total flow is measured using a flume that is placed between two of the treatment ponds. Therefore, in order to calculate the total loading produced by the Halfway discharges, the total treated flow rate was used in conjunction with the highest acidity and sulfate readings that were obtained at two untreated flow stations that were monitored (6” overflow and Wheel Treater). This approach should overestimate the amount of loading produced by the Halfway discharges, because not all of the water that is being treated will be of the worst quality.

In order to evaluate the amount of pollution loading that is present in the entire Beech Creek watershed, the daily average flow rate data from the USGS gauging station at Monument (Station 25, See Map 1) was obtained. Data was used for the same 112 days that the Halfway flow rate was measured between July 2004 and July 2005. The chemistry of Beech Creek at this station was measured 9 times in this time period.

The data for Beech Creek at Monument showed a fairly strong inverse correlation ($r^2=0.7$) between flow rate and water quality; when the flow rate was high, the pollution levels were lower due to dilution. Figure 2 shows the acidity and sulfate at this station versus the flow rate. Note that the 9 sampling points at this station occurred over a wide range of flow rate conditions.

The regression formulas obtained from Figure 2 were used in order to calculate the net acidity and sulfate concentrations at all 112 flow rates for which data was needed. This allowed a calculation of how much loading was present in Beech Creek at Monument on all of those dates. Because the actual data samples occurred over a wide range of flow rates and because the regression curves match the data fairly well, this approach should provide an accurate result.

The next step was to compare the loading of the Halfway system and Beech Creek at Monument based on the data.

The following table shows a summary of all of the data. The 90th percentile data indicate that 90% of all results were less than the reported figures..

Table 6: Halfway Chemistry and Loading Analysis

	Halfway			**Beech Creek At Monument**			**% Monument From Halfway***		
	Flow (gpm)	**Acid (ppd)**	**SO4 (ppd)**	**Flow (gpm)**	**Acid (ppd)**	**SO4 (ppd)**	**Flow (gpm)**	**Acid (ppd)**	**SO4 (ppd)**
Average	127	419	3,579	180,225	22,819	121,073	0.11%	2.1%	3.0%
Minimum	5	17	141	13,464	3,116	22,348	0.01%	0.5%	0.6%
Maximum	369	1,218	10,393	2,261,952	141,581	321,530	0.26%	4.2%	5.9%
90th Percentile	249	822	7,013	316,404	40,308	213,276	0.19%	3.7%	4.9%

** Acidity is not being released by Halfway, so this represents the % increase that would result if Halfway was not being treated. Flow and sulfate from Halfway do reach this point unchanged by the treatment system, so these values represent actual % contribution.*

In the past, the operator of the Halfway Treatment System (Waste Management, Inc) has expressed interest in trading the liability at the Halfway site for liability at another discharge (or discharges) in order to lessen their overall treatment costs and provide a greater net in-stream benefit. Previously, this was rejected by BCWA because the proposed treatment site was outside the Beech Creek watershed. However, BCWA may want to consider reopening this idea with Waste Management for several reasons. The primary reason is that the Halfway Treatment System is not resulting in any stream mile recovery in the watershed. The tributary that receives the treated Halfway discharges is highly polluted by other sources and the addition of the treated water from Halfway does not result in any stream restoration. However, if treatment was done in another area (or areas) of the watershed, considerable stream miles could be recovered.

When the idea of ‘swapping’ liability at the Halfway Coal Yard for another site was previously discussed with Waste Management and the DEP, the assumption was that the new sites would be required to treat at least as much loading as is being treated at the existing treatment system.

IV. Watershed Snapshots

More intensive watershed "snapshots" were taken of five areas within the Beech Creek watershed. These subwatersheds comprise approximately 56% of the total watershed area. Table 7 summarizes the watershed snapshots.

Table 7: Watershed Snapshot Summary

Watershed	% of Area	% of Flow at Monument*	% of SO4 Load at Monument*
North Fork	12	13	17
Sandy Run	8	5	11
Wolf Run	5	3	0.4
South Fork	11	13	4
Big Run	20	**17	**8

*These percentages valid for the date of the snapshot only
**Represent minimum values since sampling at mouth was not performed

In the case of the North Fork and Sandy Run, these snapshots were performed in highly polluted areas of the watershed in order to assess the percent pollution capture. As shown in Table 7, these areas contributed a higher percentage of sulfate loading than the percentage of flow that they contributed.

In the cases of Wolf Run, South Fork, and Big Run, snapshots were performed in order to determine the likelihood of stream-mile recovery if one or two projects are completed. These streams contributed a lower sulfate loading than the percentage of flow that they contributed.

Each stream snapshot is discussed in detail below.

A. North Fork

The North Fork of Beech Creek originates near the village of Cherry Run and flows eastward approximately 7.5 miles to its confluence with the South Fork of Beech Creek (See Map 2). The drainage area covers approximate 21 square miles (12% of the total area of Beech Creek). The North Fork upstream of the village of Pancake (5.7 stream miles) is one of the most heavily populated and most accessible portions of Beech Creek. Downstream of Pancake (2.8 stream miles), access is by foot only.

The North Fork snapshot was performed on October 22, 2004, with one sample each taken on the 18th, 21st, and 25th. The point for assessing downstream capture is Station 125, North Fork at Pancake. Fifteen samples were taken as part of this snapshot. Map 2 shows the sample locations. Samples taken on the main stem of Beech Creek at Kato (Station 90) and Monument (Station 25) will also be considered in this discussion.

Table 8 shows the flow and chemistry information that was gathered during this snapshot. Table 9 shows the loading calculations for stations where flow rate information was available.

Table 8: North Fork Snapshot Flow and Chemistry Data, October 2004

Point	Flow (gpm)	Lab pH	Cond (uS)	Field Alk	Net Acid, Meas	Fe	Mn	Al	SO4	TSS
3	5,200	4.16	356	0	25	2.0	2.2	2.2	169	3
TRIB C MOUTH	1,546	6.03	247	7	4	1.7	1.1	0.5	114	6
NF Below 3	7,168	4.29	260	0	15	1.2	1.8	1.4	116	6
71D	69	3.20	579	0	131	2.2	0.9	16.9	181	3
70	1,478	4.33	130	0	15	0.7	0.8	2.1	47	4
74	986	4.00	850	0	31	1.4	3.5	3.9	502	5
79D	28	3.56	292	0	51	1.7	1.2	2.9	103	4
75D	18	4.86	122	0	5	0.1	0.2	0.1	58	5
81	377	4.07	376	0	21	0.7	1.1	1.6	190	6
80	7,571	4.95	95	1	6	0.6	0.4	0.5	37	6
122D	17	3.27	1473	0	635	2.7	12.3	102.1	1018	8
4	2,213	6.94	256	31	-18	0.3	0.5	1.5	80	3
67D	35	3.69	389	0	40	4.6	1.2	1.8	145	2
TRIB J MOUTH	511	4.96	133	1	8	0.1	0.5	0.6	62	5
125	19,443	5.04	273	5	9	1.3	1.4	1.7	130	
90		4.76	233	0	19	1.7	1.5	1.6	96	4
25	150,000	4.71	203	0	15	0.5	1.7	1.1	99	5

Table 9: North Fork Snapshot Loadings, October 2004

Point	Fe (ppd)	Al (ppd)	Acid (ppd)	SO4 (ppd)
3	122	134	1,570	10,558
TRIB C MOUTH	31	9	65	2,122
NF Below 3	106	117	1,326	10,004
71D	2	14	107	150
70	12	37	270	826
74	17	46	372	5,935
79D	1	1	17	34
75D	0	0	1	12
81	3	7	95	858
80	57	49	531	3,380
122D	1	21	130	208
4	8	39	-487	2,119
67D	2	1	17	61
TRIB J MOUTH	1	4	47	381
125	299	387	2,093	30,354
25	954	1,944	26,334	177,660

On the day of the snapshot, the North Fork at Pancake (Station 125) contributed 13% of the flow, 8% of the acidity loading, and 17% of the sulfate loading of Beech Creek at Monument (Station 25). Thus, this area of the watershed is a significant contributor of pollution loading to the entire main stem of Beech Creek.

The North Fork is badly contaminated beginning in its headwaters in the village of Cherry Run (Station 3). Landowner restrictions would not permit access to this area. However, the largest percentage of loading present at Station 125 was coming from Station 3. This included 35% of the sulfate loading.

The second highest sulfate loading was contributed by Tributary D (Station 74, 20%), followed by Little Sandy Run (Station 80, 11%) and Tributary H (Station 4) and Tributary C, each with 7%.

Five distinct discharges in this area were sampled as part of this project (71D, 122D, 79D, 75D, and 67D). However, none of these discharges supplies a significant (>2%) of the sulfate loading present at Station 125. This indicates that the primary reason for contamination to this portion of the North Fork is contaminated base flow that enters the stream directly. While treating these discharges may provide some improvements, wide-spread reclamation should be the first step in restoring the North Fork.

The only tributary to the North Fork that demonstrates good water quality for a significant length of stream is Little Sandy Run. Above Station 79D, the stream is of generally good quality, but with a low buffering capability, making it vulnerable to acidic inputs. This represents approximately 3 stream miles on the main stem, plus tributary miles. However, the final 1.2 miles of Little Sandy Run is severely impacted by mine drainage. Two distinct discharges (79D and 75D) and Tributary G (Station 81) flow to Little Sandy Run. They contribute approximately 6% of the flow and 27% of the sulfate loading present at the mouth of Little Sandy Run. This means that over 70% of the loading to Little Sandy Run is from contaminated base flow entering the stream. Again, reclamation is the first recommendation.

One of the top priorities for the North Fork of Beech Creek is to gain landowner permission to access the areas upstream of Station 3 in order to determine if the pollution loading is coming from discrete discharges, from contaminated base flow into the stream, or a combination of the two.

B. Sandy Run

Sandy Run originates along the east side of Route 144 north of the village of Cherry Run (See Map 3). It flows south approximately 4.1 miles before turning east where Contrary Run enters it and flowing approximately 4.3 miles to its confluence with Beech Creek approximately 1 mile upstream of the bridge at Kato. The watershed encompasses 13 square miles (8% of the total area of Beech Creek).

Upstream of Contrary Run, Sandy Run is typical of many poorly-buffered streams in this area. Low buffering ability makes these streams vulnerable to acidic inputs. It has low pH, low alkalinity, and low metals concentrations. Contrary Run represents the first input of mine drainage to Sandy Run. Other polluted tributaries include Beauty Run and Tributaries N, M, O, P. Based on water quality, the 2.8 miles of Sandy Run downstream of Beauty Run and all of Sandy Run’s tributaries in this area are devoid of aquatic life.

The Sandy Run snapshot was performed over several days between October 18th and 25th. Most of the samples were taken on October 18th or 21st, with a few samples taken on October 25th. Twenty-six samples were taken as part of this effort. Samples taken on the main stem of Beech Creek at Kato (Station 90) and Monument (Station 25) will also be considered in this discussion.

Table 10 shows the flow and chemistry information that was gathered during this snapshot. Table 11 shows the loading calculations for stations where flow rate information was available.

Table 10: Sandy Run Snapshot Flow and Chemistry, October 2004

Point	Flow (gpm)	Field pH	Cond (uS)	Field Alk	Net Acid, Meas	Fe	Mn	Al	SO4
Sandy Above Contrary	1,850	5.45	79	6	3	0.1	0.1	0.8	15
Contrary Mouth	144	3.96	120	0	17	1.6	1.1	0.9	50
Sandy Above Beauty	2,670	5.10	60	5	8	0.2	0.1	0.1	18
91D	5	2.60	1235	0	235	5.4	18.4	29.4	850
92D	3	3.10	709	0	133	5.1	15.5	13.4	455
93D	3	3.30	865	0	228	0.3	14.5	30.5	665
Beauty Mouth	2,218	4.60	74	1	18	0.6	0.5	0.5	24
34	175	3.32	352	0	53	1.8	3.5	5.6	179
38D	9	2.60	1695	0	335	4.5	30.8	34.8	1237
39D	16	3.06	1036	0	237	1.0	17.2	30.8	750
Sandy Above N	3,924	4.53	94	0	20	1.2	0.8	0.6	42
27D	70	2.50	2233	0	223	3.3	38.1	22.8	2004
29D	225	2.65	1594	0	203	19.5	29.2	15.4	1074
31D	13	2.80	615	0	90	0.2	5.4	11.3	332
32D	60	3.30	249	0	16	0.4	0.6	1.1	107
Trib N Mouth	2,334	2.73	1006	0	138	12.2	9.7	7.4	533
40D	22	2.36	2085	0	374	26.0	30.3	31.0	1564
132D	4	2.31	1929	0	399	17.2	32.0	39.6	1493
Sandy Above O	6,716	3.33	402	0	45	3.3	3.1	2.8	166
41D	15	2.81	578	0	169	0.7	2.6	25.7	244
42D	2		908	0	162	4.5	12.0	21.1	350
43D	39	2.70	827	0	259	1.3	5.2	37.4	460
44D	22	3.09	880	0	335	1.3	3.2	51.7	430
45D	15		524	0	170	0.4	2.4	26.9	269
Trib O Mouth	184	2.95	665	0	142	3.9	8.0	14.8	386
105D	376	2.46	1880	0	453	15.0	30.2	49.1	1253
90		4.40	233	0	19	1.7	1.5	1.6	96
25	150,000	4.18	203	0	15	0.5	1.7	1.1	99

Table 11: Sandy Run Snapshot Loadings, October 2004

Point	Fe (ppd)	Al (ppd)	Acid (ppd)	SO4 (ppd)
Sandy Above Contrary	2	18	69	333
Contrary Mouth	3	2	30	87
Sandy Above Beauty	6	4	256	567
91D	0	2	14	51
92D	0	0	5	16
93D	0	1	8	24
Beauty Mouth	15	14	472	625
34	4	12	111	377
38D	0	4	37	137
39D	0	6	45	144
Sandy Above N	55	28	955	1,978
27D	3	19	187	1,683
29D	53	42	548	2,900
31D	0	2	14	50
32D	0	1	11	77
Trib N Mouth	341	206	3,867	14,934
40D	7	8	99	413
132D	1	2	19	72
Sandy Above O	268	226	3,599	13,378
41D	0	5	30	44
42D	0	1	4	8
43D	1	18	121	215
44D	0	14	88	113
45D	0	5	31	48
Trib O Mouth	9	33	314	853
105D	68	221	2,042	5,654
25	954	1,944	26,334	177,660

Above Contrary Run, Sandy Run displays generally good water quality. This finding is supported by the data contained in the Contrary Run report (Bucek, 2004), which found that Sandy Run above Contrary Run was net neutral with low metals.

Figures 3 and 4 graphically present some of the data for the four main stem Sandy Run locations. Large increases in pollution concentration and loading occurs between Tributary N and Tributary O. Almost all of this increase can be attributed to Tributary N, which is the most polluted tributary to Sandy Run. On the day of the snapshot, Tributary N supplied 32% of the flow and 75% of the sulfate loading to Sandy Run.

The largest discrete sources of pollution was Station 105D, which collected several sources of seepage from abandoned pits and highwalls. This discharge forms the headwaters of Tributary P. On the day of the snapshot, Station 105D supplied 5% of the flow and 28% of the sulfate loading to Sandy Run.

On the day of the snapshot, Sandy Run contributed 5% of the flow, 23% of the acidity loading, and 11% of the sulfate loading to Beech Creek at Monument (Station 25). These figures were obtained by summing the results from Sandy Above O, Trib O Mouth, and Station 105D. It is likely that additional loading enters Sandy Run through base flow between these stations and the mouth. Therefore, these numbers probably underestimate the contribution of Sandy Run to the pollution of the main stem of Beech Creek. Regardless, these numbers demonstrate that Sandy Run is a major contributor of pollution to the main stem of Beech Creek.

C. Wolf Run

Wolf Run flows approximately 5.7 miles from its origin along Route 144 to its confluence with Beech Creek just downstream of the bridge at Kato (See Map 5). Approximately 1 mile upstream of its confluence with Beech Creek, Little Wolf Run enters Wolf Run. Wolf Run and Little Wolf Run are typical of poorly buffered streams in the region, with low metals, low alkalinity, and moderate pH. No distinct mine discharges were found to Wolf Run or Little Wolf Run, but the streams would benefit from alkaline addition.

The watershed encompasses approximately 8.8 square miles (5% of the total area of Beech Creek).

The Wolf Run snapshot was performed in August 2004. Samples were taken at 3 locations on Little Wolf Run and 2 locations on Wolf Run. These five locations are shown on Map 5.

As shown in Table 12, all stations on Wolf Run and Little Wolf Run were weakly net acidic with low metals. This type of chemistry represents the extreme limits for sensitive aquatic species such as trout. While these species may survive in waters of this type if they are stocked, reproduction is severely limited. Little Wolf Run had slightly worse water quality with respect to acidity and pH than Wolf Run.

Table 12: Wolf Run Snapshot Data, August 2004

Point	Flow (gpm)	Field pH	Cond (uS)	Field Alk	Net Acid, Meas	Fe	Mn	Al	SO4	TSS
82		5.40	30	4	3	0.6	0.0	0.0	6	2
9		4.85	39	1	5	0.1	0.1	0.3	8	2
10		4.24	41	0	8	0.1	0.2	0.2	10	3
8		4.66	44	0	7	0.1	0.2	0.4	13	3
88	3,028	5.50	30	0	4	0.1	0.0	0.0	8	4

Wolf Run and Little Wolf Run would greatly benefit from small-scale alkaline addition. While some watershed groups have focused on lime sand dosing directly into streams, this is not generally recommended because it can cause habitat degradation and be of limited usefulness in net neutral streams.

An alternative approach is to install a small dam that takes the water directly from the stream to an open limestone bed. Up to 60 mg/L of alkalinity can be generated using these types of systems. Placing one to three of these small open limestone beds on Wolf Run and/or Little Wolf Run could result in substantial water quality benefits.

One of the limiting factors for construction in this area is access. The extreme headwaters of Wolf Run can be accessed off State Route 144. Allan Dam Road and State Line Road also provide access to this area. The headwaters of Little Wolf Run are less accessible. Placing these systems in the headwaters ensures that the entire stream length receives treatment benefits. Due to permitting restrictions, it is preferable to site this type of system where the watershed drainage area is 100 acres or less. However, care should be taken to place systems where flow is perennial.

To construct a system of this type, mapping with 2’ contour intervals is required. A low-head dam (less than 3 feet) is generally installed to ensure flow to the system. The amount of limestone varies based on the expected flow, with 500 – 1,500 tons being typical. Construction costs are generally between $30 – 70,000. Engineering, design, and permitting costs are generally between $15 – 30,000, depending mainly on the availability of existing mapping and the specific permitting requirements.

D. South Fork

The South Fork of Beech Creek originates south of Interstate 80 and flows 11.4 miles north and east to its confluence with the North Fork (See Map 6). The watershed encompasses approximately 18 square miles (11% of the total area of Beech Creek).

For the first 7 miles of its course, the South Fork is typical of poorly-buffered streams in the area, with very low metals, low conductivity, and low alkalinity. Polluted tributaries of the South Fork are Butts Run (Tributary K) and Jonathan Run. Both of these tributaries have been studied recently (see Hedin (2003) and Bucek (2004)). While little or no mining took place in the watershed, the construction of Interstate 80 polluted Jonathan Run. It is not known if the construction of I-80 or a nearby coal processing facility (or some combination of the two) polluted Butts Run.

The South Fork snapshot was performed on April 19, 2005. Samples were taken at 7 locations on the South Fork for this snapshot. Table 13 shows a summary of the data. Data taken at two other locations in the watershed is shown for comparison.

Table 13: South Fork Snapshot Data, April 2005

Point	**Flow (gpm)**	**Field pH**	**Cond (uS)**	**Lab Alk**	**Net Acid, Meas**	**Fe**	**Mn**	**Al**	**SO4**
SFAbove144	9,605	6.40	73	3	1	0.0	0.0	0.0	14
109 (K Mouth)	403	5.01	316	1	16	0.0	0.9	2.2	72
SFAboveJon	10,752	6.56	83	4	2	0.0	0.0	0.0	10
SLB1		5.96	237	8	-1	0.0	0.8	2.3	57
SLB9	444	4.77	330	1	26	0.0	1.3	4.4	115
JRMOUTH	1,205	5.40	123	2	4	0.0	0.2	0.3	29
SFBelowJon	11,957	6.32	87	3	-1	0.0	0.0	0.0	16
125	6,093	4.10	430	0	25	3.1	2.8	2.8	222
25	89,760	4.33	209	0	12	0.0	1.7	1.2	57

Above Tributary K (Butts Run), South Fork chemistry is typical of poorly-buffered streams in the area, with very low metals, low conductivity, and low alkalinity (SF Above 144). While the stream is poorly buffered and could benefit from alkaline addition, it is likely sustaining an aquatic community.

SLB1 represents Jonathan Run immediately south (upstream) of Interstate 80. Work was done in this area in 2002 and 2003 to improve the watery quality. While the aluminum concentration at this station is still above the in-stream limit, the water quality has improved. SLB9 represents Jonathan Run near the lodge lake north (upstream) of I-80. This station is downstream of all known sources of pollution. Elevated acidity and aluminum are found at this station. Pollution from the Jonathan Run headwaters causes the entire length of Jonathan Run to display poor water quality. Even at the mouth of Jonathan Run (JRMouth), where the flow has tripled compared to the SLB9 station from dilution by unpolluted water, the stream displays a net acid condition with slightly elevated aluminum.

The South Fork both above and below Jonathan Run is of similar quality. The moderate amounts of pollution from Tributary K and Jonathan Run were largely diluted on the date of the snapshot. However, it is possible that the quality varies seasonally as the stream flows fluctuate.

Compared with Beech Creek at Monument (Station 25), the South Fork below Jonathan Run supplied approximately 13% of the total flow on the date of the snapshot. This is more than would be expected considering that the entire South Fork comprises only 11% of the total watershed area. Also worth noting is that the flow of the South Fork at this point was nearly twice the flow of the North Fork at Pancake on that date.

Table 14 shows a summary of the pollution loadings for the stations involved in the South Fork snapshot. Note that no flow rate is available for SLB1 so loading calculations are not possible.

Table 14: South Fork Snapshot Loading Summary

Point	Flow (gpm)	Fe (ppd)	Al (ppd)	Acid (ppd)	SO4 (ppd)
SF Above 144	9,605	5	5	90	1,591
109	403	0	11	75	348
SF Above Jon	10,752	5	5	252	1,329
SLB9	444	0	23	139	611
JR MOUTH	1,205	1	4	54	422
SF Below Jon	11,957	6	6	-85	2,324
125	6,093	224	205	1,811	16,217
25	89,760	43	1,271	12,602	61,396

Note that of the two sources of pollution entering the South Fork, Jonathan Run supplies about 2/3 of the pollution loading and Tributary K (Station 109) supplies about 1/3 of the pollution loading. These percentages are valid only for the day of the snapshot.

PennDOT is currently planning to complete mitigation and/or treatment system construction in order to treat all of the pollution coming from Jonathan Run. This will greatly improve 1.5 miles of Jonathan Run and 1.5 miles of the South Fork from its confluence with Jonathan Run to its mouth.

2.8 miles of the South Fork from the Tributary K Mouth (Station 109) to the South Fork Mouth could be greatly improved and protected if the pollution from Tributary K and Jonathan Run are both addressed.

E. Big Run

Big Run is the largest tributary to Beech Creek. Big Run originates along Route 144. It flows south approximately 12 miles to its confluence with Beech Creek approximately 2 miles upstream of the village of Monument. The East Branch, Middle Branch, and West Branch of Big Run are all named tributaries. The watershed encompasses approximately 34.5 square miles (20% of the total area of Beech Creek).

Only the East Branch and Middle Branch are affected by mine drainage (See Map 4). A single large surface mine is responsible for the degradation. Most of the surface mine has been reclaimed, with a few ponds and small open areas remaining. However, vegetation is well-established over most of the site.

The Big Run snapshot was performed on July 19 and 20, 2005. Nine stations were sampled as part of this effort. Map 4 shows the locations of these sampling stations. Three of the sampling stations (18D, 21D, 22D) were regularly sampled as part of this project. The other six stations were sampled for this effort only. The snapshot was performed in very low flow conditions.

Table 15: Big Run Snapshot, July 2005

Point	Flow (gpm)	Lab pH	Cond (uS)	Field Alk	Net Acid, Meas	Fe	Mn	Al	SO4	TSS
BR4	363	4.93	53	1	4	0.1	0.6	0.7	15	14
BR7	318	6.36	31	5	-1	0.3	0.1	0.0	4	1
21D	0									
22D	0									
BR5	1706	5.95	42	3	2	0.1	0.1	0.1	8	3
BR2	81	3.42	2122	0	323	94.7	71.9	22.9	1442	1
BR3	108	3.05	1997	0	261	36.4	63.5	18.6	1327	5
18D	0.25	6.21	405	6	3	0.8	4.0	0.0	165	1
BR6	25	4.12	411	0	26	0.1	8.4	3.1	176	2

Both the Middle Branch (BR4) and East Branch (BR7) of Big Run display water quality typical of the poorly buffered streams in the region when sampled above the known pollution. The BR4 sampling station showed slightly elevated metals that may indicate sub-surface contamination from the surface mine. However, metals, sulfate, and conductivity were low. The two branches have comparable flow rates at these stations.

The East Branch of Big Run was sampled again approximately 3.3 miles downstream of BR7 (BR5). This entire stream reach was investigated during reconnaissance. No point-source discharges were found. However, the pH of the stream decreased somewhat and alkalinity decreased markedly in this reach due to generally acidic groundwater that is caused by the surface mine. Stations 21D and 22D enter the stream between these two points, but on this sampling date, both were dry. The only other distinct source of pollution to the East Branch comes from Station 18D. Again, flow was very low on this sampling date.

For comparison purposes, the following table shows the average flow and chemistry from the three Big Run discharges that were sampled as part of this project.

Table 16: Big Run Discharge Average Data

Date	Flow (gpm)	Field pH	Lab pH	Cond (uS)	Lab Alk	Net Acid, Meas	Fe	Mn	Al	SO4	TSS
18D Average	43.1	4.32	4.69	440	0	36	0.4	4.5	4.3	235	3
21D Average	13.2	4.45	4.77	196	1	12	0.7	3.6	0.7	101	4
22D Average	26.6	4.36	4.65	475	1	23	1.0	10.7	2.1	268	4

Several other discharges flow from the surface mine to the Middle Branch of Big Run. However, due to access problems they could not be sampled during this assessment. During this assessment, DEP Bureau of Abandoned Mine Reclamation (BAMR) was in the process of constructing a treatment system for the largest of these discharges (BR2). During reconnaissance, several other, much smaller, discharges were also found in this area. All of the discharges flow to a small tributary to the Middle Branch, which was sampled at its mouth (BR3).

The primary recommendation for the Middle Branch of Big Run is to monitor the success of the BAMR system, which went on-line during early 2006. This treatment system may provide enough excess alkalinity to offset the other, smaller discharges to the Middle Branch of Big Run. In addition to the treatment system effluent, the Middle Branch downstream of this tributary should be sampled. If it is still net acidic, treatment of the other discharges may be required.

The recommendations for the East Branch of Big Run are to provide treatment for 18D, 21D, and 22D. While these discharges do not flow throughout the year, they do provide significant acidity and metal loading to the East Branch. See Section XII for specific discharge recommendations.

V. Watershed Goals and Objectives

The goals of the Beech Creek Watershed Association are to:

1. Restore Beech Creek and its tributaries to their designated uses of “fishable, swimmable, drinkable.” Progress on this goal will be measured in stream miles recovered.
2. Improve and protect the fishery of Bald Eagle Creek from degradation by Beech Creek. Progress on this goal will be measured in pounds per day of pollutants removed from Beech Creek.
3. Increase the opportunities for the public to access, use, and enjoy the natural resources of the area by working with private landowners and by improving publicly-owned areas of the watershed.
4. Engage the community through publicity, education, and volunteerism in order to form and strengthen partnerships and membership of the BCWA.

The projects and priorities recommended by this plan were formulated with these goals in mind.

VI. Treatment and Mitigation Alternatives

There are several ways to mitigate and/or treat mine drainage that vary depending upon the origin, chemistry, and geographical surroundings of the discharge. Mitigation is also referred to as “source reduction” and indicates one-time activities that lessen the amount or severity of pollution that is produced. The purpose of this section is to describe the basic treatment and mitigation alternatives that are currently available for discharges in the study area.

A. *Mitigation Alternatives*

Mitigation targets the amount (flow rate) or severity (pollutant concentration) of mine drainage discharges through a one-time effort. Typical types of mitigation include surface reclamation, removal or isolation of toxic materials, revegetation, alkaline addition to the surface or subsurface, and source plugging. This section will discuss these mitigation alternatives.

When the source of contaminated mine water is a distinct point source, such as a mine opening or a well, it may be feasible to eliminate the discharge by blocking the flow path. Deep mine entries may be sealed with either wet seals that allow the discharge to flow through the seal or with dry seals that prevent discharges. This approach has limited applicability in the Beech Creek watershed due to the geologic setting.

If the discharge cannot be eliminated, methods to decrease the contaminant loadings should be considered. Acidity and metals loading can be decreased using several methods, including:

- Reducing contact between water and acid-producing materials by increasing runoff and eliminating impoundments;
- Isolating the materials by capping or moving them to a dry location; and
- Adding alkaline materials to neutralize acid production.

Surface reclamation is common mitigation effort that involves grading spoil piles, identifying and isolating or removing acid-producing materials, eliminating impounded water and encouraging surface runoff. Reclamation lessens contact between clean precipitation or groundwater flow and acid-producing materials. The result can be significant reductions in the quantity and/or improvements in the quality of discharges.

Reclamation, alkaline addition and revegetation are most effective for small, intermittent flows of contaminated drainage that flow directly from the surface of spoils. Reclamation is not as effective for discharges that may be influenced by groundwater flow or deep mine voids.

Reclamation usually includes revegetation and some form of alkaline addition. Establishing good cover vegetation on poor mine spoil or soil typically requires heavy additions of agricultural lime or another alkaline product. Fertilizer and mulch are also used. Vegetation prevents erosion and allows more water to run off a site rather than percolate into the spoil, where it can generate more mine drainage pollution.

Neutralization is increased through the addition of alkaline materials to the site. Limestone ($CaCO_3$) and lime ($Ca(OH)_2$ or CaO) products are widely available and are commonly used for alkaline addition. Several seams of limestone are present near the watershed. Bellefonte, a major limestone production area, is approximately 30 miles from Snow Shoe. Limestone is also available in Lock Haven. Alkaline waste products can also be used, including large quantities of waste line that are available in Bellefonte. Other examples include fly ash, fluidized bed bottom ash, processed slag, and paper, pulp, tannery, or other industrial by-products.

Many reclamation projects are supported by state and federal reclamation programs. The Bureau of Abandoned Mine Reclamation (BAMR) is a bureau of the PA DEP that performs many such projects. The Moshannon District Mining Office of DEP serves the Beech Creek Watershed area. However, the presence of marketable coal and/or coal refuse material on a site makes reclamation through coal mining activities possible. In this case, the mining company is provided with incentives to "re-mine" the coal and/or refuse and reclaim the abandoned spoils. The mining company pays the costs of the reclamation on a re-mining project. These activities can result in a reduction in the contaminant production. Government Financed Construction Contracts (GFCCs) have been used to encourage re-mining in areas where it will provide solutions to land and/or water problems.

While mitigation is an important component of any restoration plan, the results of mitigation are difficult or impossible to predict. Mitigation is not an option for every discharge. At some sites, reclamation and well plugging have dramatically reduced the amount of pollution to a watershed, while other efforts have had little to no effect. Often, mitigation efforts such as reclamation must be performed over wide areas to be effective and treatment may be a less expensive option. In addition, well plugging and mine sealing can have adverse consequences if the water is diverted to a less favorable location. Cost/benefit analyses that include the possible successes and failures and potential risks of treatment and mitigation should be examined in order to choose the best alternative for each specific site.

B. Active Treatment Alternatives

Active treatment involves the use of chemicals and mechanical devices to treat mine water. Active treatment methods are well-developed. Sodium-based products such as sodium hydroxide (NaOH, caustic) or sodium carbonate (Na_2CO_3, soda ash) or calcium-based products such as hydrated lime ($Ca(OH)_3$) and quick lime (CaO) are generally used. The sodium products are more soluble and are easier to use for low flows, in remote locations, and/or where a permit requires manganese removal. The calcium products are less expensive, but generally require mechanical mixing and aeration to be effective. Large flows can usually be treated more cost-effectively with lime. Regardless of the type of alkaline reagent used, chemical treatment produces metal sludge that must be periodically collected and disposed of. Disposal usually occurs in an on-site sludge disposal pond or into an underground coal mine void. The costs of sludge management are substantial, sometimes exceeding the costs of the chemicals used to treat the water.

The long-term costs of active treatment usually make it an unattractive treatment solution. However, there are circumstances where it is the used, often with highly effective results. In limited cases, chemicals have been added directly to streams, eliminating sludge management costs but sacrificing some in-stream miles for down-stream improvements. The quality of the East Branch of the Clarion River Reservoir is maintained through mechanical lime additions to a highly acidic stream (Swamp Creek). Major improvements in the quality of Toby Creek are largely due to installation of several active treatment systems. The DEP is currently pursuing chemical treatment systems in the Hollywood and Bennetts Branch areas. Active treatment is usually proposed when it is the only feasible alternative, because

- the chemistry of the discharge is too severe for passive treatment,
- contaminated base flow requires whole-stream treatment,
- there is not enough land area to achieve treatment using passive methods,
- a suitable alkaline chemical is available at a greatly reduced price, and/or
- the value of the treatment (in terms of stream recovery) is high.

C. Passive Treatment Alternatives

Passive treatment involves the use of natural products, natural processes, ponds, and constructed wetlands to remediate mine drainage. Limestone and microbial processes neutralize acidity. Metals are precipitated as oxides and hydroxides in sedimentation ponds and wetlands. The chemistry of the mine drainage determines what type of passive systems will be effective. The flow rate of the mine drainage determines the size of the system.

A variety of passive treatment technologies exist. In general, the more acidic the mine water the more problematic passive treatment becomes because the technology is less well developed and the O&M requirements are often greater as acidity increases. Waters with aluminum concentrations less than 20 mg/L are being effectively treated with reasonable O&M requirements. Waters with higher aluminum concentrations can be effectively treated with passive treatment, but the frequency of system renovations is likely to increase. The selection of the appropriate technology is generally dependent on the mine drainage chemistry.

Ponds and Wetlands

Mine waters that are naturally net alkaline (alkalinity greater than acidity) are usually only contaminated with iron (Fe). The iron can be passively precipitated through oxidation and settling in sedimentation ponds and constructed wetlands. The systems are designed to promote aeration (sheet flow and waterfalls) and provide long retention times. Ponds are usually used to decrease iron concentrations to 10-15 mg/L, and wetlands are used to remove the residual iron. For ponds with a net alkaline influent with iron concentrations over 30 mg/L, a removal rate of 25 g Fe/m^2/day is used. Wetlands with a net alkaline effluent generally remove iron at a rate of about 5 g Fe/m^2/day.

In many cases, it is desirable to add an alkaline substrate, such as compost mixed with limestone, to the bottom of wetlands that receive a net acidic influent. This alkaline substrate has been shown to neutralize acidity and produce alkalinity, ensuring the success of wetland vegetation. Alkaline-amended wetlands have proven success in slightly net acidic waters where flow rates are relatively low. The assumed acidity removal rate for this type of system is 3.5 g acidity/m^2/day.

Many successful pond/wetland systems have retention times of several days. Ponds and wetlands are also placed after other passive treatment system components to provide settling and polishing.

Anoxic Limestone Drains

Mine water that is net acidic (acidity greater than alkalinity), contaminated with iron, and low in dissolved oxygen, ferric iron, and aluminum concentrations can be treated with an anoxic limestone drain (ALD). An ALD is a buried bed of limestone that is designed to be completely flooded to maintain anoxic conditions throughout. Acidic mine water is directed through the bed, resulting in the generation of alkalinity (through limestone dissolution) without the precipitation of iron solids. The alkaline discharge from the anoxic limestone drain is followed by sedimentation ponds and constructed wetlands, where iron precipitates as an iron oxide solid. Properly designed and constructed anoxic limestone drain systems are among the most effective type of passive treatment and have been proven viable for treatment in the long term (over 15 years). In order to achieve the maximum alkalinity possible, at least 12 hours of retention time are required.

Vertical Flow Ponds

Mine waters that are net acidic and contain aluminum present the most challenging cases for passive treatment. The acidic waters require neutralization, but the tendency for metal solids to precipitate within the compost or limestone and decrease the permeability of the system complicates treatment and can cause complete system failure. Short circuiting has also been demonstrated as a problem for these systems. Many passive systems constructed to treat mine water with aluminum fail because they plug, and the acid water cannot flow through the alkaline materials. The plugging problem has been partially mitigated through the design of ponds where water flows vertically through a large bed of limestone. If iron is present in the mine water, the bed is typically covered with an organic substrate in order to remove oxygen that would otherwise cause the precipitation of iron within the limestone aggregate. These ponds have been referred to as vertical flow ponds (VFP), successive alkalinity producing systems (SAPS), and reducing and alkalinity producing systems (RAPS). While some systems may work well for several years with no maintenance, the accumulation of iron and aluminum solids eventually causes permeability problems that can result in system failure. Renovation typically requires replacement of the organic substrate and a portion of the limestone aggregate. To counter this problem, VFPs are usually constructed with solids flushing capabilities. The flushing systems operate passively and are driven by elevation differences designed into the VFPs.

The challenges presented by highly acidic mine drainage have resulted in the development of innovative technologies. There is little consensus among treatment system designers on the details of the flushing systems.

VFPs are designed based on the acidity loading removal rate, which for the purposes of this report is assumed to be 35 $g/m^2/day$.

Oxic Limestone Beds and Channels

Limestone is not effective for AMD treatment if it plugs or is coated with metal solids. In cases where iron and aluminum concentrations are low, additional alkalinity can be generated with flow through an open bed of limestone aggregate. Oxic limestone beds are increasingly being placed at the end of passive systems to boost pH and promote microbial manganese-removal processes.

In some cases, self-flushing units have been attached to open limestone beds in order to flush them, similar to VFPs. Experimental systems of this type have been used to treat high aluminum levels with good short-term success. The first well-studied site that used this technology is located on Jonathan Run, a tributary to the South Fork of Beech Creek. However, this technology has not been studied in the long term and should be considered experimental.

In cases where steep gradients exist between the discharge and the receiving stream, it may be feasible to partially treat the water with an open limestone channel. The velocity of water moving through the limestone carries solids out and prevents plugging. Research shows that even if the limestone in open channels is armored with iron, it is still reactive and can generate some alkalinity.

Sulfate-Reducing Bacteria Systems

One new type of treatment system that has recently been constructed on a pilot scale is the sulfate-reducing bacteria (SRB) system. For these systems, AMD is directed into a buried bed of organic material. The anoxic conditions that result permit sulfate-reducing bacteria to dominate the system. Their activities cause aluminum to precipitate as a dense solid and also generate alkalinity. Both iron and aluminum are removed.

A system of this kind was constructed for a discharge on Cook Run in Sproul State Forest. The system treated 1 to 3 gpm of water with 1,000 – 3,000 mg/L as $CaCO_3$ of acidity and 200 – 300 mg/L of aluminum. While the system showed mixed results, with good treatment success at times but flow management (plugging) problems. In addition, 600 cubic yards of substrate are typically required for each gallon per minute of flow, resulting in very large system sizes and construction costs. However, systems of this type may be the only passive method for treating extremely contaminated mine discharges. Systems of this type are expected to have a capital cost of at least $25,000 per gallon per minute of flow, making them viable alternatives for only small discharges. Full-scale systems of this type are planned and should be monitored for success to determine if they are successful and cost-effective.

Manganese Removal Beds

Manganese precipitates as an oxide under alkaline conditions in the absence of iron. The process is microbially mediated. The Pyrolusite^{TM} process involves the inoculation of oxic limestone beds with microbes selected for manganese oxidation. However, many systems of this type are not inoculated and still remove manganese. Manganese removal is usually considered the final step of passive treatment and is not always included, even for discharges where manganese is high.

Maintenance of Passive Treatment Systems

Many design features can be incorporated into the construction of passive treatment in order to facilitate the maintenance of these systems. For instance, flow channels, berms, and pipes that discourage muskrat activities can prevent problems from developing. Designing two or more parallel cells for some treatment units, such as wetlands and vertical flow ponds, allows one cell to be taken off-line for maintenance while the rest of the system continues to operate normally. As long as maintenance is performed during low-flow conditions, this does not result in a decline in final water quality.

Despite these design improvements, some operation and maintenance activities are necessary. All systems require regular visual inspections to ensure that they are working properly and that pests or high flow events have not damaged the system. Monthly inspections are sufficient in most cases, though inspections should be performed as soon as possible after large flooding events. Other regular maintenance activities are discussed in detail below.

Wetlands usually require minimal maintenance. Most maintenance is related to the activities of pests, such as muskrats and beavers, which burrow in berms, plug outlets and destroy vegetation. Wetlands can be designed to minimize the risk of pest damage, but visual inspections are necessary. Severe pest damage can usually be controlled by trapping efforts. Wetlands have also been damaged by ATVs, which run through the wetlands and cause channels to develop.

The primary maintenance issue with settling ponds is solids removal. Ponds can also be susceptible to damage by pests. The purpose of ponds is to collect metals that form solids and accumulate. Over time, these solids build up and require removal. The solids are not hazardous and can usually be buried on site. Ponds are typically designed to operate for 15 – 25 years before being cleaned out. The required frequency of cleaning depends upon the flow rate of the discharge, the concentrations of metals, and the size of the pond. In situations where clean iron sludge is being collected, it may be possible to recover and sell the sludge, thus offsetting system maintenance costs. Research on recovering aluminum sludge is also being conducted.

When ALDs are properly constructed and designed to treat water that does not contain oxygen, aluminum or ferric iron (Fe^{3+}), they usually require no routine maintenance However, ALDs have recently been used to treat discharges that do contain low levels of oxygen, aluminum or ferric iron (Fe^{3+}). These drains are equipped with flush plumbing similar to that found in VFPs and require regular flushing. As ALDs neutralize acidity and add alkalinity, the limestone dissolves. ALDs are typically designed with enough limestone to provide full treatment for 25 years. After that period of time, more limestone must be added to the bed.

VFPs require regular flushing to avoid becoming plugged by solids. Few scientific studies have been performed to determine the best flushing frequency, which likely varies widely based on the size of the system, the design of the flush plumbing, and the chemistry of the water. Typically, the water level in the VFP is monitored and flushing is recommended when water levels rise, indicating that the VFP is beginning to plug. Alternatively, flushing can be performed on a regular basis before plugging begins. Existing systems are usually flushed once a month to once a year.

VII. Mitigation Recommendations

Reclamation is the primary mitigation alternative that is recommended for the Beech Creek area. Large areas of open cuts, spoil piles, and pits are present, particularly in the North Fork and Sandy Run. All reclamation projects should include as much alkaline addition as possible. For the purposes of this report, a cost per acre has been applied equally to all projects. This cost is based on the assumptions listed below.

Table 17: Reclamation Cost Assumptions

Item	**Cost/Acre**	**Notes**
Earthmoving	$2,500	Based on BAMR unit costs
Alkaline Addition	$2,500	Assuming 150 tons/acre
Revegetation	$1,500	Includes lime, fertilizer, mulch
Total Cost/Acre	**$6,500**	

The costs above assume only 150 tons/acre of alkaline amendment. The alkaline addition should be applied throughout the thickness of the soil or spoil that is being moved and should be well-mixed. The costs shown above assume that waste lime or another byproduct is available for $10/ton. Waste lime from the nearby Bellefonte area is one possible source of alkaline material. This cost includes trucking the material to the site. Several recent reclamation and remining projects have included much higher alkaline amendment rates (up to 2,000 tons/acre) with mixed success. Additional costs for specific jobs may include access road improvement, highwall removal, and stream channel reconstruction.

The costs listed in Table 17 do not include mapping, engineering, permitting, mobilization, demobilization, and other costs that must be applied on a “per project” basis. For the purposes of this report, these items are assumed to be $50,000 per project. However, these costs could increase, particularly if extensive design and permitting are required for items such as wetland encroachment, stream encroachment, or stream reconstruction.

For each specific project discussed, potential impacts of the project are listed, usually with respect to a station or stations that may experience a change in flow, chemistry, or both. In all cases, these stations should be monitored after the reclamation is complete in order to assess the impacts of the reclamation.

A. North Fork Area

As discussed in Section IV.A above, the North Fork of Beech Creek is highly contaminated from contaminated base flow to the stream and to widely diffuse seep zones throughout the watershed. While landowner restrictions limited access to the extreme headwaters in the area of the village of Cherry Run, this area is a major contributor.

Throughout the North Fork there are large areas of open cuts and unreclaimed spoil. The USGS map of the area indicates that every tributary in the area has mining impacts, shown as brown or purple stipple patterns. Until these areas are addressed and contaminated base flow to the stream is reduced, treating individual discharges will have little impact on the stream.

Several priority areas have been identified for reclamation. The projects are shown on Map 7. These projects are not the only sites where reclamation is warranted, but they represent areas where initial work will allow assessments of the effectiveness of reclamation. The projects are summarized in the following table. Each project is then discussed below.

Table 18: North Fork Reclamation Recommendation Summary

Location	Acres	Cost Estimate	Anticipated Impacts
Tributary H	36	$327,000	Reduce/eliminate discharge 122D; downstream improvements on Tributary H (Station 4)
Tributary G	130	$1,030,000	Reduced loading to Tributary G (Station 81) and Little Sandy Run (Station 80)

Reclamation on 36 acres of Tributary H is recommended as a “high” priority for several reasons. Photo 1 shows a portion of this area near discharge 122D. Tributary H displayed good water quality at Station 121D, which is located just upstream of this area. In addition, Tributary H is net neutral at its mouth (Station 4), with moderate levels of aluminum. This indicates that small changes in upstream chemistry could result in significant stream improvements. Finally, discharge 122D, which flows from this area, contains 50 – 100 mg/L aluminum and 400 – 700 mg/L acidity. While innovative passive treatment systems may be capable of treating this type of water, reclamation to reduce the pollution levels is a preferable first step. See Section IX.F for more information on this reclamation job.

Reclamation of 130 acres of open spoil in Tributary G is recommended as an important step in restoring Little Sandy Run. As discussed above, Little Sandy Run displays good water quality in its headwaters, but is impacted by several discharges and, more importantly, contaminated base flow. Reclaiming this area should reduce the base flow to Little Sandy Run. However, this job is rated “medium” because its high cost reduces its overall cost-effectiveness. See Section IX.E for more information on this reclamation job.

In addition to these specific recommendations, any reclamation work done on the extreme headwaters of the North Fork (around the village of Cherry Run) would be beneficial. Landowner restrictions did not allow for sampling in this area, but downstream sampling (Station 3) indicated significant pollution loading from this area. Tributaries C and D also have large areas of open spoil.

B. Sandy Run

As discussed in Section IV.B above, Sandy Run is highly contaminated from contaminated base flow to the stream, distinct discharges, and widely diffuse seep zones throughout the watershed. Hundreds of acres of unreclaimed or poorly reclaimed spoil, strip mining, highwalls, and pits are present. Some deep mining also took place.

Two high priority areas have been identified for reclamation. The projects are shown on Map 8. These projects are not the only sites where reclamation is warranted, but they represent areas where initial work will allow assessments of the effectiveness of reclamation. Several other "medium" priority reclamation projects are also present in this watershed (See Section X). The priority projects are summarized in the following table. Each project is then discussed below.

Table 19: Sandy Run Reclamation Recommendation Summary

Location	Acres	Cost Estimate	Anticipated Impacts
Tributary P	27	$350,500	Decreased flow/loading to Tributary P (Station 105D)
Sandy Road Phase I	18	$176,000	Decreased flow/loading to 38D, 39D, 40D, 132D, and 133D Sandy Run

Station 105D represents the largest single loading of any discharge measured in this study. Photo 6 shows the 105D discharge pool and Photo 7 shows an unreclaimed pit. The large flow and extreme chemistry of this discharge make it unsuited for reliable passive treatment. Therefore, intensive reclamation of 27 acres, including the removal of several small highwalls, is recommended. For more information on the Tributary P project, see Section X.M.

Two separate seams of surface mining along Sandy Run road have left many acres of open spoils. These spoils contribute to discharges to Sandy Run, Beauty Run, Tributary O, and Little Wolf Run. A phased approach for a total of 178 acres is recommended, with Phase I involving 18 acres of reclamation on the lower seam. Photo 3 shows unreclaimed spoil in this area. For more information on the Sandy Run Road project, see Section X.A.

Many other opportunities for reclamation exist in Sandy Run. However, these are the two projects most likely to yield significant reductions in flow rate and loading.

VIII. Active Treatment Recommendations

Although chemical treatment is usually considered a "last resort", the Beech Creek watershed will likely require active chemical treatment if it is to be fully restored. This is because:

- Thousands of unreclaimed acres exist in the watershed
- Some discharges are too contaminated for passive treatment
- North Fork and Sandy Run have significant pollution from contaminated baseflow

There are several critical variables that greatly influence the capital cost, yearly cost, and effectiveness of chemical treatment in the Beech Creek watershed. They are:

- Location(s) of treatment
- Total stream or discharge-specific treatment
- Type of chemical reagent
- Sludge management issues

Several alternative locations have been identified. The locations are summarized in the following table:

Table 20: Possible Chemical Treatment Locations

Location	**Pros**	**Cons**
Trib N (Sandy Run)	• Chemistry and flow rate make passive options unlikely	• Electricity not present • Would require large over-treatment to offset other Sandy Run discharges
105D (Sandy Run)	• Chemistry and flow rate preclude passive treatment options • Could collect discharges and use ponds for treatment and sludge instead of using the stream	• Difficult to access • Electricity not present • Would require large over-treatment to offset other Sandy Run discharges
North Fork @ Pancake (Station 125)	• Easily accessible with power available • In-stream treatment occurs in area that is largely inaccessible	• Would use stream for treatment and sludge accumulation
Beech Creek @ Kato (Station 90)	• Protects to Bald Eagle Creek • In-stream treatment occurs in area that is largely inaccessible	• Difficult to access • Electricity not present • Would use stream for treatment and sludge accumulation

Note that none of these locations would provide stream improvements to population centers in Show Shoe and Clarence. In order to benefit the North Fork in this area, treatment would be required in an upstream location or locations. Because much of this area was restricted by landowners, recommendations are difficult to make at this time. In-stream dosing upstream of this area is not recommended because chemical reactions would occur in the stream in population centers and sludge would form where the stream is highly visible.

The simplest and cheapest method of chemical treatment would be to dose alkaline materials directly to an in-stream location. This eliminates costs for pond construction and sludge management. The stream performs some or all of the mixing. Chemical reactions and metal precipitation take place directly in the stream. While this is preferable from a cost standpoint, this method results in significant accumulation of precipitates on the stream bottom. During high flow events, these precipitates will be washed downstream. Essentially, some part of the stream is “sacrificed” in order to improve water quality in downstream reaches.

IX. North Fork: Discharge-Specific Treatment Recommendations

The North Fork of Beech Creek forms the western headwaters of the watershed (See Map 2). While there are some portions of this watersheds that are unaffected (namely, Little Sandy Run headwaters and Cherry Run extreme headwaters), many discharges are present. This area of the watershed is critical because large amounts of pollution loading come from this area and because this area forms the headwaters of Beech Creek. Discharges in this area affect the main stem of Beech Creek in its entirety. 15 of the 55 sampling points measured as part of this study are located in this sub-watershed.

Section IV.A discusses the watershed snapshot of this area in more detail. In addition to the specific discharges sampled, two in-stream stations (Station 3 and Station 81) are included in the discussions below because no discharges were identified and sampled upstream of these points. The purpose of the following sections is to discuss the discharges and present strategies for addressing them.

A. *Station 3*

Station 3 is located on the main stem of the North Fork of Beech Creek, upstream of the confluence of Tributary C (See Map 2). Landowner restrictions prevented reconnaissance and sampling of individual discharges upstream of this point. Flow at this station was measured using the velocity meter.

Table 21: Station 3 Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/10/04		3.87	594	52	3.7	3.8	6.2	292	4				
10/22/04	5,200	4.16	356	25	2.0	2.2	2.2	169	3	122	134	1,570	10,558
12/17/04		4.29	425	38	2.2	2.7	3.5	238	7				
01/10/05		4.07	450	39	2.9	2.9	3.5	208	8				
02/11/05		4.24	560	27	2.6	2.5	2.3	263	1				
03/18/05	1,798	4.18	457	37	3.4	2.6	3.0	204	2	72	65	800	4,410
04/21/05	2,675	3.85	545	45	2.1	3.7	4.6	353	5	67	147	1,446	11,318
05/24/05		3.76	573	35	3.6	4.3	2.3	230	1				
06/22/05		3.70	586	34	1.7	3.7	1.3	222	5				
07/21/05		3.42	818	44	4.8	5.6	1.5	310	2				
Average	**3,224**	**3.95**	**536**	**38**	**2.9**	**3.4**	**3.0**	**249**	**4**	**87**	**115**	**1,272**	**8,762**

The chemistry at this station indicates that significant sources of pollution are present upstream. Moderate levels of acidity and metals represent a significant loading because the flow rate is high.

Because reconnaissance and sampling of individual discharges was not allowed, it is not possible to make specific treatment recommendations for this station. If it is possible to gain landowner permission in the future, individual discharges should be identified and sampled.

B. Station 71D

This discharge emerges from a drain installed during the reclamation along Cherry Run, a tributary of North Fork (See Map 2). The flow was calculated by measuring the area and velocity of the flow in the pipe that discharges to the stream during high flows. During low flows, the timed volume method was used.

Table 22: Station 71D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	240	3.14	596	130	2.4	0.7	10.5	180	1	7	30	373	518
09/22/04	804	3.11	713	185	3.7	1.4	22.0	279	1	36	212	1,787	2,689
10/22/04	69	3.20	579	129	2.2	0.9	16.9	181	3	2	14	107	150
12/17/04	207	3.13	700	157	3.0	0.9	13.4	244	2	7	33	390	605
01/10/05		3.13	590	140	3.2	0.9	11.7	196	6				
02/11/05	21	3.10	743	157	1.5	1.4	11.4	298	2	0	3	39	75
03/18/05		3.23	562	141	2.0	1.1	14.3	181	3				
04/21/05	21	3.20	558	121	1.8	1.1	13.8	457	8	0	3	30	115
05/24/05	38	3.18	627	142	3.0	1.8	13.2	163	4	1	6	64	74
06/22/05		3.25	545	136	1.9	2.3	15.6	188	1				
07/21/05	4	3.20	597	129	2.2	2.5	14.6	192	1	0	1	6	9
Average	**175**	**3.17**	**619**	**142**	**2.4**	**1.4**	**14.3**	**233**	**3**	**7**	**38**	**350**	**529**

While the chemistry of this discharge is amenable to passive treatment, its discharge location (immediately adjacent to the stream) makes passive treatment impossible. The discharge emerges from a pipe that was installed as part of a BAMR reclamation job in 1998 (Job number OSM146944). According to the plans for this job, there is very little opportunity to raise the discharge from its present elevation. Therefore, the only available treatment system location is between Hartline Road and Cherry Run, downstream of the current discharge location. Approximately 6.5 acres of land is available in this area (respecting the 50’ stream set-back).

This area is not ideal for treatment because it fairly flat, making installation of vertical flow ponds with flushing capabilities difficult. Additionally, the area appears to have many small pockets of wetlands, which make obtaining construction permits more expensive and more complicated. Therefore, the first step in addressing Station 71D is to obtain mapping of the reclamation area and of the potential treatment area between Hartline Road and Cherry Run.

If the vertical relief is sufficient, a vertical flow pond system with a design high flow rate of 240 gpm is recommended. A high-flow bypass method would be required. Based on an acidity removal rate of 35 g/m2/day and an effluent alkalinity of 100 mg/L, approximately 2.2 acres of vertical flow ponds would be required (not including berms, etc). A settling pond, wetland, and flushing pond should also be included. However, a smaller system may be necessary based on space restrictions. Therefore, no cost estimates are given for final construction. Mapping, design, and permitting of a system for this discharge is recommended as Phase I, at an anticipated cost of $50,000.

C. Station 75D

Station 75D is located along the western bank of Little Sandy Run (See Map 2). It emerges near a pipeline right-of-way and flows about 100 yards to Little Sandy Run. Flow at the station was measured using the timed volume method from a pipe installed in the discharge channel. The following table shows the flow, chemistry, and loading from the discharge.

Table 23: Station 75D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	17	4.72	144	8	0.2	0.3	0.2	63	2	0	0	2	13
09/22/04	94	4.64	198	10	0.1	0.3	0.2	86	1	0	0	11	97
10/22/04	18	4.86	122	5	0.1	0.2	0.1	58	5	0	0	1	12
12/17/04	24	4.75	188	7	0.0	0.3	0.1	87	8	0	0	2	25
04/21/05	4	4.83	184	6	0.0	0.3	0.1	79	5	0	0	0	4
05/26/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**20**	**4.76**	**167**	**7**	**0.1**	**0.3**	**0.1**	**216**	**4**	**0**	**0**	**2**	**19**

This discharge is mildly contaminated, with low levels of metals and acidity. Therefore, the loading contributed by this discharge is small. Because the flow rate of this discharge is intermittent and the loading is small, no action is recommended at this time. If other problems on Little Sandy Run are cleaned up, it may be desirable to provide treatment to this discharge. An anoxic limestone drain (ALD) would remove the acidity and boost the alkalinity from this discharge. Because the metals are very low, no settling pond or wetland would be required.

The system would require a design that would prevent the ALD from drying out during dry times of the year. In order to retain the average flow rate for 30 hours, about 600 tons of limestone would be required. While 30 hours is generally more than is recommended for ALDs, using less limestone is not recommended because of the highly variable flows. 600 tons would provide the highest measured flow rate with about 6.4 hours of retention time, which should be sufficient to create a net alkaline condition. The anticipated cost for a project of this type, including design and permitting, is approximately $40,000.

D. Station 79D

Station 79D measures flow from a drain installed during reclamation (See Map 2). The drain discharges at the lower edge of a field along a pipe line right-of-way on the western side of Little Sandy Run. This is the first known discharge of pollution into Little Sandy Run, which is clean above this point. Flow at the station was measured using the timed volume method from a pipe installed in the discharge. The following table shows the flow, chemistry, and loading from this discharge.

Table 24: Station 79D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	28	3.41	380	65	1.8	1.0	4.2	123	1	1	1	22	41
09/22/04	72	3.17	537	119	3.2	0.9	7.9	160	1	3	7	103	138
10/22/04	28	3.56	292	51	1.7	1.2	2.9	103	4	1	1	17	34
12/17/04	47	3.46	389	65	1.5	1.3	4.7	137	4	1	3	37	77
04/21/05	17	3.48	329	57	2.2	1.6	4.5	265	3	0	1	12	54
05/26/05	4	3.81	287	37	9.2	2.4	1.5	92	1	0	0	2	4
06/22/05	2	3.93	230	28	7.9	2.6	0.4	94	2	0	0	1	2
07/21/05	3	3.74	278	26	10.0	2.8	0.4	96	4	0	0	1	3
Average	**25**	**3.57**	**340**	**56**	**4.7**	**1.7**	**3.3**	**134**	**3**	**1**	**2**	**24**	**44**

As shown in Table 24, Station 79D is moderately contaminated with acidity and metals. The flow rate varies widely based on seasonal rainfall. While the chemistry of the discharge is well suited for passive treatment, the difficulty arises in designing a treatment system for such a highly variable flow rate.

Some types of passive treatment systems do not respond well to periodic dry periods, which can cause bacteria in compost to die, cause metals to harden on limestone, or introduce oxygen into areas that should be anoxic. Therefore, a simple aerobic wetland with alkaline substrate is recommended for this discharge. This type of treatment system should not be as susceptible to large variations in flow rate.

Because of the high variability of this discharge, sizing a treatment system can be difficult. An acidity loading of 20 pounds per day was chosen as the target for removal. At 3.5 g/m2/day, this requires a 28,000 square foot wetland would be required. Assuming a water depth of 4”, the highest flow rate measured with 16 hours of retention. At average flow, 46 hours of retention time would be provided.

The wetland substrate should be comprised of 2/3 compost and 1/3 fine limestone, such as #11 or sand. These items should be well-mixed, then placed to a total depth of 6” in the bottom of the wetland. Wetland plants should then be planted in this media.

The wetland should discharge to an open limestone bed. At this point, the water should be net neutral or net alkaline with very low metals. It is desirable to generate as much excess alkalinity as possible from this system in order to offset contaminated base flow and other discharges to

Little Sandy Run. Approximately 430 tons of AASHTO #1 limestone should be used. This will provide the highest measured flow with 6 hours of retention time. At the average flow rate, 17 hours of retention would be provided. The following table shows the projected costs for this system.

Table 25: Station 79D System Cost Estimate

Item	**Cost Estimate**
28,000 sq.ft. wetland construction	$28,000
Compost (substrate, 240 CY)	$6,000
#11 LS (substrate, 160 tons)	$3,200
Wetland Plants, 3,200	$3,200
Construct open limestone bed	$6,000
AASHTO#1 LS (polishing bed, 430 tons)	$8,600
Mob/Demob, E&S, Reveg, etc.	$10,000
Construction Total	**$65,000**
Mapping/Design/Engineering/Permitting	$20,000
TOTAL	**$85,000**

The system should be constructed below the pipeline location. There is sufficient room between the pipeline and Little Sandy Run for the construction of this system. The treatment system should discharge net neutral or net alkaline water with all metals less than 1 mg/L.

The total anticipated cost for a system of this type is $85,000. This includes mapping, design, engineering, and permitting. However, this cost assumes that no Joint Encroachment Permit would be required.

E. Station 81

Station 81 measures the mouth of Tributary G, as it enters Little Sandy Run near the township building (See Map 2). The flow at this station was measured using the velocity meter. The following table shows the flow, chemistry, and loading from the discharge.

Table 26: Station 81 Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	676	3.91	387	24	0.9	0.9	1.4	199	3	7	11	198	1,616
09/22/04	2,179	3.91	460	26	0.8	1.2	2.4	200	1	21	63	688	5,230
10/22/04	377	4.07	376	21	0.7	1.1	1.6	190	6	3	7	95	858
12/17/04		3.90	421	26	0.6	1.0	1.6	222	7				
01/10/05		3.93	387	22	0.5	0.9	1.6	168	4				
02/11/05		3.95	384	20	0.6	1.0	0.9	95	5				
03/18/05	159	3.89	435	20	1.0	1.1	1.9	199	8	2	4	39	379
04/21/05	449	3.76	435	25	0.5	0.9	1.8	256	8	2	10	133	1,379
05/24/05	135	3.72	488	31	1.4	1.6	2.0	171	1	2	3	51	278
06/22/05	72	3.69	523	41	1.6	1.9	2.8	245	3	1	2	36	212
07/18/05	34	3.53	608	38	2.3	1.9	1.9	245	2	1	1	15	100
Average	**510**	**3.84**	**446**	**27**	**1.0**	**1.2**	**1.8**	**199**	**4**	**5**	**13**	**157**	**1,256**

The entire Tributary G subwatershed has been subjected to surface mining. Seep zones are present throughout the drainage. Unreclaimed and poorly reclaimed surface spoils are present over many acres. This is one reason why the flow rate of Tributary G varies so drastically.

Reclamation is the recommended approach for this area. The entire area covers approximately 130 acres, which could be reclaimed in a phased approach. The first step of this project would be to have the entire area mapped to 2’ contours using aerial photography. This mapping may reveal a phased approach to reclaiming the area. However, the following table assumes that the reclamation is performed at one time.

Table 27: Tributary G Reclamation Costs

Item	**Cost Estimate**
Reclamation of 130 acres ($6,500/acre)	$845,000
Access Improvements	$10,000
Stream/Wetland Mitigation	$70,000
Mob/Demob, E&S	$25,000
Construction Total	**$950,000**
Mapping/Design/Engineering/Permitting	$80,000
TOTAL	**$1,030,000**

After reclamation is complete, Stations 81 and 80 (the mouth of Little Sandy Run) should be monitored to assess the impacts of reclamation.

F. Station 122D

Station 122D measured a discharge channel from an area of unreclaimed mine spoil (See Map 2). The discharge area is show in Photo 1. The discharge contaminates Tributary H to the North Fork. The tributary displays good water quality above this discharge. The flow rate was measured using the timed volume method. The following table shows the flow, chemistry, and loadings from the discharge.

Table 28: Station 122D Flow, Chemistry, and Loading

									LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	35	3.25	1492	621	2.2	9.8	76.8	1100	3	1	32	261	462
09/22/04	112	3.11	1780	714	2.9	13.4	113.3	1128	2	4	152	960	1,517
10/22/04	17	3.27	1473	635	2.7	12.3	102.1	1018	8	1	21	130	208
12/17/04	44	3.31	1349	441	2.0	12.3	66.9	1035	7	1	35	233	546
01/10/05	40	3.25	1329	460	2.0	11.4	68.7	940	5	1	33	221	451
03/18/05	15	3.32	1255	426	2.6	12.7	70.2	772	1	0	13	77	139
04/19/05	30	3.28	1305	399	1.9	12.4	71.5	1545	3	1	26	143	552
05/24/05	6	3.34	1296	417	5.8	14.1	54.9	697	1	0	4	30	50
06/22/05	3	3.26	1268	405	4.0	13.4	58.5	664	4	0	2	13	21
07/21/05	2	3.10	1378	392	4.6	13.5	56.6	755	5	0	1	9	18
Average	**30**	**3.25**	**1393**	**491**	**3.1**	**12.5**	**73.9**	**965**	**4**	**1**	**32**	**208**	**396**

This discharge is highly variable in flow rate and chemistry, with worse chemistry at higher flow rates. Reclamation of approximately 36 acres of spoil adjacent to this discharge is recommended for two reasons. First, the highly variable flow rate indicates a shallow groundwater or surface water source for the discharge that makes the success of reclamation more likely. Also, the severe chemistry of this discharge is outside the limits of reliable passive treatment.

The following costs have been developed for this project. These costs include the additional permitting and mitigation that will likely be necessary to work within the stream barrier of Tributary H. A Joint Encroachment Permit is anticipated.

Table 29: Tributary H Reclamation Costs

Item	**Cost Estimate**
Reclamation of 36 acres ($6,500/acre)	$234,000
Access Improvements	$8,000
Stream/Wetland Mitigation	$20,000
Mob/Demob, E&S	$15,000
Construction Total	**$277,000**
Mapping/Design/Engineering/Permitting	$50,000
TOTAL	**$327,000**

After reclamation is completed, Station 122D should be monitored to assess any changes in flow and/or chemistry that may result from reclamation. Station 4, located near the mouth of Tributary H, should also be monitored. Even after reclamation, chemical treatment may be necessary for this discharge.

G. Station 67D

Station 67D discharges to the headwaters of Tributary J of the North Fork (See Map 2). The discharge is shown in Photo 2. This was the only discharge to Tributary J that was located and sampled, though the North Fork snapshot shows other loading is entering the tributary (See Section IV.A). The discharge appears to originate from an abandoned deep mine drift. The flow rate was measured using a 6” H-flume that was installed in the discharge channel under the power line right-of-way. The following table shows, the flow, chemistry, and loading from the discharge.

Table 30: Station 67D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	60	3.78	322	23	2.0	0.9	1.3	116	3	1	1	16	83
09/22/04	105	3.90	283	18	1.1	0.7	1.0	101	3	1	1	23	127
10/18/04	35	3.69	389	40	4.6	1.2	1.8	145	2	2	1	17	61
12/15/04	110	3.77	287	23	1.4	0.8	1.0	100	4	2	1	30	131
01/10/05	150	3.85	265	21	1.3	0.6	0.8	91	5	2	1	38	164
02/11/05	35	3.57	370	35	5.1	1.2	1.3	215	4	2	1	15	90
03/18/05	40	3.68	422	42	7.9	1.2	1.8	143	13	4	1	20	68
04/19/05	42	3.70	315	25	3.4	0.9	1.6	228	2	2	1	13	115
05/24/05	10	3.30	545	59	45.9	1.9	2.9	151	1	6	0	7	18
06/21/05	5	3.33	520	73	16.0	1.9	2.8	155	1	1	0	4	9
07/18/05	3	3.25	601	68	16.4	2.1	3.3	178	3	1	0	2	6
Average	**54**	**3.62**	**393**	**39**	**9.5**	**1.2**	**1.8**	**147**	**4**	**2**	**1**	**17**	**79**

This discharge contains low to moderate levels of acidity and metals, with worse chemistry at lower flow rates. While the chemistry of the discharge is well suited for passive treatment, the difficulty arises in designing a treatment system for such a highly variable flow rate.

Some types of passive treatment systems do not respond well to periodic dry periods, which can cause bacteria in compost to die, cause metals to harden on limestone, or introduce oxygen into areas that should be anoxic. Therefore, a simple aerobic wetland with alkaline substrate is recommended for this discharge. This type of treatment system should not be as susceptible to large variations in flow rate.

Because of the high variability of this discharge, sizing a treatment system can be difficult. An acidity loading of 23 pounds per day (the 80th percentile loading) was chosen as the target for removal. At 3.5 g/m2/day, this requires a 32,000 square foot wetland would be required. Assuming a water depth of 4”, the highest flow rate measured with 9 hours of retention. At average flow, 24 hours of retention time would be provided.

The wetland substrate should be comprised of 2/3 compost and 1/3 fine limestone, such as #11 or sand. These items should be well-mixed then placed to a total depth of 6” in the bottom of the wetland. Wetland plants should then be planted in this media.

The wetland should discharge to an open limestone bed. At this point, the water should be net neutral or net alkaline with very low metals. It is desirable to generate as much excess alkalinity as possible from this system in order to offset contaminated base flow and other discharges to Little Sandy Run. Approximately 900 tons of AASHTO #1 limestone should be used. This will provide the highest measured flow with 6 hours of retention time. At the average flow rate, 16.7 hours of retention would be provided. The following table shows the projected costs for this system.

Table 31: Station 67D System Cost Estimate

Item	**Cost Estimate**
32,000 sq.ft. wetland construction	$32,000
Compost (substrate, 400 CY)	$10,000
#11 LS (substrate, 270 tons)	$5,500
Wetland Plants, 3,500	$3,500
Construct limestone bed	$7,000
AASHTO#1 LS (polishing bed, 900 tons)	$18,000
Mob/Demob, E&S, Reveg, etc.	$8,000
Construction Total	**$84,000**
Mapping/Design/Engineering/Permitting	$20,000
TOTAL	**$104,000**

The system should be constructed between the power line and Tributary J, upstream of the road. There appears to be sufficient room in this area. The treatment system should discharge water with approximately 50 mg/L net alkalinity and all metals less than 1 mg/L.

The total anticipated cost for a system of this type is $104,000. This includes mapping, design, engineering, and permitting. However, this cost assumes that no Joint Encroachment Permit would be required.

H. Station 129D

Station 129D is a discharge that originates near the Three-points Sportsmen's Club's archery range. It flows to the North Fork of Beech Creek downstream of Station 125. The flow was measured using the timed volume method. The following table shows the flow, chemistry, and loading from the discharge.

Table 32: Station 129D Flow, Chemistry and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/10/04	10	5.31	62	5	0.1	0.1	0.0	20	4	0	0	1	2
07/18/05	1	5.11	136	7	0.1	0.2	1.6	58	1	0	0	0	1

As shown, this discharge is a low flow of mildly acidic water. The discharge was only sampled twice because it is not a significant contributor of loading to the stream. No action is recommended at this time.

X. Sandy Run: Discharge Specific Treatment Recommendations

Sandy Run originates along the east side of Route 144 north of the village of Cherry Run (See Map 3). It flows south approximately 4.1 miles before turning east where Contrary Run enters it and flowing approximately 4.3 miles to its confluence with Beech Creek approximately 1 mile upstream of the bridge at Kato. 24 of the 55 sampling points measured as part of this study are located in this sub-watershed.

Section IV.B discusses the watershed snapshot of this area in more detail. Sampling indicates that this tributary supplies more loading to Beech Creek than any other subwatershed.

Discharges that flow directly to Sandy Run are discussed first, followed by tributary discharges starting in the headwaters and working downstream. In addition to the discharges discussed below, several discharges to Contrary Run were sampled as part of the Bucek report. Data and recommendations for these discharges can be found in that report. The purpose of the following sections is to discuss the discharges and present strategies for addressing them.

A. Stations 132D and 133D

Stations 132D and 133D share a common source (and a common solution), so they will be discussed together (See Map 3). Both discharges represent flow from unreclaimed surface mines above the Sandy Run road. The flows are collected in road culverts, where they were measured. Flows were measured using the timed volume method. The following tables show the flow, chemistry, and loading from the discharges.

Table 33: Station 132D Flow, Chemistry and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	3	3.03	1928	352	10.2	27.1	41.4	1353	2	0	1	13	49
09/23/04	5	2.95	2267	439	19.7	34.7	49.9	1309	2	1	3	26	79
10/18/04	4	3.06	1929	399	17.2	32.0	39.6	1493	2	1	2	19	72
12/15/04	6	3.16	1921	410	29.6	32.8	43.8	1224	13	2	3	30	88
02/11/05	12	3.28	1317	272	12.6	20.3	29.0	710	5	2	4	39	102
04/20/05	2	2.99	1843	303	7.5	29.5	39.9	1938	7	0	1	7	47
05/24/05	5	2.99	2157	425	35.0	39.4	43.4	1342	1	2	3	26	80
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**4**	**3.07**	**1909**	**371**	**18.8**	**30.8**	**41.0**	**1338**	**5**	**1**	**2**	**18**	**57**

Table 34: Station 133D Flow, Chemistry and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
03/18/05	12	3.41	1505	338	11.6	27.3	47.8	1154	10	2	7	49	166
04/20/05	25	3.09	2200	481	8.4	34.5	84.0	2877	4	3	25	144	863
05/24/05	3	3.24	1848	393	34.7	35.0	46.0	1275	1	1	2	14	46
06/21/05	0.25	3.23	1798	457	4.3	31.9	62.5	1267	4	0	0	1	4
07/21/05	0									0	0	0	0
Average	**8**	**3.24**	**1838**	**417**	**14.7**	**32.2**	**60.1**	**1643**	**5**	**1**	**7**	**42**	**216**

As shown above, both discharges are intermittent, with high levels of acidity and metals. Their low flow rates result in moderate pollution loadings. Both discharges are caused by unreclaimed spoil areas above the road. Two seams of coal were mined in this area. The lower seam surface mine covers approximately 18 acres. The higher seam surface mine covers approximately 160 acres. Map 8 shows the reclamation areas. The discharges that are likely caused by these two surface mines include 132D, 133D, 38D and 39D (See Section X.C), 40D (See Section X.B), 91D, 92D, and 93D (Beauty Run, See Sections X.D and X.E), and 42D (Tributary O, See Section X.J). A phased approach is recommended for reclamation in this area. This is because many of the discharges are not amenable to reliable passive treatment.

Phase I should involve reclamation and alkaline addition for the 18 acre surface mine on the lower seam. Phase II should involve reclamation and alkaline addition on approximately 60 southern-most acres of the upper seam surface mine. If the discharges do not improve significantly, Phase III should involve reclamation of the remaining 100 acres of surface mining on the upper seam. These phases have been devised because reclamation is generally more effective when the discharges are close to the reclamation area. These phases start closest to the discharges, and proceed further away.

The following costs have been developed for Phase I. This reclamation job should be straight forward, with limited access and permitting issues.

Table 35: Sandy/Beauty/Trib O Phase I Reclamation Costs

Item	**Cost Estimate**
Reclamation of 18 acres ($6,500/acre)	$117,000
Access Improvements	$4,000
Mob/Demob, E&S	$15,000
Construction Total	**$136,000**
Mapping/Design/Engineering/Permitting	$40,000
TOTAL	**$176,000**

When the mapping for this job is conducted, the entire upper and lower seam surface mines should be mapped. This will result in a cost savings for Phases II and III, if they are performed. During reclamation, as much alkaline material as possible should be added throughout the spoil as it is regraded. Excess lime will likely be necessary to establish vegetation on the poor spoils. Manufactured soil or soil supplements may also be necessary, though this cost is not included above.

The cost for Phase II is anticipated at $450,000, while the cost of Phase III is anticipated at $720,000. After each phase, the discharges should be monitored for at least 1 year to determine the effectiveness of reclamation. Subsequent phases may or may not be necessary. After one or more phases, treatment may still be required for some or all of the discharges.

B. Station 40D

Station 40D measures the discharge from a large kill zone between Sandy Run and Sandy Run Road (See Map 3). Photo 4 shows the kill area. Flow was measured at two locations using the timed volume method. The flow rates were added to determine the total flow rate from the kill zone. The following table shows the flow, chemistry, and loading from the discharge.

Table 36: Station 40D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	17	2.98	1960	319	23.3	21.3	19.0	1854	6	5	4	65	378
09/23/04	35	3.01	1810	260	18.4	19.9	22.0	831	2	8	9	109	349
10/18/04	22	3.07	2085	374	26.0	30.3	31.0	1564	2	7	8	99	413
12/15/04	27	3.18	1576	291	23.3	22.6	29.5	1142	5	8	10	94	370
02/11/05	55	3.32	1573	304	18.5	21.0	35.0	1230	4	12	23	201	814
03/18/05	23	3.28	1650	308	39.3	22.5	25.4	1103	9	11	7	85	304
04/20/05	5	2.93	2156	303	18.6	30.5	28.1	2237	3	1	2	18	134
05/25/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/18/05	1	2.62	3517	524	72.7	50.0	25.4	2586	4	1	0	4	19
Average	**18**	**3.05**	**2041**	**335**	**30.0**	**27.3**	**26.9**	**1568**	**4**	**5**	**6**	**68**	**278**

As shown in Table 36, the flow of this discharge is intermittent, with high levels of acidity and metals. Because of the location and origin of this discharge, reclamation is the primary recommendation. A phased approach that has the potential to impact several discharges in the area is discussed in detail in Section X.A above.

Even after reclamation, treatment of this discharge may be necessary. The discharge should be sampled for flow rate and chemistry after each phase of reclamation to determine the necessity of future phases of reclamation and/or treatment.

C. Stations 38D and 39D

Stations 38D and 39D originate just upstream of Sandy Run Road along Sandy Run (See Map 3). Photo 5 shows the kill zone where these discharges originate. The flow rate from each discharge was measured using the timed volume method. The following tables show the flow, chemistry, and loading from these discharges.

Table 37: Station 38D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	8	3.28	1478	236	3.4	19.7	26.9	977	3	0	3	23	97
09/23/04	22	3.30	1342	200	2.7	18.4	24.3	751	2	1	6	53	198
10/18/04	9	3.32	1695	335	4.5	30.8	34.8	1237	5	0	4	37	137
12/15/04	31	3.33	1427	240	3.5	23.1	30.0	1008	5	1	11	89	375
01/10/05	112	3.50	1120	171	3.1	15.7	20.7	662	6	4	28	229	889
02/11/05	35	3.35	1420	226	5.3	22.1	35.0	1072	6	2	15	95	450
03/18/05	20	3.46	1595	319	6.8	29.1	42.9	1110	8	2	10	77	266
04/21/05	2	3.29	1691	246	6.7	30.3	38.0	907	15	0	1	4	16
05/26/05	0									0	0	0	0
06/21/05	0									0	0	0	0
Average	**24**	**3.35**	**1471**	**247**	**4.5**	**23.6**	**31.6**	**965**	**6**	**1**	**8**	**61**	**243**

Table 38: Station 39D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	26	3.64	923	192	1.3	13.5	23.4	655	2	0	7	60	204
09/23/04	31	3.69	786	137	0.8	11.6	20.2	492	1	0	8	51	183
10/18/04	16	3.74	1036	237	1.0	17.2	30.8	750	5	0	6	45	144
12/15/04	39	3.81	835	183	0.5	14.1	29.2	535	6	0	14	86	250
01/10/05	80	3.90	650	127	0.4	10.0	16.9	405	7	0	16	122	388
02/11/05	53	3.88	869	200	0.6	13.3	29.1	574	4	0	18	126	361
03/18/05	26	3.82	1093	267	0.8	18.5	42.7	735	11	0	13	84	232
04/21/05	15	3.76	1053	206	0.7	18.6	37.5	1172	4	0	7	37	211
05/24/05	12	3.65	1338	302	2.3	27.2	39.6	770	1	0	6	44	111
06/22/05		3.49	1524	384	3.1	30.8	49.7	1044	3				
07/18/05	1	3.26	1786	379	7.3	37.2	60.9	1048	1	0	1	3	9
Average	**30**	**3.69**	**1081**	**238**	**1.7**	**19.3**	**34.5**	**744**	**4**	**0**	**10**	**66**	**209**

These discharges display highly variable flow rates, with moderate to high levels of acidity and metals. Little room is available for treatment. Because of the location and origin of these discharges, reclamation is the primary recommendation. A phased approach that has the potential to impact several discharges in the area is discussed in detail in Section X.A above.

Even after reclamation, treatment of these discharges may be necessary. The discharges should be sampled for flow rate and chemistry after each phase of reclamation to determine the necessity of future phases of reclamation and/or treatment.

D. Beauty Run - Stations 91D and 92D

Stations 91D and 92D originate within 100 feet of each other on the western side of Beauty Run, a tributary of Sandy Run (See Map 3). Because they share a common location and a common approach, they are being discussed together. The following tables present the flow, chemistry, and loading from the discharges.

Table 39: Station 91D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	3	3.32	1160	220	2.3	15.9	30.9	727	1	0	1	8	26
09/23/04	3	3.31	915	163	1.7	11.2	16.5	487	1	0	1	6	19
10/21/04	5	3.33	1235	235	5.4	18.4	29.4	850	6	0	2	14	51
04/21/05	0									0	0	0	0
05/26/05	0									0	0	0	0
06/23/05	0.9	3.27	1644	440	11.0	30.7	59.4	1817	6	0	1	5	19
07/21/05	0									0	0	0	0
Average	**2**	**3.31**	**1239**	**265**	**5.1**	**19.1**	**34.0**	**970**	**4**	**0**	**1**	**5**	**16**

Table 40: Station 92D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	0								0	0	0	0	0
09/23/04	3	3.63	775	155	6.9	15.7	14.4	481	1	0	1	6	18
10/21/04	3	3.82	709	133	5.1	15.5	13.4	455	1	0	0	5	16
04/21/05	0									0	0	0	0
05/26/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**1**	**3.73**	**742**	**144**	**6.0**	**15.6**	**13.9**	**468**	**1**	**0**	**0**	**2**	**5**

Both of these discharges are intermittent with moderate to high levels of acidity and metals. Because of the location and origin of these discharges, reclamation is the primary recommendation. A phased approach that has the potential to impact several discharges in the area is discussed in detail in Section X.A above. While the loading of these discharges alone would not be enough to justify such extensive reclamation, many discharges are thought to be caused by the spoil areas.

The discharges should be sampled for flow rate and chemistry after each phase of reclamation to determine the effectiveness of the reclamation project.

E. *Beauty Run - Station 93D*

Station 93D represents the first flow of pollution into Beauty Run (See Map 3). It is located along the western side of Beauty Run approximately 1,300 feet from its confluence with Sandy Run. The flow was measured using the timed volume method. The following table shows the flow, chemistry, and loading from the discharge.

Table 41: Station 93D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	0								0	0	0	0	0
09/23/04	5	3.70	835	257	0.3	12.0	37.1	581	1	0	2	15	35
10/21/04	3	3.92	865	228	0.3	14.5	30.5	665	4	0	1	8	24
04/21/05	0									0	0	0	0
05/26/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**1**	**3.81**	**850**	**242**	**0.3**	**13.3**	**33.8**	**623**	**2**	**0**	**0**	**3**	**8**

The flow of this discharge is intermittent, with high levels of acidity and metals. Because of the location and origin of this discharge, reclamation is the primary recommendation. A phased approach that has the potential to impact several discharges in the area is discussed in detail in Section X.A above. While the loading from this discharge would not be enough to justify such a large reclamation project, the spoil areas are thought to be affecting several other discharges in the area.

The discharge should be sampled for flow rate and chemistry after each phase of reclamation to determine the effectiveness of the reclamation project.

F. Tributary M – Stations 35D and 36D

Stations 32D and 33D flow from unreclaimed spoil near the headwaters of the left fork of Tributary M (See Map 3). The flow rates were measured using the timed volume method. The following tables show the flow, chemistry, and loading from the discharges.

Table 42: Station 35D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	44	3.44	475	101	2.3	3.7	10.2	223	1	1	5	54	118
09/23/04	108	3.67	380	106	0.6	2.2	13.2	171	1	1	17	137	221
04/21/05	0									0	0	0	0
05/24/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**30**	**3.56**	**428**	**103**	**1.4**	**2.9**	**11.7**	**197**	**1**	**0**	**5**	**38**	**68**

Table 43: Station 36D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	1	3.83	420	44	0.1	3.8	5.9	183	1	0	0	1	2
09/23/04	4	3.99	403	41	0.3	3.7	4.7	174	1	0	0	2	7

Station 36D was only sampled twice. This early sampling indicated low loading levels from this discharge, so sampling was discontinued. Station 35D is intermittent, with wide variation of flow based on seasonal precipitation. Although these were the only two point sources to Tributary M that were located and sampled, there are likely other sources, such as baseflow or diffuse seepage. This is evidenced in Figures 3 and 4, which indicate significant increase in pollution of Sandy Run between Beauty Run and Tributary N, where Tributary M enters.

Because of the intermittent nature of these discharges and because open spoils are likely contributing additional pollution, reclamation in this area is the recommended approach. However, this project is prioritized as “medium” because the anticipated cost/effectiveness of the project is lower than other projects since such large areas of open spoil are present throughout the Tributary M watershed (See Map 3). These spoils may also be affecting Contrary Run, Tributary N, and the main stem of Sandy Run.

However, if reclamation is pursued in this area, approximately 20 acres immediately adjacent to 35D and 36D should be targeted first. The cost of this project is anticipated at about $190,000.

G. Tributary N - Station 27D

Station 27D discharges to Tributary N, and may be related to an abandoned deep mine in the area (See Map 3). The flow rate was measured using the timed volume method. The following table shows the flow, chemistry, and loading of the discharge.

Table 44: Station 27D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	40	3.07	2557	320	6.4	42.1	31.8	1750	3	3	15	154	840
09/23/04	35	3.12	2103	223	3.9	34.5	20.9	1101	1	2	9	94	462
10/21/04	70	3.23	2233	223	3.3	38.1	22.8	2004	1	3	19	187	1,683
12/17/04	60	3.20	2368	249	4.4	40.1	29.7	1978	10	3	21	179	1,424
03/18/05	41	3.20	2480	285	5.1	43.4	34.2	1646	14	2	17	140	810
04/21/05	45	3.14	2489	254	5.4	43.1	32.4	2349	2	3	17	137	1,268
05/25/05	25	3.12	2693	296	12.1	53.1	28.7	2085	4	4	9	89	626
06/22/05	13	3.13	2717	376	7.9	47.4	37.0	1773	4	1	6	60	285
07/18/05	9	3.07	2898	362	10.3	56.5	40.1	1973	1	1	4	39	213
Average	**38**	**3.14**	**2504**	**287**	**6.5**	**44.2**	**30.8**	**1851**	**4**	**2**	**13**	**120**	**846**

The chemistry of this discharge shows some correlation with flow rate, with higher conductivity, metals, and sulfate at lower flow rates. This indicates that dilution may be occurring within the mine pool. The chemistry of the discharge is not amenable to the most reliable types of passive treatment.

Reclamation may be successful in reducing the flow rate, the variability of the flow rate, and/or the severity of the pollution. The first step of this project should be to determine if the discharge is flowing from a deep mine. If mine maps are available, they should be examined to determine the area, depth, orientation, coal seam, and other information about the deep mine. Investigation of this discharge should also include investigation of Station 29D (see next section).

This project is given a priority of “low” because of the high cost and uncertainty involved in reclaiming wide areas of open spoil that are not immediately adjacent to this discharge.

H. Tributary N - Station 29D

Station 29D is presumed to be a deep mine opening that flows to Tributary N of Sandy Run (See Map 3). It is the largest source of loading to Tributary N and the second largest source of loading to Sandy Run. The flow rate was measured using the timed volume method. The following table shows the flow, chemistry, and loading of the discharge.

Table 45: Station 29D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	115	2.97	2550	398	33.7	47.1	24.2	1750	5	46	33	549	2,414
09/23/04	150	3.06	2220	337	23.6	39.0	30.7	972	2	42	55	606	1,750
10/21/04	225	3.32	1594	203	19.5	29.2	15.4	1074	7	53	42	548	2,900
12/17/04	130	3.24	2509	387	50.6	52.4	29.6	2238	8	79	46	604	3,491
03/18/05	150	3.20	2375	390	45.7	51.6	28.7	1882	24	82	52	702	3,387
04/21/05	125	3.01	2722	347	33.9	56.0	30.9	2773	7	51	46	520	4,159
05/25/05	75	2.93	2976	402	21.5	65.3	23.3	2112	6	19	21	362	1,901
06/22/05	60	2.82	3234	583	39.2	62.3	28.3	2795	6	28	20	420	2,013
07/18/05	38	2.68	3740	490	47.2	73.5	29.7	2790	2	22	14	223	1,272
Average	**119**	**3.03**	**2658**	**393**	**56.5**	**52.9**	**26.8**	**2043**	**7**	**47**	**37**	**504**	**2,587**

The chemistry of this discharge shows some correlation with flow rate, with higher conductivity, metals, and sulfate at lower flow rates. This indicates that dilution may be occurring within the mine pool. The chemistry of the discharge is not amenable to the most reliable types of passive treatment. However, this discharge has improved since the Scarlift study was performed in 1970. At that time, the flow rate was near 2,000 gpm. Reclamation on the eastern side of Tributary N may have resulted in the dramatic reduction in flow rate. Continued reclamation on the western side of Tributary N may result in further improvements in flow rate and/or chemistry.

Reclamation may be successful in reducing the flow rate, the variability of the flow rate, and/or the severity of the pollution. The first step of this project should be to determine if the discharge is flowing from a deep mine. If mine maps are available, they should be examined to determine the area, depth, orientation, coal seam, and other information about the deep mine. Investigation of this discharge should also include investigation of Station 27D (see section above).

This project is given a priority of “low” because of the high cost and uncertainty involved in reclaiming wide areas of open spoil that are not immediately adjacent to this discharge.

I. Tributary N - Stations 31D and 32D

Stations 31D and 32D are toe-of-spoil discharges that form the headwaters of Tributary N (See Map 3). The flow rates were measured using the timed volume method. The following tables show the flow, chemistry, and loading from the discharges.

Table 46: Station 31D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/11/04	4	3.50	706	128	0.3	6.0	15.5	333	5	0	1	6	14
09/23/04	36	3.38	890	166	0.4	8.7	23.5	548	1	0	10	72	237
10/21/04	13	3.46	615	90	0.2	5.4	11.3	332	3	0	2	14	50
04/21/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**9**	**3.45**	**737**	**128**	**0.3**	**6.7**	**16.8**	**404**	**3**	**0**	**2**	**15**	**50**

Table 47: Station 32D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/11/04	39	3.87	301	23	0.3	0.7	2.2	120	4	0	1	11	56
09/23/04		4.05	250	13	0.4	0.4	1.1	110	2				
10/21/04	60	4.04	249	16	0.4	0.6	1.1	107	3	0	1	11	77
04/21/05	20	3.89	367	22	0.1	0.9	1.5	164	5	0	0	5	39
05/25/05	2	3.84	374	27	1.1	1.2	1.8	143	3	0	0	0	3
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**20**	**3.94**	**308**	**20**	**0.5**	**0.8**	**1.5**	**129**	**3**	**0**	**0**	**5**	**29**

Both of the discharges are intermittent with low to moderate levels of acidity and metals. Because of the intermittent flow, passive treatment is not recommended because the treatment system would provide no benefit for several months of the year.

However, these discharges originate from spoil areas that cover well over 100 acres (See Map 3). Therefore, reclamation of this area is given a low priority because of the low cost-effectiveness.

J. Tributary O – Station 42D

Station 42D discharges from a presumed deep mine opening on the western side of Tributary O (See Map 3). The flow of the discharge was measured using the timed volume method. The following table shows the flow, chemistry, and loading from the discharge.

Table 48: Station 42D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	1	3.35	983	168	5.3	11.5	20.0	500	1	0	0	2	6
09/23/04	8	3.49	829	166	2.0	8.8	23.8	512	1	0	2	15	46
10/25/04	2	3.49	908	162	4.5	12.0	21.1	350	2	0	1	4	8
12/15/04	7	3.68	753	156	1.5	9.9	22.0	466	5	0	2	12	36
04/21/05	2	3.55	1005	160	2.3	14.6	23.3	849	10	0	1	4	20
05/25/05	1	3.41	1068	191	9.4	18.7	19.2	592	1	0	0	2	7
06/21/05	0									0	0	0	0
07/18/05	0.25	3.02	1437	194	4.6	18.3	19.0	626	1	0	0	1	2
Average	**3**	**3.43**	**998**	**171**	**4.2**	**13.4**	**21.2**	**556**	**3**	**0**	**1**	**5**	**16**

The flow of this discharge is intermittent, with moderate levels of acidity and metals. Because of the location and origin of this discharge, reclamation is the primary recommendation. A phased approach that has the potential to impact several discharges in the area is discussed in detail in Section X.A above. While the loading from this discharge would not be enough to justify such a large reclamation project, the spoil areas are thought to be affecting several other discharges in the area.

The discharge should be sampled for flow rate and chemistry after each phase of reclamation to determine the effectiveness of the reclamation project.

K. Tributary O – Stations 41D, 45D, and 43D.

These stations originate near each other and have a common source and recommendation (See Map 3). Therefore, they will be discussed together. Station 41D measures water that is collected in the Tributary O access road. Station 45D is also a collected flow that crosses this road. Station 43D flows to Tributary O from a presumed deep mine drift on the eastern side of the stream. The flows were measured using the timed volume method at each site. The following tables show the flow, chemistry, and loading from the discharges.

Table 49: Station 41D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	24	3.37	590	159	0.6	2.2	25.0	292	2	0	7	46	84
09/23/04	96	3.50	394	89	0.3	1.6	12.4	170	1	0	14	102	196
10/25/04	15	3.46	578	169	0.7	2.6	25.7	244	4	0	5	30	44
12/15/04	75	3.44	494	133	0.4	2.4	20.8	224	16	0	19	120	202
02/11/05	12	3.85	332	90	0.3	2.4	13.9	192	2	0	2	13	28
03/18/05	11	3.49	523	174	0.5	3.2	25.2	287	9	0	3	24	39
04/21/05	14	3.51	589	182	0.3	4.1	31.1	617	5	0	5	31	104
05/25/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/18/05	0									0	0	0	0
Average	**25**	**3.52**	**500**	**142**	**0.4**	**2.6**	**22.0**	**289**	**6**	**0**	**6**	**37**	**70**

Table 50: Station 45D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	5	3.42	553	179	0.9	2.3	23.8	261	1	0	1	11	16
09/23/04	9	3.37	571	184	0.4	2.1	29.1	284	1	0	3	19	29
10/25/04	15	3.50	524	170	0.4	2.4	26.9	269	2	0	5	31	48
12/15/04	40	3.49	492	156	0.3	2.6	22.5	191	3	0	11	75	92
04/21/05	12	3.65	368	92	0.1	2.7	15.0	352	5	0	2	13	51
05/25/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**10**	**3.49**	**502**	**156**	**0.4**	**2.4**	**23.5**	**271**	**2**	**0**	**3**	**19**	**29**

Table 51: Station 43D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	41	3.23	872	275	1.7	3.8	36.9	471	1	1	18	135	232
09/23/04	107	3.29	700	191	0.9	3.2	30.3	351	1	1	39	246	451
10/25/04	39	3.28	827	259	1.3	5.2	37.4	460	4	1	18	121	215
12/15/04		3.34	697	208	0.7	5.1	30.8	363	2				
04/21/05	28	3.34	760	220	0.8	6.7	36.2	783	3	0	12	74	263
05/25/05	8	3.37	773	230	2.7	8.4	25.3	559	3	0	2	21	50
06/22/05	2	3.40	823	245	6.4	10.0	32.3	517	4	0	1	7	14
07/18/05	1	3.20	1052	161	7.4	13.2	19.6	512	1	0	0	1	4
Average	**32**	**3.31**	**813**	**224**	**2.7**	**6.9**	**31.1**	**502**	**2**	**0**	**13**	**86**	**176**

These discharges are highly variable in flow rate, with moderate levels of acidity and aluminum and low levels of iron. They appear to be caused by two small, isolated surface mines, one of 13 acres and one of 8 acres. Reclamation is the recommended approach for these three discharges. Although the discharges supply significant loading during high flow times, their intermittent nature makes them poorly suited for treatment.

Reclaiming these 21 acres would cost approximately $200,000. However, this reclamation job is rated as a low priority because the discharges do not flow directly off the toe of spoil, and therefore are less likely to be greatly impacted by reclamation.

L. Tributary O – Station 44D

Station 44D represents the headwaters of the right fork of Tributary O (See Map 3). The flow was measured using the timed volume method. The following table shows the flow, chemistry, and loading from the discharge.

Table 52: Station 44D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/09/04	8	2.81	1472	496	7.9	4.9	56.4	579	1	1	5	48	56
09/23/04	16	2.77	1515	536	12.1	4.9	72.8	647	1	2	14	104	126
10/25/04	22	3.20	880	335	1.3	3.2	51.7	430	4	0	14	88	113
12/15/04	60	2.99	1103	430	4.6	6.3	61.0	565	2	3	44	309	406
04/21/05	0									0	0	0	0
05/25/05	0									0	0	0	0
06/21/05	0									0	0	0	0
07/21/05	0									0	0	0	0
Average	**13**	**2.94**	**1243**	**449**	**6.5**	**4.8**	**60.5**	**555**	**2**	**1**	**10**	**69**	**88**

Station 44D is intermittent in nature, with high levels of acidity and aluminum, and low levels of iron. The source of this discharge is a large surface mine which completely rings the ridge between Tributary O and Little Wolf Run (See Map 3). Reclamation of the 24 acres of open spoil adjacent to this discharge is the recommended approach for this discharge. Treatment is not recommended because of the intermittent nature of this discharge and because of the extreme chemistry.

This project would likely cost approximately $230,000. Unlike the other discharges on Tributary O, Station 44D flows more directly from the toe of the spoil, making the success of reclamation more likely. Therefore, this project has been given a priority of medium.

M. Tributary P - Station 105D

Station 105D measures a series of discharges that form the headwaters of Tributary P to Sandy Run. Several small pools collected near an abandoned highwall discharge in a small channel. Photo 6 shows the final discharge pool. Photo 7 shows another pit in the area. The velocity meter was used to measure the flow. The following table shows the flow rate, chemistry, and loadings from this discharge.

Table 53: Station 105D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/11/04	493	3.06	1942	450	14.2	25.4	51.0	1112	8	84	302	2,661	6,579
09/23/04	1,873	3.06	1574	359	10.7	18.1	39.3	815	1	240	883	8,078	18,325
10/18/04	376	3.11	1880	453	15.0	30.2	49.1	1253	10	68	221	2,042	5,654
12/17/04		3.13	1972	430	16.1	28.8	59.4	1538	7				
04/21/05	485	3.10	1746	347	17.5	27.0	51.1	1504	6	102	298	2,021	8,753
05/25/05		3.11	1930	416	9.2	32.6	41.6	1229	1				
06/22/05	300	3.14	1937	456	15.0	31.7	57.7	1542	4	54	208	1,641	5,550
07/18/05		3.03	2281	496	23.2	39.2	64.3	1496	10				
Average	**705**	**3.09**	**1908**	**426**	**15.1**	**29.1**	**51.7**	**1311**	**6**	**109**	**382**	**3,289**	**8,972**

This discharge is the largest single source of mine drainage that was sampled in the entire Beech Creek Watershed. The next highest loading contributor (Station 29 on Tributary N) contributes an average of about 500 ppd acidity to the watershed. Station 105D contributes as much acidity and aluminum loading to the watershed as all other sampled discharges combined (including Stations 3 and 81 in North Fork). For the five sampling events where flow rates were available at this station, it supplied an average of 19% of the acidity and 9% of the sulfate loading present in Beech Creek at Monument.

The high flow rate and severe chemistry of this discharge make reliable passive treatment very difficult. For instance, assuming 35 g/m^2/day of acidity removal by vertical flow ponds, an average flow rate of 700 gallons per minute, and a discharge with 100 mg/L net acidity, 14 acres of vertical flow ponds would be required (not including berms, water distribution areas, settling ponds, flush ponds, wetlands, or other treatment cells). The largest vertical flow pond complex in Pennsylvania, located near the town of Morris in Tioga County, is less than half of this size and cost over $2 million to build in 2003/2004. Additionally, vertical flow ponds have been known to rapidly fail when aluminum levels are high.

Self-flushing limestone technology may be able to provide treatment for water of this type, but this treatment has not been proven. Studies are currently underway that should indicate if this type of treatment will work on this type of water. However, even if this type of treatment shows promise, it would likely cost at least $3-4 million to design and construct.

A two-phase approach is recommended for this discharge. Intensive reclamation of approximately 27 acres near 105D is recommended as the first step (See Map 8). While the flow rate of this discharge indicates a perennial source (such as ground water or a deep mine), surface reclamation with alkaline addition could intercept groundwater flow paths and lessen the severity of the discharge, making the eventual treatment method more reliable and/or less expensive. This reclamation would involve removing several abandoned highwalls, which are less than 40’ in height. The pools that have formed at the bases of the highwalls would be removed.

Based on 27 acres of reclamation, the following costs have been developed for this project. These costs include the additional permitting and mitigation that will likely be necessary to work in the wetlands and pools that have formed against the highwalls. These pools form the headwaters of Tributary P, so a Joint Encroachment Permit is anticipated.

Table 54: Tributary P Reclamation Costs

Item	**Cost Estimate**
Reclamation of 27 acres ($6,500/acre)	$175,500
Access Improvements	$10,000
Highwall Removal	$40,000
Stream Channel Reconstruction	$60,000
Mob/Demob, E&S	$15,000
Construction Total	**$300,500**
Mapping/Design/Engineering/Permitting	$50,000
TOTAL	**$350,500**

After reclamation is completed, Station 105D should be monitored to assess any changes in flow and/or chemistry that may result from reclamation. It is not likely that 100% of the pollution will be mitigated, and treatment of some type will likely still be necessary. Even after reclamation, chemical treatment may be necessary for this discharge.

XI. South Fork: Discharge-Specific Treatment Recommendations

The South Fork of Beech Creek has been more widely studied than any other part of the watershed (See Map 6). The two polluted tributaries, Jonathan Run and Butts Run (Tributary K), have each been subjected to their own studies (Hedin, 2003 and Bucek, 2004, respectively). For more details on the South Fork, refer to these reports. For more discussion on the South Fork, see Section IV.D of this report, which discusses the South Fork snapshot.

A. Jonathan Run

The pollution to Jonathan Run was caused by the construction of Interstate-80 through the stream valley. The Pennsylvania Department of Transportation (PennDOT) has been cooperating with the BCWA and DEP since 1999, when DEP funded a Growing Greener grant to study the watershed (Hedin, 2003). In 2005, PennDOT funded a final study/design grant in order to move towards a solution to this problem. As of the writing of this report, PennDOT plans to have a final solution in place by 2007.

The BCWA should monitor PennDOT's progress to ensure that a suitable resolution is reached. After the final mitigation and/or treatment recommendations have been implemented, BCWA, PennDOT, or DEP should continue to monitor station JRU09, which is located downstream of the sources of pollution (adjacent to the Snowshoe Summit Lodge lake). Monitoring at this station will allow a comparison with historical data contained in the Hedin report (2003) and will determine if more measures are necessary to recover the stream.

B. Tributary K (Butts Run)

According to the Bucek report (2004), Butts Run is clean above a point called BT06, which is a developed spring (See Map 6). This point represents the mouth of the north fork of Butts Run, called “Unnamed Trib A” in the report. The pollution comes from BT06 and from BT07, which represents the mouth of the south fork of Butts Run, called “Unnamed Trib B” in the report.

The majority of the pollution present in Butts Run is coming from point BT06. On four dates, the Bucek report contains flow and chemistry data for both BT06 and for the mouth of Butts Run (BT01). Between 50 and 100% of the acidity, aluminum, and sulfate loading present at the mouth is originating from this spring. Both the flow and the loading from BT07 are much less than BT06. Therefore, addressing BT06 should be a top priority for this subwatershed. Table 55 shows data for BT06 taken from the Bucek report.

Table 55: Butts Run Spring Flow, Chemistry, and Loading, from Bucek 2004

Date Sampled	Flow (gpm)	Field pH	Cond.	Net Acid	Iron (mg/l)	Mn (mg/l)	Al (mg/l)	SO4 (mg/l)	TSS (mg/l)	Acid (ppd)	Al (ppd)
05/03/99	100	<4.5		126	0.2	4.8	16.4	188	<2	151	20
08/03/00	50	4.5	705	88	0.1	3.6	11.9	162	<2	53	7
09/09/00	30	4.5	748	128	0.1	5.4	18.9	225	<2	46	7
09/20/00	25	4.0	778	134	0.3	6.6	19.7	152	<2	40	6
10/09/00	48		779	118	0.2	5.9	18.8	227	12	68	11
11/21/00	48		770	132	0.2	5.2	18.5	197	4	76	11
12/21/00	120		689	94	0.1	3.8	13.4	106	20	135	19
04/13/01	200	4.0	697	106	0.1	3.7	15.5	156	<2	254	37
05/25/01	113	4.5	659	86	0.1	3.4	11.1	139	<2	117	15
09/27/01	58	3.5	822	106	0.1	3.8	12.6	154	0.3	74	9
12/21/01	165	3.2	610	104	0.1	3.5		125	1.7	206	
02/22/02	147	3.7	734	120	0.1	4.0		157	1.7	212	
04/02/02	274	4.1	713	134	0.1	4.9		182	0.3	441	
05/25/02	224	3.7	669	102	0.1	4.1		184	1.0	274	
06/30/02	68	4.3	547	88	0.1	3.2		134	1.0	72	
07/29/02	26	3.8	594	102	0.1	3.9		127	0.3	32	
08/27/02	7	3.9	699	110	0.2	4.8		193	0.3	9	
09/30/02	48	3.6	708	100	0.1	4.4	13.2	176	2.3	58	8
10/30/2002	60	4.0	825	120	0.1	4.8	15.5	192	2.3	86	11
3/12/2004		4.4	632	80	<0.05	3.2	10.6	153	<5.7		
3/26/2004		5.3	568	66	0.1	3.1	9.3	122	<5.7		
4/9/2004		4.4	631	62	<0.05	2.6	8.5	126	<5.7		
5/24/2004		4.4	463	53	<0.05	2.2	6.6	99	<5.7		
Average	**95**	**4.1**	**684**	**103**	**0.1**	**4.1**	**13.8**	**160**	**3.6**	**126**	**13**

As shown in Table 55, the flow of this discharge varies widely, while the chemistry is relatively stable. The 10th percentile flow rate (26 gpm) is nearly an order of magnitude lower than the 90th percentile flow rate (205 gpm). The chemistry of this discharge is suitable for passive treatment. The most challenging aspect of treating BT06 will be finding an area suitable for treatment system construction.

Based on USGS mapping, it appears possible to capture BT06 in a pipe and transfer it to a flat bench area along Butts Run, approximately 1,000 feet from the discharge. The discharge could be treated on this bench and then discharged back into Butts Run, so that treated water could neutralize untreated discharges flowing to Butts Run.

Because the discharge is low in iron but contains acidity and aluminum, self-flushing limestone cells are recommended. While this treatment technology has not been proven over the long term, it is currently being studied and presents a good chance of success for this type of water. As an alternative to self-flushing, a vertical flow pond (VFP) could be used. Compost would not be necessary because the discharge contains very low iron. However, the widely variable flow rates demonstrated by this discharge could cause problems for VFPs. Based on 35 g/m2/day and assuming the 80th percentile loading is to be treated (208 ppd acidity), approximately 29,000 square feet of VFP would be required. Additional cells, such as a flush pond, settling pond, and polishing wetland, would add to the system size for a total treatment area of 1.5 – 2 acres.

Assuming that the self-flushing system is selected as the best alternative, the discharge should be captured and piped to the treatment area. Four limestone cells with 300 tons of limestone each will provide the average flow rate with 12 hours between flush cycles (six hours of average retention). Each limestone cell should be equipped with a siphon unit. The siphons should have a discharge rate of 3,000 gpm or higher. A flow splitter box will be required to evenly divide the flow to each limestone cell and to allow for extremely high flows to overflow directly to the settling pond.

The limestone cells should flush into a common settling pond, which will retain a total of 4 flush cycles from each limestone cell. The settling pond should be divided into several ‘compartments’ in order to reduce the effect of the pulsed inputs and to deter short circuiting. This can be accomplished using internal berms. The settling pond should discharge back into Butts Run.

Assuming that the limestone cells are six feet deep, approximately 8,000 square feet will be required. This area assumes that the limestone cells share common central berms. Assuming that the pond is 5’ deep, approximately 10,000 square feet will be required (including berms). When site access, splitter box area, and channels are included, the project will likely affect approximately 1 acre. Several parcel owners in this area will likely be involved. Contacting the affected landowners and assessing their willingness to cooperate with the project should be among the first steps taken.

Table 56: Tributary K Treatment System Cost Estimate

Item	**Cost Estimate**
Water Collection and Piping	$20,000
AASHTO#1 LS (1200 tons, installed)	$36,000
Flow Splitter Box, Installed	$6,000
Siphons and Siphon Tanks (4)	$40,000
Excavation and Labor	$100,000
Plumbing	$8,000
Mob/Demob, E&S, Reveg, etc.	$12,000
Construction Total	**$222,000**
Mapping/Design/Engineering/Permitting	$48,000
TOTAL	**$270,000**

The cost of this project is estimated at $270,000, of which $222,000 is for materials and construction and $48,000 is for mapping, design, engineering, and permitting. These costs assume that the bench area can be excavated in order to install the limestone cells. If shallow bedrock limits excavation, an additional $60,000 will likely be required in order to construct above-grade limestone tanks for the limestone.

This project will affect 0.5 miles of Butts Run and 1.3 miles of South Fork between Butts Run and Jonathan Run. Additionally, South Fork downstream of Jonathan Run will be improved and protected. Treatment of BT06 may be sufficient to restore and protect the South Fork and improve Butts Run to an acceptable level. If a treatment system is constructed, post-construction water quality data in Butts Run and in the South Fork should be conducted to determine if treatment of the other Butts Run discharges (such as BT07) is necessary.

Another alternative for this discharge is to further explore its source to determine if mitigation is possible to reduce the flow or pollution from the discharge. Three potential sources of impairment of BT06 exist and were identified in the Bucek report. The sandstone borrow area directly upslope of the spring would seem to be a likely suspect, however analysis by Bucek of rock from the borrow area revealed very low sulfur concentrations (>0.04%). Therefore, it is unlikely that the sandstone borrow area is generating any significant amount of acidity.

With the sandstone borrow area at least marginalized as a source of impairment, only two probable sources remain; the Carlin Tipple and Interstate 80. The close proximity of these two features to one another combined with the fact that access to the privately owned tipple site is unlikely makes determining if either the Carlin Tipple or Interstate 80 or both are contributing to the impairment of BT-06 a challenge. The Carlin Tipple is bound to the south and north by the right-of-ways of I-80 and S.R. 144 respectively. Since impaired water from I-80 or the Carlin Tipple would have to flow south to north to reach the BT-06 Spring, it is likely that this plume of water could be detected through the performance of geophysical surveys and/or installation of monitoring wells along said right-of-ways. Similar work is currently underway in the Jonathan Run watershed just to the east of the site. Results of this work can be used to evaluate the likelihood of success for isolating the source of impairment to BT-06. In addition, the work in Jonathan Run can be used as a guide for designing the investigation as well as interpreting results. The results of the Jonathan Run study are expected to be completed by fall 2006.

XII. Big Run: Discharge-Specific Treatment Recommendations

Three discharges to the East Branch of Big Run were monitored as part of this study (See Map 4). No other distinct sources of AMD to the East Branch were found during reconnaissance. Several sources of mine drainage to the Middle Branch of Big Run were located, but access issues prevented sampling. BAMR is in the process of completing a treatment system to the largest discharge to the Middle Branch (See Section IV.E). This treatment system will impact 0.5 miles of unnamed tributary and 1.2 miles of the Middle Branch. This treatment system alone may be enough to restore the Middle Branch of Big Run. Monitoring of the Middle Branch downstream of the treatment system should be conducted in order to determine if more treatment in the Middle Branch is needed.

Two treatment systems, discussed below, would greatly improved and protect the East Branch of Big Run. Upstream of the mine drainage, the stream is poorly buffered, and thus vulnerable to any acidic inputs. Bringing these discharges under treatment will improve and protect 4.8 miles of the East Branch and 1.3 miles of unnamed tributary.

If both the Middle Branch and East Branch are improved and protected, 3.9 miles of Big Run downstream of the Middle Branch/East Branch confluence will also be improved and protected. Thus, a total of 11.7 miles of streams can be affected by three projects in Big Run (BAMR system, 18D, and 21D/22D).

A. 18D

Station 18D measured the discharge from an existing pond (See Map 4). Photo 8 shows the origin of the discharge. The pond collects drainage from an old cut. The flow rate was measured using the timed volume method from the pond discharge pipe. The pond flows to an unnamed tributary of the East Branch of Big Run. The tributary flows approximately 0.7 miles to the East Branch of Big Run, which then flows another 1.6 miles to its confluence with the Middle Branch of Big Run. This sampling point was the only distinct source of AMD to this unnamed tributary. The unnamed tributary has a significant impact on the East Branch of Big Run. Cleaning up this discharge will impact 2.3 miles of stream. The following table shows the flow, chemistry and loading of this discharge during the study period.

Table 57: Station 18D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	66	4.33	435	53	0.4	4.8	5.9	232	4	0	5	42	184
09/22/04	206	3.96	490	56	0.6	5.6	6.7	245	2	1	17	138	606
10/21/04	14	4.53	433	48	0.3	5.5	5.5	277	4	0	1	8	47
04/20/05	14	4.38	462	51	0.1	6.5	8.3	326	5	0	1	9	55
05/25/05	1	4.56	435	27	0.3	0.0	3.0	202	1	0	0	0	2
06/23/05	0	4.84	422	14	0.2	5.4	0.7	196	4	0	0	0	1
07/19/05	0.25	6.21	405	3	0.8	4.0	0.0	165	1	0	0	0	0
Average	**43**	**4.69**	**440**	**36**	**0.4**	**4.5**	**4.3**	**235**	**3**	**0**	**3**	**28**	**128**

As shown in Table 57, the discharge flow varies widely on a seasonal basis, from 0 to in excess of 200 gpm. The reading on September 22nd likely represents a maximum flow for this discharge, as it was sampled just four days after Hurricane Ivan dropped over 5 inches of rain on the region.

The chemistry of the discharge also varied, with less severe chemistry at lower flows. This may indicate that contamination is occurring when ground water rises into the disturbed spoil and emerges on the surface.

The chemistry of this discharge is well-suited for passive treatment. The difficulty arises in sizing a treatment system to handle the wide variations in flow rate. Some types of passive treatment systems do not respond well to periodic dry periods, which can cause bacteria in compost to die, cause metals to harden on limestone, or introduce oxygen into areas that should be anoxic. Therefore, a simple aerobic wetland with alkaline substrate is recommended for this discharge. This type of treatment system should not be as susceptible to large variations in flow rate.

A 22,000 square foot wetland with 4” of water would provide the highest flow rate measured with 4.4 hours of retention. At the average flow rate, 21 hours of retention time would be provided.

The wetland substrate should be comprised of 2/3 compost and 1/3 fine limestone, such as #57. These items should be well-mixed then placed to a total depth of 6” in the bottom of the wetland. Wetland plants should then be planted in this media.

The site appears to have sufficient room available above the existing pond for this wetland. The wetland could be installed in the old cut above the access road where the seepage originates, and below the access road. The wetland would act as a collection and treatment facility.

The wetland should discharge to the existing pond. At this point, the water should be net neutral or net alkaline with very low metals. It is desirable to generate as much excess alkalinity as possible from this system in order to offset diffuse seepage that is also reaching the tributary and the East Branch. Therefore, the existing pond should be converted into an open limestone polishing bed. The pond should be drained, cleaned out, lined with fabric, and filled with limestone. Approximately 450 tons of AASHTO #1 limestone should be used. This will provide the highest measured flow with 2 hours of retention time. At the average flow rate, 10 hours of retention would be provided. The treatment system should discharge water with approximately 50 mg/L net alkalinity and all metals less than 1 mg/L.

Table 58: Station 18D System Cost Estimate

Item	**Cost Estimate**
22,000 sq.ft. wetland construction	$22,000
Compost (substrate, 280 CY)	$7,000
#57 LS (substrate, 190 tons)	$3,500
Wetland Plants, 2,500	$2,500
Clean out and prepare existing pond	$7,000
AASHTO#1 LS (polishing bed, 900 tons)	$18,000
Mob/Demob, E&S, Reveg, etc.	$8,000
Construction Total	**$68,000**
Mapping/Design/Engineering/Permitting	$20,000
TOTAL	**$88,000**

The total anticipated cost for a system of this type is $88,000. This includes mapping, design, engineering, and permitting. However, this cost assumes that no Joint Encroachment Permit would be required. Some savings are likely to result if this system is built in conjunction with the 21D/22D system, which is discussed below. A proposal to complete this project was submitted to the PA DEP Growing Greener program in March 2006.

B. 21D and 22D

Discharges 21D and 22D will be discussed together because their proximity will likely mean that a common treatment complex will be used for both discharges (See Map 4). Photo 9 shows the pit where the discharges originate. These two stations are located near the end of a series of several ponds that flow from a old cut area. Station 21D measured flow that was leaving the final pond. Station 22D measured water that was bypassing the ponds. Flow at both stations was measured using the timed volume method. Both of these discharges flow to the East Branch of Big Run via an unnamed tributary. The tributary enters the stream just south of the site access road. From this point to the next inflow of contamination (Station 18D Tributary), the East Branch flows approximately 3.2 miles. Therefore, 3.2 miles of East Branch and 0.6 miles of unnamed tributary would be greatly improved and protected by a project that treats 21D and 22D. The following tables show the flow, chemistry and loading of these discharges during the study period.

Table 59: Station 21D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	44	4.48	560	32	1.1	10.5	2.6	324	6	1	1	17	171
09/22/04	27	4.91	72	7	0.5	1.0	0.2	26	3	0	0	2	8
10/21/04	16	5.25	76	8	0.4	1.1	0.2	33	4	0	0	1	6
04/20/05	3	4.66	118	8	0.6	1.9	0.2	54	6	0	0	0	2
05/25/05	2	4.54	156	8	1.1	3.5	0.2	65	2	0	0	0	2
06/21/05	0									0	0	0	0
07/19/05	0									0	0	0	0
Average	**13**	**4.77**	**196**	**12**	**0.7**	**3.6**	**0.7**	**101**	**4**	**0**	**0**	**3**	**27**

Table 60: Station 22D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/06/04	41	5.14	65	5	0.8	1.0	0.3	25	8	0	0	2	12
09/22/04	87	4.46	582	36	3.9	12.2	3.8	296	3	4	4	37	309
10/21/04	29	4.61	560	32	0.2	11.8	2.5	365	5	0	1	11	127
04/20/05	24	4.56	567	22	0.0	14.0	2.3	356	1	0	1	6	104
05/25/05	5	4.47	603	18	0.2	14.7	1.7	296	1	0	0	1	18
06/21/05	0									0	0	0	0
07/19/05	0									0	0	0	0
Average	**27**	**4.65**	**475**	**23**	**1.0**	**10.7**	**2.1**	**268**	**4**	**1**	**1**	**8**	**82**

As shown in Tables 59 and 60, the flow rates of the discharges varied widely on a seasonal basis. The highest total flow was 114 gpm, with the average total being 40 gpm. Because of the proximity of the discharges, a single treatment system will be recommended for the total flow.

The discharges are mildly contaminated mine drainage and are well-suited for passive treatment. As with Station 18D, however, the difficulty arises in sizing a treatment system to handle the wide variations in flow rate. Some types of passive treatment systems do not respond well to periodic dry periods, which can cause bacteria in compost to die, cause metals to harden on limestone, or introduce oxygen into areas that should be anoxic. Therefore, a simple aerobic wetland with alkaline substrate is recommended for this discharge. This type of treatment system should not be as susceptible to large variations in flow rate.

A 11,000 square foot wetland with 4” of water would provide the highest flow rate measured with 4.0 hours of retention. At average flow, 11.4 hours of retention time would be provided.

The wetland substrate should be comprised of 2/3 compost and 1/3 fine limestone, such as #57. These items should be well-mixed then placed to a total depth of 6” in the bottom of the wetland. Wetland plants should then be planted in this media.

The existing ponds have sufficient area to construct the recommended wetland. However, it may be difficult to route the 22D discharge to this wetland because it originates lower in elevation than the current ponds. Therefore, it may be necessary to construct the wetlands in the area below the final discharge pond. Site mapping will be required to make this determination.

The wetland should discharge to an open limestone bed. At this point, the water should be net neutral or net alkaline with very low metals. It is desirable to generate as much excess alkalinity as possible from this system in order to offset diffuse seepage that is also reaching the East Branch. Approximately 300 tons of AASHTO #1 limestone should be used. This will provide the highest measured flow with 2.5 hours of retention time. At the average flow rate, 7.5 hours of retention would be provided.

It may be possible to construct this open limestone bed in the final existing pond, or it may be necessary to construct it in the area below the pond. Site mapping will be required to make this determination. The treatment system should discharge water with approximately 50 mg/L net alkalinity and all metals less than 1 mg/L.

Table 61: Station 21D/22D System Cost Estimate

Item	**Cost Estimate**
11,000 sq.ft. wetland construction	$11,000
Compost (substrate, 140 CY)	$3,500
#57 LS (substrate, 100 tons)	$1,800
Wetland Plants, 1,200	$1,200
Construct open limestone bed	$7,000
AASHTO#1 LS (polishing bed, 500 tons)	$10,000
Mob/Demob, E&S, Reveg, etc.	$7,000
Construction Total	**$41,500**
Mapping/Design/Engineering/Permitting	$20,000
TOTAL	**$61,500**

The total anticipated cost for a system of this type is $61,500. This includes mapping, design, engineering, and permitting. However, this cost assumes that no Joint Encroachment Permit would be required. Some savings are likely to result if this system is built in conjunction with the 18D system, which is discussed above. A proposal to complete this project was submitted to the PA DEP Growing Greener program in March 2006.

XIII. Other Discharges: Discharge-Specific Treatment Recommendations

A. Station 46D

Station 46D measures a discharge to the headwaters of Tributary R (See Map 5). This tributary enters Beech Creek between Sandy Run and Wolf Run. The discharge appears to be flowing from an old deep mine drift. Large piles of “red dog” material are present in and near the discharge channel. The flow rate was measured using a 6” H-flume installed in the discharge channel. The following table shows the flow, chemistry, and loading from the discharge.

Table 62: Station 46D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/10/04	80	3.69	662	197	0.2	5.4	27.4	408	1	0	26	189	392
09/23/04	150	3.69	667	197	0.2	5.7	33.0	420	1	0	59	355	756
10/25/04	85	3.75	506	133	0.2	3.9	19.9	295	3	0	20	136	301
12/15/04	145	3.81	482	135	0.1	4.8	23.6	209	1	0	41	235	364
02/11/05	140	3.88	347	91	0.1	3.4	11.3	185	5	0	19	152	311
03/18/05	40	3.41	372	93	0.1	3.6	14.5	205	9	0	7	45	99
04/20/05	60	3.81	500	124	0.1	5.6	22.9	394	4	0	17	89	284
05/24/05	21	3.82	381	87	0.3	3.9	11.3	148	1	0	3	22	37
06/21/05		3.82	397	91	0.2	3.9	12.2	178	1				
Average	**90**	**3.74**	**479**	**128**	**0.2**	**4.5**	**19.6**	**272**	**3**	**0**	**24**	**153**	**318**

This discharge has a perennial flow with moderate to high levels of acidity and aluminum and low levels of iron. Several types of passive treatment are being used to treat this type of water, although long-term success has not been proven. However, the biggest challenge in addressing this discharge will be to find sufficient area for treatment system construction. The most likely area for treatment is near the confluence of Tributary R with Beech Creek, approximately 1,500 feet from the discharge. However, even in this area, only about 1 acre of usable space is available.

Because the discharge is low in iron but contains acidity and aluminum, self-flushing limestone cells are recommended. While this treatment technology has not been proven over the long term, it is currently being studied and presents a good chance of success for this type of water. As an alternative to self-flushing, a vertical flow pond (VFP) could be used. Compost would not be necessary because the discharge contains very low iron. However, the widely variable flow rates demonstrated by this discharge could cause problems for VFPs. Based on 35 g/m2/day and assuming the 80th percentile loading is to be treated (217 ppd acidity), approximately 30,000 square feet of VFP would be required. Additional cells, such as a flush pond, settling pond, and polishing wetland, would add to the system size for a total treatment area of 1.5 – 2 acres.

Assuming that the self-flushing system is selected as the best alternative, it is recommended that studies and advances in this type of treatment be incorporated into the final design. The design presented below is based on current best practices. The discharge should be captured

The discharge should be captured and piped to the treatment area. Four limestone cells with 360 tons of limestone each will provide the average flow rate with 16 hours between flush cycles (eight hours of average retention). Each limestone cell should be equipped with a siphon unit. The siphons should have a discharge rate of 3,000 gpm or higher. A flow splitter box will be required to evenly divide the flow to each limestone cell and to allow for extremely high flows to overflow directly to the settling pond.

The limestone cells should flush into a common settling pond, which will retain a total of 4 flush cycles from each limestone cell. The settling pond should be divided into several ‘compartments’ in order to reduce the effect of the pulsed inputs and to deter short circuiting. This can be accomplished using internal berms. The settling pond should discharge back into Tributary R.

Assuming that the limestone cells are six feet deep, approximately 9,000 square feet will be required. This area assumes that the limestone cells share common central berms. Assuming that the pond is 5’ deep, approximately 12,000 square feet will be required (including berms). When site access, splitter box area, and channels are included, the project will likely affect approximately 1 acre.

Table 63: Station 46D Treatment System Cost Estimate

Item	**Cost Estimate**
Water Collection and Piping	$20,000
AASHTO#1 LS (1200 tons, installed)	$43,000
Flow Splitter Box, Installed	$6,000
Siphons and Siphon Tanks (4)	$40,000
Excavation and Labor	$100,000
Plumbing	$8,000
Mob/Demob, E&S, Reveg, etc.	$12,000
Construction Total	**$229,000**
Mapping/Design/Engineering/Permitting	$50,000
TOTAL	**$279,000**

The total anticipated cost of this project is $279,000, of which $50,000 is anticipated for mapping, design, engineering, and permitting. This project has been given a priority of “medium” because of the uncertainty involved with this type of treatment over the long term and because of the extremely limited area available for treatment. In addition, little or no actual stream-mile recovery will result from this project because the system will discharge to Beech Creek, which is heavily contaminated in this area. However, significant loading reduction would result.

B. Station 50D

Station 50D measures the headwaters of the right fork of Tributary L (See Map 5). Tributary L flows to Beech Creek approximately 1,900 feet upstream of the Sandy Run confluence. The flow rate of this station was measured using the timed volume method. The following table shows the flow, chemistry, and loading from the discharge.

Table 64: Station 50D Flow, Chemistry, and Loading

										LOADINGS			
Date	**Flow (gpm)**	**Lab pH**	**Cond (uS)**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**TSS**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**
08/10/04	20	3.68	854	216	2.2	10.1	31.2	554	1	1	7	52	133
09/23/04	50	3.74	870	243	0.9	10.8	40.9	621	1	1	25	146	372
10/25/04	25	3.85	740	195	1.1	9.4	29.1	479	3	0	9	58	144
04/20/05	20	3.92	801	202	0.5	11.7	39.7	121	5	0	10	48	29
05/25/05	0									0	0	0	0
06/23/05	1	3.69	745	206	2.8	10.7	28.7	529	3	0	0	2	6
07/21/05	0									0	0	0	0
Average	**17**	**3.78**	**802**	**212**	**1.5**	**10.5**	**33.9**	**461**	**3**	**0**	**7**	**44**	**98**

As shown, this discharge is intermittent, with high levels of acidity and aluminum and low levels of iron. It should be noted that Station 49D was established on the left fork of Tributary L (See Map 5), but landowner permission to sample was not obtained. One sample taken during reconnaissance indicated chemistry similar to 50D.

Both of these areas are impacted by unreclaimed spoils, which cover well over 100 acres (See Map 5). However, this project has been given a low priority because of the intermittent flow of the discharges and because of the limited stream mile improvements that would result.

XIV. Restoration Plan Recommendations

The goal of the restoration plan is to provide a series of recommendations that will most effectively meet the stated goals of the BCWA (See Section V).

A. Discharge Summary

The Table 65 shows the average flow, chemistry, and loading of the discharges that were sampled as part of this project. The discharges have been sorted based on the average acidity loading. Table 66 shows the discharge listed in the same order, with the priority level, project description, and project cost estimate for each project. Note that some projects, particularly reclamation projects, may affect more than one discharge, but that all discharges affected by that project are listed as “high” priorities.

Table 65: Summary of Discharge Flow, Chemistry and Loading

								LOADINGS				
Point	**Flow (gpm)**	**pH**	**Net Acid**	**Fe**	**Mn**	**Al**	**SO4**	**Fe (ppd)**	**Al (ppd)**	**Acid (ppd)**	**SO4 (ppd)**	**Description**
105D	705	3.1	426	15	29	52	1311	109	382	3,289	7,477	Sandy Run Trib P source from spoils and highwalls
3	3,224	4.0	38	3	3	3	249	87	115	1,272	8,762	North Branch of North Fork at main road crossing
29D	119	3.0	393	56	53	27	2043	47	37	504	2,587	Sandy Run Trib N discharge form assumed deep mine
71D	175	3.2	142	2	1	14	233	7	38	350	529	Pipe at Hickory Rd from Cherry Run Reclamation job
122D	30	3.2	491	3	13	74	965	1	32	208	396	North Fork Trib H discharge from open spoils
81	510	3.8	27	1	1	2	199	5	13	157	1,256	North Fork Trib G mouth near TWP Building
46D	90	3.7	128	0	4	20	272	0	24	153	318	Headwaters of Trib R to Beech Creek
BT06*	95	4.1	103	0	4	14	160	0	13	126	186	Butts Run (Trib K) developed spring discharge
27D	38	3.1	287	7	44	31	1851	2	13	120	846	Sandy Run Trib N discharge; may be deep mine
SLB9a**	159	4.3	77	0	3	13	128	0	17	102	172	Jonathan Run near Summit Lodge Lake
43D	32	3.3	224	3	7	31	502	0	13	86	176	Sandy Run Trib O discharge at Y; may be old drift
44D	13	2.9	449	6	5	61	555	1	10	69	88	Sandy Run Trib O right fork source
40D	18	3.0	335	30	27	27	1568	5	6	68	278	Sandy Run discharge from kill zones below road
39D	30	3.7	238	2	19	35	744	0	10	66	209	Sandy Run discharge near 38D, above road
38D	24	3.4	247	4	24	32	965	1	8	61	243	Sandy Run kill zone discharge just above road
50D	17	3.8	212	1	11	34	461	0	7	44	98	Trib L right fork origin
133D	8	3.2	417	15	32	60	1643	1	7	42	216	Sandy Run road culvert discharge from upslope spoil area
35D	30	3.6	103	1	3	12	197	0	5	38	68	Sandy Run Trib M toe-of-spoil discharge 500' from stream
41D	25	3.5	142	0	3	22	289	0	6	37	70	Sandy Run Trib O discharge under Eberly Camp Road
18D	43	4.7	36	0	5	4	235	0	3	28	128	East Br Big Run, seepage flows to existing pond
79D	25	3.6	56	5	2	3	134	1	2	24	44	Little Sandy Run discharge in field along gas line
45D	10	3.5	156	0	2	23	271	0	3	19	29	Sandy Run Trib O eastern side along access road
132D	4	3.1	371	19	31	41	1338	1	2	18	57	Sandy Run discharge 75' below road culvert
67D	54	3.6	39	10	1	2	147	2	1	17	79	North Fork Trib J possible drift discharge under powerline
31D	9	3.4	128	0	7	17	404	0	2	15	50	Sandy Run Trib N toe-of-spoil discharge to headwaters
22D	27	4.6	23	1	11	2	268	1	1	8	82	East Br Big Run discharge bypassing ponds
42D	3	3.4	171	4	13	21	556	0	1	5	16	Sandy Run Trib O left fork source
91D	2	3.3	265	5	19	34	970	0	1	5	16	Beauty Run discharge from the east side
32D	20	3.9	20	0	1	2	129	0	0	5	29	Sandy Run Trib N discharge near tree line
93D	1	3.8	242	0	13	34	623	0	0	3	8	Beauty Run first discharge
21D	13	4.8	12	1	4	1	101	0	0	3	27	East Br Big Run discharge from series of ponds
75D	20	4.8	7	0	0	0	216	0	0	2	23	Little Sandy Run spring near gas line
92D	1	3.7	144	6	16	14	468	0	0	2	5	Beauty Run discharge near 91D

*Data from Bucek 2004 **Data from 1999 – 2003; represents all discharges upstream of this point prior to south side improvements

Table 66: Summary of Recommended High, Medium, and Low Priority Projects

Point	**Priority**	**Project Description**	**Cost Estimate**	**Discharge Description**
105D	**High**	27 acres of reclamation, highwall removal	$350,500	Sandy Run Trib P source from spoils and highwalls
3	Medium	Obtain landowner permission for sampling	?	North Branch of North Fork at main road crossing
29D	**Low**	Reclamation; investigate deep mine; high uncertainty	?	Sandy Run Trib N discharge form assumed deep mine
71D	Medium	Mapping, design, and permitting	$50,000	Pipe at Hickory Rd from Cherry Run Reclamation job
122D	**High**	36 acres of reclamation	$327,000	North Fork Trib H discharge from open spoils
81	Medium	Reclamation of 130 acres	$1,030,000	North Fork Trib G mouth near TWP Building
46D	Medium	Limestone self-flushing system	$279,000	Headwaters of Trib R to Beech Creek
BT06*	**High**	Limestone self-flushing system	$270,000	Butts Run (Trib K) developed spring discharge
27D	**Low**	Reclamation; investigate deep mine; high uncertainty	?	Sandy Run Trib N discharge; may be deep mine
SLB9a**	**High**	PennDOT-implemented plan for all discharges	funded	Jonathan Run near Summit Lodge Lake
43D	**Low**	Reclaim 21 acres	$200,000	Sandy Run Trib O discharge at Y; may be old drift
44D	Medium	Reclaim 24 acres	$230,000	Sandy Run Trib O right fork source
40D	**High**	Phased reclamation, starting with 18 acres	$175,000	Sandy Run discharge from kill zones below road
39D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Sandy Run discharge near 38D, above road
38D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Sandy Run kill zone discharge just above road
50D	**Low**	No action recommended at this time	-	Trib L right fork origin
133D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Sandy Run road culvert discharge from upslope spoil area
35D	Medium	Phased reclamation, starting with 20 acres	$190,000	Sandy Run Trib M toe-of-spoil discharge 500' from stream
41D	**Low**	Reclaim 21 acres	(See 43D)	Sandy Run Trib O discharge under Eberly Camp Road
18D	**High**	Alkaline wetland; limestone polishing bed	$88,000	East Br Big Run, seepage flows to existing pond
79D	Medium	Alkaline wetland; limestone polishing bed	$85,000	Little Sandy Run discharge in field along gas line
45D	**Low**	Reclaim 21 acres	(See 43D)	Sandy Run Trib O eastern side along access road
132D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Sandy Run discharge 75' below road culvert
67D	Medium	Alkaline wetland; limestone polishing bed	$104,000	North Fork Trib J possible drift discharge under powerline
31D	**Low**	Reclamation of large area not cost-effective	-	Sandy Run Trib N toe-of-spoil discharge to headwaters
22D	**High**	Alkaline wetland; limestone polishing bed	$61,500	East Br Big Run discharge bypassing ponds
42D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Sandy Run Trib O left fork source
91D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Beauty Run discharge from the east side
32D	**Low**	No action recommended at this time	-	Sandy Run Trib N discharge near tree line
93D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Beauty Run first discharge
21D	**High**	Alkaline wetland; limestone polishing bed (with 22D)	(see 22D)	East Br Big Run discharge from series of ponds
75D	**Low**	Anoxic Limestone Drain	$40,000	Little Sandy Run spring near gas line
92D	**High**	Phased reclamation, starting with 18 acres	(See 40D)	Beauty Run discharge near 91D

B. Priority Projects

The following eight high priority projects have been identified. The first five projects listed focus on stream-mile improvements. The last three projects focus on loading reduction through reclamation.

Table 67: Summary of Priority Projects

Project	**Description**	**Estimated Cost**	**Stream-mile Impacts***
Big Run 18D	Alkaline Wetland / Open Limestone Bed	$88,000	1.6 miles of East Branch; 0.7 miles of unnamed trib
Big Run 21/22D	Alkaline Wetland / Open Limestone Bed	$61,500	3.2 miles of East Branch; 0.6 miles of unnamed trib
Butts Run BT06	Self-Flushing Limestone Cells, Pond	$270,000	1.3 miles of South Fork; 0.5 miles of Butts Run
Jonathan Run	PennDOT-funded project to treat/remove all pollution	funded	1.5 miles of South Fork; 1.5 miles of Jonathan Run
Wolf/Little Wolf Alkaline Addition	2 sites, open limestone beds treating the stream	$150,000	2-6 miles of Wolf and Little Wolf, depending on location
Tributary H Reclamation	36 acres of reclamation	$327,000	Reduced loading from station 122D to Trib H
Tributary P Reclamation	27 acres of reclamation; highwall removal	$350,500	Reduced loading from station 105D to Trib P
Sandy Run Road Reclamation Phase I	18 acres of reclamation	$176,000	Reduced loading from 38D, 39D, 40D, 123D, 133D

**Stream-mile impacts are listed from the discharge point to the next downstream discharge or to the next confluence with a larger stream that will see less significant impacts. However, all projects have some impact on all streams that they flow into.*

Several other projects have been identified as “medium” priority projects. These projects are rated as lower priorities for a variety of reasons. These reasons include lower cost/effectiveness, uncertainty of results, or limited loading impacts. Projects not rated “high” or “medium” are rated “low” priority, usually because they involve low loadings to highly contaminated streams.

C. Assessing Plan Effectiveness

The effectiveness of each individual restoration project and the restoration plan as a whole can easily be evaluated by monitoring the water quality parameters at in-stream locations that were sampled as part of this project or as part of the DEP’s TMDL studies in the watershed. Quarterly sampling for a period of one year after major projects are completed should be performed in order to assess the new conditions of the stream. The in-stream station just upstream and just downstream of the project should be monitored, as well as other stations if desired. This data can then be directly compared to the data contained in this report in order to assess water quality improvements.

Two main measures can be used to assess effectiveness; stream miles recovered and pollution loading reduced. In-stream sampling can help make both of these determinations. It may also be desirable to conduct macroinvertebrate and/or fish sampling at some in-stream locations where chemistry improvements bring water quality into a range acceptable to aquatic life.

D. Potential Funding Sources and Partners

Numerous state and federal agencies have money available to support watershed restoration activities. Some of the most common sources of funding are discussed below, however, other sources such as private foundations also exist. Each funding source has its own application procedure, funding limitation, matching funds requirements, and administrative techniques.

The **Pennsylvania DEP Growing Greener Program** provides funds to projects dealing with all aspects of watershed restoration, including mine drainage pollution. The program has funded numerous programs since its inception in 1999, including the project to fund this assessment and restoration plan. Applications for the Growing Greener Program are accepted each year, generally in the late winter or early spring. Grants do not require matching funds or services, though they are desirable. There is no funding limit and grants can last two or three years.

A portion of the Growing Greener funds are allocated directly to each county. These **Growing Greener County Initiative** funds may be available in some counties to address mine drainage impacts. Each county will decide how to allocate their portion of the funding, so county commissioners and/or county conservation districts should be contacted directly.

The **DEP Technical Assistance Grant (TAG) Program** is a special section of the Growing Greener Program. Several non-profit groups are authorized TAG providers and can assist watershed groups with small-scale projects that do not include construction. For more information on both of these programs, visit the DEP website at http://www.dep.state.pa.us/growgreen/defaultdep.htm

The **Office of Surface Mining (OSM) Appalachian Clean Streams Initiative** also provides grants to fund projects that address abandoned mine problems, specifically mine drainage treatment systems. They can provide up to $150,000 for projects that involve construction. Matching funds or in-kind services are required, but there is no set amount of matching that is required. For more information on this program, visit http://www.osmre.gov/acsihome.htm.

The **U.S. E.P.A. 319(h) Nonpoint Source Management Grant Program** is administered by the DEP and provides funds to projects for all nonpoint sources of pollution, including mine drainage. These grants are awarded through the Growing Greener application process, so no new paperwork is required. The E.P.A. also periodically offers other grants which may pertain to mine drainage restoration.

The DEP's **Bureau of Abandoned Mine Reclamation (BAMR)** specializes in land reclamation projects and can provide mapping and design services or funding for these projects. Projects are chosen through an on-site visit process with BAMR personnel. More information is available at http://www.dep.state.pa.us/dep/deputate/minres/bamr/bamr.htm.

The **U.S. Army Corps of Engineers** has recently embarked upon several ecosystem restoration projects involving mine drainage pollution. Through their process, they provide a restoration plan document that outlines all the projects necessary to restore a watershed to its designated uses. If the watershed group accepts this document, the Corps will then provide up to $5 million dollars to complete the projects. However, the watershed group is required to provide matching funds that total at least 35% of the total project amount. This matching money can be any non-federal matching funds, such as Growing Greener funds.

In addition to these potential funding sources, valuable partnerships can be formed with private businesses, individuals, private foundations, and others. Potential project partners include anyone who can provide funding, materials, or in-kind services such as system inspections, water sample collection, equipment use, or other matching.

XV. References

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