BLACKLICK CREEK
WATERSHED ASSESSMENT / RESTORATION PLAN

Prepared for:

Blacklick Creek Watershed Association

Prepared by:

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1.0 INTRODUCTION

The Blacklick Creek Watershed Association (BCWA) is an independent, non-profit organization formed in 1993 to provide a structure and focal point for the improvement of the environmental quality of the Blacklick Creek Watershed. Membership of the association is composed of concerned citizens, conservation groups, sport's men's associates, government agencies, and private business representatives. BCWA is initiating this study in an effort to establish a framework for future remediation and development within the watershed. All readily available information was compiled in order to determine the locations, types, extent and impacts of non-point source/point source (NPS/PS) pollution in the study area. This assessment report offers general solutions associated with water quality impacts in the project area, and for future remediation projects within the watershed. In addition to the assessment, this project also included an outreach/education effort aimed at increasing the involvement of Indiana County municipal leaders and residents in environmental issues. Major tributaries in the watershed are Blacklick Creek, Two Lick Creek, and Yellow Creek.

L. Robert Kimball & Associates is a multidiscipline engineer consulting firm with more the 50 years of experience in performing water quality and mining-related assessments. L. Robert Kimball & Associates provided the oversight of data entry into a database and the geographic information system (GIS) program design.

The Spatial Sciences Research Center (SSRC) has been affiliated with Indiana University of Pennsylvania's Department of Geography and Regional Planning since 1992. From this position, it developed its original function to focus on issues and methods surrounding the design, development, and deployment of Geographic Information Systems (GIS). The SSRC's expertise in providing GIS services has made it a major asset to the University. SSRC provided the acquisition of varies types of data layers from various sources, digitizing mapping, overseeing the sampling program and data entry of hard copy data.

1.1 Purpose

The purpose of the assessment was to create a comprehensive Watershed Assessment/Restoration Plan for the Blacklick Creek Watershed, with respect to both Non-Point Sources (NPS) and identified Point Source (PS) locations of pollution in the $540^{\pm}$ square mile watershed. The watershed contains significant abandoned mine land (AML) discharges, as well as other sources of pollutants (including combined sewer overflows, agricultural/animal waste, industrial, residential, etc.), and the intent of this project was to establish a comprehensive, holistic approach toward assessment and eventual pollution abatement and remediation of the existing water quality problems. The Watershed Assessment / Restoration Plan will provide a framework for future efforts by the BCWA for prioritizing and coordinating restoration/planning activities with citizens and local and state agencies. The final assessment report will serve as a working template/framework to guide future remediation/planning and monitoring efforts and will assist in setting remediation priorities. Priority identification will assist in planning and performing a more efficient restoration of identified NPS outfalls and related impacts and will provide the means for efficient use of already limited funding.

The final Watershed Assessment / Restoration Plan will become the property of the BCWA to guide future remediation/planning efforts and to provide a central depository for additional information and data gathered for the study area.

1.2 Limitations of the Study

This assessment was based on existing and readily available data generated as a result of previous studies within the watershed, data held by local, state and federal government agencies and one year of sampling conducted for this assessment at a limited number of locations.

This assessment did not address discharges from permitted active mining operations, and other permitted discharges such as sewage/wastewater treatment plants, and miscellaneous discharges regulated by local, state, or federal government agencies. However, to the extent possible, the locations and descriptions of these discharges were included as reference information relative to stream evaluation, planning and restoration.

1.3 Objectives

The assessment report will serve as a Watershed Restoration Plan for future remediation projects sponsored by the BCWA, and will be available as a public document to all entities desiring to work within the watershed. Limited assessment efforts have been conducted within the Blacklick Creek Watershed to-date, however they have been focused on specific problem areas, and no comprehensive watershed assessment of the locations, types, extent and impacts of NPS/PS pollution has been conducted. This type of an assessment is needed to identify locations of AMD and other NPS/PS discharges, prioritize sites and develop general recommendations for remediation strategies.

The first objective of this study was to identify major NPS discharges within the Blacklick Creek watershed, obtain existing analytical/physical data associated with the discharges, and develop a working Geographic Information System (GIS) database of the data collected. The created database will be used to compile existing data from various sources, identify gaps in data collection, perform data analysis in regard to watershed restoration and planning, and serve as a depository for data gathered in the future.

The second objective was to utilize the GIS database to evaluate the impacts of NPS discharges in regard to water quality and to generate a current priority list of NPS sources for which general remediation strategies would be developed.

Since funding may not be available to remediate or address every problem, attacking them on a priority basis would eliminate those problems that are too small or costly. While the underlying goal is cleaner water, there are several specific improvements to the watershed and surrounding communities as determined by the BCWA.

1.4 Study Area

The Blacklick Creek watershed includes the tributaries of Yellow Creek and Two Lick Creek. The watershed covers approximately 540 sq. miles straddling both Indiana and Cambria counties in Pennsylvania. The watershed boundaries are depicted on **Figure 1**. Stream flow is roughly east to west into the Conemaugh Lake Reservoir. For this assessment, we have divided the watershed into nine sub-watersheds: Blacklick Creek – Main Stem, North Branch Blacklick Creek, South Branch Blacklick Creek, Lower Blacklick Creek Upper Two Lick Creek, Lower Two Lick Creek, Tearing Run, Upper Yellow Creek and Lower Yellow Creek. Sub-watershed boundaries are presented on **Figure 2**.

Resource activities within the watershed consisted initially of agriculture and forestry. By the turn of the century most of Pennsylvania's forest had been clearcut. Today most of the forest is second and third growth. Agriculture and forestry continue to be a significant factor in the local economy.

Beginning at the turn of the century, Indiana County entered an era of tremendous coal production. New towns were constructed by coal companies. Tipples, coke ovens and boney pile began dotting the landscape. Rochester and Pittsburgh Coal and Iron Company and the Clearfield Bituminous Coal Corporation built communities such as Lucerne, Coal Run, and Commodore. Also at the turn of the century the coke industry was born in the area. Long rows of beehive coke ovens were constructed. In the 1890's a coke plant was built at Graceton. Soon afterwards, a second plant was built near Coral. Over 300 ovens were constructed at the Coral plant. A battery of 152 coke ovens were also constructed in Vintondale and operated until 1945. In 1952, 264 coke ovens were constructed in Lucerne. All of the facilities ceased operations by 1972. Many of the early mines were constructed upslope. This provided a natural drainage of the groundwater that accumulated in the mine. With the development of the mines a large railroad network was constructed to hall the coal and coke to eastern markets.

Although sewage treatment facilities serve the larger municipalities, direct discharges of raw sewage and leaky on-lot septic systems degrade local stream throughout the basin.

Runoff from agriculture areas affect stream water quality in several areas. Brush Creek is impacted by siltation from agriculture.

In 1963 Yellow Creek State Park was created. The park includes a 720 acre lake formed by damming Yellow Creek. Two Lick Reservoir was constructed in 1963 by Pennsylvania Electric Company to supply water to the Homer City Power Plant. The reservoir is 1,800 acres.

1.5 Hydrogeology

The Blacklick Creek Watershed is made up of 9 sub-watersheds that define the drainage areas for each tributary and Blacklick Creek (Refer to **Figure 2**).

Main Stem Blacklick Creek

Located within Indiana County, the creek is an east to west flowing stream. In the Village of Blacklick, the creek merges with Two Lick Creek. From this point the creek is considered "lower" Blacklick Creek. The watershed area is approximately 98 square miles. From Vintondale to Blacklick the stream flows 22.2 miles.

From east to west the named tributaries of the Blacklick are Rummel Run, Ramsey Run, Clark Run, Mardis Run (north), Mardis Run (south), Brush Creek, Aulds Run, and Laurel Run. Aulds Run is severely degraded by AMD. Brush Creek is unaffected by AMD and is a stocked trout stream. Laurel Run is moderately impacted by AMD.

North Branch Blacklick Creek

Located in Cambria County, the creek is a north to south flowing stream. In Vintondale the creek joins South Branch Blacklick Creek to form Blacklick Creek. The watershed area is approximately 91 square miles. From the headwaters to the mouth, the North Branch flows approximately 16.4 miles. Elk Creek has been impacted by AMD and flows 5.0 miles from the headwaters to the mouth.

From north to south the named tributaries to the North Branch are Wolf Run, Teakettle Run, Dutch Run, Stevens Run, and Elk Creek. Named tributaries to Elk Creek beginning at the headwaters are Californian Run, Hill Creek, Crooked Run, Little Elk Creek, and Simmons Run. The Spangler Reservoir, which is a public water supply source, is located on a un-named tributary to North Branch. Colver Reservoir is on the North Branch.

South Branch Blacklick Creek

Located within Cambria County, the creek is an east to west flowing stream. In Vintondale the creek joins North Branch Blacklick Creek to form Blacklick Creek. The watershed area is approximately 60 square miles. From the headwaters to the mouth, the stream flows 14.2 miles.

Several tributaries have been degraded by acid mine discharges. From east to west the named tributaries of the South Branch are Williams Run, Stewart Run, Pergrin Run, Coal Pit Run, Bracken Run and Shuman Run. Pergrin Run is severely degraded by AMD. Coal Pit Run is moderately impacted by AMD. Bracken and Shuman Runs are slightly degraded by AMD. Stewart Run is unaffected by AMD and is a stocked trout stream. Williams Run is also a good quality stream. Williams Run Reservoir is a public water supply source.

Lower Blacklick Creek

Located within Indiana County, the creek is an east to west flowing stream from the confluence of the Main Stem Blacklick Creek and Lower Two Lick Creek to its mouth at the Conemaugh River. The watershed area is approximately 43 square miles. Through this watershed, the stream flows approximately 10.2 miles.

Named tributaries of the Lower Blacklick Creek are Muddy Run, Greys Run and Stewart Run which are generally unaffected by AMD.

Upper Two Lick Creek

Located within Indiana County, the creek is a north to south flowing stream. The headwaters are formed at the confluence of the North Branch and South Branch Two Lick Creek flowing south through Clymer to the Two Lick Reservoir. From this point forward the stream is considered the "Lower" Two Lick Creek. The watershed area is approximately 83 square miles. Through this watershed, the stream flows approximately 7.8 miles.

Named tributaries of the Upper Two Lick Creek include the North Branch Two Lick Creek, South Branch Two Lick Creek, Browns Run, Buck Run, Dixon Run and Penn Run. The Upper Two Lick Creek along with Penn Run are affected by AMD.

Lower Two Lick Creek

Located within Indiana County, the creek is a north to south flowing stream. The headwaters are formed at the Two Lick Reservoir south of Clymer flowing south past Homer City to the confluence with the Main Stem Blacklick Creek. The watershed area is approximately 76 square miles. Through this watershed, the stream flows approximately 17.8 miles.

Named tributaries of the Lower Two Lick Creek include Ramsey Run which is affected by urban and agricultural runoff, Whites Run, Marsh Run affected by urban and agricultural runoff, Stoney Run affected by municipal discharges, and Cherry Run. The Lower Two Lick Creek is affected by AMD as well as urban and agricultural discharges.

Tearing Run

Located within Indiana County, the creek is an east to west flowing stream located south of Homer City. The stream flows approximately 3.2 miles through the approximately 6 square mile watershed to its confluence with the Lower Two Lick Creek. Tearing Run is effected by AMD throughout its length. There are no named tributaries to Tearing Run.

Upper Yellow Creek

Located within Indiana County, the creek is an east to west flowing stream. From the headwaters into the west, the stream flows approximately 10.9 miles to the Yellow Creek State Park Lake. The approximately 1.5 square mile lake is located entirely within the approximately 77 square mile watershed. From the lake, the stream continues for about 3.9 miles. From this point, the creek is considered "Lower" Yellow Creek.

Named tributaries of the Upper Yellow Creek include Leonard Run, Laurel Run, Rose Run, Little Yellow Creek and Gillhouser Run which flow directly into the Yellow Creek State Park Lake, and Ferrier Run. Leonard Run is affected by AMD.

Lower Yellow Creek

Located within Indiana County, the creek is an east to west flowing stream. This watershed begins where Ferrier Run spills into Yellow Creek and extends the mouth of Yellow Creek at Two Lick Creek. Through this approximately 9 square mile watershed the creek flows approximately 4.6 miles into Homer City. Significant AMD impacts are evident in this watershed.

There are no named tributaries to the Lower Yellow Creek.

Stream Classification

Pennsylvania Code Title 25, Chapter 93 lists the established water quality goals for all streams within the Commonwealth. Water uses to be protected are established for each stream, as well as specific water criteria necessary to protect these uses. These criteria are to be used to establish waste discharge permit limits. "Exceptional Value Waters" (EV) designation refers to streams that are relatively pristine, with little or no development or access and are an outstanding natural resource. In a "High Quality" (HQ) stream, the water quality can be lowered only if a discharge is the result of necessary social or economic development, and all the existing uses of the stream are protected. "Cold Water Fishery" (CWF) designation refers to a stream capable of maintaining or propagating, or both, fish species including the Salmonidia and additional flora and fauna that are indigenous to a cold water habitat. "Trout Stocking Fishery" (TSF) designation refers to a stream capable of maintaining stocked trout from February 15 to July 31 and capable of maintaining or propagating, or both, fish species and additional flora and fauna that are indigenous to a warm water habitat. "Warm Water Fishery" (WWF) designation refers to streams capable of maintaining or propagating, or both, fish species and additional flora and fauna that are indigenous to a warm water habitat. The following summarizes the streams classifications within the watershed:

Classification of Streams within the Watershed

Stream	Zone	County	Water Use Protected
BC – Main Stem			
Blacklick Creek	Main Stem, Confluence of North and South Branches to Mouth	Indiana	TSF
Unnamed Tributary to Blacklick Creek	Basins, Confluence of North and South Branches to Mouth	Indiana	CWF
Rummel Run	Basin	Indiana	CWF
Ramsey Run	Basin	Indiana	CWF
Clarke Run	Basin	Indiana	CWF
Mardis Run (North)	Basin	Indiana	CWF
Mardis Run (South)	Basin	Indiana	CWF
Brush Creek	Basin	Indiana	CWF
Ramsey Run	Basin	Indiana	CWF
Aulds Run	Basin	Indiana	CWF
Laurel Run	Basin	Indiana	CWF
NBBC			
North Branch Blacklick Creek	Basin, Source to Confluence with South Branch	Indiana	CWF
SBBC			
South Branch Blacklick Creek	Main Stem, Source to Confluence with North Branch	Indiana	CWF
Unnamed Tributary to South Branch Blacklick Creek	Basin, Source to Confluence with South Branch	Cambria	CWF
Williams Run	Basin	Cambria	CWF
Steward Run	Basin	Cambria	HQ-CWF

Stream	Zone	County	Water Use Protected
Coalpit Run	Basin	Cambria	CWF
Bracken Run	Basin	Cambria	CWF
Shuman Run	Basin	Cambria	CWF
Lower Blacklick Creek			
Muddy Run	Basin	Indiana	CWF
Greys Run	Basin	Indiana	CWF
Stewart Run	Basin	Indiana	CWF
Upper Two Lick Creek			
Two Lick Creek	Basin	Indiana	CWF
South Branch Two Lick Creek	Basin, Source to Confluence with North Branch	Indiana	HQ-CWF
North Branch Two Lick Creek	Basin, Source to Confluence with South Branch	Indiana	CWF
Two Lick Creek	Main Stem, Confluence of North and South Branches to Mouth	Indiana	TSF
Unnamed Tributary to Two Lick Creek	Basin, Confluence of North and South Branches to Mouth	Indiana	CWF
Browns Run	Basin	Indiana	CWF
Buck Run	Basin	Indiana	CWF
Dixon Run	Basin	Indiana	CWF
Penn Run	Basin	Indiana	CWF
Lower Two Lick Creek			
Allen Run	Basin	Indiana	CWF
Ramsey Run	Basin	Indiana	CWF
Stoney Run	Basin	Indiana	CWF
Cherry Run	Basin	Indiana	CWF
Weirs Run	Basin	Indiana	CWF
Tearing Run			
Tearing Run	Basin	Indiana	CWF
Upper Yellow Creek			
Yellow Creek	Main Stem, Source to Yellow Creek State Park	Indiana	CWF
Unnamed Tributary to Yellow Creek	Basin, Source to Yellow Creek State Park Dam	Indiana	CWF
Leonard Run	Basin	Indiana	CWF
Laurel Run	Basin	Indiana	CWF
Rose Run	Basin	Indiana	CWF
Little Yellow Creek	Basin	Indiana	HQ-CWF
Yellow Creek	Main Stem, Yellow Creek State Park Dam to Mouth	Indiana	TSF

Stream	Zone	County	Water Use Protected
Unnamed Tributary to Yellow Creek	Main Stem, Yellow Creek State Park Dam to Mouth	Indiana	CWF
Ferrier Run	Basin	Indiana	CWF

Established TMDLs

The Pennsylvania Department of Environmental Protection (PADEP) is required to develop Total Maximum Daily Loads (TMDLs) for streams in the Commonwealth to address nonpoint source pollution in waterbodies that are deemed to be "water quality impaired". These are waterbodies that do not meet PADEP standards for their designated use. TMDLs are simply the implementation of rules included in Section 303(d) of the Clean Water Act of 1972. Today, TMDLs are an integral part of the watershed approach to water quality management. The perspective is that all point and nonpoint source pollution in a watershed, as well as the physical characteristics of the water body itself, cannot be disentangled. As a result, TMDLs aims at managing all sources of pollution which affects beneficial uses of water, covering both point and nonpoint sources. Draft TMDL loadings have been published for Elk Creek and South Branch Blacklick Creek.

Trout Stocked Streams and Lakes

The Fish and Boat Commission has classified the following streams, and lakes as "approved trout waters" for stocking. These water bodies meet the qualifying criteria. In the Blacklick Creek watershed, Brush Creek is the only stream stocked. In the Two Lick watershed, South Branch Two Lick Creek is the only stream stocked. In the Yellow Creek watershed, Laurel Run, Little Yellow Creek, Yellow Creek, and Yellow Creek State Park Lake are stocked.

Impaired Streams

Many miles of streams are impacted by AMD, untreated sewage, and agricultural run-off limits the recreational, economical and social values of the communities within the watershed. Regional employment opportunities and populations have declined over the last twenty-five years. With out the availability of good jobs, many of the young people move away. Substandard water supplies and sewage treatment systems are preventing businesses and perspective residents from relocating to the area. The poor aesthetics associated with the discolored and polluted water of the streams detract from the area's potential for growth and development. It also affects the recreational opportunities available for the region.

Impaired Streams within the Watershed Requiring TMDLs

STREAM	IMPAIRMENT	MILES
Elk Creek	Abandoned Mine Drainage/Siltation Abandoned Mine Drainage/Metals	0.5

Elk Creek	Abandoned Mine Drainage/Siltation Abandoned Mine Drainage/Metals	1.2
Elk Creek	Abandoned Mine Drainage/Siltation Abandoned Mine Drainage/Metals	1.6
Elk Creek	Habitat Modification/Siltation Abandoned Mine Drainage/Metals	5
Leonard Run	Abandoned Mine Drainage/Metals	2.6
Marsh Run	Urban Runoff/Storm Sewers/Thermal Modification	2
McCarthy Run (Unit 44230)	Urban Runoff/Storm Sewers/Thermal Modification Urban Runoff/Storm Sewers/Suspended Solids	3.8
McCarthy Run (Unit 44231)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	0.5
McCarthy Run (Unit 44232)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	0.8
McCarthy Run (Unit 44233)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	0.4
McCarthy Run (Unit 44234)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	0.4
McCarthy Run (Unit 44235)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	0.5
McCarthy Run (Unit 44236)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	1.1
McCarthy Run (Unit 44237)	Urban Runoff/Storm Sewer/Suspended Solids Urban Runoff/Storm Sewer/Thermal Modifications	1.4
Penn Run	AMD/Other Inorganics	4
Ramsey Run (Unit 44249)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	4.2
Ramsey Run (Unit 44250)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	1
Ramsey Run (Unit 44251)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.7
Ramsey Run (Unit 44252)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.4
Ramsey Run (Unit 44253)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.8
Ramsey Run (Unit 44254)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.9
Ramsey Run (Unit 44254)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.4
Ramsey Run (Unit 44255)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.5
STREAM	IMPAIRMENT	MILES
Ramsey Run (Unit 44256)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.8
Ramsey Run (Unit 44257)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	1.2

Ramsey Run (Unit 44258)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.4
Ramsey Run (Unit 44259)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	0.7
Ramsey Run (Unit 44260)	Agriculture/Pathogens Urban Runoff/Storm Sewer/Pathogens	10.8
Richards Run	Abandoned Mine Drainage/Metals	1.8
South Branch Blacklick Creek	Abandoned Mine Drainage/pH Abandoned Mine Drainage/Metals	1.6
South Branch Blacklick Creek	Abandoned Mine Drainage/Metals	1
South Branch Blacklick Creek	Abandoned Mine Drainage/pH Abandoned Mine Drainage/Metals	5.1
Stoney Run	Municipal Point Source/Organic Enrichment/Low D.O.	0.8
Tearing Run	Abandoned Mine Drainage/Metals	2.2
Trout Run	Upstream Impoundment/Organic Enrichment/Low D.O.	1.1
Two Lick Creek	Abandoned Mine Drainage/pH Abandoned Mine Drainage/Metals	9.2
Two Lick Creek	Agriculture/Pathogens Urban Runoff/Storm Sewers/Pathogens	0.5
Yellow Creek	AMD – pH and metals	4.9

1.6 Geology Features

The watershed is situated in the Pittsburgh Low Plateau section of the Appalachian Plateaus physiographic province. A smooth to irregular undulating surface and narrow, relatively shallow valleys characterize topography. The underlying sedimentary rock strata have been folded into moderate to low amplitude folds.

Bedrock is composed of sedimentary strata of the Pennsylvanian Age Glenshaw Formation and Allegheny Group. The Glenshaw Formation, the lowermost formation of the Conemaugh Group, is estimated to be 350 feet thick in Indiana County. The remaining strata are composed predominantly of shales, sandy shales, sandstones, thin coals and limestones. The Mahoning sandstone, near the base of the Glenshaw Formation, becomes locally massive and very coarse-grained.

The Allegheny Group underlies the Glenshaw Formation and in Indiana County is estimated to be 290 feet thick. The Allegheny Group is composed of alternating beds of shale, sandstone, fireclay, coal, and limestone. No other coal beds are known to be of economical importance within the watershed.

Limestones and fireclays are only locally developed and are not economically important within the project area. Gas from the wells is produced from the Upper Devonian Bradford Group.

1.7 Non-Point Source Impacts

Untreated sewage discharges are entering several streams throughout the watershed. In many areas on-lot septic systems have failed. Several areas that could be economically served by a sewage authority are not. Some existing treatment systems are inadequate to handle current loads and need upgraded.

As the use of potable water continues to grow, there is growing concerns that there is not a sufficient supply to meet demands. In several areas groundwater has been contaminated by mining rendering the water unfit for consumption. In other areas surface water has been contaminated by AMD.

Septic systems (also called on-lot systems) are sewage systems on the property of the homeowner which treat and dispose of domestic sewage through natural processes. Liquid waste from the treatment tank or field percolates throughout the soil, where biodegradation gradually decomposes the effluent. If well maintained, and properly constructed, these systems are very effective in the treatment of residential waste. From an NPS pollution standpoint, the problem is that the operation and maintenance is typically the sole responsibility of the homeowner. Many systems are not maintained properly or constructed in unsuitable soil and are discharging partially treated sewage.

The community of Tide has a sewage collection system that discharges into a deep mine. The communities of Dilltown, Kenwood and Pine Flats do not have sewage treatment plants. The community of Mentcle could possibly connect to the Heilwood STP. The community of Diamondville could possibly connect to the Penn Run STP.

1.8 Previous Studies

The following studies were used in preparation of this report. Several are in progress as of this report.

- Two Lick Creek Mine Drainage Pollution Abatement Project, A Part of Operation Scarlift, prepared for Pennsylvania Department of Mines and Mineral Industries, prepared by L. Robert Kimball Consulting Engineers, March, 1971

- Blacklick Creek Mine Drainage Pollution Abatement Project, A Part of Operation Scarlift, prepared for Pennsylvania Department of Mines and Mineral Industries, prepared by Michael Baker Jr., Inc., March 1978

- Abandoned Mined Lands Survey Demonstration, Indiana and Cambria Counties, Pennsylvania, Boone County, West Virginia, prepared for U.S. Department of the Interior, Bureau of Mines, prepared by Skelly and Loy, October, 1978

- Aquatic Survey of the North and South Branches of Blacklick Creek, prepared by PADEP Bureau of Abandoned Mine Reclamation, March 21, 1997.

- General Reevaluation Report, Ecosystem Restoration Webster Mine Discharge, Nanty-Glo, Pennsylvania, prepared by U.S. Army Corps of Engineers, March, 1999

- South Branch Blacklick Creek Watershed Restoration Plan, prepared by PADEP Bureau of Abandoned Mine Reclamation, April 28, 2000.

- Draft Elk Creek Watershed TMDL, Cambria County, For Acid Mine Drainage Affected Segments, prepared by Pennsylvania Department of Environmental Protection, November 6, 2004

- Draft South Branch Blacklick Creek Watershed TMDL, Cambria and Indiana Counties, For Acid Mine Drainage Affected Segments, prepared by Pennsylvania Department of Environmental Protection, November 6, 2004

- Draft Phase II Watershed Assessment and Restoration Plan for the Upper Two Lick Creek Watershed, prepared by the Blacklick Creek Watershed Association and Indiana University of Pennsylvania, January, 2005.

- Multi-County Watershed Assessment Restoration Plan, prepared by Indiana County Conservation District

- Lower Yellow Creek Restoration Project, samples were collected and analyzed by PADEP Bureau of Mining

- Kiski-Conemaugh Stream Team, samples are being collected by volunteers throughout the watershed and analyzed by PADEP

- U.S.G.S. National Water Information System is a database of stream water quality data. Several stream sampling locations are within the watershed

- USEPA STORET is a database containing raw biological, chemical, and physical data on surface water collected by federal, state and local agencies, volunteer groups, academics and others. Data is continuously added to the database. There were several sets of data for samples collected within the watershed.

1.9 Reclamation Projects/Active Treatment Systems

There are two large mine discharge treatment plants operating on the South Branch Blacklick Creek (SBBC), both maintained by BethEnergy Mines, Inc. The BethEnergy Mine No. 33 treatment plant discharges into the South Branch Blacklick Creek near Beulah, while the BethEnergy Mine No. 31 plant discharges into the South Branch Blacklick Creek just upstream of Nanty Glo. While the quantity of the discharges varies seasonably, each of these plants typically discharges four to five million gallons per day of treated water into the SBBC. Not only does pumping and treatment of this water protect streams in the region from the potential for mine drainage breakouts, it provides a source of additional alkalinity to the SBBC

There is one mine discharge treatment plant on Allen Run in the Two Lick Creek Watershed. Mine water is pumped from Dixon Run Mine to the Chestnut Ridge Treatment Plant. Edison

Mission Energy is currently paying to operate the plant until a permanent solution is determined. One of the Snyder #1 mine discharges is being treated in the Tearing Run watershed. This is a crude treatment system being operated by Consolidated Coal Company. Soda ash is dumped into a large tank and the mine water flows through it.

BethEnergy Mines Inc., in an effort to reduce their treatment cost, has submitted a proposal to pump and pipe the raw mine water from the abandoned Mine No. 33 to the abandoned C. A. Hughes and PA Coal & Coke B Seam Mines. The Mine No. 33 raw mine water will mix with raw mine water present in the C. A. Hughes and PA Cola and Coke B Seam Mines and be treated and discharged or will be directly discharged into the Little Conemaugh River. Should BethEnergy receive approval to relocate the discharge the South Branch Blacklick Creek would no longer reap the benefits of the excess alkalinity obtained from the treated discharge. The excess alkalinity appears to mitigate the effects of the existing discharges associated with the Revloc refuse pile. Should treatment of these discharges cease or be relocated, the South Branch Blacklick Creek, as well as other nearby streams and private water supply wells, could be adversely impacted.

1.9.1 Upper Two Lick Creek

The Richards Treatment System is designed to treat a discharge emanating directly from the sealed Egypt mine. Flow from the mine is split and diverted in three parallel vertical flow reactor (VFR) systems. Effluent from the VFR systems flows into a settling pond.

1.9.2 Lower Two Lick Creek

The Penn Hills #2 Treatment System was built as a cooperative venture by the Watershed Association, Edison Mission Energy and the PADEP. Penn Hills Mine #2 discharge flowed directly into the northern end or the Two Lick Reservoir. Passive vertical flow reactors were designed by PADEP for this site. Up to 1,000 gallons per minute of acidic mine water is discharged from the mine. The passive treatment system was built to replace a chemical treatment system.

In February 2003, Indiana County purchased 10.7 acres of property along Two Lick Creek below the Pennsylvania-American water treatment plant from Consol Energy, Inc. On the property is an abandoned mine discharge from the R & P Lucerne 3A mine. It is envisioned that educational and recreational facilities be built at the site and a passive treatment system by constructed for the discharge. Water released from the Two Lick Reservoir is relatively good and supports a brown trout fishery. The next major AMD discharge is seven miles downstream.

1.9.3 Upper Yellow Creek

There are no current or completed projects within this watershed.

1.9.4 Lower Yellow Creek

The Lower Yellow Creek Restoration Project in the Blacklick Creek watershed was launched in 1998 as a 5 phase plan to restore the last 3.5 miles of Yellow Creek in Indiana County. At the time, that stream section was the only one in the entire 420 square mile Blacklick Creek Watershed meeting DEP recommended comprehensive sequential approaches to watershed restoration. Phase 1A and 1B passive treatment systems were installed in 1998 and 1999 and were initially funded by 319NPS grants which were later supplemented by Western PA Watershed Protection funds. Subsequent Phase 2 passive systems (2A, 2B and 2C) were initially funded by Growing Greener, 319 NPS and W. Pa. Watershed Protection Grants. The first 4 systems were modified to sulfate reducing bio-reactors (SRB) in subsequent upgrades and Phase 2C was designed and built completely as a deep bed SRB in 2003. Operation, Maintenance, Replacement costs were generally funded by W. Pa. Watershed Protection and various corporate and foundation grants. In general the AMD being treated exhibited pH values from 2.5 to 3.0, aluminum content around 25 mg/l and iron content from 30 to 100 mg/l. Each system has displayed success for varying periods of time - generally producing effluent of pH 6.0 or above with significantly reduced metal loadings (Aluminum <0.10 mg/l, Iron < 1.0 mg/l). Discharge flow rates into each of the treatment systems have varied from 30 gpm to over 250 gpm.

Also in Phase II, an in-situ bioremediation demonstration project is being conducted on the Tide # 1 mine, also known as the Water #3 Mine, by Arcadis G & M. The project is designed to demonstrate the effectiveness of a proprietary in-situ passive treatment technique for acid mine drainage. Boreholes were drilled into the mine pool. Molasses and methanol were injected directly into the mine pool. An anaerobic, sulfate-reducing environment was created within the mine pool by the increased activity of naturally occurring bacteria as they consume the readily available sugars and alcohol. The acidity of the water in the mine pool is neutralized and dissolved iron and aluminum will be precipitated by the formation of sulfide, hydroxide and carbonate.

Phase III of the Restoration Project involves remediating two small discharges in to an un-named tributary, locally known as the Tide Tributary. A proposal has been submitted to PADEP for an investigation to determine the best method to treat the discharges.

Phase IV of the Yellow Creek Restoration Project involves the removal of refuse piles next to the village of Tide. During storm events, refuse migrates from the refuse pile directly into the Yellow Creek. Small seeps are also flowing along the toe of slope adjacent to the stream. A permit has been issued to RNS for the reprocessing of the refuse. The piles are being mined and reclaimed with alkaline circulating fluidized bed ash from the company's power plant in Ebensburg. The reclamation should reduce the acid, iron and aluminum loadings from the seeps to Yellow Creek. The stream bank with refuse will also be stabilized.

1.9.5 North Branch Blacklick Creek

Inter-Power's Colver Power Project is currently reprocessing the refuse pile in Colver. The piles are being mined and reclaimed with alkaline circulating fluidized bed ash from the power plant. There is at least a 20 year supply of refuse material on-site. Seeps from the refuse pile contribute high concentrations of metals to Elk Creek. Elevated concentrations of metals have impacted the stream.

There are two large mine discharge treatment plants operating on Elk Creek. The first plant is located near Duman Lake and is a former Barns & Tucker plant. Funding to operate the plant is exhausted and the PADEP is currently operating the plant. The second plant is operated by Eastern Coal Associates. Not only does pumping and treatment of this water protect streams in the region from the potential for mine drainage breakouts, it provides a source of additional alkalinity to the streams. Since all corporations have a finite life, financial assurances are necessary to ensure the discharges will be treated in perpetuity.

Red Mill Discharge is located on the North Branch Blacklick Creek (NBBC) below the confluence with Elk Creek. This discharge is the first major discharge on the NBBC. Water quality in Elk Creek has slowly been improving with the reprocessing of the Colver refuse pile and the active treatment of two mine discharges. The Red Mill discharge severely degrades two miles of NBBC down to the Vintondale boreholes (3 boreholes in NBBC at Vintondale) near the confluence with the South Branch. PA BAMR and BCWA continue to monitor the discharge. Flows from this discharge have been as high as 750 gpm. This site has been proposed for construction of a passive treatment system.

1.9.6 South Branch Blacklick Creek

AMD & ART, Inc. is remediating a 35 acre site by constructing a passive treatment system surrounded by a native Litmus Garden, an Emergent Wetlands, and an active recreation area. The treatment system being constructed consists of six ponds of limestone and compost designed to raise the pH of the AMD and remove iron and aluminum. The discharge water then flows into a polishing wetland to remove additional iron and aluminum. From the polishing wetland water flows into an emergent wetland before discharging into the SBBC. There are approximately 10 acres of constructed wetlands.

The US Army Corp of Engineers, Pittsburgh District, constructed a passive treatment system for the Webster Mine discharge in Nanty Glo. Two lined vertical flow reactors treat an average of 450 gallons a minute of water that is high in acidity, aluminum, and iron. The water then flows into constructed wetlands where the metals precipitate out of solution before emptying into Pergrin Run. This is the largest source of pollution on the SBBC. Six miles of AMD impacted stream was remediated. Surface water in Pergrin Run has been routed around the Loraine refuse pile. This refuse pile is a major contribution of AMD to SBBC and will be reprocessed at a later date.

Ebensburg Power Company is currently reprocessing the refuse piles in Revloc. The piles are being mined and reclaimed with alkaline circulating fluidized bed ash from the company's power plant in Ebensburg. The Revloc operation is expected to be completed within the next several years. Monitoring wells in the areas where reclamation has been completed are beginning to show significant improvements in water quality. The discharges from the piles contribute high concentrations of aluminum to the SBBC. If reclamation of the Revloc Pile is successful in reducing the acid and aluminum loadings to the SBBC a healthy macroinvertebrate population will be reestablished in a 4.5 mile section of the SBBC from Revloc to Nanty Glo.

The Blacklick Creek Flood Protection Project was completed in the Borough of Nanty Glo. The project involved channel excavation, construction of compacted earth levees and the installation of rock erosion protection along a 4000 foot reach of the SBBC and a 700 foot reach of a tributary to the SBBC. The project also involved construction of a 300 foot long concrete floodwall along the SBBC and approximately 350 feet of concrete rectangle channel.

Coal Pit Run Treatment System is being constructed to treat an abandoned mine discharge near Twin Rocks. Components of the system will include construction of a wetlands and a settling pond.

1.9.7 Blacklick Creek – Main Stem

Laurel Run Treatment System #1 was constructed in 2001. Two parallel vertical flow systems were constructed to treat a discharge from the Upper Freeport mine workings near the headwaters of Laurel Run.

Laurel Run Treatment System #2 has been proposed to treat the only other major discharge in the Laurel Run watershed. This discharge is also located in the headwaters. The proposed system is designed to treat a highwall discharge emanating from the Lower Kittanning abandoned workings. The discharge flows through a cattail "swamp' which is currently directed to a drainage ditch that flows into an un-named tributary to Laurel Run. This tributary was relocated east of its original channel during mining operations. Spoil fill, likely from overburden removal, was pushed into the area currently proposed for construction of a passive treatment system. In addition to the AMD discharge and spoil materials, there is also an existing dangerous highwall exposed at the north end of the site. This highwall is roughly 54 feet high at the northeast corner, and the AMD discharges at the base.

1.9.8 Lower Blacklick Creek

There are no current or completed projects within this watershed.

1.10 Flooding Problems

Marsh Run in Indiana
For the last several decades, flooding has been a problem along Marsh Run in eastern and southern Indiana Borough. In addition to flooding along the stream, erosion of the stream bank is also compounding the problem. In 1997 the PA DEP conducted a study, made recommendations for improvements and pledged state funding to help pay for the improvements. The stream meanders for 5,600 feet through a residential area and under 16 bridges. Topography throughout the area is relatively flat. Funding for the project continues to be delayed. Final design of the project has not been completed.

Clymer Borough
Over the years, flow within Two Lick Creek has been restricted by the buildup of sediment which has created sandbars and islands. The restriction of water flow has caused flooding along the creek in the Clymer area. The hardest hit areas by flooding are Adams and Sherman Streets. A proposed flood control project by the Army Corps of Engineers would control flood waters within the stream channel with the use of levees and expansion of the flood wall. A $1,000,000 commitment from

the State of Pennsylvania will be used to elevate homes along Two Lick Creek above the flood level and remove several homes that cannot be elevated.

1.11 Recreational Features

Yellow Creek State Park is located between Indiana and Ebensburg on Route 422. The park has over 3,000 acres available for recreational use. There are over 5 miles of hiking trails. The 720 acre lake is well stocked with warm-water game fish for fishing. Up to 20 horsepower motor boats are permitted on the lake. A large beach is open during the summer for swimming. Picnic tables are located throughout the day use area. Winter activities include ice fishing, iceboating and cross-country skiing. Hunting is permitted in certain areas.

Two Lick Creek Reservoir located east of Indiana is owned by EME. Boating rights are leased to a local association. Larger horsepower boats are permitted on the reservoir. Water skiing is permitted. State Game Lands abut several miles of shoreline providing access for fishing.

Duman Lake County Park is located on Route 271 between Belsano and Nicktown. The lake is owned by the Pennsylvania Fish and Boat Commission and operated by the Cambria County Parks. This 70-acre park offers picnic facilities, playing fields and courts, and a children's train. The 60 acre lake is well stocked for fishing.

The Hoodlebug Trail extends seven miles from Indiana to Red Barn along Route 119. With the widening of Route 119 between Homer City and Route 22 an extension of the bike trail will pass through Saylor Park in the village of Blacklick and end a Cornell Road in Blairsville. Several sections of the trail parallel the Two Lick Creek. The trail is open year round for hiking, biking and cross-country skiing.

The Ghost Town Trail currently extends 16 miles from Ebensburg to Dilltown along the Blacklick Creek. A second section is under construction from Heshbon to Saylor Park in Blacklick where it will link with the Hoodlebug Trail extension. The Indian Trails Council is searching for addition funding to complete the missing link. The Rexis Branch extends four miles from Vintondale to Route 422 along the North Branch Blacklick Creek. The trail is open year round for hiking, biking and cross-country skiing.

The rails-to-trails project in Clymer will extend from Sample Run Park at the south end to Lee Street at the north end. It will be 1 ¼ miles long run along an abandoned rail bed.

The Blacklick Valley Natural Area is managed by the Indian County Parks. It is located along the Ghost Town Trail near Dilltown and straddles the Blacklick Creek. There are six miles of hiking and cross-country ski trails.

Brush Creek, Laurel Run which flows into Yellow Creek, Two Lick Creek – South Branch, Repine Run, Yellow Creek to the Route 954 Bridge and Little Yellow Creek in Indiana County are currently stocked with trout by the Pennsylvania Fish and Boat Commission. Blacklick Creek – North Branch and Stewart Run in Cambria County are stocked with trout. Stewart Run, Brush

Creek Pompey Run and Repine Run support wild brook trout populations. Several other small tributaries also support native brook trout populations.

There are several State Game Lands located within the watershed. State Game Lands (SGL) 79 is located within the South Branch Blacklick Creek watershed, and borders the creek for approximately five miles. SGL185 is located in the headwaters of the South Branch Blacklick Creek watershed. SGL 248 (829 acres) surrounds a large section of Two Lick Reservoir. SGL 273 is located within the Yellow Creek watershed. SGL 276 (3,941 acres) is located in the Blacklick Creek – Main Stem between Heshbon and Josephine.

There are several streams within the watershed suitable for canoeing, rafting, and kayaking especially during the spring of the year. One of the more scenic sections of the Blacklick Creek is between Heshbon and Josephine. The stream elevation drops quickly creating cascades and rapids.

2.0 DATA COLLECTION

The following sub-sections provide a description of the data collection procedures used and data sources queried to achieve the assessment objectives. For this assessment, a combination of existing and newly acquired water quality data were used

2.1 Existing Data

In order to develop a complete assessment of the study area, Kimball completed an existing data search and gathering effort. The following procedures were used to collect the existing data used in this assessment:

1. Telephone Surveys – Several local, state, and federal agencies were contacted by telephone to solicit input and data associated with the study area and objectives of the assessment.

2. Internet Investigations – Several internet web sites were visited in order to identify and retrieve pertinent data. Sites included the United States Environmental Protection Agency (USEPA), Pennsylvania Department of Environmental Protection (PADEP), and the United States Geological Survey (USGS). Data identified were downloaded for use in the assessment.

3. Office Visits – When direct investigation of local and/or state files was required, Kimball personnel conducted office visits to review hard copies of information kept in agency files. Offices visited included the PADEP Bureau of Abandoned Mines Reclamation, Ebensburg (BAMR); and District Mining Operations in Ebensburg.

Local citizens, regulatory agencies, and non-profit organizations were contacted requesting any information related to AMD discharge and stream water quality data within the study area. **Tables 1 and 2**, provide a listing of sources of analytical/physical data by stream monitoring point and AMD/NPS location respectively. The following sub-sections present a brief summary of data received from each major category.

2.1.1 Local /Non-Profit Organization Input

Kimball was an active participant in meeting held by the BCWA to gather local input regarding data and information. Meeting attendees were solicited to identify AMD discharges and mark the locations on USGS topography maps.

Non-profit organizations such as the Environmental Alliance for Senior Involvement (EASI) and the Kiski-Conemaugh Stream Team provided water quality data for both streams and discharges throughout the watershed.

Indiana University of Pennsylvania provided results of a recent assessment of the Upper Two Lick Creek. Stream and discharge water quality data were extracted and included in the project database/GIS.

2.1.2 Regulatory Agency Input

Several local, state, and federal regulatory agencies were contacted for available data. Inquiries to these agencies resulted in the following:

The Pennsylvania Department of Environmental Protection (PADEP) provided or made available a significant portion of the current assessment database. Information included mine permit data, Operation Scarlift Reports, recent TMDL studies for Elk Creek and South Branch Blacklick Creek, 1997 assessments of the Redmill and Diamondville discharges, a 2002 assessment of Coalpit Run, an assessment of south Branch Blacklick Creek and a 1999 assessment of Two Lick Creek. In addition, the PADEP also provided listings and data associated with permitted discharges within the watershed including public and private water treatment plants. These locations are included in the project database/GIS.

The United States Geological Survey (USGS) provided stream gauge data from 15 locations throughout the watershed. Water quality data were extracted and included in the assessment.

United States Environmental Protection Agency (USEPA) stream water quality data were provided from three stations within the watershed. Water quality data were extracted and included in the assessment.

The United States Army Corp of Engineers (ACOE) provided data related to a study of the Webster mine discharge including discharge and stream water quality. Water quality data were extracted and included in the assessment.

The Indiana County Conservation District provided water quality data and GIS layers associated with a 2002 assessment covering the watershed in both Indiana and Cambria counties.

2.1.3 Other Data Sources

Other data sources contacted regarding pertinent data included various internet data clearing houses such as PASDA. Data downloaded from these and other similar sites generally consisted of data layers for use in the final assessment GIS such as area geology, rivers and streams, roads, mined areas and municipalities. Sites hosted by most of the agencies listed in Section 2.1.2 above were visited as well as sites hosted by the PADEP Bureau of Watershed Management.

The Spatial Sciences Research Center (SSRC), affiliated with Indiana University of Pennsylvania's Department of Geography and Regional Planning, provided the acquisition of varies types of data layers from various sources, digitizing mapping, and data entry of hard copy data.

2.2 Current Sampling

As part of this assessment, water quality data were obtained through the collection of stream and discharge water samples. Sixty total locations were sampled monthly over a twelve month period in order to provide additional information for the current assessment and fill known data gaps within the watershed.

Thirty five discharges and twenty five stream locations were sampled for the assessment. Sample locations per watershed sub-division were as follows:

Watershed	**Discharge**	**Stream**
Blacklick Creek Main Stem	16	11
Blacklick Creek North Branch	3	3
Lower Two Lick Creek	5	4
Lower Yellow Creek	2	2
Tearing Run	6	3
Upper Two Lick Creek	3	2

Specific monitoring locations are presented below. At each location, water quality samples collected were analyzed for flow, specific conductance, pH, alkalinity, acidity, iron, manganese, aluminum, sulfate, total suspended solids, and total dissolved solids.

Location ID	Sample ID	Name	Type
Blacklick Creek Main Stem			
BCMS-001	MB-25	Bells Mill Mine	Discharge
BCMS-006	MB-21	Crichton Coal & Coke Co. Mine	Discharge
BCMS-013	MB-4	Artesian shaft	Discharge
BCMS-040	MB-18	Drift Mine	Seep
BCMS-066	MB-12	Strip Mine	Discharge
BCMS-070	MB-7	Refuse Pile	Seep
BCMS-074	MB-24	Dunkard Creek Coal Co.	Discharge
BCMS-183	MB-22	Laurel Run	Stream
BCMS-194	MB-13	Discharge Sample	Discharge
BCMS-196	MB-20	Laurel Run	Stream
BCMS-204	MB-3	Blacklick Creek	Stream
BCMS-206	MB-5	Blacklick Creek	Stream
BCMS-209	MB-16	Blacklick Creek	Stream
BCMS-214	MB-17	Virginian No. 14 Mine	Discharge
BCMS-215	MB-1	Blacklick Creek above Rummel Run	Stream
BCMS-216	MB-11	Oneida - Deep mine discharge	Discharge
BCMS-217	MB-14	Discharge from refuse piles	Discharge
BCMS-218	MB-15	Deep mine discharge at Heshbon	Discharge
BCMS-220	MB-19	Refuse pile discharge at Hesbon	Stream
BCMS-221	MB-2	Rummel Run at the mouth	Stream
BCMS-222	MB-23	Seeps near old strips, near Rte. 22 peak	Discharge
Location ID	Sample ID	Name	Type

Blacklick Creek Main Stem continued			
BCMS-223	MB-26	Blacklick Creek at Bells Mills	Stream
BCMS-224	MB-6	Discharge across stream from Scott Glen	Discharge
BCMS-225	MB-8	Blacklick Creek above Oneida Mine	Stream
BCMS-226	MB-9	Aulds Run above Oneida	Stream
BCMS-237	NB-7	NB Blacklick Creek at South Branch	Stream
BCMS-252	MB-10	Deep Mine entry along Rte. 56	Discharge
Blacklick Creek North Branch			
BCNB-001	NB-5	RedMill Mine, Mine #16	Discharge
BCNB-005	NB-6	Red Mill Mine & Refuse discharge	Discharge
BCNB-010	NB-1	Refuse Pile seep	Seep
BCNB-013	NB-2	Mouth of California Run	Stream
BCNB-032	NB-4	NB Blacklick Creek above Red Mill discharge	Stream
BCNB-039	NB-3	Elk Creek before NB Blacklick	Stream
Lower Two Lick Creek			
LTLC-001	LT-6	Potter Mine	Discharge
LTLC-012	LT-7	Heavy borehole discharge - aluminum etc.	Discharge
LTLC-014	LT-8	Homer City Borehole Discharges	Discharge
LTLC-034	LT-2	Allan Run	Stream
LTLC-051	LT-1	Penn Hills No. 1 Mine	Discharge
LTLC-060	LT-3	Twolick Creek above sewage treatment plant	Stream
LTLC-061	LT-4	Risinger Shaft Discharge - Homer City	Discharge
LTLC-062	LT-5	Twolick Creek at Rt. old Rt. 56 bridge	Stream
LTLC-063	LT-9	Twolick Creek at mouth	Stream
Lower Yellow Creek			
LYC-069	YC-1	YC Rt. 954 Bridge	Stream
LYC-085	YC-4	Yellow Creek at the Floodway Park	Stream
LYC-086	YC-2	Lucierne #2 Borehole under Rt. 119	Discharge
LYC-094	YC-3	Weir at wetlands near Rt. 119 bridge	Discharge
Tearing Run			
TR-002	TR-1	Drift Mine	Discharge
TR-005	TR-5	Waterman Mine discharge	Discharge
TR-046	TR-9	Tearing Run	Stream
TR-048	TR-7	Snyder No. 1 Mine #1	Discharge
TR-049	TR-6	Snyder No. 1 Mine #2	Discharge
TR-052	TR-8	Tearing Run Mine	Discharge
TR-054	TR-2	Tearing Run above discharge	Stream
TR-055	TR-3	Tearing Run discharge	Discharge
TR-056	TR-4	Tearing Run above Snyder Mines	Stream
Location ID	Sample ID	Name	Type
Upper Two Lick Creek			

UTLC-134	UT-5	Penns Run	Stream
UTLC-173	UT-4	Cherryhill No. 1 and Victor No. 47 Mines	Discharge
UTLC-234	UT-1	South Branch Twolick Creek	Stream
UTLC-235	UT-2	Starford Area - Refuse Piles	Discharge
UTLC-236	UT-3	Surface mine discharge below Clymer	Discharge

The Spatial Sciences Research Center (SSRC), affiliated with Indiana University of Pennsylvania's Department of Geography and Regional Planning, provided coordination of the sampling effort.

3.0 DATA EVALUATION AND COMPILATION

The following sub-sections provide a description of the data evaluation and compilation procedures and results.

3.1 Procedures

Data evaluation and compilation were conducted using a three-phase process. First, each data set received was evaluated for relevance, completeness, accuracy, and usability. A listing of the data provided was produced indicating the type of data received, quality of the data, year of data collection, critical entries (coordinates, flow, water quality, etc.), and duplication within the set.

Once the listing was complete for each data set, a comparative analysis between data sets was performed to evaluate and determine which information was the most complete and accurately reported across all data sets. The result of this effort was to merge several data sets from several different sources into one coherent data set.

Finally, reported data collection and AMD/NPS locations were compared via coordinates (if supplied), name, reported location, and other criteria to evaluate which data locations are or could be the same between data sources. When possible, locations provided without coordinates were matched with data locations provided by the regulatory agency and plotted in the evaluated location. Similarly, data provided by separate regulatory agencies (with coordinates) were compared and matched.

3.2 Data Evaluation

Each of the data sets received, as described in section 2.0 above, were evaluated using the above procedure. In general, most data contained coordinates, names of discharges, and complete water quality data over a range of dates. Analysis of these data sets resulted in the use of the following analytical and physical data parameters in the assessment:

- Flow (gallons per minute)
- pH
- Acidity
- Aluminum
- Iron
- Manganese
- Sulfate

3.3 Identified Data Gaps and Evaluation Concerns

In general, a few concerns were raised during the evaluation of the available data. The most notable were the lack of flow data associated with much of the sampling data (approximately 25% of the data), differences in analytical procedures and reporting, and the lack of information pertaining to how samples were collected and/or how field parameters (pH, flow, etc.) were determined. Without this information, comparison of results at a single location or between locations is very qualitative at best. The following paragraphs describe concerns associated with and between the most prevalent data obtained.

Table 3 and Table 4 present the number of sample results obtained for each stream monitoring point and NPS/AMD location respectively. Although a large amount of data was gathered for the assessment, it represents a relatively limited analysis of the study area's water quality and impacts. The majority of assessments and studies completed within the watershed focused primarily on AMD impacts to the streams which in turn focused the efforts on the upper portions of the watershed. Little to no data has been produced in regard to other stream impacts. The following paragraphs describe concerns associated with and between the most prevalent data obtained

Infrequent Sampling Events
Although very comprehensive, a large portion of the project database is made of short term or "snapshot" data collection episodes with limited information regarding exact sample locations or descriptions. In addition, data associated with the Operation Scarlift reports are dated as these assessments were completed in the early 1970's

Lack of Flow Data
A large portion of the data supplied by the PADEP represents AMD samples collected in the vicinity of an active or inactive mining permit. Unfortunately, flow measurements are not required. Data entered into the database were entered sporadically. At most locations, quarterly water quality data over a two-year period do not exist. This information would be useful to determine seasonal water quality changes. The lack of flow data at the time of sample collection limits evaluations based on contaminant loading.

4.0 DATA ANALYSIS AND SITE PRIORITIZATION

Once the data evaluation and compilation processes described in Section 3.0, above, were completed, the data were analyzed utilizing the project database and GIS. Data analysis activities were divided into two phases separating stream/river water quality analysis and NPS/AMD discharge water quality analysis.

4.1 Location Designation

Table 5 presents the entire list of reported stream water quality monitoring locations, by sub-watershed, that could be plotted based on supplied coordinates or a provided map location. All reported and pertinent information is presented including site identifications, names, source, coordinates (provided by source), etc. When possible, monitoring point identification numbers were retained in the database as originally reported by the data source.

In addition, possible corresponding identifications based on criteria described in Section 3.1 above are provided. Based on the corresponding locations determined through the cited evaluation, a total of 344 unique locations were identified.

Table 6 presents the entire list of reported discharge locations, by sub-watershed, identified through the data gathering process and that could be plotted based on either supplied coordinates or a provided map location. All reported and pertinent information is presented including site identifications, names, source, coordinates (provided by source), etc. When possible, location identification numbers were retained in the database as originally reported by the data source.

In addition, possible corresponding identifications, based on criteria described in Section 3.1 above, are provided. Based on the corresponding locations determined through the cited evaluation, a total of 492 unique discharge locations were identified within the watershed

Table 7 presents the distribution of reported discharges and other point source discharge locations by sub-watershed.

4.2 Water Quality Data Analysis

Stream monitoring point data analysis included monitoring point designation, average pH evaluation, and average contaminant concentration evaluation. Results of the evaluation were compared to the results of recent TMDL studies and other assessments within the watershed. Conclusions regarding the stream water quality for the watershed were then developed. Results of the stream water quality data analysis were used to aid in the prioritization of NPS sites.

Similar to the stream monitoring points described above, steps in the discharge data analysis included site designation, average flow, pH, and contaminant concentration evaluation. In addition, average contaminant loading and acid loading evaluations were made. Discharge sites were then quantitatively ranked based on the evaluation of the collected data.

As noted above, several data comparison concerns dictated the data analysis process. The following sections describing data analysis procedures and results include descriptions of the points where these concerns may influence the interpreted results.

4.2.1 Stream Physical and Analytical Data Analyses

Data analysis for stream monitoring locations consisted of an evaluation of average pH, and average total contaminant concentrations for a combination of select indicator parameters (Aluminum, Iron, Manganese, Sulfate and Acidity) for each watershed. The analysis of average contaminant concentrations of selected indicator parameters was completed to provide the basis for later comparative analysis. For each parameter, the number of samples and the average concentration was calculated. A final average of the select indicator parameters was then calculated and the data sorted from highest average concentration to lowest concentration.

In all cases, averages were calculated to account for variations in the date samples were collected and measurements were made and in the number of samples/measurements collected, and in order to provide overall evaluations among data collected by different sources.

4.2.2 Discharge Physical and Analytical Data Analyses

Based on the data received, several data analysis steps were performed to evaluate and compare discharge locations. Data analysis was conducted by first evaluating average flow rates, average pH, and average contaminant concentrations for each select indicator parameter (Aluminum, Iron, Manganese, Sulfate and Acidity). The analysis of contaminant concentrations independent of flow was a necessary step in the evaluation process. In general, evaluation and prioritization of discharges are usually based on contaminant loading which factors the flow rate of the discharge with the contaminant concentrations. Due to the nature of the existing data available for the study area, the additional analysis of contaminant concentrations independent of flow was required for comparative analysis of analytical results without accompanying flow data (loadings cannot be calculated) and results with flow data. The problem does not only exist between locations but it also exists within the data for an individual location. By evaluating both total concentrations and contaminant loading, a more complete comparative analysis can be achieved. The analysis was completed to provide a general overview of each parameter independently and a total average to provide the basis for later comparative analyses between the data sets.

Second, average contaminant loadings were calculated, when possible, to provide the basis for evaluating the contributions of each discharge to the total watershed contamination. This analysis was also completed to provide an independent overview of each analytical parameter independently and provide the basis for later comparative analysis.

For each data analysis set described above, ranking criteria were developed and applied. The ranking criteria varied between data sets based on the type of data analyses conducted and amount of raw data available. The following subsections present a more in-depth discussion of the data analyses and the ranking criteria.

Water Quality Analysis The following data tables presenting the water quality analysis (independent of flow) for each watershed were formatted to provide results of individual parameters as well as an overall evaluation of the watershed. For each discharge, the data table contains the number of analyses for each parameter, the average concentration, a rank factor and rank. The ranking factor was introduced based on the number of samples available at each location and the date range of said samples. In general, for each sample location containing only one sampling event conducted post 1990, the resultant average concentration was multiplied by a factor of 0.5 to account for the lack of information and provide a conservative concentration during lower flow periods. Similarly, for each sample location with only one sampling event conducted pre 1990, the resultant average concentration was multiplied by an additional factor of 0.167 (aggregate factor of 0.33) to account for generally higher contaminant concentrations that are not as representative of current conditions. Each parameter was then sorted by the ranking factor (maximum to minimum) and the locations assigned a rank based on the resulting order.

Finally, an average of the individual parameter rankings was calculated for each discharge to provide an overall water quality rank of the sites.

Discharge Loading Analysis Similar to the analyses described above, average contaminant loadings were calculated for each reported discharge location that contained the required flow data. The table formats are identical to the formats described above presenting for each parameter the number of analyses, the average loading, a rank factor and rank. For the each parameter loading analysis, a ranking factor was calculated as described above. Each parameter was then sorted by the ranking factor (maximum to minimum) and the locations assigned a rank based on the resulting order

Finally, an average of the individual parameter rankings was calculated for each discharge to provide an overall discharge loading rank of the sites

4.3 Quantitative Ranking of Discharge Locations

Prior to the final quantitative ranking of the discharge locations, one final adjustment to the available data was performed. The data available for a few watersheds, specifically the Main Stem and South Branch Blacklick Creek, includes locations that were only evaluated during Operation Scarlift. In order to provide a more accurate analysis of the watersheds, locations containing data exclusively from the Operation Scarlift assessments were eliminated from further data analysis and final ranking. The locations and data averages have been retained at the bottom of each data table and the project database but were not included in the final ranking

Once the discharge locations evaluated exclusively during Operation Scarlift were removed, the analyses described in **Sections 4.2.1 to 4.2.2**, above were combined to provide an overall quantitative ranking of discharge sites per watershed. The final water quality average rank and final discharge loading average rank were combined for each discharge and a final numerical rank assigned.

4.4 Priority List of AMD/Impacted Areas

Based on conclusions reached in the evaluation of the stream water quality data analysis and evaluation of the final discharge ranking, Kimball then compiled the following priority list of impacted areas/sites for each watershed:

Assessed Rank	Site	Name	Sub-watershed
Blacklick Creek Main Stem			
1	BCMS-214	Virginian No.14	Aulds Run
2	BCMS-112	Deep Mine Discharge	Blacklick Creek
3	BCMS-111	Deep Mine Discharge	Blacklick Creek
4	BCMS-013	Artesian Shaft	Ramsey Run
5	BCMS-001	Bells Mill Mine	Blacklick Creek
6	BCMS-066	Strip Mine	Blacklick Creek
7	BCMS-252	Deep Mine entry along Rte. 56	Blacklick Creek
8	BCMS-194	Discharge Sample	Blacklick Creek
9	BCMS-217	Discharge from refuse piles	Blacklick Creek
16	BCMS-216	Oneida – Deep mine discharge	
Blacklick Creek North Branch			
1	BCNB-001	Redmill Mine #16	N. Br. Blacklick Creek
2	BCNB-005	Red Mill Mine and refuse	Elk Creek
Assessed Rank	Site	Name	Sub-watershed
3	BCNB-010	Refuse Pile Seep	N. Br. Blacklick Creek
Blacklick Creek South Branch			
1	BCSB-124	Discharge #6 SBBC Project R-2A	S. Br. Blacklick Creek
3	BCSB-164	Discharge MP-14	S. Br. Blacklick Creek
4 8	BCSB-099 BCSB-100	Discharge #2and #3 SBBC Proj 4(A) and 4(B)	S. Br. Blacklick Creek
5	BCSB-080	Mine Discharges to CPR Site 6	Coalpit Run
6	BCSB-065	Mine Discharge to CPR Site 12	Coalpit Run
7	BCSB-079	Mine Discharges to CPR Site 5	Coalpit Run
9	BCSB-066	Mine Discharge to CPR Site 13	Coalpit Run
10	BCSB-068	Mine Discharge to CPR Site 15	Coalpit Run
11	BCSB-017	Drift Mine SBBC Proj. MP7	S. Br. Blacklick Creek
12	BCSB-112	Deep Mine West Area CPR Site 2	Coalpit Run
Upper Two Lick Creek			
1	UTLC-191	Discharge SW of Clymer (IUP Site 1)	Two Lick Creek
2	UTLC-220	Diamondville Discharge	Two Lick Creek
7	UTLC-236	Surface mine discharge below Clymer	Two Lick Creek
10	UTLC-180	Buterbaugh/Harve Mack Mine #2 (IUP Site 12)	N. Br. Two Lick Creek
12	UTLC-145	Victor No. 29 mine, seeps (IUP site 2)	Dixon Run
13	UTLC-223	Discharge to NB Two Lick Creek (IUP Site 9)	N. Br. Two Lick Creek
14	UTLC-231	Discharge to Buck Run (IUP Site 4)	Buck Run
17	UTLC-232	Large Seep to Two Lick Creek (IUP Site 5)	Two Lick Creek
19	UTLC-173	Cherryhill No. 1 and Victor No. 47 Mines	Two Lick Creek
21	UTLC-193	Discharge to NB Two Lick Creek	N. Br. Two Lick Creek
Lower Two Lick Creek			

1	LTLC-061	Risinger Shaft Discharge Homer City	Two Lick Creek
3	LTLC-014	Homer City Borehole Discharges	Two Lick Creek
4	LTLC-001	Potter Mine	Two Lick Creek
5	LTLC-012	Heavy Borehole Discharge	Cherry Run
7	LTLC-064	Josephine Borehole AMD Discharge GW-9	Two Lick Creek
8	LTLC-051	Penn Hills No. 1 Mine	Two Lick Creek
Tearing Run			
1	TR-005	Waterman Mine Discharge	Tearing Run
2	TR-052	Graceton No. 3	Tearing Run
5	TR-049	Snyder No. 1 Mine #2	Tearing Run
7	TR-055	Tearing run Discharge	Tearing Run
8	TR-019	Seep	Tearing Run
14	TR-002	Drift Mine	Tearing Run
Upper Yellow Creek			
2	UYC-042	Deep mine Discharge	Leonard Run
3	UYC-007	Deep mine Discharge	Little Yellow Creek
Lower Yellow Creek			
1	LYC-095	Discharge below ACV refuse pit	Yellow Creek
2	LYC-088	Judy #14 Discharge	Yellow Creek
3	LYC-086	Lucerne #2 Borehole under Rt. 119	Yellow Creek
4 15	LYC-080 LYC-079	Tide Refuse Pile Seep	Yellow Creek
Assessed Rank	Site	Name	Sub-watershed
9	LYC-094	Weir at wetlands near Rt. 119 bridge	Yellow Creek
10	LYC-026	Mine Discharge	Yellow Creek
11	LYC-097	Deep mine discharge SE of tide	Yellow Creek
16 18 19	LYC-030 LYC-029 LYC-028	Mine Discharge	Yellow Creek
17	LYC-083	Lucerne #3 Mine	Yellow Creek
20	LYC-021	Deep mine Discharge	Yellow Creek

In general, the priority list of sites for each watershed generally mirrors the final quantitative rankings described above. The only exception is the elimination of several sites from each priority list that were evaluated based on a single sampling event. These locations, although included in the quantitative ranking, were evaluated as containing insufficient data necessary to provide treatment recommendations and analysis.

Also, several priority sites are represented by two or more sources. In each case, sites were selected for grouping based on proximity and likelihood of representing discharges from the same mine pool or other source. This strategy was used to provide the end users with options for addressing individual sites or groups of sites as appropriate. However, the site grouping does not represent that sites can be treated as a group. It is assumed that additional data will be accumulated prior to application for funding. Any treatment design would require additional site specific analysis

More detailed descriptions of each site including range of flows; general water chemistry and site specific comments are summarized for each watershed below. In each case, referenced data tables are provided in individual tabs for each watershed at the end of this report. Priority locations are depicted on **Figure 11**.

Blacklick Creek – Main Stem

Discharge and stream sample locations in the Main Stem Blacklick Creek watershed are depicted on **Figure 3**.

Stream Analysis – **Table 8** presents the analysis of stream water quality. Analysis of the stream water quality data indicates low average pH values (< 5.0) along the length of the main stem from Vintondale to the mouth of Two Lick Creek. Tributaries entering the Main Stem generally exhibit higher pH values with the exception of Laurel Run with several recorded values of less than 5.0 and an unnamed tributary at the eastern end of the watershed with recorded values of less the 4.0. Average contaminant concentrations are relatively low (10 mg/l) along the length of the stream. Higher concentrations are evident within Mardis Run before entering the Main Stem, within an unnamed tributary entering the Main Stem form the north near the center of the watershed (with potential impairments evident downstream in the Main Stem) and along the length of Laurel run.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 9** and **Table 10**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 65 discharge locations were included in the final ranking. **Table 10** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 10** were included in the final prioritization.

Tables 9 and **10** also present the discharge locations with available water quality data from Operation Scarlift (1973-1974) only (bottom of each table). As discussed in Section 4.3 above, these locations were extracted from the list of discharges and evaluated independently. Forty eight locations monitored during Operation Scarlift and that could not be readily identified as one of the more recently monitored discharge locations are included in the extracted list. These locations were evaluated in a similar fashion as described above to provide a preliminary ranking. Additional investigation regarding the current disposition of these reported discharges and their potential to be representative of more recently evaluated discharges should be conducted.

Priority Sites – Table 11 presents the final priority listing for the Blacklick Creek Main Stem. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Ten priority locations were identified within the Main Stem Blacklick Creek spanning three sub-watersheds. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the ten priority listings, six locations were passed over between the ninth and tenth ranked priority sites. The six locations were passed over in favor of the Oneida deep mine discharge which represents the next largest Aluminum and Iron load to the watershed after the first nine priority sites. Of the six locations passed in the final prioritization, two contained only one monitoring event and two did not contain aluminum results for evaluation.

Blacklick Creek – North Branch

Discharge and stream sample locations in the North Branch Blacklick Creek watershed are depicted on **Figure 4**.

Stream Analysis – **Table 12** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH values (> 6.0) in the watershed with most data collected along Elk Creek. Relatively lower pH values are evident along Crooked Run and the headwaters of Elk Creek which improve downstream to the confluence with North Branch. Relatively low pH values are also evident along the North Branch where Carney Run enters the stream to the mouth of the North Branch. Similar to the distribution of pH values, Average contaminant concentrations are relatively high near the headwaters of Elk Creek and along Crooked Run. Water quality of Elk Creek appears to improve a short distance down stream of the mouth of Crooked Run however impacts are evident in Elk Creek. Water quality below Little Elk Creek appears to remain rather consistent into the North Branch and to the mouth of the North Branch Blacklick Creek.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 13** and **Table 14**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 3 discharge locations were included in the final ranking. **Table 14** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 14** were included in the final prioritization.

Priority Sites – Table 15 presents the final priority listing for the Blacklick Creek North Branch. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Three priority locations were identified within the North Branch Blacklick Creek spanning two sub-watersheds. An explanation of treatment options is provided in Section 5.0 below.

Blacklick Creek – South Branch

Discharge and stream sample locations in the South Branch Blacklick Creek watershed are depicted on **Figure 5.**

Stream Analysis – **Table 16** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH values (> 5.0) in the watershed. Relatively low pH values are evident along Coalpit Run with average pH values below 4.0, and along Braken Run and an unnamed tributary before Bracken Run. Impacts to the South Branch Blacklick Creek are evident downstream of each of these tributaries. Average contaminant concentrations are greatest near Revloc (10 to 50 mg/l) with impacts evident approximately one mile downstream. Water quality along the South Branch appears to improve until the town of Nanty Glo where concentrations again increase relatively dramatically (> 50 mg/l). Water quality appears to improve slightly before Coalpit Run where increased concentrations are evident (4 to 8 mg/l). Impacts from Coalpit Run are evident to the confluence with the Main Stem.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 17** and **Table 18**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 42 discharge locations were included in the final ranking. **Table 18** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 18** were included in the final prioritization.

Tables 17 and **18** also present the discharge locations with available water quality data from Operation Scarlift (1973-1974) only (bottom of each table). As discussed in Section 4.3 above, these locations were extracted from the list of discharges and evaluated independently. Twenty locations monitored during Operation Scarlift and that could not be readily identified as a more recently monitored discharge location were included in the extracted list. These locations were evaluated in a similar fashion as described above to provide a preliminary ranking. Additional investigation regarding the current disposition of these reported discharges and their potential to be representative of more recently evaluated discharges should be conducted.

Priority Sites – Table 19 presents the final priority listing for the Blacklick Creek South Branch. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Ten priority locations were identified within the South Branch Blacklick Creek spanning two sub-watersheds. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the ten priority listings, one location (Webster discharge) was passed over as treatment has recently been initiated.

<u>Lower Blacklick Creek</u>

Discharge and stream sample locations in the Lower Blacklick Creek watershed are depicted on **Figure 6.**

Stream Analysis – **Table 20** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH values (> 6.5) in the watershed. Average contaminant concentrations Indicate little to no impacts within the watershed with the highest average concentration (< 5 mg/l) near the town of Blacklick and just downstream of the confluence of the Main Stem Blacklick and Two Lick Creeks.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 21** and **Table 22**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 9 discharge locations were included in the final ranking.

Priority Sites – Discharge data available for this watershed was generated exclusively during Operation Scarlift. As such, Kimball did not attempt to prioritize sites. However, review of the available discharge data and the stream water quality; it appears there are little to no impacts within the watershed (Aluminum and Iron loadings < 12 pounds/day).

<u>Upper Two Lick Creek</u>

Discharge and stream sample locations in the Upper Two Lick Creek watershed are depicted on **Figure 7.**

Stream Analysis – **Table 23** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH values (> 5.0) in the watershed. Relatively low pH values are evident near the headwaters of the North Branch Two Lick Creek and along Penn Run in the southern portions of the watershed. Relatively lower pH values are evident along Dixon Run and Buck run but impacts are not evident within Two Lick Creek. Average contaminant concentrations are generally low throughout most of the watershed with increased average values evident near the mouths of Dixon Run and Buck Run (> 5 mg/l). Similar contaminant concentrations are also evident along the length of Penn Run in the southern portion of the watershed (> 7 mg/l).

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 24** and **Table 25**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 82 discharge locations were included in the final ranking. **Table 25** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 25** were included in the final prioritization.

Priority Sites – Table 26 presents the final priority listing for the Upper Two Lick Creek. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Ten priority locations were identified within the Upper Two Lick Creek spanning four sub-watersheds. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the ten priority listings, 11 locations, each represented by only one monitoring event, were passed over. These locations were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations.

Lower Two Lick Creek

Discharge and stream sample locations in the Lower Two Lick Creek watershed are depicted on **Figure 8.**

Stream Analysis – **Table 27** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH values (> 5.0) throughout most of the watershed. Extremely low pH values (< 4.0) are evident along Allen Run which flows directly into the Two Lick Reservoir. Blow the reservoir, pH values are good until the confluence with Yellow Creek and Tearing Run where values drop of below 5.0 again. Impacts from Yellow Creek and Tearing Run are evident to the mouth of Two Lick Creek. Average contaminant concentrations are only available along Allen Run and below Yellow Creek within the watershed. As expected, average concentrations are relatively high along Allen Run and impacts form Yellow Creek and Tearing Run are evident at least two miles downstream.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 28** and **Table 29**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 10 discharge locations were included in the final ranking. **Table 29** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 29** were included in the final prioritization.

Priority Sites – Table 30 presents the final priority listing for the Upper Two Lick Creek. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Six priority locations were identified within the Lower Two Lick Creek spanning two sub-watersheds. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the six priority listings, four locations, each represented by only one monitoring event, were passed over. These locations were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations.

Tearing Run

Discharge and stream sample locations in the Tearing Run watershed are depicted on **Figure 8.**

Stream Analysis – **Table 31** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally low pH values (< 4.0) along Tearing Run from the headwaters to the mouth at Two Lick Creek. More moderate pH values are evident in unnamed tributaries south and north however the impacts are not evident along Tearing Run. Average contaminant concentrations are highest near the town of Waterman probably due to refused piles in the area. Better quality water enters the stream from the north just west of Waterman and appears to have an impact on Tearing Run. However, the water quality degrades again as higher average concentrations enter the stream from tributaries near the town of Tearing Run. Impacts are evident to the streams mouth at Two Lick Creek.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 32** and **Table 33**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 25 discharge locations were included in the final ranking. **Table 33** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 33** were included in the final prioritization.

Priority Sites – Table 34 presents the final priority listing for Tearing Run. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Six priority locations were identified within the Tearing Run watershed. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the six priority listings, six locations, each represented by only one monitoring event, were passed over. These locations were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Also, two additional locations were passed over because treatment has been initiated and is ongoing.

Upper Yellow Creek

Discharge and stream sample locations in the Upper Yellow Creek watershed are depicted on **Figure 9.**

Stream Analysis – **Table 35** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH (> 6.0) throughout the watershed. Impacts are not apparent based on the pH values. Increased average contaminant concentrations are evident at the headwaters of Little Yellow Creek, along Leonard Run, and at the headwaters area of Yellow Creek. However, the impacts do not appear to be far reaching along the streams. Note that the available data for this watershed is generally based on a single "snapshot" sampling event.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 36** and **Table 37**, respectively.

Each table is sorted based on the final ranking for the individual analysis. In general, three discharge locations were included in the final ranking. **Table 37** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 37** were included in the final prioritization.

Priority Sites – Table 38 presents the final priority listing for Upper Yellow Creek. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Two priority locations were identified within the Upper Yellow Creek watershed. Note, however that the water quality at these discharges is extremely good relative to the surrounding watersheds. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the two priority listings, one location, represented by only one monitoring event, was passed over. This location was excluded from the final prioritization because it was evaluated as containing too little information for later treatment recommendations.

Lower Yellow Creek

Discharge and stream sample locations in the Lower Yellow Creek watershed are depicted on **Figure 10.**

Stream Analysis – **Table 39** presents the analysis of stream water quality. Analysis of the stream water quality data indicates generally good pH (> 6.0) in the upper portions of the watershed. Below the Judy #14 and Tide tributaries, average stream pH falls to values closer to 5.0 or less through Homer City. The Tide and Judy #14 tributaries exhibit extremely low pH throughout their lengths. Similar to the pH trends, increased average contaminant concentrations are evident along each tributary with impacts through Homer City. Upstream of the Judy #14 tributary, average contaminant concentrations are generally less than 1 mg/l.

Discharge Analysis – Results of the discharge water quality analysis and the discharge loading analysis, including the final site rankings, are provide in **Table 40** and **Table 41**, respectively. Each table is sorted based on the final ranking for the individual analysis. In general, 39 discharge locations were included in the final ranking. **Table 41** also includes an identification of ranked sites that were excluded from the final priority sites. As discussed above, locations with only one sampling event were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. Shaded locations depicted on **Table 41** were included in the final prioritization.

Priority Sites – Table 42 presents the final priority listing for Lower Yellow Creek. The table is representative of the priority tables throughout this section containing the final assessed rank for each location, the final loading rank, the final water quality rank, site identification and name, sub-watershed, flow range, a summary of water quality, treatment options and comments. Ten priority locations were identified within the Lower Yellow Creek watershed. An explanation of treatment options is provided in Section 5.0 below.

During the process of establishing the ten priority listings, six locations, each represented by only one monitoring event, were passed over. These locations were excluded from the final prioritization because they were evaluated as containing too little information for later treatment recommendations. One additional location (Tide borehole) was passed over as treatment has recently been initiated and is ongoing.

Locations of the prioritized sites for each watershed are depicted on **Figure 11**.

5.0 GENERAL REMEDIATION STRATEGIES

5.1 General Remediation Strategies and Design Standards

As a first step in the recommendation of remediation alternatives for the prioritized sites identified above, a series of broad goals have been established. These goals will be used to assist in the analysis of alternatives and ultimately to assess the performance of the remediation measures.

- The first goal involves the specific chemistry associated with the discharges. This is difficult to summarize since the chemistry will vary with each location, even seasonally, and following precipitation events. However, the general goals for the treatment alternatives will be to achieve typical Title 25 standards for the following parameters at the discharge of each remediation system:

    1. Reduction of iron concentrations to less than 7.0 mg/l
    2. Reduction of aluminum concentration to less than 1.0 mg/l
    3. Reduction of manganese concentrations to the extent practical
    4. pH levels with the range of 6.0 – 9.0
    5. Alkalinity exceeding acidity

- The second goal is to increase public awareness of environmental issues and help to restore a sense of pride and community partnership within the watershed. Since the region has a long history of mining and the associated mine discharge problems, citizens have grown used to seeing orange streambeds devoid of life. Environmental change associated with remediation of mine discharge problems will result in an increase in local interest in the streams. A small (but noticeable) change can have a significant impact on community involvement. As such, it will be important to locate the proposed remediation sites in locations where the improvement will be highly visible to the residents.

- The third goal is to establish a recreational corridor along the various waterways to take advantage of the improving environmental conditions in the streams. This will make the improvements more obvious to the public and further expand public awareness of the need for additional improvements. If possible, the remediation techniques should incorporate walking paths with informational placards describing the treatment methodologies. In addition, signs identifying those groups responsible for the remediation will pay dividends.

Awareness of these three goals will aid in the selection of remediation strategies for each of the prioritized sites. General strategies, which will be evaluated for each site, will include the following:

General Remediation Strategies – In general, there are three approaches to remediation of abandoned mine drainage (AMD) discharges. These are:

Elimination of the source of the discharge
Passive treatment of collected flows

Active treatment of collected flows

Examples of each of these techniques are discussed below:

Elimination of the source of discharge

Where possible, the most cost-effective means of dealing with AMD discharges is to eliminate the source of the discharge. This can involve: capping refuse piles to reduce infiltration through the waste materials, sealing mine openings, preventing upstream recharge of abandoned mines, and reclaiming abandoned sites to eliminate exposed highwalls and deep mine entries. Since these methods are very site-specific, it is difficult to assess their use in this report, and the remainder of the document will generally emphasize the use of passive and active treatment systems. However, it should be noted that these methods should be evaluated for certain sites, especially those where stream flow loss to deep mines has been noted.

Within the Blacklick Creek watershed, source elimination could be a major contributor to watershed restoration given the expansive spoil and refuse piles. It has been reported that some of these activities are currently being conducted such ass the reclamation of soil piles near Revloc. Source elimination could also be a major factor in the restoration of non-AMD impacted streams identified in the watershed.

Passive treatment of collected flows

There are a host of passive treatment methodologies available for remediation of the discharges identified throughout the watershed. Passive treatment is accomplished primarily via contact with limestone, which tends to raise the pH and neutralize the acidity of the flows. In addition, some passive treatment methods utilize sulfate-reducing bacteria and wetland vegetation to assist with the removal of metals. The interaction of the limestone and bacteria can form a complex bio-chemical reaction, which results in a sulfate-reducing environment that promotes the oxidation and precipitation of dissolved metals in the drainage upon aeration. This same process can be achieved in stand-alone wetlands if the influent chemistry is appropriate.

The use of passive treatment is a relatively new process and although there is significant literature available regarding different methods, the systems still tend to be rather experimental in nature. As such, hard design standards have not been generated for these techniques, but various “rules-of-thumb” are included herein for use in sizing the structures.

Passive treatment systems have been shown to be very effective on relatively small discharges, with space for creation of treatment systems identified as the critical issue. As such, for flows with relatively large flows or flows that tend to fluctuate dramatically during precipitation events, passive treatment may not be appropriate. In addition, passive treatment systems do tend to accumulate metal precipitate, which must be removed periodically, and portions of the treatment system may require cleaning or replacement to remove deposition. Some systems also require a considerable initial “breaking-in” period before the sulfate-reducing bacteria are present in sufficient quantity to aid in treating the influent. There is also frequently an initial BOD problem with the discharge, resulting from the compost material used within the treatment system, although this problem tends to decrease rapidly.

The following is a brief discussion of various passive treatment techniques, with special emphasis on the site conditions that are appropriate for use of these methods, as well as general design considerations for use.

Aerobic Wetlands - These systems are man-made pools or enhancements of existing swampy areas, which tend to be the simplest and least expensive treatment systems to establish. However, they require influent with a relatively high pH (over 6.0), impermeable bases to limit infiltration, an imported highly organic substrate, and specific wetland vegetation capable of continuous submersion.

The principal function of these systems is the removal of certain metals resulting from the action of aerobic bacterial activity and oxidation. This results in the precipitation of the solution as a metal hydroxide sludge, which settles to the bottom of the wetland. Maintenance may be required periodically to prevent excessive clogging. The oxidation process results in increased acidity and decreased pH, and some form of limestone neutralization may be required at the outlet prior to discharge.

Aerobic wetland systems require influent pH ranges of between 6.0 and 8.0 and sufficient surface area and retention time for adequate oxidation to permit metal precipitation. Some systems utilize multiple ponds constructed in parallel to spread the flows over a larger area, which makes it easier to maintain the system. Aerobic wetlands are primarily used for the reduction of ferrous iron in concentrations up to 70 mg/l, but they have not been shown to be effective on aluminum or manganese concentrations.

Based on the equations presented in the text "*The Science of AMD and Passive Treatment,*" the minimum wetland size is computed as follows:

(Ac) = (Fe loading / 180) + (Mn loading / 90) + (Acidity / 60)
(where loadings are listed as lb/day, and the 180, 90 and 60 represent typical lb/ac/day capacity values)

Loadings are computed by multiplying the flow (gpm) by the concentration (mg/l) and then by 0.012 to convert gpm and mg/l to pounds per day. Use of this equation results in a recommended aerial extent of aerobic wetland, although this value must be evaluated to include specific site conditions, including fluctuations in inflow rate, site topography, and site accessibility.

Anaerobic Wetlands – These systems are similar to aerobic wetlands, except that the bio-chemical activity takes place within the thick, oxygen-free organic substrate, consisting of composted organic materials containing high concentrations of iron-reducing bacteria. These bacteria break down the sulfates in the influent, raise the pH level and precipitate some dissolved metals.

They are suitable for use with influent pH as low as 3.0 without additional alkalinity being added to the system, but high dissolved oxygen levels in the influent can be problematic. These systems tend to work well with certain metals (including copper, lead, zinc, cadmium, and iron), but they are inadequate for large concentrations of aluminum or manganese.

Like aerobic systems, anaerobic wetlands are most effective when used to treat small AMD flows of moderate water quality. Hedin, et al ("*Treatment of acid coal mine drainage with constructed wetlands,*" 1989) indicate that anaerobic wetland systems for the treatment of net acid influent can be sized based on using a factor of 3.5 grams of acidity/m^2/day.

When used in combination with limestone, anaerobic wetlands are frequently sized to provide a minimum retention time in excess of six hours, but when used independently this value should probably be extended to roughly 24 hours. As such, for a flow of 100 gpm, the anaerobic wetland would be sized to contain roughly 19,250 cubic feet of submerged, composted materials. This would be equivalent to a pond with surface area of approximately 60' x 160' x 2' deep.

If aluminum concentrations are relatively high (greater than 1.0 mg/l), a vertical drain system, which incorporates anaerobic wetlands and limestone flow paths, may be more cost-effective. Since the anaerobic activity results in significant metal precipitate, these systems may require periodic cleaning, and the substrate may need to be replaced if the precipitate results in a decrease of bacterial action.

Oxic/Anoxic Limestone Trenches – For the treatment of low pH flows with limited metal content, Oxic (in the presence of atmospheric oxygen) channels are highly efficient and inexpensive. These systems utilize open channels filled with high-carbonate crushed limestone, which is less caustic than lime. Since limestone dissolves slowly, it cannot result in overdosing in the treatment system and tends to dissolve more rapidly in poor water quality conditions, which is desirable.

However, if the limestone treatment occurs when the metal content is relatively high, and atmospheric oxygen is present, a buildup of metallic hydroxide compounds results on the surface of the stone. This armoring reduces the limestone contact surfaces with a subsequent decrease in effectiveness. When working properly, oxic channels can function for 5-10 years before they require replacement, but if the metal content is fairly high, they may lose effectiveness much more rapidly.

For situations where the metal content is higher than recommended for oxic channels, anoxic limestone drains can be utilized. These systems typically utilize subsurface trenches, covered by an impermeable cap, to exclude atmospheric oxygen.

Anoxic trenches can be cheap and effective, but the life of the system is a direct function of the influent water quality and carbonate content of the limestone. When the stone has deteriorated to an extent that it has lost its effectiveness, the entire system must be dug up and replaced. If the influent has a significant dissolved oxygen content prior to introduction into the trench, anoxic trenches are less effective, so it is recommended that these trenches be connected directly with mine pools before the discharge has significant contact with the atmosphere.

There is little in the literature regarding sizing of oxic limestone channels since they are easily accessible, and maintenance involves merely replacing the deteriorated stone as required. Anoxic trench maintenance is more problematic since the system is buried throughout its entire length, so sizing is more critical. Based on the equations in "*The Science of AMD and Passive Treatment*," the mass of limestone required (M) is:

M (tons) = (Qpt/Vv) + (QCT/x), where:

Q = flow in m^3/day;
p = bulk density of limestone (approx. 145#/cf = 2.56 Tons/m^3);
t = retention time in days (generally 15 hours = 0.625 days);
Vv = bulk void ratio of limestone (use 0.48 based on experience);
C = effluent alkalinity concentration
T = design life of drain in days (25 years = 9125 days)
x = $CaCO_3$ content of limestone (use 0.90 for high quality stone)

Limestone Diversion Wells/Ponds - In addition to oxic channels and anoxic trenches, there are applications for other, similar systems. Diversion wells consist of a low dam, which is used to divert flow through a pipe into the top of a cylinder filled with limestone gravel. High velocity flows generated by dropping the flow 5 to 10 feet are flushed through this system to keep the armoring scoured and to encourage degradation of the limestone for very efficient treatment. However, these systems require high maintenance by the nature of the construction, and the gravel must be replaced frequently (as much as twice per month). These systems are best used in conjunction with a wetland or a settling pond to permit settlement of the oxidized metals, but they can be used mid-stream.

Other sites have used limestone ponds, in which seepage from a mine opening is forced to flow vertically upward through a crushed limestone layer to force anoxic conditions. These systems also generally discharge to a settling pond or wetland for deposition of the precipitated metals. Again, this can be a relatively high-maintenance arrangement, and the limestone may have to be replaced frequently.

Limestone treatment is ineffective in situations where the pH is higher than neutral, and armoring of the stones causes a dramatic reduction in the performance of the system if not cleaned periodically. When O_2 is present, or when iron levels are in excess of 5 mg/l, the systems tend to develop armoring rapidly. Armoring can occur even more rapidly if the sulfate levels are in excess of 2000 mg/l, wherein an insoluble gypsum precipitate occurs.

Vertical Flow Reactor Systems – These treatment systems, which come in a variety of different types, including Successive Alkalinity-Producing Systems (SAPS), Vertical Drains, Sulfate Reducing Bacteria Systems (SRB) and limestone vertical upflow ponds, combine the bio-chemical properties of anaerobic wetlands and limestone ponds to produce very effective treatment systems. They are generally comprised of a series of ponds placed in series, including: a small settling pond used to drop large diameter suspended solids and attenuate peak runoff events; a "vertical drain" composed of perforated pipes placed at the bottom of a pond overlain with layers of limestone and compost; and a settling pond and/or aerobic wetland for the collection metal precipitate. For the limestone vertical upflow ponds, the perforated pipes are used for both influent and effluent, with the discharge controlled by a siphon system which controls retention time within the limestone base. These systems typically do not use an organic zone, and do not attempt to utilize biological activity for AMD treatment.

Regardless of which technique(s) is utilized, multiple systems can be constructed in series to permit cleaning (by taking one system "off-line") and to allow for peak inflows following precipitation events. If sufficient elevation difference is available between ponds, a flushing system can be incorporated to permit periodic cleaning of the perforated pipes and limestone layer (may not be required in limestone vertical upflow ponds). This permits use of VFR systems for influent conditions with low pH and high iron & aluminum contents without removal of the limestone for cleaning.

The general approach to sizing vertical drain systems is to create a series of ponds with sufficient volume to permit adequate retention times. The specific rules-of-thumb for design of these facilities continue to be updated as various systems are constructed and re-evaluated. A good source for sizing design can be found at the following web site: http://amdtreat.osmre.gov, where the software "AMDTreat" can be downloaded. This AMD abatement cost-estimating tool was developed cooperatively by the Pennsylvania Department of Environmental Protection, the West Virginia Department of Environmental Protection, and the Office of Surface Mining Reclamation and Enforcement (OSM), and is available free of charge.

As discussed in previous sections, limestone is a very efficient means of increasing pH values for acidic influent from AMD sites. However, it tends to deteriorate with time and does require long-term maintenance. The rules-of-thumb mentioned above are based on the creation of a system with an effective life of 20-25 years, at which time the limestone will probably require replacement. However, there are no existing systems that have been in place for more than 20 years, so this is speculation.

Vertical flow reactor systems can be very efficient for flows up to approximately 500 gpm, assuming that sufficient room is available to construct ponds large enough to meet the retention time requirements discussed above. The ponds can treat influent with very low pH and relatively high iron, aluminum, and sulfate levels, and if a flushing mechanism has been included in the design, armoring of the limestone and piping can be controlled for many years. The different types of VFRs have been shown to be effective for different types of AMD discharges, and the specific VFR technique should be selected based on a variety of factors, including: influent chemistry; variations in influent flow and chemistry; site topography; accessibility for construction and maintenance; availability of volunteers for periodic maintenance; etc.

However, the systems require some level of hands-on manipulation, at least initially, to achieve a workable system. This is partially a function of the need for sufficient bacteriological activity to develop a balance of the bio-chemical reactions, and frequent flushing may be required for some months. In addition, there is typically a high BOD discharge from the settling pond in the first few weeks until the compost becomes stabilized. Again, the limestone vertical upflow pond systems may not require the same level of initial maintenance, but there are few of these types of systems in operation, so the long-term maintenance needs are not well defined.

Active Treatment of collected flows

Active treatment of mine discharges has been on-going for hundreds of years with techniques ranging from dilution of the influent to the establishment of sophisticated treatment plants. These methods typically integrate components that employ chemical, biological, and physical processes.

The chemical components involve bringing the flows in contact with alkaline substances to neutralize the acid in the mine discharges through the buffering action of the alkaline materials. Raising the pH of the discharges is often essential for treatment since highly acidic discharges prevent the oxidation and precipitation of metals in settling ponds. Alkaline materials frequently used for pH adjustment include limestone, hydrated lime, quick lime, soda ash briquettes, caustic soda, and anhydrous ammonia. These additives tend to neutralize the acidity of the discharges and permit precipitation of dissolved metals, which can also be removed by application of potassium permanganate, other oxidizing agents, and physical aeration.

In addition to straight chemical reactions, some methods utilize bacteria-induced reduction so that the metal precipitates become stable and settle out. Physical aeration accelerates this process by exposure to large pool surface areas or by using of bubbler systems, waterfalls, or fountains. Larger systems may incorporate several of these techniques.

Since there are currently numerous packaged systems available involving hydrated lime treatment plants or water-wheel addition of caustic soda, which can be designed for specific flows and water quality conditions, it is difficult to recommend a general approach to active treatment of AMD sites.

It is recommended herein that both passive and active treatments be considered for each prioritized site. However, special emphasis should be given to possible remediation funding sources since active systems tend to require a relatively high annual operation and maintenance (O&M) cost, and this is typically not included in funding available to watershed groups. As such, relatively inexpensive active treatment systems may be very difficult to maintain as compared to passive systems, depending on the source of funding.

Based on the site descriptions, chemistry and discussions contained elsewhere in this report, we have prepared general remediation recommendations for the sites identified in each watershed. **Tables 11, 15, 19, 26, 30, 34, 38 and 42 (Section 4.4 above)** present the general remediation recommendations for each site in the Blacklick Main Stem, North Branch Blacklick, South Branch Blacklick, Upper Two Lick, Lower Two Lick, Tearing Run, Upper Yellow Creek and Lower Yellow Creek, respectively.. It is assumed that additional data will be accumulated prior to application for funding, and the recommendations contained in the above tables are intended as a starting point for future engineering evaluations.

5.2 General Cost Estimates

The previous discussion is intended as a preliminary evaluation of possible remediation measures which can be undertaken at the sites identified as priorities within the watershed. Since these recommendations are considered preliminary, pending additional data collection at each of the sites, development of detailed cost estimates for the remediation measures was not possible.

However, to assist in the evaluation process, the following rules-of-thumb are offered as typical costs that can be anticipated for the remediation process. These costs are certainly not intended to be comprehensive, or to account for costs beyond the basic construction items, such as engineering and mapping, permit acquisition, contract administration, land acquisition and, utility relocation. These costs are offered herein merely for use in comparing different alternative remediation methodologies and for selecting funding prioritizes.

In general, it can be assumed that if an active treatment option is selected, it will result in the acquisition of a batch treatment plant, designed for the site-specific parameters in question. There are numerous manufacturers of batch plants, and it would be best to approach several of these companies to get accurate estimates. However, approximate estimates can be assumed to be roughly \$100,000 per each 100gpm intended for treatment, for the initial capital expenditure. If extensive regrading or piping is required, this value could be substantially higher. In addition to the capital costs, active treatment plants require a substantial annual O&M cost, which can range from \$10,000 to \$50,000 per year depending on the system selected, and some plants may require a full-time operator. In the event that the plant is closed and removed at some point in the future, there is a possibility of some salvage value, but it is best to ignore this possibility for comparison purposes.

By their nature, passive treatment systems tend to have a slightly higher capital cost, but little or no annual O&M. Since the funding for the selected remediation alternate will probably be obtained from a one-time government grant, this approach is generally more amenable. (It is frequently difficult to obtain continuing O&M funding for active treatment plants.) Costs associated with passive treatment can vary greatly, depending on the degree of earthwork required to shape the ponds, and whether raw materials for the construction are available in the excavation. However, for this analysis, a general assumption can be used that the capital cost will be roughly \$150,000 per 100 gpm treated, with an annual O&M of approximately \$1,000 to \$5,000 per year (for general maintenance). There will probably be some degree of maintenance required initially, but this will become minimal in the later years. However, portions of the system may have to be completely replaced at the end of the service life (generally considered to be 25 years). Naturally, aerobic wetlands tend to be less expensive than vertical drain systems since they require less material and detailed earthwork.

When evaluating the different systems, it is important to consider the potential funding source, the capabilities of the personnel intended to oversee the installation and operation, the location and accessibility of the site, and the degree of community involvement anticipated. If the site is generally remote and it is anticipated that little local involvement will be forthcoming, it may be necessary to hire a part-time employee to assure continued operation of the treatment system.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The assessment of the Blacklick Creek Watershed resulted in the identification of 492 reported discharge locations throughout the watershed. Based on the available data used in this assessment, impact evaluations are only qualitative at best. The assessment required combination of unlike data, comparisons of locations based solely on one sampling or flow measurement event, and almost no evaluation of seasonal or physical changes in local hydrology. A general observation for all of the database sites is that there is considered to be insufficient data available to give firm recommendations to any one site. It is assumed that additional data will be accumulated prior to application for funding.

Quantitative data analysis resulted in the ranking of 278 individual discharge locations with sufficient water quality and flow data available. The above analysis resulted in the identification of 57 priority sites/impacted locations spanning eight watersheds.

The prioritized sites were evaluated to identify general remediation strategies applicable to the unique properties of each site. Recommended general remediation strategies included, vertical drains, sulfate reducing bacteria treatment, and aerobic and anaerobic wetlands, among others. Based on the data analysis and conclusions of this report, Kimball offers the following recommendations:

- Because many identified locations lack adequate water quality and/or flow data, we recommend that organized sampling and monitoring plans be established for prioritized and other sites. The monitoring plan should include the evaluation/inspection of discharge locations that could not be readily associated with more recently monitored locations and discharge locations with only one monitoring event identified. The monitoring plan should include identification of these points, measurement of flow, water quality sampling and testing, upstream and downstream monitoring, and maintenance of the project database. The partners should consider forming alliances with local officials, schools, universities, and regulatory agencies while seeking volunteers to perform the anticipated monitoring.

- Because several prioritized sites are related to refuse piles and infiltration through said piles may be contributing to other discharges, we recommend increased efforts to reclaim these areas. Concerned citizens should work closely with the PADEP to identify opportunities for reuse or reclamation of spoils piles.

- In order to evaluate all available data for identified sites, we recommend that the partners form alliances with the local PADEP mining office and permitees (coal companies) so that data collected by these organizations are made available for future site evaluation.

- As a continued verification of the results of this study, we recommend that several field trips be organized to walk each tributary and identify/confirm all discharge locations, especially Operation Scarlift locations and locations sampled by the Indiana County Conservation District. Final verification of all locations will be necessary as the design of remediation activities begins and maintenance of the project database continues.

7.0 REFERENCES

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