CLEARFIELD CREEK WATERSHED

ABATEMENT AREA C
POWELL RUN

<u>Location</u>

Powell Run, which flows from Blandburg eastward to Van Ormer in Reade Township, Cambria County, is the largest tributary source of acid mine drainage to Clearfield Creek south of the town of Glen Hope. This stream discharges an adjusted average acid load of 9500 lbs/day to Clearfield Creek, which is slightly neutral just upstream from Powell Run. Two large strip and undermined hills, one east of Van Ormer and one south of Blandburg, are the major sources of acid to Powell Run. This acid contribution to Clearfield Creek is evident as far downstream as station 29.71, not because the water at this station is severely degraded by acid mine drainage but because the stream has shown only slight overall improvement in the 4 1/2 stream miles below Powell Run. This marginal improvement be comes significant upon inspection of the map of subwatershed modules. This module map shows that nearly all water entering Clearfield Creek in the stretch between Powell Run and station 29.71 is of good quality, yet the average alkalinity of the creek increases by only 6 mg/l. This data indicates that Powell Run significantly inhibits many miles of water quality improvement in Clearfield Creek. Any abatement in the Powell Run Watershed will be evident not only by a decrease in the acid load in Powell Run, but also by an increase in the alkalinity of Clearfield Creek itself as far south as station 29.71.

Geology

Both abatement areas lie on the southeast flank of the Houtzdale Syncline. Relief is extreme within the watershed and all Allegheny Group rocks units from the Brookville-Clarion to the Upper Freeport outcrop within both portions of the abatement area. Strata strike northeast-southwest throughout the watershed and dip rather steeply at 2 to 3 degrees to the northeast. Several northwest trending faults occur in the eastern portion of the abatement area around strip mine #10.

Acid deep mine discharges in the vicinity of Van Ormer suggest that the "C' "seam is locally acid here. This is quite unusual and was found in no other portion of the Clearfield or Moshannon Creek Watersheds.

Mining

Both major acid producing areas have been extensively deep and strip mined with only minimal reclamation. South of Blandburg, the "A" and "B" coals were extensively deep mined by the Bellefield Coal and Coke Company, Lloydsville, Frick No.2 and Great Bend No.4 mines. These relatively small deep mines are shown on the Mine Development Drawing, but it seems likely that most of the remaining

"A" and "B" coal here has been mined out. All coal seams have been extensively strip mined above and adjacent to the old deep mines, but very little reclamation work of any kind was done. These "A" and "B" seam strip and deep mines account for much of the acid polluting Powell Run.

The mining history of the area just east of Van Ormer is much the same as that just discussed. The major deep mining activity was on the "C"', "D", and "E" seams by the Peerless Mines No.5, 2, and 1 respectively. Here again, extensive strip mining adjacent to and above the deep mines has occurred and no reclamation work has been done.

Mine Drainage and Hydrology

The mine drainage and hydrology of both portions of the abatement area are quite similar despite the fact that the major seams deep mined in the two areas differ. The mining activities in both areas have greatly altered the local natural hydrologic systems. The unreclaimed strip mines effectively trap runoff from the adjacent hilltops and hillsides. The runoff trapped in strip mines #10 through #14 seeps laterally through the spoil material and infiltrates downward into the underlying deep mines. Any seepage through the pyritic "A" and “B" seam spoil produces acid and all water entering the underlying "A" and" B" seam deep mines is rendered acid within the deep mine workings.

No seepage was observed emanating from any of the spoil at strip mine #15. Most runoff entering the unreclaimed cuts here apparently is infiltrating downward or laterally into underlying or adjacent deep mine workings. All water entering the deep mines in this area infiltrates downward to the lowest workings, in the "C"' coal, through local fractures caused by roof collapse of underlying workings and along minor faults. The Upper Kittanning, "C'" coal is apparently locally acid in this vicinity, as all observed discharges emanating from the deep mine workings in this seam were acid in nature. These deep mine discharges were the principal acid sources in the vicinity of strip mine # 15.

<u>Water Quality</u>

EPA sample data for the mouth of Powell Run, obtained between August, 1964, and August, 1967, showed an average acid load of 5,100 lbs/day. Skelly and Loy's data for the same station, adjusted to represent an average yearly flow, attributed 9,500 lbs/ day (unadjusted 4030 lbs/day) acid to Powell Run.

Skelly and Loy's intensive sampling program south of Blandburg revealed an adjusted 9,900 lbs/day acid discharging from the following point sources: 14.11, 14.12, 14.13, 14.3, 14.4, 14.41, 14.5, 14.6, 14.7, 14.8, 14.9. Stations 14.3, 14.4 and 14.6 monitor drainage.

from the Frick No.2 deep mine with relatively high acid concentrations. Skelly and Loy sample station 15.2 and EPA station 15.3 monitor drainage from a refuse storage area only during wet weather periods. Sampling by Skelly and Loy east of Van Ormer, at stations 11.1 and 29.42, adjusted to a yearly average, indicated 800 lbs/day acid entering both Powell Run and Clearfield Creek directly.

Therefore, the total adjusted acid load for Abatement Area C was 10,700 lbs/day.

Recommended Abatement

The relatively steeply dipping strata make deep mine sealing impractical in this watershed and, as a result, all recommended abatement work will attempt to minimize the amount of water entering the deep mines from adjacent and overlying strippings. The solution therefore proposed for Abatement Area C and its associated deep and strip mine pollution sources is a general restoration of the stripped land surface as follows:

Minimal earthwork backfilling and regrading of open strip cuts will decrease the permeability of the mine surfaces and effect quick runoff. Drainage ditches should be provided and surface channels reconstructed as necessary to pass surface flow across strip mines.

Surface restoration efforts should be suited to the requirements of each particular strip mine to obtain soil pH and fertilizer conditions conducive to plant growth. Limestone treatment of strip mine spoil should generally be limited to the acid "A" and "B" seam material. Grasses, legumes and trees should be planted as appropriate on the strip mines surfaces.

All bony material should either be disposed of in strip cuts prior to backfilling, or if excessively large volumes exist, should be graded, treated with limestone, fertilized and revegetated in place. Both of these methods of dealing with the bony material will attempt to minimize acid production in the material.

The recommended abatement should effectively eliminate 30% of the acid emanating from this abatement area. A lesser percentage of abatement, 5%, will be achieved for strip mine #11 .

<u>Powell Run Mine Drainage Data</u>

SAMPLE			ACID LOAD	
Station #	Description	Strip Mine #	Unadjusted	Adjusted
14.11	unnamed trib to PR	10	60	600
14.12	unnamed trib to PR	10	17	170
14.13	unnamed trib to PR	10	2	20
14.3	deep mine discharge	13,14	933	933
14.4	deep mine discharge	12	390	390
14.41	strip seepage	13,14	350	2100
14.5	strip seepage	12	11	110
14.6	strip and deep mine	11	394	3940
14. 7	strip seepage	10, 11	280	2800
14.8	strip seepage	10, 11	18	180
14.9	strip seepage	10, 11	18	180
11.1	deep mine & strip disch	15	300	1100
29.42	bony seepage	15	87	174
13.16	acid spring	15	0	0

Estimated Construction Cost

Strip Mine #10

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes as necessary.

80 Ac @ $2800/ Ac = $224,000

Construct diversion ditches as necessary

127 Ac @ $100/Ac = $12,700

Strip Mine #11

3 Ac @ $2600/ Ac = $7800

Strip Mine #12

Backfill, regrade, fertilize, revegetate unreclaimed strip mine

56 Ac @ $2600/ Ac = $145,600

Strip Mine #13

Backfill, regrade, fertilize, revegetate unreclaimed strip mine

27 Ac @ $2600/ Ac = $70,200

Strip Mine #14

Backfill, regrade, fertilize, revegetate unreclaimed strip mine

40 Ac @ $2600/ Ac = $104,000

Total Strip Mines #10-14 = $564,300

Strip Mine #15

Backfill, regrade, add limestone and fertilizers as necessary, revegetate, construct diversion ditches and flumes as required.

132 Ac @ $3000/ Ac = $396,000

Backfill to promote runoff, fertilize, revegetate, construct diversion ditches and flumes as necessary.

29 Ac @ $900/ Ac = $26, 100

Regrade bony, roto-till limestone, fertilize, revegetate.

4.4 Ac @ $2600/Ac = $11,440

Total Strip Mine #15 =$433,540
Call: $433,500

Total Estimated Cost, Abatement Area C = $1,042,840
Call: $1,050,000

Cost Effectiveness

Strip Mine #10

$236,700 per 711 lbs/day = $333 per lb/day acid abated.

Strip Mine #11

$7,800 per 82 lbs/day = $95 per lb/day acid abated.

Strip Mine # 12

$145,600 per 150 lbs/day = $970 per lb/day acid abated.

Strip Mine #13

$70,200 per 460 lbs/day = $152 per lb/day acid abated.

Strip Mine #14

$104,000 per 454 lbs/day = $229 per lb/day acid abated.

Strip Mine #15

$433,450 per 382 lbs/day = 1134 per lb/day acid abated.

<u>Overall Cost Effectiveness</u>

$1,050,000 per 2240 lbs/day =$468 per lb/day acid abated.

CLEARFIELD CREEK WATERSHED

ABATEMENT AREA D
COALPORT BONY DISPOSAL AREA

Location

The bony disposal area is situated just east of Coalport in the valley of a tributary to Clearfield Creek which flows west through that town. The area lies in Beccaria Township, southern Clearfield County.

Geology

This abatement area is located near the crest of the Laurel Hill Anticline, with the bulk of the adjoining Irvona Coal and Coke. Company workings extending southeast on the flank of the anticline. The pyritic Lower Kittanning coal was extensively deep mined here, and the strata dip shallowly to the southeast. No known faulting exists in the abatement area.

Mining

The bony material here came from Lower Kittanning "B" seam deep mines, the Blain Run mine and the adjacent interconnected Irvona Coal and Coke Company deep mines just to the north. The bony has not been graded or vegetated, and lies on the flanks and floor of the stream valley. A small portion of the bony pile is presently burning a-long its southeastern edge adjacent to a dirt road.

Mine Drainage and Hydrology

The "B" seam drifts located just above the bony disposal area were driven downdip and much of the drainage from these mines exits along Pine Run, northeast of Coalport. The bony disposal area and the "B" seam mines are separate AMD conditions and have no hydrogeologic association. The mine discharges are relatively small and acid loads are correspondingly low, because overlying non-acid "0" seam deep mines dewater the hill. This dewatering process involves channelization of much infiltrating water through the "D" seam workings and into surface drainage, minimizing the amount of water that ever reaches the underlying "B" seam workings. Dewatering keeps water levels in the "B" seam deep mines low enough to prevent discharge at the Coalport end of the mines.

The bony material covers both sides of the stream valley and intercepts runoff from the hill above. Water seeps downhill through the bony and enters the tributary at water level. No surface discharges from the bony were observed. The tributary which passes directly through the bony area, drains about 185 acres of which 27 acres drains directly onto the bony. This extended contact with the bony material renders the tributary acid.

Welter Quality

Skelly and Loy's sample station 29.84 indicated that drainage through this bony area adds about 600 lbs/day acid, adjusted to a yearly average, to Clearfield Creek at Coalport. The tributary contained 851 mg/l acidity and 1,680 mg/l sulfate at its mouth, but field investigation revealed pH's above 5.0 upstream from the bony area. A portion of this acid load is directly attributable to the "B" seam bony material scattered throughout the abatement area. This data indicates that the tributary is degraded by AMD during its passage through the bony material.

Recommended Abatement

The abatement plan here will utilize diversion ditches around the bony to prevent infiltration of runoff from surrounding hillsides. This will decrease acid formation and halt the erosion and flushing of bony fines into the tributary. The tributary should be flumed or channeled through bony areas and any bony material presently in contact with the tributary should be removed by minor regrading. This abatement work should effectively abate at least 15% of the acid load of the adjacent stream or 100 lbs/ day.

Estimated Construction Cost

Regrade to achieve drainage

5.5 Ac @ $1000/Ac = $5,500

Construct diversion ditches

2500 ft @ $1.50/ft = $3,750

Construct flumes

400 ft @ $10.00/ft = $4,000

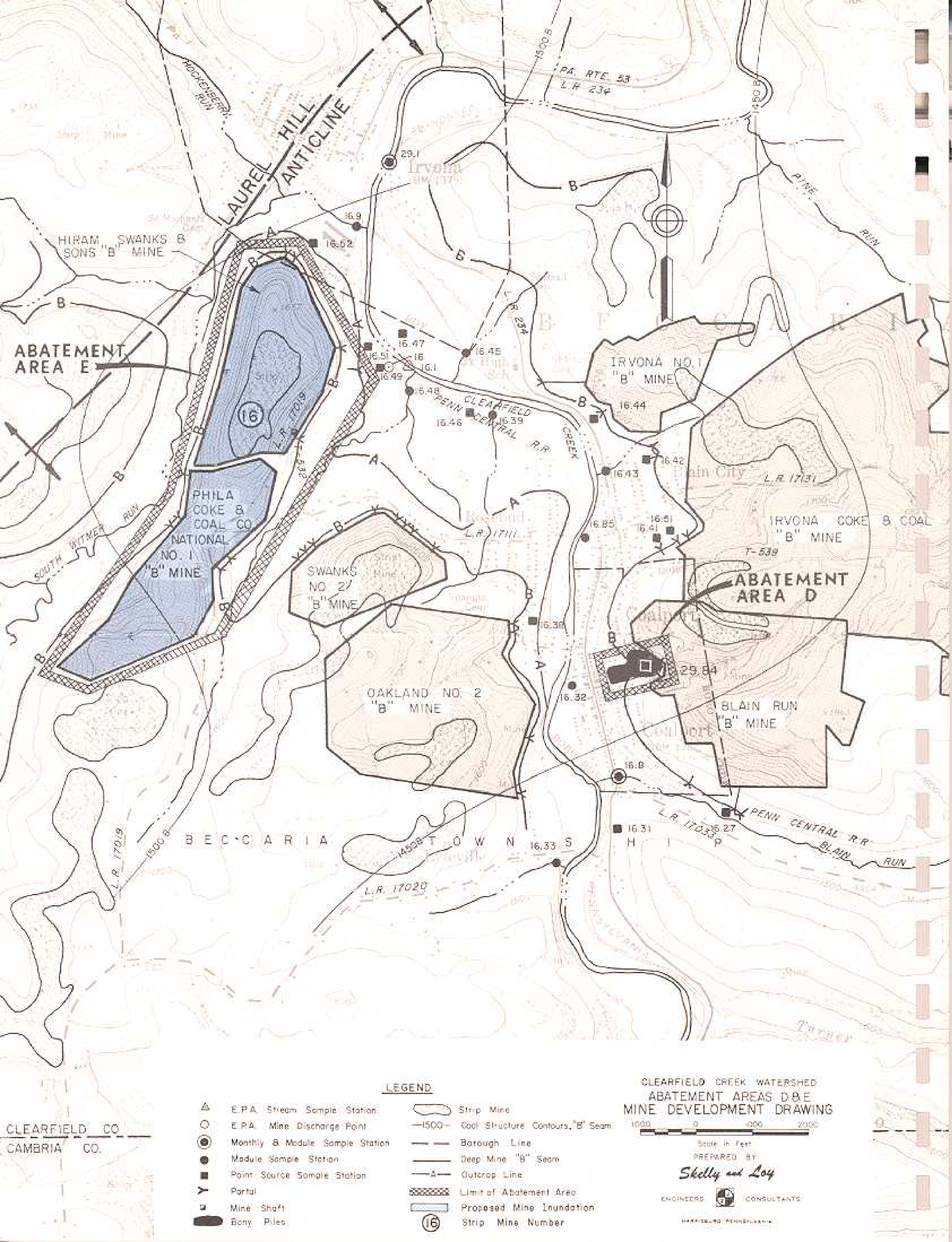
Fertilize and revegetate

4 Ac @ $355/Ac = $1,420

<u>Total Estimated Cost, Abatement Area D</u> = $14,670
Call: $15,000

<u>Cost Effectiveness</u>

<u>$15,000 per 100 lbs/day acid = $150 per lb/day acid abated</u>



CLEARFIELD CREEK WATERSHED
ABATEMENT AREAS D & E
MINE DEVELOPMENT DRAWING
Scale in Feet
PREPARED BY
Shelly and Loy
ENGINEERS
CONSULTANTS
HARRISBURG PENNSYLVANIA
LEGEND
E.P.A. Stream Sample Station
E.P.A. Mine Discharge Point
Monthly & Module Sample Station
Module Sample Station
Point Source Sample Station
Portal
Mine Shaft
Bony Piles
Strip Mine
Coal Structure Contours, "B" Seam
Borough Line
Deep Mine "B" Seam
Outcrop Line
Limit of Abatement Area
Proposed Mine Inundation
Strip Mine Number
ABATEMENT AREA E
ABATEMENT AREA D
LAUREL HILL ANTICLINE
HIRAM SWANKS & SONS "B" MINE
PHILA COKE & COAL CO. NATIONAL NO. 1 "B" MINE
SWANKS NO. 2 "B" MINE
OAKLAND NO. 2 "B" MINE
IRVONA NO. 1 "B" MINE
IRVONA COKE & COAL "B" MINE
BLAIN RUN "B" MINE
PA. RTE. 53
L.R. 234
L.R. 17019
L.R. 17111
L.R. 17131
L.R. 17033
L.R. 17020
T-539
PENN CENTRAL R.R.
CLEARFIELD CREEK
SOUTH WITMER RUN
HOCKENBERRY RUN
PINE RUN
BLAIN RUN
BECCARIA TOWNSHIP
CLEARFIELD CO.
CAMBRIA CO.

CLEARFIELD CREEK WATERSHED

ABATEMENT AREA E
SWANK'S MINE

Location

Abatement Area E consists of strip and deep mined areas located just south of Irvona between Clearfield Creek and South Witmer Run. The area lies within Beccaria Township in southern Clearfield County and discharges a large acid load to Clearfield Creek.

Geology

The abatement area lies on the southeast flank of the Laurel Hill Anticline just one mile from the anticlinal axis. Allegheny Group rock units from the Brookville-Clarion to the Lower Freeport outcrop on the hill above the deep mine. The local strata dip very shallowly, at less than 1/20 to the southeast and have no apparent faulting.

Mining History

The narrow north-south trending hill on which Abatement Area E is located has been extensively deep mined by several companies. Since the early 1900's, Hiram Swank's and Sons mine and Philadelphia Coal and Coke Company's National No.1 mine have completely undermined the hill on the "B" seam. Swank's and Sons also operated a deep mine which extracted the high quality Brookville-Clarion underclay 15 feet below the "B" seam. The relatively low quality "B" coal also extracted here was used to fire the furnaces that converted the clay to bricks and pipes. Today the mine workings are extensively caved all along the coal and clay outcrops

Shortly after World War II the "D" coal on the hilltop was stripped, and no reclamation was performed.

Mine Drainage and Hydrology

The natural hydrologic system in the vicinity of the hill is extensively altered by the unreclaimed strip mine and underlying deep mine. The finely divided shale spoil and the ponds within the strip cuts are apparently non-acid, as no acid discharges from the strip mine were observed. Most of the water entering the strip mine infiltrates downward until it is intercepted by the acid producing "B" seam.

Much of the acid water is discharged directly from the downdip end of the "B" seam workings, rather than the underlying Brookville-Clarion deep mine. This suggests that the pliable Lower Kittanning underclay may have sealed many of the cracks and fractures produced by the partial collapse of underlying Brookville-Clarion workings. Some water does migrate downward into the underlying Brookville-Clarion workings, which were also acid producers, through the remaining open fractures. This small amount of acid water then exits the deep mine complex from the Brookville-Clarion drifts.

Water Quality

The deep mine discharge from the Swank's Sons deep mine was sampled only once, at station 16.49, during Skelly and Loy's intensive sampling program. This sample data was adjusted to represent a yearly flow average but not in exactly the same manner as all other data. The flow constant calculated for the date on which the sample was taken would have increased the sampled acid load by over 3.6 times. The discharge here originated entirely within a small deep mine area, and deep mine discharge flow variations generally do not coincide on a day to day basis with natural stream flows. It was felt that this flow adjustment factor was too high, therefore, the flow at the time of sampling was simply doubled. This adjustment yielded an unadjusted acid load of nearly 2700 lbs/day discharging directly into Clearfield Creek from this deep mine.

Recommended Abatement

The abatement plan for the Swank's Mine area involves two phases - deep mine sealing and strip mine regrading. The dip of the coal in this vicinity is very shallow, and the complete flooding of this deep mine complex will create no more than thirty feet of hydraulic head. Complete flooding of the deep mine here will inundate the 242 Ac of workings and effectively reduce the oxygen supply to the point where the pyrite reaction rate in the flooded mine will be near zero, thereby minimizing acid production.

There are ten known drift openings and one shaft to be sealed. The final determination of the exact seal type and the final sealing scheme can be made in the design phase, following a detailed study of 100 foot/inch scale photogrammetric mapping of the area. Some type of manual drawdown system will also be installed in the lower end of the mine pool with a valve that will act as a safety device to lower the mine pool if required.

The "A" and "B" seam outcrops around the mine are completely unstripped, eliminating the problem of sealing along any strip cuts. However, caving of the mine workings is quite extensive near the outcrop, and those collapsed areas that will be below water level when the mine is inundated will require seating of some type. Seating of both the “B” seam and Brookville-Clarion seam will be required at some places. This too can be more specifically determined during the design phase of the project.

The unreclaimed "D" seam strip mine above the workings should be completely restored to minimize water infiltration into the deep mine and promote natural surface drainage. The strip mine surface should be back-filled, regraded, fertilized, and revegetated with grasses, legumes or trees as slopes dictate.

This deep mine sealing and strip mine regrading plan should effectively abate <u>all</u> acid emanating from Abatement Area E.

Estimated Construction Cost

Construct double-bulkhead seals

11 @ $15,000/unit-$176,000

Seal subsidence areas - $50,000

Backfill, regrade, fertilize, revegetate
strip mine

30 Ac @ $2,600/Ac $78,000

Total Estimated Cost, Abatement Area E - $293,000

Cost Effectiveness

$293,000 per 2,700 lbs/day acid = $109 per lb/day acid abated

CLEARFIELD CREEK WATERSHED

ABATEMENT AREA F
SHOFF MINE
(INCLUDED IN INTERIM REPORT II)

Location

The entire Shoff Mine abatement area is located within a large hill in the central portion of the Clearfield Creek Watershed. The mine is situated just west of Madera on the west bank of Clearfield Creek, and south of Pine Run in Bigler Township, Clearfield County, Pennsylvania. It occupies a total area of 428 acres, or roughly 2/3 square mile. All discharges from the Shoff Mine enter Clearfield Creek between Madera and sample station 29.8.

Geology

The Shoff Mine abatement area is located on the southeast limb of the northeast-southwest trending Laurel Hill Anticline. The center of the mine lies only one mile southeast of the anticlinal axis, and the strata of the mine dips only slightly because of its location near the crest of the Anticline. The strike of the strata is northeast-southwest. The dip averages 0.8 degrees to the southeast. All of the Allegheny Group rocks, except the Upper Freeport, outcrop on the hill. The upper portion of the Pottsville Group outcrops below the Brookville-Clarion Coal at the base of the hill. The geology of this area has been mapped by

Mr. William Edmunds of the Pennsylvania Geological Survey. Most of the geological mapping was provided by Mr. Edmunds even though his work has not yet been published.

<u>Mining</u>

This area was extensively deep mined from the latter part of the 19th century to the early 1930' s. Since 1940 some stripping has also been done, but there are no active strip mines in the area. The hill was completely undermined in the Brookville-Clarion, or "A", coal by several interconnected deep mines prior to 1930. Although the hill contains all of the Allegheny Group coals, apparently only the "A", and "D" coals were deep mined. All available deep mine maps showing the extent of the Shoff and Greenwood workings were obtained and plotted on the Mine Development Drawing, attached inside the back cover of this report.

In the early 1940's, small portions of the "A" and "B" coal on the southeast edge of the Shoff Mine were stripped. The length of the "A" cut is about 1500' and the "B" cut is roughly 2000'. Some of this stripping has since been backfilled, regraded and planted, and now supports good plant growth. Portions of the" D" and" E" coals were also strip mined above the deep mine. There are two large bony piles and some mine subsidence along the southern edge of the deep mine.

Mine Drainage and Hydrology

All of the acid mine drainage in this area is emanating from the extensively deep mined "A" seam which underlies the hill. The Shoff Mine is continuous throughout most of the hill and thus serves as an underdrain for much of the ground water. The mine collects and channels most of the water infiltrating the hill. The water flows downdip through the mine and appears at the downdip end of the mine as five major discharges and several smaller intermittent seeps.

The "A" seam is a typically heavy acid producer, and it, along with the "B" seam, are responsible for most of the acid production in the entire watershed. The Shoff Mine is no exception and discharges water with very high concentrations of acid.

Although the Shoff Mine occupies 428 acres and discharges 5700 lbs/day acid, the total discharge from the mine averages only 0.48 cfs. A theoretical average discharge was computed to check the validity of our flow measurements. The amount of precipitation falling on the 428 acre mine was computed using an average yearly rainfall of 41". This computation indicates the land surface above the mine is receiving an average rate of 2.2 cfs rainfall. A generally accepted figure of 30% infiltration was used to calculate that an average of 0.66 cfs of water should be entering the mine, which indicates that our average flow measurement may be low and the Shoff Mine probably produces more acid than measured. The 73 acres of strip mined land overlying the mine certainly increases infiltration to the mine. Infiltration of rainfall throughout the hill is also increased in the subsidence areas.

The fact that a relatively constant flow is maintained year round is probably a reflection of the long time period required for the water to percolate through the 150' - 250' of cover above the mine.

Water Quality

Water quality data for the Shoff Mine complex was obtained from nine separate sample runs. All of these show this mine is a major source of acid mine drainage to Clearfield Creek. All water flowing from the mine was found to have a low pH and very high acidity (averaging 2,207 ppm). The sample runs will be discussed in chronological order except for the third modular run, the most detailed, which will be discussed last. No flow adjustments were made to Shoff Mine sample data.

EPA data for the Shoff Mine area, gathered on August 24, 1966, listed an add load of 3,100 lbs/day. This sampling was accomplished in the midst of the extended drought period of the mid-1960's, and the EPA reports a total of only 0.30 cfs. for all Shoff Mine discharges.

The first modular run, made just after the passage of tropical storm Agnes, did not directly sample any of the discharges from the Shoff Mine complex, or from Clearfield Creek in the vicinity of the mine, thus it is impossible to even approximate the acid load from the mine for this run. However, the large amount of erosion caused by the mine discharges and a mine blow-out along Traffic Route 53 indicates that flow from the mine was extremely high during Agnes.

Again in the second modular run, none of the Shoff Mine discharges were directly sampled. Clearfield Creek main stream stations 29. 1 (6 miles upstream of the area at Irvona) and 16.11 did indicate a high acid load entering the creek from the Shoff Mine, but an accurate acid load value could not be computed from the data obtained.

The Shoff Mine acid load was computed using the net acid gain between Clearfield Creek main stream sample station 29.71, about 1 mile upstream from the area, and sample station 16.11, just below the area, for the remaining monthly sample runs. In each of these runs, Clearfield Creek itself had more alkalinity than acidity at station 29.71, but was acid at sample station 16. 11. The third monthly run showed the Shoff Mine to be contributing 14,200 lbs/day acid, 20% of the total load at the mouth of Clearfield Creek. The fourth monthly run disclosed an acid load of 5,400 lbs/day or 7% of the total acid load at the mouth of Clearfield Creek. The fifth monthly run indicated an acid load of 6,200 lbs/day for the Shoff Mine.

The remaining three sources of water quality data for the Shoff Mine complex were obtained during the third modular sample run, when all pollution sources in the area were sampled. This data consists of samples of all of the discharges from the Shoff Mine taken on three separate occasions. The following five stations, which are plotted on the Mine Development Drawing, were sampled for the Shoff Mine: 29.79, 29.81, 29.82, 29.92, 29.94. They were first sampled in mid-September and showed a total acid load of 8,400 lbs/day with a total flow of 0.55 cfs. The stations were again sampled in mid-October and yielded a total of 7,600 lbs/day acid with 0.56 cfs total flow. A third sampling of these discharges in early November showed the Shoff Mine to be the source of3,500 lbs/day acid with a total flow of 0.32 cfs.

To obtain a workable acid load value for the Shoff Mine, the results of the various point source sampling runs discussed above were averaged, resulting in 5,600 lbs/day acid contributed by the Shoff Mine to Clearfield Creek. This value comprises roughly 8% of the total acid load at the mouth of Clearfield Creek. The acid load values obtained in the monthly sample runs (where only main stream stations on Clearfield Creek were utilized) averaged 8,600 lbs/day acid. This verifies the findings of the more detail third modular sample run.

In addition to the acid discharges of Shoff Mine itself, there is the periodic slugging effect of the bony piles located along the southern perimeter of the mine. Although the acid load is minor, amounting to about 36 lbs/day acid (in addition to the Shoff Mine discharges), the slugging of the 22,000 cubic yards of bony, which covers 1.86 acres, has been sufficient to degrade at least one natural spring in the area.

Recommended Abatement

Partial flooding of the Shoff Mine is the best solution to the mine drainage problem in this area. There would be too much head contained to completely inundate the mine. It can be sealed for approximately 50 feet of head, and this will inundate 303 acres or 70% of the 428 acre deep mine. This will effectively reduce the oxygen supply to the point where the pyrite reaction rate in the flooded portion of the mine will be near zero, thereby minimizing acid production in 70% of the deep mine. Inundation of mine workings greatly reduces the formation and discharge of AMD exemplified by the flooded Yorkshire No.1 deep mine located on the same seam adjacent to the Shoff Mine. The Yorkshire is almost totally flooded and discharges mine drainage with 20 times less acidity than the Shoff Mine. This would indicate reductions in AMD are achievable from flooding the Shoff Mine. Treatment of the Shoff Mine's AMD using lime neutralization is not recommended. A suitable site for a plant is not available and high treatment cost should be avoided. This money could be used more effectively in other abatement areas.

There are 13 drift openings to be sealed. Some of these seals will be double bulkhead-inaccessible entry seals. Final determination of seal type will be made during design. Seals at the lower elevations will have to withstand 55 feet of head, while the higher seals will be subject to lesser amounts. A manually operated drawdown system will be installed in the southern end of the mine. This will consist of a pipe to the lower portion of the mine pool with a valve that will act as a safety device to lower the mine pool if required.

A small portion of the "A" seam has been stripped in the southeast corner of the deep mine. This strip cut will have to be opened and a clay liner placed against the highwall to prevent the mine from discharging through this strip mine, thereby preventing flooding of the mine. This liner will be designed to withstand a maximum of 60 feet of head. Projects using clay liners to seal stripped out deep mines and contain 60 feet of head have not been demonstrated. From an engineering standpoint, a clay liner backfilled with earth having a combined weight of

300,000 pounds per foot of outcrop should contain the mine pool. Seepage could occur if the liner were not constructed as high as the maximum mine pool elevation.

There are three shafts to the mine, however, none will have to be sealed. Two of the shafts are higher in elevation than the mine pool. The westernmost shaft will be utilized as a "top water" mine discharge point to prevent the mine pool from exceeding the desired 1,450 foot level and building up dangerously high heads on the seals. The discharge shaft will be drilled and cased, with the exit point at the 1,450 foot elevation. This discharge will be directed into the natural stream course next to the shaft.

An underdrain will be installed along the southeastern portion of the deep mine to prevent any seeping water from entering the housing area in that region. The underdrain will be placed just southeast of the clay liner in the strip cut to intercept any excess water forced through the area by the pressure of the mine pool. This underdrain will insure against any water damages to the buildings in the area.

Some of the construction in the southern end of the mine will be in close proximity to Traffic Route 53, which will require some traffic detour during construction. This will not be a heavy burden to motorists because this portion of the road is lightly traveled, and a detour will not be a major inconvenience.

There is some mine subsidence in the vicinity of the proposed drift seals. These sink holes will have to be sealed to prevent mine water discharges. The sealing will depend upon the elevation of the individual sink hole with respect to the mine pool elevation. Some of the sink holes will have to withstand a maximum of 40 feet of head, requiring a seal to be constructed. Some of the sink holes will have to withstand only minimal head and will require minor sealing procedures. These seals will be designed after accurate photogrammetric mapping has been obtained .

As a result of inadequate previous surface restoration when the several small areas above the Shoff Mine were stripped, normal surface runoff in these areas is greatly limited. The open and partially backfilled strip cuts intercept rain water and some surface runoff, allowing it to infiltrate and eventually enter the mine below.

In order to increase surface runoff and decrease infiltration, restoration of the 73 acres of strip mines #17 through #21 above the mine is recommended. Backfilling and regrading of these stripped areas will achieve three major results: 1) increase runoff from the strip mines; 2) establish good vegetative cover; 3) provide drainage diversion ditches and surface flow channels to prevent surface water entry into the deep mine. Various types of backfilling (contour, terrace, swale) will be used where appropriate to decrease the per meability of the strip mine surface and to effect quick runoff.

Surface restoration will be designed to the requirements of the particular mine. The regraded areas will be treated, if necessary, to obtain the proper pH, fertilized, and seeded with grasses and legumes. In regraded areas with a slope stability problem, trees will also be planted. The establishment of a good vegetative cover over all of the stripped surfaces will decrease the amount of water entering the deep mines. The vegetation will consume water and establish a soil profile to help hold water near the surface, where it will later be lost by evapo-transpiration. In addition, highwalls will have drainage diversion ditches constructed above them to collect and channel the water away from the strips.

There are two fairly large piles of bony material associated with the two major entryways of the Shoff Mine. These two piles definitely contribute to the acid pollution of Clearfield Creek. It is extremely difficult to measure the add load produced by these piles. This, of course, is due to the seasonal and rainfall-dependent nature of their acid production, and the many small discharge points. Bony piles can become an important pollution factor during wet weather, but may contribute little acid during dry periods. Theoretical computations yield an average 36 lbs/day acid produced by the bony piles.