A RESTORATION PLAN FOR LITTLE LAUREL RUN, CAMBRIA COUNTY, PENNSYLVANIA

by

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Prepared for

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INTRODUCTION

Little Laurel Run is located in northeastern Cambria County in Dean and Gallitzin Townships near the town of Ashville and the village of Buckhorn (Figure 1). The stream has a watershed of about 3 square miles, and is heavily impacted by acid drainage from abandoned coal mining. The stream was chosen by the Clearfield Creek Watershed Association for restoration from acid drainage effects as a result of the Clearfield Creek Watershed Assessment (Melius and Hockenberry et al., 2004). It has been designated a Priority Stream by the PA DEP. On the 303(d) list, Little Laurel Run is classified as "not attaining" its quality as a Cold Water Fishery, because of acid mine drainage. In addition to the degradation of Little Laurel Run itself, this stream is a significant contributor to acidification of Clearfield Creek into which it flows. The combination of Little Laurel Run and Brubaker Run, about 3 miles downstream, wipe out stream biota in Clearfield Creek for about 12 miles downstream as far as Coalport. A project involving construction of passive treatment systems in the Little Laurel watershed for two acid discharges is underway at the abandoned Klondike Mine. As a requirement for the use of EPA Section 319 funds for this project, a restoration plan for the watershed is required. This report describes the water quality problems of the Little Laurel Run watershed and discusses the steps needed to remedy the degradation caused by acid drainage and related activities.

The report identifies the pollution sources in the watershed and discusses the reductions in load required to meet applicable water quality standards. A TMDL determination is in progress for the watershed, but will not be completed for more than a year. Best Management Practices (BMP) proposed for decreasing the loading of acidity, iron and aluminum are described for each of the various pollution sources, and the costs of accomplishing the decrease are evaluated. Potential funding for the proposed measures is discussed, and the costs of the several BMP's are summarized. The entire program has been discussed with and supported by the Clearfield Creek Watershed Association and the Cambria County Conservation District.

CHARACTERISTICS OF THE LITTLE LAUREL RUN WATERSHED

Little Laurel Run is a tributary of Clearfield Creek, entering this stream from the east about 2 miles north of Ashville. From its mouth, Little Laurel Run extends southeastwards for about 3 miles to its headwaters near Buckhorn (Figure 1). The stream has a drainage area of about 3 square miles (1900 acres) and a length of 2.98 miles.

Most of the watershed is forested, and about 1/3 is in State Gameland 184. About 30% (600 acres) of the watershed has been surface mined for coal at various times, mainly prior to 1975, and most of this area has naturally reforested to small trees. However, one area of 90 acres near Buckhorn (the abandoned Ferris Wheel Mine) is only partly revegetated with scattered pine trees, and most of the surface is bare rocky debris. Of the remainder, about 40 acres is farmland, mainly pasture adjacent to Beldin Hollow Road, and about 40 acres is occupied by homesites along Beldin Hollow Road and at Buckhorn. A total of 12 homes lie within the watershed along Beldin Hollow Road, and about 30 homes are clustered near the drainage divide at Buckhorn.

Nearly all the area has been logged, mostly many tens of years ago, but some areas, especially near PA 36, were logged about 15 years ago. The forest in areas that have not been mined or recently logged is composed of maple, beech, hemlock and lesser birch, cherry, and other deciduous species. The recently logged areas near PA 36 are covered with a dense growth of small black birch with lesser striped maple, and occasional larger hemlock and other species. The strip mined areas are also dominated by black birch, or in some cases by small Scotch pine and Jack pine trees. Areas near the stream are commonly occupied by dense rhododendron thickets.

Most of the Little Laurel Run watershed is underlain by coal-bearing rocks of the Pennsylvanian Allegheny series. Major coal beds mined in the watershed include the Brookville, Clarion, Lower Kittanning (B), and locally the Mercer, Middle Kittanning (C) and Upper Kittanning (C') coals, but others may be present locally (Glover, 1990). The coals and intervening shales and sandstones dip northwestward down the valley at a few degrees toward Clearfield Creek, and crop out along the sides of the valley. The only current mining is the Buckhorn-Coupon surface mine of Cooney Bros. Coal Co. to the south of PA 36. In this area, coal beds from the Mercer to the Upper Kittanning have been and are being surface mined in extensive and deep pits, most of which have been reclaimed. A second recent surface mine by E.P. Bender Coal Co. removed the Clarion, B and C coals on the north side of the stream near the mouth. This mine was completely reclaimed a few years ago and is now revegetated in grass.

Average annual precipitation in the area is 40 to 48 inches per year, according to maps and data in cdo.ncdc.noaa.gov. The precipitation is higher in the higher elevations near Buckhorn. Average temperatures range from 24^{o}F in January to 70^{o}F in July at the station at Prince Gallitzin Park about seven miles away. Temperatures in the higher elevations of Little Laurel watershed are probably slightly cooler.

WATER QUALITY

Sources of Data

Several sources of data on water quality have been compiled for this evaluation.

A major source of data has been the sampling and analysis of acid discharges and the mouth of Little Laurel Run in 2001-02, reported in "Clearfield Creek Watershed Assessment, Phase I and II" (Melius and Hockenberry et al., 2004). A total of six acid discharges in the Little Laurel Run watershed were sampled monthly for one year, with flows determined by weirs, and the mouth of Little Laurel Run was sampled quarterly six times. Sampling by the Clearfield Creek Watershed Association on two of these discharges, on which treatment systems are about to be constructed (32R2 and 32R2A), has continued to the present time.

A second source of data at the mouth is a set of six samples collected quarterly in 2003-04 by the Susquehanna River Basin Commission in preparation for a TMDL evaluation and furnished by Beth Dillon of SRBC.

A third set of data comes from the mining permit files for recent and current mining in the drainage. Permit 11850102 to Cooney Bros. Coal Co. provided quarterly sampling at sites B-14 (a Subchapter F point on the "Cooney tributary" to Little Laurel Run, with a weir), B-40 (same tributary just upstream from Little Laurel Run, but only estimated flows) and B-43 (Klondike Mine, same as 32R2A of the Assessment Report, with a weir). Permit 11930102 of E. P. Bender Coal Co. has provided data for the mouth of Little Laurel Run (184-25, estimated flows) and several discharges on the north side of Little Laurel Run (184-1, -2, -3, -4, -5, -9, -10, and -11, with weirs) over many years.

A fourth source of data has been recent sampling by the Clearfield Creek Watershed Association at two new weirs (32MS2 and 32MS3) located on Little Laurel Run above and below the proposed Klondike treatment systems and at a new weir at the mouth of Little Laurel Run (32MS1). In addition, a number of the above sites have been re-sampled during the present study, and one new weir was established in the Ferris Wheel area (32R5).

The characteristics of the sampling points are summarized in Table 1. Water quality data for these sites are listed in Tables 2 and 3, and summarized in Table 4. For most sites, the pH, temperature and specific conductance were measured in the field, and the water depth on a weir was measured, or a flowmeter was used. For some of the mining permit data, flows were only estimated, and are not reported in the table. For essentially all the samples, a non-filtered, non-acidified sample and a non-filtered acidified sample were sent to a certified lab and analyzed for pH, specific conductance, alkalinity, hot peroxide acidity, Fe, Mn, Al, SO_4, and total suspended solids.

Water Quality Standards

The Water Quality Standards that should be met for a TMDL on Little Laurel Run are expected to be 0.75 mg/L Al, 1.5 mg/L Fe, and pH 6.0 to 9.0. These standards are on a total metal basis, and the dissolved metals would likely be lower. A possible alternative for the pH standard would be the natural background value, which for a stream of this type may be somewhat lower. For a TMDL, the standards should be met 99% of the time, and a Monte Carlo method would be used to obtain 99% values. However, for this report the average values at various sites will be used. It is assumed that changes in stream concentrations and loads will be compensated by changes in discharge concentration and load.

The acidity is the best indicator of improvements that would be needed to reach the pH standard. The acidity measures the amount of $CaCO_3$ that would have to be added to reach pH 8.2. A somewhat lower amount of alkaline material would be needed to reach pH 6.

The acidity depends on the concentration of Fe, Al, Mn, H^+ and other heavy metal cations in the water, and the concentrations of these constituents can be used to calculate the portion of acidity due to each (Hedin, 2004; Cravotta and Kirby, 2004). For this evaluation, the removal of Fe, Al and pH to the standards is considered acceptable, and acidities expressing only these constituents are calculated from the analytical data. By pH 6, all Fe and Al should have become insoluble, so that at that point, the standards should be met.

Discussion of Water Quality

As indicated in Tables 2 and 4, the stream water at the mouth of Little Laurel Run (PA 53 crossing) has an average pH of 3.2 to 4.5, acidity of 38 to 52 mg/L $CaCO_3$, Fe about 1 mg/L, Al 2 to 3.3 mg/L and Mn 3 to 4.8 mg/L. The stream bottom is covered with Fe precipitate, and both samplings for macroinvertebrates yielded zero organisms, indicating the very poor quality of the water and stream bottom habitat (Melius and Hockenberry, 2004). Figure 2 shows the relation of acidity to flow at this site. Nitrate was not detected at 1 mg/L (Melius and Hockenberry, 2004), and there are no indications at this site or elsewhere in the drainage of significant contamination from sewage or agricultural sources.

Upstream, the water quality becomes worse. At site 184-39, 7000 ft upstream, the acidity has increased to 58 mg/L $CaCO_3$, the Fe to 3 mg/L, and Al to 3.6 mg/L. At site 32MS2, about 10,000 feet above the mouth and just below the inflow of the Klondike discharges, the average pH is 3.5, acidity 55 mg/L $CaCO_3$, Fe 6.7 mg/L and Al 3.8 mg/L. Two thousand feet further upstream at 32MS3, above the Klondike discharges, the quality is slightly worse (acidity 68 mg/L $CaCO_3$). The stream bottom is heavily covered with Fe precipitate in this zone. The "Cooney" tributary at PA 36 (site B-14) is still worse, with an average 77 mg/L acidity and 16 mg/L Fe.

Ten significant acid discharges have been identified and measured in the watershed. In addition, numerous small seeps with negligible flow have been noted. The water quality of the significant discharges is summarized in Table 4, and the discharges are plotted on Figure 1.

The most downstream discharge is site 184-1, where a small stream (26 gal/min) runs out of an abandoned strip mine on the north side of the valley. Average acidity is 19 mg/L at pH 4.4. A few tens of feet to the west is a small Fe-rich flow (184-2), and three other smaller flows have been sampled by Bender Coal in this vicinity. The Bender permit also shows sites 184-9 to -11 from abandoned underground adits about 2000 ft. northwest, but these sites always had negligible flow and are currently completely dry.

Progressing upstream, the next acid discharge is 32L1. This is a somewhat larger stream emanating from the abandoned Gibson-Halstock strip mine on the Brookville through Middle Kittanning coals. This flow averages pH 3.5, acidity 60 mg/L, Fe 2.6 mg/L and Al 3.6 mg/l at 82 gal/min.

A short distance further upstream on the opposite side of the valley, the abandoned Beldin deep mine on the Lower Kittanning coal exhibits a flow averaging 43 gal/min with pH 3.6, acidity 80 mg/L, Fe 26 mg/l and Al 0.6 mg/L. This discharge flows into a small tributary on the south side of the valley.

At the abandoned Klondike Mine about 10,000 feet upstream from the mouth, two acid discharges enter Little Laurel Run from the southwest. Discharge 32R2A (also sampled by DEP as B-43) emerges from the abandoned underground Klondike Mine on the Lower Kittanning Coal at a flow rate averaging 160 gal/min with pH 3.6, acidity 50 mg/L, Fe 5.3 mg/L and Al 1.5 mg/L. This water emanates from the Klondike Mine worked by F.A. Garman, permitted in 1948 as permit 960. About a thousand feet further upstream, discharge 32R2 flows from an abandoned strip mine on the Clarion , Lower Kittanning and Middle Kittanning coals. This property was mined by T.W. and P.T. Delozier under permits 17297 and 17298 issued in 1957, and Cambria Coal Co. under permit 4278BC9 in 1979. This surface mining apparently mined out the main entrance to the Klondike underground mine. Some augering was done on the latter permit, and probably connects the surface mine with the Garman (Klondike) mine. These surface mines were not reclaimed. The 32R2 discharge averages only about 15 gal/min, but has an acidity of 405 mg/L, Fe 134 mg/L, Mn 28 mg/L and Al 4 mg/L at pH 3.4.

The worst group of discharges is from the abandoned Ferris Wheel strip mines near Buckhorn. The Ferris Wheel surface mine extracted Mercer or Brookville coal, and is only slightly vegetated many tens of years after mining. The entrance of an older underground mine may have been mined away in this area. Three discharges are measured here. Site 32R3 flows at an average 78 gal/min at pH 3.2, acidity 92 mg/L, Fe 10 mg/L and Al 3.1 mg/L. This flow emerges mainly from an iron mound, possibly fed by an abandoned borehole. Discharge 32R4 is a small stream draining the open strip cut of the Ferris Wheel surface mine. It flows at an average 97 gal/min with average pH 3.4, acidity 119 mg/L, Fe 6.3 mg/L and Al 9.2 mg/L. The third discharge, 32R5, just recently recognized, drains from the toe of the Ferris Wheel strip, with a flow of 13 gal/min. at pH 3.5 and acidity 107 mg/l. Little Laurel Run upstream from 32R5 receives some minor seeps, and has pH 4.6 with a conductivity less than 100 μS/cm, indicating minor acid influx. Recent samples show only about 0.5 mg/L Al.

The final acid discharge is measured at weir B-14 on the "Cooney tributary". At this point, the average pH is 3.5 with an acidity of 76 mg/L, 16 mg/L Fe and 0.7 mg/L Al at a flow rate of 60 gal/min as measured on a weir. The water emerges into a small beaver dam from strip mine spoil about 1000 feet south of B-14. According to maps in the Cooney files, the water discharges along a small valley buried by spoil. This flow is a Subchapter F point for the Buckhorn Mine of Cooney Bros. Coal Co. to the south of this spoil. To date the point has not been triggered by any increase in loading. The main flow from the Cooney operation is captured in a large pond to the west. This water has reasonably good quality, but very small flow.

Loadings

Comparison of discharges is facilitated by calculations of loadings, measuring the mass of contaminant flowing past the site in a given time. In this report, loadings are reported in pounds per day, calculated by the product of flow and concentration. Loadings have been calculated for acidity, Fe and Al, and are listed in Tables 2, 3 and 4.

In a simple situation, the acidity loading is conservative, i.e., it should be constant downstream from an acid discharge unless inflows of alkalinity or additional acid enter the flow. Therefore, the acidity load at a downstream point should equal the acidity loadings of all upstream acid sources, less any net alkaline inflows. In contrast, loadings of Fe may decrease because of oxidation and mineral precipitation downstream, or increase if the stream is dissolving

Fe-oxides from the stream bed. Loading of Al may decrease if the pH is increased, resulting from alkaline influx, or increase by dissolution of Al from the stream bed.

To compare loadings of acidity, ideally one should have statistically representative sets of flow and concentration measurements for the period of interest. The resulting loadings will then be representative of the time period in question, with an associated standard deviation, but loadings for a different time period may be considerably different because of different rainfall history or changes in sources. In addition, the measurements must also be free of bias in the measurements of flow and concentration. An evaluation of the quality of the measurements and the resulting loading is therefore needed.

The acidity loading is the single most important loading, because it integrates the effects of pH, Fe, Al and Mn, and represents the amount of $CaCO_3$ that must be added to the flow to neutralize it to a pH of 8.3. The acidity is a conservative quantity, in that oxidation and precipitation of Fe does not change the acidity, but only changes its form from Fe to H^+, as indicated by the following equations:

$$Fe^{2+} + 0.25\ O_2 + H^+ = Fe^{3+} + 0.5\ H_2O$$

$$Fe^{3+} + 3\ H_2O = Fe(OH)_3 + 3\ H^+$$

As indicated in Table 4, the sum of the acidity loadings of the ten acid discharges is 463 lb/day $CaCO_3$. By comparison, the acidity load of Little Laurel Run at its mouth, based on the three sets of data for which flow is available, is 782±485, 771±310 and 574±194 lb/day, where the ± values are one standard deviation. Using all the loading values from the three data sets, the average loading is 692±386 lb/day. Comparison of the average value at the mouth (692 lb/day) to the sum of the discharges (471 lb/day) suggests that additional acid sources must exist in the watershed. However, the standard deviation is very large, and the average for the mouth does not differ significantly from the sum of discharge loading. In addition, a careful field survey found only minor seepages and trickles in addition to the known discharges. Also, a detailed QA/QC evaluation indicates several possible problems. The measured discharges represent a drought period but the SRBC samples represent a high precipitation period. Also, some of the data appear to be biased. The available data have therefore been adjusted in order to have a valid comparison of discharges with stream data.

A main problem is that most of the acid discharges were sampled during a relatively dry year, whereas the SRBC values for the mouth were measured during a much wetter period, with resulting much higher flow and loadings. As can be seen on Figure 3, most of the acid discharges were sampled during a period in 2002-03 when the precipitation, and presumably the flow, was distinctly less than average and had been low for several years, whereas the SRBC flows were measured during a period of much higher than average precipitation during 2003-04. In addition, one SRBC measurement was at a time of extremely high flow (20,000 gal/min on 1/5/04). At the Dimeling gauging station downstream on Clearfield Creek (waterdata.usgs.gov/nwis.sw, Station 01541500), the flow of Clearfield Creek on this date was the fifth highest day during the past 10 years. Flow on this date has been deleted from the average for Little Laurel Run.

To correct for this temporal effect, the discharge loadings and the stream loadings have been adjusted to average flow conditions. The stream flow of Little Laurel Run is assumed to vary proportionally to stream flow at the Dimeling gauging station on lower Clearfield Creek (Station 01541500 at waterdata.usgs.gov/nwis/sw). During the period 4/1/02 to 5/31/03 when most of the discharge measurements were made, the average flow at Dimeling was 611 ft^3/s. The long-term average flow is 830 ft^3/s. During the period 11/1/03 to 8/31/04 when the SRBC samples were collected, the average flow was 993 ft^3/s. Based on this data, the flows and loadings for most of the discharges (32L1, 32R1, 32R2, 32R2A, 32R3, 32R4) have been multiplied by 830/611 = 1.36 in order to convert them to average flow conditions. The resulting adjusted loadings are listed in Table 4.

The small number of flows measured at the mouth of Little Laurel Run is not considered to be representative, in part because of a few extreme flows (20,251 gal/min as noted above, and also several flows in the 4000 to 5000 gal/min range), as well as the highly variable flow shown by the measurements. Instead, the average flow has been estimated from the area of the Little Laurel Run watershed (3.0 mi^2) relative to the Clearfield Creek watershed above the Dimeling gauging station (371 mi^2). From the average flow at Dimeling, an average for Little Laurel Run can be calculated as 3036 gal/min.

In order to obtain acidity values expressing the load removal necessary to meet the Fe, Al and pH standards, the acidity has been calculated from the concentrations by the procedure discussed by Hedin (2004) and Cravotta and Kirby (2004). The full equation for acidity is

Calculated acidity (mg/L $CaCO_3$) =

$$50\,[(2C_{Fe}/55.85) + (3C_{Al}/27) + (2C_{Mn}/54) + 10^{3-pH}] - \text{Alkalinity}$$

where C is the concentration of the subscripted solute in mg/L. If the samples contain appreciable suspended solids, the calculated acidity can be high owing to inclusion of suspended Fe, Al and Mn. In order to consider removal of only the Fe, Al and pH acidity needed to increase the pH to above 6 and remove essentially all Fe and Al, the acidities involving Fe, Al and pH have been calculated. These values are termed *neutralization acidities*.

Figure 2 plots neutralization acidity vs. flow at the mouth of Little Laurel Run. The acidity clearly decreases with increasing flow. At the average flow of 3036 gal/min, the neutralization acidity is 20 mg/L $CaCO_3$. This gives an average acidity loading of 731 lb/day $CaCO_3$. Similar plots indicate concentrations of 0.8 mg/L Fe and 2.0 mg/L Al at a flow of 3000 gal/min. Based on these numbers, the loading for Fe is 29 lb/d, and for Al is 73 lb/day.

Given the acceptable concentrations of 0.75 mg/L Al and 1.5 mg/L Fe, the acceptable loading at the mouth is calculated to be 54 lb/d Fe and 27 lb/d Al, based on the average flow. Using these figures, the required removal of acidity, Fe and Al compares to the sum of the sampled discharges as follows:

	Load at mouth	Removal required	Sum of discharges
Acidity (neutralization)	731 lb/day	731 lb/day	608 lb/day
Fe	29	0	90
Al	73	43	30

The above data show that treatment of the known discharges to eliminate the acidity, Fe and Al in their effluent will bring the stream close to an acceptable condition. If the treatment systems add 25 mg/L $CaCO_3$ of net alkalinity to each effluent, then an additional 150 lb/day of acidity load will be neutralized. This addition will bring the stream to a net alkaline condition, with pH above 6. At pH 6, Al is insoluble and will be precipitated, thereby bringing the stream into an acceptable state.

The data do suggest that minor unrecognized sources of acidity and Al exist within the watershed. The possibility of major acid discharges in the watershed is considered to be very low, based on many days search by Earl Smithmyer, who lives nearby and has hunted the area for many years, and on 4 days spent in the field by the writer during the current project. However, a number of slightly acidic seeps and puddles with flow less than 1 gal/min were found, mainly along the north side of the valley, downslope from the abandoned strip mines. Although the surface flows are negligible, it is possible that additional acid and Al enter the stream as groundwater inflow. In the discussion of remediation, a method for capturing and treating this flow is discussed.

The conclusion from this section on loading is that the ten known discharges represent the dominant source of acidity, Fe and Al in Little Laurel Run. If the acidity in these discharges is neutralized and reasonable additional alkalinity imparted by treatment methods, then the water will reach acceptable conditions. Some additional neutralization of small acid seeps on the north side of the valley may be needed.

RESTORATION PLAN

In order to restore Little Laurel Run to an acceptable state, it is necessary to remove the acid contaminants from the ten known discharges. A variety of technologies are available for accomplishing this restoration. The method used at a given site depends on the characteristics of the discharge and its surroundings. The following paragraphs discuss each discharge in terms of the technology appropriate for each one. The costs of most of the treatment methods are derived from the AMDTreat computer program of the U.S. Office of Surface Mining, and are based on recent costs of materials and labor. In general, facilities have been sized at about 175% of the average flow at the site.

Discharges 184-1 and 184-2

These discharges emerge from a long-abandoned strip mine on land owned by the Pennsylvania Game Commission. Discharge 184-1 is a small stream (26 gal/min) that flows along a small valley onto the strip mine spoil, across a small wetland, and then cascades down the steep front of the spoil. The acidity is 19 mg/L $CaCO_3$ with pH 4.4, Fe 0.6 and Al 0.7 mg/L. This discharge can be partially treated with an oxic limestone channel located in the steep segment down the front of the spoil, plus a small retention pond to capture the precipitate. The channel in this section is steep enough that the limestone will be kept largely clean of precipitate, and will continue to react. After construction of the open limestone channel, it will be monitored to determine if the outflow remains net alkaline. If not, a vertical flow pond and settling pond will be added to complete treatment.

Discharge 184-2 is a small seep (4 gal/min) that emerges from spoil below the upper part of stream 184-1. However, chemically it is much more Fe-rich. The acidity is 12 mg/L $CaCO_3$ with 14 mg/L alkalinity at pH 5.6. The flow is judged small enough and close enough to net alkalinity that a small aerobic wetland is appropriate for treatment. This wetland would also be designed to capture several other nearby small seeps of negligible flow.

In order to gain access to this area, a road into the vicinity is needed. One possibility is to restore an abandoned mine road down from Blacksnake Pike across the strip mine and along the bottom of the valley to the vicinity of the sites. This road would also access site 32L1. Another possibility would be to construct a road across the reclaimed Bender strip mine and down the slope to provide access below the abandoned strip mine. This road would be about 200 ft. in length, but additional road would be needed to access 32L1.

Costs of this program were estimated using the AMDTreat software as follows:

Oxic limestone channel (300 ft.)	$7,271
Retention pond	5,000

Vertical flow pond (optional, 16 hr ret. time)	17,669
Retention pond (optional)	5,000
Road (1000 ft.)	6,770
Aerobic wetland	5,039
Total	$24,080 to 46,749

Discharge 32L1

This discharge emerges from a gap in the same abandoned Gibson-Halstock surface mine that generates 184-1. It is on land owned by the Pennsylvania Game Commission. With a flow of 82 gal/min and acidity 60 mg/L at pH 3.5 and 4.5 mg/L Al, this discharge is much more important than the previously discussed ones. The flow cascades about 100 feet down a steep slope from the strip mine to the valley floor, so an oxic limestone channel is considered an effective treatment method. The limestone channel would be followed by a pond to capture the precipitate generated by neutralization of the water. The effluent will be monitored to determine whether a small vertical flow pond and settling pond should be added. Access to the site would be provided by the road included in 184-1, plus an existing abandoned road along the valley.

Costs of this treatment system are estimated as follows:

Oxic limestone channel (300 ft.)	$ 8,207
Vertical flow pond (16hr)	49,897
Retention ponds (2)	7,216
Total	$65,320

32R1 discharge (Beldin Mine)

This discharge emerges from an abandoned Beldin underground mine on the B coal. The owner of the mineral (and surface?) rights is E.P. Bender Coal Co. The discharge has a flow averaging 50 gal/min with acidity 50 mg/L at pH 3.6, 26 mg/L Fe, and 0.6 mg/L Al. The flow emerges at the top of a slope with about 50 ft of relief, which is again appropriate for an oxic limestone channel, but the relief is probably not adequate to completely treat the water by this method. Therefore, a vertical flow pond and settling ponds preceding and succeeding are selected as a key part of the treatment system.

The costs of this treatment system are as follows:

Oxic limestone channel	$ 8,207
Vertical flow pond (35 $g/m^2/d$)	29,609
Ponds (2)	10,000

Total	$47,816

Discharges 32R2 and 32R2A (Klondike Mine)

The 32R2 discharge is a small flow (15 gal/min) emerging from an abandoned strip mine on the Clarion or Brookville coal. It has an acidity of 405 mg/L at pH 3.4, with 134 mg/L Fe and 4 mg/L Al. Discharge 32R2A is a larger flow (averaging 160 gal/min) emerging from an abandoned underground mine with pH 3.6, acidity 50 mg/L, Fe 5 mg/L, Mn 3 mg/L and Al 1.5 mg/L. The property owners are the Blair County Solid Waste Authority and the Hite-Dodson family, with some mineral rights owned by Cooney Bros. Coal Co. and a successor trust.

An EPA 319 grant for $391,512 has been awarded by PA DEP for construction of vertical flow ponds and accessory settling ponds on these two discharges, plus re-establishing a small stream that flows over a highwall and sinks into the pit floor, to emerge as part of discharge 32R2A. Construction on this project is expected to begin in 2005or early 2006. The passive treatment systems are designed to remove all acidity, Fe and Al and generate a net alkalinity.

Discharges 32R3, 32R4, and 32R5

These discharges are related to the Ferris Wheel abandoned surface mine near the village of Buckhorn. Most of the land is owned by the Blair County Solid Waste Authority. The total flow totals about 188 gal/min, with pH about 3.4, acidity 110 mg/L, 8 mg/L Fe and 6 mg/L Al. Much of the flow emerges from a long-abandoned surface mine that is mostly non-vegetated. Revegetation of this area is proposed with the objective of reducing infiltration into the area as well as improving habitat and appearance. Additional flow emerges from an iron-mound that may represent a drillhole into an underlying sandstone aquifer. Two vertical flow ponds and associated settling ponds are selected for treatment.

Proposed treatment facilities are as follows:

Vertical flow pond (two, 35 g/m^2/d)	$234,086
Ponds (4)	20,000
Road (1000 ft)	7,209
Revegetation (53 acres at $2000/acre)	106,000
Total	$367,295

The costs above assume a single vertical flow pond on each of the two sites, but a single system for less money may be possible. Ponds are sized for about 170% of the average flow.

B-14 Discharge

The B-14 discharge is measured where it crosses the highway (PA-36), but the source is about 1000 ft upstream, where the flow emerges from a large spoil pile into a beaverdam. Old mining maps indicate that this outflow is the site of a former stream channel draining an underground mine and associated spoil piles, which were apparently buried by the recent Cooney spoil. The property is controlled by the Cooney Bros. Coal Co., and the B-14 discharge is a subchapter F point for their active mining permit. The loadings have so far not generated any responsibility for Cooney on this discharge. The discharge flows at an average 60 gal/min with pH 4.4, acidity 80 mg/L, Fe 117 mg/L, and 0.8 mg/L Al.

The low Al of this discharge suggests than an anoxic limestone drain would be a satisfactory treatment method. The facilities and costs are as follows:

Anoxic limestone drain		$58,756
Ponds (2)		10,808
	Total	$69,564

North Side Aluminum Removal System

As discussed above, some Al is apparently discharging from the north side of the valley downslope from the abandoned surface mines. After construction of the above systems, the stream will be monitored to determine whether further Al removal is needed. If so, detailed sampling of seeps on the north side of the valley will be used to select sites for a french drain system to collect Al-bearing water and channel it to a small treatment system.

The costs for this system are estimated as follows:

French drain (1000 ft)		$50,000
Vertical flow system (flushable)		20,000
Settling pond		5,000
Road (1000 ft)		7,209
	Total	$82,209

Table 5 summarizes the estimated costs for the anticipated treatment systems. The total cost is estimated at $1,048,013, of which $391,512 is approved for the Klondike systems (32R2 and 32R2A, plus a stream channel restoration). Sources for the additional funds are the recently approved Growing Greener II program, EPA 319 grants, Chesapeake Bay grants, Office of Surface Mining Appalachian Clean Streams program, and numerous other sources.

In addition to the costs of construction summarized in Table 5, some costs of maintainance and repair are expected. The expected life of the systems is 25 years. A study by a committee set up by the PA Department of Environmental Protection (DEP) (on which Rose served) estimated that long-term maintenance of passive systems would amount to about 4% of the construction cost. About half this expense will be covered by volunteer efforts of the Watershed Association. The Clearfield Creek Watershed Association (CCWA) will inspect and monitor the performance of the systems, and conduct all minor maintenance. The systems will be inspected, the inflow and outflow of the systems sampled, and flows measured, at least quarterly. Analytical funds are currently arranged within CCWA for at least several years of analyses. PA DEP is setting up funding for analysis, engineering advice and maintenance in the Growing Greener program. Additional sources of funds for possible major repairs or rebuilding are specific Growing Greener grants, EPA 319 grants, Chesapeake Bay grants, Heintz Foundation grants and other sources.

PRIORITIZATION, SCHEDULING AND EVALUATION

The two treatment systems at the Klondike site (32-R2 and 32-R2A) plus a stream channel restoration to decrease the flow in 32-R2A have been designed and are expected to be bid and constructed in the next year.

The next project is selected to be the 32-R3, -R4 and -R5 sites at the Ferris Wheel mine. Submission of a proposal by CCWA for this set of discharges is anticipated for 2006. The Ferris Wheel systems are expected to be completed by 2008. The treatment of the Klondike and Ferris Wheel acid flows will remove about 88% the acid in the upper half of the Little Laurel Run watershed, and will allow the upper half of the stream to become net alkaline, though with possible Fe precipitation where the B-14 flow joins the main stream. Little Laurel Run above the "Cooney' tributary should recover completely. On this basis, the year 2008 is a milestone for recovery of the upper half of the Little Laurel Run watershed to a net alkaline conditions with low aluminum. The acidity at the mouth of Little Laurel Run will also be markedly decreased, as will the load of acidity into Clearfield Creek.

Priority for treatment of B-14 will await developments on the Cooney mining permit, since this site is a Subchapter F point for the permit. If Cooney obtains bond release on this permit, the B-14 treatment system will be constructed as soon as possible. In view of a five-year waiting period after completion of mining before bond release by DEP, treatment of this discharge is probably many years away.

The 32L1 and 184-1 and 184-2 sites have the next priority, possibly in 2008 or 2009. At these sites, limestone channels will be constructed and monitored for at least a year to determine if further treatment is needed.

The 32R1 discharge (Beldin Mine) is the final priority, perhaps in 2009-2010. Previous discussions with E.P. Bender Coal Co. indicated that they plan to mine in this area in the foreseeable future. If they mine here, they will probably become responsible for this discharge.

Completion of all these projects in 2010 will restore the entire stream to a net alkaline condition, with negligible background values of Fe and Al. The macroinvertebrates should recover, and along with them fish should enter and thrive in the stream, as they once did. This is the final milestone of the project.

The maintenance and monitoring program will involve inspection of the systems by CCWA members at least quarterly, and more frequently in the initial year. Samples of the inflow and outflow of each system will be collected, and flows will be measured by weirs installed at these points. Samples will be analyzed for pH, specific conductance and temperature in the field, and for pH, specific conductance, acidity, alkalinity, Fe, Mn, Al, Ca and SO_4 by a DEP-certified lab. The results will be evaluated by Arthur Rose, (PhD, PG) and John Foreman, (PG) and compared with a net alkaline condition as expected by the design. Rose has published extensively on the performance of passive systems of the type proposed (Rose, 2004; Rose and Dietz, 2002) and continues research on vertical flow systems. If the systems decline in performance below that expected, the reasons will be investigated and remediation proposed.

In addition, the monitoring program includes at least two weirs on Little Laurel Run, one at the mouth and one just below the Klondike project. These two sampling sites will be monitored at least quarterly to assess the improvement of the stream chemistry. Macroinvertebrate sampling will also be conducted at these sites by the Cambria County Conservation District on an annual basis to follow recovery of the biota. If they do not meet expectations of net alkaline conditions and low Fe and Al, the source of the problem will be sought by CCWA personnel, and any additional remediation systems needed will be designed and proposals written by CCWA for implementation.

When CCWA water quality and benthic monitoring indicate that an impaired section of Little Laurel Run may once again comply with its designated use, the watershed group will notify DEP's Regional Office and request reassessment of that segment for delisting. Little Laurel Run has a total length of 2.98 miles, according to the 303(d) listing. The upper section that would be cleaned up by the completion of the Ferris Wheel project in 2008 extends from the headwaters to the inflow from the Beldin Mine discharge (32R1), a stream distance of about 1.75 miles.

PUBLIC PARTICIPATION

The prime mover in remediation of the Little Laurel watershed is the Clearfield Creek Watershed Association (CCWA), which was organized in 2001. The Association has about 115 dues-paying members, a majority of whom live near Little Laurel Run in the southern part of the Clearfield Creek watershed. The CCWA is incorporated with 501(c)3 status. The Association meets monthly at the Laurel Run Sportsman's Club in Dysart, or during winter, at the Prince Gallitzin Park Office. Typical attendance is 12 to 20. The Association holds clean-ups on 9 miles of highway and 5 miles of Clearfield Creek. These cleanups commonly draw 40 or more volunteers four times a year. CCWA also sponsors a Kids Fishing Derby at Dysart that has drawn in excess of 100 participants and a fund-raising Skeet Shoot that has drawn many dozen participants. All these activities are advertised by notices and articles in several local papers, which have drawn a number of new members. Through the efforts of the CCWA Public Relations Committee, the CCWA has received attention for its activities and projects in at least 25 newspaper articles since January 2003. This effort will continue to publicize the projects, and to educate the public on needs in the watershed.

Volunteers from the CCWA have been very active and productive on numerous projects in the area. Members of the Association conducted a year-long monthly sampling of acid discharges during 2002-3. In 2003 the Association applied for and received a $12,855 Growing Greener grant from the Commonwealth of Pennsylvania for design and permitting of the Klondike treatment facilities. Members have contributed in excess of $17,000 of volunteer effort toward this project. The in-kind contributions have included design and permitting activities, sampling and weir installation, improvement and clearing brush from roads, and other activities. In 2004 the Association applied for and was granted $391,512 for construction of these facilities. This project includes $43,890 of volunteer time and contribution of property. Members have been active in establishing new weirs in the Little Laurel Run watershed, and in sampling them monthly. Another project on Brubaker Run, about 5 miles north, has recently been funded by the Bureau of Abandoned Mine Reclamation for $209,620. This project is studying the source of a major acid discharge and means of eliminating or treating it. Activities on these projects are discussed at the monthly meetings of members. Numerous articles in local papers have described the projects based on information supplied by members. The Association has a web site at www.clearfieldcreekwatershed.org. Members are very active in the southern watershed area in discussing CCWA programs with their friends and acquaintances.

This Restoration Plan was presented at the July 19, 2005 meeting of the CCWA members and extensively discussed. The Association voted unanimously to approve the Plan as presented here.

Another active contributor has been the Cambria County Conservation District. The Conservation District helped to foster the formation of the CCWA. Personnel of the Conservation District collected data on tributary flow, water quality and macroinvertebrates during the Clearfield Creek Assessment, and participated in the report on the Assessment. They have continued to assist with installation of weirs and sampling, and have participated in most meetings of the Association. They have also assisted with permitting for the Klondike project. The Cambria County Conservation District has reviewed this plan and indicated its approval. The needs and activities of the watershed are very effectively publicized by the Conservation District at many meetings, shows and activities in the Cambria County. A poster on CCWA activities is displayed at Conservation District events. Two members of CCWA have been recognized by the Conservation District with "Special Conservationist Awards".

Other contributors to activities in the Little Laurel watershed have been the property owners (Blair County Solid Waste Authority, Hite-Dodson family, Cooney Bros. Coal Co. and Angels Coal Trust). In-kind contributions to the project have been made by Cree Surveying, U.S. Environmental Research Service, and Michael Wills, as well as numerous CCWA members. The Pennsylvania Game Commission, which owns nearby downstream land, has been supportive of the project. Other supporters have been the Dean Township and Gallitzin Township Boards of Supervisors, the Pennsylvania Fishing and Boating Commission, the Susquehanna River Basin Commission, the Laurel Run Sportsmans Club, and the Western Pennsylvania Coalition for Abandoned Mine Reclamation. Personnel of the Pennsylvania Department of Environmental Protection in the Cambria and Moshannon District Mining offices have strongly supported the projects in Little Laurel Run, and have assisted Association members in crucial ways. The PA DEP has identified the Clearfield Creek Watershed as a "priority watershed." Recently, a group of state and regional organizations have joined in a program to attack acid drainage in the West Branch of the Susquehanna River. Several local legislators have also supported the Klondike proposals.

CONCLUSIONS

Little Laurel Run is severely contaminated with acid mine drainage from abandoned mines. In addition to a lack of fish and other biota in the stream itself, the stream is a major source of acid and metals to Clearfield Creek. Ten discharges are responsible for essentially all acid and metals in this contaminated stream. Two of the major sources, at the Klondike Mine, will be treated by passive treatment systems for which funding has currently been committed. A second project will remove the effects of the Ferris Wheel discharges and allow the upper half of Little Laurel Run to recover. Smaller projects in two additional areas will handle acid in the lower part of the watershed. A dedicated group of volunteers in the Clearfield Creek Watershed Association will carry through these projects, with assistance from area residents and state and other sources of funding.

ACKNOWLEDGEMENTS

Acquisition of the data and information reported here was a contribution of many individuals and organizations. In particular, Earl Smithmyer is responsible for the sampling of discharges during 2002-3 and more recently has been the leader in installing several weirs on Little Laurel Run and sampling these regularly. He has been assisted by numerous other CCWA members. Bryan Rabish of the Cambria County Conservation District conducted sampling at the mouth of the stream and the macroinvertebrate investigation. As previously indicated, the Conservation District and its director Rob Piper were instrumental in getting the CCWA program started and assisted at all stages. John Foreman advised and instructed the CCWA volunteers on procedures at the start of the sampling program, and has contributed the design drawings and permitting of the Klondike site. Joseph Allison, Watershed Coordinator of PA DEP, was extremely helpful in starting the sampling program and advising on funding. Others at PA DEP, such as Max Scheeler, have also aided the sampling and evaluation. Beth Dillon of Susquehanna River Basin Commision contributed data on Little Laurel Run. All these individuals, and others too numerous to mention, have been essential to the success achieved in being able to prepare this report.

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The nearest station for precipitation measurement in the upper Clearfield Creek watershed is at Prince Gallitzin State Park (station 367167), available in the web site www.dcdc.noaa.gov/oa/pub/data/coop-precip/.

Table 1. Characteristics of water sample sites and analyses

Site	Name	Sampler	Period	Flow	Lab	
A. Main stream or major tributary						
32MS1	LLR Mouth	CCWA	9/04 - 5/05	12 ft. weir	Mahaffey	
32	LLR Mouth	CCCD	8/01 - 11/02	Flowmeter	Mountain Labs	
LTLR1.0	LLR Mouth	SRBC	11/03 -8/04	Flowmeter	DEP	
184-25	LLR Mouth	DEP, Bender		Estimated		
184-39	LLR Upstream	DEP, Bender		Estimated		
32MS2	KL2 downstream	CCWA	9/04 - 5/05	12 ft. weir	Mahaffey	
32MS3	KL1 upstream	CCWA	9/04 - 5/05	12 ft. weir	Mahaffey	
B-14	Cooney trib.	DEP, Cooney		3.5 ft. weir	Mahaffey	
B. Discharges						
32L1	Gibson-Halstockl Strip	CCWA	4/02 - 5/03	90^{o} V weir	Mahaffey	
32R1	Beldin Mine	CCWA	4/02 - 5/03	90^{o} V weir	Mahaffey	
32R2	Klondike Mine	CCWA	4/02 - 5/03	90^{o} V weir	Mahaffey	KL1 Treatment Sy
32R2A	Old Klondike Mine	CCWA	4/02 - 5/03	3 ft. weir	Mahaffey	KL2 Treatment Sy
32R3	Ferris Wheel 1	CCWA	4/02 - 5/03	90^{o} V weir	Mahaffey	
32R4	Ferris Wheel 2	CCWA	4/02 - 5/03	2 ft. weir	Mahaffey	
32R5	Ferris Wheel 3	CCWA	5/05	1 ft. weir	Mahaffey	
B-15	Cooney Trib.	DEP, Cooney		3.5 ft weir		
B-40	Cooney Trib.	DEP, Cooney		Estimated	Mahaffey	
B-43	Old Klondike Mine	DEP, Cooney		3 ft. weir	Mahaffey	Same as 32R2A
184-1	Strip Mine runoff	DEP,Bender		90^{o} V weir		
184-2	Strip Mine runoff	DEP,Bender		90^{o} V weir		
184-3	Strip Mine runoff	DEP,Bender		Weir?		
184-4	Strip Mine runoff	DEP,Bender		Weir?		
184-5	Strip Mine runoff	DEP,Bender		Weir?		
184-9	Strip Mine runoff	DEP,Bender		Weir?		
184-10	Strip Mine runoff	DEP,Bender		Weir?		
184-11	Strip Mine runoff	DEP,Bender		Weir?		

Table 2. Data for sample sites on main stream of Little Laurel Run
Data from DEP Permit Files, Cambria Co Conservation District, Susq. River Basin Comm and CCWA

Date	Flow	pH fld.	pH lab	Cond.	Temp.	Alk.	Acid.	Acidity	Fe	Mn	Al	SO4	TSS	TDS	Ca	Acidity load	Fe load	Al load	Mn load	Acid.load (calc.)	Neut. Acidity	Neut acidity load
	gal/min			uS/cm	C	mg/L	mg/L	Calc.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/d	lb/d	lb/d	lb/d	Calc	mg/L	lb/d
Site 32	**Mouth of Little Laurel Run**					**CCConsD**																
8/8/2001	ND		3.7	500		0	48	53	0.46	7.7	5	190		327							39	
11/30/2001	3094		3.5	416		0	39	36	0.86	4.2	2	161		210		1454	32	75	157		28	1061
2/28/2002	1578		3.7	374		0	36	34	1.1	3.5	2.8	107		217		685	21	53	67		28	523
5/22/2002	4549*		3.9	328		0	45	27	0.84	2.8	2.5	96		164							22	
8/27/2002	452		3.42	563		0	54	55	0.54	6.8	4.1	191		334		294	3	22	37		43	233
11/25/2002	1802		3.68	421		0	32	31	0.84	3.9	2.1	185		206		695	18	46	85		24	513
Average	1732		3.7	433.7		0.0	42.3	39	0.8	4.8	3.1	155.0		243.0		782	19	49	86			
																485						
LTLR1.0	**Mouth of Little Laurel Run**				**SRBC**																	
11/3/2003	1458	3.1	3.7	445	14.3	0	44.4	32	0.999	3.83	2.38	124.4	<3		18.4	780	18	42	67	564	25	439
1/5/2004	20251*	3.6	4.4	35	4.7	5.6	34.6	12	0.859	1.16	1.22	48	<3		7.87							
3/23/2004	4911	3.3	4	311	0.4	2	51.8	22	1.06	2.29	1.96	102.8	12		13.7	3066	63	116	136	1304	18	1053
5/11/2004	2042	3.2	3.7	411	16.2	0	66	30	0.724	3.43	2.2	151.4	<3		17.1	1624	18	54	84	735	23	578
6/21/2004	1351	3.2	3.7	438	14.8	0	63.4	33	0.612	4.21	2.58	154.3	4			1032	10	42	69	541	25	414
8/2/2004	2321	3	3.8	367	17.8	0	53	26	0.776	3.3	1.82	120.1	<3			1483	22	51	92	714	19	543
Average	2416.6	3.23	3.88	334.5	11.4	1.3	52.2	26	0.838	3.037	2.027	116.8	8		14.27	1597	26	61	90	771		
32MS1	**Mouth of Little Laurel Run**				**12 ft rectangular weir**					**CCWA**												
9/21/2004	2238		3.9	383	12.0	0.0	31.0	31	0.85	3.53	2.98	117	<5.7	194		836	23	80	95		24	657
12/19/2004	1703	3.9	3.7	391	3.0	0.0	36.0	27	1.01	2.57	1.82	133	10	246	12.5	739	21	37	53		22	449
2/27/2005	1930	3.6	3.9	393	2	0	34	31	1.02	3.83	2.77	136	<5.7	204.3	22.4	791	24	64	89		24	547
3/17/2005	1215*																					
3/19/2005	999	4.0	3.8	425	3	0	34	34	1.53	4.08	2.87	142	<5.7	226		409	18	35	49		27	320
3/21/2005	2238*																					
3/26/2005	3441*																					
3/30/2005	7097*																					
4/9/2005	793																					
5/9/2005	793	3.2	3.6	492	10	0	44	38	0.94	4.15	2.87	154	<5.7	254	20.5	421	9	27	40		30	289
5/17/2005	793	3.6		400			56															
6/9/2005	432	2.9	3.4	546	17	0	47	49	0.86	5.2	3.2	153	<6.2	319		245	4	17	27		39	
Average	1210.1	3.53	3.72	432.9	7.8	0.0	40.3	34.8	1.0	3.9	2.8	139.2	10.0	240.6	18.5	573.5	16.5	43.5	58.8			
184-25	**Mouth of Little Laurel Run**					Bender																
6/29/1999		4.5	3.6	529	18	0	48		1.28	6.66	4.43	191	4.3									
9/22/1999		4.3	3.6	529	10	0	52		0.63	6.31	4.02	180	1.3									
12/15/1999		4.5	4	252	10	0	20		0.91	2.19	1.62	78	0.3									
3/xx/00			3.8	367		0	32		0.93	3.21	2.46	119	0.3									
6/20/2000			3.7	413		0	36		1.14	4.41	2.81	134	0.7									
9/27/2000		4.5	3.6	516	10	0	42		1.17	5.72	3.08	168	1.7									
12/21/2000		4.5	3.9	389	1	0	28		1.35	3.73	2.54	121	0.3									
3/13/2001		4.5	3.9	324	2	0	28		1.31	2.33	2.18	90	8									
6/22/2001		4.5	3.5	461	15	0	40		1.18	4.52	3.05	156	0.3									
9/24/2001		4.5	3.5	616	16	0	64		0.86	8.03	5.21	233	0.3									
12/28/2001			3.7	410		0	42		1.48	4.64	3.12	159	1									
3/18/2002		4.5	3.7	345	3	0	40		1.07	3	2.57	104	1.3									
6/13/2002		4.5	3.6	384	15	0	34		0.7	3.69	2.99	128	0.3									
9/16/2002		4.6	3.4	665	16	0	134		0.94	8.14	5.88	233	0.3									
Average		4.5	3.7	442.9	10.5	0.0	45.7		1.1	4.8	3.3	149.6	1.5									
184-39	**Little Laurel Run 8000 ft upstream**					Bender																
9/22/1999		4.2	3.4	613	8	0	66		2.83	7.02	3.86	212	1.3									
12/15/1999		4.6	4	256	5	0	24		1.48	2.34	1.94	76	1.3									
3/xx/00			3.7	374		0	36		1.92	3.93	2.88	131	0.3									
6/20/2000			3.5	453		0	48		2.36	4.68	3.08	143	0.3									
9/27/2000		4.4	3.4	541	10	0	54		2.73	5.89	2.93	179	2.3									
12/21/2000		4.6	3.7	433	1	0	36		2.98	4.64	3.26	133	0.3									
3/13/2001		4.5	3.9	339	1	0	30		2.89	2.67	2.93	93	33.7									
6/22/2001		4.8	3.5	480	15	0	42		5.27	4.88	6.31	158	74.7									
9/24/2001		4.7	3.3	712	15	0	82		3.97	8.68	4.5	244	0.3									
12/28/2001			3.6	470		0	56		3.24	4.96	3.41	172	2									
3/18/2002		4.5	3.4	414	2	0	50		2.87	3.78	3.35	114	3									
6/13/2002		4.5	3.4	414	14	0	50		2.04	3.54	3.48	128	0.3									
9/16/2002		4.5	3.1	853	17	0	182		4.31	9.31	4.73	266	0.3									
Average		4.5	3.5	488.6	8.8	0.0	58.2		3.0	5.1	3.6	157.6	9.2									
32MS2	**Little Laurel Run below Klondike discharges**						**12 ft rect. Weir**				**CCWA**											
9/21/2004	1308		3.5	419.0	12.0	0.0	53.0	59	4.9	4.0	4.9	124.0	<5.7	211		836	76	78	63			
12/19/2004	793	3.7	3.4	536.0	4.0	0.0	58.0	55	6.3	4.2	2.9	162.0	14.3	267	18.2	554	60	28	40			
2/27/2005	999	3.4	3.5	484.0	0.0	0.0	56.0	66	8.4	6.0	4.4	172.0	<5.7	256	26.1	674	102	53	72			
3/19/2005	432	3.5	3.4	550.0	3.0	0.0	54.0	58	7.0	4.8	3.1	162.0	<5.7	259	21.7	281	37	16	25			
5/9/2005	432	3.2	3.3	693.0	7.0	0.0	76.0	66	7.4	5.9	3.1	201.0	<5.7	339	24.2	396	39	16	31			
6/9/2005	281	2.9	3.0	803.0	12.0	0.0	86.0		8.2	7.0	3.3	247.0	<6.2	466		291	28	11	24			
Average	707.5	3.34	3.35	580.8	6.3	0.0	63.8	61.0	7.0	5.3	3.6	178.0	14.3	299.7	22.6	505.4	56.9	33.5	42.3			
32MS3	**Little Laurel Run above Klondike discharges**						**12 ft. rect. Weir**				**CCWA**											
9/21/2004	1143		3.7	351.0	12.0	0.0	59.0	60	4.1	3.2	6.6	102.0	5.7	194		813	57	90	44			
12/19/2004	603	3.9	3.5	415.0	3.0	0.0	54.0	45	5.2	2.7	2.6	124.0	8.6	219	9.8	392	38	19	19			
2/27/2005	793	3.7	3.6	444.0	0.0	0.0	64.0	58	8.5	4.1	4.1	140.0	<5.7	214	15.9	612	81	39	39			
3/19/2005	281	3.9	3.6	471.0	6.0	0.0	51.0	57	9.3	4.3	3.6	137.0	<5.7	226	18.5	173	31	12	14			
4/17/2005	431	3.5		420.0			70.0									364						

Table 2 (cont.). Data for sample sites on main stream of Little Laurel Run
Data from DEP Permit Files, Cambria Co Conservation District, Susq. River Basin Comm and CCWA

Date	Flow	pH fld.	pH lab	Cond.	Temp.	Alk.	Acid.	Acid ity	Fe	Mn	Al	SO4	TSS	TDS	Ca	Acidity load	Fe load	Al load	Mn load	Acid.load (calc.)	Neut. Acidity	Neut acidity loa
	gal/min			uS/cm	C	mg/L	mg/L	Calc.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/d	lb/d	lb/d	lb/d	Calc	mg/L	lb/d
32MS3	**Little Laurel Run above Klondike discharg**							**12 ft. rect. Weir**			**CCWA**											
9/21/2004	1143		3.7	351.0	12.0	0.0	59.0	60	4.1	3.2	6.6	102.0	5.7	194		813	57	90	44			
12/19/2004	603	3.9	3.5	415.0	3.0	0.0	54.0	45	5.2	2.7	2.6	124.0	8.6	219	9.8	392	38	19	19			
2/27/2005	793	3.7	3.6	444.0	0.0	0.0	64.0	58	8.5	4.1	4.1	140.0	<5.7	214	15.9	612	81	39	39			
3/19/2005	281	3.9	3.6	471.0	6.0	0.0	51.0	57	9.3	4.3	3.6	137.0	<5.7	226	18.5	173	31	12	14			
4/17/2005	431	3.5		420.0			70.0									364						
5/9/2005	281	3.1	3.3	641.0	8.0	0.0	78.0	69	9.6	5.0	3.2	190.0	<5.7	303	19.2	264	33	11	17			
5/17/2005	212	3.4		533.0			84.0									215						
6/9/2005	212	2.8	3.0	693.0	15.0	0.0	83.0	100	11.6	6.1	3.2	187.0	<6.2	387		212	30	8	16			
Average	495	3.47	3.45	496.0	7.3	0.0	67.9	64.7	8.1	4.2	3.9	146.7	7.2	257.2	15.9	380.5	44.9	29.9	24.8			
B-40	**West Trib. Of Little Laurel Run above Little Laurel Run**										Cooney											
9/12/1994	82	7	6.8	953	17	30	0		1.9	2.24		466	17									
11/7/1994	35	4	6.5	354	9	20	0		1.85	4.78		152	15.3									
3/13/1995	260	5.7	6	204	12	16	0		0.64	1.48		54	17.3									
4/24/1995	75	4.7	5.4	304	9	10	0		0.86	2.68		82	9.3									
9/25/1995	18	5	4.8	482	16	6	12		1.28	6.38		205	4.7									
12/4/1995	125	6.7	6.5	180	7	12	0		0.37	0.88		60	5.7									
1/31/1996	150	5.6	5.2	235	5	6	6		0.84	1.6		59	24									
5/5/1996	158	5.9	5	374	12	8	12		0.68	4.99		163	7.3									
9/16/1996	170	6.8	6.3	354	15	10	0		1.37	3.12		142	19.3									
11/5/1996	65	5.2	5	665	10	8	46		4.67	12.35		308	22									
2/10/1997	100	4.4	4.8	516	3	6	40		12.59	8.1		250	9.7									
6/16/1997	79	4.4	4.6	384	15	6	20		2.81	3.3		151	3									
9/8/1997	19	5.9	3.3	968	18	0	80		14.61	12.63		372	7.7									
11/5/1997	79	4.4	4.6	451	8	10	34		3.19	5.3		180	8.3									
1/26/1998	252	3.2	3.9	571	5	0	50		7.96	6.29		204	10									
5/15/1998	250	5	5.5	212	20	10	8		0.84	1.92		70	10.7									
9/14/1998	55	3.7	3.5	728	21	0	74		7.17	11.42		260	13.7									
11/8/1999	100	5.4	5.6	359	11	10	4		4.65	4.87		141	11									
3/24/2000	78		6.6	159	10	12	0		2.16	0.85		49	27.7									
6/30/2000	100		3.7	471		0	28		5.54	6.18		154	12.3									
9/13/2000	32		3.8	587	17	0	36		7.98	8.31		203	20.7									
11/21/2000	75		3.8	460	2	0	26		6.74	6.86		185	13.7									
3/27/2001	250	6	4.6	347	5	6	10		5.93	3.61		113	88.7									
9/21/2001	10		3.4	778	16	0	64		16.3	10.4		281	28.3									
11/30/2001	200		6.6	330	7	20	0		9.78	3.04		101	92.9									
3/22/2002	250		4.7	251	4	4	12		0.94	1.67		63	3.3									
6/11/2002	125		5.5	245	16	6	4		1.32	2.72		88	4.7									
9/16/2002	8		3.6	483	17	0	24		5.51	6.07		163	14.3									
12/13/2003	125		5	416	3	8	10		3.81	4.22		130	8									
3/25/2003	275		5.9	165	9	10	4		0.53	1.28		49	<1.4									
6/30/2003	70	5.2	3.4	598	16	0	55		6.65	7.37		198	21.4									
9/30/2003	12.5	6.2	5.9	273	12	8	12		2.77	3.71		85	12.9									
11/4/2003	70		6	225	10	10	10		0.94	3.42		69	<5.7									
3/30/2004	200	6	3.8	455	5	0	28		5.87	5.51		134	<5.7									
6/16/2004	100	6.5	4	448	16	0	27		6.13	6.91		155	21.4									
9/30/2004			5.1	358		6	24		10.5	6.72		144	18.6									
11/8/2004	75	5.1	3.8	459	8	0	46		11.6	6.93		192	18.6									
Average	114.7	5.3	4.9	427.1	11.0	7.0	21.8		4.8	5.1		158.8	18.3			30	7					
B-14	**Western Tributary draining Cooney strip at PA 36**								3 ft rect weir													
11/8/1999	50	4	3.4	803	10	0	66		11.49	12.52	1	292	2.7			40	7	0.6				
3/24/2000	403	5.7	5.9	227	9	8	6		2.16	2.22	0.83	72	23.3			29	10	4.0				
6/30/2000	52	4	3.3	767	17	0	66		11.03	11.25	0.87	258	8.7			41	7	0.5				
9/13/2000	18	3.8	3.3	996	17	0	114		14.61	13.7	0.56	359	0.3			25	3	0.1				
11/21/2000	58	4.4	3.3	902	7	0	92		17.16	14.33	0.26	365	1.3			64	12	0.2				
3/27/2001	50.7	5	3.8	452	4	0	28		4.31	5.16	0.84	140	4.3			17	3	0.5				
5/22/2001	24.7	3.5	3.3	689	15	0	62		10.45	8.35	0.59	227	5.3			18	3	0.2				

Table 2 (cont.). Data for sample sites on main stream of Little Laurel Run
Data from DEP Permit Files, Cambria Co Conservation District, Susq. River Basin Comm and CCWA

Date	Flow	pH fld.	pH lab	Cond.	Temp.	Alk.	Acid.	Acid ity	Fe	Mn	Al	SO4	TSS	TDS	Ca	Acidity load	Fe load	Al load	Mn load	Acid.load (calc.)	Neut. Acidity	Neut acidity lo
	gal/min			uS/cm	C	mg/L	mg/L	Calc.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/d	lb/d	lb/d	lb/d	Calc	mg/L	lb/d
B-14	**Western Tributary draining Cooney strip at PA 36**								3 ft rect weir													
11/8/1999	50	4	3.4	803	10	0	66		11.49	12.52	1	292	2.7			40	7	0.6				
3/24/2000	403	5.7	5.9	227	9	8	6		2.16	2.22	0.83	72	23.3			29	10	4.0				
6/30/2000	52	4	3.3	767	17	0	66		11.03	11.25	0.87	258	8.7			41	7	0.5				
9/13/2000	18	3.8	3.3	996	17	0	114		14.61	13.7	0.56	359	0.3			25	3	0.1				
11/21/2000	58	4.4	3.3	902	7	0	92		17.16	14.33	0.26	365	1.3			64	12	0.2				
3/27/2001	50.7	5	3.8	452	4	0	28		4.31	5.16	0.84	140	4.3			17	3	0.5				
5/22/2001	24.7	3.5	3.3	689	15	0	62		10.45	8.35	0.59	227	5.3			18	3	0.2				
9/21/2001	13.5	5.8	3.1	1430	15	0	184		29.1	19.3	0.52	625	0.3			30	5	0.1				
																0	0	0.0				
6/30/2003	35	5.8	3	1220	17	0	150		22.3	15.7	1.53	602	32.9			63	9	0.6				
7/25/2003	50.7	3.2	3	1370	17	0	150		13.9	16.1	1.37	559	14.3			92	8	0.8				
8/26/2003	40	4.8	3.2	731	16	0	84		17.4	8.95	1.24	231	40			40	8	0.6				
9/30/2003	53.1	4	3.7	462	13	0	35		6	5.97	0.65	141	18.6			22	4	0.4				
10/9/2003	33		3.1	940	10	0	113		17.1	12.2	1.15	238	25.7			45	7	0.5				
11/26/2003	53	4.2	3.5	509	10	0	39		7.74	6.38	0.88	157	5.7			25	5	0.6				
12/9/2003	35		3.3	748	5	0	82		14.5	8.78	0.49	225	24.3			35	6	0.2				
1/7/2004	Frozen																					
2/10/2004	Frozen																					
3/30/2004	50.7	4.6	3.4	656	7	0	72		13.1	8.03	1.03	187	<5.7			44	8	0.6				
4/16/2004	70.9	5	3.8	344	7	0	21		7.38	3.89	0.78	89	10			18	6	0.7				
5/11/2004	68	4.2	3.1	941	11	0	100		21.6	11.6	1.2	252	38.6			82	18	1.0				
6/6/2004	53.1	4.8	3.2	773	16	0	77		14.3	9.37	1.23	256	25.7			49	9	0.8				
7/20/2004	38	4.6	3.1	840	17	0	97		24.3	12.4	1.09	326	28.6			44	11	0.5				
8/16/2004	35.1		3.2	785	17	0	83		32.6	12.9	1.02	265	37.1			35	14	0.4				
9/30/2004	30		3.5	560		0	50		23.5	7.37	0.49	192	41.4			18	8	0.2				
10/20/2004	87.9	4.6	3.5	518	10	0	46		15.2	6.11	0.35	183	21.4			49	16	0.4				
11/8/2004	53.1	4	3.4	695	8	0	81		21.8	9.05	0.45	269	18.6			52	14	0.3				
12/27/2004	Frozen	4.6	3.5	673	2	0	72		25.4	8.31	0.4	256	24.3									
1/13/2005	50.7	4.9	4.8	313	4	5	27		9.52	4.38	0.63	115	8.6			16	6	0.4				
2/14/2005	53.1	5	4.1	472	5	0	60		24	7.89	0.72	204	12.9			38	15	0.5				
4/17/2005	38	3.5		650														0.0				
5/9/2005	79	3.1	3.2	1000	12	0	124		33.6	12.6	1.17	376	15.7	580	47.4	118	32	1.1				
5/17/2005	44	3.2		855			128									68						
6/9/2005	15	2.9	2.9	1120	20	0	151		51.8	16.4	0.95	437	71.4	737		27	9	0.2				
Average	57.9	4.3	3.5	756.2	11.4	0.4	82.0		17.8	10.0	0.8	272.3	20.1	658.5		41.6	9.1	0.6				

Table 3A. Detailed data for discharges monitored by Clearfield Creek Watershed Association

Date	Flow	Weir	pH field	pH lab	Cond.lab	Temp.	Alk.	Acidity	Iron	Manganese	Aluminum	Sulfate	TSS	TDS	Acid.Load	Fe Load	Al load
	gpm	in			uS	F	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day
Site 32-L-1		V notch		Gibson-Hallstockl strip													
4/15/2002	50.4	3.5	3.6	3.6	528	46	0	62	2.2	4.19	6.19	160	1.7	301	37.62	1.33	3.76
5/15/2002	193.9	6	3.7	3.4	452	46	0	54	2.4	3.2	5.24	137	4	255	126.08	5.60	12.23
6/17/2002	94.5	4.5	3.4	3.5	487	51	0	58	2.31	3.85	4.71	148	0.3	274	65.97	2.63	5.36
7/14/2002	27.6	2.75	3.6	3.4	554	58	0	60	3.72	5.52	4.6	197	0.3	321	19.92	1.24	1.53
8/14/2002	12.4	2	3.5	3.2	667	56	0	60	3.88	5.66	2.83	190	0.7	384	8.99	0.58	0.42
9/16/2002	8.9	1.75	3.4	3.3	706	57	0	94	2.82	5.52	2.2	202	0.7	336	10.08	0.30	0.24
10/14/2002	6.1	1.5	3.4	3.2	667	50	0	52	2.18	5.26	2.04	204	1	314	3.79	0.16	0.15
11/14/2002	12.4	2	3.3	3.3	618	42	0	54	2.05	4.79	2.02	196	11	317	8.09	0.31	0.30
12/15/2002	27.6	2.75	3.4	3.4	466	43	0	68	2.16	4.64	4.27	172	<1	286	22.58	0.72	1.42
1/9/2003	156.0	5.5	3.2	3.6	587	42	0	64	1.73	4.16	6.94	197	1	315	120.21	3.25	13.04
3/7/2003	70.4	4	3.6	3.3	490	36	0	62	3.19	3.95	5.01	154	<1.4	270	52.53	2.70	4.24
4/3/2003	122.9	5	3.1	3.5	544	42	0	68	2.27	5.03	7.66	187	<1.4	311	100.65	3.36	11.34
4/10/2005	285.1	7	3.7		385			31							106.41		
Average	82.2		3.5	3.4	550.1	47.4	0.0	60.5	2.6	4.6	4.5	178.7	2.3	307.0	52.5	1.8	4.5
Site 32-R-1		V notch		Beldin deep mine													
4/15/2002	34.3	3	3.6	3.5	843	48	0	82	26.4	3.96	0.8	321	3	549	33.84	10.90	0.33
5/15/2002	34.3	3	3.6	3.4	700	48	0	76	22.6	3.27	0.58	285	0.3	475	31.37	9.33	0.24
6/17/2002	34.3	3	3.6	3.5	725	50	0	80	27.5	3.68	0.56	288	1.3	509	33.02	11.35	0.23
7/14/2002	34.3	3	3.8	3.4	729	54	0	78	29.2	3.97	0.65	285	0.3	474	32.19	12.05	0.27
8/14/2002	27.6	2.75	3.9	3.5	738	54	0	76	29.6	3.87	0.54	290	3	482	25.24	9.83	0.18
9/16/2002	34.3	3	3.9	3.5	760	54	0	108	26.6	3.77	0.44	291	4.3	453	44.57	10.98	0.18
10/14/2002	27.6	2.75	3.5	3.6	739	52	0	72	24.7	3.59	0.41	315	1.3	477	23.91	8.20	0.14
11/14/2002	41.9	3.25	3.4	3.4	774	46	0	80	23.1	4.18	0.67	328	10	487	40.33	11.65	0.34
12/15/2002	50.4	3.5	3.5	3.4	736	48	0	80	24.7	4.18	0.46	330	<1	518	48.54	14.99	0.28
1/9/2003	70.4	4	3.2	3.5	817	46	0	70	23.3	3.91	0.48	328	3	517	59.31	19.74	0.41
3/7/2003	59.9	3.75	3.5	3.5	821	46	0	82	26.9	4.19	0.59	363	<1.4	567	59.12	19.40	0.43
4/3/2003	70.4	4	3.2	3.5	765	48	0	72	27.2	4.12	0.46	325	<1.4	487	61.00	23.05	0.39
Average	43.3		3.6	3.5	762.3	49.5	0.0	79.7	26.0	3.9	0.6	312.4	2.9	499.6	41.0	13.5	0.3
Site 32-R-2		V notch		Old Klondike mine													
4/15/2002	12.4	2	3.2	3.1	1530	48	0	282	95.6	22.5	3.98	819	7.3	1061	42.24	14.32	0.60
5/15/2002	21.7	2.5	3.2	3.1	1250	46	0	230	72.2	19.2	3.82	664	1	914	60.18	18.89	1.00
6/17/2002	12.4	2	3.2	3.1	1380	51	0	276	83.6	21.1	3.35	726	2.3	1054	41.34	12.52	0.50
7/14/2002	8.9	1.75	3.3	3.1	1660	54	0	362	135	29.1	4.51	1021	0.7	1317	38.83	14.48	0.48
8/14/2002	3.8	1.25	3.3	3	1980	56	0	420	168	31.6	4.59	951	14.7	1608	19.43	7.77	0.21
9/16/2002	3.8	1.25	3.4	3.3	2380	55	0	758	217	37.5	5.67	1217	3	1845	35.06	10.04	0.26
10/14/2002	3.8	1.25	3.3	3.3	1990	50	0	500	220	35.9	5.49	1320	2.3	1922	23.13	10.18	0.25
11/14/2002	6.1	1.5	3.2	3.2	1990	46	0	534	211	34.8	5.14	1180	15	1790	38.96	15.39	0.38
12/15/2002	8.9	1.75	3.9	3.2	1700	44	0	480	178	31.8	4.49	1180	<1	1653	51.49	19.09	0.48
1/9/2003	21.7	2.5	3.2	3.1	1710	42	0	346	126	27.4	4.39	1004	5	1245	90.53	32.97	1.15
3/7/2003	8.9	1.75	3.3	3.2	1830	38	0	448	161	30.5	3.97	1139	2.9	1559	48.05	17.27	0.43
4/7/2003	16.7	2.25	3.1	3.1	1460	46	0	268	97.3	27.4	4.77	689	1.4	1050	53.88	19.56	0.96
5/14/2003	12.4	2	3.4	3.2	1640	48	0	360	105	25.6	3.51	799	7.1	1247	53.92	15.73	0.53
6/4/2003	34.3	3	3.4	3.2	1380	9	0	288	101	26.6	4.67	719	4.3	1059	118.87	41.69	1.93
7/15/2003	12.4	2	3.4	3	1720	56	0	368	119	29	4.13	972	1.4	1336	55.12	17.82	0.62
9/29/2003	41.9	3.25	3.9	3	1470	56	0	285	93.2	24.9		692	<5.7	1090	143.69	46.99	0.00
10/25/2003	16.7	2.25	3.5	2.8	1830	10	0	364	130	29.4	4.21	875	11.4	1423	73.18	26.14	0.85
12/19/2004	16.7	2.25	3.4	3.1	2010	8	0	645	104	22.6	1.33	1052	12.9	1680	129.68	20.91	0.27
2/27/2005	21.7	2.5	3.2	3.2	1960	6	0	442	44.8	9.88	0.67	1013	5.7	1164	115.65	11.72	0.18
3/19/2005	16.7	2.25	3.5	3.1	2050	9	0	444	213	45.2	2.63	1176	<5.7	1896	89.27	42.83	0.53
5/9/2005	16.7	2.25	3.2	3.1	2310.0	8	0	490	194	40.7	2.37	1277	14.3	1941	98.52	39.00	0.48
6/9/2005	12.8	2	2.9	2.9	2420.0	14	0	600	238	47.7	2.57	1379	<6.2	2297	92.15	36.55	0.39
Average	15.1		3.3	3.1	1802.3	36.4	0.0	417.7	141.2	29.6	3.8	993.8	6.3	1461.4	68.8	22.4	0.6
32R2A, B43		3 ft. rect.			Klondike Mine lower outflow												
5/22/2001	80.0			3.3	605.0	17.0	0.0	54.0	5.7	3.5		165.0	3.7		52.07	5.53	
9/21/2001	77.7			3.0	868.0	17.0	0.0	92.0	9.4	6.5		260.0	0.3		86.16	8.81	
11/1/2001	242.0			3.4	626.0	9.0	0.0	50.0	3.5	3.6		171.0	0.3		145.84	10.27	
3/22/2002	125.0			3.3	404.0	4.0	0.0	40.0	3.3	1.3		79.0	1.7		60.26	4.99	
6/11/2002	75.0			3.4	421.0	16.0	0.0	36.0	3.4	1.8		105.0	7.0		32.54	3.04	
9/16/2002	20.0			3.1	910.0	16.0	0.0	90.0	11.6	7.9		270.0	5.0		21.70	2.80	
3/7/2003	69.9	0.75	3.4	3.5	529.0	4.0	0.0	50.0	4.6	2.3	2.0	127.0	<1.4	222.9	42.15	3.89	1.70
4/3/2003	197.0	1.5	3.3	3.4	462.0	7.0	0.0	36.0	4.8	2.3	1.7	101.0	<1.4	193.0	85.49	11.49	3.96
5/14/2003	150.1	1.25	3.8	3.6	452.0	9.0	0.0	36.0	3.4	2.2	1.2	110.0	11.4	194.0	65.12	6.06	2.22
6/4/2003	622.2	3.25	3.9	4.0	261.0	10.0	0.0	22.0	4.1	1.4	1.1	74.0	12.9	136.0	164.98	31.05	8.16
7/15/2003	69.9	0.75	3.5	3.3	578.0	12.0	0.0	66.0	5.9	3.8	1.9	164.0	5.7	264.0	55.64	5.01	1.61
9/29/2003	360.4	2.25	3.9	3.7	376.0	13.0	0.0	33.0	3.7	1.6		84.0	<5.7	160.0	143.36	15.94	
10/25/2003	69.9	0.75	3.7	3.3	699.0	10.0	0.0	60.0	7.0	4.1	1.7	185.0	20.0	297.0	50.59	5.90	1.41
12./19/05	150.1	1.25	3.5	3.3	555.0	9.0	0.0	46.0	4.4	2.4	1.0	161.0	18.6	243.0	83.21	8.00	1.72
2/27/2005	150.1	1.25	3.4	3.4	468.0	5.0	0.0	44.0	4.6	2.8	1.3	125.0	<5.7	209.0	79.60	8.39	2.40
3/19/2005	107.5	1	3.7	3.4	549.0	7.0	0.0	42.0	5.7	3.5	1.4	142.0	10.0	226.0	54.44	7.39	1.85
5/9/2005	107.5	1	3.4	3.4	603.0	10.0	0.0	50.0	5.4	3.4	1.3	162.0	<5.7	256.0	64.81	7.03	1.62
6/9/2005	53.2	0.63	3.0	3.3	647.0	9.0	0.0	52.0	6.9	4.7	1.6	171.0	7.1	337.0	33.37	4.40	1.04
Average	151.5		3.5	3.4	556.3	10.2	0.0	49.9	5.4	3.3	1.5	147.6	8.0	228.2	73.4	8.3	2.5
Site 32-R-3		V notch		Ferris Wheel surface #1													
4/15/2002	122.9	5	3.6	3.5	458	48	0	38	3.21	1.79	0.76	76	4.7	177	56.24	4.75	1.12
5/15/2002	122.9	5	3.5	3.3	417	45	0	40	3.83	1.94	0.83	85	1	166	59.20	5.67	1.23
6/17/2002	70.4	4	3.2	3.2	598	54	0	66	6.16	2.94	0.66	117	1	214	55.92	5.22	0.56

Table 3A (con Detailed data for discharges monitored by Clearfield Creek Watershed Association

Date	Flow	Weir	pH field	pH lab	Cond.lab	Temp.	Alk.	Acidity	Iron	Manganese	Aluminum	Sulfate	TSS	TDS	Acid.Load	Fe Load	Al load
	gpm	in			uS	F	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day
Site 32-R-3		V notch		Ferris Wheel surface #1													
4/15/2002	122.9	5	3.6	3.5	458	48	0	38	3.21	1.79	0.76	76	4.7	177	56.24	4.75	1.12
5/15/2002	122.9	5	3.5	3.3	417	45	0	40	3.83	1.94	0.83	85	1	166	59.20	5.67	1.23
6/17/2002	70.4	4	3.2	3.2	598	54	0	66	6.16	2.94	0.66	117	1	214	55.92	5.22	0.56
7/14/2002	34.3	3	3	3	948	56	0	132	16	6.29	1.03	225	0.3	4.2	54.48	6.60	0.43
8/14/2002	21.7	2.5	2.9	2.8	1230	67	0	172	23.9	9.47	1.38	299	1.7	536	45.00	6.25	0.36
9/16/2002	27.6	2.75	3	3	1270	63	0	238	21.3	9.52	1.98	357	0.3	494	79.03	7.07	0.66
10/14/2002	34.3	3	2.9	3	964	49	0	118	14.1	6.28	1.61	240	1	392	48.70	5.82	0.66
11/14/2002	70.4	4	3.1	3.2	697	44	0	76	8.3	3.71	1.2	159	11	269	64.39	7.03	1.02
12/15/2002	70.4	4	3.7	3.3	658	36	0	74	9.96	2.12	24.3	135	<1	268	62.70	8.44	20.59
1/9/2003	122.9	5	3.3	3.3	576	32	0	56	7.17	2.88	1.04	116	<1	182	82.88	10.61	1.54
3/7/2003	81.9	4.25	3.4	3.3	652	30	0	56	6.9	2.96	1.15	128	<1.4	261.4	55.21	6.80	1.13
4/3/2003	156.0	5.5	3.4	3.5	522	36	0	34	5.3	2.31	0.78	83	<1.4	219	63.86	9.96	1.47
4/17/2005	74.9	4.1	3.2		753												
5/17/2005	34.3	3	3		875			158							65.21		
6/26/2005	24.6	2.63	2.7	2.8	1350		0	228	41.9	11.3	1.63	445	<6.2	683	67.39	12.39	0.48
Average	71.3		3.2	3.2	797.9	46.7	0.0	106.1	12.9	4.9	3.0	189.6	2.6	297.4	61.4	7.4	2.4
Site 32-R-4		2 ft. rect.		Ferris Wheel #2 surface													
4/15/2002	200.52	2	3.6	3.6	475	49	0	62	2.16	3.25	5.83	115	3	234	149.67	5.21	14.07
5/15/2002	238.76	2.25	3.6	3.4	529	46	0	94	1.99	4.29	11.4	174	1	331	270.19	5.72	32.77
6/17/2002	130.79	1.5	3.4	3.3	570	52	0	102	3.62	4.59	9.9	163	1	295	160.60	5.70	15.59
7/14/2002	25.38	0.5	3.3	3.1	808	55	0	152	8.22	6.92	12.3	226	0.3	435	46.45	2.51	3.76
8/14/2002	25.38	0.5	3.1	2.9	996	68	0	152	10.2	7.94	8.82	297	1.3	488	46.45	3.12	2.70
9/16/2002	25.38	0.5	3.2	3.1	954	63	0	216	12.3	7.7	6.28	264	0.7	436	66.01	3.76	1.92
10/14/2002	25.38	0.5	3.2	3.1	738	48	0	112	10.5	7.11	5.96	221	2.7	364	34.22	3.21	1.82
11/14/2002	71.50	1	3.5	3.4	592	43	0	90	4.84	4.91	8.84	170	9	313	77.46	4.17	7.61
12/15/2002	46.54	0.75	3.7	3.3	646	35	0	122	7.59	6.31	9.6	187	<1	374	68.35	4.25	5.38
1/9/2003	130.79	1.5	3.7	3.4	628	34	0	112	3.89	5.57	12.8	203	<1	328	176.35	6.13	20.15
3/7/2003	71.50	1	3.3	3.4	656	29	0	100	7.22	5.83	9.08	191	<1.4	332.9	86.07	6.21	7.82
4/3/2003	238.76	2.25	3.4	3.5	571	38	0	84	2.97	4.56	9.88	142	<1.4	283	241.44	8.54	28.40
5/17/2005	25.38	0.5	3.2		675			143							43.70		
6/26/2005	17.17	0.39	2.8	2.9	939		0	162	15.1	7.73	6.57	311	<6.2	490	33.48	3.12	1.36
Average	90.9		3.4	3.3	698.4	46.7	0.0	121.6	7.0	5.9	9.0	204.9	2.4	361.8	107.2	4.7	11.0
32R5		1 ft. rect.		Ferris Wheel #3 surface													
5/17/2005	12.64	0.5	3.5		385		0	107							16.28		
6/26/2005	4.49	0.25	3.4	3.3	434		0	84	3.53	3.46	8.79	103	<6.2	224	4.54	0.19	0.47
Average	8.56		3.45	3.30	409.50		0.00	95.50	3.53	3.46	8.79	103.00	<6.2	224.00	10.41	0.19	0.47

Table 3B. Detailed data for discharges, compiled from DEP permit files.

Klondike Mine (DEP data)

Date	Flow	pH fld	pH lab	Cond	Temp	Alk	Acid	Calc Acid	Fe	Mn	Al	SO4	TSS	Acid load	Fe load	Al load
184-1																
12/21/2000	7.2	4.4	4.2	390	3	6	12		0.8	3.17	0.76	141	0.3	1.04	0.07	0.07
1/19/2001	4.3	4.6	3.9	446	5	0	18		0.36	3.37	0.7	136	0.3	0.93	0.02	0.04
2/13/2001	83	4.5	4.1	466	7	2	16		0.48	2.57	0.89	134	1	16.01	0.48	0.89
3/13/2001	14.4	4.3	4	460	5	0	16		0.37	2.57	0.51	118	0.7	2.78	0.06	0.09
4/25/2001	35	4.5	4.2	477	15	2	12		0.49	2.21	0.72	120	0.7	5.06	0.21	0.30
5/21/2001	7.2	4.7	4.1	467	11	2	12		0.55	2.88	0.8	132	1.3	1.04	0.05	0.07
6/22/2001	6.2	4.8	4	450	11	0	16		0.64	3.47	0.88	124	0.3	1.20	0.05	0.07
7/18/2001	2.8	4.8	3.8	506	15	0	20		0.37	3.53	1.11	133	2.3	0.67	0.01	0.04
8/14/2001	2	4.5	3.6	557	16	0	30		0.34	4.88	0.75	130	0	0.72	0.01	0.02
9/24/2001	0.9	4.8	3.5	557	15	0	36		0.91	4.41	0.63	113	0.3	0.39	0.01	0.01
10/26/2001	0.9	4.8	3.4	609	7	0	36		1.69	5.67	0.61	131	1	0.39	0.02	0.01
11/29/2001	0.9	4.5	3.5	534	10	0	34		2.26	4.48	0.35	106	0.3	0.37	0.02	0.00
12/9/2003	17	4.3	4.4	391	3	5	14		0.33	1.95	0.64	118	7.1	2.87	0.07	0.13
1/27/2004	9.8	4.2	4.4	423	3	4	27		0.56	1.9	0.69	98	14.3	3.19	0.07	0.08
2/27/2004	4.3	4.1	4.2	366	6	3	74		0.56	2.07	0.65	95	<5.7	3.84	0.03	0.03
3/19/2004	25	4.1	4.5	427	3	4	14		0.45	1.86	0.84	98	<5.7	4.22	0.14	0.25
4/27/2004	22.9	4.3	4.3	701	8	3	11		0.42	1.57	0.57	96	<5.7	3.04	0.12	0.16
5/26/2004	96.7	4.3	4.6	354	12	5	10		0.21	1.44	0.56	83	<5.7	11.66	0.24	0.65
6/18/2004	17	4.1	4.6	367	14	5	13		0.46	1.6	0.55	89	<5.7	2.66	0.09	0.11
7/21/2004	4.3	4	4.1	391	15	1	13		0.56	2.44	0.55	95	<5.7	0.67	0.03	0.03
8/30/2004	8.5		4.2	389		2	13		0.43	1.99	0.48	99	<5.7	1.33	0.04	0.05
9/21/2004	198	4.1	4.4	371	11	4	13		0.21	1.56	0.9	118	<5.7	31.02	0.50	2.15
10/18/2004	9.8	4.2	4.3	398	9	2	15		0.69	2.59	0.78	119	<5.7	1.77	0.08	0.09
11/24/2004	16.1	4.3	4.3	347	8	3	14		0.25	1.84	0.55	110	8.6	2.72	0.05	0.11
12/29/2004	22.9	4.1	4.4	337	4	3	10		0.14	1.45	0.47	97	<5.7	2.76	0.04	0.13
1/20/2005	51.6	4.5	4.5	337	6	4	10		0.27	1.34	0.55	99	<5.7	6.22	0.17	0.34
2/15/2005	44.5	4.3	4.5	318	5	4	12		0.36	1.4	0.46	88	8.6	6.44	0.19	0.25
4/10/2005	35	4.5		335			22							9.28		
Average	26.4	4.4	4.1	438.4	8.7	2.4	19.3		0.6	2.6	0.7	111.9	2.9	4.4	0.1	0.2
184-2																
12/21/2000	2.8	5.8	6.2	323	7	18	4		8.15	3.41	0.07	113	0.3	0.13	0.28	0.00
1/19/2001	2.8	5.8	5.7	347	6	18	6		9.61	3.53	0.07	108	1.7	0.20	0.32	0.00
2/13/2001	12.8	5.7	5.3	405	5	6	10		2.62	2.76	0.43	124	1.7	1.54	0.40	0.07
3/13/2001	6.2	5.5	5.9	368	6	12	10		5.94	3.21	0.07	115	1.3	0.75	0.44	0.01
4/25/2001	7.2	5.8	5.5	377	11	10	8		5.54	3.17	0.22	109	1	0.69	0.48	0.02
5/21/2001	2.2	5.9	6	366	10	20	10		9.84	3.54	0.13	110	2	0.27	0.26	0.00
6/22/2001	2.2	6	5.9	335	11	12	8		9.57	4.03	0.08	112	0.3	0.21	0.25	0.00
7/18/2001	2.2	5.9	6	350	12	22	10		11.03	3.69	0.67	103	3	0.27	0.29	0.02
8/14/2001	0.9	6.2	6	337	15	16	14		14.9	4.4	0.02	101	5.3	0.15	0.16	0.00
9/24/2001	0.6	6	5.6	330	13	18	10		16	3.93	0.04	86	1.7	0.07	0.12	0.00
10/26/2001	2.2	6.2	5.7	362	8	20	10		18.1	4.32	0.01	92	7.3	0.27	0.48	0.00
11/29/2001	1.7	5.5	6	389	10	24	18		16.2	3.87	0.01	83	2.7	0.37	0.33	0.00
																0.00
12/9/2003	3.9	4.3	5.6	342	4	15	13		6.27	2.87	0.17	107	<5.7	0.61	0.29	0.01
1/27/2004	3.5	5.5	5.7	350	5	15	28		7.23	2.8	0.15	93	12.9	1.18	0.30	0.01
2/27/2004	2.2	5.2	4.4	333	6	2	10		8.53	3.04	0.1	90	<5.7	0.27	0.23	0.00
3/19/2004	3.5	4.2	6	349	3	14	10		7.13	2.86	0.18	90	<5.7	0.42	0.30	0.01
4/27/2004	4.3	5.5	5.8	333	7	13	8		7.12	2.7	0.13	94	<5.7	0.41	0.37	0.01
5/26/2004	8.5	5.4	5.6	301	12	11	9		6.02	2.64	0.12	81	<5.7	0.92	0.62	0.01
6/18/2004	3.9	5.4	4.5	322	14	4	12		8.68	3.01	0.09	90	<5.7	0.56	0.41	0.00

Table 4. Average Values for Sampling Sites

	Data source (N)	Flow gpm	pH field	pH lab	Cond. uS/cm	Temp C	Alk. mg/L	Acidity mg/L	Fe mg/L	Mn mg/L	Al mg/L	SO4 mg/L	TSS mg/L	TDS mg/L	Ca mg/L	AcidLoad lb/d	Fe load lb/d	Al load lb/d		Loads adjusted to normal flow		
Little Laurel Mouth (32,184-25, 32MS1, LTLR1.0)																						
Average	CCCD (6)*	1732		3.65	433.7		0.0	42.3	0.8	4.8	3.1	155.0		243.0		782	18.5	49				
Average	DEP (14)		4.49	3.68	442.9	10.5	0.0	45.7	1.1	4.8	3.3	149.6	1.5									
Average	SRBC(6)*	2417	3.23	3.88	334.5	11.4	1.3	52.2	0.8	3.0	2.0	116.8	8.0		14.3	771	26.0	61				
Average	CCWA (7)	1210.1	3.53	3.72	432.9	7.8	0.0	40.3	1.0	3.9	2.8	139.2	10.0	240.6	18.5	573.5	16.5	43.5				
184-39																						
Average	DEP (13)		4.53	3.53	488.6	8.8	0.0	58.2	3.0	5.1	3.6	157.6	9.2									
32MS2																						
Average	CCWA (5)	708	3.34	3.35	580.8	6.3	0.0	63.8	7.0	5.3	3.6	178.0	14.3	299.7	23	505.4	56.9	33.5				
32MS3																						
Average	CCWA (5)	495	3.47	3.45	496.0	7.3	0.0	67.9	8.1	4.2	3.9	146.7	7.2	257.2	16	380.5	44.9	29.9				
B-40 (Cooney Trib.)																						
Average	DEP (28)	115	5.33	4.93	427.1	11.0	7.0	21.8	4.8	5.1		158.8	18.3			30	6.7					
B-14 (Cooney Trib. At PA 36)																						
Average (11/00-2/05)	DEP(29)	59	4.45	3.51	735.2	11.0	0.5	78.0	16.0	9.7	0.8	262.4	18.3			39	8.3					
Acid Sources																			Factor	Ac.load	Fe load	Al load
184-1	DEP(27)	26	4.4	4.1	438.4	8.7	2.4	19.3	0.6	2.6	0.7	111.9	2.9			4.4	0.1	0.2	1	4.4	0.1	0.2
184-2	DEP (27)	4	5.59	5.7	340.5	8.7	13.6	11.8	9.3	3.3	0.1	99.4	5.1			0.5	0.4	0.0	1	0.5	0.4	0.0
32L1(Gibson-Halstockl	CCWA(12)	82	3.5	3.4	550.1	47.4	0.0	60.5	2.6	4.6	4.5	178.7	2.3	307.0		53	1.8	4.5	1.36	71.4	2.5	6.1
32R1 (Beldin)	CCWA(12)	43	3.6	3.5	762.3	49.5	0.0	79.7	26.0	3.9	0.6	312.4	3	500		41	13.5	0.3	1.36	55.8	18.3	0.4
32R2A (Klondike KL-2)	CCWA(18)	152	3.5	3.4	556.3	10.2	0.0	49.9	5.4	3.3	1.5	148	8	228	33.9	73	8.3	2.5	1.36	99.8	11.3	3.4
32R2 (Klondike KL-1)	CCWA(22)	15	3.3	3.1	1802.3	36.4	0.0	417.7	141.2	29.6	4	994	6	1461.4	284	68.8	22.4	0.6	1.36	93.5	30.5	0.8
32R3 (Ferris Wh#1)	CCWA(14)	71	4.1	3.9	678.7	21.1	2.6	89.6	23.8	7.4	2.0	267.9	7.9	550.7	111.3	61.4	7.4	2.4	1.36	83.5	10.1	3.3
32R4 (Ferris Wh#2)	CCWA(14)	91	3.4	3.3	698.4	46.7	0.0	121.6	7.0	5.9	9.0	204.9	2.4	361.8	83.6	107.2	4.7	11.0	1.36	145.8	6.4	15.0
32R5 (Ferris Wh #3)	CCWA(2)	9	3.5	3.3	409.5		0.0	95.5	3.5	3.5	8.8	103.0	<6.2	224		10	0.2	0.5	1	10.4	0.2	0.5
B-14 (Cooney area)	DEP (8)	59	4.40	3.48	752.2	11.1	0.5	80.9	18.4	10.1	0.8	272.7	20.0	41.9	42.7	42.7	9.9	0.6	1	42.7	9.9	0.6
184-9-11(Bender area)	DEP (21)	1		4.50			1.0	10.0	0.2							0	0.0		1	0.1	0.0	0.0
Sum																463	68.7	22.6		608.1	89.6	30.3

*CCWA = Clearfield Creek Watershed Monitoring
DEP = Mine permit files at DEP
CCCD = Cambria County Cons. Dist.

Table 5. Summary of Load Reductions and Estimated Costs

		Existing Load			Est. Load Removal		
Discharge	Est. Cost	Acidity	Fe	Al	Acidity*	Fe	Al
		lb/d	lb/d	lb/d	lb/d	lb/d	lb/d
184-1, 184-2	$24,080	4.9	0.5	0.2	13.9	0.5	0.2
32L1	65,320	71.4	2.5	6.1	96.1	2.5	6.1
32R1	47,816	55.8	18.3	0.4	68.7	18.3	0.4
32R2,32R2A	391,512	193.3	41.8	4.2	243.6	41.8	4.2
32R3,-R4,-R5	367,512	239.7	16.5	16.1	293.0	16.5	16.1
B14	69,584	42.7	9.9	0.6	60.5	9.9	0.6
N Side Al	82,209	?		?	?		13
Total	$1,048,013	608.1	89.6	30.3	776	90	43
Required Removal					731	0	43

*Assuming 25 mg/L net alkalinity in effluent

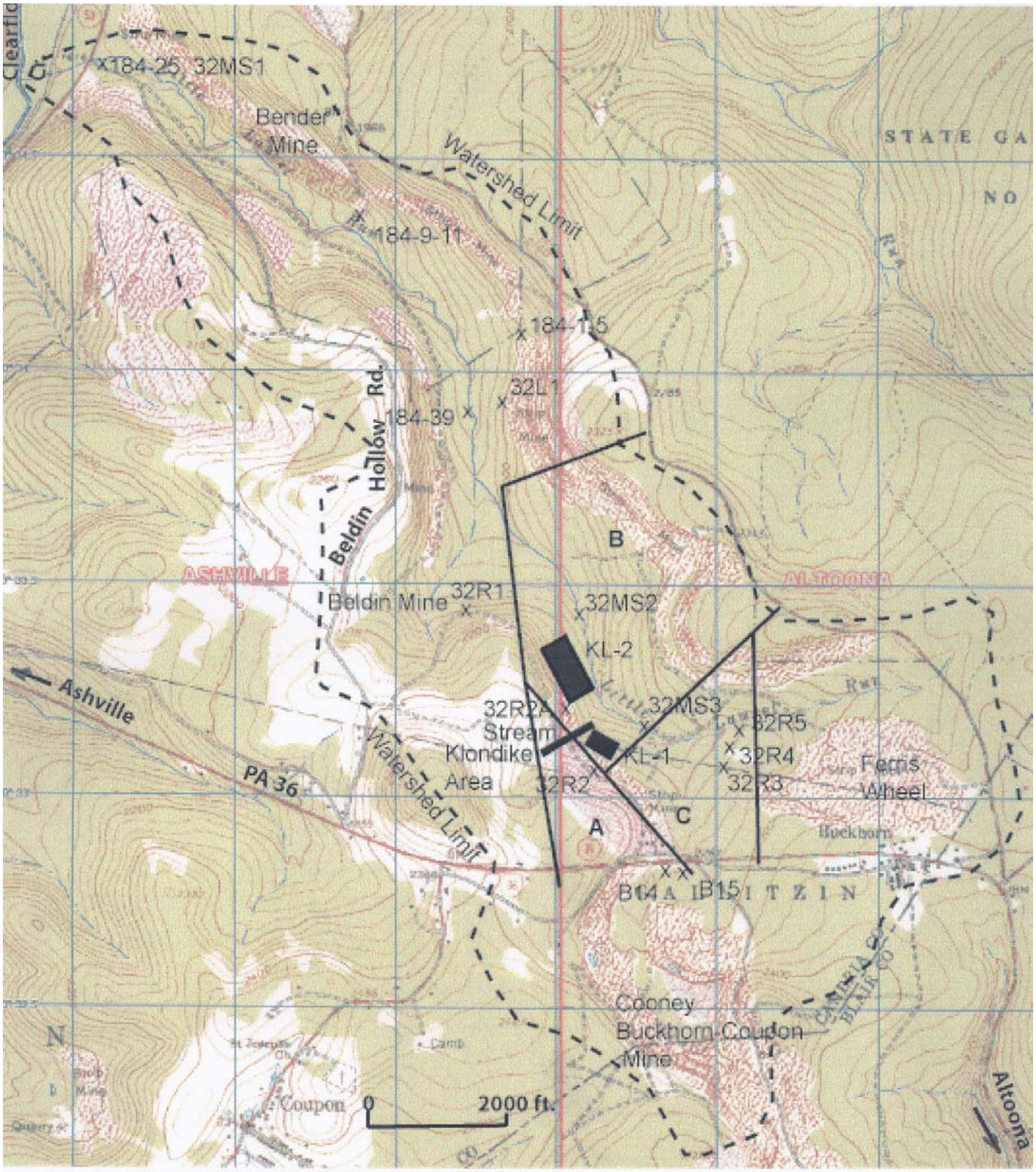

Figure 1. Map of Little Laurel Run watershed, sample points, properties and project area. Scale 1:24,000. Ashville and Altoona quadrangles. Properties: A: Hite, B: Blair Co., C: Cooney

Figure 2. Neutralization acidity vs. flow, Mouth of Little Laurel Run

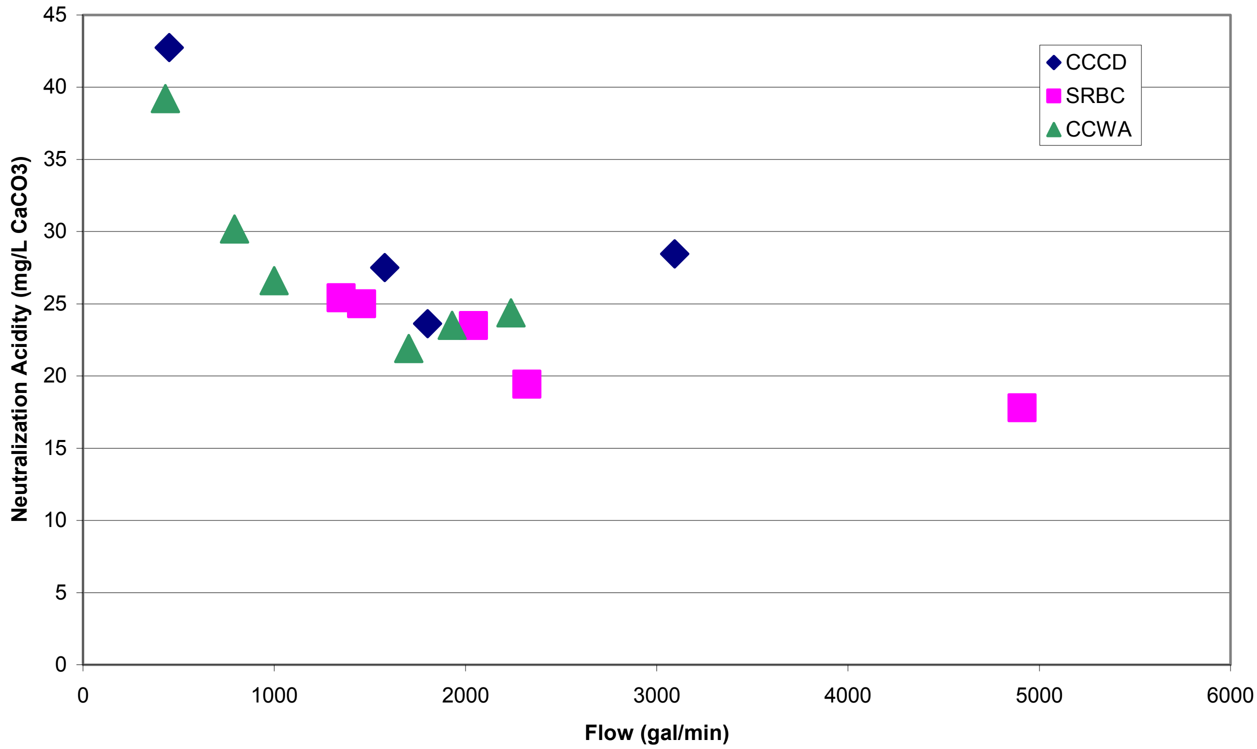

Figure 3. Precipitation vs. time at Prince Gallitzin Park