SECTION I

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

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REPORT SUMMARY

Location of Study Area

Loyalhanna Creek and its tributaries are located in the eastern portion of Westmoreland County, in southwestern Pennsylvania. The Loyalhanna watershed is within the outer fringe of the Pittsburgh metropolitan region and as designated by the Department of Commerce, all of Westmoreland County is within the Pittsburgh Standard Metropolitan Statistical Area (SMSA).

Description of Study Area

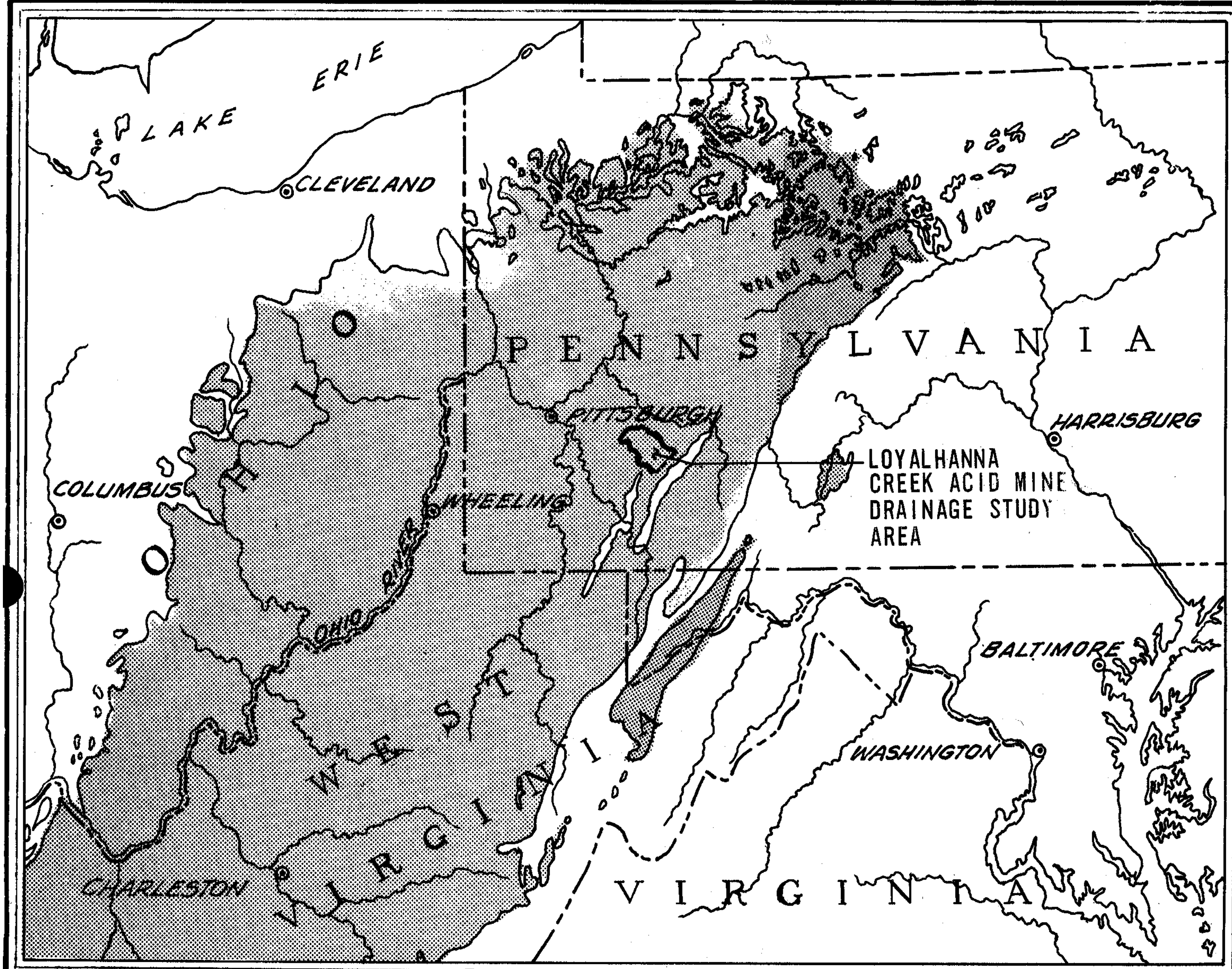
The area through which the Loyalhanna flows is not declining but is experiencing growth as an outlying portion of the Pittsburgh region. In the decade 1960-1970 population increased by 6.9% in the county. The presence of acid mine drainage in the main stream of the watershed and in Loyalhanna reservoir, which is located at the base of the watershed has not hindered economic development of the area, but has foreclosed the greater recreational use of the area as a recreational resource of the Pittsburgh metropolitan region.

Study Area Needs Related to Water Quality

Previous regional studies and reports have indicated a severe shortage of water oriented recreational facilities within the greater Pittsburgh area. The Westmoreland County Department of Economic and Industrial Development examined water based recreation needs in a report issued

December 1971, and proposed, as a way of responding to the se needs, the creation of a Beaver Run - Loyalhanna Reservoir Recreation Complex. The county report cites a study conducted by the Bureau of Outdoor Recreation in 1960 which indicated that only 25% of the recreation demand in the Pittsburgh SMSA was being met. Related to swimming demand, it was estimated that by 1980, a need for 90, 000, 000 swimming days per person would exist. (A swimming demand day is one swimmer desiring to swim one day). This demand must be satisfied from a potential facility capacity of only 7, 000, 000 swimming days which leaves a deficit of 83, 000, 000 demand days unfulfilled. In addition to swimming demand there will be in 1980, 14, 000, 000 demand days of fishing which cannot be satisfied by existing facilities. These demands are for the total Pittsburgh region of which the Loyalhanna Watershed is only a part. The Westmoreland County Report further states that the Corps of Engineers (who operate the Loyalhanna dam and recreation area) estimate that of the 83,000, 000 unfulfilled recreation days predicted for 1980, an expanded Loyalhanna facility could provide 3, 000, 000 swimming days annually or slightly less than 4% of the potential demand. The imbalance between supply and demand should insure close to full utilization of any expanded facility.

The commission's proposal or any proposal to provide additional water based recreation facilities is, of course ,contingent upon the improvement



SHADED AREAS OF MAP ARE UNDERLAID BY PITTSBURGH COAL DEPOSITS.

LOCATION OF STUDY AREA IN WESTERN PENNSYLVANIA	MINE DRAINAGE POLLUTION ABATEMENT MEASURES FOR THE LOYALHANNA WATERSHED	PLATE
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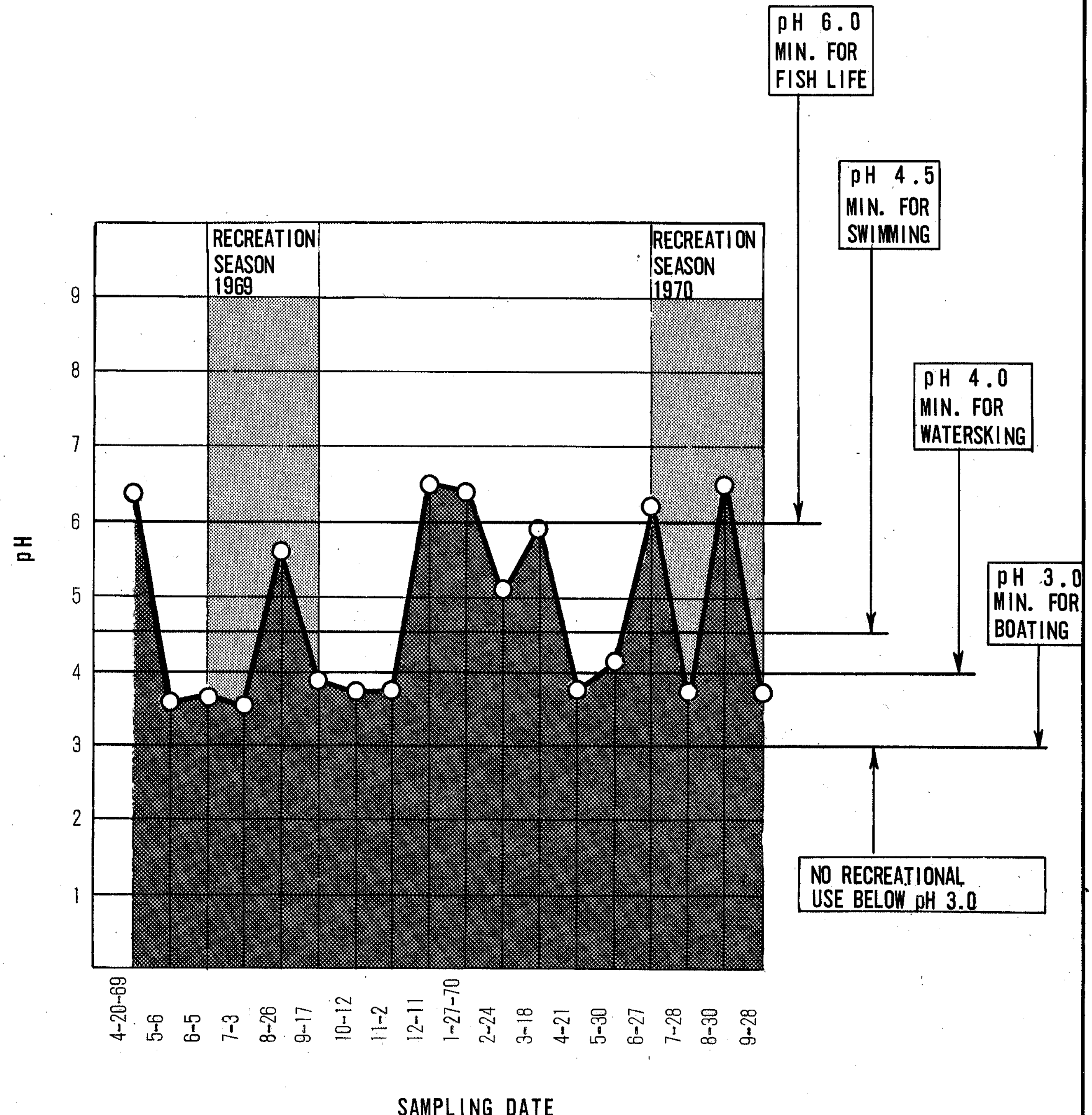

MEASURED pH IN LOYALHANNA RESERVOIR 1969 - 1970	MINE DRAINAGE POLLUTION ABATEMENT MEASURES FOR THE LOYALHANNA WATERSHED	PLATE I-2
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of water quality in the reservoir pool. In past recreation seasons, Loyalhanna reservoir has been judged too polluted to permit swimming or water skiing. The data collected by Buchart-Horn during the 18 month water quality sampling program confirmed this judgment. The pH of the reservoir was below 4.0 on two or more of the monthly sampling dates during the 1969 and 1970 recreation Seasons. The Appalachia Regional Commission (ARC) concluded in their study entitled, "The Impact of Mine Drainage on Recreation, " that people tend not to swim at a pH of below 4.5 This conclusion was verified at Loyalhanna Reservoir. The use of a Water body for recreational fishing is directly related to the health of the stream life community. The health of aquatic communities is adversely affected by acidity below pH 6 as the density and diversity of species decline significantly. While Loyalhanna reservoir has not been found to be totally de void of fish life the limited number of species and individuals present does not encourage its use for sport fishing.

Other than its detrimental effect upon the creek and reservoir's recreation potential, the presence of acid mine drainage has not adversely affected the economy or growth of the area. All water supply needs are presently satisfied by the use of non-polluted tributaries. There are no other water use demands other than recreation related uses which cannot be satisfied by means other than acid mine drainage abatement in the foreseeable future.

The Loyalhanna Watershed Study's Relationship to Study Area Needs

The Loyalhanna Watershed Acid Mine Drainage (AMD) Abatement Study was undertaken to provide answers to the following questions:

1. What are the sources of acid discharge into the creek and reservoir?
2. What is the average acid load entering the reservoir on a daily and annual basis?
3. To improve the quality of the creek and reservoir so as to permit fishing and full water oriented recreation, how much of the in coming acid load must be eliminated?
4. How can a sufficient number of sources of acid mine drainage within the watershed be terminated or treated to achieve the desired improvement in water quality?
5. What will the annual cost of improved water quality be?

Sources of Acid Mine Drainage in the Study Area

A field survey of the study area in conjunction with an 18 month sampling program indicated that there exists about 60 discharges of acid mine drainage within the watershed. Many of the minor discharges are seasonal or intermittent and discharge only at times of high ground water levels. An average value of the discharges from all inventoried AMD sources within the watershed, except direct runoff from gob piles, is about 63,500 lbs. of acid per day. However, the total discharge may decrease to less than 1 0,000 lbs. of acid per day during low flow drought periods or increase to over 100, 000 lbs. per day when flushing caused by temporarily high ground water occurs. Of this average acid discharge of 63,500 lbs., approximately 8, 000 pounds of acidity originates down stream from the dam and does not flow into the reservoir. Of the remaining 55,500 lbs. per day of acid, 48, 000 lbs. per day were traceable to 3 major sources. All other discharges upstream of the reservoir accounted for only 7, 500 lbs. per day. A secondary and irregular source of acid Inflow was found to be direct runoff from exposed gob piles. These flows are infrequent and occur only with the first flush of runoff associated with major ram storms or snowmelts. They are sometimes referred to as "slug" loads. It is estimated that on an annual basis, the gob piles of the watershed dies- charge acid into the reservoir at a rate equal to 4,400 tons per year. This would be equivalent to a daily discharge of 24, 000 lbs.

Major Discharges

The three major discharges, which contribute roughly 87% of the total non- runoff associated acid load to the reservoir, are low point drainage outlets for the flooded mines of the two major coal mining areas of the watershed, the Latrobe and Greensburg Synclines. Almost all other subsurface dis- charges in these two synclines are interconnected with these major dis- charges and are located at higher elevations. All other discharges occur when the three major discharges are flowing at full capacity.

The three major discharges (as were all discharges) were assigned numbers by the original Environmental Protection Administration investigators and these numbers have been retained for continuity. The major discharges by number, location and discharge are the following:

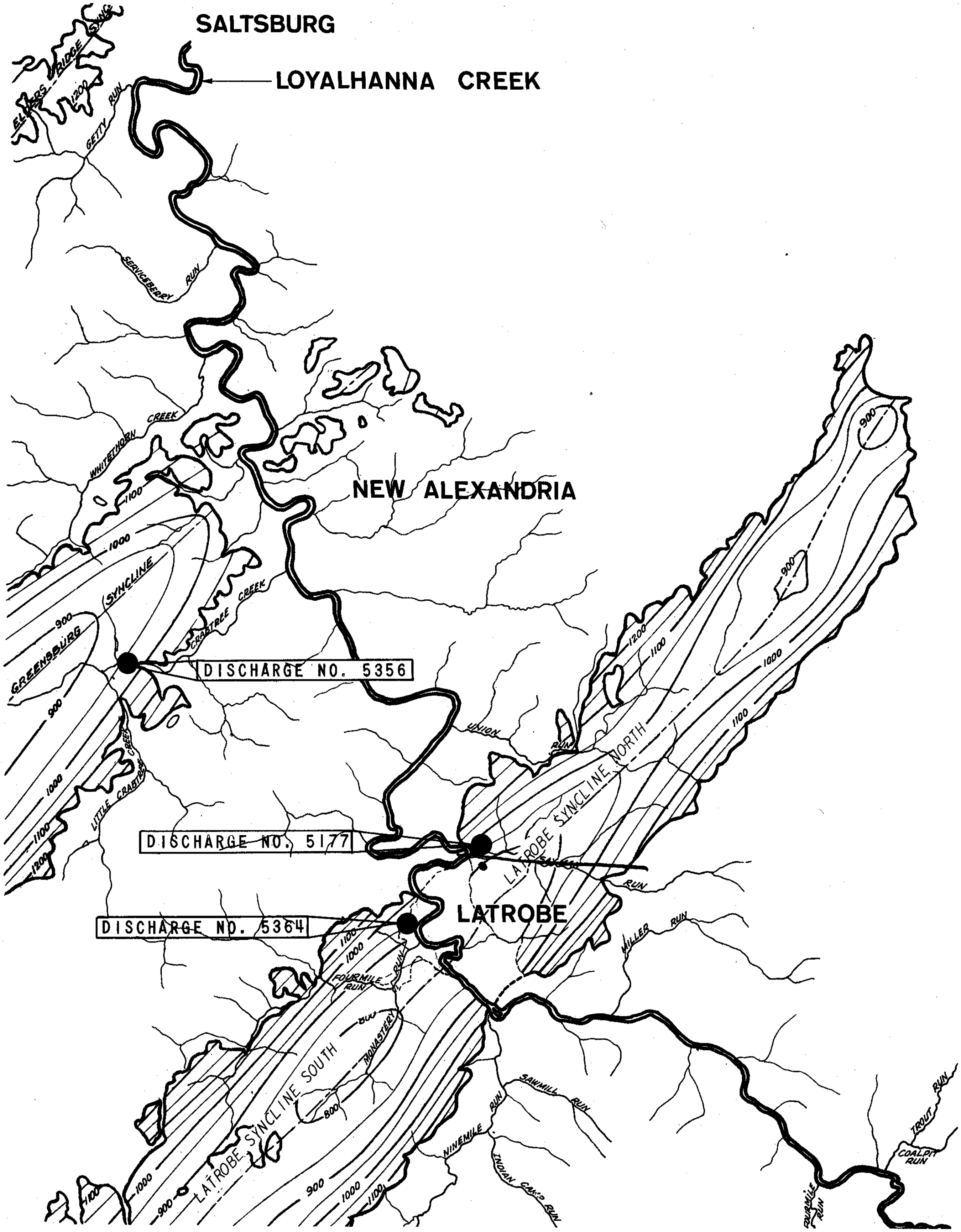
#5356 - Located on Crabtree Creek, east of Crabtree.
Discharges 19,600 lbs. of acid per day.

#5177 - Located on Saxman Run, west of Route 981.
Discharges 14, 000 lbs. of acid per day.

#5364 - Loyalhanna Creek in Latrobe, downstream from Monastery Run. Discharges 14,300 lbs. of acid per day.

Measured Acid Inflow to the Reservoir Pool

To measure the acidity carried by the creek into the reservoir, eight sampling stations were established along the length of waterway. Sampling Station #3 is located on Loyalhanna Creek downstream of all major discharges into the reservoir. Acid loadings sampled at Sampling Station #3 are equal to the total acid flow carried into the reservoir pool. During the 18 month sampling program, acid inflow as measured at Station 3 varied from 8,000 to 250,000 lbs. per day. This range of these values may be taken as an indication of the variable strength of acid discharges as acid producing conditions change from day to day and season to season. The low values were recorded during extended low flow periods, principally occurring in summer and fall, while the high values were recorded during high flows in winter and spring. The extreme high values occurred



LOCATION MAP - MAJOR WATERSHED
SUBSURFACE ACID DISCHARGES

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MINE DRAINAGE POLLUTION ABATEMENT MEASURES FOR THE LOYALHANNA WATERSHED

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immediately after major precipitation or snowmelts. The average of 18 measured daily acid loads at Station 3 was 79, 000 lbs. of acid per day. This average included the effects of peak acid loads following peak runoff. A second average was calculated excluding the three highest values associated with runoff acidity. This average was 53, 000 lbs. of acid per day. A third average calculated without the three highest or three lowest values was 63,500 lbs. of acid per day. An analysis of the stream sampling data and related source data indicated the following:

<u>Summary of Measured Acid Inflow-Loyalhanna Reservoir</u>

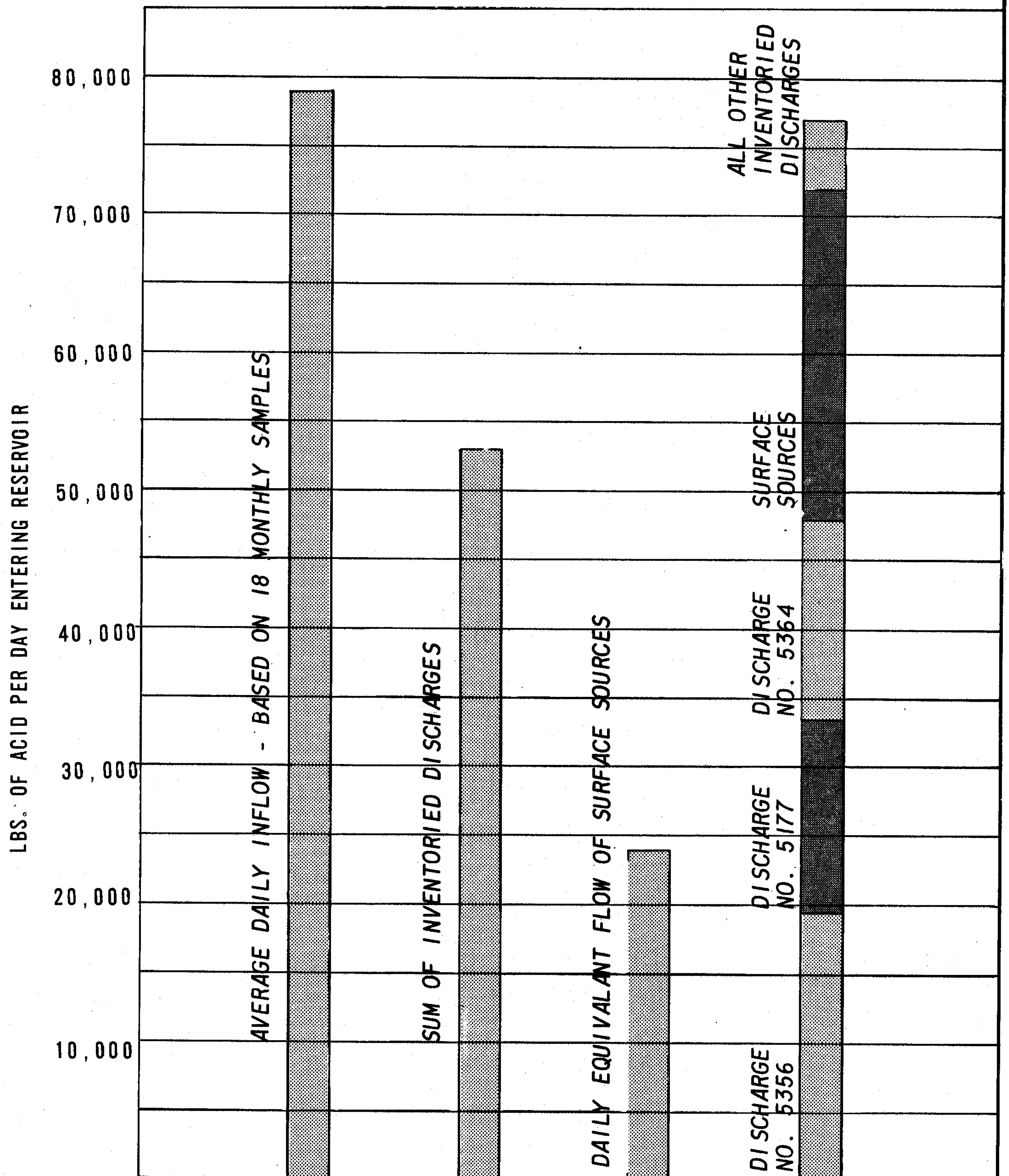
1. Average daily acid inflow measured at reservoir based on 18 samples.	79, 000 lbs.
2. Average acid load carried into reservoir excluding periods of high runoff (based upon 15 lowest sample values)	53, 000 lbs.
3. Estimated surface runoff acidity prorated on equivalent daily basis (based upon 50 lbs. /acre/day	24, 000 lbs.
4. Estimated daily acid inflow less acid runoff (1. minus 3.)	55, 000 lbs.
5. Sum of average discharge of all inventoried discharges tributary to reservoir	55,400 lbs.
6. Acid load from three major discharges	48, 000 lbs.

<u>Interpretation of Loyalhanna Reservoir Acid Inflow</u>

While in theory the sum of all acid discharges into the watershed above the reservoir should equal the amount of acid entering the reservoir (less instream neutralization) the average acid load entering the reservoir exceeds by 40% the sum of the average of all upstream discharges. The sum of the average of all inventoried discharges (5.), is 55,500 lbs. per day while the average acid load entering the reservoir is (1.) 79,000 lbs. per day. This excess of 23,500 lbs. per day may be attributed to 1) non constant sources which only discharge at times of precipitation and 2) daily variations in flow strength not fully measurable on a 1 in 30 day sampling program. To compensate for the non-constant sources, which are generated by runoff from gob and refuse piles, the average inflow was reduced by l) excluding flows occurring during or immediately after precipitation from the averaging calculations and 2) estimating the acid contribution generated by non constant sources. The average inflow excluding the three major runoff associated acid loading was recalculated as (2.) 53, 000 lbs. per day. Alternately, by subtracting the estimated equivalent daily acid production generated by non constant sources (24, 000 lbs.) the daily Inflow was recalculated as (4.) 55,000 lbs. per day. Both of these estiindies, considering the variable nature of the acid discharges, are remarkably close to the inventoried discharge inflow of (5.) 55,500 lbs. /day.

The effect of the three major acid discharges upon reservoir water quality may be seen by comparing the combined acid discharge of these sources, (6.) 48,000 lbs. per day, to the total acid inflow of 55,500 lbs. per day.

The non constant source contribution while calculated at (3.) 24,000 lbs. per day actually occurs on a limited number of days per year and accounts



ACID INFLOW AS MEASURED AT LOYALHANNA RESERVOIR	MINE DRAINAGE POLLUTION ABATEMENT MEASURES FOR THE LOYALHANNA WATERSHED	PLATE
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for additional acid inflows above base flow. This extra additional acidity has been estimated to be as high as 170,000 lbs. per day on specific days. However, the high stream flow accompanying these discharges was sufficient to dilute the acid to concentrations equal to or less than average reservoir acidity. High acid flows are invariably accompanied by high stream flows which lower acidity concentrations.

Relationship of Acid Load, Water Quality and pH in Reservoir Pool and Creek

During the 18 month sampling period, the measured pH of Loyalhanna Reservoir and Loyalhanna Creek downstream of Latrobe ranged from 3.5 to 8.0. At the same time the acidity as Calcium Carbonate ($CaCO_3$) ranged from concentrations of 2 to 100 parts per million (ppm). The in-stream pH while related to acidity is also dependent upon the total dis solved solids content or ionic balance of the water in the stream. The relationship of pH and acidity in a pure solution containing no buffers or alkalinity is given by the equation, $pH = 3.0 - \log10 \frac{\text{Acidity as mg /l } CaCO_3}{50}$

In a non-pure stream solution the effects of alkalinity and buffers is to raise the pH to a value closer to neutrality for a given concentration of acidity than that pH which would occur in a pure acid solution with the same acidity concentration.

The observed relationship of acidity to pH m the Loyalhanna watershed or any watershed is critical to AMD abatement because the severity of AMD pollution is related to pH, not acidity concentration. If two waters have equal acidity concentrations but unequal pH, the stream with the lower pH will show the more serious affects of acid pollution. However, pH is defined as a resultant hydrogen ion concentration fixed by the imbalance of acidity and alkalinity in a solution. Acidity or alkalinity may be added or removed from a solution by direct or indirect means but hydrogen ions may not. The degree of pH improvement required, or the degree of hydrogen ion removal needed must be defined in terms of pounds of acidity to be removed or neutralized. To calculate the pounds of acidity removal required to maintain the desired pH m the reservoir it is necessary to determine the highest acidity concentration which has not in the past under natural conditions reduced pH below the required level. If acidity concentration is not allowed to increase above that level, the desired pH will be maintained.

A minimum pH level of 6.0 is recommended by this study to both maintain cold water fish life and allow full water contact utilization of the reservoir. A minimum (fall back) pH of 4.5 is recommended as an absolute minimum pH below which the reservoir should not be allowed to drop under any circumstances.

In the 18 month study period the following pH:Acidity relationship was observed:

> When net acidity was at 20 parts per million or less,
> pH was always 4.5 or higher

When net acidity was at 10 parts per million or less, pH was always 6.0 or higher.

Degree of Abatement Required to Maintain Desired Water Quality

If a stream pH above 6.0 is to be maintained, the instream concentration of acidity must be 10 ppm or less. A concentration of 10 ppm is equivalent to 54.0 lbs. per day per cubic foot per second (cfs) of flow. Therefore, at a typical summer low flow of 100 cfs to maintain a pH of 6. 0 or higher, the acid load must not exceed 5,400 lbs. per day. Acidity inflow during the summer is normally lower than the average annual inflow of 79,000 lbs. per day and except for acidity, generated by high runoff acidity rarely exceeds 30,000 lbs. per day. Maintaining the desired reservoir pH will require the elimination or abatement of 25,000 lbs. of acidity per day at summer flows of 100 cfs. During higher flow periods, flows equal to the average annual flow of 456 cfs, may carry into the reservoir acidity loads of up to 25,000 lbs. per day without lowering the pH below 6. O. During the winter-spring period of higher than average flows it has also been observed that the effect of acidity concentration on pH was less severe than that observed during the summer and fall. Therefore, as can be observed from the measured winter-spring pH levels. little abatement is necessary during the winter and spring months.

Abatement Measures Required to Maintain Desired Water Quality

To reduce instream acidity a maximum of 5, 400 lbs. per day as required during periods of low flow m summer, It will be necessary to reduce acid loading s by more than 80% or an amount about equal to the contribution of the three major discharges. In addition, to protect the quality of the reservoir waters, the acid slug loadings associated with surface gob pile runoff must be controlled or reduced. Any abatement plan which does not control all three major discharges cannot insure the maintenance of a desired level of water quality. Control measures affecting all other discharges are of secondary importance.

Means of Achieving Desired Levels of AMD Abatement

1. Subsurface Discharges

A. Termination by Sealing

To stop the subsurface production and subsequent discharge of acid mine drainage it will be necessary to either:

1. Eliminate all contact between acid forming pyritic materials in the mines and sources of oxygen and moisture and /or
2. Eliminate all means of acid transport by preventing water from flowing into or out of acid producing formations.

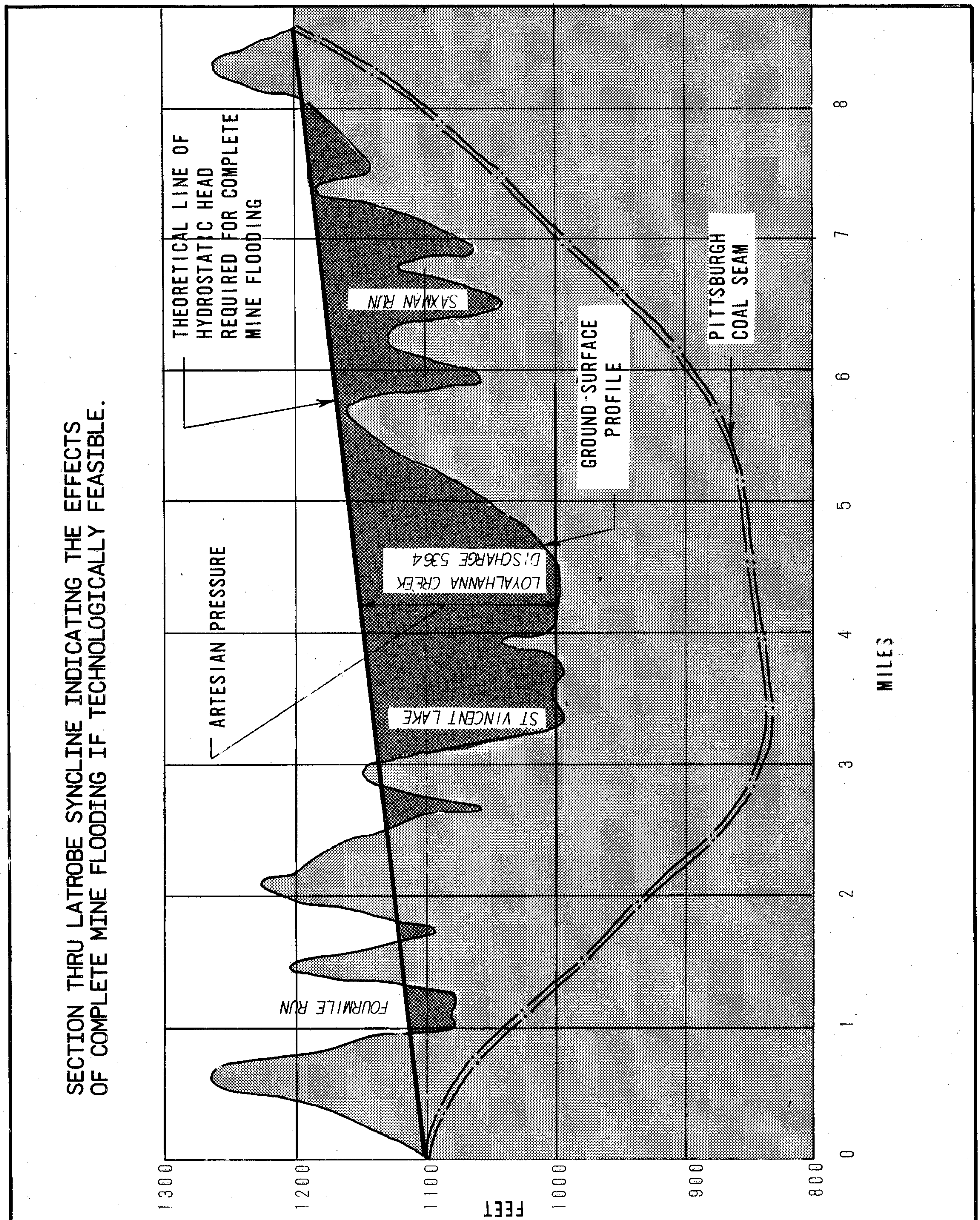
The most commonly used method of achieving land 2 is through the application of a mine seal at either the point of discharge or the point at which water enters the mine. The applicability of seals to discharges #5177, #5356 and #5364 has been considered in great detail as a possible solution to the AMD contamination of the watershed, However, an investigation of the feasibility of seals at these discharges revealed the following:

1. Discharge #5364, a horizontal pipe emerging from the south bank of Loyalhanna Creek in Latrobe, was initially installed in an attempt to drain the flooded mines underlying the area. According to the Environmental Protection Administration, "Before the installation of the pipe the drainage was discharged to the surface by a number of boreholes and natural drainways. " Therefore, simply sealing discharge H 5364 Without preventing the entry of water into the mines would recreate the earlier condition of uncontrolled seepages, for which the installation of discharge #5364 was intended as a solution.
2. The uncontrolled entry of water into the mines of the Pittsburgh Coal Seam is due to both infiltration and roof collapse and is a widespread occurrence of long duration. In 1924, geologist George Sisler in a publication of the Pennsylvania Geological Survey reported of the Pittsburgh seam mines in the Loyalhanna Watershed, ". . . frequent squeezes (the settling of an unbroken roof over a coal bed) ruined large areas (of the mines) . . . Without modern methods of pumping mines the water problem was exasperating. Large areas of coal were completely lost by flooding. These old workings have now caved in . . . " To prevent the inflow of water into the mines would require the almost

complete rebuilding of the mine roofs or the complete refilling of the mined out coal seam with non porous backfill material. The rebuilding of the roof structure by remote grout application could be accomplished in the mines contributing to discharge #5364 at an estimated cost of $400,000,000. This technique was rejected as economically infeasible.

3. The placement of seals in flowing mines has been effective against flows of up to 200 gallons per minute. Flows in discharge #5356 exceed 5,000 gallons per minute (gpm). Discharge 5177 flows at 2,250 gpm and discharge #5364 at 3,000 gpm. Sealing such high flow mines without prior dewatering is beyond the present limits of mine seal technology. The dewatering of these mines subject to constant infiltration is also infeasible.

4. The production of acid within the mines could be stopped by complete flooding. Flooding of the lower mines only, as is now occurring, is not effective. To achieve complete unnundation of the total seam up to and including the outcrop areas, seals capable of withstanding up to 200 feet of hydrostatic pressure would be required. Even if reinforced seals capable of resisting this head were feasible, it is doubtful if the natural soil and rock overburden in the Loyalhanna, Crabtree and Saxman Run Valleys already weakened by mine collapse and subsidence could resist



SECTION THRU LATROBE SYNCLINE INDICATING THE EFFECTS OF COMPLETE MINE FLOODING IF TECHNOLOGICALLY FEASIBLE.

SECTIONAL VIEW OF LATROBE SYNCLINE SHOWING EFFECTS OF MINE SEALING	MINE DRAINAGE POLLUTION ABATEMENT MEASURES FOR THE LOYALHANNA WATERSHED	PLATE
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these upward flow pressures. The anticipated result of a program of mine sealing and flooding would be the creation of widespread and uncontrolled "acid springs" such as those existing in Latrobe prior to the installation of discharge #5364.

To summarize, because the three major discharges of the watershed are located in valleys significantly below the peak elevations of the coal seams which they drain, it is very unlikely that acid pools within the voids of the abandoned mines could be sealed off without creating sufficient hydrostatic pres sure to generate artesian discharges of mine drainage within these valleys. The inability of these mines to hold water to their full depth prevents the use of complete innundation as an effective acid formation control technique. We have concluded that for the reasons given above and others within the report text acid flows from the three major discharges cannot be reduced significantly in strength or volume utilizing presently available mine sealing and soil technology.

B. Treatment Alternatives

1. Neutralization

The sole advantage of acid mine drainage abatement by treatment methods is that it will improve water quality when all other methods

of abatement cannot be successfully applied to the drainage sources. Neutralization-oxidation treatment has been found by this study to be the lowest cost and most feasible method of lowering instream acidity in the Loyalhanna watershed to levels which will permit its full recreational use utilizing now available technology.

II. Surface Discharges

The surface generated acid discharges of the water shed contribute a quantity of acid equivalent to one major subsurface discharge on an annual basis. However, these discharges occur on a sporadic basis and are the cause of the peak or slug loading s of acid which follow periods of precipitation. While these slug loadings could be compensated for by the use of additional oxidation/neutralization capacity, they may be effectively reduced by the surface restoration of the refuse pile acid generation sites.

The restoration process consists of 1) regrading the sites to reduce erosion 2) neutralizing and sealing the top two feet of the refuse pile with the application of flyash 3) re-establishing a vegetative cover. Experimental work has indicated that this process is effective in reducing slug acid loads generated by surface sites as well as reducing surface seepage of acid from within the piles during dry weather periods.

CONCLUSIONS

The following conclusions relevant to the formulation of an Acid Mine Drainage abatement plan may be drawn from the Loyalhanna Watershed study.

1. The primary water quality improvement needs of the Loyalhanna watershed are related to its recreational use. Water quality improvements for domestic, municipal, industrial or consumptive uses are of a much lower priority.

2. 'To fully utilize the waters of Loyalhanna Reservoir for Water oriented recreation and sport fishing, the pH of the reservoir should be elevated to a value of 6. 0, and not allowed to drop below a value of 4.5 at any time. A higher degree of improvement is not required. 'The presence of mine drainage related dissolved solids does not appear to affect recreational utilization. To improve the water quality of the watershed to a lesser degree than that required for recreation use will produce no benefit.

3. The focus of potential recreation use is Loyalhanna Reservoir and Loyalhanna Creek. The water quality of the tributaries to Loyalhanna Creek is of importance only as it affects mainstream water quality. The improvement of tributary water quality not required for the improvement of the mainstream is of a much lower priority as it affects localized potential uses only.

4. Under summer conditions, if the pH of the reservoir is to be maintained at pH 6.0, the acidity of inflow cannot exceed 10 ppm. To

maintain a minimum pH of 4. 5, inflow cannot exceed 20 ppm of acidity (as CaCO3).

5. During the low flow period, which corresponds to the summer recreation season, inflow into Loyalhanna Reservoir decreases to an average flow of about 100 cfs. At an inflow rate of 100 cfs, acid inflow must be limited to 5,400 lbs. per day to maintain a pH of 6.0. An increase in acid inflow to 11,000 lbs. per day would reduce pH to 4.5 Because of the low-flow regulation function of Loyalhanna Reservoir, the storage of dilution water to offset low flow acidity is not feasible.

6. During low flow periods, acidity inflow decreases to as little as 10,000 lbs. per day as ground water acquifers are depleted and the transport mechanisms for removing acidic materials are curtailed. Average total low flow acid discharges are about 30,000 lbs. of acid per day, excluding runoff from storm flows. To maintain a pH of 6.0, a minimum of 25,000 lbs. of acidity must be removed, neutralized or prevented from flowing into the reservoir each day.

7. The three major sources of acid mine drainage, discharges #5356, #51 77 and #5364 contribute respectively 36%, 25% and 26% or a total of 87% of the average annual acid loading. During low flow periods, as upland discharges interconnected with these major discharges cease flowing, and refuse pile drainage flows decrease, the se three discharges may account for almost 100% of the daily acidity flowing into the reservoir.

8. It would not be possible to reduce acid inflow to the reservoir to below 5,000 lbs. per day unless acid discharges from all three major sources were reduced or eliminated. Reduction of flows from any of the other 57 existing discharges will be of less than significant value in maintaining reservoir water quality.

9. A secondary and sporadic source of acid discharge into the reservoir is runoff from surface gob piles. Runoff immediately after precipitation contains extremely high acid loadings on a total weight basis, but acid concentrations are equal to or les s than acid concentrations which occur during dry weather. This is due to the dilution effect of runoff from areas without sources of surface pollution.

10. Due to a combination of pre-existing geological and topographic conditions and the methods of mining employed during the early exploitation of the Pittsburgh Coal Seam, effective termination of acidic flows from the three major discharges is not feasible.

11. The primary direct benefit attributable to improved water quality in Loyalhanna Creek is an additional 3, 150, 000 annual recreation days possible at Loyalhanna reservoir. Secondary indirect benefits include improved recreation conditions in and along Loyalhanna Creek west of Latrobe.

12. The construction of three Acid Mine Drainage neutralization -oxidation plants will be necessary to maintain stream conditions suitable for recreational use. These three neutralization-oxidation plants will intercept flows from the three major discharge sources and neutralize these

discharges sufficiently to maintain an acceptable instream pH in Loyalhanna Creek and Reservoir. In conjunction with the construction of these plants an instream pH monitoring and feedback system placed in the reservoir to regulate the degree of neutralization provided, and the regrading, sealing with fly ash and revegetation of the four major surface mine refuse piles will be necessary.

A PLAN FOR THE ABATEMENT OF LOYALHANNA WATERSHED ACID MIN E DRAINAGE

At the conclusion of the sampling, literature review and analysis phases of the watershed study, sufficient information had been acquired to determine:

1. The major water resource related needs of the watershed.

2. The degree of acid mine drainage abatement required to satisfy these needs.

3. The acid contribution of each discharge to total watershed acidity.

4. The amenability of each discharge source to abatement and the related abatement cost.

With this information an abatement plan consisting of the following major and minor elements was developed.

MAJOR PLAN ELEMENTS

The abatement of discharges #51 77, #5356 and #5364 and the elimination of acid runoff from refuse piles #55 (Shieldsburg), #65 (Hannastown), #66 (Crabtree) and #124 (Hostetter) should accomplish the stated watershed goal of improving the water quality of Loyalhanna Reservoir sufficiently to permit full recreational use on an all year basis. The elimination of these seven sources of acid should reduce the daily acid inflow to below 5,000 lbs. per day. The costs of these plan elements are as follows:

Cost of Abatement Plan - Major Elements

The capital cost expenditure required for the upgrading of water quality is

itemized as follows:

Plant	Location	Estimated Construction Cost
Plant #1	Disch. #5356	$ 261,000
Plant	Disch. #5177	192,000
Plant #3	Disch. #5364	187,000
TOTAL PLANT COST		$ 640,000
Water Quality Monitors		$ 50,000

Surface Restoration - Refuse Piles Located at:

Shieldsburg	$ 262,000
Hannastown 557,000 Crabtree 269,000 Hostetter	288,000
TOTAL SURFACE RESTORATION	$1,380,000

Total Cost - Top Priority Projects	
Estimated Construction Cost	$2,070,000
Estimated Project Cost (Construction cost plus design fees, survey and financing costs, etc.)	$3,100,000

ANNUAL COST OF FACILITIES

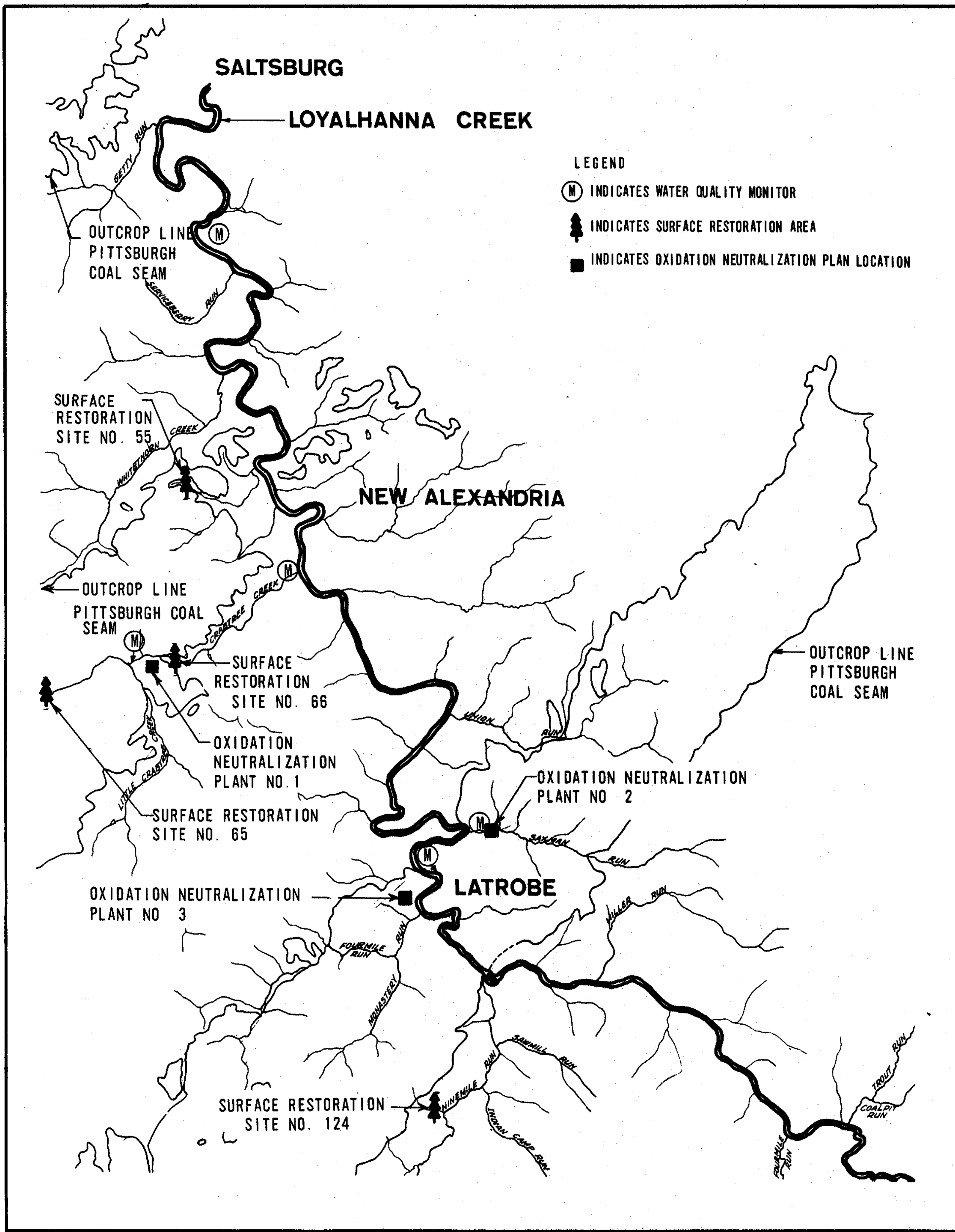
Neutralization Plants

Capital Recovery Cost @ 6% interest assumed life = 20 year

Annual Cost = $87.18 per $1,000	$ 83,000

Cost of Operation

Operations Cost based upon 180 operating days per year	$ 277,000
TOTAL ANNUAL PLANT COST	$ 310,000
TOTAL ANNUAL WATER QUALITY MONITOR COST	$ 6,000



MAJOR ABATEMENT PLAN ELEMENTS, LOCATION PLAN	MINE DRAINAGE POLLUTION ABATEMENT MEASURES FOR THE LOYALHANNA WATERSHED	PLATE I-6
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Surface Treatment

Capital Recovery Cost		
Refuse Pile Restoration	$	179,000
TOTAL ANNUAL WATERSHED COST	$	500,000

Cost per user day - Swimming benefit only based upon 80% utilization of potential 3,150,000 swimming days 20 c. per user

Note: If benefits for additional fish oriented recreation and stream rehabilitation in general are included, cost per user is substantially lower.

EFFECTS OF INCREASED PLANT CONSTRUCTION COST

The plant design utilized for cost estimating was based upon a minimum practical design. It is possible that plant design standard upgrading could increase the plant cost by 400%.

The revised annual cost would be as follows:

Capital Recovery Cost	$	332,000
Operations Cost		227, 000
Total Plant Cost	$	559, 000
Capital Recovery Cost		
Refuse Pile Restoration	$	179, 000
TOTAL COST	$	738,000
Cost per swimmer	30 c.	

Because the recommended major plan elements utilize abatement techniques still in the developmental stage, it is further recommended that rather than initiate the construction of three prototype plants simultaneously, that the abatement plan be implemented in two stages.

In stage one, it is recommended that one neutralization- oxidation plant be built and two refuse piles be restored. To best evaluate the effectiveness of each of these abatement measures, it is recommended that all three be located in the watershed of Crabtree Creek. By placing all three projects within one tributary watershed and abating the three major AMD sources, the performance of these plants may be easily observed with the use of two instream pH analyzers and recorders. A third instream pH analyzer placed in the reservoir pool will indicate the effect of the abatement of these discharges upon the total water shed.

At the completion of stage one construction, and after one year ' s operating experience has been acquired, construction of the remaining major plan elements should be initiated. Prior to the construction of neutralization-oxidation plant #2 on Saxman Run, the feasibility of joint facilities utilizing the existing Latrobe Sewage Treatment Plant as a part of the AMD abatement plant should be considered.

<u>SECONDARY PLAN ELEMENTS</u>

While the abatement of minor AMD sources will not affect the overall water quality of the basin, the application seals to minor discharges and other similar measures where feasible, will bring about significant local water quality improvements. These improvements are discussed in Section X.

OPTIONAL PLAN ELEMENTS

There exist within the watershed many mine related surface features which do not directly contribute to the deterioration of water quality but whose restoration would improve their immediate environment. These surface features are inventoried in Appendix B. While the restoration of these pits, banks and refuse piles will not improve water: quality in the watershed, local communities might consider this work beneficial.

RECOMMENDATIONS

Based upon the findings of this study program that recreation benefits for an estimated 3,000,000 annual one day visitors to the Loyalhanna Reservoir Recreation Area plus additional benefits to the residents of the watershed and downstream areas in the form of improved environmental conditions could be provided at an annual cost of between $500,000 to $750,000, it is recommended that the following be done.

1. The contents of this report be reviewed by all appropriate governmental agencies at the Federal, State, County and Municipal levels and all interested citizens of the watershed. After suitable review it is recommended that the findings of this report and the proposed plan of action be adopted by those agencies as an official plan for the water shed.

It is further recommended that:

2. A bioassay of Loyalhanna Reservoir water treated at laboratory scale according to the processes recommended in Section IX should be initiated to determine if the processes recommended will, as anticipated, remove all substances detrimental to game fish survival. If toxic effects persist subsequent to neutralization and iron removal, further investigation beyond the original scope of the study may be required to determine the presence of other non-AMD sources of watershed contamination.

3. If the results of the recommended bioassay of treated reservoir water are favorable, an acid mine drainage neutralization-oxidation plant feasibility and process investigation study should be initiated to determine:

a. Exact location and space requirements for each plant

b. Treatability of each discharge and process modifications
if required

c. Final design criteria

In additioI1, mapping of the four major refuse piles (#55 Shieldsburg, #65 Hannastown, #66 Crabtree and #124 Hostetter) should be prepared to a scale of 1" = 200' and a contour interval of 5’. Preliminary site use and regrading plans of the reclaimed areas should be developed.

4. If the cost recommendations developed in the plant feasibility study are acceptable to the Commonwealth and a satisfactory method of cost allocation and operations funding can be devised, it is recommended that the following projects in the drainage area of Crabtree Creek be initiated as the first stage of the Loyalhanna water quality improvement program.

a.	AMD treatment plant #1		
	(1) minimal facility	$ 390, 000	
	(2) upgraded facility		$1, 560, 000
b.	Restoration of refuse pile #65	850, 000	850, 000
c.	Restoration of refuse pile #66	400, 000	400, 000
		$1, 640, 000 to	$2, 810, 000

Total Project Cost for State I is estimated to be between $1,640,000 and $2,810,000. As noted in Section X, the final cost of each AMD treatment plant will depend upon design criteria and construction materials selected.

5. Coincident with the implementation of Recommendation 4., a network of water quality monitors at the following locations should be established:

a. Loyalhanna Reservoir Pool
b. Crabtree Creek at mouth
c. Crabtree Creek at U. S. 119 Bridge
d. Saxman Run at mouth
e. Loyalhanna Creek at Route 981 Bridge

Estimated cost is equal to $ 50, 000. Data obtained from this water quality network should be utilized to:

a. Regulate operation of AMD treatment plant #1 (stations at a, b and c only)

b. Evaluate the effects of stage one construction on reservoir water quality. (all stations)

6. Based upon an evaluation of one year's operating experience gained at AMD Treatment Plant #1, and water quality changes as recorded by the water quality monitors in the watershed, a decision should be made as to the need for the initiation of stage II construction. If a significant reduction in surface generated peak acidity loads has been observed at water quality stations at band c, as a result of the surface restoration of refuse piles #65 and #66, then the additional restoration of the following refuse piles is recommended:

	Total Project Cost
Refuse Pile #124	$435,000
Refuse Pile #55	$390,000
	$825,000

If operating experience gained at AMD Treatment Plant #1 proves satisfactory, it is recommended that plants #2 and #3 be constructed in Stage II.

		Total Project Cost	
Plant #2 (Saxman Run)			
a. minimal facility	$290,000		
b. upgraded facility		$1,150, 000	
Plant #3 (Loyalhanna Creek at Latrobe)			
a. minimal facility	$280, 000		
b. upgraded facility		$1, 120, 000	
Refuse Pile #124	$435,000	435,000	
Refuse Pile #55	$390, 000	390, 000	
	$1,395,000	$3,105,000	

Total Project Cost is estimated as between $1,395,000 and $3,105,000 as determined by AMD Treatment Plant design standards.

7. Continuous monitoring of Loyalhanna Watershed water quality should be continued as an aid to the operation of the oxidation-neutralization plants. The flexibility of these plants should be utilized to encourage continuous experimentation to determine more efficient and more effective unit operations to remove mine drainage contaminants.