SUMMARY AND RECOMMENDATIONS

SUMMARY

Operation Scarlift Project SL 103-5 assesses the gross hydrogeologic behavior of the Irwin Syncline basin as it relates to seven substantial acid mine water discharges associated with the inundated bituminous Pittsburgh coal seam. This report describes those findings and develops a treatment oriented abatement scheme aimed at countering the combined average daily discharge of 21 million gallons of acid mine drainagenfrom the Export, Delmont, Coal Run, Irwin, Marchand, Upper Guffey Station and Lower Guffey Station discharges. Each day an average of 16 1/2 tons of acid and 9 1/3 tons of iron are deposited by these discharges into Commonwealth waters.

Spanning approximately one hundred square miles, the study area is situated along the west edge of rural Westmoreland County and is delineated by the outcrop of the Pittsburgh coal seam and the Youghiogheny River. Following Appendix D a Composite Map of the area at 1" = 4000' scale is provided for reference.

Mined extensively since the mid-eighteen hundreds, approximately 95% of the coal has been recovered. As mines throughout the basin were exhausted, abandoned and permitted to flood, a vast pool of water accumulated in the seam. Estimated at 350 billion gallons, this pool came to rest against the barrier of Consolidated Coal Company's Hutchison mine, one of the two remaining active mines, the other being Republic Steel Corporation's Banning No. 4. Ironically, Hutchison was shut down one month before the start of Project SL 103-5. With Hutchison flooded, the pool now rests against the northernmost barrier of the still-active Banning No. 4 mine, located south of, and adjacent to, Hutchison. The flooding of Hutchison was one of many reasons that prolonged a conclusive interpretation of the basin's subsurface hydrology. A comprehensive basin-wide abatement scheme was eventually developed, however, which takes into account the potential hazards of disturbing the pool which abuts Banning No. 4.

On the premise that the overburden is the primary source of water recharge to the mine pool, abatement efforts were specifically aimed at treating the water as it exits the mine rather than preventing its entry by eliminating point sources of inflow. To supplement monthly chemical quality analyses and flow measurements from the seven major discharges, a mine pool monitoring program was undertaken. A dozen boreholes, pumpholes and airshafts to the abandoned mines were found throughout the basin which were used to regularly monitor the pool surface. These measurements, in conjunction with the discharge data, were not expected to immediately provide a complete understanding of the subsurface flow network because of other unknowns such as the condition of major mine barriers, the location of dams and the existence of various drainage tunnels. However, this new data did serve as a useful tool in evaluating the relative importance of these unknowns and indicated that more information was needed. The mine pool monitoring data, when combined with the discharge analyses, provided an insight into the basin's internal response to seasonal variations in precipitation as well as the inundation of the Hutchison mine. Sixteen pool monitoring wells were later installed and the sum of this information ultimately led to a comprehensive analysis of the basin hydrology.

Retarding the transformation of the mine pool monitoring and discharge data into a good working knowledge of the basin were the conditions of the several miles of major barrier pillars. Many barriers are breached, or severed, others are of minimal thickness; in some instances, sections of the barrier are completely removed. Analysis of the mine pool monitoring data substantiates these conditions. Understanding the highly variable influence of width and overall integrity of the mine barriers on the basin flow network is further compounded by the local stratigraphy and hydraulic gradient, the cross-sectional area of the barrier and the barrier permeability. Typically, in the deeper coal regions barrier effectiveness is negated by high differential heads.

Dams and drainage tunnels constructed during mining were included in the analysis. Dams constructed in haulways that traverse a coal reserve in the Delmont mine, for example, help to retain a pool of water that results in the artesian Delmont discharge. In the Irwin area, dams were built to force water out of the Irwin discharge to allow further mining; conflicting accounts of their removal required a more cautious analysis of the Irwin discharge.

A most interesting subsurface structure is the Dillon-Gibbon rock tunnel, built in 1942, marking the start of a very dynamic period in the basin's subsurface hydrology. Prior to its construction, a 5' x 5 1/2' tunnel through the barrier pillar separating the Keystone and Ocean mines to equalize the water level between them, and pumping from the Marchand mine were the only actions taken to reduce the pressure head acting on the Hutchison mine barriers. Installation of the rock tunnel induced a redistribution of the pooled water throughout this deepest part of the basin where most of the mines were abandoned and inundated. The pool remained relatively stable until the mid-1950's when the last active mines (Adams, Larimer and South Side) near Irwin were abandoned and pumping operations in the adjacent Biddle mine were halted. Shutting down these pumping operations resulted in an overall rise of the pool, assuming its present piezometric surface.

The data obtained from the initial set of mine pool monitoring locations suggested other relationships concerning the performance of the basin. For instance, it was determined that the Irwin discharge and the mine pool were quite responsive to seasonal variations in precipitation. The fluctuations displayed by the Irwin discharge were related closely enough with those of the mine pool, as measured at the Edna No. 2 borehole and the McCullough shaft, to construct a stage-discharge relationship that permits the Irwin discharge to be estimated with reasonable accuracy in the range of three to fifteen million gallons per day.

The response of the basin to the abandonment of the Hutchison mine was closely monitored. As it flooded, the following occurred.

1. Increased seepage into the adjacent Banning mine was sufficient to force Banning officials to abandon work in several areas along the barrier.

2. The combined total acid load of the Marchand, Upper Guffey and Lower Guffey Station discharges started to decline. In an earlier report on the conditions of the Hutchison mine, it was predicted that the acid load would fall from ten to two tons per day by 1980. The latter figure was associated with the Hutchison pool coincident with the surrounding pool, which was accurately estimated to occur in early 1975. Project SL 103-5 water quality data from March through September of 1975 shows a decreasing trend on total combined net acidities, however, it should be recognized that this period included the normal low acid-producing season. Therefore no conclusions about the long-range validity of these predictions can be made.

3. Additional AMD discharges occurred from the overlying Redstone coal seam; an indication of the extent of fracture of the strata between the Pittsburgh and Redstone seams.

Mine pool readings in the Marchand side of the Dillon-Gibbon rock tunnel were inconsistent with respect to surrounding mine pool elevations. Knowing that the tunnel plugged periodically, it was proposed that cleaning the tunnel and boreholes would be useful in restoring flow and generating valid data. This proposition was discarded and a new observation well on the Marchand side of the tunnel was drilled out of concern for the safety of the Banning mine.

In October, 1975, sixteen (16) monitoring wells were installed as Operation Scarlift Project SL 103-5-101.5. Eight of the new wells were installed in the Export-Delmont area. Up to this time, discharge flow and chemical quality data of the Export and Delmont discharges were the only type of data available in this area. Because of the limitations imposed by having only discharge information, the following could not be established.

1. The affect of the Irwin Syncline basin pool on the Export and Delmont discharges.

2. Whether these discharges were related in any way. If they were unrelated, what was the true nature of their water recharge and the subsurface conditions responsible for each.

3. Was there validity in the suspicion that the largest discharge in the Thorn Run watershed actually was associated with the same body of water responsible for the Delmont discharge?

The remaining eight wells were installed in the lower basin area where the original set of mine pool monitoring sites were scattered. They were located in areas where little information was available (i.e., the Guffey Station area) or where results would enhance existing data. Appendix B contains the pool monitoring data obtained during SL 103-5. By this time, the Hutchison mine had completely flooded. The data from the new wells combined with the original set of pool monitoring data and the discharge information is sufficient to permit a reasonably conclusive evaluation of the basin's subsurface hydrology and flow network.

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The Export and Delmont discharges to Turtle Creek are almost identical in average daily flow and chemical composition as shown in the accompanying table, About two-thirds of the Export discharge average flow is attributed to overburden recharge, the remainder to the outcrop and some direct sources within the Thorn Run watershed which were remedied during 1976 and 1977.

Average Discharge Characteristics

	Flow (MGD)	pH	Acidity (mg/l)	Alkalinity (mg/l)	Total Fe (mg/l)	Ferrous Fe (mg/l)	Sulfates (mg/l)
Export discharge	1.14	2.9	439	0	27	6	711
Delmont discharge	1.13	3.4	140	1	30	21	539

The coal beneath the east-west aligned railroad corridor is undisturbed for the most part although it was the option of the mining company to extract a maximum of 60% of this reserve. Mine maps show that aonly the Mellon mains traverse the railroad reserve between the Export-Delmont barrier and the coal outcrop near Export. It has been concluded that this reserve, although it is supposedly severed, retains a pool of water in the Export mine. The limit of this pool is fixed by its intersection with the Export discharge.

Analysis of the mine pool monitoring data indicates that the northernmost edge of the basin pool lies about an eighth of a mile south of the Export discharge and even during maximum flow conditions does not affect it.

The Delmont discharge is an artesian source forced from the mine through two 8-inch pumpholes. The pool is confined by the Export-Delmont barrier and the above-mentioned railroad corridor reserve, with some assistance by the south barrier of the Delmont mine. Haulways through this reserve were sealed with dams. The Delmont pool extends approximately to syncline axis mile 21.

Overlying portions of both the Export and Delmont mines is the Thorn Run watershed, a two square mile sub-basin of the Beaver Run Reservoir. A study of the acid mine drainage conditions in this area by Pullman Swindell in 1974 revealed that surface runoff which should have been confined to Thorn Run was being diverted to the mined-out Pittsburgh coal seam via openings in the ground surface and contributing to the Export and Delmont discharges. It was also suspected that the largest single discharge (TR-1) in the Thorn Run watershed and the Delmont discharge originated from the Delmont mine pool. This was prior to the installation of the new monitoring wells under Project SL 103-5-101.5. With the new wells it was concluded that the Delmont mine pool does not extend to the TR-1 location. Mine maps do not provide sufficient detail of the haulways or barriers to determine the exact conditions responsible for the TR-1 discharge which averages 50000 GPD, 400 pounds of acid per day and 40 pounds per day of iron.

The Municipal Authority of Westmoreland County operates a lime neutralization facility to treat the polluted waters in the Thorn Run watershed before they enter the Beaver Run Reservoir. The Authority intends to eventually upgrade this facility, however the consultant recommended delaying such plans until improvements are made via Operation Scarlift Project SL 103-5 recommendations. Thus, as part of the recommended scheme for abatement work for the Delmont discharge, exploratory excavation is recommended to determine the actual subsurface conditions responsible for the TR-1 discharge. Basically, abatement of the AMD would be by diversion into the Delmont mine.

Abatement of the Export and Delmont discharges does not require treatment. Based on projections of the Irwin pool, it can be shown that enough void area is available in the mined coal seam south of Export to accommodate both discharges. Abatement will take the form of absorption of the acid mine drainage by the vast Irwin pool.

Abatement of the Export discharge is presumed, for cost estimate purposes, to be achieved by pumping the raw AMD into the No. 2 Export mine "dip mains." The estimated total capital cost, which includes some exploratory excavation, is $273 thousand. Unit abatement pollution costs to remove the iron and acid are $0.40 and $0.03 per pound respectively. Utilizing the artesian pressure, the Delmont discharge can be conveyed to the main syncline pool at an even lower cost of $172 thousand. This includes the cost of exploratory excavation in the TR-1 discharge area. Pollution removal costs are estimated at $0.16 and $0.03 per pound of iron and acid. A tabular summary at the end of this section summarizes all costs.

Alternative abatement schemes were also developed. Based on the results of the exploratory excavation recommended to precede the start of final design for the Export discharge, it may be possible to pump this source to a lower terminus, i.e., to the No. 2 Export mains rather than to the dip mains on which the recommended scheme is premised. This will entail lower initial costs and, of course, generate lower operating costs. Another possibility is the combined treatment of the Export and Delmont discharges using the neutralization-oxidation process. Much higher capital and operating costs would result as well as substantially greater unit pollution load abatement costs. Treating either of these discharges individually would drive the unit costs even higher as shown in the tabular summary, using the Delmont discharge as an example. A remote possibility is the combined treatment of the AMD and local sewage. Local officials are contemplating installation of sewage treat-facilities but, while the technology for combined treatment is certainly available, no realistic figures can be provided.

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After the Adams, Larimer and South Side mines were abandoned in 1955, the South Side drainageway became a major outlet for the mine pool. This outlet, actually the Irwin discharge, averages 11 MGD. The mine pool is also drained via the nearby Coal Run discharge which flows from two (2) twelve-inch pipes protruding from the wall inside a culvert carrying the Coal Run watercourse to Brush Creek beneath Legislative Route 64209 in Irwin. These pipes become clogged with iron oxide formations resulting in an erratic-flow.

Average Discharge Characteristics

	Flow (MGD)	pH	Acidity (mg/l)	Alkalinity (mg/l)	Total Fe (mg/l)	Ferrous Fe (mg/l)	Sulfates (mg/l)
Coal Run	0.97	5.9	57	91	22	19	461
Irwin	11.16	4.0	290	10	126	109	1164

Analysis of the mine pool monitoring date reveals that the pool in the Irwin-Coal Run area is characterized as being somewhat analogous to the drawdown of a water table when water is pumped from an aquifer. In the central part of the basin, away from the Irwin and Coal Run discharges, the pool fluctuates considerably during the year. However, near the discharges, the fluctuation of the mine pool is considerably smaller as the water "rushes" toward the outlets. Mine pool elevations at locations close to these sources, such as Adams and South Side air shaft, remain essentially stable throughout the year.

The erratic flow from Coal Run is due mainly to the interference of the Paintertown mine barrier, which parallels the local coal contours, and creates a "step" effect in the pool surface. The dampening effect of the barrier presumably causes the water in the Paintertown mine to become almost static, an ideal condition for the formation of the ferric hydroxide that clogs the pipes. When the water level within the mine rises sufficiently, the "yellowboy " is forced out by the static pressure and flow resumes.

It is difficult to condense the description of the subsurface flow network when discussing the Marchand and Guffey Station discharges. The pool surface is quite irregular and more difficult to visualize for several reasons: barrier conditions, the shallow coal structure along the left flank, the action of the Dillon-Gibbon rock tunnel and the effect of the discharges. By reconstructing the sequence of mining and the basin-wide flooding process, and combining this knowledge with past and present mine pool elevation data, the existing complex pool surface can be developed in addition to its relationships with the various discharges.

For instance, it was determined that the artesian Marchand discharge exhibits a drawdown effect on the surrounding pool. In essence, radial projections extending from the discharge along the piezometric surface would form a parabolic shape similar to a drawdown curve. This discharge, which emerges from the main slope entry of the Marchand mine, started just after the construction of the Dillon-Gibbon rock tunnel. Previously, before the flow entered Big Sewickley Creek through some culvert pipes the AMD was retained in a series of impoundments which permitted much of the iron to precipitate. Recently the culverts were cleaned out and the impoundments breached. These actions, by persons unknown, allow the AMD to now flow directly into the creek.

Average Discharge Characteristics

	Flow (MGD)	pH	Acidity (mg/l)	Alkalinity (mg/l)	Total Fe (mg/l)	Ferrous Fe (mg/l)	Sulfates (mg/l)
Marchand	2.76	5.7	293	185	196	163	2425
Upper Guffey Station	2.07	5.8	106	127	58	55	1050
Lower Guffey Station	1.55	5.9	91	115	55	39	621

Upper Guffey Station is reportedly the outlet of a drainageway excavated below the coal for the purpose of allowing further coal recovery in the Shaner mine. Its intersection with the Irwin pool accounts for its gravity type flow. Lower Guffey supposedly originated when water accumulated sufficiently in the mine to simply blow out at this location on the outcrop. Mine maps of this area are very limited in detail. The actual origin of the Lower Guffey Station cannot be verified.

The recommended abatement schemes for the Irwin, Coal Run, Marchand, and both Guffey Station discharges are treatment oriented. Source collection and treatment facility siting are the major difficulties. In all cases a neutralization-oxidation process is proposed for implementation.

It was assumed that sufficient land for constructing a treatment facility large enough to accommodate the Irwin discharge could not be acquired adjacent to the discharge. For cost estimate purposes, the Irwin discharge would presumably have to be routed to a plant site along Brush Creek where the Coal Run discharge could also be treated. The plant design capacity would be approximately 18.0 MGD with an 80 acre-feet equalization lagoon constructed to store flows in excess of the expected average of 12.0 MGD. Total capital cost would be $4.2 million with annual operating costs of $1 million. The resulting abatement costs for acid and iron removal are estimated at $0.16 and $0.34 per pound, respectively.

The Marchand discharge can easily be collected and treated. Level land surrounds the source and sufficient open space is available. A neutralization-oxidation process would be employed with an estimated total capital cost of approximately $1.2 million and annual operating costs of $250 thousand. It will cost an estimated $0.22 per pound to prevent the 4500 pounds of iron from being discharged by this source into Sewickley Creek each day and $0.40 per pound to abate the daily 2500 pound net acid load.

The Guffey Station discharges are situated in a narrow valley setting and will probably require constructing the treatment facility at some distance from the outlets. The only hydraulically compatible site for the neutralization-oxidation process suggested is located near the Youghiogheny River. Estimated capital cost for the facility is $1.6 million and annual operating and maintenance costs are $329 thousand. Abatement costs are applicable to iron removal only, at a rate of $0.77 per pound. While the combined net acid load of the Guffey Station discharges may periodically be acidic, it is alkaline on the average and thus, the yearly acid removal cost will be nil.

An alternative method to abate the Irwin, Coal Run and Marchand discharges is the use of centralized pumping. This method is based on the premise that the pool could be efficiently pumped from the Biddle and Marchand mine air shafts at specified rates to lower the pool and eliminate these three discharges. At each pump site a treatment facility utilizing a neutralization-oxidation process would be constructed. It is estimated that the capital costs would be comparable to the corresponding facilities just described, i.e., the Biddle pump site facility would cost $4.2 million, the cost estimated for the Irwin-Coal Run treatment facility. The treatment facility at the Marchand air shaft would cost about the same as the facility suggested for the Marchand discharge.

The major potential benefit of this method is estimated lower operation and maintenance costs. Other advantages include the certain elimination of the Redstone cropline discharges along Little Sewickley Creek propagated by the Hutchison mine abandonment, possible improvements in the Upper Guffey discharge and an added factor of safety against the northernmost edge of the pool advancing toward the Export-Delmont area. The main drawback is the need to perform pump tests to optimize the design of the pumping and treatment facilities which would be located at the Marchand and Biddle pump sites. The testing program would be for determining the most satisfactory long-term pumping and treatment flow rates.

The recommended scheme for treating the Irwin and Coal Run discharges was based on Coal Run being conveyed from its present outlet location within the culvert. As an alternative, it may be simpler to convey this source indirectly by pumping from the Penn Shaft, within the Paintertown mine, sufficiently to eliminate the Coal Run discharge. Capital cost for the Coal Run-Irwin AMD treatment facility rises to $5 million (from $4.2 million) but unit abatement costs remain about the same.

On the other hand, a decision to treat the Irwin discharge alone results in initial capital costs of $3.6 million although unit abatement costs remain at $0.32 per pound of iron and $0.14 per acid pound. The Coal Run discharge could feasibly be added at a later date.

A final alternative examined was the possibility of combining the Upper and Lower Guffey Station and Marchand discharges for treatment. The total annual cost for this alternative is slightly lower than for the recommended separate facilities, $818,158 vs. $843,718. This scheme appears desirable but does not allow isolating the treatment of the Marchand discharge as an initial step in the overall abatement program. Also, the net alkaline quality of the Guffey Station discharges has a neutralizing effect on the Marchand source, resulting in a lower net acid load. Based on comparable annual costs, the effect is substantially high unit acid load abatement costs of $l.24 per pound.

Long term activity in the basin centers on the abandonment of the Banning No. 4 mine. Like Hutchison it will join the vast Irwin pool when it floods. No additional acid mine water discharges are expected as inundation occurs. On the other hand, a slight increase in average daily flow might occur at Marchand which can be accomodated by increasing the equalization lagoon storage volume or plant design capacity.

<u>RECOMMENDATIONS</u>

I. As the initial step toward implementing the recommended basin-wide abatement scheme, the design of a treatment facility for the Marchand discharge is recommended. Favoring the start of work at this site is the fact that it is hydrologically independent of the other discharges and is physically isolated as well. The artesian pressure exerted by the surrounding pool insures a continuous source of acid mine drainage which can be simply collected in a sump structure for pumping through the treatment facility. Another favorable aspect is that abundant, level acreage surrounds the discharge.

A pre-design phase should precede final design; this would entail approximately six months of additional laboratory study to determine whether the neutralization-oxidation process is the best suited treatment method. Either the neutralization process or an alternate treatment process would be incorporated in the final design.

II. For cost estimate purposes, abatement of the Export discharge was based on pumping the raw acid mine drainage into the No. 2 Export mine "dip mains." Flowing toward the syncline axis, this raw AMD would be absorbed by the vast Irwin syncline pool. A pre-design phase aimed at exploratory excavation of the No. 2 Export mine, as described in Section 3.l, is recommended; this will reveal if the "mains," the "dip mains" or neither haulway can serve as the pumping terminus. Pre-design would include detailed planning of the investigative procedure and scope of work description, specifications preparation and letting of the contract. One year is estimated for pre-design. Pending results of the exploratory work, either the final design would be pursued as recommended or an alternate abatement scheme would be implemented.

III. Preceding any work relative to the Delmont discharge, exploratory excavation of the TR-1 discharge in the Thorn Run watershed is recommended. The acid mine drainage can then be directed into the Delmont mine or allowed to continue its present discharge into Thorn Run, depending on the findings made during this investigative work.

IV. An acceptable terminal location for depositing the acid mine drainage from the Delmont mine should be secured before design of the actual conveyance system is pursued. Camera surveillance might be used to investigate the subsurface conditions at the base of the terminal borehole.

Pre-design would include detailing the scope of work, plans preparation, specifications, contracting letting, and analysis of the findings. The recommended abatement can then be pursued or an alternate implemented.

This exploratory work could feasibly be packaged with the exploratory work suggested in Items II and III to better coordinate these closely related projects and to facilitate execution.

Should diversion of the Export and Delmont discharges to the main pool be found unfeasible the recommended alternative scheme would be the combined treatment of the Export and Delmont discharges.

V. Abatement costs for the Irwin and Coal Run discharges have been based on their combined treatment at an intermediate site, deemed necessary on the assumption of inadequate land availability adjacent to either discharge. Given that the Coal Run discharge constitutes less than ten percent of the average daily plant flow of 18.0 MGD estimated for the combined sources, there is no reason to delay a pre-design stage directed at the Irwin discharge alone. In this instance, pre-design would essentially entail further water quality analyses using laboratory techniques to finalize the use of the neutralization-oxidation treatment process or an alternate treatment method. Land requirements can be established and final design could be initiated.

Few changes in overall plant siting and sizing would be incurred even if the Coal Run source was added at a later date. Simultaneously with plant pre-design, exploratory work in the Coal Run area is suggested. This work would commence with an effort to locate and open the Penn Shaft, followed by temporary pumping to determine the effects on the Coal Run discharge. Research for details of the culvert construction would be undertaken if the pumping from Penn Shaft fails to halt the discharge. In either case, the intent of final design is to efficiently collect and deliver the Coal Run discharge to the treatment facility.

VI. Final design of an abatement facility for the Guffey Station discharges must be preceded by a pre-design phase that will be directed solely at Lower Guffey. Exploratory excavation is necessary to establish its actual origin and determine the best collection method. Because severe limitations on suitable acreage may be difficult to overcome, abatement of these sources should probably be assigned lowest priority.

Irwin Syncline Basin
Mine Drainage Pollution Abatement Project
Operation Scarlift Project SL 103-5
- COST ESTIMATE SUMMARY -

	Total Capital Cost	Operating Costs (¢ per 1000 Gallons)	Amortized Capital Costs	Total Operating Cost	Total Annual Cost	System Design Flow (MGD)	Average Flow (MGD)	Abatement Costs ($/lb.) Iron	Acid	Remarks
RECOMMENDED SCHEMES			* * * EXPORT - DELMONT AREA * * *							
Export Discharge	$ 273,250	-	$ 25,790	$ 12,000	$ 37,790	3.60	1.14	0.40	0.03	Discharge absorbed by pool via No. 2 Export mine "dip mains"
Delmont Discharge (Including the TR-1 discharge in the Thorn Run watershed	172,110	-	16,245	3,000	19,245	1.70	1.13	0.16	0.03	Discharge absorbed into pool via Mellon mains
ALTERNATIVE SCHEMES										
Export via No. 2 "mains"	205,000	-	19,350	9,000	28,350	3.6	1.14	0.30	0.02	Discharge absorbed by pool similar to recommended scheme
Combined Treatment of Export and Delmont Discharges	1,500,000	25	141,590	207,140	348,730	3.4	2.27	1.77	0.17	Using a neutralization-oxidation process
Treatment of Delmont Discharge Only	1,074,000	25	101,380	103,110	204,490	1.70	1.13	1.98	0.43	Using a neutralization-oxidation process
RECOMMENDED SCHEMES			* * * LOWER BASIN * * *							
Irwin-Coal Run Treatment	4,200,000	25	396,467	1,095,000	1,491,467	18.0	12.0	0.34	0.16	Using a neutralization-oxidation process
Marchand Treatment	1,200,000	25	113,250	250,938	364,188	2.75	2.75	0.22	0.40	Using a neutralization-oxidation process
Guffey Station Treatment	1,600,000	25	151,030	328,500	479,530	5.40	3.60	0.77	-	Both discharges net alkaline
ALTERNATIVE SCHEMES										
Centralized Pump Scheme I Biddle Site	4,200,000	20	427,712*	876,000	1,303,712	18.0	12.0	0.30	0.14	Using a neutralization-oxidation process
II Marchand Site	1,200,000	20	113,250	200,750	314,000	2.75	2.75	0.19	0.35	Using a neutralization-oxidation process
Treatment of Irwin Discharge Only	3,600,000	25	339,815	1,018,350	1,358,165	17.0	11.16	0.32	0.14	Using a neutralization-oxidation process
Irwin-Coal Run Treatment (Coal Run via Penn Shaft)	5,000,000	25	471,965	1,095,000	1,566,965	18.0	12.0	0.36	0.17	Using a neutralization-oxidation process
Combined Treatment of Marchand and Guffey Station Discharges	2,500,000	25	235,983	582,175	818,158	9.50	6.38	0.36	1.24	Using a neutralization-oxidation process

*Includes $31,245 for pump tests.