SECTION IV

ALTERNATIVES

4.0 ALTERNATIVE ABATEMENT SCHEMES

As demonstrated in Sections 3.1 and 3.2, continuous water treatment is not necessary to abate the Export and Delmont pollution loads. Other than elemental changes within the recommended scheme, such as different pipeline routes or terminal points, true alternatives consist solely of treatment facilities.

A centralized collection system is an interesting alternative to the direct treatment schemes recommended in Sections 3.3 through 3.5. Premised on comparable initial costs, its advantage lies in potentially lower operating costs.

4.1 CENTRALIZED COLLECTION IN THE LOWER BASIN AREA

Given the relationships among the Irwin, Coal Run, Marchand, Upper Guffey and Lower Guffey Station discharges and the Irwin syncline basin mine pool, an alternative to the recommended scheme (Sections 3.3 through 3.5) would be to pump the pooled water at a constant rate to the surface for treatment at two locations; the Marchand mine air shaft second north (ASSN) and the Biddle air shaft. Pumping at Biddle and the ASSN sites would be utilized to sufficiently lower and then maintain the pool elevation necessary to eliminate the Marchand, Irwin and Coal Run discharges.

The pool could just as well be pumped from the McCullough shaft, Edna No. 2 pumphole, Ocean No. 1 borehole, South Side airshaft, Adams shaft or any combination of these mine pool monitoring sites. However, the Biddle and ASSN sites are chosen because they are easily accessible and are adjacent to spacious unused areas. Most important is the fact that they are situated closest to the Irwin, Coal Run and Marchand discharges in order to optimize the pool drawdown effect. Premised on initial costs comparable to those for the recommended schemes for these three sources, lower annual operating costs are predicted for the Biddle and ASSN treatment facilities, assuming that they would be required to treat equal average raw AMD flow rates in order to maintain the reduced pool elevation, i.e. 12.0 MGD at Biddle in place of the Irwin-Coal Run facility and 2.75 MGD at ASSN in place of Marchand. Part of the justification for assuming lower operating costs is the better mechanical efficiencies associated with constant operating conditions as opposed to treating a wide range of flows as would be necessary at Irwin, which ranged from 3 to 23 MGD. Of greater significance is the fact that the acid producing potential of the mine environment may decrease as the pool is lowered. The lowered pool will also provide storage capacity for wet weather conditions.

Depending on the basin's hydrogeological response to this pumping the Upper Guffey Station discharge could partially recede. Improvements in Upper Guffey are not guaranteed, however, the efficiency of the total scheme would be directly enhanced by lowering the annual cost of treatment for the Guffey Station discharges.

The initial phase of the centralized scheme involves pump tests. Water from the mine pool is pumped via the two air shafts. As noted previously, these sites provide abundant acreage to accommodate both temporary and permanent treatment installations. In addition, the shafts are approximately 15' in diameter, offering a better link to the inundated coal seam, thereby insuring optimum water supply to the pump intakes. In the event that the air shafts were not sound enough to support vertical deep mine pumps, approximately 275 feet of at least 24" diameter well casing would have to be installed.

For discussion purposes, the maximum test pump capacities are arbitrarily set at 4000 GPM (5.76 MGD) and 10,000 GPM (14.40 MGD) at the Marchand and Biddle sites respectively. Basically, the tests would consist of gradually increasing the pumping rate from both sites to determine the pump conditions necessary to achieve and maintain the pool level required to permanently eliminate the Irwin, Coal Run and Marchand discharges.

Simultaneously with the pump tests, the entire basin would be monitored with the exception of the Export-Delmont area. Discharge flow rates and mine pool elevations would be measured to assess the effects of the pump test on the basin.

Since the desired combination of optimum pump intake elevations and pump rates is not known, the test pumps would be situated near the air shaft bottoms. This insures sufficient depth to exercise the maximum pump capacities. Also, since raising and lowering the pump in the shaft is costly, they would be set to provide the maximum possible drawdown. The total dynamic head is estimated at 60 feet and 95 feet at the ASSN and Biddle sites respectively.

The test pumps would be "standard construction pumps," i.e. constructed of materials of the quality necessary to withstand acid conditions for only a short duration. After the tests are completed these temporary pumps would be salvaged, because if this abatement method is implemented, permanent deep mine pumps will have to be manufactured. They would be made of higher quality materials and designed for long term use. For instance, the bowls in the temporary pumps would be cast iron, those of the permanent installation bronze. The pump line shaft in the temporary setup would be polished carbon steel but those in the permanent assembly would be stainless steel and rubber coated. Both assemblies will be oil-lubricated pumps. Power could be supplied in several ways. For cost estimate purposes electric motor drives powered by a diesel generator are assumed. A 350 HP motor is needed for the 10,000 GPM pump at Biddle and a. 125 HP motor for the Marchand site 4000 GPM pump.

It has been assumed for cost estimate purposes that three additional observation wells might be needed. These wells would be designed to reflect only mine pool elevations insuring no groundwater intrusion. Pool readings will also be recorded at existing locations such as the Hutchison pumphole, Yough Slope shaft, the Dillon-Gibbon rock tunnel, and the monitoring wells installed under Operation Scarlift Project SL 103-5-101.5. An effort to locate and open the Riley shaft might also be considered. One of the three new wells might be placed within Riley.

The water pumped from the mine pool during the pump test cannot be indiscriminately dumped into the nearby streams, temporary treatment facilities are needed. The raw AMD would be directed to neutralization tanks where a lime slurry is added to raise the pH to approximately 7.5 or 8.0. Samples of the raw water would be chemically analyzed to establish operating conditions of the permanent facility. Based on the raw water quality analyses of the discharges, contained in Appendix A, a lime consumption rate of about 0.003 pounds of lime per treated gallon of raw AMD has been estimated. This is based on a hydrated lime having a 95% CaO content, mixed to a 10% slurry proportion. Following neutralization, the water flows into settling lagoons that will provide roughly 12 hours detention time. Sufficient solids removal to yield acceptable effluent quality would be required.

A cost estimate of the pump tests is provided in Table A. The actual test time is estimated at two weeks of continuous operation although the final cost is not sensitive to overrun.

It is estimated that a total of about six to nine months would be required to generate pump test data. Four to six months would be allocated to researching mineral and surface ownership, developing the observation well layout, preparing job specifications and soliciting bids. Equipment installation and pump test performance is arbitrarily set at one to two months followed by approximately one month for evaluating the program and pump test data.

Assuming that the pump tests confirm the original hypothesis (that the Irwin, Coal Run and Marchand discharges can be eliminated by sufficiently lowering the pool and then maintaining a constant pumping rate at the Biddle and ASSN sites) then the final design stage could be entered. A basic cost estimate summary for the Biddle and ASSN permanent facilities is presented in Table B. Amortization of the pump test cost of $331,000 is included with the Biddle site.

- TABLE A -

CENTRALIZED PUMP SCHEME
COST ESTIMATE - PUMPING TESTS

Includes Biddle and Marchand Sites

I. Actual Test Costs

Install and dismantle pumping apparatus including structural supports		$ 23,500
Installation of three observation wells		11,800
Labor (for pump tests over two weeks)		20,000
Vertical deep mine pump assemblies		
A. Biddle Site:		
10,000 GPM - 16" Dia. Pump		24,000
350 HP Motor		10,400
250 KW Diesel Generator		6,000
B. Marchand ASSN		
4,000 GPM - 12" Dia. Pump		8,000
125 HP Motor		3,300
150 KW Diesel Generator		4,000
Mobilization and demobilization		10,000
	Sub Total	$121,000

II. Temporary Treatment Facilities

Earthwork (settling basins)		$ 75,000
Labor		42,000
Equipment (lime feed storage, feeder, etc.)		23,000
Lime		40,000
Mobilization		30,000
	Sub Total	$210,000
	Total	$331,000

- TABLE B -

CENTRALIZED PUMP SCHEME
PERMANENT TREATMENT INSTALLATIONS
COST ESTIMATE SUMMARY

Biddle Air Shaft Site

Plant design flow 18.0 MGD Average flow 12.0 MGD

Estimated total capital cost $4,200,000

Annual Costs

Total Capital Costs @ 7% over 20 years	$ 396,467
Ammortization of total cost for pump tests (re: $331,000 at 7% over 20 years)	31,245
Estimated operation and maintenance costs @ $0.20 per 1000 gallons treated (based on avg. flow of 12 MGD)	876,000
Total annual costs	$1,303,712

Air Shaft Second North (Marchand Mine)

Plant design flow = average flow = 2.75 MGD

Estimated total capital cost $1,200,000

Annual Costs

Total Capital Costs @ 7% over 20 years	$113,250
Estimated operation and maintenance costs @ $0.20 per 1000 gallons treated	200,750
Total annual costs	$314,000

The cost estimate summary for the Biddle site consists of:

1. Plant design capacity of 18 MGD ... as assumed in the discussion, identical to the design flow for the recommended scheme in Section 3.3. This capacity is required to provide initial drawdown and treat maximum flows in excess of pool storage.

2. Estimated total capital cost ... equal to the Section 3.3 costs.

3. Annual Costs

    a. Total capital costs ... item 2 amortized at 7% over 20 years

    b. Pump test cost amortized at the same rate

    c. Estimated operation and maintenance (O/M) costs of $0.20/1000 gallons treated. (For the recommended treatment facilities in Sections 3.3 through 3.5, 0/M costs are estimated at $0.25/1000 gallons treated premised on less efficient water treatment.) At an average flow of 12 MGD, assumed to be required to maintain the pool elevation after initial drawdown, total annual operation and maintenance costs are given.

The costs associated with the ASSN treatment facility are essentially the same as those for the Marchand facility in Section 3.4 except operation and maintenance. The pump test costs have been included with the Biddle facility for which it is interesting to examine the possible variations in cost.

The difference in total annual costs (neglecting the ammortized pump costs) between this basic scheme and the recommended scheme is $219,000 per year, i.e. $0.05/1000 gallons at an average flow of 12.0 MGD. This annual savings represents slightly more than one half of the annual cost ($396,467) of financing the total capital cost, <u>plus</u> the pump test costs which totals $427,712. An alternate way of describing the benefits: the current worth of twenty annual future deposits of $219,000 is approximately 2.3 million dollars, or roughly half of the initial capital cost. (For the Marchand site annual operation and maintenance savings amount to $50,000 per year, again, about one half the annual amortized cost of construction of $113,250).

Suppose that the pump tests reveal that the Biddle plant design capacity must be 18.0 MGD to affect drawdown to the required pool elevation and 12.0 MGD to maintain it as originally proposed, but the capital costs must double to 8.4 million. Assuming $0.20/1000 gallons as the O/M cost, the resulting annual cost breakdown is:

Amortized capital. Costs ($8.4 million)	$ 792,935
Pump Costs	31,245
O/M @ $0.20/1000 gallons treated at 12.0 MGD (average flow)	876,000
Total	$1,700,180

Identical savings in 0/M costs accrue, $219,000 per year, but they now represent just one-fourth of the annual cost of financing the capital construction cost plus the pump tests ($824,180).

Assume that the required pumping rate must be 50% larger in order to affect drawdown, i.e. 27.0 MGD (with 18.0 MGD average flow) but the facility can he constructed for the original estimate of 4.2 million. Based on $0.20/1000 gallons treated:

Amortized capital costs (4.2 million)	$ 396,467
Pump costs	31,245
O/M @ $0.20/1000 gallons treated at 18.0 MGD (average flow)	1,314,000
Total	51,741,712

In terms of total annual cost the result is just in excess of the previous total. However, two variables have been changed: the average flow and the construction cost. By returning one variable to a previous value, the differences can be more easily compared. For instance, hold the capital cost and pump costs fixed and determine the O/M cost per 1000 gallons at 18 MGD design (12 MGD avg.)

Amortized capital costs (4.2 million)	$ 396,467
Pump costs	31,245
O/M @ $0.30/1000 gallons treated at12 MGD (average flow)	1,314,000
Total	$1,741,712

This constitutes an extreme case and serves as an indicator of the interaction of the variables involved. In this case, the O/M unit cost reaches a maximum.

Returning the O/M cost to $0.20/1000 gallons and the feed rate to 12.0 MGD, what is the effect on capital cost?

Amortized capital cost	$ 834,467
Pump cost	31,245
O/M @ $0.20/1000 gallons for 12.0 MGD	876,000
	$1,741,712

The net effect is an increase in the original amortized capital cost by a factor of 2.1 ($834,467 vs. $396,467). All three variables have experienced some change from the original cost estimate.

In summary, the benefits of a centralized pump scheme cannot be properly evaluated without conducting the pump tests. At the extreme, the pump tests may prove totally irrelevant and indicate that this scheme should not be pursued; the costs would have to be absorbed by the recommended scheme as follows:

Total capital cost for Irwin-Coal Run treatment facility from Section 3.3		$4,200,000
Pump tests as failure		331,000
	Total	$4,531,000
Annual Costs:		
Total cost amortized @ 7% for 20 years		$ 427,712
O/M cost @ $0.25/1000 gallons (12.0 MGD)		1,095,000
	Total	$1,522,712

Pollution Load Removal Costs:

A. Total iron load of Irwin and Coal is 11,896 pounds per day.

$$\frac{\$1{,}522{,}712}{11{,}896\ \#/\text{day} \times 365} = \$0.35/\text{lb.}$$ vs. $0.34/lb. if pump test costs are not included (re: Section 5.2.1) and $0.30/lb. for centralized pump scheme (re: Section 5.2.2, Alternative Scheme A)

B. Total net acid load of Irwin and Coal Run is 25,765 pounds per day.

$$\frac{\$1{,}522{,}712}{25{,}765\ \#/\text{day} \times 365} = \$0.16/\text{lb.}$$ vs. $0.16/lb. if pump test costs are not included and $0.14/1b. for centralized pump scheme.

A prime advantage of the centralized pumping scheme over the recommended scheme is the certain elimination of the AMD being emitted via the Redstone coal seam at approximate elevation 785± (re: Section 2.3.1). The cause of this discharge group has been shown to be due to the pool within Hutchison mine rising to meet the surrounding piezometric surface. Removal of the associated acid and iron loads will improve the true effectiveness of the centralized pump scheme.

Another advantage is that drawdown of the mine pool will provide a factor of safety against the northernmost edge of the pool advancing towards the Export-Delmont area.

If the Upper Guffey Station discharge is eliminated by lowering the pool, it is safe to assume that Lower Guffey could be abated simply by directing it across Guffey Hollow Run and into the Irwin pool. This would be similar to directing the Export discharge via the No. 2 mains.

This pumping scheme is also compatible with the probable long range subsurface activity in the basin. If the permanent pumping operation at the Marchand ASSN site is functional before the Banning No. 4 mine is abandoned, the result would be a reduced hydrostatic pressure acting along its north barrier pillar. In reverse, an inundated Banning mine would simply become part of the Irwin basin pool as proposed in Section 3.6 and is therefore not likely to result in any appreciable increase in pump rate demand to maintain the necessary pool elevation. Increased storage lagoon capacity could accommodate what minimal increase might occur.

4.2 OTHER ALTERNATIVES - LOWER BASIN

If the pump test data reveal that the Upper Guffey Station discharge is unaffected by the lowering of the mine pool, albeit successful in terms of eliminating Irwin, Coal Run and Marchand, then the recommended abatement scheme of Section 3.5 could be implemented; combined treatment of both Guffey Station discharges near the Yough River. If the test data reveal that the centralized pump scheme was unsuccessful then the appropriate recommended schemes would be implemented at Irwin and Marchand (re: Sections 3.3 and 3.4).

Consider the Coal Run and Irwin discharges. As cited in Section 3.3, the optimum location for a treatment facility will depend on final design and in-depth cost analyses. However, since any alternative sites would be of similar proximity to the discharges as the recommended scheme, the costs are going to be comparable.

It has also been estimated that a small savings in cost can be realized by treating only the Irwin discharge, however, Coal Run would go unabated. It might be feasible to treat Irwin only and add the Coal Run discharge at a later date. The estimated construction cost for treating Irwin alone is as follows:

Site Preparation	$ 1,684,550	
Electrical	293,000	
Mechanical	1,012,000	
Operations Building	33,250	
Subtotal	$ 3,022,800	
Contingencies @ 10%	302,280	
Subtotal	$ 3,325,080	say 3.6 million
Engineering @ 8%	266,000	
Total	$ 3,591,080	

Another method of abating the Coal Run discharge would be to pump the Paintertown mine from the Penn Shaft. As shown on Plate 34, the shaft is located at the deepest, southeast corner of this mine. Trial pumping could be done and the effects on the Coal Run discharge monitored to determine if this would be a feasible permanent abatement method. The only drawback to this scheme would be that the discharges from the North Side mine along the Coal Run railroad grade would go unabated. If it can be determined that the pollution load from these discharges could be easily assimilated by the Coal Run and Brush Creek streams, then no further work should be done. With a pressurized pipeline paralleling Brush Creek from Penn Shaft to the Irwin Coal Run treatment facility, the initial cost of the Irwin-Coal Run treatment facility may approach $5 million dollars.

A remote possibility would be the combined treatment of the Marchand and two Guffey Station discharges at some intermediate location or at Marchand or Guffey Station. The estimated cost for a facility at Guffey Station with the Marchand discharge pumped overland along a straight path to the plant is as follows:

Site Preparation	$ 716,000	
Electrical	229,000	
Mechanical	1,096,000	
Operations Building	64,000	
Subtotal	$2,105,000	
Contingencies @ 10%	210,500	
Subtotal	$2,315,500	
Engineering @ 8%	185,240	
Total	$2,500,740	say 2.5 million

The total cost is less than the sum (2.8 million) of providing separate facilities at Guffey Station and Marchand as described in Sections 3.4 and 3.5. However, the total unit pollution load removal costs (iron and net acidity) are greater than for the separate facilities, $1.60 per pound versus $1.39 per pound; re: Section 5.2, Alternative D. This increase is due primarily to the neutralizing effect of the net alkaline Guffey Station discharges, which reduce the total net acid load, thereby increasing the unit cost.

4.3 EXPORT - DELMONT AREA

If the exploratory excavation phase of the recommended scheme (re: Section 3.1) reveals that the Export No. 2 mains do have sufficient hydraulic capacity, and the dams at their intersection with the dip mains can be removed, then the Export discharge should be directed to the basin pool via this route.

The Export discharge is approximately two feet higher than the bulkhead elevation of the No. 2 mains as indicated on Plate 32. This implies a gravity flow situation, however, the conduit has to pass beneath the railroad bed serving the small industrial facility near the Export discharge. Numerous schemes are possible. An example would be a sump to collect the discharge from which it is pumped, similar to the recommended scheme. The cost to construct and operate this alternative is estimated at approximately 75% of the recommended scheme, or a total of $205,000.

Another alternative for removing the pollution loads of the Export and Delmont discharges from the headwaters of Turtle Creek would be to provide a treatment facility to accommodate both sources. A neutralization-oxidation process plant could be constructed near either discharge. Enough land is available. This would entail having to pump an average daily flow of about 1 MGD over a one mile distance. The hydraulics favor a plant at Export. The estimated total cost for this scheme is approximately $1.5 million dollars, summarized as follows:

Site Preparation	$ 573,200	
Operations Building	32,500	
Electrical	139,000	
Mechanical	497,500	
Subtotal	$1,242,200	
Contingencies @ 10%	124,220	
Subtotal	$1,366,420	
Engineering @ 8%	109,315	
Total	$1,475,735	say 1.5 million

As an indicator of the high unit removal costs to be expected for providing treatment at only one discharge, consider the Delmont source. A total construction cost of about 1.074 million dollars is estimated to provide treatment for an average pollution load of 283 pounds of iron and 1310 pounds of acid per day. Section 5.0 will show that the result is unit removal costs of $1.98 and $0.43 per pound respectively.

Another contrasting alternative was discovered in discussions with the Bureau of Water Quality Management. Future plans call for the construction of a sewage treatment plant in the Delmont-Franklin Boro region. Preliminary studies relevant to this construction are currently in progress but a definite timetable has not been established. It is technologically feasible to treat combined domestic sewage and acid mine drainage although extensive analysis and coordination is imperative. As an alternative this possibility should be further investigated.