PROPOSED ABATEMENT PLAN

PROPOSED ABATEMENT PLAN

General Considerations

The essential purpose of this mine drainage investigation is to formulate an abatement plan to effectively deal with source pollution from mining areas. The success of a program proposal is largely measured by the ability to orientate the study to problem-solving objectives, which identify specific abatement project areas.

Some general considerations with regard to mined land abatement-reclamation, problems and procedures are covered in the following discussion.

Much of the material disturbed by strip mining in the Slippery Rock Creek Watershed consists of exposed rocks and soil which are virtually unweathered and devoid of vegetation. Weathering is accelerated and sheet erosion, gullying and channeling of spoil banks causes a large sediment discharge to streams. Flocculation commonly occurs after acid drainage from spoil banks enters a stream. Tributary streams carry the soluble products of chemical weathering into the main stream. Sediment yields are high in the summer when thunderstorms produce heavy precipitation and rapid runoff.

Coal strip mining affects the ground water system above, at and below the strip mined area. The hilly topography of the Watershed is modified by the strip mining and the ground water table is also changed because of its relation to this topography. Impervious and denuded spoil banks increase runoff and tend to reduce ground water recharge and, storage for the support of base flow. Water contributed to underlying sandstones is available for the support of base flow. Slight dip of beds, fracture orientation and concentration causes some variation in ground water drainage. Ground water moves faster through fractures and, therefore, contamination from strip mining is more rapid. Water at great depth is generally independent of local topography, and is not significantly affected by strip mining.

Consideration must be given to spoil properties - acidity, compaction, stoniness, slope, direction, and erosion before reclamation is carried out. Proper reclamation of strip mined areas reduces runoff and slows erosion, thus minimizing or eliminating stream pollution and mine drainage. Soil neutralization via lime injection may also be required.

Drift mining of coal removes support from the overlying rocks and induces caving. The rocks fail by plastic deformation and brittle failure, producing cracks which increase the permeability of the geologic section. Precipitation saturated with oxygen enters the mine and reacts with disulphide minerals existent in the coal beds and associated strata. Pollution from mine drainage results (Barnes and Clarke, 1964).

The hydraulic mine seals being recommended to abate mine drainage in the Slippery Rock Creek Watershed are designed to prevent and retard the formation of mine drainage through the construction of watertight seals or bulkheads in the mine openings. These seals create a hydraulic head which must be contained by the surrounding strata if they are to be effective. When the mine is completely flooded, air is excluded, preventing the oxidation of disulphide minerals.

A thorough study of geologic and hydrogeologic conditions affecting each mine must be individually investigated and evaluated before any hydraulic seals are constructed. If the mine seals are to be effective in abating mine drainage, the study must examine several important factors (Emrich and Thompson, 1969):

1. Mineral composition and stratigraphy of the coal beds, underclays and associated strata - rock types and distribution of acid-producing minerals to be determined by surface studies and from test drilling.

2. Structure - strike and dip of beds, faults, folding, fractures and joints to be determined by test drilling.

3. Ground water levels - obtained from well records and borings, springs, local wells and occurrence in the mine.

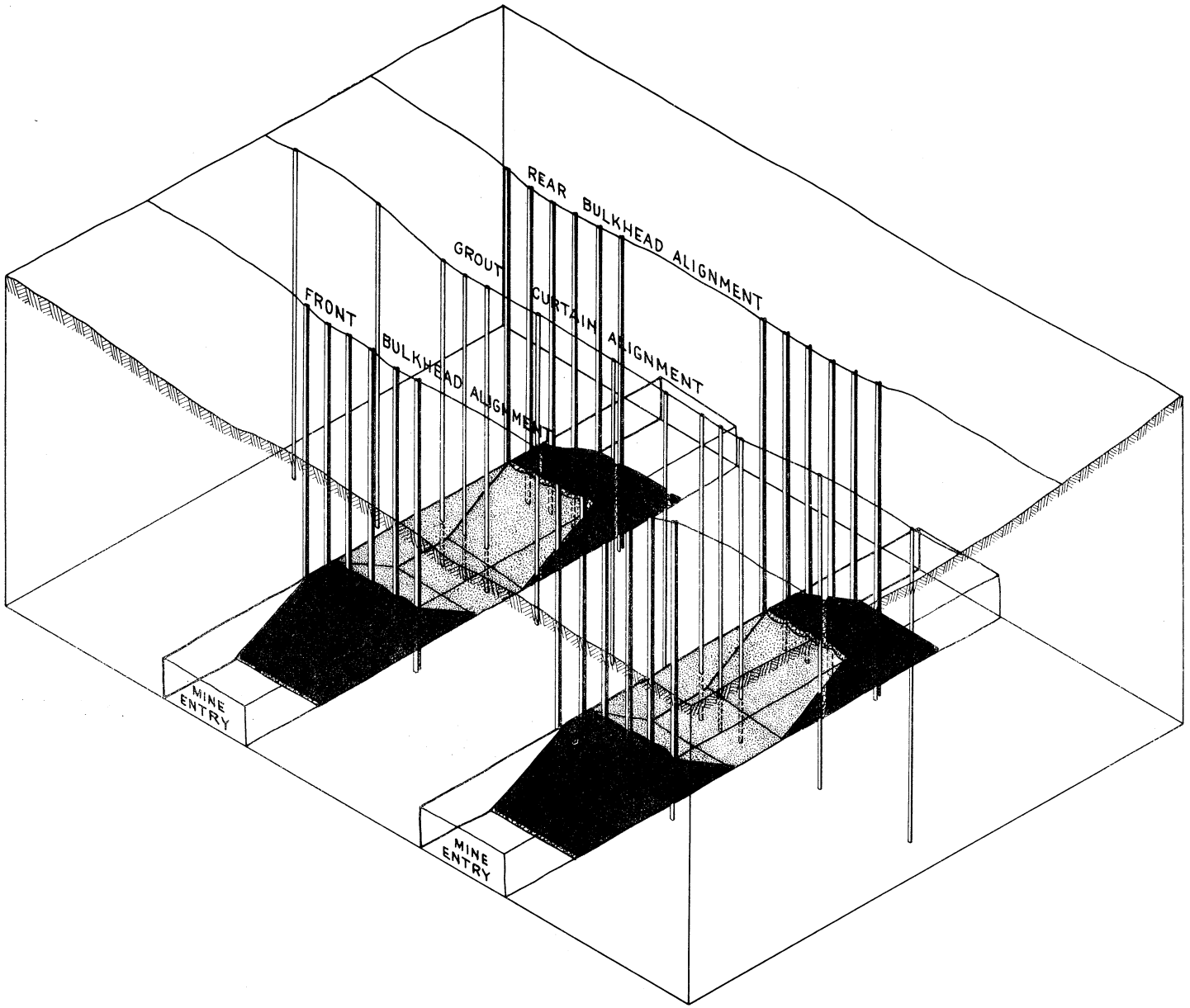
4. Lateral and vertical permeability of rock types, ground water movement and recharge conditions.

5. Hydraulic head on the seals, thickness of barriers and overburden.

6. Condition and extent of mine workings and relation to geologic setting.

This background information is also essential to an understanding of conditions during post-sealing surveillance.

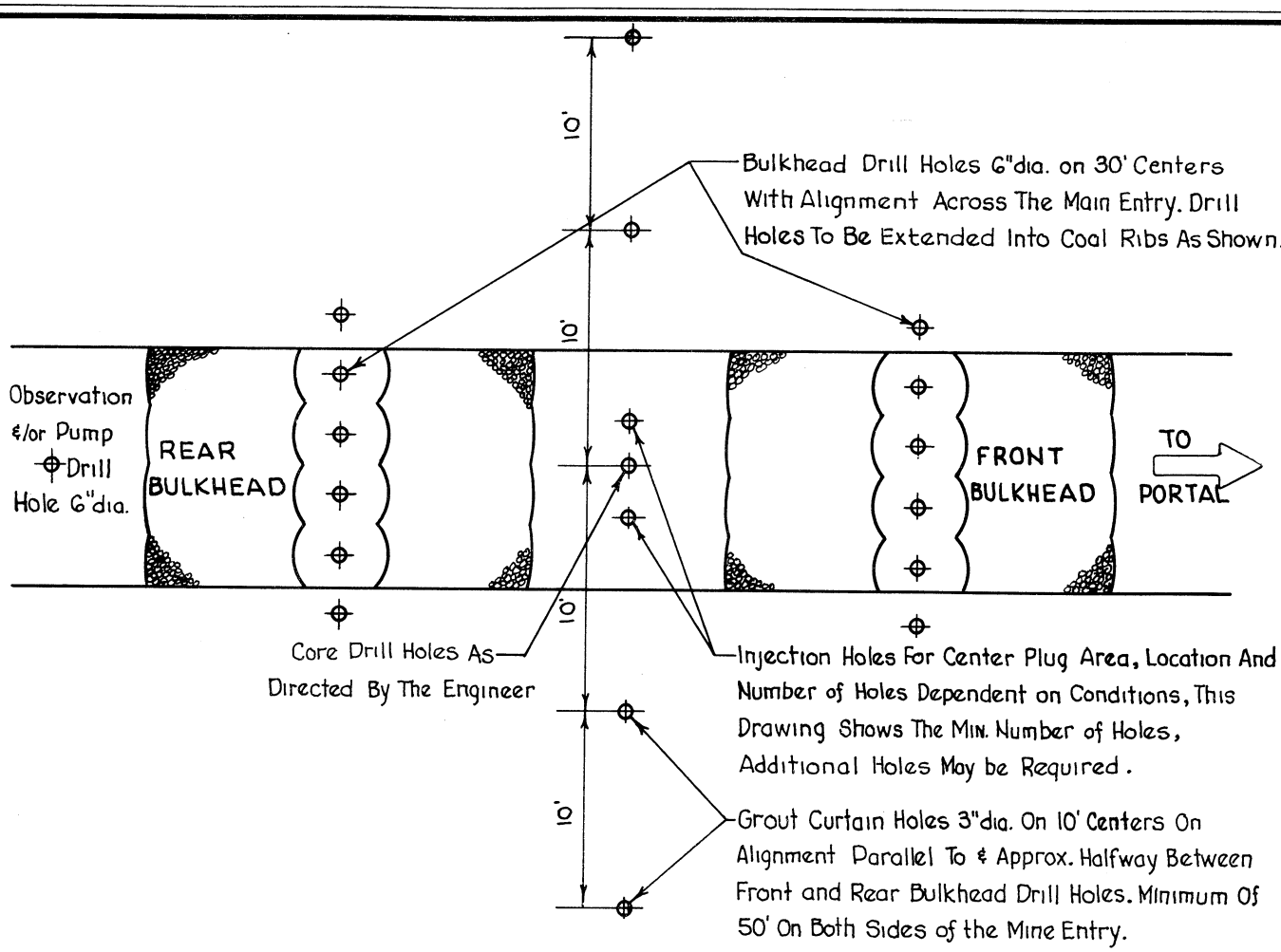
Application of geologic and hydrogeologic principles in conjunction with engineering design and construction will assure that environmental damage resulting from past coal mining operations is controlled or eliminated.



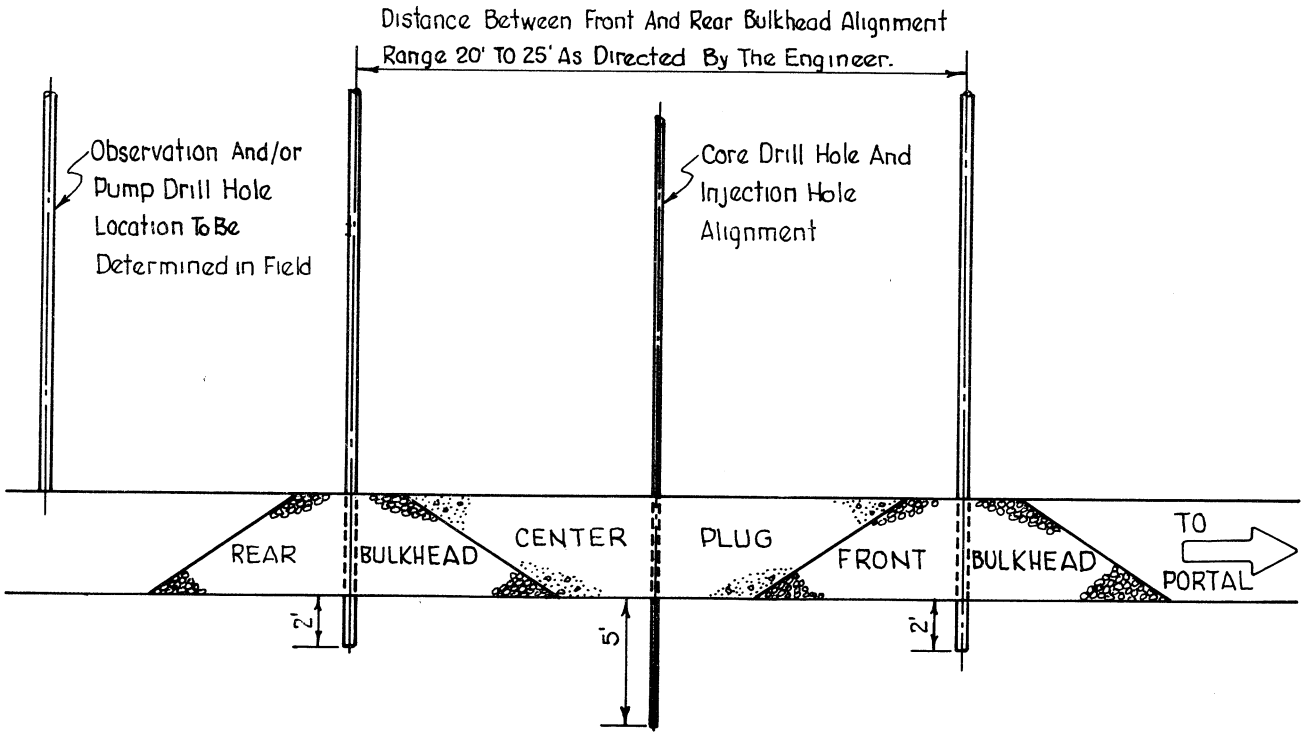
ISOMETRIC DRAWING OF DEEP MINE SEALS

NO SCALE

Fig. 25



PLAN



PROFILE

CONSTRUCTION DRAWING OF DEEP MINE SEAL

FIG. 26

Information obtained from the use of naturally occurring hydrogeologic and geochemical systems to abate pollution from abandoned strip and underground mines can be applied to establish the quality and quantity of pollution in advance of, and during mining operation. Achievement of this objective will be a progressive step towards the most practical and preferred solution of the mine drainage problem - prevention at the source, thus eliminating the costly remedial measures required today.

Basis for Cost Estimates

Cost estimates for the proposed abatement work in the Watershed have been based on the construction costs for recent reclamation contracts of a similar nature in Western Pennsylvania. The following is a brief discussion concerning the range in costs and the work involved in each of the major abatement methods.

1. Deep Mine Sealing

   Because most of the mine entries scheduled to be sealed are caved at the portal, the installation of these mine seals in the entries will be performed through drilling procedures. After the mine seals have been placed in the entries, pressure grouting operations will be performed in the adjacent strata. An isometric drawing and general construction details of the deep mine seals are indicated in Figures 25 and 26. The costs for individual mine seals range from a low of $9,000 to a high of $70,000 per entry due to the variance in the quantities required for the grouting operations associated with the mine sealing work. The average cost per mine seal in the Moraine State Park was approximately $13,000. For estimating purposes, we have used values ranging from $12,000 to $30,000 per entry for the proposed mine sealing projects.

2. Strip Mine Reclamation

   Strip mine reclamation work will include backfilling, soil treatment, planting, and in many instances, the construction of diversion ditches and slope drain flumes. Most of the backfilling will be terrace type restoration. Strip mine reclamation costs have varied from a low of $420 per acre to a high of $2,300 per acre based on recent restoration contracts. The cost per acre for strip mine reclamation work will vary with volume (cubic yards) and distance the material is to be moved, the type of material,

the configuration of the area, the soil treatment and planting requirements, and associated work such as diversion ditches and slope drain flumes. We have used estimates varying from $1,000 per acre to $2,000 per acre for reclamation costs in the project areas. Figure 27 indicates backfill and drainage details for the strip mine reclamation projects.

3. Refuse Pile Abatement

Refuse abatement projects will consist of the removal of mine refuse and burial in strip mine areas or grading and leveling mine refuse piles, covering, treating and planting. The cost per cubic yard for moving and placing this material has varied from approximately $1.00 to $4.00, depending on conditions. The soil treatment and planting costs, if applicable, would be additional costs in this type of abatement work. For estimating purposes we have used $2.00 per cubic yard as the costs in the refuse abatement projects.

4. Surface Sealing

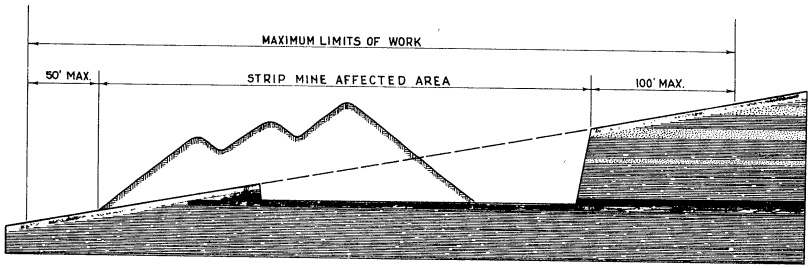
These projects include sealing mine drifts, slopes and air shafts with clay and other suitable material. Costs for this type of work generally varies from approximately $200 to $2,000 per opening. Figures within this range have been used in estimating costs for the proposed projects in the area.

5. Curtain Grouting

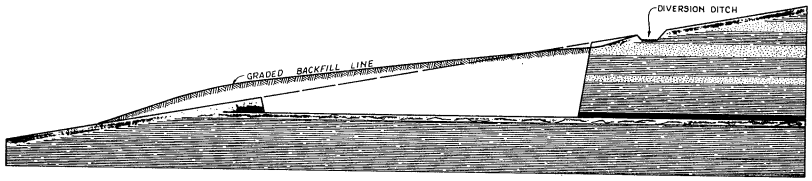
Pressure grout curtains are proposed to be placed in seepage areas along certain sections of the outcrop and above the highwalls in-specified locations. Because quantities are extremely difficult to estimate, pressure grouting projects are performed on a unit-cost basis. Generally, the drilling will vary from $2.00 to $3.50 per lineal foot, the cement for grouting from $4.00 to $5.50 per cubic foot, fly ash for grouting from $30.00 to $40.00 per ton, admixtures from $2.50 to $10.00 per sack depending on the material, and the mobilization varies with the size of the project. The estimates used in the project areas were prepared from our experience on similar projects; however, the actual construction costs can vary widely from the estimates.

6. Spoil Pile Neutralization

The abatement work in these projects will consist of treating the subsurface materials in certain strip mine spoil piles with neutralizing agents. This is accomplished by injecting a neutralizing slurry containing pulverized limestone and/or hydrated lime

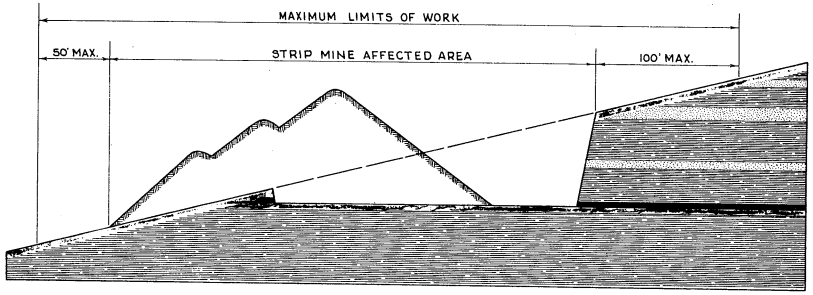


BEFORE BACKFILLING



AFTER BACKFILLING

APPROXIMATE ORIGINAL CONTOUR BACKFILL



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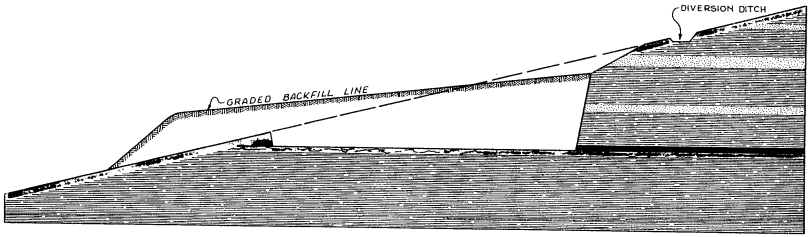
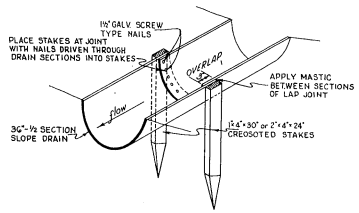


AFTER BACKFILLING

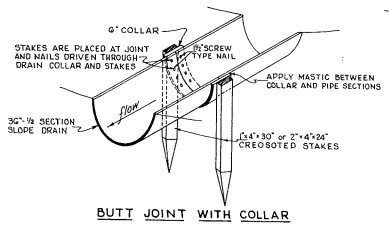
TERRACE TYPE BACKFILL

GENERALIZED CROSS-SECTIONS OF PROPOSED BACKFILLING METHODS

SCALE: 1"=40'

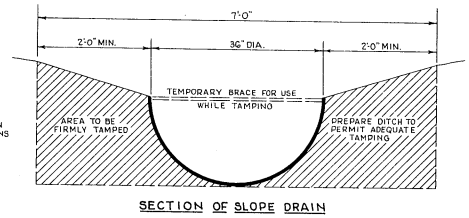


OVERLAPPED JOINT

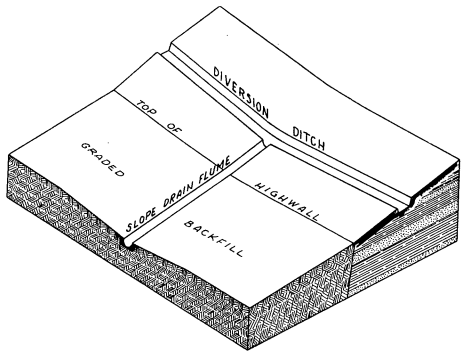


BUTT JOINT WITH COLLAR

DRAIN INSTALLATION DETAILS



SECTION OF SLOPE DRAIN



ISOMETRIC DRAWING SHOWING TYPICAL DRAINAGE DETAILS

GENERAL NOTES

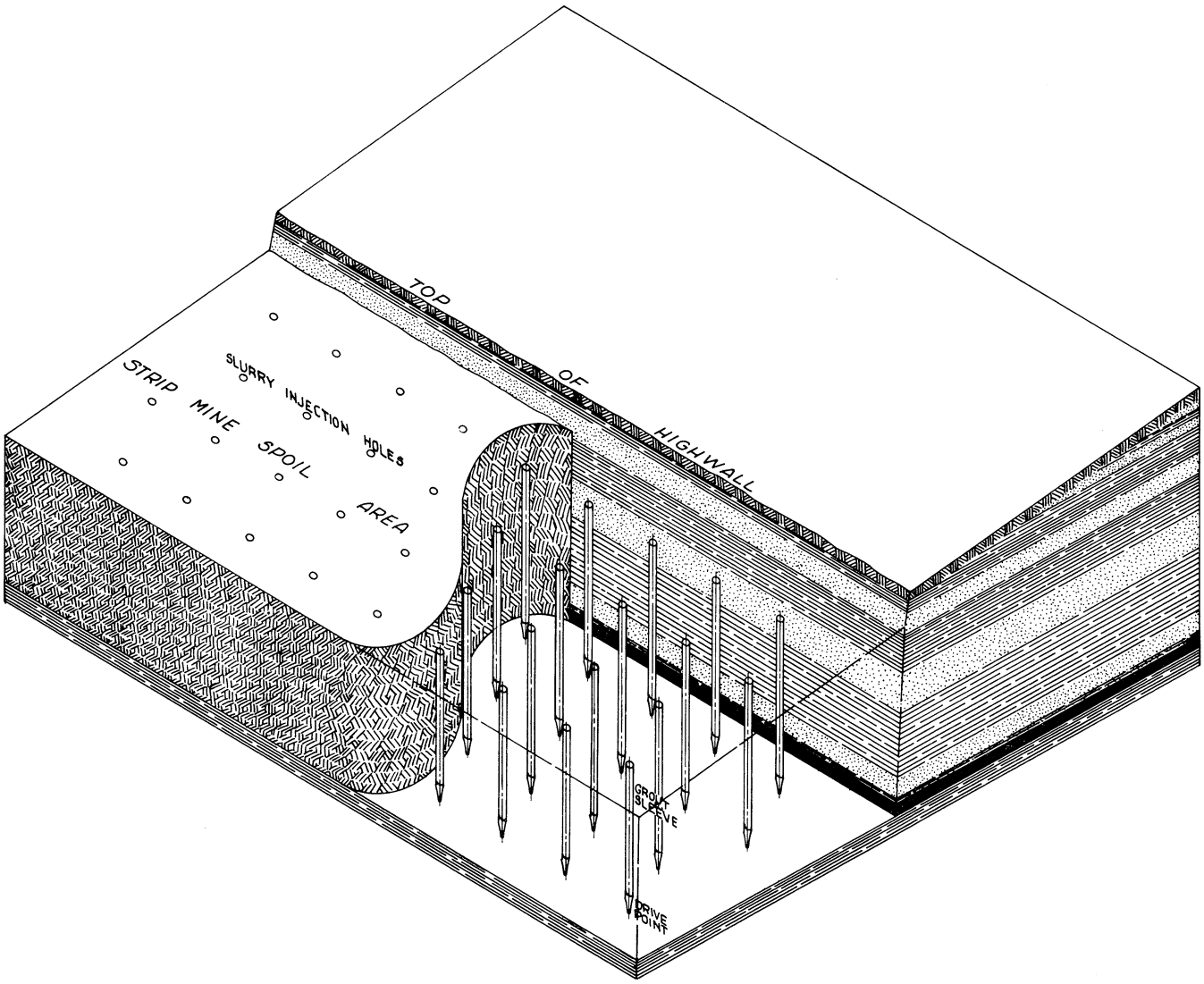
1. BACKFILLING SHALL BE PERFORMED IN ACCORDANCE WITH THE RULES AND REGULATIONS OF THE LAND RECLAMATION BOARD, PENNSYLVANIA DEPARTMENT OF MINES AND MINERAL INDUSTRIES AND THE PENNSYLVANIA BITUMINOUS COAL OPEN PIT MINING CONSERVATION ACT.
2. THE BACKFILLING SHALL BE EITHER APPROXIMATE ORIGINAL CONTOUR OR TERRACE TYPE RESTORATION AS INDICATED ON THE APPLICABLE STRIP AREA MAPS AND IN THE SPECIFICATIONS.
3. THE MAXIMUM LIMITS OF WORK WITH REFERENCE TO BACKFILLING SHALL BE 100 FEET ABOVE THE HIGHWALL OF THE AFFECTED AREA AND 50 FEET BELOW THE TOE OF SPOIL AS INDICATED ON THE ABOVE CROSS SECTIONS.
4. ALL DIVERSION DITCHES AND SLOPE DRAIN FLUMES SHALL BE EXCAVATED AND INSTALLED AS INDICATED ON THE STRIP AREA MAPS AND IN ACCORDANCE WITH THE SPECIFICATIONS. THE ISOMETRIC DRAWING TO THE LEFT INDICATES A TYPICAL INTERSECTION OF A DIVERSION DITCH AND FLUME.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF MINES & MINERAL INDUSTRIES
STRIP MINE RECLAMATION
BACKFILL & DRAINAGE DETAILS

SCALE	GWIN ENGINEERS, INC. CONSULTING ENGINEERS
AS SHOWN	ALTOONA PENNSYLVANIA

JOHN W. FOREMAN ENGINEER 10498-E

Fig. 27



ISOMETRIC DRAWING SHOWING
SPOIL PILE NEUTRALIZATION

FIG. 28

into the spoil through grout sleeves. The drive points and grout sleeves are driven vertically through the spoil on predetermined centers and the slurry is injected into spoil banks under pressure. Figure 28 is an isometric drawing indicating a general plan for a spoil pile neutralization project. Quantities for these projects are difficult to estimate. This work is usually performed on a unit-cost basis. Average unit costs for this work are as follows: slurry injection holes at $6.00 per hole, driving grout sleeves at $1.00 per lineal foot, pulverized limestone at $12.00 per ton in place and hydrated lime at $35.00 per ton in place. Cost estimates for the various project areas were determined and are indicated in the applicable sections of this report.

Abatement Project Areas

After an evaluation of the mine drainage information collected throughout the watershed, certain areas have been designated as needing reclamation work. Thirty-seven (37) areas are being submitted as project areas on the following pages. A map of each area at a scale of 1" = 1000' showing mined areas, deep mine openings, refuse piles and weir locations is included with this report.

The Project areas are divided into three priority groupings to show the relative order in which construction work should progress. The twelve areas in the first priority group are those that are producing more than 350 pounds of acid per day; the seven areas in the second priority group are those that are producing 100 pounds to 350 pounds of acid; the eighteen areas in the third priority group are those producing less than 100 pounds of acid per day. In a few areas the priority ratings were changed to reflect other parameters bearing on conditions or special circumstances.

The efficiency of mine drainage control involving source abatement methods can be related to acid load reduction estimates based on results of similar work in comparable areas. Our experience in the Muddy Creek Area with the Moraine State Park Project provides us with excellent guidelines for evaluating the effectiveness of on-site control techniques for the Slippery Rock Creek Watershed. The table on the following page summarizes the priority schedule and the recommended mine drainage abatement plan in terms of effectiveness (percent acid reduction) and costs. Drainage areas A, B, and C refer to the portions of the watershed shown in Figure 12, page 28 and described on page 61 of the Stream Quality Section.

Table 29

Estimated Acid Reduction & Abatement Costs

in

Areas A, B, C
for
First Priority Projects
First & Second Priority Projects
First, Second & Third Priority Projects

	Avg. Acid Load, lbs./day	Est. Acid Red. lbs./day	Est. Acid Red. %	Est. Abatement Costs
Area A	4,893			
1st Priority		3,117	64%	$3,997,000
1 & 2 "		3,624	74%	5,260,000
1, 2 & 3 "		3,817	78%	5,735,000
Area B	1,956			
1st Priority		1,189	61%	$1,300,000
1 & 2 "		1,469	75%	2,330,000
1, 2 & 3 "		1,565	80%	3,083,000
Area C	1,214			
1st Priority		1,021	84%	$ 5,19,000
1 & 2 "		(1,021)	(84%)	(519,000)
1, 2 & 3 "		1,068	88%	1,049,000

Recommendations and estimated costs for abating the mine drainage pollution for each project area are listed on the following pages. The Index to Project Maps shows the location and priority ratings of these project areas.

- Table 30

Estimated Abatement Project Costs

First Priority Project Areas

Project Area No.	Average Acid Load #/Day	Estimated Costs $
1	128	$ 44,000
SL 110-5 2	373	265,000
SL 110-4 3	659	210,000
SL 110-5 8	433	337,000
SL 110-4 12	526	1,600,000
SL 110-3 13	632	230,000
SL 110-5 14	480	270,000
SL 110-5 SL 110-3 19	1,562	800,000
SL 110-1 21 SL 110-18D	469	760,000
SL 110-5 SL 110-1 29 SL 110-18D	460	110,000
SL 110-2 35 SL 110-2A	368	720,000
SL 110-1 36 SL 110-1C	640	470,000
	6,730	$5,816,000

Second Priority Project Areas

Project Area No.	Average Acid Load #/Day	Estimated Costs $
5	88	$ 210,000
SL 110-5 7	192	93,000
SL 110-3 18	113	305,000
SL 110-4 20	70	515,000
24	100	140,000
SL 110-4 31	170	450,000
SL 110-4 37	208	580,000
	941	$2,293,000

Third Priority Project Areas

Project Area No.	Average Acid Load #/Day	Estimated Costs $
4	31	$ 190,000
SL 110-5 6	49	45,000
9	27	78,000
10	41	98,000
11	10	40,000
SL 110-5 15	10	4,000
16	16	17,000
17	42	60,000
22	5	60,000
23	3	23,000
25	33	340,000
26	24	195,000
SL 110-1 27 SL 110-1A	4	100,000
28	17	54,000
30	42	154,000
32	1	66,000
33	1	44,000
34	35	190,000
	392	$1,758,000

TOTALS

Priority Rating	Average Acid Load #/Day	Estimated Costs $
1	6,730	$5,816,000
2	941	2,293,000
3	392	1,758,000
	8,063	$9,867,000