SECTION I

DESCRIPTION OF THE STUDY AREA

1.0 INTRODUCTION

Acid mine drainage is attributable to man's eagerness to recover one of his precious natural resources. Governmental regulations addressing resource recovery are today aimed at minimizing the environmental impact, however, our definition of environment has grown more sophisticated and encompasses more than just the physical. As expected, the public has grown aware of the social costs of the recovery effort as well as the costs paid by the ecosystem. To compound the problem the economic demands of extracting unrenewable natural resources as part of the present national energy policy have intensified. The culminant effect of the complex interaction of the environmental, production and economic factors is that fair regulation is undermined. Nonetheless, environmental quality was inadvertently, although understandably, disregarded when coal recovery was the prime concern at the turn of the century.

Many miles of streams have been polluted by the resulting mine acid drainage. The effects of acid discharges from abandoned mining operations are often so severe the watercourses are considered lost as an economic, industrial or recreational resource. For the most part, the impact of a mine discharge is related to (1) alteration of water quality causing direct toxicity to aquatic organisms, or (2) increased suspended solids loads causing changes in the physical nature of the stream system which indirectly affect the biota. Water quality alteration is produced by exposure of chemically reactive minerals associated either with the mineral resource or associated strata. The most common mineral linked to water quality degradation is iron pyrite (FeS) although other metal sulfides may be highly reactive. The oxidation and hydrolysis of these metal sulfides produce acid and concentrated metal salt solutions which severely alter the chemical nature of the receiving stream producing conditions toxic to most aquatic organisms. Erosion due to land disturbance increases suspended solids loading and correspondingly greater stream sediment loads result. These higher sediment loads cause changes throughout the physical environment of the stream. Due to vegetative disturbance, rainfall is not retained, and the rising and receding limbs of the hydrograph are shortened while peaks are increased. Combined changes in sediment loads and hydrograph characteristics alter channel morphology, and aquatic habitats are destroyed by abrupt shifts of channel substrate materials or increased sediment deposition due to higher suspended loads.[(19)]

In the western part of Westmoreland County there are seven major acid mine water discharges that severely damage many miles of receiving watercourses. These discharges originate from the bituminous Pittsburgh coal seam of the Irwin Syncline basin. Their combined average flow is 20.8 million gallons per day; they discharge an average net acid load of 16 1/2 tons and 9 1/3 tons of iron per day. In June of 1973, Pullman Swindwll was contracted by the Department of Environmental Resources of the Commonwealth of Pennsylvania to conduct an in-depth study of these acid mine drainage discharges and associated conditions.

Encompassed by the outcrop line of the Pittsburgh coal seam and the Youghiogheny River as illustrated in Plate l, the study area spans approximately one hundred (100) square miles.

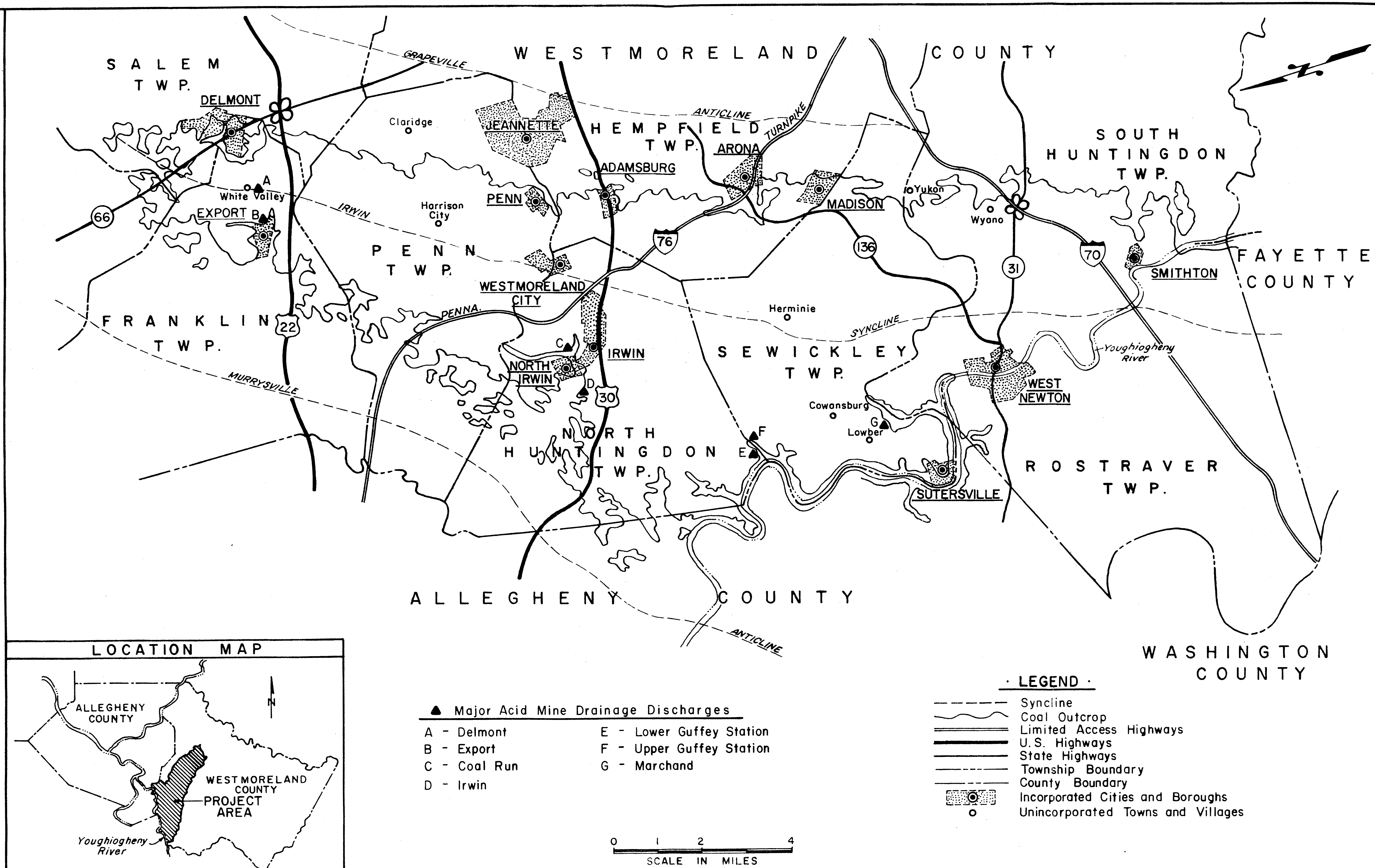
l.0.1 Objectives

It is a well documented fact that a pool of water almost fills the tilted, spoon-like Irwin syncline basin and somehow associated with this pool are seven pollution-laden mine water discharges. The ultimate purpose of this investigation is to develop the most feasible and economical basin-wide abatement plan to reduce the pollution load being emitted from these discharges to an acceptable minimum.

To achieve this total objective, several fundamental tasks were accomplished. By examining available deep mine maps and seeking out individuals familiar with the basin mining sequence, the influence of the early mining activity on the present conditions was evaluated. The water recharge characteristics of the basin, a function of the overburden and outcrop conditions as well as climatological patterns, the local stratigraphy, the location and condition of major barrier pillars, and other unique man-made subsurface structures such as the Dillon-Gibbon rock tunnel were examined to develop an understanding of the subsurface hydrology. Joint monitoring of the mine pool fluctuation and the accompanying changes in the characteristics of the major discharges in response to variations in precipitation over a two year period allowed the future pollutants that will require treatment to be quantified. Finally, taking into account long range conditions of the basin (there is still one mine in operation) a recommended abatement scheme and several alternatives were generated.

l.0.2 Problem Discussion

In the early days of the mining industry "mine drainage" consisted of keeping the active mine workings dewatered. This usually consisted of underground pumping operations and, in some cases, the construction of underground dams. These dams or bulkheads were used to prevent mine water from flooding the active workings and as an aid in pumping. Mine dams were also built to flood mines in order to extinguish mine fires or to suppress mine gases. Any mine seals constructed at the portals of the mines were installed primarily as a safety measure. In these initial deep mines, the location of one or more entries at the lower elevations along the outcrop provided gravity drainage to the outside. It was also common practice, for purposes of drainage, to cut through the barrier from an active mine (at a higher elevation) into an abandoned or inactive section of an adjacent mine (at a lower elevation). These conditions plus other mining and hydrogeologic factors have made mine drainage from abandoned deep mines the most difficult, complex and expensive to abate. [12]



PS CONTRACT NO.	OPERATION SCARLIFT PROJECT No. SL 103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN B.M.C. CHECKED R.C.O. SCALE As Shown	IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT GENERAL LOCATION MAP

PLATE I

DRAWING NO

Since the discharges in the basin are geographically clustered (Export-Delmont, Coal Run-Irwin, Upper and Lower Guffey Station, Marchand), four acid mine drainage treatment facilities could be constructed to eliminate the pollution. Is this the best solution, however, in terms of overall cost which basically includes the cost of (1) planning (2) design (3) construction (4) right-of-way acquisition (5) operation and maintenance and (6) the cost of financing? Secondly, is it feasible? Consider the fact that an AMD treatment plant sized to accommodate the Irwin and Coal Run discharges (estimated design flow 18.2 MGD) would span a considerably larger area than the Brush Creek Sewage Treatment facility presently under construction (design flow 4.5 MGD). The Guffey Station discharges are in a hollow with steeply rising hillsides and a very narrow valley floor. The nearest hydraulically compatible site is near the Yough River one quarter mile away. Another consideration is the long term behavior of the discharges. It was predicted that the combined total iron and acid loads of the Marchand, Upper and Lower Guffey Station discharges would reduce significantly after the Hutchison mine was abandoned.[14] If this holds true it should be taken into account in the design of any treatment facilities. Similarly, what will be the effect of the abandonment of the Republic Steel Corporation Banning No. 4 mine which is not expected for approximately five years ... after certain treatment facilities are already built? As thorough an understanding as possible of the subsurface hydrology is necessary to determine exactly what does and what does not affect the discharges on both short and long term bases so that drastic changes in the system do not render the abatement effort ineffective.

In conjunction with measuring the flow rate of the discharges and sampling them for chemical analysis, a pool monitoring program was initiated. Access to the pool was possible via boreholes, airshafts and pumpholes of several abandoned mines. These initial points were insufficient and additional pool monitoring wells were installed. Section II explains the existing subsurface conditions based on all pool monitoring data interpreted in light of the conditions generally known to exist within abandoned, inundated deep mines.

The dominant means by which precipitation recharges the pool is overburden percolation. This is significant in that it guides development of an abatement scheme. Treatment of the mine water discharges as they exit the seam becomes necessary because eliminating point sources of inflow will not affect the major source of pool recharge; i.e. the overburden. The development of an abatement scheme then centers on questions such as: Will treatment of acid mine discharges be cost-effective? Should the discharges be treated singly or in combination? Are there other cost-effective means of abatement besides treatment? What long term conditions must be considered?

Other factors must be considered. Coal reserves, mine barriers, dams, drainage tunnels and active mines may or may not be significant to the analysis of the long range behavior of the subsurface hydrology or to the development of the present abatement scheme. Items of this nature were found through careful scrutiny of mine maps and through personal communications. Interpretation of the mine pool monitoring data is the only way to determine how the tunnels and dams, etc. are functioning and what influence the mine barriers and abandonment of mines have on the discharges as well as the pool.

The remainder of Section I provides the setting for the analysis; the land and its use, a geologic perspective, the impact of the mine drainage on surface water quality, and a capsulization of the past and present basin mining activity.

Section II is an in-depth analysis-evaluation of the available data in light of some fundamentals concerning the subsurface behavior of this "black box system." A recommended basinwide abatement scheme is developed in Section III, followed by alternatives in Section IV. The economics are then examined in Section V. Conditions in the Thorn Run Watershed are discussed in Section VI, followed by report conclusions in Section VII.

1.1 LAND USE AND POPULATION

In Westmoreland County the predominant land use categories are rural in nature; i.e. agricultural and unused space. According to a general land use percentage analysis cited in the Westmoreland County Solid Waste Plan, prepared in 1971 by the County's Planning Commission, undeveloped land in the form of agriculture - forestry and unused space accounted for 244,700 acres (36.8%) and 343,000 acres (51.6%) respectively of the 664,000 total acres within the County. Developed land, defined to include residential, manufacturing and non-manufacturing, transportation, communications and utilities, commercial, institutional and public safety, and outdoor recreation totalled 76,300 acres.

Of the developed land, 39.6% was residential (30,215 acres), 27.5% transportation, communications and utilities (20,983 acres) and 22.5% outdoor recreation (17,168 acres).[36] Presently within the study area, the percentage of developed land is estimated to be on the order of 20% inasmuch as it encompasses several small population centers. There are several boroughs in the area ranging in 1970 population from 436 persons (Madison Borough) to 4059 (Irwin Borough). Approximately two-thirds of North Huntingdon Township, having a 1970 population of 30,000 persons, lies within the project boundaries. Second class townships in the vicinity include Hempfield Township (39,000) and Sewickley Township (6735 persons, 1970 census).

1.2 GEOLOGY

1.2.1 Stratigraphy

The Pittsburgh coal seam is located in the Monongahela Group of the Pittsburgh Series in the Pennsylvanian System. These Pennsylvanian Age rocks lie in the Appalachian Plateau physiographic province. Throughout most of the Plateau, Pennsylvania strata occur in hills and ridges of erosional remnant type and show a dendritic outcrop pattern. The beds in many parts of the Appalachian Plateau are so gently inclined that dips are difficult to detect in small outcrops. However, throughout the Plateau the rocks are folded into a series of northeast-southwest trending anticlines and synclines.

From Pittsburgh eastward to the Allegheny Front there are seven anticlinal crests spaced, on the average, eight miles apart. In the western end of the state, these anticlines are characterized by broad, open folds having an amplitude of 300 to 400 feet. Eastward the folds become more intense, and in the southeastern part of the plateau, anticlinal folds like Chestnut Ridge, Laurel Hill, and Negro Mountain have amplitudes of 2900 feet and exhibit flank dips at the surface of up to 15 degrees.(8,14)

The Pennsylvanian beds lie disconformably on Mississippian strata. The Pennsylvanian stratigraphic section, totaling about 1600 feet, is predominantly elastic and is subdivided into four stratigraphic units. From the base upward, the units are the Pottsville, Allegheny, Conemaugh and Monongahela Groups. These major groups are illustrated on Plate 2, generalized stratigraphic column for the Greensburg Quadrangle.(21)

The Monongahela Group averages approximately 400 feet in thickness and has the Waynesburg and Pittsburgh coal seams as its respective upper and lower boundaries. Compared to the Pittsburgh coal seam, the group's other seams which include the Redstone, Sewickley, and Uniontown in addition to the Waynesburg, have been mined to a much lesser extent. Generally, the Monongahela formation is calcareous with nearly one half its total thickness comprised of beds of limestone. Many of these are fresh water limestones, the thickest of which is the Benwood whose upper and lower parts total nearly 100 feet. As generalized by Emerich and Thompson (10) .. "there is a tendency for discharges in extreme southwestern counties to have more alkalinity, becoming more acid toward the northwest as a result of more limestone beds to the southwest." The remainder of the formation consists of variable shales, discontinuous sandstone beds, and persistent coal seams.(30)

1.2.2 Pittsburgh Coal Structure

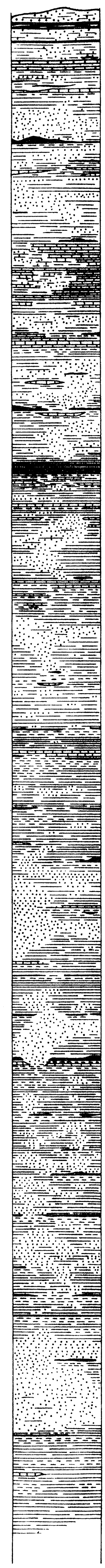
The Irwin (Port Royal) Syncline lies between the Murrysville Anticline to the northwest and the Grapeville Anticline to the southeast. It is an asymmetrical fold with the axial plane plunging one and one half (1.5) degrees to the southwest and having a general northeast-southwest trend. The axis passes one quarter of a mile west of Herminie, through Westmoreland City, half a mile west of Harrison City, and one mile east of Export.[21] North of Irwin, the eastern flank of the basin has an average slope of 6 percent. This slope flattens to about 3 percent south of Irwin. The slope of the basin's western flank varies from 3 percent north of Irwin to about 1 percent south of Irwin with a 2 percent average occurring in the Irwin vicinity. As the southern extreme of the synclinal axis passes under the Youghiogheny River and crosses the Westmoreland County-Fayette County boundary, the slope of the axis begins to rise at a rate of approximately a half percent (0.5%) until it coincides with the northern end of the Brownsville Anticline a quarter mile inside Fayette County. The low point of the Irwin synclinal axis occurs about four miles northeast of the Youghiogheny River.

The study area is located entirely within the Irwin syncline basin. As illustrated on Plate 1, the study area is defined by the outcrop line of the Pittsburgh coal seam except for the south-southwest boundary which is the Youghiogheny River. Defining the study area in this manner is unique in that a topographic feature is the limit for a subsurface investigation. The syncline's subsurface pool is contained by the east-west barrier pillar common to the operating Republic Steel Corporation mine complex on the syncline's southwest extreme and the flooded Yough Slope, Hutchison and Osborne Mines on the northwest side of the barrier. Since no discharges of any consequence occur southwest of the barrier, the barrier rather than the river could have been designated as the study boundary.

The Pennsylvania Geologic Survey, Oil and Gas Division, provided the most current mapping of the Pittsburgh Coal structure, outcrop and overburden thickness developed at the same scale as USGS maps (1:24000). Overburden above the Pittsburgh coal seam within the project area varies from zero to 550 feet with an average of about 350 feet. The coal seam itself is divided as follows: a roof and rooster division 2 to 3 feet thick which is impure and usually not mined, a clay or "draw slate" parting, and a main coal 4 to 9 feet thick averaging about 6 feet. This main coal is itself divided by thin partings into an upper breast coal about 40 inches thick, a "bearing-in" bench 4 inches thick, a "brick" bench 10 inches thick, and an impure bottom coal of 10 inches. While the roof division and bottom coal was not usually mined, the remaining coal is an excellent clear, low sulfur coal unexcelled for coking.[24,32] The seam has been mined extensively with estimates running in the range of 95% removal.[16] The remaining coal reserves in the Pittsburgh bed are not solid blocks of coal but are in the form of pillars which were left as roof supports. In addition to Plate 2 which shows the Pittsburgh seam as part of a generalized section of the Greensburg Quadrangle, Plates 4, 5, 6, and 7 show specific geologic logs with the Pittsburgh seam as datum. A profile of the Pittsburgh seam along the synclinal axis is shown on Plate 3.

GENERALIZED COLUMNAR SECTION FOR THE GREENSBURG QUADRANGLE

SCALE 1 INCH=100 FEET

System	Series	Group	Symbol	Columnar Section	Avge. thickness (feet)	Names of strata	General character of groups
PERMIAN	DUNKARD	Washington	Cd		140+	Washington coal Little Washington coal Colvin Run limestone Waynesburg A coal and Mount Morris limestone Waynesburg sandstone	Composed largely of friable arkosic sandstones and sandy shale. One important limestone member occurring only in southern part of Irwin syncline. Several unimportant coal beds.
PENNSYLVANIAN	PITTSBURGH	Monongahela	Cm		380	Waynesburg coal Little Waynesburg coal Waynesburg limestone Uniontown sandstone Uniontown coal Benwood limestone "Bench" sandstone and coal Benwood limestone Sewickley sandstone and coal Fishpot limestone Redstone coal and limestone Pittsburgh sandstone Thin local coal bed Pittsburgh coal	Prevailingly calcareous, particularly in the southern part of the quadrangle. Increasing percentage of sandstone towards the northeast. Contains three important coal beds.
		Conemaugh	Ccm		660	Thin local coal bed Pittsburgh limestone Thin local coal bed Connellsville sandstone Thin local coal bed Clarksburg limestone Morgantown sandstone Wellersburg coal, clay and limestone Duquesne coal and clay Ames limestone Harlem coal Upper Bakerstown coal Woods Run limestone Lower Bakerstown coal Saltsburg sandstone Pine Creek limestone and coal Buffalo sandstone Brush Creek limestone Brush Creek coal Mahoning coal Mahoning sandstone	Composed chiefly of shale. Sandstone beds are locally very thick and prominent. Contains several coal beds which locally are thick enough to mine, but only two of which are being mined today (1923). The upper half of the group includes two limestone beds which in the southern half of the quadrangle are frequently thick enough to make it profitable to quarry them. The lower half of the group contains three thin fossiliferous limestone beds which are important stratigraphic "markers". The red beds of this group are often conspicuous in the landscape.
		Allegheny	Ca		285	Upper Freeport coal Lower Freeport coal Upper Kittanning coal Middle Kittanning coal Lower Kittanning coal Clarion (?) coal Brookville coal.	An important coal-bearing group. Only one coal bed outcrops in the quadrangle, but two others are important and will some day be mined. The group is composed chiefly of gray shales, although sandstones are locally important.
	POTTSVILLE		Cpv		180	Homewood sandstone Mercer coal Connoquenessing sandstone Sharon coal	This group does not outcrop within the quadrangle, but farther east the sandstones form conspicuous features of the topography.
MISSISSIP-PIAN	MAUCH CHUNK		Cmc		40		Composed of red and green shales and usually some limestone.

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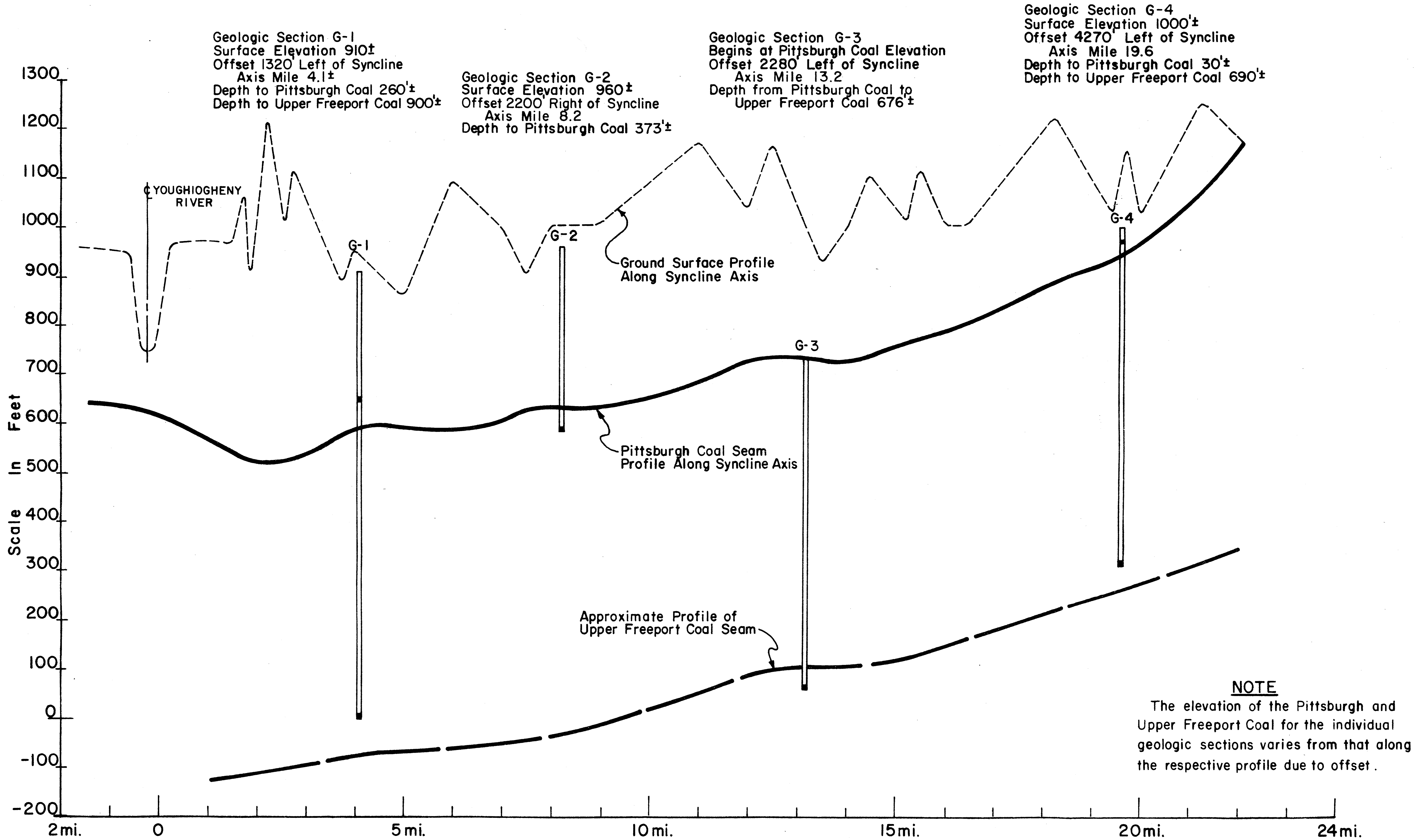
DRAWN B.M.C.
CHECKED R.C.O.
SCALE None

IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT
GENERALIZED GEOLOGIC COLUMNAR SECTION
GREENSBURG QUADRANGLE

PLATE 2
DRAWING NO.



NOTE

The elevation of the Pittsburgh and Upper Freeport Coal for the individual geologic sections varies from that along the respective profile due to offset.

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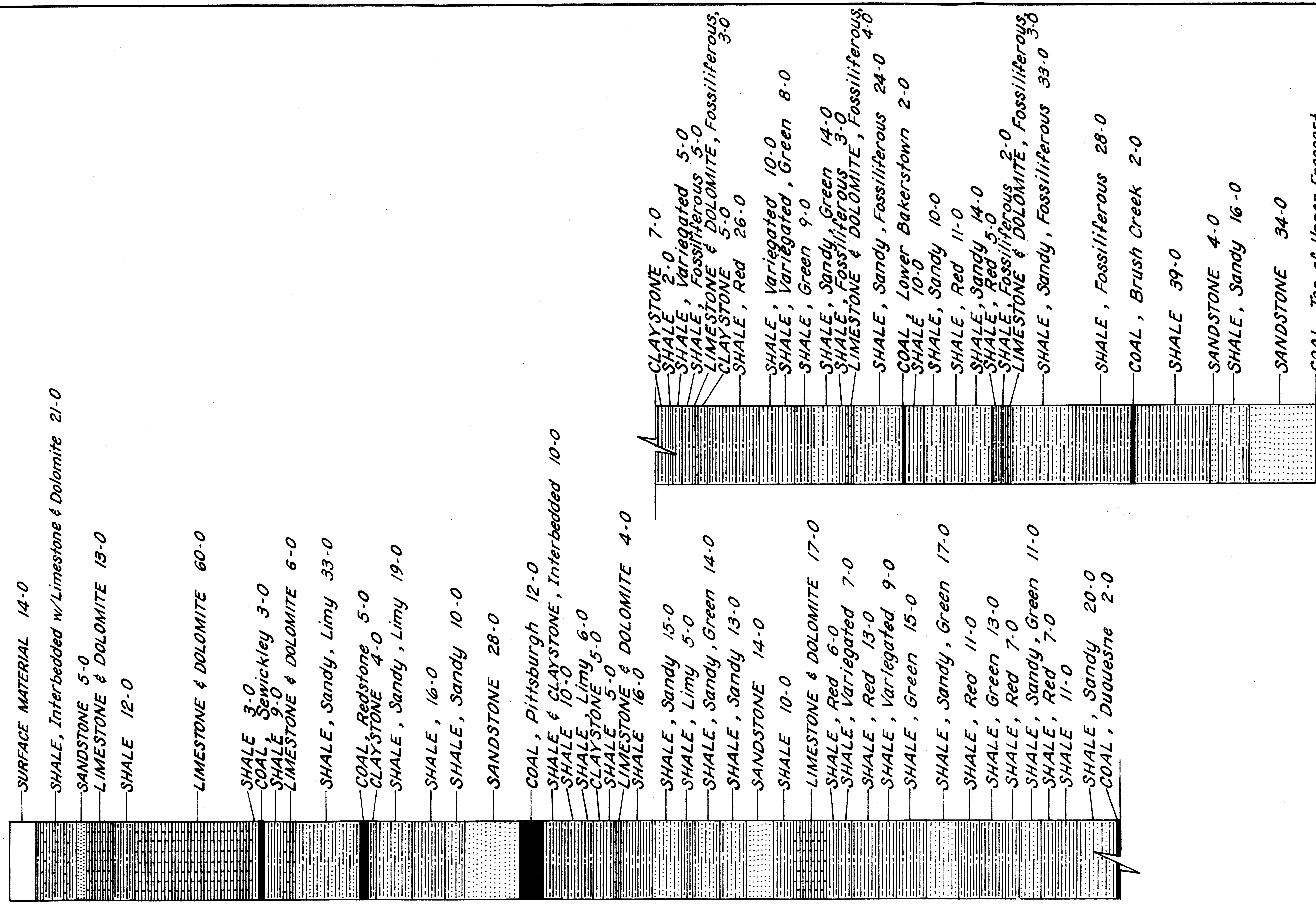
PS CONTRACT NO.

GEOLOGIC SECTION G-1

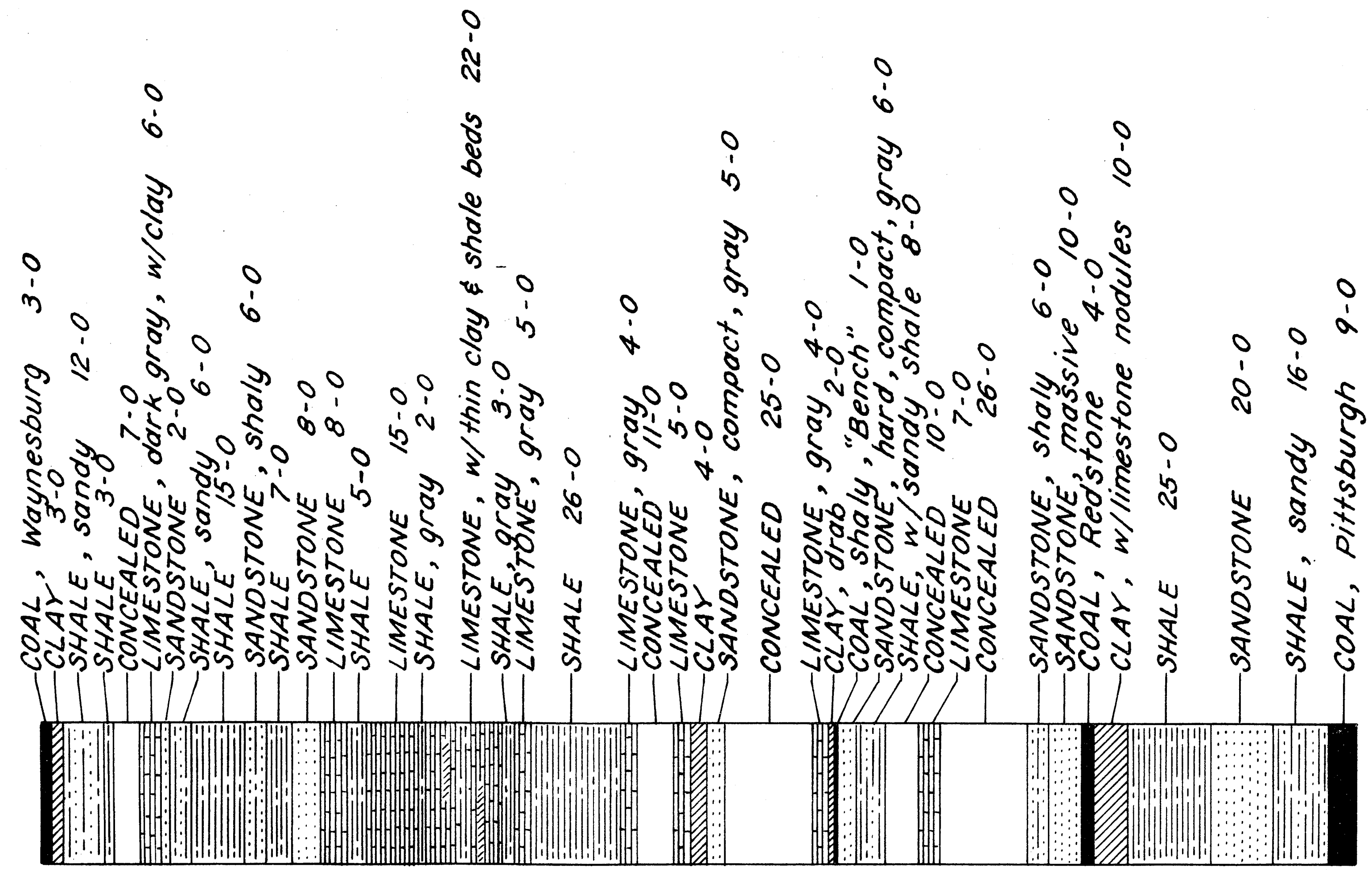
Surface Elevation 910 ±
Offset 1320' Left of Syncline
Axis Mile 4.1 ±
Depth to Pittsburgh Coal 260' ±
Depth to Upper Freeport Coal 900 ±



PS CONTRACT NO.	OPERATION SCARLIFT PROJECT No. SL 103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN B.M.C. CHECKED R.C.O. SCALE None	IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT GEOLOGIC SECTION G-1	PLATE 4 DRAWING NO.

GEOLOGIC SECTION G-2

Section Measured Near Herminie,
Sewickley Township
Westmoreland County, Pa.
Surface Elevation 960 ±
Offset 2200' Right of Syncline
Axis Mile 8.2
Depth to Pittsburgh Coal 373' ±



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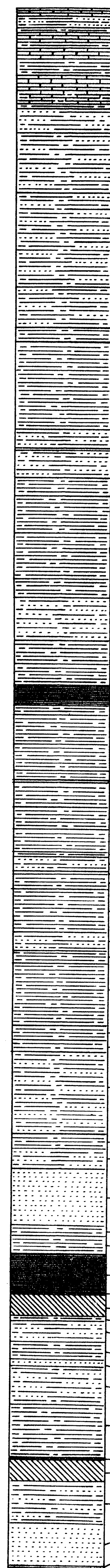
GEOLOGIC SECTION G-3

Partial Record of Diamond Drill Bore-Hole at Biddle,
North Huntingdon Township, Westmoreland County, Pa.
Begins at Pittsburgh Coal Elevation
Offset 2280' Left of Syncline - Axis Mile 13.2

Depth from Pittsburgh Coal to Upper Freeport
Coal 676' ±



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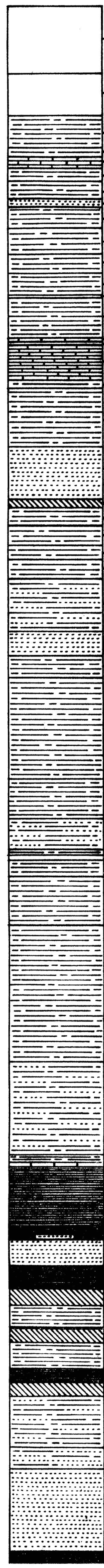
ATLAS LITHO CO., PGH., PA. 1020 CLEARPRINT

GEOLOGIC SECTION G-4

Partial Record of Diamond Drill Bore-Hole at Export,
Franklin Township, Westmoreland County, Pa.
Surface Elevation 1000' ±
Offset 4270' Left of Syncline - Axis Mile 19.6
Depth to Pittsburgh Coal 30' ±
Depth to Upper Freeport Coal 690 ±



OPERATION SCARLIFT PROJECT No. SL 103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN B.M.C. CHECKED R.C.O. SCALE None	IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT GEOLOGIC SECTION G-4

PLATE 7
DRAWING NO.

PS CONTRACT NO.

1.2.3 Adjacent Coal Deposits

The extensiveness of the Upper Freeport Coal seam is well documented, and its location relative to the Pittsburgh seam is well defined (Refer to Plate 3). The Upper Freeport coal bed lies at the top of the Freeport Formation, the uppermost formation of the Allegheny Group of the Pennsylvanian Age. It is the largest known recoverable reserve of any bed in Westmoreland County and has replaced the Pittsburgh coal as the most valuable in Allegheny and Westmoreland Counties. Unlike the Pittsburgh coal, however, the Upper Freeport is variable in thickness and quality, ranging from only a few inches to ten feet of recoverable coal while having high to low sulfur, clay and ash content. The coal bed is especially thick along the Allegheny River between Allegheny and Westmoreland Counties where it has been mined heavily.(4)

Due to the scarcity and irregularity of the Redstone coal seam its location relative to the Pittsburgh coal is sporadic. Generally, it lies in the Pittsburgh Formation, Monongahela Group, about 65 feet above the Pittsburgh seam and has been widely mined at the surface. Although appreciable areas of reasonably thick Redstone probably remain, large scale underground mining of the Redstone is not likely in the foreseeable future.(4) It is not of consistent thickness and large portions have been broken up by collapse as a result of mining operations in the Pittsburgh coal bed just beneath which caused extensive fracturing of the intervening strata. Plate 23 in Section 2.3.1 depicts the Redstone outcrop in the vicinity of the Hutchison and Marchand mines.

1.3 AVAILABILITY AND QUALITY OF SURFACE WATER

1.3.1 Precipitation and Surface Drainage

The western portion of Westmoreland County receives an annual average of about 40 inches of precipitation which is generally well distributed throughout the year. For the County as a whole, summertime rainfall ranges from 14 to 17 inches with the greatest monthly amounts during May, June and July. September through February are the driest months. About one-fifth of the total annual-precipitation occurs as snow. From mid-November to early April, 25% to 50% of the precipitation is normally received as snow which is frequent and abundant with monthly totals averaging from less than 3 inches up to 50 inches. In 4 out of 10 winter seasons, 20 inches of snow can be expected in the major river valleys of the County.

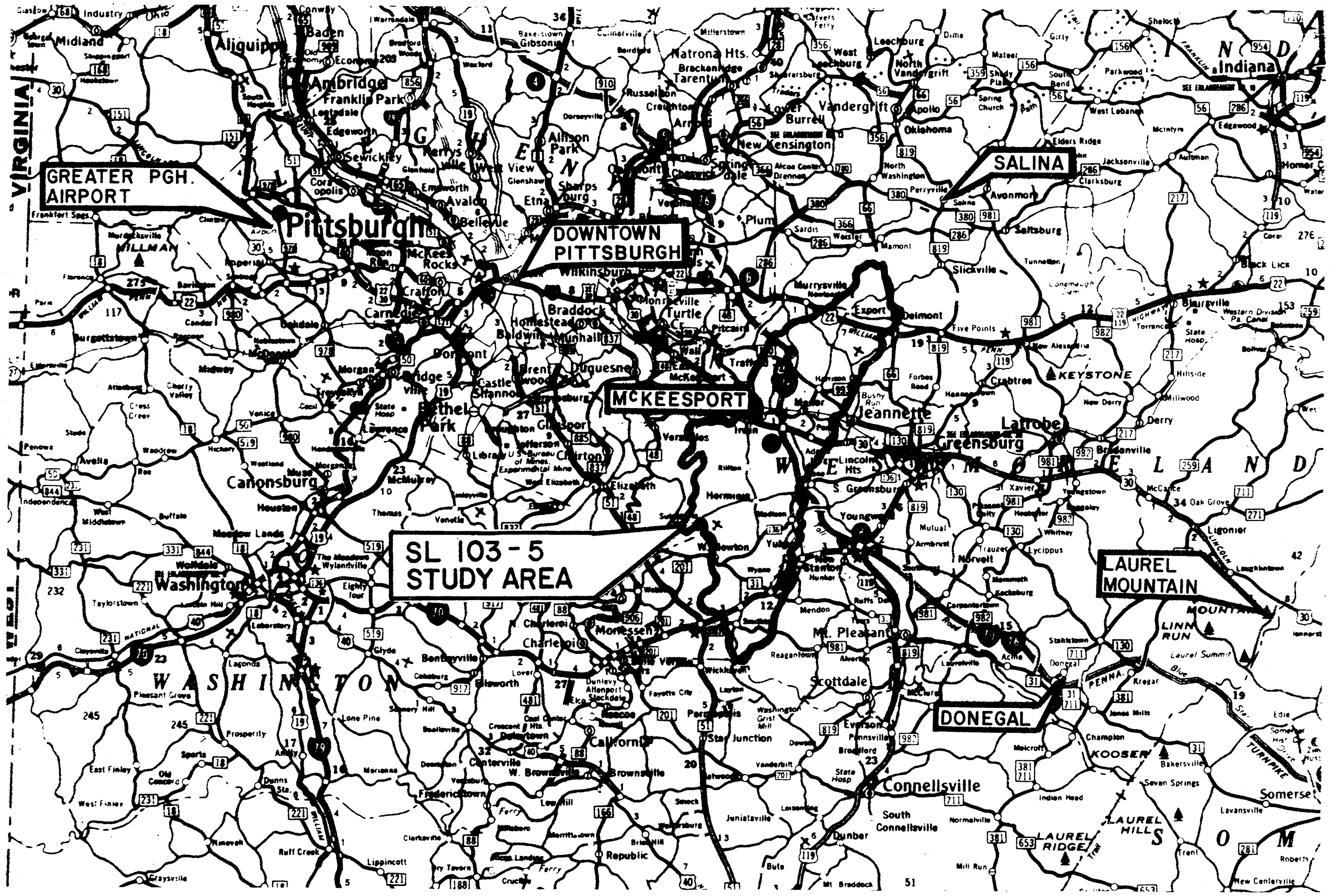
The total normal and actual monthly amounts of precipitation as compiled by the National Weather Service for the Greater Pittsburgh International Airport and downtown Pittsburgh are listed in Table 1. These stations are illustrated on Plate 8 along with four other weather recording stations in the area for which normal monthly precipitation data was not available.

TABLE 1

ACTUAL AND NORMAL TOTAL MONTHLY PRECIPITATION (inches)

	National Weather Service Pittsburgh, Pennsylvania Federal Building		Greater Pittsburgh International Airport	
	Actual	Normal	Actual	Normal
Jan. - 1973	1.86	2.82	2.03	2.97
Feb.	1.46	2.31	1.80	2.19
Mar.	3.12	3.52	3.86	3.32
Apr.	4.63	3.37	4.69	3.08
May	3.98	3.75	5.87	3.91
June	4.05	3.95	3.12	3.78
July	2.10	3.60	2.16	3.88
Aug.	1.27	3.50	3.40	3.31
Sept.	3.99	2.67	3.56	2.54
Oct.	3.94	2.50	4.45	2.52
Nov.	3.05	2.34	2.65	2.24
Dec.	1.99	2.54	2.15	2.40
Jan. - 1974	3.18	2.61	3.47	2.79
Feb.	1.83	2.29	2.10	2.35
Mar.	3.01	3.58	3.72	3.60
Apr.	2.40	3.44	3.26	3.40
May	4.73	3.59	5.36	3.63
June	4.55	3.74	5.08	3.48
July	2.30	3.78	3.30	3.84
Aug.	3.67	3.18	2.93	3.15
Sept.	5.62	2.53	4.42	2.52
Oct.	1.03	2.47	1.12	2.52
Nov.	2.30	2.49	3.06	2.47
Dec.	4.44	2.52	4.02	2.48
Jan. - 1975	3.15	2.61	3.34	2.79
Feb.	4.21	2.29	4.64	2.35
Mar.	4.14	3.58	4.62	3.60
Apr.	2.37	3.44	2.27	3.40
May	3.04	3.59	1.84	3.63
June	2.97	3.74	4.58	3.48
July	4.19	3.78	4.38	3.84
Aug.	7.24	3.18	7.56	3.15
Sept.	4.80	2.53	5.06	2.52
Oct.	3.42	2.47	3.46	2.52
Nov.	1.70	2.49	1.77	2.47
Dec.	2.96	2.52	2.90	2.48

SL103-5 Study Period



RAINFALL GAGING STATIONS

OPERATION SCARLIFT PROJECT No. SL103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN W.J.M. CHECKED R.C.O. SCALE ONE INCH EQUALS APPROX. NINE (9) MILES	PLATE 8

As an indicator of the normal behavior of the major acid mine water discharges in the study area, the precipitation values in Table 1 will suffice. During the study period, the total precipitation recorded at the Pittsburgh and airport stations was 92.83 and 99.79 inches respectively as opposed to the normal totals of 80.98 and 80.52 inches at these locations. Thus for the study period, approximately fifteen percent (15%) and twenty-four percent (24%) greater than normal precipitation occurred for these stations, an average about one-fifth greater than normal. If it is assumed that precipitation within the study area also exceeded its normal by one-fifth, the average discharge flow rates of the major discharges can be assumed to have been twenty percent (20%) greater than normal; not considered significant enough to be taken into account in the sizing of any treatment facilities.

The precipitation is disposed of via three basic processes; as direct runoff, as infiltration or via the evaporation and transpiration mechanisms. Direct runoff is captured in one of three local watersheds in the basin area; the Youghiogheny River, Turtle Creek or the Beaver Run Reservoir, illustrated in Plate 9 along with their main tributaries.

1.3.2 Stream Quality

It is beyond the scope of this study to detail the impact of the acid mine drainage on the primary receiving streams (Turtle Creek, Brush Creek, Sewickley Creek and Guffey Hollow Run). This has been done in previous studies culminating in the need for this comprehensive abatement plan. However, stream quality data collected in the past by the Department's Bureau of Water Quality Management illustrates the typical surface water quality (See Table 2 and Plate 10 for water quality data and stream sampling locations.) A degradation in Turtle Creek occurs immediately downstream of the mine water discharges, followed by gradual improvement in quality with increasing watershed area. The Youghiogheny River deteriorates in this stretch due to the introduction of the Upper and Lower Guffey Station and Marchand discharges from the Irwin Syncline, acid mine water discharges from the Pigeon Creek Syncline near Sutersville, and numerous smaller discharges in between.

The relationship between mine acid drainage concentration and stream flow is quite complicated. The discharge volume and pollutant concentrations of mine drainage have been shown to be seasonally related. The mine drainage volume is dependent on rainfall infiltration to underground areas. Although pyrite oxidation is not appreciably changed by the amount of water present, the concentration of pyrite oxidation end products will vary with volume. Because the infiltration rate is greater during the winter, the volume of mine discharges is increased from December through April. Infiltration decreases during the summer months; thus mine drainage volumes also decrease.

The major source of acid in an underground mine is pyritic materials located above normal water levels. When the mine is flooded by high base flow (i.e. high infiltration rate) the pyritic oxidation is limited by oxygen transport relationships in the water,

IRWIN SYNCLINE BASIN SURFACE DRAINAGE SCHEMATIC

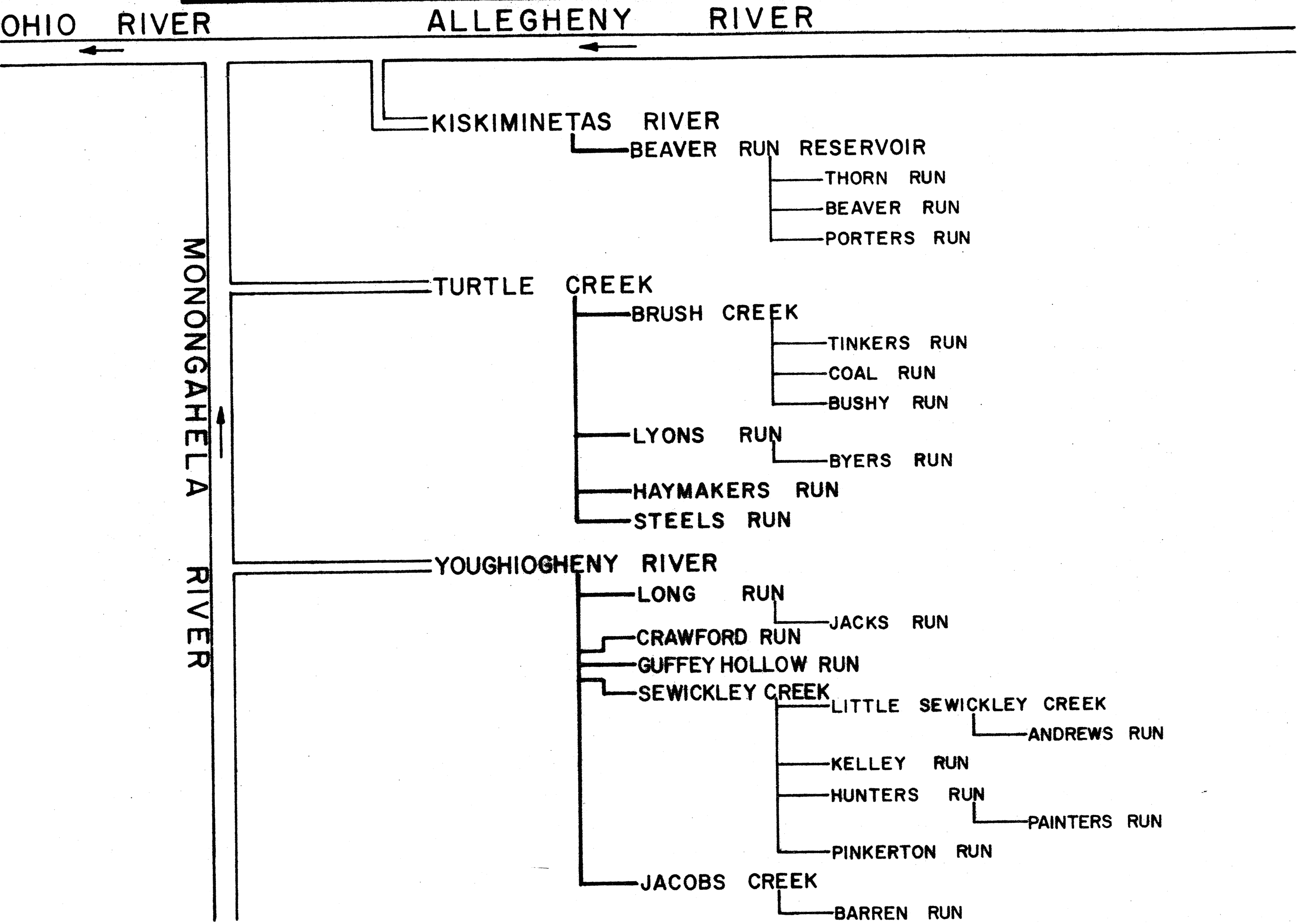


Plate 9

TABLE 2

SUMMARY OF STREAM QUALITY DATA
Collected by the Pennsylvania
Department of Environmental Resources
Bureau of Water Quality Management

Watershed	Stream Sampling Location Number or AMD Discharge (See Plate 10)	Description	Sample Date	Lab pH	Acidity* (ppm)	Total Iron (ppm)	Sulfates (ppm)
TURTLE CREEK WATERSHED	A	Delmont discharge		No Sample			
	101		5-68/10-70	3.3	287	55	655
	B	Export discharge	5-68/10-70	3.1	495	44	827
	102		5-68/10-70	3.2	300	52	710
	103		5-68	3.3	350	48	863
	104		5-68	3.3	300	56	805
	105		8-72 thru 11-75	3.9	134	22	400
	106		8-73	8.1	-80	.1	230
	107		8-73	4.3	136	.3	250
	108		3-72 thru 3-76	6.3	-5	2.8	204
	109		2-67	7.0	-6	18	249
	C	Coal Run discharge		No Sample			
	D	Irwin discharge	3-69	5.3	370	180	983
	110		8-73	3.2	660	2	845
YOUGHIOGHENY RIVER WATERSHED	111		7-68	3.3	-120	60	610
	112	former Hutchison Mine discharge	7-68	2.9	340	80	1170
	113		8-73	6.1	-10	7	915
	114		7-68	3.4	-100	20	800
	G	Marchand discharge	7-68	4.3	380	280	3100
	115		2-67	7.0	-6	18	249
	116		2-67	7.0	-4	18	207
	117		2-67	6.5	-6	3	50
	118		2-67	7.0	-4	9	220
	**119a		3-72/ 4-73	6.3	-2	7	130
	119b		6-73/ 3-76	7.1	-18	2	70
	120		6-67	6.9	-4	5	106
	121		5-67	3.7	20	11	217
	F	Upper Guffey discharge	-	5.7	-76	40	400
	122		-	4.2	35	12	312

* Negative denotes net alkaline condition.
** Hutchison mine shut down June, 1973.

reducing overall acid mine drainage concentration. If flow through the mine has been low for some time, however, the oxygen rich atmosphere of the mine allows rapid oxidation of pyrite, and large quantities of oxidation products may be present on unflooded surfaces. As flow through the mine increases, these oxidation products are put into solution resulting in acidity and the release of metals and sulfates to the water system. This first flush discharge may be highly concentrated.

Superimposed on this pattern of seasonal changes in base flow and acid mine drainage concentration are several concentration and stream impact relationships. First, because first flush discharges may be more concentrated, the assimilative capacity of the stream may be overloaded from these slug loads. Second, the capacity of the receiving stream to assimilate a given drainage volume and concentration varies with stream discharge, and is particularly related to the percentage of base flow represented in the receiving stream, the presence of calcareous rocks, and several other physical factors such as temperature.

The stream assimilative capacity is based on both alkalinity and stream discharge volume. During the spring, mine drainage volume is usually high, but dilution is increased by higher stream discharge which improves assimilative capacity. As spring high flows recede, mine drainage volumes may remain high thus increasing the impact of the discharge. During the late spring and summer months when mine drainage volume is low, normal stream discharge is also low. This may result in extended periods of low water quality indicated by high concentration of sulfate. The assimilative capacity of the stream may be quite variable during these periods because the base flow of the stream during these periods is dominated by groundwater input. In areas where groundwater flows through limestone formations, alkalinity is increased thus improving assimilative capacity. In late summer mine drainage volumes remain low because heavy vegetative cover maintains high transpiration rates further reducing infiltration. As stream discharge increases in late summer and early fall due to greater rainfall, stream conditions improve because the dilution capacity of the receiving stream is increased. During the winter the cycle begins again. High infiltration rates increase mine drainage volumes, but stream discharge volumes during these periods are generally high, and the assimilative capacity is correspondingly good. [19]

Table 3 summarizes the average daily net acid and total iron loads discharged to the primary receiving streams based on discharge rate measurements and chemical sampling analyses conducted from August, 1973 to October, 1975 for the major AMD sources in the Irwin syncline basin.

TABLE 3

SUMMARY OF POLLUTION LOADS

Major Watershed	Total Drainage Area[1] (Sq.Mi.)	Portion of Irwin Syncline Basin Study Area[3] Within Major Watershed (Sq.Mi.)	Major AMD Discharges in the Study Area Within the Major Watershed	Average Flow Rate (MGD)	Average Net Acid Load[4] (Lbs./Day)	Average Iron Load (Lbs./Day)
Youghiogheny River	1763[2]	60.4	Marchand	2.76	2482	4504
			Upper Guffey Sta.	2.07	-363	1001
			Lower Guffey Sta.	1.55	-310	710
Turtle Creek	148	38.4	Export	1.14	4172	257
			Delmont	1.13	1310	283
			White Valley	0.20	-	-
			Irwin	11.16	26040	11718
			Coal Run	0.97	-275	178
Beaver Run Reservoir	55	2.2	(Several small AMD discharges)	0.35*	2450	300

(1) Areas obtained from the United States Geological Survey, Division of Water Resources.
(2) Includes 489 square miles in West Virginia and Maryland.
(3) Total study area approximately 101 square miles.
(4) Negative indicates alkaline condition.

* Total for all AMD discharges within Thorn Run watershed.

1.4 CHRONOLOGICAL ACCOUNT OF BASIN MINING

It has been estimated that approximately 95% of the coal has been recovered from the Pittsburgh coal seam in the basin.[16] Using the room and pillar method mostly, with either shaft or slope entry systems, the area has been mined since the 1850's. The first car of coal shipped east of the Allegheny Mountains was mined in the Westmoreland Coal Company's Shady Grove (later North Side) Colliery in Irwin in 1853. The coal was hauled from the mine to the freight station by horse drawn wagon and loaded into a then "standard" box car of nine ton capacity.[16] It was a high quality, metallurgical-grade coal that helped Pittsburgh meet its growing steel production demands of the late nineteenth and early twentieth centuries.

The sequence of mining the basin is interesting not only from a historical viewpoint but also because of its influence on the basin subsurface hydrology. It was common to construct water diversion structures such as dams and tunnels to reduce the volume of water that had to be pumped from an active mine. Eventually, these structures determined the location and flow rate of a few of the major discharges. It follows that these structures warranted some consideration in determining their influence on this study, particularly with respect to the development of a final basin abatement scheme.

Based on a review of mine maps from various sources, aided by the recollection of individuals familiar with the early mining activities of the basin, the duration of the major mining operations have been chronologically reconstructed in Plate 11. A review of WPA mine maps would show that several smaller operations (Armstrong, Central Yough, Eureka, Ayres Hollow, Penn Gas No. 1, Klondike mines) located along the outer edge of the basin have not been depicted graphically on plate 12 nor included chronologically. A major tract of coal was commonly divided into several smaller operations solely by boundary lines as opposed to the presence of barrier pillars separating differently owned mines. These smaller workings can be justifiably omitted for two reasons: (1) they are not enclosed by barrier pillars and thus hardly influence the subsurface hydrology of the basin and (2) in most cases records of operation were not available and are assumed to coincide with the parent operation.

The North Side and Larimer mines near Irwin opened in 1852 and 1855 respectively, followed by the Paintertown mine (1865), Adams (1871) and the Biddle and Guffey mines (1872). Available data indicates that the Shaner mine near Guffey was presumably worked simultaneously with Guffey. Similarly, the opening of the South Side mine is unknown but is presumed to coincide with the Larimer, Adams, and Biddle operations. The Jimtown mine opened in 1880, followed by Penn Manor No. 5 (1890), Lyon's Run (estimated at late 1890's), Penn (late 1890's), Claridge (1892), Marchand (1903), Yough Slope (estimated concurrent with neighboring Marchand), Banning No. 4 (1900), Riley (1904), Ocean (1905), Edna (1907), Keystone (1908) and Magee (1908). It was not until 1908 (Export mine) and 1913 (Delmont mine) that mining began in the upper reaches of the basin near Export. By this time, the North Side (1900), Paintertown (1906) and Larimer (1907) mines had closed. Along with the opening of the Osborne (1915) and McCullough (1917) mines, the Waverly mine is presumed to have opened. The Jimtown and Penn Manor No. 5 mines closed in 1920.

BASIN MINING CHRONOLOGY BAR GRAPH

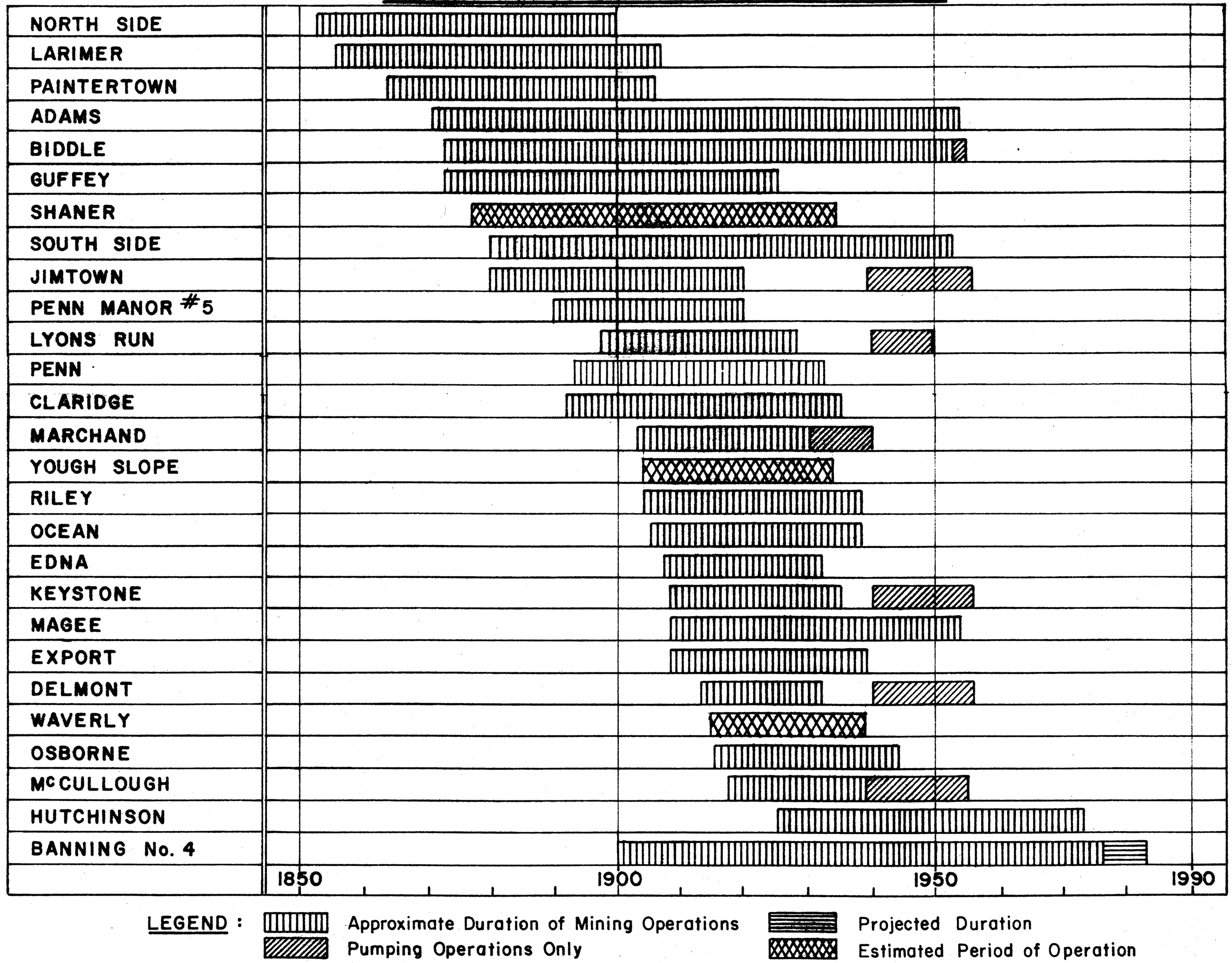
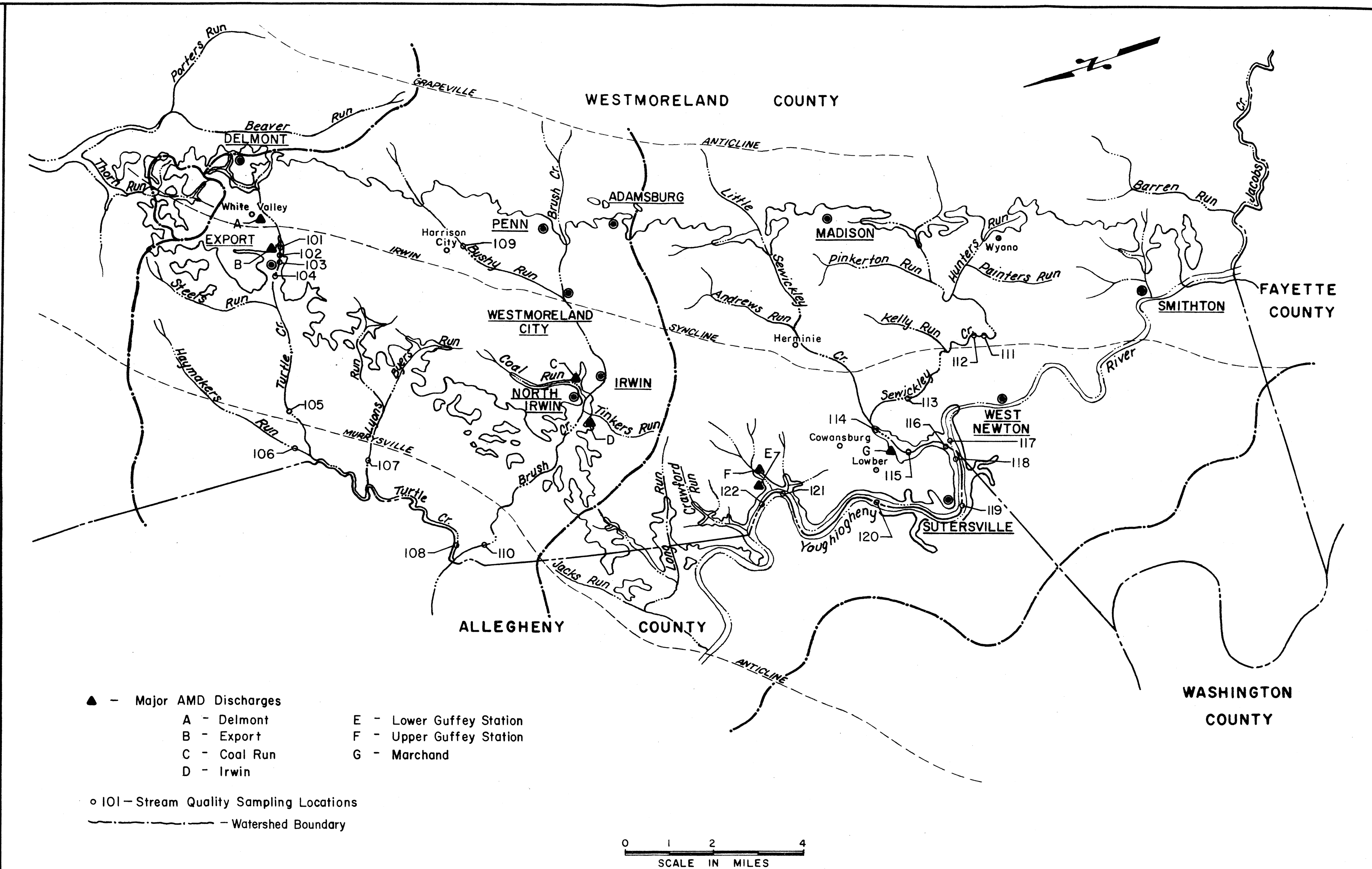


Plate 11



PS CONTRACT NO.	OPERATION SCARLIFT PROJECT No. SL103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN B.M.C. CHECKED R.C.O. SCALE As Shown	IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT STREAM QUALITY SAMPLING LOCATIONS	PLATE 10 DRAWING NO.

Following the opening of Hutchison in 1925, Guffey stopped (1926) as did Lyon's Run (1928), Marchand (1930), Delmont and Edna (1932), Penn (1933), Keystone, Claridge and Shaner (1935), Riley and Ocean (1938), McCullough and Export (1939). The abandonment of mines along the flanks complicated recovery efforts in the deeper, still-active workings. Not only was water generated at the working face and via the overburden, but increasing water pressure due to inundation in the adjacent, higher-lying flooded mines caused substantial water flow over, under and through the common barriers. Thus coal recovery in the deeper mines such as Ocean, Riley and Edna became costly.

A measure of the severity of this problem was the ratio of the tonnage of water pumped from a mine to recover a ton of coal. During normal operation, a ratio of ten might be acceptable. This ratio might triple or quadruple when an operation was completely surrounded by inundated mines. For the Biddle, Hutchison, McCullough and Magee mines owned by the Westmoreland Coal Company, the pumping and coal removal records illustrate how this ratio increased.

Year	Gallons of Water Pumped	Tons of Water Pumped	Tons of Coal	Tons of Water per Ton of Coal
1940	4,079,067,050	16,996,103	1,961,805	8.7
1941	4,496,686,500	18,736,206	2,282,996	8.2
1942	5,092,221,500	21,217,588	2,327,044	9.1
1943	6,119,933,500	25,499,722	2,139,451	11.9
1944	5,008,783,400	20,869,930	2,124,594	9.8
1945	6,367,359,200	26,530,663	1,787,004	14.9
1946	5,580,047,500	23,250,198	1,474,673	15.8
1947	5,478,413,900	22,826,724	1,508,616	15.1
1948	6,977,673,000	27,073,637	1,271,249	21.3
1949	6,232,280,500	25,967,835	1,013,925	25.6
1950	6,835,293,000	28,480,386	1,283,145	22.2
1951	9,007,311,380	37,530,463	1,264,269	29.7
1952	7,540,891,000	31,420,379	1,008,497	31.2
1953	6,169,254,000	25,705,255	1,004,762	25.6
1954	6,061,932,000	25,258,050	505,416	50.0

With many of the mines flooded a pool of water accumulated and rose rapidly as measured in the Ocean, Marchand and Edna mines, (refer to Plate 13). As a result, more water was forced through the Hutchison mine barrier and recovery became extremely difficult. To equalize the water level between the Keystone and Ocean mines a 5 x 5-1/2 foot tunnel was driven through the barrier pillar between them at elevation 640 feet. Pumping was also maintained at the Marchand mine until 1938 (closed to production in 1930) to alleviate the flow of water into Hutchison. To lower the water level of the Ocean-Keystone pool, a rock tunnel was constructed above the coal seam connecting the Ocean No. 1 and Marchand mines. (See Plate 15, Section 2.1.3). The purpose of the tunnel, constructed in 1942, was to keep water in the Ocean-Keystone mines at an elevation just sufficient to cause flow in the tunnel, thereby reducing the possible head on the Hutchison mine which borders Ocean and Keystone for about three miles.[31]

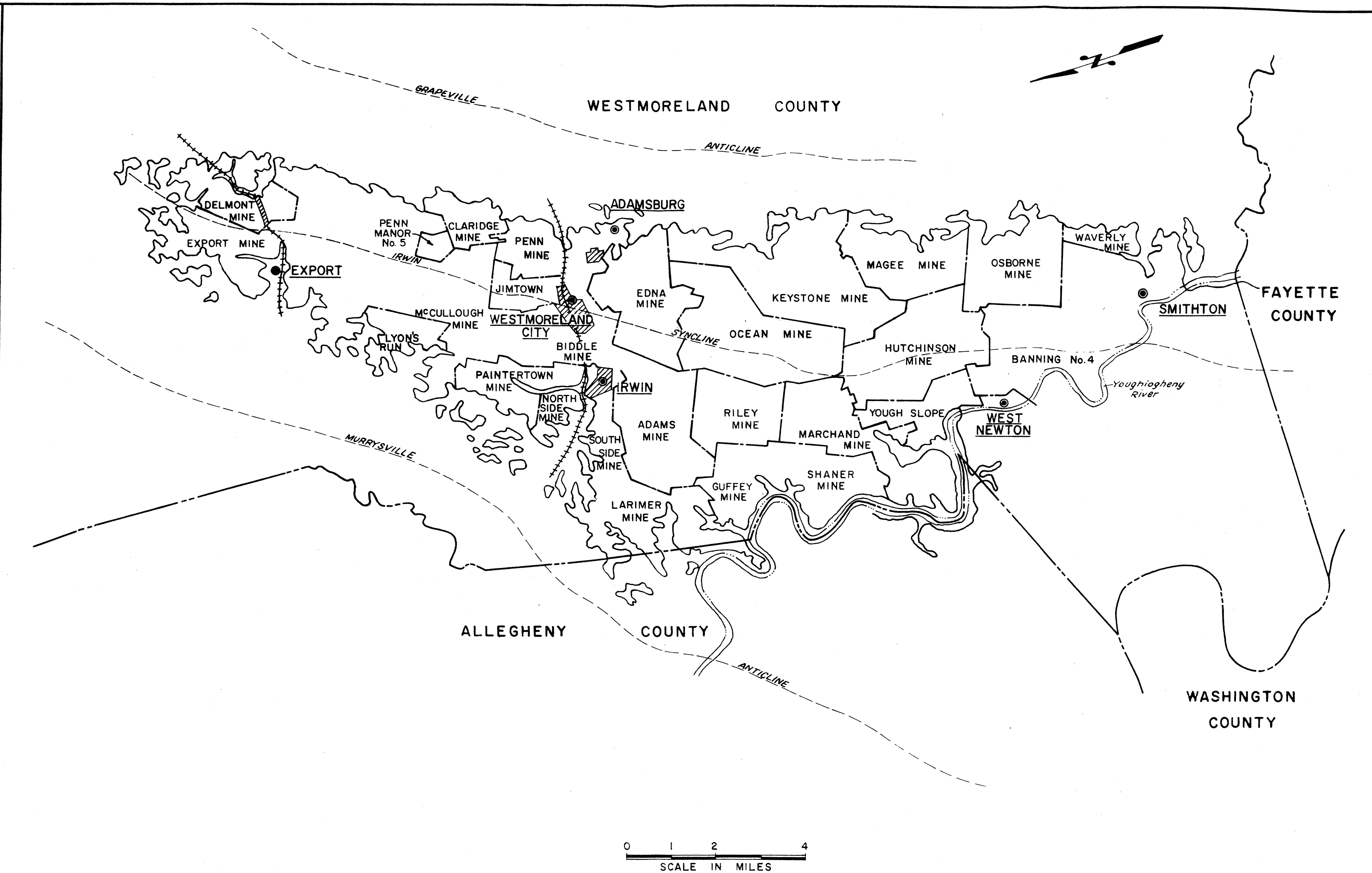
The tunnel, referred to as the Dillon-Gibbon (D/G) tract rock tunnel, is at elevation 785. Vertical boreholes connected each end of the tunnel with the coal seam on the respective sides of the barrier pillar and the water flowed up from the ocean side and down into Marchand. Except when the boreholes clogged, an elevation at or near 800 feet was maintained, depending on the precipitation. This is evidenced by the fluctuation of Ocean, Edna, and Keystone shaft water elevations about the 800 foot elevation and the sharp declines in the D/G tract as it suddenly unclogged.

The present Marchand discharge did not begin until the Dillon-Gibbon rock tunnel was constructed even though pumping from Marchand was stopped in 1938. With the influx of water via the tunnel, the water level in Marchand, as measured at the Second North Airshaft, rose to elevation 764, the main slope surface elevation of the entry (re: Section 2.1.3).

Other than the Hutchison, Magee, Osborne, Banning No. 4 and Waverly mines at the toe of the basin, the remaining active mines during the 40's and early 1950's were the South Side, Adams and Biddle mines near Irwin. Pumping was maintained at the McCullough mine after its abandonment to retard water flow to Biddle. The Adams mine had to contend with seepage from the Edna and Riley mines. Biddle had to pump water being generated from Paintertown and Jimtown. Some of the water generated in the Larimer mine was disposed of via the South Side mine drainageway (eventually becoming the Irwin discharge) with the rest continuing on to the Biddle Mine through a few headings in the unmined coal between Irwin and the Edna mine.

During abandonment in 1953, dams were constructed in the Lower 3rd haulways of the South Side mine to keep water out of the Biddle Mine, forcing it out at the South Side drain since it would have been more costly to pump it from Biddle, about a 200' head. When the Biddle mine was abandoned later in 1953, holes were blasted in the dams to allow the water to flow towards Biddle and thereby allowing the Adams mine to continue mining inasmuch as it was also getting water from South Side and Larimer.

Since the Biddle, Adams and McCullough mines were all owned by the Westmoreland Coal Company, pumping was maintained at Biddle and McCullough to help the situation at Adams as much as possible, and maintained even after closing to allow retrieval. When Adams was abandoned, it and Biddle flooded, the water level becoming coincident with the Edna-Ocean pool. As shown in Plate 13, the pool in the Biddle and Edna mines rose during 1955-1957 to the elevation of the South Side drain at elevation 876, to become known as the Irwin discharge.



OPERATION SCARLIFT PROJECT No. SL 103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN W.J.M. CHECKED R.C.O. SCALE As Shown	IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT DEEP MINE LOCATIONS	PLATE 12 DRAWING NO.

PS CONTRACT NO.

ATLAS LITHO CO., PGH., PA. 1020 CLEARPRINT

1.5 CURRENT AND FUTURE MINING ACTIVITIES

When Operation Scarlift Project SL 103-5 began, only two deep mines were active in the Irwin syncline basin, Hutchison and Banning No. 4. The Hutchison mine, owned by the Consolidation Coal Company, opened in 1925. Being surrounded on three sides by abandoned, inundated mines created quite a water removal problem within Hutchison. During maximum flow conditions four (4) sixteen inch, 4200 GPM pumps, were just barely sufficient to permit operation.

Hutchison continues to operate as a coal processing facility since its abandonment in June of 1973, just prior to the start of SL 103-5. As will be discussed throughout the text this change in the system was monitored closely for its effects. As shown on Plate 13 the water elevation in the mine rose rapidly, averaging about 3 feet per week during the first ten months, eventually stabilizing at elevation 800'±.

The Republic Steel Corporation owns Banning No. 4, adjacent to and south of the Hutchison mine. Although the barrier between them is just over 100 feet thick the inundation within Hutchison initially forced enough water into Banning to cause several small workable areas to be abandoned.

Best estimates are that Banning may operate until 1981 or 1982. In light of the expected increased demand for coal, mining the Upper Freeport coal seam beneath Banning by extending their existing shafts could speculatively be the only link between the Irwin syncline basin and future deep mining efforts. Any mining of the Pittsburgh seam in the study area will probably be of a surface nature.

1.6 RELATED REPORTS

1. Operation Scarlift Project No. SL 103, Youghiogheny River Basin Mine Drainage Pollution Abatement Project by Gibbs and Hill, Inc., September, 1972

    This report defined the extent and degree of mine drainage pollution in the Youghiogheny River Basin. Specific sources were located and catalogued according to sub-basin. Conceptual plans and recommendations for abatement works were provided in addition to order-of-magnitude cost estimates for the recommended works.

    Specific AMD sources from the Irwin Syncline area within the Yough River Basin include the Upper and Lower Guffey Station discharges as well as the Marchand discharge (refer to Sections 2.2.6 through 2.2.8 of this text). At that time the Hutchinson mine was active and water was being pumped from abandoned workings from boreholes on the southwest side of Sewickley Creek across from the mine tipple and was considered a major pollution source. Republic Steel's Banning #4 mine had one untreated discharge which has since been provided treatment.

2. Operation Scarlift Project No. SL 146, Strip Mines in White Valley and Delmont, Westmoreland County, Pa. by M. J. Liebergott and Associates, 1970

At the headwaters of Turtle Creek in Franklin Township and Delmont Borough a strip mined area covering approximately one-half square mile was investigated. The largest AMD source documented was an 18-inch diameter pipe located about one mile east southeast of the Delmont discharge (refer to the White Valley discharge, Section 2.2.3). Recommendations were essentially rehabilitative in nature such as strip mine backfilling, sealing of discharges, recontouring, regrading, etc.

3. Operation Scarlift Project No. SL 146-1, Preliminary Report on the DEL-EX Project, by G. R. Wright, April, 1972

A preliminary report summarizing "quick start" projects for minor source corrections within the project area, located near the Boroughs of Delmont and Export. A rationale on the information and investigation required to abate the study's major discharge, source 1104/1106, or the DEL-EX discharge was included. (Refer to Section 2.2.2, Delmont discharge). Twenty sources of AMD pollution were located. Combined, they were estimated to constitute better than 80 percent of all the water in the headwaters of Turtle Creek above Export. Abatement of source 1104/1106 was limited to a discussion of the various methods available, pending in-depth analysis. Abatement recommendations for the "quick start" projects included mine sealing, grout curtains and strip mine corrections.

4. Report. On Thorn Run Drainage Area To Beaver Run Watershed, Westmoreland County, Pennsylvania, by J. B. Brunot, August, 1965

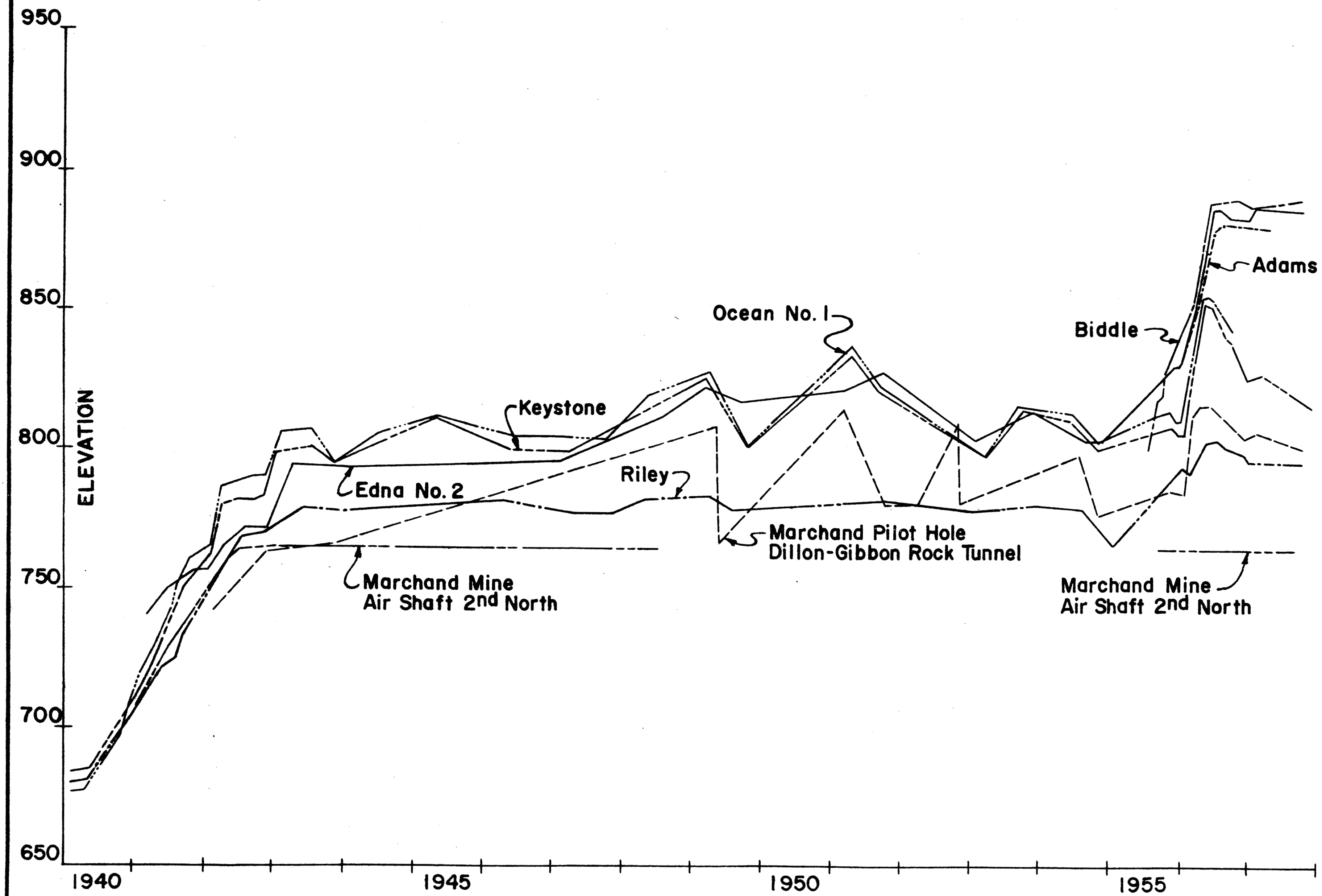
A study of the drainage conditions within the Thorn Run Watershed, which is a sub-basin of the Beaver Run Reservoir, to determine the feasibility of diverting acid mine drainage into abandoned mine workings and outletting in Turtle Creek versus pumping the water to the Turtle Creek Watershed.

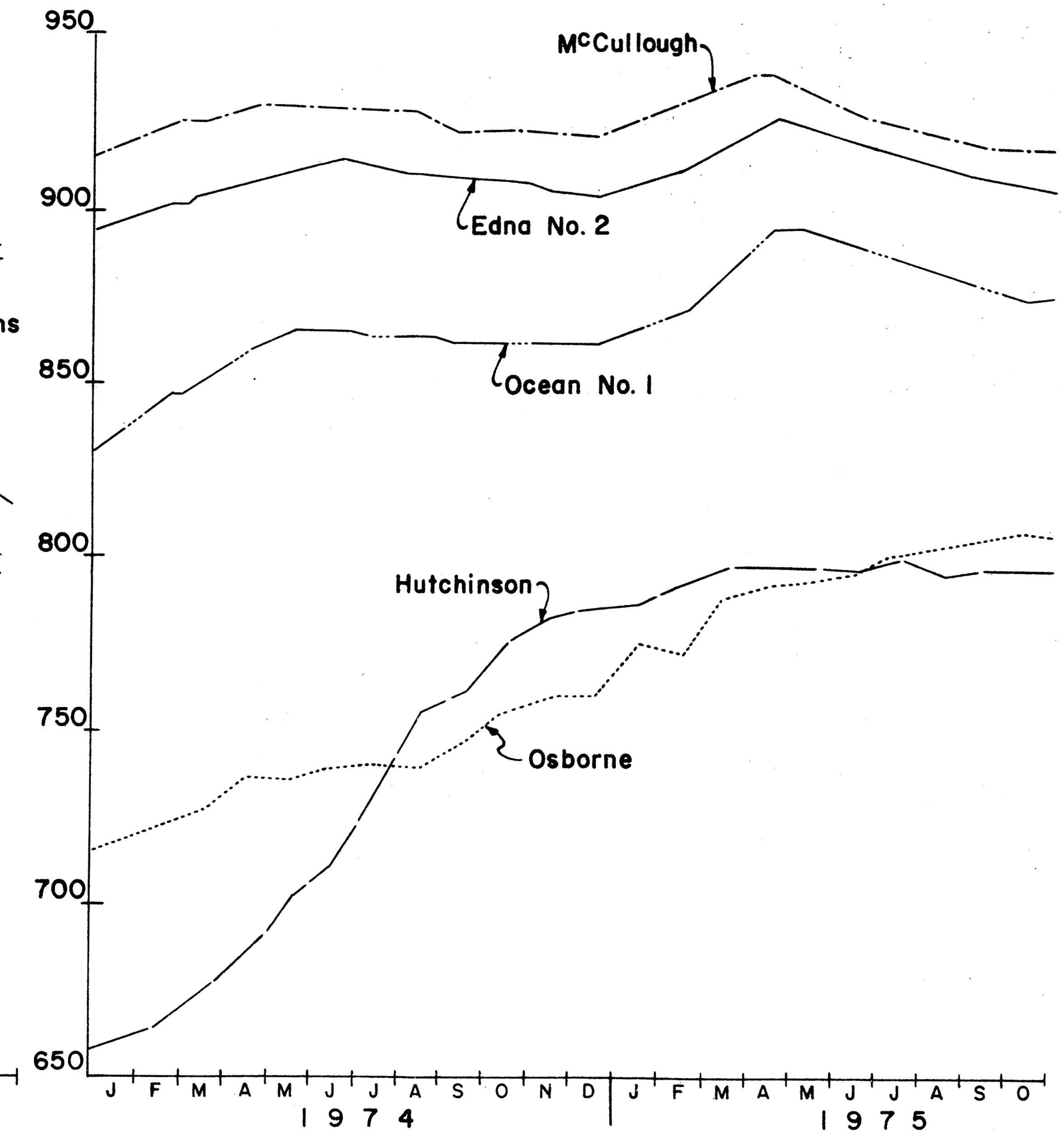
5. Hutchinson Mine - A Problem In Coal Mine Drainage, by E. P. Hall and J. L. Rozance, 1959

Presented as a paper to the American Institute of Mining Engineers, this report discussed the difficulty encountered in mining coal from the Hutchinson Mine due to the water flowing into it from adjacent abandoned, flooded mines in addition to the expected face water and water from abandoned portions of the mine.

6. Hydrogeologic Investigation of Hutchinson Mine, by G. R. Emerich, 1969

An investigation was made of the hydrogeology, mining and mine drainage conditions of the Hutchinson mine and immediately adjacent mines located in Sewickley and South Huntingdon Townships.





PS CONTRACT NO.	OPERATION SCARLIFT PROJECT No. SL 103-5	· COMMONWEALTH OF PENNSYLVANIA · DEPARTMENT OF ENVIRONMENTAL RESOURCES	DRAWN W.J.M. CHECKED R.C.O. SCALE As Shown	IRWIN SYNCLINE BASIN MINE DRAINAGE POLLUTION ABATEMENT PROJECT MINE POOL ELEVATIONS

PLATE 13

DRAWING NO.