## SUMMARY

This report culminates an intensive survey of the Upper Lackawanna River Watershed that has been undertaken to determine the extent of pollution in the River from acid mine drainage, the location of the sources of said pollution, and the recommendations for correction and abatement of acid mine drainage pollution in the Upper Lackawanna River.

The survey area is situated in a deep South to Southwest trending drainage basin at the Northern end of the Lackawanna Valley in portions of Susquehanna, Wayne, and Lackawanna Counties. The extent of the river that is located in the survey area runs approximately eight and two tenths (8.2) miles in length from the Stillwater Dam downstream to Simpson, Pennsylvania.

The area is underlain with consolidated rocks of the Devonian and Pennsylvania age. The Pottsville sandstone and conglomerates are the major underground water supply strata aquafers. The Pottsville formation is capped by the coal bearing rocks of the Post-Pottsville (Llewellyn) formation. The entire area was once covered by glaciers with Glacial materials being mixed with recent colluvium and alluvium.

The average annual precipitation is 47". Surface drainage enters underground mine workings through strip mines, fractured rock strata, mine air shafts and mine portals. Ground water in the area is controlled by the elevation of the Lackawanna River and the mine water pools.

Information was obtained by extensive field work, guidance, assistance and information from the Pennsylvania Department of Mines and Mineral Industries, U.S. Bureau of Mines, other Government Agencies, remaining Coal Companies and former Mining Engineers and Miners.

The sources of pollution were subjected to quantitative and qualitative analysis for a period of 18 months. In all, water was sampled from fifty-five (55) locations.

There are three underground mine water pools and nine mine water outfalls in the Project Area. Mine water from the pools not emerging to the surface at these outfalls ultimately comes to the surface at the Jermyn Outfall near the Archbald fault outside the Project Area. The three pools and most outfalls are related by a series of underground watercourses and fractures in the barrier pillars.

The Lackawanna River during it's flow course through the study area changes in quality due to the adverse effects of acid mine drainage, by an average of approximately 1/3 the alkalinity and four times the sulphate. The pH becomes slightly lower and the iron increases slightly.

The abatement plan consists of eight projects selected to prevent surface water from entering the deep mines, construction of water seals and drilling boreholes to establish a more accurate and controlled underground water flow pattern. Priorities and cost estimates for each project are included.

The design project consists of preparing plans and specifications for the work involved in sealing the bed of Wilson Creek to prevent it's waters from penetrating through the earth's surface, into the underground water pools. Several hundred thousands of gallons of rain water can be diverted from entering the underground water pools thereby avoiding contact with pyrite-the acid producing agent.

The total average contribution of mine drainage to the Lackawanna River throughout the Project is:

| | |
|---|---|
| GALLONS/DAY | 6,155,434 |
| IRON LBS./DAY | 31 |
| SULPHATES LBS./DAY | 9,110 |
| GROSS ACID LBS./DAY | 181 |
| GROSS ALKALINITY LBS./DAY | 361 |
| NET ALKALINITY LBS./DAY | 180 |

These figures representing the total are not objectionable, however most outfalls enter the river at separate locations and are individually objectionable.

**RECOMMENDATIONS**

A. No A.M.D. treatment plant will be required. Early assumptions led us to feel that treatment facilities should be constructed to neutralize acid mine water. Samples of A.M.D. taken at a few locations showed a high acid contribution to the river. Continued investigations along the 8.2 miles of river length began to reveal quantities of acid that are not critical. In many locations, no acid-relatively normal river water pH and alkalinity were observed.

B. Surface water diversion which will minimize rain water, melting snow and ice from entering the underground water pools is primary. Although this is costly, there is no yearly owning and operating expense. This can be done in phases beginning with backfilling and sealing all strip pits with existing spoil bank material. Suitable cover material is not available but can be developed with known landscape, erosion control and stimulated vegetation growth. New land use development can be programmed for industrial and residential construction.

C. Implement all priority projects listed in the abatement plan.

D. Sanitary sewage now being discharged into the river from municipalities along this 8.2 mile distance well soon be discontinued. Interceptor sewers and a sewage treatment plant are presently under constructions. Discharge of human waste has been the dominating factor in the pollution of river water. As further corrections are made to controlling discharge from the existing underground water pools and from the Northwest dump, the quality of the river water should soon reach a point where aquatic life can be sustained. The potential for Recreation en this area is unquestionable.

E. Divert all discharge from underground water pools.

## INTRODUCTION

The Pennsylvania Department of Mines and Mineral Industries on June 27, 1969 authorized Albert E. Peters Associates to prepare an engineering report encompassing the acid mine drainage pollution problem of the Upper Lackawanna River Basin.

## PURPOSE

The purpose of this engineering report was to locate all sources of pollution of the Lackawanna River that were a direct result of deep mining or strip mining and recommend correctional procedures aimed at eliminating these sources or reducing them to a tolerable minimum.

## LOCATION

The study area is located at the Northern end of the Lackawanna Valley in portions of Susquehanna, Wayne and Lackawanna Counties.

The drainage area was used as the limit of the study area so that all water entering or leaving the study area could be identified and catalogued for our physical and chemical examination.

## TOPOGRAPHY

The study area is located in the upper reaches of a deep south/southwest trending drainage basin. The basin is limited by parallel sharp mountain ridges which coverage and finally merge northward at the Lackawanna River Water Gap. Elevations vary from 2300 feet above mean sea level at the mountain tops, to 1150 feet above mean sea level where the Lackawanna River leaves the study area at Simpson, Fell Township.

South from the Water Gap, the valley broadens rapidly. The Lackawanna River is entrenched by mountains, on the east side of the valley normally two to three hundred feet below mountain elevations.

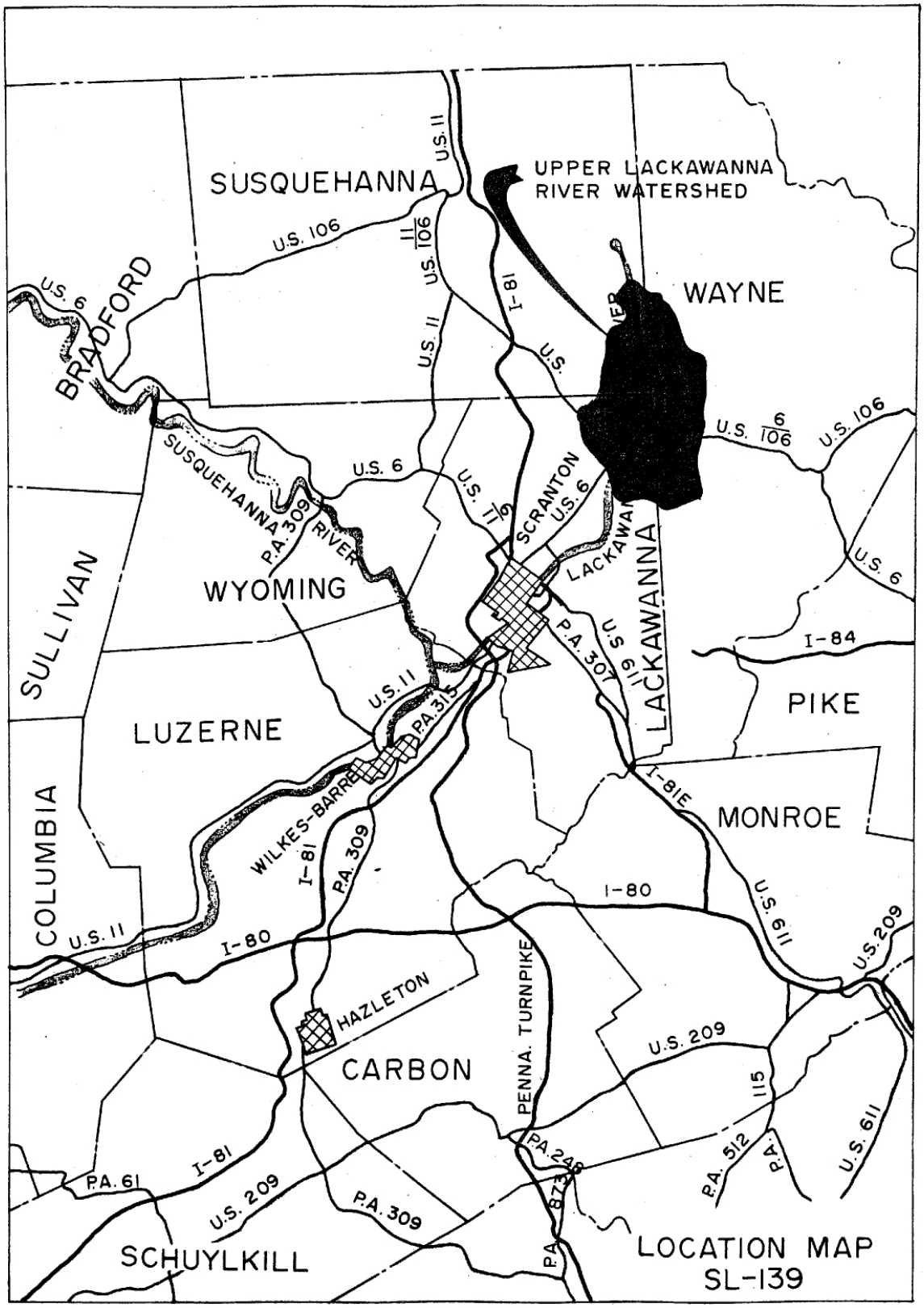
The base elevation of the river is 1551 feet above mean sea level at the river gauge near Stillwater Dam. The river meanders through the project for a distance of approximately eight miles to Simpson in which distance the elevation drops 400 feet. The tributary drainage area of the river contained in the study area is approximately 25.5 sq. miles. The area encompassing the coal measures is approximately 12.15 sq. miles.

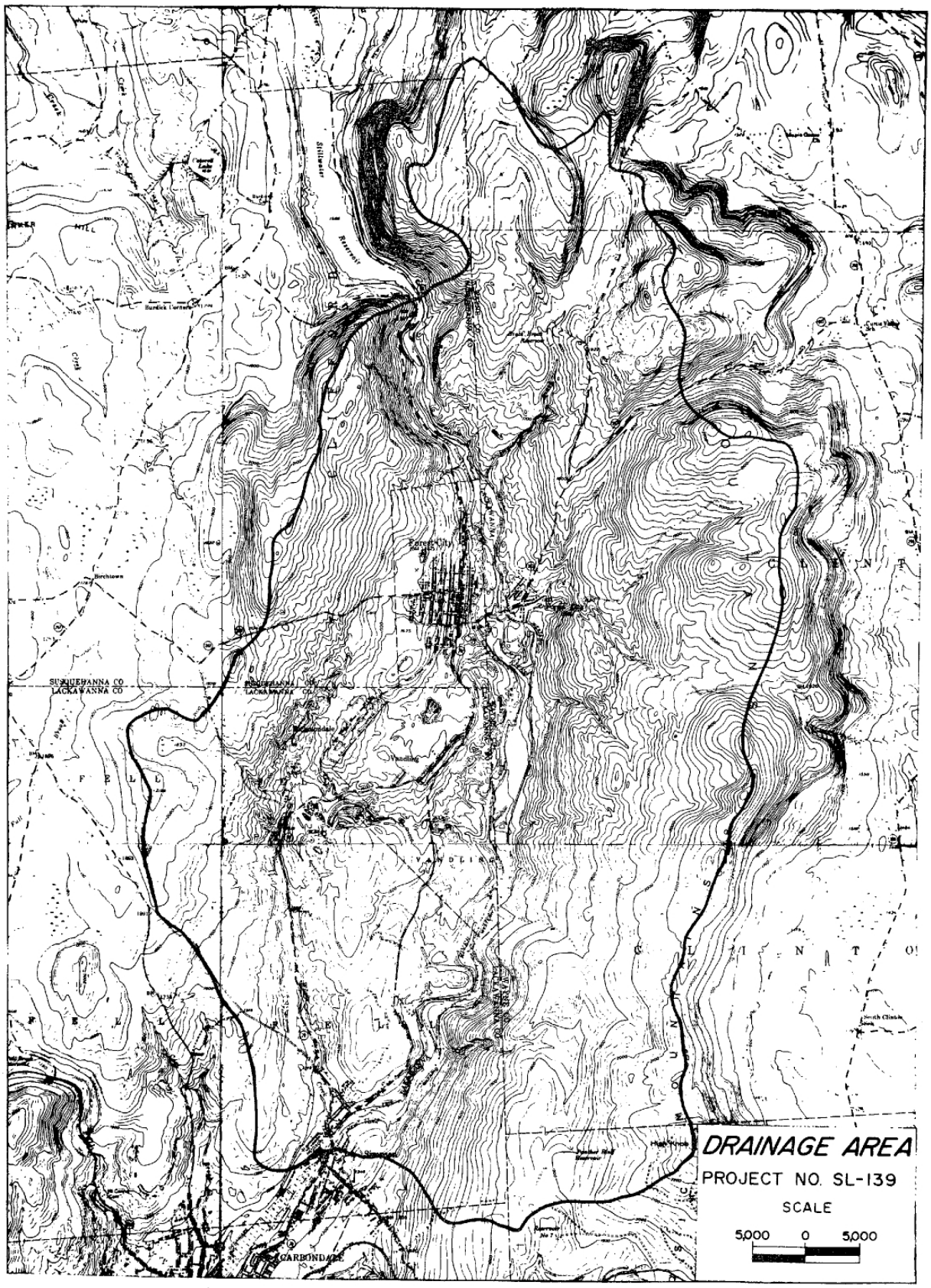
**GEOLOGY**

The Study Area is underlain with consolidated rocks of the Devonian and Pennsylvania Age which are locally masked by glacial deposits of the Pleistocene Age.

Resistant sandstone units of the Catskill formation hold up the mountain crests on the margin of the drainage basin. Green and red Catskill shale units lie between the margin of the basin and the prominent ledges which are located about a third the way down the mountain slope at the base of the Pottsville formation. This formation is composed of conglomerates, sandstone and shale. Pottsville sandstone and conglomerates between 125 and 240 feet thick are the major underground water supply strata-aquifers in the area.

The Pottsville formation is capped by the coal bearing rocks of the Post-Pottsville (Llewellyn) formation. These strata are compressed repetitions of sandstone, slatey shale, local conglomerate lenses, claystone and mineable coals. These rocks occupy the center of the basin with minor basal remnants preserved on the lower flanks of the mountains.


SUSQUEHANNA
UPPER LACKAWANNA RIVER WATERSHED
WAYNE
BRADFORD
WYOMING
SULLIVAN
LUZERNE
COLUMBIA
LACKAWANNA
PIKE
MONROE
CARBON
SCHUYLKILL
HAZLETON
SCRANTON
WILKES-BARRE
SUSQUEHANNA RIVER
PENNA. TURNPIKE
U.S. 11
U.S. 106
U.S. 6
I-81
I-80
I-84
I-81E
U.S. 209
U.S. 611
PA. 309
PA. 315
PA. 307
PA. 61
PA. 248
PA. 512
PA. 115
PA. 435
LOCATION MAP
SL-139


DRAINAGE AREA
PROJECT NO. SL-139
SCALE
5,000 0 5,000
SUSQUEHANNA CO
LACKAWANNA CO
CARBONDALE

Structurally, the Project Area is located at the Northern most end of the Lackawanna Syncline. The coal bearing strata dip down gently into the simple south of southwest plunging syncline. In cross section (east-west) the structure has a broad relatively flat central portion with mildly dipping asymmetric flanks. The strata of the west flank dips down from a maximum of about 20 degrees to a near horizontal synclinal axis. The east flank dips somewhat less sharply, seldom exceeding 10 to 12 degrees. The syncline is gently tilted. Equivalent coals are found about 400 feet lower in elevation at the southern project limit than they are at the northern boundary. One longitudinal and three transverse sections illustrating the elevation of the various coal veins were constructed from the elevations found on the mine maps and are included as APPENDIX "C". The lines on which the sections were constructed can be found on EXHIBIT "A", the large scale fold out at the back of the report.

The entire area was once covered by glacial action and numerous glacial features are present. Remnants of glacial materials, sand and gravel are found on the lower slopes of the Lackawanna River flood plain. Normally, these deposits are thin and mixed with recent colluvium and alluvium. However, sand and gravel was reported in the Clinton Colleries while mining the Dunmore No. 3 coal vein more than 60 feet below the surface, and an isolated drill record of the Hudson Coal Company (BH#376) penetrated 141 feet of glacial debris in Forest City on Pennsylvania Route 247.

**HYDROLOGY SURFACE**

Records of the U.S. Soil Conservation Service indicate an average of 47" of precipitation per year in the Project Area. Surface run off is very rapid due to the steep slopes of the Mountains, especially from the eastern-Moosic Mountain-side of the Lackawanna River. Except during periods of intense rainfall, most surface drainage from the mountains to the west of the Lackawanna River enters the abandoned underground mine workings through strip mines, fractures in strata overlying mined areas, mine air shafts and mine entrances. Portions of the study area have been

extensively strip mined and not properly backfilled. Subsequently surface runoff diverted into abandoned stripping pits is exposed to acid forming materials and acid mine drainage (AMD) takes place. The underground mine water then seeps into deeper mine workings then overflows into the Lackawanna River. Rainfall and surface runoff also percolate through mine refuse, breaker waste, and silt dumps to form AMD.

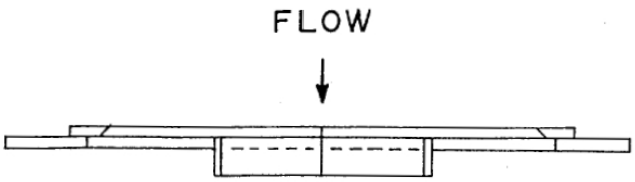
Interpretation of runoff data in the drainage area as reported from gauging stations below the Stillwater Dam and Archbald reveals that a flow of 1.3 to 1.6 cubic feet per second per square mile can be used to determine basin characteristics.

**HYDROLOGY GROUND**

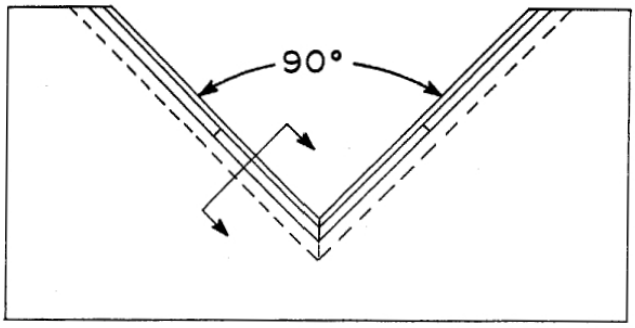
Ground water level in areas effected by mining is controlled by the local elevation of the Lackawanna River and by the elevations of the No. 1, 2 and 3 mine water pools. Water percolating downward through soil layers and rock strata reaches the mine working through faults and fractures in the mine roof induced by mine subsidence. A majority of the ground water supply in this region is intercepted in this manner before it reaches a natural outlet or aquifer. Ground water traveling through the fracture zones has a direct relationship with the flow of water into and out of existing abandoned workings. Water traveling laterally through the major fractures gains access into mine workings where the workings are above (mine pool) levels. Conversely, acid mine drainage from mine pools may be contributed to surface drainage where pool elevations are above stream level. As the water flows through the zones of fracture it is exposed to the acid forming iron sulfide minerals, associated with shales and coal, and the material is oxidized to form acid mine water.

**METHODS OF ENGINEERING INVESTIGATION**

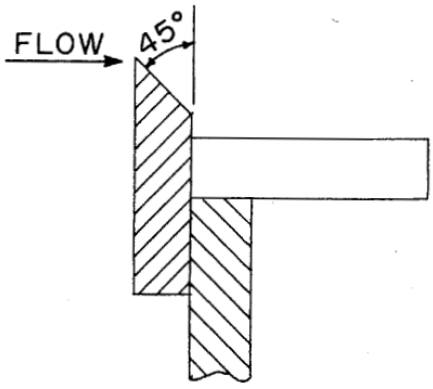
The first step to achieve the objectives of the study was to locate




PLAN




ELEVATION




SECTION

# TYPICAL 90° V-NOTCH WEIR

end identify ell possible sources of pollution. This was accomplished by extensive preliminary field work. To obtain precise location in the field, a base line survey was established end staked longitudinally through the entire project. With this for ground control, it was quite easy to correlate between available drawings and actual field locations.

At the same time our personnel contacted Pennsylvania Department of Mines, U.S. Bureau of Mines, Pennsylvania Department of Health, United States Geological Survey, F. W. P. C. A. Coal Companies, end numerous others to obtain ell available information. When this information was accumulated, it consisted of Mine Maps, Aerial Photographs, contour Maps, both published end un-published reports end a wealth of first hand information from personal interviews.

All of the data obtained was then evaluated. The sampling locations illustrated on EXHIBIT "A" reflect the technique used. This method consists of sampling the receiving stream, in this case the Lackawanna River, above the point where the pollution enters. Another sample is taken et the mine drainage discharge point before it is diluted with river water. A third sample is taken in the stream at a point far enough downstream so that the total effect of the outfall on the river can be determined.

These sources of Pollution were then subjected, for a period of six (6) months, to chemical examination in the field by the use of a test kit made by the Hach Chemical Company. This kit was recommended by the United States Geological Survey Hydrologists. During a Conference with Department of Mines Personnel on April 16, 1970, the Department recommended that an independent testing laboratory be employed to chemically test all water samples. To date, 310 samples have been analyzed.

The test results ere incorporated in APPENDIX "A" end "B" end indicate the net alkalinity/acidity. APPENDIX "A" is the laboratory

determinations from May 1970 to April 1971. APPENDIX "B" is the field determinations made by this office from November 1969 to April 1970. The total period of testing was from November 1969 up to and including April 1971, or eighteen (18) months.

Weirs were installed at fifteen locations, nine outfalls and six streams. No weirs were installed on the Lackawanna River due to the quantity of water, instead sections were surveyed across the river and open channel flows calculated. These figures were then checked by the use of a Gurley current meter.

Having obtained this data in the field and with the information already accumulated, we are able to draw the following conclusions:

## SURVEY RESULTS

There are three underground mine water pools in the project. The number one pool is at an elevation of approximately 1386 feet above mean sea level and covers an area of approximately 146 acres. The number two and three pools have an elevation of approximately 1350 and 1207 feet above mean sea level and an area of approximately 25 and 27 acres, respectively.

The number one pool, being the largest and having the highest elevation, is the controlling influence of the entire subsurface water condition, it's waters drain directly to the surface at the Vandling outfall (Number 32). However, its main outlet is underground via water courses, fractures and broken barrier pillars to the other pools, their outfalls, and the upper Wilson Outfall (Number 5) and the lower Wilson Outfall (Number 6) which are primarily dependant on the Number One pool for their water source. The underground outlets are of a restricted nature that release a relatively constant volume of water that is apparent at the upper and lower Wilson Outfalls, Numbers 5 and 6. Conversely, the Vandling Outfall (Number 32), controls the maximum elevation of the pool and draws off the surge of water from rains entering the pool and is subject to great fluctuation, eg., over 3,000,000 gallons per day in May, 1970 to dry in September 1970.

The number two pool discharges to the surface by the Beaver Outfall (Number 20), and Grey Slope (Number 28). The Beaver Outfall is restricted; located at an elevation of approximately 1340 feet above mean sea level while the number two pool is at an elevation of approximately 1350 feet. Therefore, it's flow is quite constant. The Grey Slope Outfall is at an elevation of approximately 1350 feet and controls the maximum elevation of the pool. The Grey Slope Outfall being located at the maximum elevations of the pool is subject to fluctuation and varies from dry in July, 1970 to 1.13 million gallons per day in November, 1970.

A portion of the water of the number two pool flows underground through a broken barrier pillar, across the Northwest Colliery to the upper and lower Wilson Outfalls, Numbers 5 and 6, respectively. The volume of this flow cannot be measured because it is combined with the waters of the Number one pool before it emerges to the surface at the outfalls.

The Number three pool is located at an approximate elevation of 1207 feet above mean sea level. The main discharge is the lower Simpson Outfall (Number 4) which is the outfall with the largest volume of the project. Mine water in this area that does not come to the surface at this point crosses a small anticline and into the next pool. We believe eventually, it will flow to the Jermyn Outfall, the next major water discharge point, located several miles south of the lower project limit line at Simpson, PA.

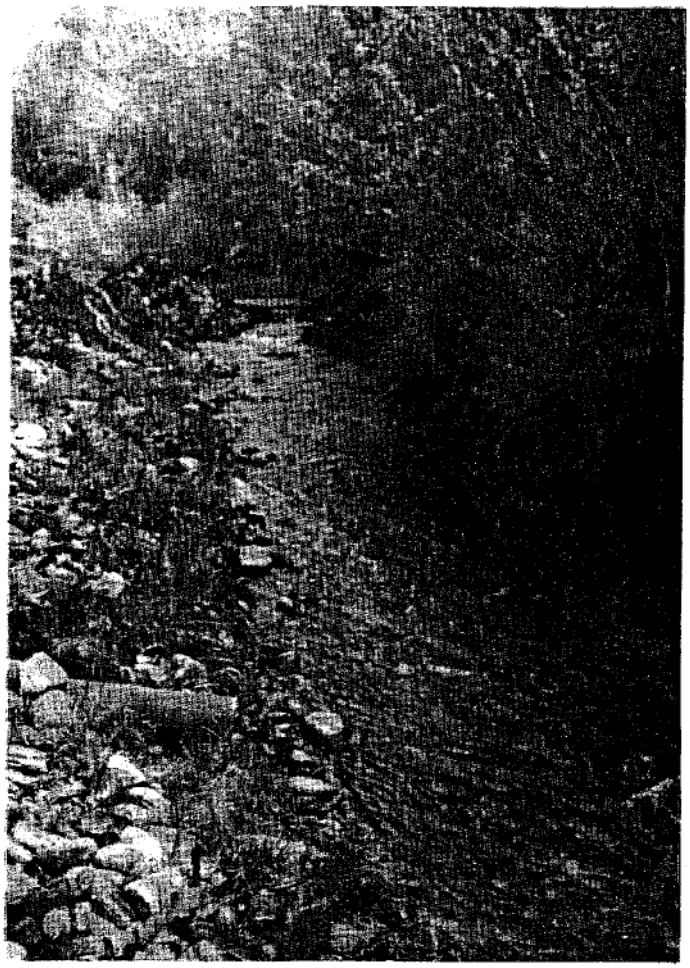
The total acidity alkalinity for each testing period is illustrated on Table "A" on the following page.

# TABLE "A"

| OUTFALL NUMBER AND NAME | 5-4-70 LBS./DAY | | 5-20-70 LBS./DAY | | 6-15-70 LBS./DAY | | 6-13-70 LBS./DAY | | 8-5-70 LBS./DAY | | 8-28-70 LBS./DAY | | 9-21-70 LBS./DAY | | 11-16-70 LBS./DAY | | 12-28-70 LBS./DAY | | 2-20-71 LBS./DAY | | 4-1-71 LBS./DAY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. | ALK. | ACID. |
| No. 4 Lower Simpson | | | 63 | 0 | 0 | 0 | 248 | 0 | 235 | 0 | 201 | 0 | 64 | 0 | 360 | 0 | | | 248 | 0 | 206 | 0 |
| No. 5 Upper Wilson | 119 | 0 | 0 | 0 | 31 | 0 | 25 | 0 | 21 | 0 | 15 | 0 | 9 | 0 | 7 | 0 | 1 | 0 | 51 | 0 | 32 | 0 |
| No. 6 Lower Wilson | 189 | 0 | 166 | 0 | 437 | 0 | 119 | 0 | 146 | 0 | 47 | 0 | 133 | 0 | 0 | 0 | 0 | 0 | 287 | 0 | 150 | 0 |
| No. 13 N. W. Borehole | 4 | 0 | | | 5 | 0 | 4 | 0 | 4 | 0 | 6 | 0 | 4 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | 0 |
| No. 15 N. W. Dump | 0 | 26 | 0 | 65 | 0 | 42 | 0 | 89 | 0 | 21 | 0 | 32 | 0 | 32 | 0 | 5 | 0 | 40 | 0 | 106 | 0 | 49 |
| No. 20 Beaver | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 23 | 0 | 0 | 0 | 37 | 0 | 13 | 0 | 7 |
| No. 28 Grey Slope | 0 | 47 | 0 | 77 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 94 | 0 | 14 | 0 | 262 | 0 | 74 |
| No. 32 Vandling | 0 | 70 | 0 | 229 | 0 | 117 | 0 | 4 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 94 | 0 | 51 | 0 | 320 | 0 | 135 |
| No. 39 Browndale | | | | | 0 | 5 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 2 | 0 | 115 | 0 | 16 | | | 0 | 27 |
| GROSS TOTAL | 312 | 169 | 229 | 371 | 473 | 168 | 396 | 94 | 406 | 33 | 269 | 39 | 210 | 57 | 372 | 308 | 6 | 158 | 591 | 701 | 393 | 292 |
| NET ALKALINITY | 143 | | | | 305 | | 302 | | 373 | | 230 | | 153 | | 64 | | | | | | 101 | |
| NET ACIDITY | | | | 142 | | | | | | | | | | | | | | 152 | | 110 | | |

THE LOWER SIMPSON OUTFALL (NUMBER 4) is the Number 20, Molenski, slope of the Hudson Coal Company's Coalbrook Colliery to the Number Two Dunmore Bed. Although the number two Dunmore vein was not mined in this area, the Number 20 slope was constructed strictly for drainage of the Number one Dunmore (ring) bed and the Clarks. It is connected to the veins above by a series of slopes between the veins. The flow at the slope averages 1,564 gallons per minute which is 2.25 million gallons per day. The quality of water is:

| | |
|---|---|
| pH | 5.6 - 6.0 |
| ACIDITY | 0 MG/L |
| ALKALINITY | 0 - 18 MG/L |
| SULPHATES | 84 - 360 MG/L |
| IRON | .1 - .8 MG/L |
| AVG. ANNUAL TEMP. | 50º F. |

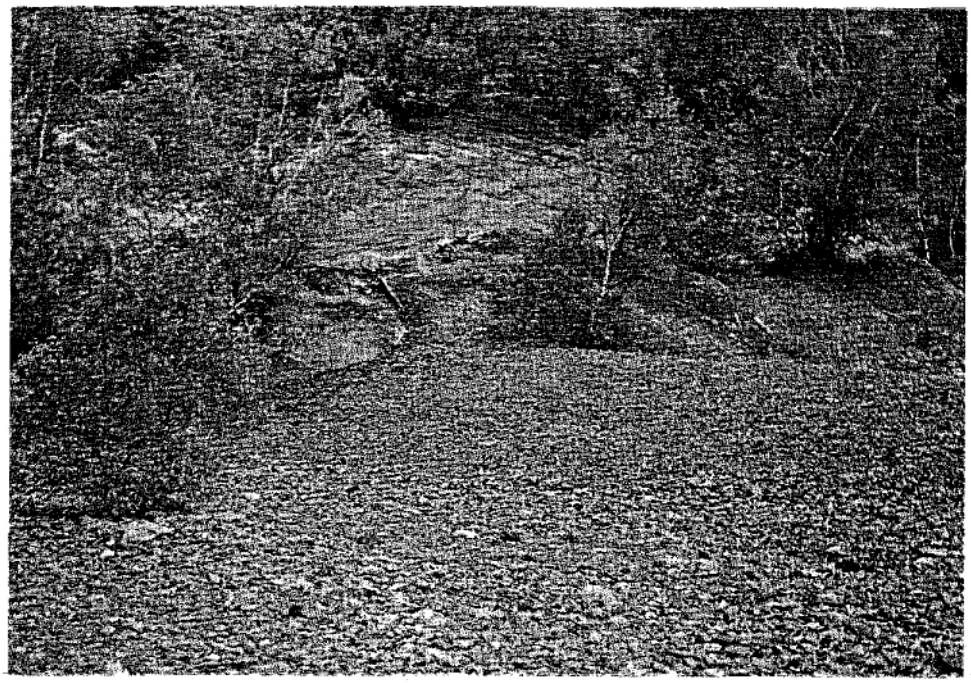


THE UPPER WILSON OUTFALL (NUMBER 5) is a restricted outfall created by a roof drop near the outcrop of the Clark Vein. The source of this water is primarily the number one pool. The water emerges from a crevice in the bed of Wilson Creek. The flow averages 336 gallons per minute or 484,000 gallons per day. The test results are:

| | |
|---|---|
| pH | 5.6 - 6.2 |
| ACIDITY | 0 MG/L |
| ALKALINITY | 0 - 22 MG/L |
| SULPHATES | 116 - 360 MG/L |
| IRON | .1 - .9 MG/L |
| AVG. ANNUAL TEMP. | 50º F. |

THE LOWER WILSON CREEK OUTFALL (NUMBER 6) is a drift to the bottom Clark Vein from the Amzi Wilson tract of the Morse Hill Coal Company. The source of this outfall is the number one pool. The flow is relatively constant averaging 634 GPM or 914,000 gallons per day. The water quality at this point is:

| | |
|---|---|
| pH | 5.8 - 6.4 |
| ACIDITY | 0 MG/L |
| ALKALINITY | 0 - 60 MG/L |
| ULPHATES | 116 - 360 MG/L |
| IRON | .1 - .9 MG/L |
| AVG. ANNUAL TEMP. | 50º F. |



THE NORTHWEST DUMP OUTFALL (NUMBER 15) contributes water having the highest degree of AMD pollution in the entire project. The dump is composed of mine and breaker refuse with a silt pond. Surface water is funneled onto the dump where it percolates through the silt and rock to the Lackawanna River which is adjacent to the base of the dump. Because the dump extends into and along the river for a distance of approximately 1000 feet, it was impossible to weir all of the seepage. The volumes indicated are from one weir which we believe measured a majority of the flow. However, without removing a great deal of the bank, a total flow could not be measured.

Sections were surveyed across the Lackawanna River above and below the dump and flows were measured with a current meter. The flow meter determinations showed an increase of 4,280 gallons per minute across the dump. The increase could not be completely related to the Northwest Dump because the water quality of the Lackawanna River does not deteriorate proportionally. The increase is probably due to natural springs in the river bed and beneath the dump. The water quality from this dump is:

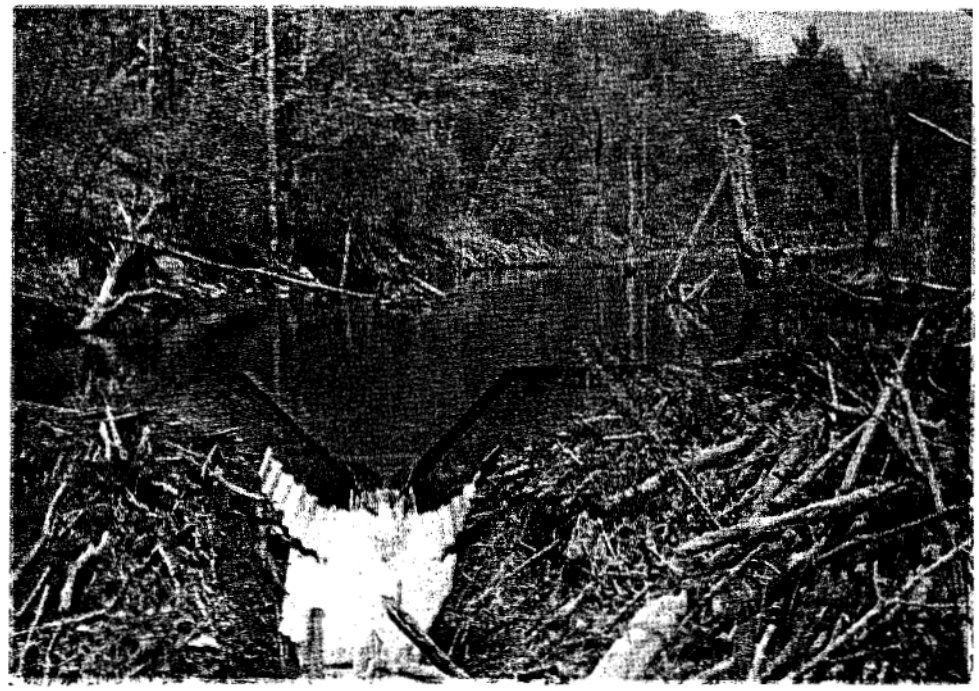
| | |
|---|---|
| pH | 2.8 - 3.4 |
| ACIDITY | 20 - 340 MG/L |
| ALKALINITY | .0 MG/L |
| SULPHATES | 240 - 1050 MG/L |
| IRON | .1 - 11.0 MG/L |
| AVG. ANNUAL TEMP. | 47ºF. |

THE EFFLUENTS OF OUTFALLS NUMBER 4, 5 AND 6 drain into Wilson Creek averaging 2,500 gallons per minute or 3.65 million gallons per day. The water quality is:

| | |
|---|---|
| pH | 6.0 - 6.7 |
| ACIDITY | 0 MG/L |
| ALKALINITY | 6 - 18 MG/L |
| SULPHATES | 135 - 360 MG/L |
| IRON | .1 - .4 MG/L |
| AVG. ANNUAL TEMP. | 50º F. |

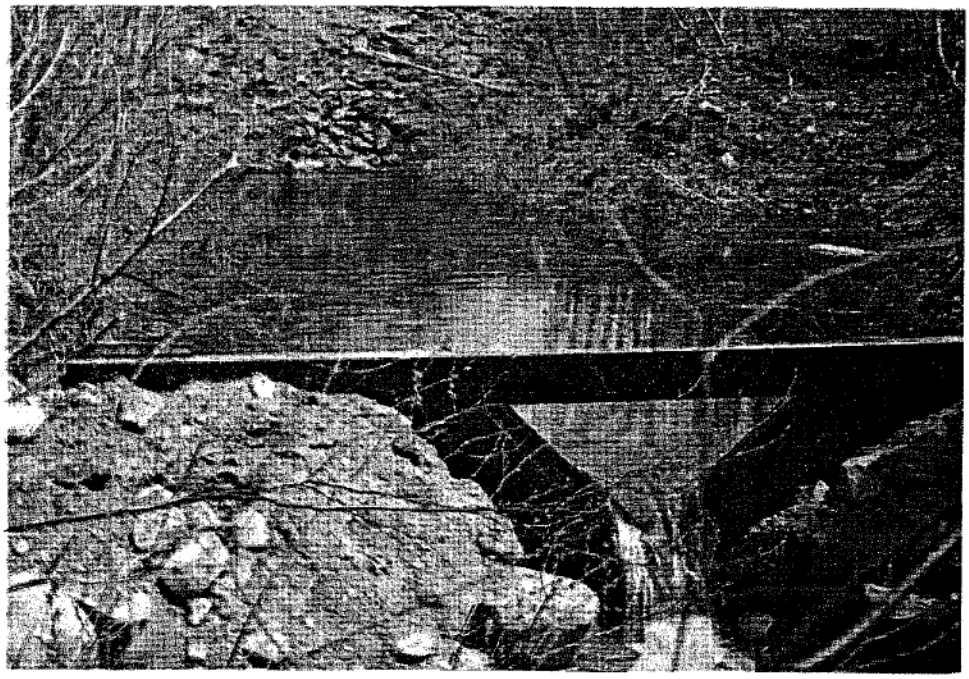
THE NORTHWEST BOREHOLE (NUMBER 13) is a 10" single cased well drilled through the coal bearing strata to the Pottsville Conglomerate. It was drilled as a water source for the breaker of the Northwest Colliery and now flows as an artesian well. The flow is very slight and the quality is:

| | |
|---|---|
| pH | 6.4 - 7.3 |
| ACIDITY | 0 MG/L |
| ALKALINITY | 50 - 78 MG/L |
| SULPHATES | 24 - 38 MG/L |
| IRON | .1 - 1.05 MG/L |
| AVG. ANNUAL TEMP. | 49º F. |



THE BEAVER OUTFALL (NUMBER 20) is a restricted flow located at the southern end of the number two Pool. The outfall emanates from a fracture created by a roof fall in a large room near the outcrop of the Number Three Dunmore vein. It's flow is relatively constant averaging approximately 300 gallons per minute or 433,000 gallons per day. The water quality is:

| | |
|---|---|
| pH | 4.6 - 5.7 |
| ACIDITY | 0 - 16 MG/L |
| ALKALINITY | 0 MG/L |
| SULPHATE | 64 - 130 MG/L |
| IRON | .1 - .5 MG/L |
| AVG. ANNUAL TEMP. | 51ºF. |



THE OTHER OUTFALL ON THE NUMBER TWO (2) POOL IS GREY SLOPE (NUMBER 28) This slope was the main haulage way from the Grey tract of Pennsylvania Coal Company's Forest City Colliery. The actual slope opening was covered with mine rock in the early 1960's. Water filtering through this rock may at least partially account for the water quality being acid. The flow from this slope fluctuates considerably, with the average flow being 420 gallons per minute or 608,000 gallons per day. The water quality is

| | |
|---|---|
| pH | 4.4 - 5.2 |
| ACIDITY | 2 - 20 MG/L |
| ALKALINITY | 0 MG/L |
| SULPHATES | 32 - 145 MG/L |
| IRON | .1 - .35 MG/L |
| AVG. ANNUAL TEMP. | 49º F. |

The only direct outlet of the number one pool is the VANDLING OUTFALL (NUMBER 32). It is the number six tunnel of the Hudson Coal Company's Clinton Colliery to the number three Dunmore vein. The elevation is approximately 1386 or the maximum elevation of the number one pool. The entrance of the slope is directly under the Delaware and Hudson Railroad's main track to Albany. The flow averages slightly more than one million gallons per day with the water quality being:

| | |
|---|---|
| pH | 4.2 - 5.0 |
| ACIDITY | 4 - 20 MG/L |
| ALKALINITY | 0 MG/L |
| SULPHATES | 44 - 140 MG/L |
| IRON | .1 - 1.2 MG/L |
| AVG. ANNUAL TEMP. | 48º F. |

THE BROWNDALE OUTFALL (NUMBER 39) is the number 13 drift to the number three Dunmore vein. It drains a small isolated area of the Hudson Coal Company's Clinton Colliery. The mine maps indicate that there is no relationship between this outfall and the pools. The elevation of the mine slopes up away from the drift so that there is no pooling and detention time if the water in the mine is minimal. Because there is no pool to sustain this outfall, the flow fluctuates with precipitation averaging approximately 300 gallons per minute or 425,000 gallons per day. The water quality is:

| | |
|---|---|
| pH | 4.3 - 4.8 |
| ACIDITY | 2 - 18 MG/L |
| ALKALINITY | 0 MG/L |
| SULPHATES | 32 - 105 MG/L |
| IRON | .1 - 1.4 MG/L |
| AVG. ANNUAL TEMP. | 50º F. |

THE STANDPIPE OUTFALL (NUMBER 24) is a single cased well adjacent to the Delaware and Hudson Railroad tracks. It is assumed that it supplied a water tower for steam locomotives. The only time a flow was detected was December 12, 1969; although it was checked every sampling period and at numerous other times. The water quality as determined in the field was:

| | |
|---|---|
| pH | 5.1 |
| ACIDITY | 51 MG/L |
| ALKALINITY | 0 MG/L |
| SULPHATES | 90 MG/L |
| IRON | 2.0 MG/L |

**RELATIONSHIP OF POOLS**

The number one pool emerges directly to the surface at the Vandling Outfall (Number 32). It's waters also flow underground to the east to contribute to the number two pool and come to the surface at the Beaver Outfall (Number 20) and the Grey Slope Outfall (Number 28).

The water flowing underground from this pool to the south sustains the upper and lower Wilson Outfall (Number 5 and 6), respectively. The remainder contributes to the number three pool and emerges as the lower Simpson outfall (Number 4) or flows across this pool, out of the project, possibly to come to the surface at the Jermyn outfall located at the Archbald fault.

The only outfalls segregated from the number one pool are the northwest borehole (Number 13), the northwest dump (Number 15) and the Browndale (Number 39).

## LACKAWANNA RIVER WATER QUALITY

The Lackawanna River during its 8.2 mile course through the project limits changes in quality doe to the adverse effects of mine drainage by an average of approximately 1/3 the Alkalinity and four time the Sulfate. The pH becomes slightly lower and the Iron increases slightly.

The average water quality at sample location number one, at the south end of the project and at sample location Number 55 the north end before the river is subjected to mine drainage is:

| SAMPLE LOCATION | NUMBER FIFTY FIVE | NUMBER ONE |
|---|---|---|
| pH | 6.1 - 6.9 | 5.6 - 6.8 |
| ACIDITY | 0 MG/L | 0 - 16 MG/L |
| ALKALINITY | 20 - 24 MG/L | 0 - 18 MG/L |
| SULPHATES | 12 - 36 MG/L | 16 - 152 MG/L |
| IRON | .1 - .4 MG/L | .1 - .58 MG/L |

## ABATEMENT PLAN

The most effective method of eliminating drainage from deep mines is to control and reduce surface water entering the abandoned mines. The following five projects are intended to reduce the flow of surface water into the underground water pools.

### Project Number One-4200' West of Sta. 45 to 8,800' West of Sta. 140

Wilson Creek runs over the mined area for a distance of approximately 7,000 feet; in that distance a large percentage of it's waters percolate through the stream bed and into the mines. Doe to the contour of the valley and Pa. Route 171 the stream cannot be relocated. It most be lined

over the fractured area. The department selected this to be the design project for this report which is included as Quick Start Project No. 1. The effect of this project will be apparent by a reduced flow at the Lower Simpson Outfall No. 4 and more clean water will be added to the Lackawanna River.

**Project Number Two-400' West of Sta. 230 +**

This stream runs nearly parallel to the adjacent stripping. During the period of mining a dirt bank was constructed to prevent the water from entering the stripping. The bank has eroded and a portion of the stream now enters the stripping and perculates into the deep mines and on to the number one pool. If the bank was rebuilt, a minor project, it would eliminate most of the water that now enters the stripping. The other alternative is to backfill the stripping which, in this case, would only be slightly more effective but much more costly. This project will reduce the volume of water being introduced into the No. 1 Pool and subsequently reduce the Volume of the discharge.

This project was submitted as Quick Start Project Number One, currently being considered by the Department.

**Project Number Three-80' West of Sta. 185+**

This stripping is located on the edge of the Number Two Pool. It's water elevation is the same as the elevation of the pool with the maximum being 1350'. The Lackawanna River is at an elevation of 1360 where it passes the stripping. Either a retaining wall would have to be constructed or the stripping properly backfilled to retard the flow. This would reduce the flow at Grey Slope (Number 28) and Beaver Outfall (Number 20). This project is currently being considered by the Department.

**Project Number Four-2000' West of Sta. 170 +**

This stripping is now being used as a discharge point for the Vandling Sewerage System. A sewage Treatment Plant and interceptor mains

are now being constructed. When the treatment plant is complete and when operating, this stripping will no longer be utilized as the discharge point and should be properly backfilled, graded and drainage ditches constructed. This project will reduce the amount of water flowing into the pools and reduce the discharge. This project is currently being considered by the Department.

**Project Number Five-4,800' West of Sta. 194 +**

The construction of an access road through the area has diverted this stream from it's natural bed into a partially collapsed slope and on to the Number One Pool. A weir was placed on this stream, and the flow into the slope was measured at 200 gallons per minute. The stream should be diverted away from the slope and an air seal placed over the opening. The effect of this project would result in a reduced flow from the Number One Pool.

Subatted as Quick Start Project Number Two, this project is currently being considered by the Department.

**THE REMAINING FOUR PROJECTS** are larger in scope, however, the relative benefit is also greater and should be included in the comprehensive abatement plan.

**Project Number Six-400' West of Sta. 115 +**

The northwest dump is composed of mine refuse, breaker waste and silt. It covers an area of approximately 60 acres of a small natural valley. Because it was originally located in a natural valley the exact depth is not known and the cubic yardage could not be calculated.

Surface water is funneled onto the dump where it percolates through the rock and silt to the Lackawanna River which flows at the base. It is possible that natural springs under the dump help to contribute to the flow, however the exact amount is not known.

The cost to remove this dump would be prohibitive. An alternative would be to construct a series of diversion ditches to channel as much water as possible away from the dump and directly to the Lackawanna River.

**Project Number Seven**

Regrade all banks and dumps and backfill all strippings. There is approximately 400 acres of strip mines in the project and an equal amount of mine refuse, breaker waste and stripping spoil bank. This project would eliminate surface water entering deep mines and AMD leeching from banks. The cost would be high but would be partially offset by reclaiming land that is now worth less.

This project is currently being considered by the Department.

**Project Number Eight-800' West of Sta. 205 +**

The Vandling outfall (Number 32) is the only direct outlet of the number one pool to the surface. If a water seal is installed on this outfall the water would then flow underground, southwest, down the valley with some emerging to the surface in Simpson (outfalls No. 4, 5 and 6); the remainder would flow underground through Carbondale to the Jermyn outfall located at the Archbald Fault. This project would elianate a volume of up to three million gallons per day from entering the Lackawanna River for a minimum distance of about four miles.

The number one pool would rise slightly, estimated approximately two feet, and could be monitored at an open air shaft near the center of the pool. The difficulty in installing a water seal is that the Delaware and Hudson Railroad tracks are directly over the outfall. Test borings would have to be taken to determine thickness and continuity of the rock strata so as not to weaken the railroad bedding and tracks.

This project is currently being considered by the Department.

**Project Number Nine-11311-11 No. 1 1200' West of Sta. 150+ BH No. 2 2000' West of Sta. 170+**

The concept of this project is to lower the levels of the existing mine water pools so that they no longer emerge to the surface and drain off the mine water underground via existing water courses and gangways.

Large diameter boreholes would be drilled into the vein or veins overlaying the pool but not associated with it and on to the vein or veins inundated by the pool. The mine water would then flow through this new route to the next pool south or to an outfall at the surface or onto the Jermyn Outfall.

Basically this concept is to utilize existing mines as much as possible in order to convey mine drainage to one location and one treatment plant before entering the Lackawanna River.

Relating this concept to Project SL-139, two single case boreholes would be drilled, one into the number one pool near Vandling, the other into the number two pool in the Valley below Vandling, thereby draining all of their waters underground to outfalls numbers 4, 5 and 6 in Simpson or beyond to the Jermyn outfall located adjacent to the Archbald fault. The effect of this would be to lower the number one and two pools eliminating the Vandling outfall (Number 32) on the number one pool, and also the Grey Slope Outfall Number 28 and the Beaver outfall (Number 20) on the number two pool. The water, upon entering the upper vein, would then flow through existing water courses to the three Simpson outfalls or out of the project, before coming to the surface.

Extensive investigation will be required to the Jermyn Outfall before this project is initiated. The feasibility of this project will be determined as part of Project SL-139-1. (Lackawanna River Part 11).

## QUICK START PROJECT NO. 1

### Design Criteria

Wilson Creek originates from a small pond west of Vandling, Pa., and continues for approximately 19,000 feet before emptying into the Lackawanna River at Simpson, Pa. The drainage area is 2,824 acres or 4.41 square miles. The elevation of the creek drops from 1900 feet above mean sea level at it's headwaters to 1,080 feet at it's confluence with the Lackawanna River or 820 feet. The average slope of the stream is approximately 4.32% or $2^{1}/20$.

Wilson Creek crosses part of the number one and three pools and the deep mined area for approximately 11,000 feet between stations 5+ and 27 (See drawings). The bed elevation of the creek is constantly above the elevation of the pools and varies from 274 feet to 53 feet.

During it's journey to the Lackawanna River, Wilson Creek loses a portion of it's waters to the deep mines through fractures and fissures in the creek bed which are concealed by alluvium, colluvium and glacial remnants.

In order to determine the area or areas where water is being lost; the creek was measured and stations were established at 500' intervals. Flow measurements were first attempted on March 9, 1971 but due to the amount of ice and snow in the creek, these readings are not complete. From April 6 to April 8, 1971, the first complete set of flow readings were taken. However, the snow was just beginning to melt. Due to these circumstances, additional readings and studies are being made. These figures will be completed so that information necessary to design the project will be complete.

The figures show a definite decrease in flow and verifies our observations. The decrease is evident although water was infiltrating from melting snows. The figures compiled are listed on the following page.

## WILSON CREEK FLOW READINGS

| STATION NUMBER | 3-9-71 G.P.M. | 3-26-71 G.P.M. | 4-1-71 G.P.M. | 4-6-71 G.P.M. | 4-7-71 G.P.M. | 4-8-71 G.P.M. |
|---|---|---|---|---|---|---|
| 1 | | 209 | | 1163 | | |
| 2 | | | | 1290 | | |
| 3 | | | | 1401 | | |
| 4 | | | | 1424 | | |
| 5 | | | | 1479 | | |
| 6 | | | | 2391 | | |
| 7 | | 589 | | 1342 | | |
| 8 | | | | 1324 | | |
| 9 | | | | 1462 | 1580 | |
| 10-225 | | | | | 1462 | |
| 10 | 450 | 398 | | | 1541 | |
| 11 | | | | | 2065 | |
| 12 | | | | | 1849 | |
| 13 | 2326 | | | | 3927 | |
| 14 | | | | | 4705 | |
| 15 | | | 3750 | | 3594 | |
| 16 | | | | | 4317 | |
| 17 | 1813 | | | | 5991 | |
| 18 | | | | | 4759 | |
| 19 | | | | | 4434 | 3229 |
| 20 | 1228 | | | | | 2634 |
| 21 | | | | | | 2666 |
| 22 | 1521 | | | | | 2601 |
| 23 | | | | | | 2684 |
| 24 | | | | | | 3120 |
| 25 | | | 527 | | | 2289 |
| 26 | 706 | | 525 | | | 3285 |
| 27 | | | | | | 2504 |
| 28 | | | 512 | | | 3078 |
| 28 + 400 | | | | | | 2180 |

The Drawings for the construction of a concrete flume to line the area where the creek is lost has been forwarded to the Department of Environmental Resources for approval.

## PRIORITIES OF ABATEMENT PROJECTS AND COSTS

The major factor in establishing abatement project priorities is the Cost/Benefit Ratio.

The projects listed are those mentioned under the abatement plan with priority being as follows:

### PRIORITY 1

**SOURCE DESCRIPTION:** Wilson Creek percolates into deep mines.

**RECOMMENDED ABATEMENT MEASURE:** Reconstruct channel of creek. (See design project)

**COST:** $150,000.00

### PRIORITY 2

**SOURCE DESCRIPTION:** Bank of stream has eroded, water now enters stripping, percolates into deep mines.

**RECOMMENDED ABATEMENT MEASURE:** Rebuild stream bank.

**COST:** $500.00

### PRIORITY 3

**SOURCE DESCRIPTION:** Construction of access road diverted stream into portal.

**RECOMMENDED ABATEMENT MEASURE:** Reconstruct channel so stream flows in natural waterway. Construct seal over portal.

**COST:** $1,500.00

## PRIORITY 4

**SOURCE DESCRIPTION:** Vandling outfall.

**RECOMMENDED ABATEMENT MEASURE:** Install water seal.

**COST:** $15,000.00

## PRIORITY 5

**SOURCE DESCRIPTION:** Lackawanna River drains into stripping and into number two pool.

**RECOMMENDED ABATEMENT MEASURE:** Backfill stripping.

**COST:** $15,000.00

## PRIORITY 6

**SOURCE DESCRIPTION:** Northwest Dump.

**RECOMMENDED ABATEMENT MEASURE:** Construct diversion ditches to channel surface water away from dump.

**COST:** $40,000.00

## PRIORITY 7

**SOURCE DESCRIPTION:** Stripping is discharge point for Vandling Sewer System.

**RECOMMENDED ABATEMENT MEASURE:** When interceptor sewer system is complete and sewage no longer drains into stripping it should be backfilled.

**COST:** $76,500.00

## PRIORITY 8

**SOURCE DESCRIPTION:** Drain number one and two pools underground to Simpson or beyond, eliminate sources number 20, 28, and 32.

**RECOMMENDED ABATEMENT MEASURE:** Drill two large diameter boreholes. One 275' into the number one pool, and another 300' into the number two pool.

**COST:** $30,000.00

## PRIORITY 9

**SOURCE DESCRIPTION:** Water enters deep mines thru stripping pits and poor quality seeps from refuse banks.

**RECOMMENDED ABATEMENT MEASURE:** Bury refuse in strip pits and cover and vegetate.

**COST:** $500,000,000.00

**TOTAL COST PROJECTS 1 THRU 8 $328,500.00**

**PROJECT NO. 9 INCLUDES PROJECTS NO. 2, 3, 4 AND 6**

## EXTENT AND SEVERITY OF POLLUTION

The Lackawanna River crosses the coal measures and enters the northern anthracite field as a basically unpolluted clean stream used for drinking water in Forest City, it supports aquatic life and is, used for fishing and swimming. During it's eight mile course through the project to the southern limit at Simpson it gradually regresses to an open conveyance system for drainage and sewage.

The total average contribution of mine drainage to the Lackawanna River the project is:

| OUTFALL NO. AND NAME | GALLONS PER DAY | IRON | | SULPHATES | | ACIDITY | | ALKALINITY | |
|---|---|---|---|---|---|---|---|---|---|
| | | MG/L | LBS./DAY | MG/L | LBS./DAY | MG/L | LBS./DAY | MG/L | LBS./DAY |
| No. 4 Lower Simpson | 2,252,160 | .250 | 8.40 | 232 | 4,524 | | | 9.00 | 169 |
| No. 5 Upper WIlson | 484,020 | .375 | 2.70 | 211 | 884 | | | 8.25 | 33 |
| No. 6 Lower Wilson | 913,860 | .400 | .50 | 235 | 1,859 | | | 20.50 | 155 |
| No. 13 N.W. Borehole | 8,712 | .210 | .03 | 37 | 3 | | | 56.40 | 4 |
| No. 15 N.W. Dump | 19,668 | 5.800 | 1.70 | 586 | 9 | 246.0 | 40 | | |
| No.20 Beaver | 433,620 | .250 | 1.60 | 87 | 326 | 2.0 | 7 | | |
| No. 28 Grey Slope | 605,292 | 1.090 | 9.90 | 71 | 372 | 9.0 | 45 | | |
| No. 32 Vandling | 1,012,462 | .400 | 6.00 | 101 | 886 | 8.0 | 67 | | |
| No. 39 Browndale | 425,640 | .500 | | 67 | 247 | 6.3 | 22 | | |
| NET TOTAL | 6,155,434 | .340 | 31.00 | 171 | 9,110 | 0 | 0 | 3.50 | 180 |

## REFERENCE MAPS

### I. HUDSON COAL COMPANY

A. Clinton-Stillwater Colliery

**1" = 400' scale drawings**

1. Surface maps (two drawings)
2. Grassy bed
3. New County bed
4. Top Clark bed
5. Bottom Clark bed
6. Dunmore No. 1 bed
7. Dunmore No. 2 bed
8. Dunmore No. 3 bed (two drawings)

**1" = 100' scale drawings**

1. Surface (four drawings)
2. Grassy bed (two drawings)
3. New County bed
4. Top Clark bed (two drawings)
5. Bottom Clark bed
6. Dunmore No. 1 bed (two drawings)
7. Top Clifford bed (two drawings)
8. Clifford bed (five drawings)

B. Coalbrook Colliery

**1" = 400' scale drawings**

1. Surface
2. Grassy bed
3. Top Clark bed
4. Bottom Clark bed
5. Ring bed
6. Dunmore bed

**1" = 100' scale drawings**

1. Surface
2. Grassy bed (two drawings)
3. New County bed
4. Top Clark bed (two drawings)
5. Bottom Clark bed (two drawings)
6. Third bed (two drawings)

C. Powderly Colliery

**1" = 400' scale drawings**

1. Surface
2. Grassy bed
3. New County bed
4. Top Clark bed
5. Bottom Clark bed
6. Third bed
7. Dunmore bed

## II. PENNSYLVANIA COAL COMPANY

A. Forest City Colliery

**1" = 400' scale drawings**

1. Dunmore No. 3 bed

**1" = 100' scale drawings**

1. Grassy bed (three drawings)
2. New County bed (two drawings)
3. Top Clark bed (two drawings)
4. Bottom Clark bed (three drawings)
5. Dunmore No. 1 bed (four drawings)
6. Dunmore No. 2 bed (four drawings)
7. Dunmore No. 3 bed (nine drawings)

## III. PEARL COAL COMPANY

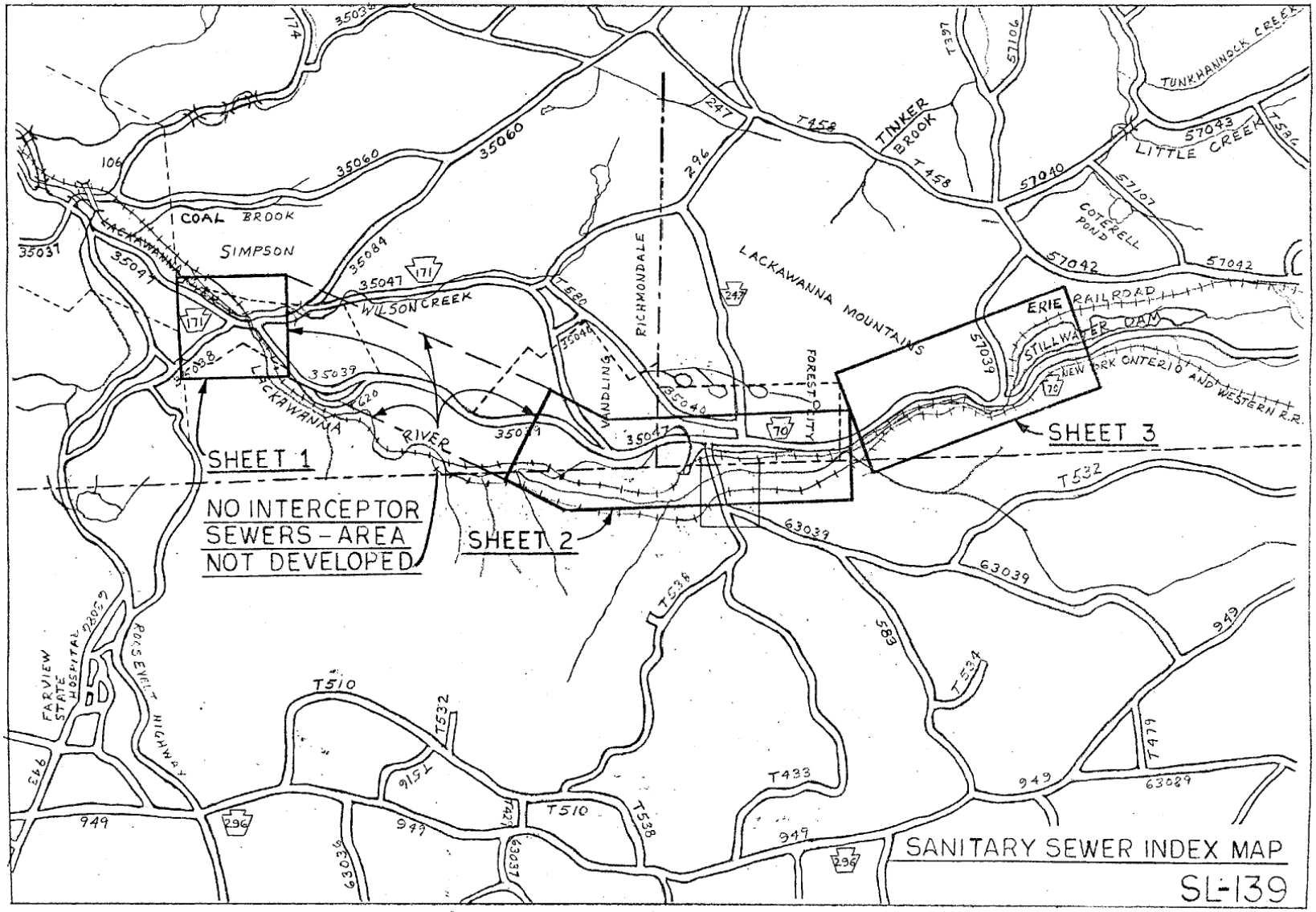
**1" = 400' scale drawings**

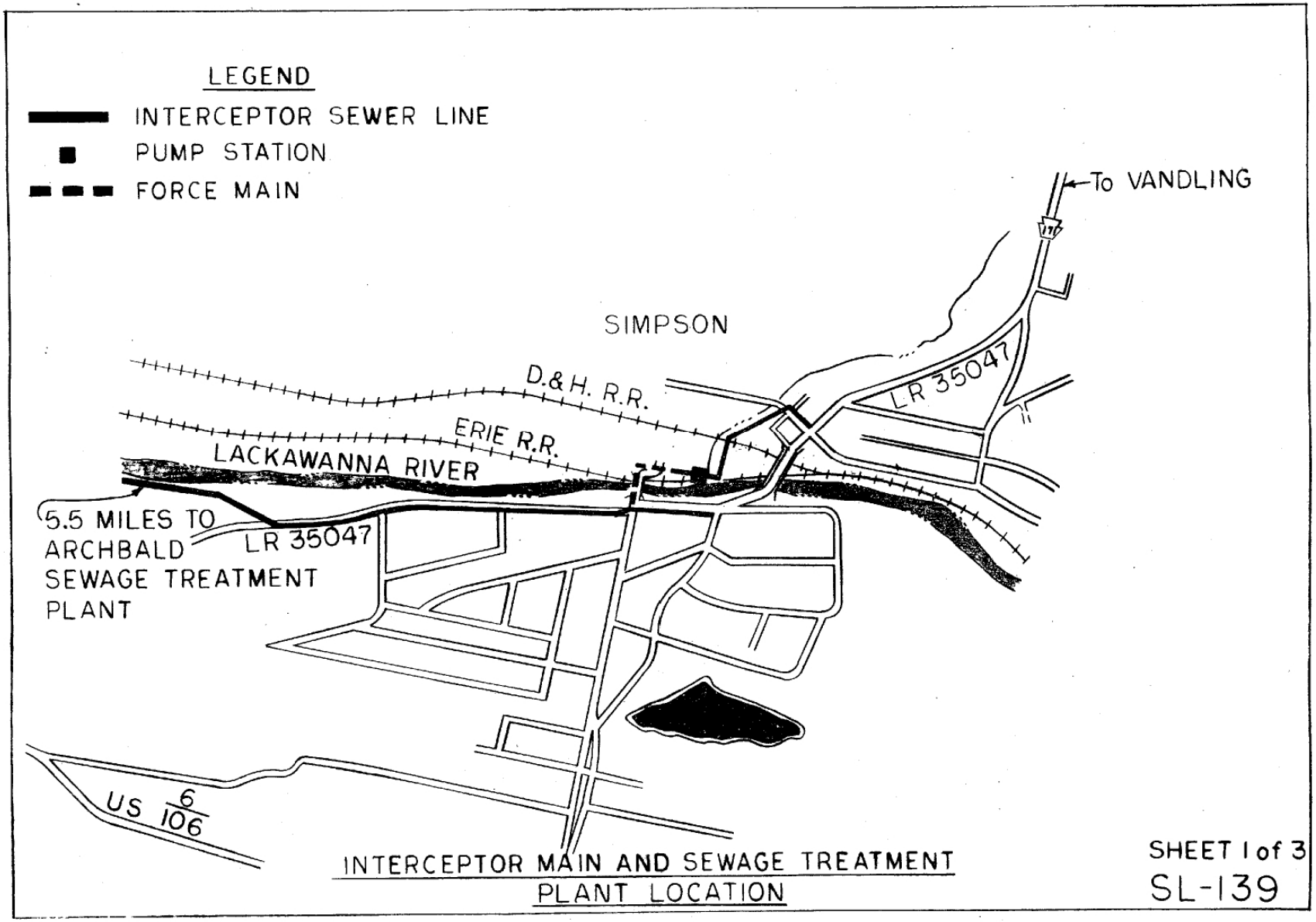
1. Dunmore No. 2 bed
2. "A" vein

## IV. NORTHWEST COAL COMPANY

**1" = 400' scale drawings**

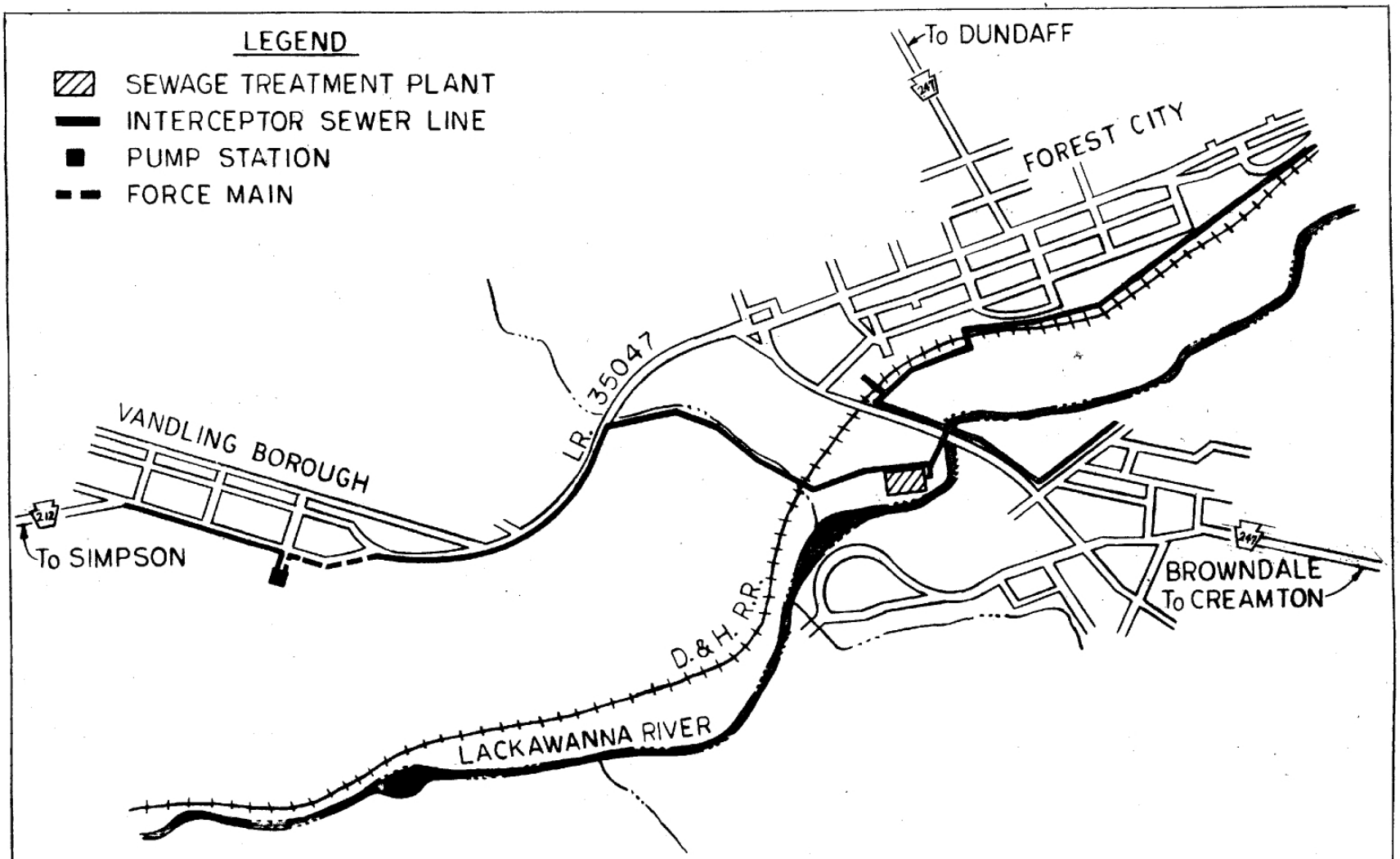
1. Surface
2. Mills
3. Top Clark
4. Bottom Clark (top and bottom splits)
5. No. 1 Dunmore
6. No. 2 Dunmore
7. No. 3 Dunmore


SHEET 1
NO INTERCEPTOR SEWERS - AREA NOT DEVELOPED
SHEET 2
SHEET 3
SANITARY SEWER INDEX MAP
SL-139
COAL BROOK
SIMPSON
WILSON CREEK
LACKAWANNA RIVER
RICHMONDALE
LANDLING
FORESTCITY
LACKAWANNA MOUNTAINS
TINKER BROOK
TUNKHANNOCK CREEK
LITTLE CREEK
COTERELL POND
ERIE RAILROAD
STILLWATER DAM
NEW YORK ONTERIO AND WESTERN R.R.
FARVIEW STATE HOSPITAL
ROOSEVELT HIGHWAY



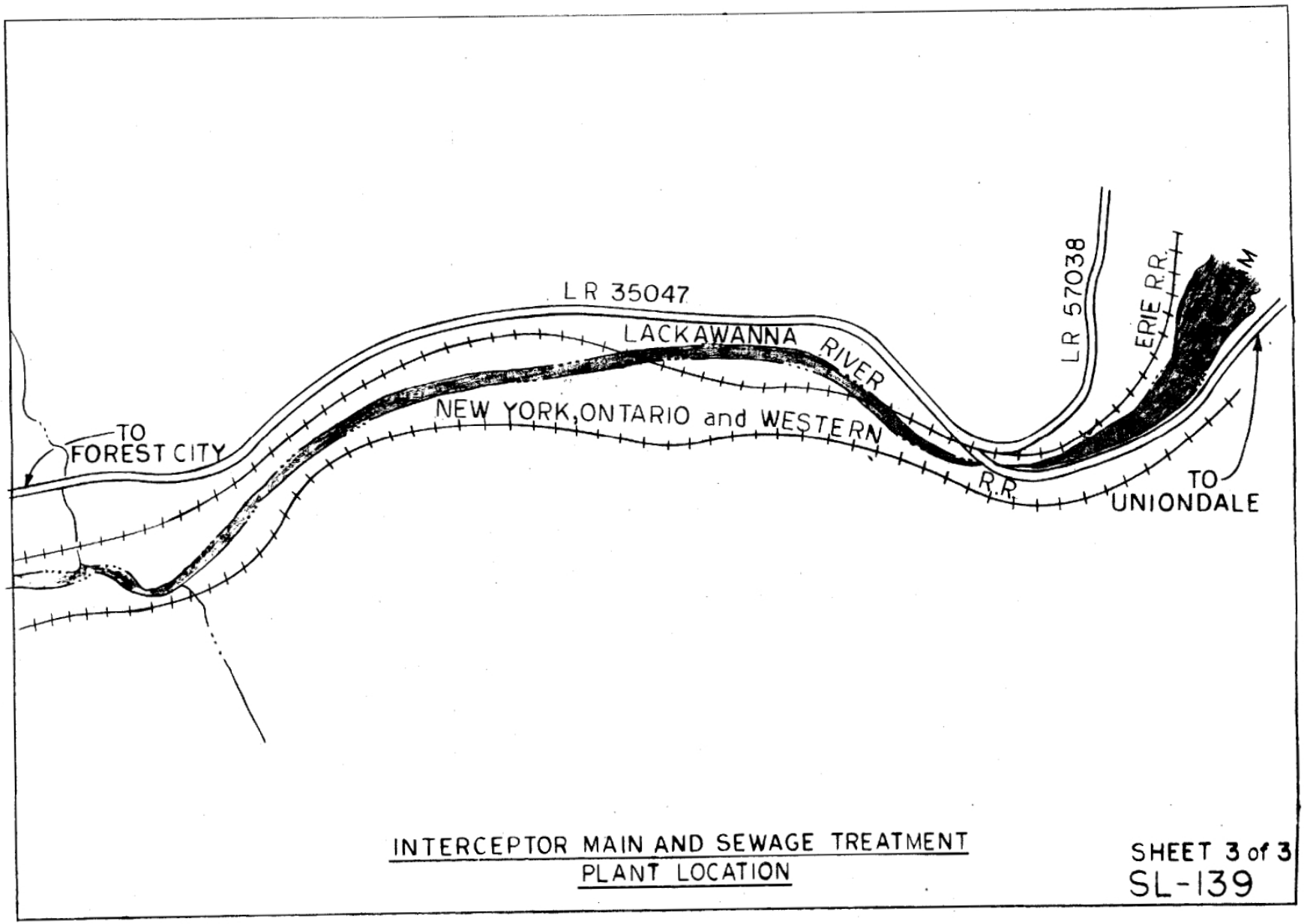

INTERCEPTOR MAIN AND SEWAGE TREATMENT PLANT LOCATION

SHEET 1 of 3
SL-139




INTERCEPTOR MAIN AND SEWAGE TREATMENT PLANT LOCATION

SHEET 2 of 3
SL-139




INTERCEPTOR MAIN AND SEWAGE TREATMENT
PLANT LOCATION

SHEET 3 of 3
SL-139