# II. EXISTING CONDITIONS

## WATERSHED CHARACTERISTICS.

For the study purposes, each watershed was divided into subareas, representing different topographic, mining, or runoff conditions. Limits of these watersheds and sub-area descriptions are shown in Figure 1 (page 5). Geologic conditions are shown on Figure 2 (page 7), and monitoring station locations and observed field conditions are shown on Figure 3 (page 11).

Outside the coal measures, the unmined areas (A and B) are in the upper reaches of the watersheds and are relatively undisturbed forested areas. Due to the absence of mining activities, the existence of tree cover and the relatively steep slopes, the characteristics of the surface water in these areas are as follows:

a. Good quality
b. "Base flow" in streams is steady and dependable with no losses from streambeds.
c. "Time of concentration" is relatively short, resulting in quick response to precipitation runoff.

In Area A, surface runoff and base flow contribute to the flow of the streams that are located outside of the coal measures. After crossing the coal measures, most of Area A's streams begin to lose water into the deep mines. Surface runoff from Area B is generally intercepted by downslope strip pits and subsidence depressions that are located within the coal measures. An exception to this condition is Area B runoff that crosses unmined coal measures and is intercepted by the Water Company flume between Mill Creek and Laurel Run (see Figure 1, page 5). A section of the flume crosses a deep mined area where significant losses of flow have been recorded.

Within the coal measures, the watersheds are divided into three sub-areas. These areas have been exposed to deep and strip mining operations and contain urbanized areas. The upper areas (C and D) are areas where the groundwater table and mine pools are well below the surface of the stream levels. This combined area extends down slope of the bottom coal outcrop line (limit of coal measures) to about the confluence of Mill Creek and Laurel Run. Area C contains isolated suburban areas and was extensively strip mined and deep mined. Most of the precipitation and runoff in this area is intercepted by strip pits, waste piles and subsidence depressions and infiltrates into the deep mines. Runoff contribution to stream flow is negligible in Area C. Area D is urban and suburban with extensive abandoned deep mines and limited strip mining operations. Most of the runoff from precipitation over this area is intercepted by storm drainage structures and diverted to streams. Field observations and unverified reports indicate that some of the urban storm drainage systems are losing flow directly to the deep mine pools. Direct discharge of drainage into boreholes drilled into the deep mines and losses from broken drains in subsidence areas are the major contirbutors to mine pool recharge from urban areas. Although the magnitude of such losses can be very significant, the type, location, extent and causes of storm drainage system losses and the abatement of these losses are beyond the scope of the present study. Some Area D runoff is intercepted by strippings resulting in limited water losses to the deep mines. Although runoff contribution to stream flow from sub-area D is moderate, some stream flow is lost by exfiltration from stream beds. Area E extends along the channel of Mill Creek from its confluence with Laurel Run to the Susquehanna River. In Area E, groundwater and mine pool elevations are near the streambed levels of Mill Creek. Consequently, there are no significant streambed losses to the deep mines.

## GEOLOGIC CONDITIONS.

GENERAL. Basic geologic and mining information was obtained from maps and reports published by State and Federal Agencies. This information and specific geologic and mining conditions were verified during field investigations by an Engineering Geologist from GEOTechnical Services.

The study area's watersheds are in the Southeastern part of the Wyoming Valley coal basin which is at the Southern end of the Northern Anthracite Field of Pennsylvania. This, coal field is within the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. The coal basin is part of a large synclinorium that trends in a general Northeast-Southwest direction. The basin is rimmed with

with resistant sandstone ridges to the North and South and is bisected by the Susquehanna River. Topographic relief in the watershed ranges from elevation 520' at the confluence of Mill Creek and the Susquehanna to elevation 2,16Q' on the mountain ridges along the Southeast limit of the watershed. These mountain ridges also represent the Western Rim of the Pocono Mountain Plateau area to the East.

Topographic features, the approximate limits of the various rock formations, a generalized stratigraphic column and other geologic features are shown on Figure 2, "Geologic Map", page 7.

STRATIGRAPHY. The bedrock strata underlying the valley and adjacent mountains consist of sandstone, shale, siltstone, conglomerate and coal. In stratigraphic sequence from the. oldest (lower strata) to the youngest (upper strata), the following rock formations are present:

Catskill Formation (Devonian Age): Red, gray and green shale, siltstone and fine to medium sandstone. This rock formation is about 2,000' thick and underlies the rolling topography of the upper watershed limits in the vicinity of Wyoming, Bald and Little Piney Mountains.

Pocono Formation (Mississippian Age): Gray, hard, massive, sandstone and conglomerate with some siltstone and shale. This resistant rock formation is about 600' thick and forms the lower Northern slopes of Wyoming, Bald and Little Piney Mountains. Mauch Chunk Formation (Mississippian Age): Red shale interbedded with some green-gray and brown shale, siltstone and sandstone. This less resistant rock formation is about 1,000' thick in the study area and is found in the narrow, NE-SW trending, elevated valley of Laurel Run, Warden Creek and Gardner Creek. Pottsville Formation (Pennsylvanian Age): Light gray to white, medium to coarse grained sandstone and conglomerate. This resistant rock is 200 to 300' thick in the study area. It underlies the Northern slope of Wilkes-Barre Mountain and the inner, lower rim of ridges on the South side of the Wyoming Valley. Llewellyn Formation (Pennsylvanian Age): Light and medium gray, fine to coarse grained sandstone and conglomerate, interbedded with light to dark gray shale, siltstone and claystone, black carbonaceous shale and anthracite coal seams.

This formation underlies the entire Wyoming Valley floor and lower mountain slopes. The formation is reported to contain at least 26 coal beds ranging in thickness from inches to 27 feet (Hollowell 1971; Ash 1954). The bottom workable coal seam of the Llewellyn Formation is the Red Ash (10'± thick) which outcrops on the mountain slopes at elevation 900' to 1,000'. The lowest mapped elevation of the Red Ash in the Wyoming Coal Basin is 1,500' below sea level in the vicinity of Askam, East of Nanticoke (Barton, 1938). In this same area, the upper beds of the Llewellyn Formation outcrop in the Mid-Valley ridge at elevation 813' above mean sea level resulting in a maximum formation thickness of at least 2,300'. In the Mill Creek watershed, the bottom elevation of the Red Ash is mapped at 800' below sea level in the vicinity of the Wiles-Barre General Hospital. The upper beds of the Llewellyn Formation outcrops at about elevation 620' for a maximum formation thickness of 1,420' within the watershed. Northeast of the Hospital, the bottom of the coal measures rises until it outcrops at the surface in the streambed of Gardner Creek in the vicinity of Ridgewood. The strata between the coal beds vary considerably in horizontal and vertical continuity. Lateral changes in thickness and lithology, cross-bedding and channel deposits are common. Some of the coal beds, however, are relatively uniform in thickness and lateral continuity.

<u>OVERBURDEN SOILS.</u> Except for thin, limited areas of recent stream sediments and residual soils, the area is blanketed with a widespread, thin to thick cover of unconsolidated glacial deposits. These glacial deposits from the Pliestocene Period of geologic time, consist of undifferentiated glacial drift, glacial lake deposits and glacial outwash deposits. The present flood plain sediments of the Susquehanna River are underlain by a deep, wide buried valley filled with sediments. that were deposited in a glacial lake that stood at a reported elevation of about 560'. Glacial outwash deposits and the buried lake sediments extend to a width of about one mile and a maximum depth of about 300' below the present flood plain Southwest of Wilkes-Barre. These sediments consist of stra-

tidied deposits of clay, silt, dine to coarse sand and gravel. The remainder of the valley floor and the mountain slopes are covered with a blanket of unstratidied glacial deposits. As a result of extensive surface strip mining in the area, much of the unstratidied, glacial drift that blankets the study area has been excavated, mixed with, and covered by strip mine waste rock. Similarly, deep underground mining and coal processing operations have resulted in the glacial drift being covered with large, high culm banks and breaker waste piles and wide-spread coal silt deposits.

STRUCTURE. The bedrock strata underlying the study area are in the Wyoming Valley Coal Basin, which is in the southern half of the large synclinorium that dorms the Northern Anthracite Coal Field. This synclinal structure trends (strikes) about N 50° E and extends a distance of about 60 miles from, Forest City on the northeast to Shickshinny on the southwest. The structure is rimmed with resistant sandstone ridges forming a crescent shaped valley with narrow ends and a broad, dive mile wide central portion. The deepest part of this structure is southwest of Wilkes-Barre where the coal basin extends to a maximum depth of 1,500 feet below sea level in the vicinity of Askam. From this low point, the bottom of the basin (the Red Ash Coal Bed) rises on the southwest to about 400 feet below sea level near Glen Lyon and rises on the northeast to about sea level near Pittston. Within the study area, the deepest part of the coal basin is about 800 feet below sea level near the Wilkes-Barre General Hospital. The coal basin rises to the northeast and intersects the surface in Gardner Creek at elevation 680' near Ridgewood.Within the Wyoming Valley, the broad, undulating bottom coal basin contains several subordinate synclines, anticlines, overthrusts and faults that vary in magnitude, complexity and continuity. Records of deep mine workings southwest of Wilkes-Barre reveal thrust faults with vertical displacements of 200 feet to 350 feet (Darton, 1940). Recent geologic mapping (M.J. Bergin, USGS, 1973) shows a low angle thrust/fault extending under the reservoir of Colebrook Dam on Laurel Run*. Field investigations, flow monitoring for 18 months and discussions with the Water Company Engineer did not reveal any adverse conditions or flow losses related to this fault. Along the

Figure 2, page 7

southeastern outer rim of the coal basin, exposures of bedrock in strip pits and road cuts of Interstate 81, exhibit a less complex structure. The strata within the study area strikes N 50° - 70° E and generally dips 16° to 20° NW, steepening to 45° NW in some areas.

<u>GROUNDWATER AND MINE POOLS.</u> Subsurface water in the Wyoming Valley is encountered under normal water table conditions and as confined groundwater that exhibits artesian pressure and flow conditions. Normal water table conditions are found in the unconsolidated flood plain sediments and shallow bedrock along and adjacent to the Susquehanna River. Normal water table conditions are also found in the upper reaches of the tributary watersheds, beyond the limits of the coal measures. Confined water under artesian pressure and flow conditions is found along the narrow elevated,. NE - SW valleys southeast of the coal measures. The pronounced water gap breaches in the mountains indicate zones of highly fractured and/or faulted bedrock, which in turn, suggests narrow highly pervious zones that facilitate rapid groundwater movement toward the coal measures. The pervious fracture zones represent high recharge areas of clean groundwater that contribute to, and become contaminated by the coal bearing strata and the deep mine pools underlying the study area. Confined water under variable water pressure conditions is found in the deep mined areas where the breached and unbreached mine barrier pillars interact with mined and unmined strata to create interconnected and stepped mine pools at different elevations. Rapid infiltration and interception of runoff in strip mine areas and direct loss of surface streams into the strip pits and underground mines result in rapid, large fluctuation of the mine pool levels. Pressure relief wells have been drilled through the confining strata at critical locations of these mine pools in the Wyoming Valley to minimize fluctuations and to maintain lower mine pool levels. These relief wells have reduced mine pool flooding problems in and adjacent to the. study area, and are expected to minimize related subsidence problems. Furthermore, these wells reduce the acid concentration of mine drainage by shortcutting the mine pool flow path contact with acid producing pyrites exposed in the deep mining operations (Hollowell, 1971).

** Area E, Figure 1, page 5*　　　　*Area A, Figure 1, page 5*

SUBSIDENCE. Surface subsidence due to deep mining for coal has occured and will continue to occur in various parts of the Wyoming Valley coal basin. Geologic and topographic features combined with complex deep mining operations involving numerous coal seams, varying degrees and depths of coal extraction and mine pool fluctuations are interacting elements that combine to cause subsidence. Consequently, it is virtually impossible to correlate the variable effects of all of these elements to predict the location, areal extent, magnitude, rate of time frame of a subsidence occurrence. Obvious subsidence potential due to localized, near surface openings can be controlled or minimized by various methods. However, uncontrollable wide spread subsidence is always a possibility due to a "falling domino" caving effect caused by collapse of numerous, deep underground openings. Such multiple caving can occur due to a vertical collapse in the immediate area or due to movement along steep "dip" slopes of mined out seams that extend beyond the immediate areas of subsidence. In general, as multiple caving migrates to the surface, a bridge or arch of broken rock develops resulting in wide spread settlement that causes a broad, shallow surface depression.

HYDROLOGIC CONDITIONS.

The watershed above the mouth of Mill Creek consists of 36.6 square miles, of which 24.9 (68%) are located outside of the coal measures. Precipitation over the watershed varies with the elevation above mean sea level. For the 12 month period 5/1/75-4/30/76, the following precipitation was recorded:

| PERIOD | WITHIN COAL BASIN | | OUTSIDE COAL BASIN |
|---|---|---|---|
| | AVOCA (INCH) | WILKES-BARRE (INCH) | STA. NO. 5 BEAR CREEK (INCH) |
| 5/1/75-4/30/76 | 40.35 | 44.70 | 51.03 |
| MEAN YEAR | 35.65 | 39.49 | 45.09 |

Surface runoff in the study area has undergone significant changes due to mining activities within the 32% of the watershed that is within the coal basin. Although the precipitation/runoff relationship above the coal measures is not affected by mining, the runoff and stream flow within the basin is affected by surface water losses into the deep mines. Therefore, if the surface water losses within the coal basin are added to the recorded flow at the mouth of Mill Creek, the sum of this flow represents the runoff conditions that prevailed prior to the mining activities in the watershed. The relationship between precipitation, runoff, and surface water losses for the 12 month period (5/1/75-4/30/76) is summarized as follows:

| DESCRIPTION | STREAM FLOW | WATER LOSSES | | POTENTIAL RUNOFF* |
|---|---|---|---|---|
| | | OFFSTREAM LOSSES | STREAMBED LOSSES | |
| (1) | (2) | (3) | (4) | (5) = (2)+(3)+(4) |
| VOLUME OF FLOW (MG) | 9,197 | 5,331 | 2,554 | 17,082 |
| DRAINAGE AREA (SQ.MI.) | ← ← ← ← | ← ← ← ← 36.6 | → → → | → → → → → |
| RUNOFF EQUIVALENT (INCHES) | 14.46" | 8.39" | 4.02" | 26.87" |
| PRECIPITATION (INCHES) | ← ← ← ← | ← ← ← 45.54" | → → | → → → → → |
| PERCENT OF PRECIPITATION | 31.75% | 18.42% | 8.83% | 59.00% |

* *If water losses were prevented.*

Distribution of surface water losses to the major mine pool groups that underlie the study area are presented in Section III of this Report. Daily precipitation records from stations that are adjacent to the study area are presented in Appendix C.

OBSERVED FIELD CONDITIONS.

GENERAL: Monthly records of stream flow, water quality sampling and continuous recorder data were obtained from selected monitoring stations. A detailed list of flow and quality data for each station is presented in Appendix B. During field reconnaissance, isolated water loss points and sewage discharge locations were observed and recorded. Pertinent data related to specific locations is tabulated on pages 28 and 29 and is shown on Figure 3, page 11. A summary of observed field conditions, land uses and other factors related to AMD within each sub-watershed is described below and pertinent locations are shown on Figure 3, page 11.

COAL BROOK TRIBUTARY: No base flow occurs between stations C-24 and C-27. Intermittent channel flow is limited to periods of runoff from the City of Wilkes-Barre, the Wyoming Valley Mall Shopping Center and other paved areas. Flooding problems are reported downstream of C-26, probably stemming from constricted culverts and storm drains. Occasional small discharges of industrial waste from a brewery near C-24 were observed and recorded. Except for major storm runoff, virtually all flow into the stream channel between C-24 and C-27 is lost through infiltration into the deep mines. Detailed reconnaissance of this stretch did not reveal any specific flow loss points.

Intermittent "clean" base flow at, C-30 and C-31 is generally lost to the deep mine pools by surface infiltration between the limit of the coal measures and the railroad 200 to 500 feet North. Downstream of the railroad, high, wet weather flows and storm runoff is carried in stone and concrete lined flumes to C-28. The entire flow passing C-28 is subsequently lost to the mines in a subsidence depression at Station C-27. No flow was ever measured at C-29. Flow at C-29A was observed and recorded on only one occasion (2/25/75) after a period of heavy rain. Normal storm runoff from an apartment complex and discharge from a sewage treatment plant upstream of C-29A infiltrates and is lost to the deep mines prior to reaching C-29A.

All surface flows that are lost to the deep mines in the Coal Brook sub-watershed become part of the Southeast Mine Pool Complex and discharge at the three South Wilkes-Barre Boreholes.

OBSERVED AND RECORDED SURFACE WATER LOSS DATA

| LOCATION | MAXIMUM LOSS (GPM) | DATE | REMARKS |
|---|---|---|---|
| (1) | 25 | 01/28/75 | Effluent from Sewage Plant lost in Creek Bed |
| (2) | 2,215 | 02/25/75 | Combined flow from C-28 and C-29A lost in caved area. |
| (3) | Unmeasured | | Virtually all Urban Runoff flow lost in Creek Bed |
| (4) | Unmeasured | | Reports of major stream loss to mines in June 1972 |
| (5) | 7,245 | 06/29/76 | See Flow Data, Appendix A, p. A-24 |
| (6) | 1,797 | 02/26/76 | See Flow Data, Appendix A, p. A-17 |
| (7) | 455 | 07/23/75 | Loss includes sewage flows 4 thru 9 |
| (8) | 1,514 | 12/30/75 | See Flow Data, Appendix A, p. A-16 |
| (9) | Unmeasured | | Reports of total loss of Mill Creek to mines in June 1972. Opening filled and stream rechanneled. |
| (10) | 3,728 | 12/30/75 | See Flow Data, Appendix A, p. A-18 |
| (11) | 250 | | Point leakage from Flume lost in downslope depression |
| (12) | 1,178 | 10/01/75 | Combined loss from Flume. See Flow Data, Appendix A, p. A-23 |
| (13) | 1,071 | 06/29/76 | See Flow Data, Appendix A, p. A-20 |
| (14) | 1,235 | 02/26/76 | See Flow Data, Appendix A, p. A-20 |
| (15) | 300 | 07/30/75 | Intermittant diversion of some flow for Breaker Operation (Kassa; Permit Number 16419) |
| (16) | Unmeasured | | All runoff from Area lost in caved bottom of Strip Pit |
| (17) | Unmeasured | | All surface flow lost in Strip and Deep Mines |

*NOTE: Numbered Locations are shown on Figure 3, page 11*

## OBSERVED SEWAGE AND INDUSTRIAL WASTE DISCHARGES

| LOCATION | MAX. EST. FLOW (GPM) | DATE | REMARKS |
|---|---|---|---|
| 1 | 15 | 2/25/75 | Milky discharge from Brewery |
| 2 | 10 | 6/19/75 | Raw Sewage from 6" VCP |
| 3 | 72 | 8/27/75 | Raw Sewage from 36" RCP |
| 4 | 100+ | 7/10/75 | Raw Sewage from 30" VCP |
| 5 | 25 | 7/10/75 | Raw Sewage from 24" VCP |
| 6 | 70 | 7/11/75 | Raw Sewage from six outlets, 6" to 24" VCP |
| 7 | 100 | 7/11/75 | Raw Sewage from nine outlets, 4" to 24" VCP |
| 8 | 60 | 7/11/75 | Raw Sewage from six 4" VCP outlets |
| 9 | 100 | 7/11/75 | Raw Sewage from 36" VCP |
| 10 | 250 | 7/11/75 | Cloudy discharge with urine odor from stable cleaning |
| 11 | 40 | 7/11/75 | Effluent from Race Track Sewage Treatment Plant |
| 12 | 15 | 7/11/75 | Effluent from Vo-Tech High School Sewage Treatment Plant |
| 13 | 20 | 7/24/75 | Raw Sewage from two outlets, 4" and 6" VCP |
| 14 | 10 | 7/24/75 | Raw Sewage from two outlets, 4" PVC |
| 15 | 360 | 7/23/75 | Diluted Industrial Waste from Owens-Corning Plant side stream |
| 16 | 200 | 7/25/75 | Effluent from Owens-Corning Waste Water Lagoon (8" steel pipe) |
| 17 | 15 | 7/25/75 | Diluted Industrial Waste from Owens-Corning Plant (36" VCP) |
| 18 | 25± | 7/08/76 | Effluent from Treatment Plant at Oakwood Industrial Park |

*NOTE: Numbered Locations are shown on Figure 3, page 11*

The steeply sloped banks North and East of Coal Brook are the remnants of an abandoned trash dump. Encroachment of trash in the stream channel and tension cracks along the top of the bank indicate that the dump slopes are unstable.

No direct single point discharges of AMD into Coal Brook were found. Limited acid and sediment pollution during high runoff periods is indicated by erosion ditches on the Zayre Strip waste piles that are along Coal Brook. Most of the strip mines and waste piles in this watershed have been, or are being reclaimed and restored for commercial or industrial use.

LAUREL RUN TRIBUTARY:- A continuous water level recorder was installed at L-23 to monitor the total flow of Laurel Run. The flow recorded includes stream flow diverted into a canal from Mill Creek to Laurel Run by the Water Company. A concrete diversion structure on Mill Creek, upstream of M-19, diverts part of the creek flow into an excavated, unlined channel (earth and rock flume; Figure 3,page11) that discharges at F-21 into Laurel Run and Colebrook Reservoir (Station L-22).

Between stations F-20 and F-20B, the Water Company flume follows the contour line of Elevation 1010 feet. Approximately 7,500 feet of this unlined flume crosses over the Coal Measures. Losses of "clean" water from the flume to the deep mines, ranging &s high as 1,178 GPM, have been recorded between F-20A and F-20B (see Appendix A). Slight gains on several occasions are attributed to seepage and runoff from rain saturated soils. One location of single point flow loss (50 to 250 GPM) from the flume was found Southwest of F-20A. Other losses are attributed to widespread seepage along the bottom and downhill slopes of the flume. Most of the flume is excavated in fractured bedrock with a downslope embankment of sandy soil and coarse rock fragments. No single point AMD discharges into the flume were found.

Geologic maps and field reconnaissance revealed the existence of and east-west, low angle fault rising from the deep mined Coal Measures to the West and extending under the Colebrook Reservoir. Approximately in line with the fault are large, open subsidence depressions 200 to 300 feet West of the Reservoir's edge. Although these conditions suggest a high potential for reservoir losses, flow measurements did not reveal any losses and the Water Company reports no evidence or indications of such reservoir losses. Observed continuous losses of several hundred gallons per minute through the face of the masonry dam are unrelated to the geologic fault or subsidence conditions.

Due to unmeasured intermittent withdrawals of water from the Colebrook Reservoir by the Water Company, spillway overflow varied widely causing the L-23 recorder charts to show large, rapid variations in stream flow. These flow variations severely hindered efforts to measure or observe possible loss points or stream stretches of possible flow loss. To document these possible losses, a continuous recorder was also installed (1/15/76) immediately downstream of the dam at L-22A. This recorder picked up the existing reservoir leakage spurting from the face of the masonry dam.

Downstream of the Colebrook Dam, about half of Laurel Run flows on fractured bedrock, underlain by abandoned deep mines. Although detailed reconnaissance did not reveal any stream flow loss points, it has been reported that, during the active mining, some flow was lost through infiltration into the deep mines. Several independent reports by local residents indicate that during Hurricane Agnes, large losses of stream flow entered an adjacent deep mine slope (No.9 slope) in the vicinity of L-23C. This entry point is now covered with mine wastes and no recent stream losses into the deep mines have been observed or reported. Subsidence problems in the Parsons area downstream of L-23C were reported (Hollowell, 1973) shortly after the June 1972 flooding. The subsidence was attributed to saturation of pervious glacial sediments by the flood-raised mine pool and subsequent collapse into underlying mine chambers. To alleviate and prevent a reoccurrence of the subsidence problems, the Department has undertaken mine filling operations in the Parsons area. To supplement this effort and to maintain lower mine pool levels in the area, the overflow casings of the South Wilkes-Barre Boreholes were cut off at elevation 527.5 feet in March 1973. From a maximum elevation of 555 feet in June 1972, the mine pool now fluctuates between elevations 530 and 535 feet. Although significant stream flow losses in this subsidence area were anticipated, stream flow measurements to document these losses revealed variable results. In order to isolate points or reaches (stretches) of stream flow loss, intermediate stream measurement stations were established and detailed field reconnaissance of both sides of the stream was conducted a second time. Although isolated points of flow loss could not be located, reaches of stream loss were found and are shown in Figure 3, page 11.

Except for City storm runoff and one small sewage discharge, the Laurel Run stream flow both within and without of the coal measures is relatively "clean". No direct single point discharges of AMD into Laurel Run were found other than the small discharge from a breaker waste bank at L-23A. The discharge was alkaline and had very low AMD parameters. Most of the strip mines and waste piles in this watershed have been or are being restored for commercial, residential and industrial use. Water quality records for Laurel Run are presented in Appendix B and are summarized in TABLE II (page 33).

MAIN STEM, MILL CREEK: A continuous water level recorder was installed at M-2 to monitor the flow of the main stem of Mill Creek. About five miles of this stream overlies the South-East Mine Pool Complex (pool elevation 530 to 535'). Approximately half of the stream stretch flows directly on fractured bedrock and some areas have been subjected to subsidence. Streambed losses for various reaches of Mill Creek are tabulated in Appendix A. Locations of stream monitoring stations and other pertinent features are shown on Figure 3, page 11.

During Hurricane Agnes in June 1972, the entire flood flow of Mill Creek broke through the South-side slope of the channel between M-5 and M-4A (loss point 9, Figure 3), flowed into a strip pit and was lost to the deep mines. The strip pit has since been backfilled and the stream channel restored to its original alignment. Although the channel and backfill material in this stretch appear to be pervious, no observable stream loss points were found after two detailed inspections of the stream channel. Nevertheless, flow measurements between M-6, G-7 and M-4A revealed some high losses*. Similarly, no observable stream flow poss point could be located in the vicinity of the caved mine slope that crosses under the Creek about one half of a mile upstream of M-4 at a reported depth of 40 to 50 feet, The portal area of this slope is visible on the northeast side of the Creek.

*see page 28, Location 8.*

# TABLE II

LAUREL RUN

SUMMARY OF WATER QUALITY RECORDS

| MONITORING STATION | | | SOURCE OF WATER | pH | | CONCENTRATION IN ppm | | | |
|---|---|---|---|---|---|---|---|---|---|
| NO. | D.A. IN SQ.MI. (1) | SUB AREA (2) | | FIELD TEST | LAB TEST | ACID | ALK | TOTAL IRON | SUL-FATE |
| L-21A | 7.86 | A | Laurel Run | 6.5 | 6.3 | 3.5 | 16 | 0.06 | 19 |
| F-21 | 9.04** | A,B&C | Laurel Run | 6.6 | 6.4 | 3.5 | 21 | 0.10 | 22 |
| L-22 | 17.50** | A,B&C | Laurel Run | 6.7 | 6.3 | 6 | 18 | 0.08 | 24 |
| L-23C | 18.16** | A,B,C&D | Laurel Run | 7.0 | 6.6 | – | 99 | 0.88 | 100 |
| L-23B* | 18.34** | A,B,C&D | Laurel Run | 6.3 | 6.6 | – | 12 | 0.50 | 20 |
| L-23A* | Neglig. | D | Waste Pile | 7.5 | 6.6 | 4 | 16 | – | 37 |
| C-31 | 0.21 | B | Coal Brook | 6.6 | 5.8 | 7 | 17 | 0.04 | 26 |
| C-30 | 0.22 | B | Coal Brook | 7.0 | 6.4 | 4 | 16 | 0.60 | 20 |
| C-28† | 0.60 | C | Coal Brook | 6.7 | 5.4 | 4 | 2 | – | ? |
| C-29 | 0.07 | C | Coal Brook | Dry during all sampling periods | | | | | |
| C-29A† | 0.90 | C | Coal Brook | 4.4 | 4.1 | 16 | – | 0.10 | – |
| C-27† | 1.50 | C | Coal Brook | 6.2 | 5.6 | 6 | 3 | 0.15 | ? |
| C-26 | 2.17 | C | Coal Brook | Dry during all sampling periods | | | | | |
| C-25 | 2.34 | C | Coal Brook | Dry during all sampling periods | | | | | |
| C-24† | 2.47 | C | Ind. Waste | 6.7 | 6.7 | 9 | 35 | 0.85 | ? |
| L-23 | 21.27** | B,C&D | Laurel Run | 7.0 | 6.3 | 6 | 16 | 0.26 | 51 |

*(1) Drainage Area (where applicable).*

*(2) For Location of Sub-Area, see Figure 1, page 5.*

* *Single Reading.*

† *One or Two readings. Dry on other samplings.*

** *Including diversion from 7.5 Square Miles on the Main Stem of Mill Creek.*

Between M-2 and M-6A, there are no direct single point discharges of AMD into the stream. However, the Gardner Creek tributary upstream of G-7 contributes AMD polluted water to the main stem. When G-7 flows are less than 2,000 GPM, all AMD parameters are substantially higher in concentration than found in M-6 during the same period of sampling. During higher flow rates, there is little difference between the quality of water at M-6 and G-7.

Between M-6A and the limit of coal measures, there are several single point mine discharges that emanate from caved and abandoned underground coal mining operations. At M-16 and M-17, the discharges contain high AMD parameters and range from a trickle to 240 GPM. At M-15, the mine portal discharge is highly polluted with raw sewage from the septic systems of the adjacent, upslope Trailer Park. The 18 to 40 GPM discharge from the mine is apparently buffered by the sewage (see Appendix B).

The stream flow at M-14 reflects discharges emanating from abandoned strip and deep mining operations upslope of the Trailer Park. Leakage of clean water from the flume flows on the surface for a few hundred feet, percolates and is lost into the ground at loss point 11*, reappears in a strip pit, moves underground for a few hundred feet, again reappears as surface flow in a natural stream channel and subsequently is monitored at M-14. Although this water has been exposed to mining operations and acid bearing materials, the 2 to 530 GPM flow recorded to date is alkaline and contains only minor concentrations of AMD parameters. The low concentrations are attributed to the limited time and extent of contact with the acid bearing materials.

The flow at M-18 (250 to 857 GPM) represents the accumulation of numerous points of "clean" water leakage losses from the flume between F-20 and the Water Company diversion structures. Since this water loss is outside the coal measures, there is no apparent direct percolation of this water into deep mining operations and no contamination by acid bearing materials.

Upstream of M-19, a stream diversion structure diverts main stem flows as high as 6,297 GPM from Mill Creek into Laurel Run via the flume. On several occasions, the entire flow (979 GPM recorded 8/28/75) of the main stem was diverted into the flume and Laurel Run. Regulation of the slide gates at the diversion structure is made by the

* *see page 28*

Water Company at irregular and unrecorded intervals.

In addition to the flume diversion of Mill Creek water, the Water Company withdraws water from storage reservoirs for its water supply distribution systems. The approximate location of the main transmission lines and average daily withdrawal rates are shown in Figure 1, page 5.

Numerous discharges of raw sewage, ranging from 5 to 100+ GPM, were observed and recorded between M-4 and M-4A. The locations of these discharges are shown on Figure 3*and flow rates are tabulated on page 29. Between M-6 and M-6A, two small sewage treatment plants discharge 15 to 40 GPM of treated effluent. At the North end of the horse stable, upstream of M-6, a surface discharge of about 250 GPM was observed on one occasion. The stable discharge was cloudy and had a strong odor of urine. Three subsequent inspections to measure flow and collect samples were unsuccessful due to the absence of flow. The observed stable discharge is attributed to periodic stable cleaning operations.

The sanitary landfill operation South of M-4A and M-5 is in an abandoned strip mine area. No runoff, base flow or discharge of Leachates emanate from the landfill to the adjacent stream. Vapor clouds from exposed, fractured bedrock in the strip areas were observed in January and February 1975. Although these vapor clouds suggested an underground mine fire, no documentation of such a fire has been found to date. Water quality records for the Main Stem of Mill Creek are presented in Appendix B and summarized in TABLE III (page 36).

<u>GARDNER CREEK. TRIBUTARY:-</u> Virtually the entire sub-watershed of Gardner Creek is outside of the barrier pillar limits of the SouthEast Mine Pool Complex (see Figure 3)*. Consequently, surface water losses to the deep mines under this sub-watershed will not contribute to the AMD discharge at the South Wilkes-Barre Boreholes (S-3). The underlying mine pools are essentially isolated or contribute to the North-West Complex which has a discharge point at the Plainsville Borehole outlet (near BH-2) and at the Buttonwood Tunnel outlet (S-2).

Between G-8A and G-8, stream flow losses as high as 1,214 GPM have been recorded during medium and low flow periods, Part of this loss is attributed to a reported diversion (300 GPM for 40 hours per week)

* Site Map, page 11.

# TABLE III

MILL CREEK - MAIN STEM

SUMMARY OF WATER QUALITY RECORDS

| MONITORING STATION | | | SOURCE OF WATER | pH | | CONCENTRATION IN ppm | | | |
|---|---|---|---|---|---|---|---|---|---|
| NO. | D.A. IN SQ.MI. (1) | SUB AREA (2) | | FIELD TEST | LAB TEST | ACID | ALK | TOTAL IRON | SUL-FATE |
| M-19 | 0.46* | A | Main Stem | 6.2 | 6.3 | 4 | 15 | 0.14 | 26 |
| M-17 | NA | C | Seeps | 3.4 | 3.5 | 75 | - | 0.50 | 191 |
| M-16 | NA | C | Seeps | 4.1 | 4.1 | 25 | 3 | 0.16 | 102 |
| M-15 | NA | C | Seeps | 5.0 | 5.6 | 10 | 17 | 0.41 | 128 |
| M-14 | 0.24* | C | Side Stream | 6.2 | 6.5 | 1 | 18 | 0.23 | 23 |
| M-6A | 9.94* | C | Main Stem | 6.2 | 6.2 | 3 | 10 | 0.10 | 29 |
| M-6 | 10.19* | A,C&D | Main Stem | 6.3 | 6.3 | 3 | 10 | 0.15 | 24 |
| G-7 | 9.70* | A&C | Gardner Cr. | 3.9 | 3.9 | 39.3 | 0.5 | 2.40 | 76 |
| M-5 | NA | D | Seeps | 5.6 | 5.2 | 7 | 10 | 1.72 | 72 |
| M-4A | 20.60* | A,C&D | Main Stem | 5.1 | 4.8 | 14 | 5 | 0.91 | 52 |
| M-4 | 22.41 | A,C&D | Main Stem | 6.4 | 5.9 | 12 | 10 | 0.70 | 54 |
| M-3 | NA | D | Ind. Disc. | 6.6 | 5.9 | 6 | 10 | 0.40 | 54 |
| M-2 | 23.10* | A,C&D | Main Stem | 6.3 | 5.7 | 13 | 10 | 0.55 | 65 |
| L-23 | 21.27* | A thru D | Laurel Run | 7.0 | 6.3 | 6 | 16 | 0.26 | 51 |
| M-1 | 36.60 | A thru E | Main Stem Near Mouth | 6.9 | 6.3 | 5 | 11 | 1.47 | 35 |

*(1) Drainage Area (where applicable).*

*(2) For Location of Sub-Areas, see Figure 1, page 5.*

* *Accounting for diversion into Laurel Run from 7.5 Square Miles above the point of water diversion (Water Co. Flume).*

from an in-stream pond at G-8 to a coal reclaiming plant. The effluent from the plant operation is discharged through a steel casing directly into the deep mines. The lower Red Ash Coal is at el-evation 550' - 575' in this area or about 150 to 175 feet below the ground surface. The owner of the plant (Kassa) has a water withdrawal permit and an industrial waste permit (No. 16419) from DER.

Between G-8 and G-9A, stream flow losses were about 1,200 GPM during medium to high flow periods. The combined losses between a-8A and G-9A are believed to be in a stream stretch of about 1,000 feet upstream and 1,000' downstream of G-8. Geologic maps indicate that the stream passes over the coal measures in this 2,000' stretch. Detailed reconnaissance of the stream shore line did not reveal any single point losses of stream flow.

Stream flow losses of 161 to 986 GPM between G-9 and G-9A have been recorded on 3 of 6 occasions. Mine maps* show that this stretch of stream channel is not underlain by coal measures. However, the stream is essentially along the axis of an anticline, such that the lower Red Ash coal seam drops 50 to 250 feet below creek level on the South and North limbs of this anticline. Consequently, the recorded stream flow losses are attributed to a depressed groundwater table caused by lower mine pool levels in the abandoned deep mines North and South of this stream bed.

The tributary stream channel from Ridgewood past station G-7A to Keystone, has no base flow. Monthly inspections of the area revealed that surface runoff never reaches station G-7A. All surface water and runoff in this tributary watershed is trapped in strip mines and percolates into the deep mine operations. Even during the heavy precipitation and runoff in February $_{1975,}$ no flow was observed at G-7A. Some restoration of the strip mine and waste piles is being made near G-7A for residential use by private interests.

Reconnaissance revealed a surface runoff loss point in a small strip pit (30' x 300' x 20' deep) Northeast of the village of Keystone. At the low point of this old abandoned mine (strip), there is a caved opening (24" x 36") into the deep mines. The cool air coming from this opening; a fresh, deeply eroded ditch; sand and gravel deposits in the area; and no outlet channel, indicate that all of the high runoff from the contributing drainage area is lost to the

* M.J. Bergen, et al; 1963 Report to U.S. Army Corps of Engineers

deep mines at this location. About 500' downslope of this pit, several small seeps (1 to 5 GPM) and high iron staining indicate a limited perched mine pool with mine water discharges at the outcrop line of the lowest mined coal seam. Larger discharges are anticipated shortly after periods of high precipitation.

Highly acid seepage into Gardner Creek emanates from the breaker waste pile and from the embankment of an acid water pond immediately upstream of G-8A. Although there is no large, single point acid discharge, Gardner Creek is severely degraded in this stream stretch as indicated by comparing test data on water samples from G-8 and G-8A. Deposits of "yellowboy" in the 500' stretch of the stream adjacent to the acid seeps and downstream, are visible evidence of this degradation.

The existence of black coal silt sediment in the stream channel downstream of G-8, suggests the possible discharge of process water, accidental spills, or runoff from stock piles and waste piles at and downstream of the Kassa breaker operation. However, no discharges or runoff from these areas has been observed or recorded to date.

Several discharges of raw sewage into Gardner Creek from private residences ranging from 1 to 10 GPM were observed and recorded in the community of Laflin, upstream and downstream of G-8 (see Figure 3)*.

At G-11 and upstream of G-12 on Lamp Black Creek, discharges of treated industrial waste ranging from 15 to 360 GPM were observed and recorded (see Figure 3)*. Special laboratory tests on samples of these discharges did not reveal any significant amounts of contaminants. Local residents reported an increased discharge rate and strong "chemical" (?) odor at G-11 during late night hours.

Active stone quarries are operating northeast of Ridgewood (upstream of G-7) and South of Old Boston (upstream of G-12). There was no evidence of process water discharging directly from the quarry operations into the adjacent streams. Both operations had sediment detention facilities. Water quality records for Gardner Creek are presented in Appendix B and summarized in TABLE IV (page 39).

OTHER MAJOR PROBLEMS IN THE STUDY AREA.

SUBSIDENCE:- Subsidence caused by caving of abandoned deep mines is a serious problem in the study area. In addition to causing major property damage and discouraging development, subsidence can aggra* Also see Sewage Discharge Data, page 29.

## TABLE IV

### GARDNER CREEK

### SUMMARY OF WATER QUALITY RECORDS

| MONITORING STATION NO. | D.A. IN SQ.MI. (1) | SUB AREA (2) | SOURCE OF WATER | pH FIELD TEST | pH LAB TEST | CONCENTRATION IN ppm ACID | ALK | TOTAL IRON | SUL-FATE |
|---|---|---|---|---|---|---|---|---|---|
| G-12 | 1.28 | A | Lampblack Cr. | 6.1 | 6.4 | 2.6 | 17.3 | 0.4 | 47 |
| G-13 | 4.28 | A | Gardner Cr. | 6.4 | 6.5 | 2.6 | 15.9 | 0.2 | 27 |
| G-11 | 0.09 | A | Side Creek Ind. Waste | 5.5 | 5.9 | 8.3 | 8.1 | 1.1 | 30 |
| G-10 | 0.85 | A&C | Side Creek | 4.5 | 4.2 | 20.3 | 3.0 | 0.2 | 82 |
| G-9 | 6.78 | A | Gardner Cr. | 5.8 | 6.2 | 4.0 | 12.7 | 0.4 | 41 |
| G-8 | 8.40 | A&C | Gardner Cr. | 5.8 | 6.1 | 8.8 | 11.6 | 0.2 | 59 |
| G-8A | 8.78 | A&C | Gardner Cr. | 4.3 | 4.4 | 140 | 5.2 | 23.6 | 195 |
| (G-8A)* | 8.78 | (A&C) | Low Flow Only | (3.0) | (3.1) | (558) | - | (87.7) | (545) |
| (G-8A) | 8.78 | (A&C) | Ex. Low Flow | (4.7) | (4.8) | 15.8 | (6.7) | (1.3) | (90) |
| G-7 | 9.70 | A&C | Gardner Cr. | 3.9 | 3.9 | 39.3 | 0.5 | 2.4 | 76 |

*(1) Drainage Area (where applicable).*

*(2) For Location of Sub-Areas, see Figure 1, page 5.*

** Low flow periods only when seeps from the Acid Pond and the Waste Bank are major contributors to stream flow, see Figure 3, page 11.*

vate AMD problems by creating areas of high surface water infiltration. Concurrent with this study, others* have been conducting studies related to subsidence and the possibility of correlating mine pool fluctuations with subsidence. Since one method of AMD abatement is to lower the present mine pool elevations, the relationship and possible effect of such lowering on subsidence potential has been evaluated and reported in these other studies*. FLOODING:- Despite surface water losses from streambeds and strip mined areas, some urban sections at the lower portion of the area are subject to flooding. Records indicate that flooding occurred in 1924, 1933, 1950, 1955, 1958, 1972 and 1975. As a. result of the 1955 flood damages (Hurricane Diane), a survey was conducted by the former Pennsylvania Department of Forests and Waters to assess flood damages and to propose remedial measures. DER has recently completed design of a flood control project for Spring Run in the Solomon Creek Area.

Extensive reclamation of abandoned mine waste piles and strip mines has been undertaken in recent years. The approximate limits and locations of the reclaimed areas are shown in Figure 3. Although such reclamation will reduce AMD related problems, it is expected to increase runoff and flood potential in the study area watersheds. Approximately 300 acres of reclamation, paving and buildings for the Wyoming Valley shopping center and adjacent apartment development has increased runoff and flood potential in Coal Brook, North of Route 309. Approximately 200 acres of reclamation in the Parsons area for a residential development will increase runoff and flood potential in Laurel Run, downstream of the Delaware and Hudson Railroad. Recently constructed drains (5' and 7' diameter) collect storm runoff from this area and discharge into Laurel Run between stations L-23B and L-23C. Approximately 225 acres of reclamation, paving and buildings for a Race Track and its stable and on-going reclamation with future development of the sanitary landfill (approximately 140 acres) will increase runoff and flood potential along the main stem of Mill Creek in the Miners Mill area. Approximately 160 acres of reclamation for a housing development East of Laflin is located on a rounded hilltop. Although runoff will be increased by the buildings, grading and paving in this area, the increased runoff flow will be distributed in

** H.R.B. Singer; A.W. Martin*

all directions and no downstream flooding problems are expected due to reclamation of this strip tined area.

The anticipated increase in runoff due to future reclamation of mine waste piles and strip mines will require compensating measures to minimize or prevent additional flooding damages. Such compensation can be achieved by constructing flood control measures such as storm retention ponds and channel improvements in the areas where flood potential has been increased.

MINE FIRES: Preliminary reconnaissance in January and February, 1975 revealed indications of a mine fire at the East end of the sanitary land fill South of M-5. Melted snow areas combined with steam clouds and a sulfurous odor emanating from open fractures in exposed bedrock and from breaker waste piles, suggested a mine fire source for the observed conditions. However, no documented data has been obtained to date to support these field indications of a deep mine fire and/or a mine waste fire.

SEWAGE: Discharges of water with odor, solid matter and milky visual characteristics of raw sewage were found at numerous locations within the watershed tributaries. Reduction in acid concentration and increase in alkalinity downstream of several of these discharges is attributed to the raw sewage. Although the eventual elimination of raw sewage will reduce organic pollution, it may cause an increase in present levels of acidity in Mill Creek and its tributary streams.

The locations of observed and recorded discharges of raw sewage are shown in Figure 3. Flow data relating to sewage are presented on the tabulation on page 29.

LAND USE: Mining activities in the past has degraded the general environmental quality and has placed severe land use restrictions on portions of the study area. Waste dumps where vegetation is very limited and scarified topography caused by strip mining are generally considered less than desirable landscapes. In the past, the extensive, steeply sloped surfaces associated with the waste dumps and stripped areas limited economical development of these land areas for residential, industrial or commercial purposes. However, in recent years, it has been economically profitable for private industry to level off several of these areas and undertake land improvements. Consequently, it may be possible to combine marginal area development projects with AMD abatement projects. The multi-purpose benefits that can be derived should stimulate local interests to actively participate in future reclamation of these waste areas.

Information gathered to date indicates that local Housing and Development Authorities are actively looking for project sites that can be economically reclaimed for residential, commercial or industrial development.

Due to the past and present mining activities, land suitable for recreation purposes is limited to the upstream parts of Mill Creek and its tributaries. These areas, located upstream of the limit of the coal measures, are wooded and unpolluted. Most of these "clean", upstream watershed areas are presently allocated to public water supply purposes. Nevertheless, multi-purpose reservoirs can be constructed to detain storm runoff, for AMD abatement, flood control and to provide storage and/or redistribution of watershed yields for water supply purposes. They can also provide water oriented recreational facilities. The need for all of these multi-purpose uses has been expressed by State Agencies, by local water companies, and by Local and Regional Planning Authorities, Commissions and Agencies.

The. foregoing problems and their relationship to AMD abatement, strongly suggests the desirability of multi-purpose projects for the study area. Such mufti-purpose projects could justify AMD abatement measures that would be prohibitive in cost as single-purpose projects.