PHASE IV

CONSTRUCTION MINE DRAINAGE ABATEMENT SYSTEM

<u>General</u>

Construction of the mine drainage abatement system for the Ernest Mine Complex, as described herein, began on December 29, 1970, and continued through August 1971. The general contractor was M. F. Fetterolf Coal Company, Boswell, Pennsylvania. Subcontractors and suppliers engaged by the general contractor were as follows:

1. Pennsylvania Drilling Company, Pittsburgh, Pennsylvania, (Drilled core borings and installed piezometers.)

2. William Woods Drilling Company, Indiana, Pennsylvania. (Drilled core borings and installed piezometers.)

3. A. J. Spory, Boswell, Pennsylvania (Performed reinforced concrete construction.)

4. Halliburton Company, Indiana, Pennsylvania. (Sealed E-4 boreholes.)

5. A. F. Moreau & Sons, Inc., Indiana, Pennsylvania. (Concrete supplier and conducted concrete strength tests.)

6. Sands Survey, Inc., Indiana, Pennsylvania.

(Performed calipering of boreholes.)

7. Sears-Roebuck Company, Johnstown, Pennsylvania. (Furnished and installed cyclone fence atop the Cummings Shaft.)

E. D'Appolonia Consulting Engineers, Inc., (EDCE) provided construction inspection for all phases of the work on an "as-needed" basis. Additional inspection was provided by personnel from the Department of Environmental Resources, Office of Engineering and Construction, Ebensburg, Pennsylvania.

Copies of the daily diary maintained by EDCE are presented in Appendix D. Progress reports summarizing the monthly construction activities for the project are included in Appendix E. Design drawings presenting as-built conditions are also enclosed.

A brief summary of the conditions encountered at each work area and the resulting construction is presented below. Details of the construction activities and as-built conditions are incorporated on the design drawings and in the daily diary and progress reports.

Material quantities and Costs

The estimated quantities and scope of work outlined prior to construction are described in the Technical Specifications (Appendix C). However, as subsequently discussed, several changes in the "Scope of Work" were required during construction to facilitate the actual field conditions. The revised quantities and costs incurred for all work areas are described in Appendix F. A summary of the total costs for each work area, comparing estimated and actual costs, is presented in Table I. Any additional work items or costs incurred subsequent to August 1971 are not presented.

Concrete Compressive Strength Tests

Table II presents results of the concrete compressive strength tests for all test cylinders obtained on the project. The concrete mix design for the specified 3000 psi concrete strength at 28 days is presented in Appendix G. The results of the concrete strength tests are significantly higher than required by the Specifications and, therefore, were acceptable.

Work Area Descriptions

Cummings Shaft (Drawing 70-108-MI0): The extension of the Cummings Shaft walls was essentially completed as originally proposed. The method of construction, however, was varied due to the actual condition of the shaft walls and the subsurface conditions.

Dewatering the shaft was initially accomplished by lowering the elevation of the drainage channel between the front wall of the shaft and Cummings Run Creek. The unsuitable portions of the existing concrete walls were removed during dewatering. It became evident as the water level was lowered that the shaft walls were not as sound as expected. The shaft front wall had been apparently opened with explosives to lower the discharge invert to El. 1061, and the blast had extensively cracked the front and side walls. The wall was un-reinforced and cracking extended to an old construction joint approximately eleven feet below the top of wall.

To control drainage from the shaft, the water was temporarily diverted through an 18-inch steel pipe. The new wall was constructed around the temporary diversion pipe and a cutoff collar welded inside and outside the pipe to eliminate seepage along the concrete and steel pipe interface. After the new wall was completed, and the permanent stainless steel pipe and valve installed at El. 1061, the temporary pipe was filled with non-shrinking grout.

The plans originally specified that the new wall was to be placed three feet into competent rock. Excavation revealed that the area adjacent to the wall had been backfilled, and competent rock was not present at the proposed depth. Therefore, it was decided to place the bottom of the new wall on undisturbed earth, approximately three feet below the old wall construction joint.

The new wall was constructed in three vertical lifts, with each lift approximately five feet high. A 6-inch pvc water stop was placed in each construction joint between lifts and the reinforcing extended through the joints. The new wall was joined to the old wall by grouting No. 4 steel reinforcing dowels into the old wall.

The outlet pipe was a 12-inch diameter stainless steel pipe (invert El. 1061.57) and stainless steel valve. A weatherized timber housing was constructed around the valve and pipe. A five-foot high chain-link fence with a gate was installed atop the new wall. All concrete surfaces exposed to acid mine water were covered with an acid-resistant coating (trade name DURA-KOTE). The channel bottom was raised in elevation to provide a uniform slope between the stainless steel valve and Cummings Run Creek. As additional protection for overflow, a four-foot wide by six-inch deep weir was formed in the top of the new wall above the outlet pipe.

An old foundation, apparently used to support a machinery hoist, was discovered adjacent to the back wall of Cummings Shaft. Since no evidence of a hydraulic connection between the foundation and the underlying mine workings was found, the foundation was backfilled.

<u>E-1 Entry (Drawing 70-108-Mil):</u> The concrete barrier at E-1 was constructed as proposed with the exception that the barrier was embedded into the mine wall to a depth of one foot instead of two feet as originally planned. This provides minimum disturbance to the mine wall and does not jeopardize the seal since the maximum water level at E-1 will be less than three feet.

The original design specified removal of air seal(s) inside the mine to permit mine water to flow from Cummings to the E-1 entry. To establish the necessity of this work, at the suggestion of the Department of Environmental Resources personnel, a simple test was performed. When Cummings Shaft construction was completed, the valve was closed and the water level permitted to rise. When the water level in Cummings Shaft reached El. 1066, the approximate elevation of E-1, mine water began to flow from E-l. Opening the valve at Cummings Shaft lowered the water level in the shaft and also stopped the flow from E-1. This test showed the existence of a direct hydraulic path between Cummings and E-1 and, therefore, no work was required inside the mine to remove the air seals and barriers shown on the mine maps.

E-1 and E-2 Transfer Pipe (Drawing 70-108-M13): The 18-inch spiralwelded steel water transfer pipe between the E-1 and E-2 openings was installed as designed. The crossing for the pipe over McKee Run was changed to facilitate the construction. The pipe was supported as specified, but the insulating box was made larger and constructed of heavier material. Additional moistureproofing and insulation were also provided.

The only change in the specified (0.6 percent slope) pipe grade was near the E-2 entry. The pipe grade was slightly raised to pass over an existing 8-inch diameter pipe. Two "wye branches" were installed back-to-back and approximately 100 feet from the E-2 entry, to serve as access to the pipe for cleaning. The steel pipe extends 75 feet into the E-2 mine entry.

E-2 Entries (Drawing 70-108-M12): The barrier for the E-2 mine entry was changed completely from the proposed design. The roof of the E-2 entry was collapsing, and it was necessary to excavate the collapsed area. Further investigation suggested that the pool of water at the E-2 entry was part of a large pool of water existing in the mine and dewatering in the area was impractical. Therefore, it was decided that an earth seal would be more effective and easier to install. Also, two lateral drifts near E-2 required sealing to isolate the pooled water from the entries.

The mine entry was dewatered by constructing a temporary earth dike inside the collapsed portion of the entry. The water was pumped from the area between the entry and the temporary dike and the wet material removed. A compacted cohesive soil seal was placed in the dry area and hand tamped around the 18-inch diameter steel pipe. The remainder of the fill outside the opening was compacted with a sheeps foot roller. The collapsed portion was similarly filled and compacted.

The two drifts adjoining E-2, designated E-2A and E-2B, were similarly sealed with compacted clay plugs. As with the E-2 openings, a temporary earth dike was used to retain the mine water while the walls and floor of the drift were dewatered and cleaned. The excavated area was backfilled with clay compacted in one-foot layers using a sheeps foot roller.

E-3 Entries (Drawing 70-108-M14): The barrier at the E-3 opening was constructed as specified. The original walls of the opening were reinforced and, therefore, the embedment of the concrete in the old wall was limited to three inches. Since the water depth adjacent to the barrier will be less than two feet, the three-inch embedment was considered sufficient to retard seepage of water between the entry wall and barrier.

The seal of the collapsed opening at E-3 was completely changed. The original plans called for a concrete wall embedded into bedrock. No bedrock could be found within a distance of 75 feet into the mine from the original opening. Therefore, it was decided to eliminate the concrete seal and compact an earth seal in the 75-foot long excavation. The area was backfilled and graded to the original contours.

Borehole DDH-44 in Creekside: The borehole DDH-44 in Creekside was not found during the exploratory investigation. The location map shown on the plans

(Drawing 70-108-M9) was incorrectly interpreted, and the exploratory excavation was conducted 250 feet southwest of the specified location. However, no overflow should occur since the ground surface elevation is about El. 1078 or 28 feet above the E-3 discharge elevation. Piezometer No. P-6 was installed to monitor the water level in the vicinity of DDH-44.

An abandoned water well near DDH-44 that extends into the mine void was brought to our attention during the construction work. The well is in the driveway of a private residence, and reportedly was improperly sealed (ground surface is approximately El. 1078). This area was monitored as a possible location for seepage of mine water.

<u>Crooked Creek Boreholes:</u> 'The borehole at Crooked Creek was cleaned and calipered prior to sealing. The bottom of the borehole was plugged with a burlap wrapped log and the borehole void filled with 2:1 water-cement grout. A grout cap, 18 inches square and 12 inches deep, was placed on top of the sealed borehole.

The sealing and valve installation of the E-4 boreholes caused the pool elevation throughout the mine complex to raise approximately five feet (to El. 1021). As a result of this water level rise, mine water was observed flowing from a second borehole located approximately 30 feet from the sealed Crooked Creek borehole. The mine maps did not show more than one borehole in this area. The borehole was also cleaned, calipered and sealed.

<u>E-4 Boreholes (Drawing 70108-M15):</u> The E-4 boreholes were plugged and valved essentially as specified. The contractor graded and filled the area around the boreholes and cleaned and calipered the holes prior to sealing. Borehole No. 3, which had not been positively located prior to construction, was uncovered and subsequently plugged with a burlap wrapped log and grouted with a 2:1 water-cement grout.

The remaining three boreholes were sealed with packers and valves as specified on the Drawings, The contractor retained Halliburton Services, Inc., from Indiana, Pennsylvania, to perform the grouting work.

The protective housing for the valves was constructed of two-inch pine stock and placed on a six-inch thick reinforced concrete pad; each valve was insulated with four inches of foamed polystyrene placed inside the box around the valve.

The portion of the stream bed below the protective housing was covered with waste concrete and broken rock for erosion protection during periods when the valves are open and discharging water.

Fulton Shafts (Drawing 70-108-M16): The two air shafts at Fulton Run were sealed in January and February 1971. Exploratory excavation was conducted at each shaft to determine the location of bedrock and groundwater and to determine the integrity of the shaft walls. A third shaft, believed to be located in the same area, was not found.

At Fulton A, the excavation on the outside of the shaft wall was made to a depth of 24 feet. No unweathered bedrock was encountered, and the shaft walls were removed to a depth of twelve feet below original ground surface. A concrete cap was placed above the groundwater level to a depth of ten feet. The interior of the shaft was filled with mine rubble which was adequate to support the concrete cap during curing, and steel decking was not required. The concrete cap was placed as designed, and a two-foot layer of clay was compacted over the concrete as additional sealing.

The Fulton B shaft was a timber-lined shaft, filled with mine rubble. The shaft was excavated approximately ten feet, and a concrete cap placed on the shaft walls. A two-foot layer of compacted clay was placed above the concrete, and the remainder of the excavation filled and compacted with the excavated materials.

Two eight-inch diameter boreholes into the mine were discovered near the Fulton B Shaft. Both boreholes had a six-inch diameter casing inside an eight-inch casing. One borehole was plugged with rubble and the other open to the mine. To seal the boreholes, the contractor used a percussion-type drilling rig. Both boreholes were cleaned, and the six-inch casing removed from each hole. The eight-inch casing in the borehole nearer Fulton B Shaft (Borehole No. 1) was driven into the mine void and could not be recovered. A plug consisting of a burlap-wrapped log was driven into the bottom of each hole and the boreholes were grouted to the surface with a 2:1 water-cement grout. A grout cap was placed above each borehole, and the entire area backfilled and graded.

A ten-inch diameter pipe was found near the Fulton A Shaft. Exploratory excavation indicated that the pipe runs horizontally under an adjacent building floor. There was no evidence of seepage noted during the monitoring program to suggest the pipe was connected to the mine.

<u>Piezometer Installation (Drawing 70-108-M16):</u> Piezometers were installed at the locations shown on Drawings 70-108-M2 and M3 to monitor the pool elevation in the mine. An NX core boring was drilled as part of the installation for the piezometers. Each boring was logged and pressure tests conducted to evaluate the competency and hardness of the overburden materials above the abandoned mine workings. Complete descriptions of the materials encountered in the borings and the rock permeabilities as determined from the pressure tests are presented on Drawings 70-108-M6 through M8. Table III summarizes the installation details for each piezometer.

Piezometers planned for Cummings and E-I were not installed. A boring was drilled adjacent to Cummings Shaft but did not encounter the mine void. Since the Cummings Shaft serves as an open piezometer and the boring furnished all required data regarding the overburden characteristics, a second boring was not necessary. Therefore, the Cummings Shaft was used as Piezometer P-1 for the piezometer monitoring program.

The piezometer at the E-1 entry (P-2) was eliminated because the water level could be easily observed at the entry and the rock overburden in the area was of little concern since no hydrostatic seals (or seal) were proposed in this area. Piezometer Borehole No. P-8 at E-4 was core drilled and pressure tested but did not encounter the mine void. A piezometer was not installed and the hole was grouted. Piezometer Borehole No. P-9, located within 50 feet of P-8, was drilled without coring, since information of the overburden materials had been obtained in the P-8 Borehole. The mine void was encountered in the P-9 Borehole and a piezometer was installed. The remaining piezometers were installed in accordance with the drawings at Fulton A, Fulton B, Crooked Creek, DDH-44, E-2, E-3(2) and E-4.

The piezometers have steel pipe housings and are protected from freezing with insulation around the pipe, and a six-inch foamed polystyrene plug above the valve. The piezometers are one-inch pvc plastic pipe with a stainless steel well screen placed in the mine void immediately above the mine roof. A concrete basket located above the well screen was used to support the grout placed around the pvc pipe to ground surface. The piezometers under pressure were equipped with a pvc valve to permit attachment of a pressure gauge for measuring the pressure head.

The piezometers installed at the treatment plant site are discussed in detail in the next section of this report.